Pentland Firth and Orkney Waters Enabling Actions Report

Strategic Area Navigation Appraisal (SANAP)





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Revision Number	Date	Summary of Change
00	9 Aug 2013	Initial Draft.
01	3 Sep 2013	Updated with TCE Comments.
02	13 Sep 2013	Updated with TCE Comments.
03	17 Jan 2014	Updated with Consultation/TCE Comments.
04	28 Feb 2014	Finalised Version.

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Abbreviations

AfL	-	Agreement for Lease
AIS	-	Automatic Identification System
ALARP	-	As Low As Reasonably Practicable
CCTV	-	Closed Circuit Television
DECC	-	Department of Energy and Climate Change
EIA	-	Environmental Impact Assessment
EMEC	-	European Marine Energy Centre
ERCoP	-	Emergency Response Co-operation Plan
GLA	-	General Lighthouse Authority
HDD	-	Horizontal Directional Drilling
IALA	-	International Association of Marine Aids to Navigation and Lighthouse Authorities
IHO	-	International Hydrographic Organization
IMO	-	International Maritime Organization
LNG	-	Liquefied Natural Gas
MCA	-	Maritime and Coastguard Agency
MOD	-	Ministry of Defence
MRCC	-	Maritime Rescue Co-ordination Centre
MS	-	Marine Scotland
NLB	-	Northern Lighthouse Board
nm	-	Nautical Mile
NM	-	Notices to Mariners
NRA	-	Navigational Risk Assessment
OFA	-	Orkney Fisheries Association
OFS	-	Orkney Fishermen’s Society
OREI	-	Offshore Renewable Energy Installation
PFOW	-	Pentland Firth and Orkney waters
SCADA	-	Supervisory Control and Data Acquisition
SCFF	-	Scottish Creel Fishermen's Federation
SFF	-	Scottish Fishermen’s Federation
SPFA	-	Scottish Pelagic Fishermen's Association Limited
SWATH	-	Small Waterplane Area Twin Hull
SWFPA	-	Scottish White Fish Producers Association
UKC	-	Under Keel Clearance
UKHO	-	United Kingdom Hydrographic Office
UN	-	United Nations
VHF	-	Very High Frequency

Glossary

Term	Definition
Allision	The act of striking or collision of a moving vessel against a stationary object.
Area to be Avoided	A routeing measure compromising an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or certain classes of ship.
Automatic Identification System (AIS)	Automatic Identification System. A system by which vessels automatically broadcast their identity, key statistics e.g. length, brief navigation details e.g. location, destination, speed and current status e.g. survey. Most commercial vessels and EU fishing vessels over 15m are required to have AIS.
Collision	The act or process of colliding (crashing) between two moving objects.
Cumulative	The effects arising from similar development projects (e.g. cumulative impacts from two or more wave energy projects).
Design Freeze	The end point of the design phase, at which the design of the technology is fix, so as to allow the production phase to begin.
Give-way Vessel	A vessel which under the Convention on the International Regulations for Preventing Collisions at Sea (1972) is obligated to keep out of the way of another vessel, when acting in accordance with the rules of the convention.
In-combination	The effects arising between different types of development project (e.g. impacts from a wave energy project in-combination with impacts from a port development).
Marine Guidance Note	A system of guidance notes issued by the Maritime and Coastguard Agency which provide significant advice relating to the improvement of the safety of shipping and of life at sea, and to prevent or minimise pollution from shipping.
Navigational Risk Assessment (NRA)	Study which must be undertaken as part of an offshore developer's Environmental Statement which addresses marine navigational safety risks.
Offshore Renewable Energy Installations (OREI)	These include offshore wind farms, marine current turbines, wave generators and any other installation, with the potential to affect marine navigation and safety.
Radar	Radio Detection And Ranging - an object-detection system which

	uses radio waves to determine the range, altitude, direction, or speed of objects.
Rochdale Envelope	This provides the basis upon which a project can be described by a series of maximum extents - the ‘worst case’ scenario - allowing the detailed design of the scheme to vary within this ‘envelope’ without invalidating the corresponding Environmental Impact Assessment.

1. Executive Summary

1.1 Introduction

This Discussion Paper is intended to support and inform the Navigational Risk Assessment (NRA) work of developers of wave and tidal stream energy projects in the Pentland Firth and Orkney waters (PFOW) area.

This report has been published by The Crown Estate as part of their enabling work to support development of the Pentland Firth and Orkney Waters (PFOW) wave and tidal projects. This work aims to accelerate and de-risk the development process, looking at a range of key issues. Work is selected, commissioned and steered by The Crown Estate in close discussion with the project developers. For more information on The Crown Estate's work in wave and tidal energy, see: http://www.thecrownestate.co.uk/energy/wave-and-tidal or contact waveandtidal@thecrownestate.co.uk

This Paper has been produced with the contributions and assistance of both the marine and energy sector regulators and advisors, and the companies involved in developing wave and tidal stream projects in PFOW. The paper considers the currently available information on the development projects, the locations of the Agreement for Lease (AfL) areas and marine traffic recorded within the areas that make up the wider PFOW Strategic Area. This has allowed a strategic appraisal of the potential, alone and in-combination/cumulative, impacts on shipping and navigation to be made.

Analysis of the vessels operating within the PFOW Strategic Area has been performed using the data available for the PFOW Strategic area. It clearly details the known routes used by both transiting and local traffic, highlighting the areas of high density traffic and variation due to weather, tides and seasonal changes. Traffic associated with the regular ferry services that run to/from Orkney Mainland and the services that operate between the islands are clearly identified, as are the transiting traffic routes past the islands within the wider strategic area. Areas of highest traffic density and current pinch points, like the transiting vessels passing through Pentland Firth, are identified as well as that of the crossing traffic and its interaction with other routes. The report also considers the influence of weather and tide has on routeing or vessels.

This naturally leads into a high-level, strategic marine traffic analysis for each of the PFOW AfL areas, identifying the amount of traffic present and the vessels operating within and near to these developments. Both of these analyses enable a better understanding of the movement of merchant shipping vessels, fishing vessels and recreational vessels. This emphasises the types of vessel and behaviour exhibited while transiting or operating in proximity to the AfL areas and makes it possible to further analyse the possible impacts associated with safety and navigation.

The assessment of potential impacts identifies the typical impacts that are associated with navigation safety grouped under the topics of traffic, navigation, design, proximity and resources. The study is continued with an appraisal of the potential cumulative impacts associated with the focused development of the twelve wave and tidal projects within PFOW. Developments are analysed under four geographical groups, namely:

- Pentland Firth (four sites in proximity to the Pentland Firth);
- West of Orkney (five sites based along the coast and offshore of the west of Orkney Mainland);
- North East of Orkney Mainland (two sites to the north east of mainland Orkney beside the island of Eday); and
- Farr Point (one site distanced from all others).

The assessment highlights the likely cumulative impacts within these development groups. This is summarised within Appendix D, where it is possible to understand the commonality of many of the impacts, even if the degree and severity do vary.

The mitigation review explores currently available guidance and best practice for the industry. This has benefited from other marine sectors, where methods have been developed for shipping or offshore wind installations previously. It details the standard methods most suitable for reducing the risks presented to marine receptors and highlights the large number of standard mitigation measures which, where relevant and necessary, could be utilised to avoid/reduce potential impacts.

The Paper also proposes an approach to the marking and charting of the development projects. Various options are outlined, and those already in place at the established test sites at EMEC's Billia Croo and Fall of Warness are detailed. The particulars of the IALA recommendations, used by the Northern Lighthouse Board, are provided and reviewed in the context of the strategic area.

The Paper finds that there is merit in considering potential further work on this subject. Developing further communication channels between regulators/advisors, developers and stakeholders would assist with ensuring that the development sites are progressed and preserving navigational safety. This could be progressed via, for example, a specific group or forum involving the PFOW developers and those who have a role and interest in promoting safety and navigation in PFOW. A stakeholder workshop, where the issues of this Discussion Paper can be openly discussed and further informed, may also be worthwhile progressing.

In addition to supporting developers' individual NRA requirements, this Discussion Paper is intended to provide stakeholders with a better understanding of the development projects and the potential impacts (alone and cumulatively) on shipping and navigation. It is expected that this will enable the key risks/challenges and available mitigation measures to be better understood and discussed. It is hoped that this Paper therefore assists the developers and all shipping and navigation related stakeholders involved.

2. Discussion Paper

2.1 Background

With plans for the phased deployment of commercial wave and tidal stream arrays at various locations around Orkney and Caithness, there is the potential for (cumulative and in-combination) impacts on shipping and navigational safety. Due to this, The Crown Estate, the Northern Lighthouse Board (NLB), the Maritime and Coastguard Agency (MCA), Marine Scotland and the Pentland Firth and Orkney waters (PFOW) developers have identified the potential benefits of approaching the risks at a strategic level.

Focussing on the development of the first arrays, this Project (the ‘Project’) will progress a strategic approach by bringing together the developers and key shipping and navigation stakeholders in PFOW. This will enable the relevant stakeholders to openly discuss the key risks/challenges of deploying the first wave and tidal arrays in PFOW and will result in the production of a short PFOW focused guidance statement/report identifying the key risks, potential mitigation measures and ways forward with respect to continued engagement and information sharing.

To develop the project, the NLB, the MCA, Marine Scotland and The Crown Estate formed a working group (the ‘Working Group’). Through this, the group progressed the initial idea and subsequently developed the Project.

Anatec, in collaboration with Xodus, has been commissioned by The Crown Estate to complete the PFOW ‘Strategic Area Navigation Appraisal’ (SANAP) project. The project is intended to support and inform developers in undertaking their Navigational Risk Assessments (NRA) for offshore tidal and wave renewable energy schemes. There are currently twelve wave and tidal projects within the strategic area, many of which will either naturally cause or encounter similar impacts to navigation. This paper will inform their planning and execution of mitigating these known impacts, identifying hazards and reducing potential risks.

The SANAP is not intended to be a project specific assessment of navigational risk and will not replace the developer’s commitment to produce an NRA for their project. It will instead support and inform the developers in the development process and in undertaking their NRA. The report aims to achieve this by engaging with key stakeholders and encouraging the exchange of information, so as to collaboratively identify risks to navigation and safety. It will also examine solutions to these issues, particularly those with the potential to cause cumulative and in-combination effects.

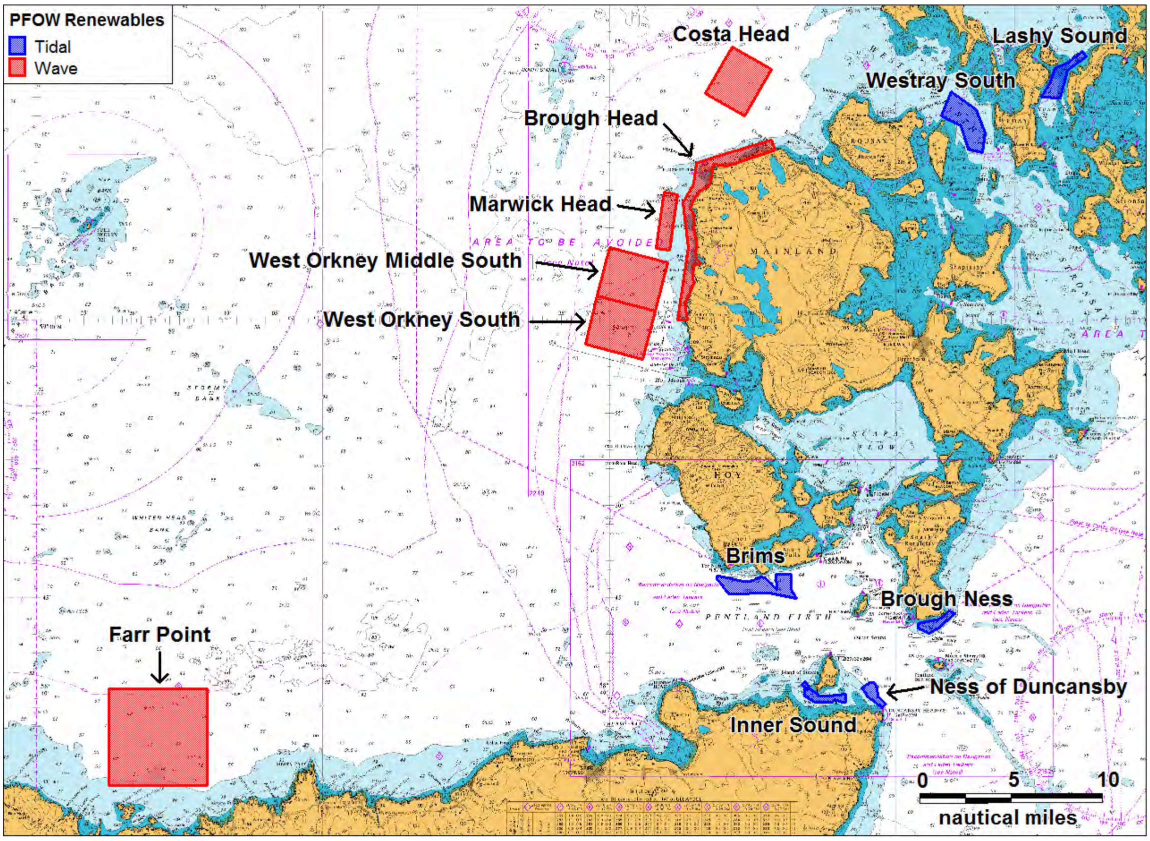


Figure 2-1 Wave and Tidal Projects within Pentland Firth and Orkney Waters

2.1.1 Objectives

The stated objectives of the Project are:

- To enable key stakeholders to exchange information on developments currently under consideration and the potential impacts (construction and operation) of the development projects on shipping and navigational safety (alone and cumulatively/in-combination).
- To facilitate discussion concerning the maximisation of wave and tidal development opportunities in PFOW, without significant impact on navigation interests and/or safety.
- To identify a standardised approach to marking and charting requirements in PFOW.
- To develop two way communication between developers and stakeholders.

2.1.2 Outcomes

The following section identifies the outcomes of this paper:

- Identify any potentially significant impacts on shipping and navigational risk from the construction and operation of each of the wave and tidal projects in PFOW (Section 5.2).

- Identify which of the potentially significant impacts have the potential to be cumulative (Section 5.3).

- Identify potential development constraints and recommendations for appropriate mitigation measures/an approach to addressing them (Section 6).

- Recommend a standardised approach to marking and charting requirements in PFOW (Section 6.6.5 and 11).

- Develop an agreed process for communication between developers and stakeholders (Section 7).

2.2 Appraisal Methodology

To fulfil the objectives, the first part of the project is the production of this Discussion Paper. Following that, given the large number of stakeholders relevant to the issues being explored, the project may lead to the holding of a stakeholder workshop.

Should a workshop be progressed, the intention is that this Discussion Paper informs the focus of discussions. Following any such workshop, producing a final report may be useful.

The key steps related to the production of this Discussion Paper include:

Step One – Kick-off meeting with the Working Group
Discussion took place with the Working Group, enabling the authors to have a clear understanding of the aims and objectives of the project. Initial relevant guidance and available data were also noted to ensure that the Discussion Paper was as informed and robust as possible.

Step Two – Desk Based Assessment/Engagement with PFOW developers and the Working Group
Developers were consulted and an overview of all current PFOW projects was developed.

Further potential impacts were assessed and identification of potentially significant impacts were considered. Suggestions were documented for suitable methods of two way communication between the developers and key stakeholders.

The current status of marking and charting was considered and a standardised approach was recommended.

2.3 Consultation

The project involves the input of PFOW developers and relevant stakeholders. Their willingness to exchange information and views collaboratively has helped inform this Discussion Paper. Should a workshop be progressed, a wider set of stakeholders could be involved in addition to those (listed below) who have contributed to date.

2.3.1 Input into the Discussion Paper

- Project working group:
  - The Crown Estate;
  - Marine Scotland (MS);
  - Maritime and Coastguard Agency (MCA); and
  - Northern Lighthouse Board (NLB).

- PFOW developers;
  - MeyGen (Inner Sound);
  - Pelamis (Farr Point);
  - SPR (Marwick Head and Ness of Duncansby);
  - Aquamarine (Brough Head);
  - SSE (Costa Head, Westray and Brims Tidal Array);
  - OpenHydro (Brims Tidal Array);
  - MCT (Brough Ness);
  - E-On (West Orkney South and West Orkney Middle South); and
  - Scotrenewables (Lashy Sound).

- Chamber of Shipping;
- Highland Council;
- Orkney Island Council (including OIC Marine Services);
- Royal Yachting Association; and
- Scottish Fishermen's Federation.

2.3.2 Additional Stakeholders

In addition to those already listed above, it is recognised that there are a significant number of other relevant stakeholders, including:

Table 2-1 Stage Two Stakeholders

Stakeholders	**Representatives**
Aggregate Dredging	British Marine Aggregate Producers Association (BMAPA)
Aids to Navigation	Northern Lighthouse Board (NLB)
Aquaculture	Aquaculture companies
Commercial Fishing	Scottish Creel Fishermen's Federation (SCFF) Scottish Fishermen’s Federation (SFF) Scottish Pelagic Fishermen's Association Limited (SPFA) Scottish White Fish Producers Association (SWFPA) Orkney Creel Fishermen’s Association Orkney Fisheries Association (OFA) Orkney Fishermen’s Society (OFS)
Commercial Shipping	Ferry operators • Orkney Ferries • John O'Groats Ferries • NorthLink Ferries • Pentland Ferries
Defence	Defence Infrastructure Organisation (DIO) Ministry of Defence (MOD)
Offshore Wind	None currently, just 6 medium term areas of search.
Oil and Gas Operations	Oil and Gas UK Health and Safety Executive (HSE)
Pollution and Salvage Response	(See ‘Search and Rescue’)
Port Navigation Operations	Transport Scotland Ports and Harbours • Gills Bay Harbour Trust • Highland Council Harbours • Scrabster Harbour Trust • Wick Harbour Authority
Recreational Fishing	Recreational users • Caithness Sea Angling Association • Orkney Islands Sea Angling Association
Recreational Yachting, Boating and Canoeing	British Canoe Union British Marine Federation Cruising Association

Stakeholders	Representatives
	Orkney Marinas Limited (OML) Royal Yachting Association Scotland Sail North Scotland Scottish Boating Alliance Scottish Canoe Association Recreational users • Caithness Kayak Club • Clyde Cruising Club • Deerness Small Boat Owners Association • Holm Sailing Club • Kirkwall Kayakers Club • Kirkwall Small Boat Owners Association • Orkney Dive Boat Operator's Association • Orkney Sailing Club • Orkney Sea Kayaking Association • Pentland Canoe Club • Pentland Firth Yacht Club • Sail Orkney Yacht Charter • Stromness Sailing Club • Stromness Small Boat Users Association • Westray Boat Owners Association • Westray Sailing Club
Search and Rescue	MCA • Shetland Coastguard RNLI • Kirkwall • Longhope • Stromness • Thurso
Subsea Cables	Scottish Hydro Electric Transmission Limited (SHETL)
Tourism e.g. scuba and wildlife watching	Recreational users • Orkney Dive Boat Operator's Association
Wave and Tidal (cumulative)	EMEC

It is hoped that these stakeholders find the information provided in this Discussion Paper informative. Should a workshop be organised, it is expected that some of these organisations may wish to participate.

3. PFOW Projects

3.1 Introduction

This section collates up to date information on the scope and progress of the PFOW wave and tidal projects. A questionnaire was distributed by Xodus to all eleven project developers who were awarded an Agreement for Lease (AfL) areas in the 1st wave and tidal leasing round and Scotrenewables who have also been awarded an AfL area for the Lashy Sound tidal energy project (Figure 2-1). All information supplied is summarised in Appendix A to this document and a summary of the information provided below. It is important to note that the information contained here is subject to change and should be checked with the relevant developer as appropriate.

3.2 Status of Projects

3.2.1 Project Overview

Twelve projects are currently being progressed in the PFOW and each is at a different stage of development. Table 3-1 below summarises the key details for each of the projects and Table 3-2 project progress to date. To date one project has submitted its consent application, this being the MeyGen Limited, Inner Sound Tidal Energy Project (Phase 1). Consent for this project was given in September 2013. Generally of the other projects actively being progressed at present they are in the process of undertaking the Environmental Impact Assessment (EIA) and Navigational Risk Assessment (NRA) with some consent applications due later in 2014 onwards.

Table 3-1 details the current projects planned for PFOW.

Table 3-1 Summary of PFOW Wave and Tidal Projects

Project	**Developer**	**Total project capacity**	**Phased development**
Tidal projects			
Ness of Duncansby	Scottish Power Renewables UK Limited	100 MW	1 (? MW) 2 (? MW) 3 (? MW)
Inner Sound	MeyGen Limited	400 MW	1a (20 MW) 1b (65 MW) 1c (? MW) 2 (? MW)
Brims Tidal Array[1]	Brims Tidal Array Development Limited[1]	200 MW	1 (≤ 60 MW) 2 (≤ 140 MW) 3 (200 MW)
Brough Ness	Sea Generation (Brough Ness) Limited	100 MW	1 (? MW) 2 (? MW)

[1] This development recently changed its name, it is now the Brims Tidal Array and the developer is Brims Tidal Array Limited (BTAL). It was previously known as Cantick Head.

			3 (? MW)
Westray South	Westray South Tidal Development Limited	200 MW	1 (< 60 MW) 2 (< 140 MW) 3 (200 MW)
Lashy Sound	Scotrenewables	30 MW	1 (10 MW) 2 (20 MW)
Wave projects			
Farr Point	Ocean Power Delivery Limited	50 MW	1 (10 MW) 2+ (? MW)
West Orkney South[1]	EON Climate & Renewables UK Limited	50 MW	1 (9.75 MW) 2 (? MW)
West Orkney Middle South[1]	EON Climate & Renewables UK Limited	50 MW	Phased but details currently unknown
Marwick Head	Scottish Power Renewables UK Limited	50 MW	1 (9 MW) 2 (? MW) 3 (? MW)
Brough Head	Brough Head Wave Farm Limited	200 MW	1a (10 MW) 1b (40 MW) 2+ (? MW)
Costa Head	Costa Head Wave Farm Limited	200 MW	1 (10 MW) 2 (190 MW)

Note: ? = Unspecified MW.

Table 3-2 contains the current status (as of autumn 2013) of development for the different projects.

[1] The future of these projects is uncertain, very little further information is available.

Table 3-2 Progress to Date of PFOW Wave and Tidal Projects

Project	Scoping Report submitted	PHA completed	Scoping opinion received	EIA in progress	NRA in progress	Application submitted	Approval received
Tidal projects							
Ness of Duncansby	✓	✗	✓	✗	✗	✗	✗
Inner Sound	✓	✓	✓	✓	✓	✓	✓
Brims Tidal Array	✓	✓	✗	✓	✓	✗	✗
Brough Ness	✗	✗	✗	✗	✗	✗	✗
Westray South	✓	✓	✓	✓	✓	✗	✗
Lashy Sound	✗	✗	✗	✗	✗	✗	✗
Wave projects							
Farr Point	✓	✓	✓	✓	✗	✗	✗
West Orkney South	✓	✓	✓	✗	✗	✗	✗
West Orkney Middle South	✗	✗	✗	✗	✗	✗	✗
Marwick Head	✓	✗	✓	✗	✗	✗	✗
Brough Head	✓	✓	✓	✓	✓	✗	✗
Costa Head	✓	✓	✓	✓	✓	✗	✗

3.2.2 Project Development Areas

An Agreement for Lease (AfL) area in PFOW, granted by The Crown Estate for a limited time period, grants a developer exclusive rights to investigate the possibility of a development (with respect to wave and tidal energy projects) within a defined area. The AfL areas are therefore generally larger than the area of seabed eventually used by a constructed project. As such, project developers continue to actively prospect their AfL areas in order to identify the right parts of the AfL areas for devices to be deployed. For example, Brough Head Wave Farm Limited has identified a preferred area for the first phase of its development, but is still to define which other areas of its AfL will be developed in subsequent phases of the project.

In addition, developers tend to only carry out survey work (such as resource assessment) once an AfL has been awarded. As such, on occasion, survey work after AfL award may identify that some aspects of sites, such as the available energy resource and water depth, are unsuitable for development. This leads to the potential need to consider the suitability of site boundaries, with the potential for some revision to the AfL boundary being necessary. An example of this is the Brims Tidal Array, which has recently agreed a new boundary with The Crown Estate to the west of the original site.

Four other proposed projects (Brough Ness (tidal), Brough Head (wave), Westray South (tidal) and MeyGen Inner Sound (tidal)) have indicated that the final proposed development area may differ from that initially awarded by The Crown Estate. MeyGen has already negotiated a change to the site boundary for the Inner Sound project and Sea Generation (Brough Ness) Limited has indicated that further work is required in order for them to define what the final project development area will be.

3.2.3 Grid Connection

All projects will be connected to shore via a subsea export cable(s). Some landfall locations are known, whilst others are not or cannot be disclosed at this time (Appendix A). The nature of landfall will vary by project, but these will likely be by traditional beach landfall or horizontally directionally drilling (HDD bore). From a navigational perspective there are a number of issues for consideration. There will be a relatively slow moving cable installation vessel/s present during the construction phase of the project. The cable also presents a snagging hazard to vessels anchoring or trawling there too (see section 5.1.2 for more details). In shallow water, near to landfall, cable protection measures could reduce navigable water depth.

3.2.4 Project Development Timescales

Table 3-3 summarises the present expected dates for construction of the different phases of each project and present expected commencement of operation dates as specified by the developers. This information was gathered from that provided by developers, as detailed within Appendix A. It is important to stress that due to the complexity of factors and inter-relationships between them, these dates are subject to change. The information represents the project status at the date of collection, and the projects may have progressed since this was prepared. The relevant developer should be contacted for up-to-date information.

The blue shading indicates the anticipated construction phases and the red expected operational start date. There is still some uncertainty over specific dates; however it can be seen that some project construction phases will overlap and that it will be a 5-10 years before all projects will be operational.

Table 3-3 Timing for Construction and Operation for PFOW Wave and Tidal Projects

Project	**Project Phase**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Tidal projects															
Ness of Duncansby	1			Q3											
	2			Q3											
	3			Q3											
Inner Sound	1a														
	1b														
	1c														
	2														
Brims Tidal Array	1	Q4													
	2														
Brough Ness	1				*	*									
	2						*	*							
	3							*	*						
Westray South	1	Q2/ Q3				*		*							
	2									*		*			
Lashy Sound	1		Q1												
	2		Q1												
	3														
Wave projects															
Farr Point	1	Q2													
	Subsequent phases TBC														
Marwick Head	1			Q3											
	2			Q3											
	3			Q3											
Brough Head						*	*								
	Subsequent phases TBC														
Costa Head	1														
	2														
Notes:															
Anticipated application date.															
Anticipated construction phase.															
Anticipated operational phase.															
* Depends on availability and timing of grid connection.															

3.2.5 Technology

Wave and tidal devices have a bearing on the potential impacts presented to navigation due to their differing profiles in the water column. This affects their ability to be seen, visually and on radar, as well as the potential for vessels to interact with the devices both above and below the water level.

Currently wave devices may be surface piercing, operate on or near the surface. While tidal devices also share these qualities, they may also be sited on the seabed or moving within the water column.

A large number of the projects are likely to comprise some surface piercing elements.

All the proposed wave energy projects will utilise surface piercing devices. It is also feasible that when wave projects are constructed to their full capability that there will be a requirement for an offshore platform containing power conditioning and/or transforming equipment.

In addition, the following tidal projects have indicated the potential to utilise surface piercing infrastructure/devices: Brough Ness (development likely to comprise a mix of surface piercing and subsea devices); Westray South (development likely to utilise both surface piercing devices and offshore substations may be required for both phases); and Brims Tidal Array (this may change since the technology for this development is currently undecided, but it may include surface piercing housings, containing electrical collection equipment etc.).

The following tidal projects do not expect to use surface piercing technology; Inner Sound and Ness of Duncansby, and based on present known plans are unlikely to include any surface piercing structures e.g. offshore platforms. However these may alter and the individual technology employed will dictate whether surface piercing elements are required.

The surface piercing nature of the technology employed may change. Until the stage of ‘design freeze’ is met, there is the possibility that different or alternative technology may be utilised.

To address the issue of a yet to be determined device and allow greater flexibility in the development proposal, it is noted that developers are adopting a technology neutral approach (often referred to as Rochdale Envelope; see section 2.4.1 for more details).
An entirely neutral approach is generally not possible as it would likely fail to fully inform the EIA and NRA process. Instead developers are defining the envelope of possible device characteristics acceptable to the project. Sometimes this is specific to a number of candidate machines and therefore significant details are known and provided.

3.2.6 Vessel and Port/Harbour Requirements

3.2.6.1 Vessel requirements

The information provided from project developers indicates that there are significant differences in the types of vessels that will be required for the different projects. Although some developers have yet to confirm the specific types of vessels they will require, of those who have been able to supply details the following types of vessel have been indicated as being required:

- Jack up barge;
- Moored barge;

- Tugs (e.g. anchor handlers);
- Multicat work vessel (e.g. work boat and dive support vessel);
- Dynamically positioned heavy lift vessels;
- Moored heavy lift barges; and
- Cable laying vessel (common to all projects).

3.2.6.2 Port/harbour requirements

All the projects have indicated that they will require the use of port/harbour facilities, however not every project has been able to indicate which specific facilities. Of those developers that have been able to provide information, the facilities proposed are clearly influenced by the geographic locations of specific projects as well as the port/harbour facilities available. The following have all been indicated as being possible facilities:

Mainland Scotland

- Scrabster;
- Loch Eribol;
- Wick; and
- Gill Bay.

Orkney

- Stromness (main pier and lighthouse pier);
- Lyness, Scapa Flow;
- Kirkwall Pier;
- Hatston, Kirkwall; and
- Sanday Harbour.

3.2.7 Inshore/Offshore Project Areas

In addition to the project development areas and the transit routes between these and the above identified ports/harbours, some projects may also require to utilise other areas to support their project, e.g. for operations and maintenance.

This has the potential to impact other users. These are detailed in section 4 of this paper.

Although specific project requirements are not well defined at the present time, it is clear that such areas will be required. Based on the information provided the following has been identified:

- Brims Tidal Array has indicated that perhaps some tow trials might be required prior to deployment and that the preferred location for these will depend on mobilisation location;
- Costa Head has indicated the potential need for local Orkney safe haven/lay-up/anchor area close to the Costa Head site e.g. Scapa Flow prior to device installation; and
- It is possible that maintenance of Pelamis devices could take place in sheltered waters (not necessarily at a port/harbour facility). This will most likely occur along the north coast.

3.3 Development Issues

There are a number of different factors that need to be considered when selecting the site and design of a wave/tidal project. It is important that stakeholders are aware of all the influences on a project and there is a realisation that there is no single factor that influences a project and its location.

One of the most important factors in the selection of a site for a wave or tidal project is the energy resource. Tidal resource in particular is very constrained and only certain areas of sea are suitable for the development of tidal energy projects. The PFOW is well documented as a key area for the development of tidal energy projects. It is also recognised for its wave resource and it has therefore always been seen as an area that would play a key role in the evolution of the marine energy industry, not only in the UK but internationally. In fact this was one of the influencing factors in the siting of the EMEC facilities in Orkney.

3.3.1 Site Characteristics

As well as the presence of a suitable energy resource, a successful marine energy project also requires some or all of the following:

- Seabed suitable for deployment of energy devices. Some areas of seabed may not be suitable for the deployment and/or mooring of devices;
- Access to the power distribution network (i.e. grid), including access to a suitable cable landfall site and provision of a suitable cable corridor to shore;
- Availability of onshore land for the location of any associated onshore facilities;
- Some projects may also have minimum water depth requirements;
- For tidal projects, protection (as far as possible) from extreme wave climates; and
- To be commercially viable.

Taking into account the above factors, it is clear that wave and tidal projects can be very constrained from a technical and economical perspective and that there are only certain areas of the sea that may be suitable for the development of these projects.

3.3.2 Identifying Constraints

Once technically suitable sites have been identified, the usual project development process is to then identify other sea and land users and environmental constraints that might influence the final location and/or design of a project development site. This requires the identification of the onshore and offshore constraints that might influence the project, including (but not limited to) the following:

- Protected habitats and species i.e. sites and species designated for their ecological conservation importance including consideration of birds, mammals and fish;
- Commercial fisheries;
- Navigational interests;
- Land availability onshore;
- Cultural heritage interests (offshore and onshore);
- Tourism and recreational interests;
- Onshore transportation;
- Landscape issues e.g. designated landscapes;

- Proximity of local population; and
- Military areas etc.

Based on this, it is very unlikely that a proposed project site meeting the required technical specifications will not be constrained by and/or impact on one or more of the above receptors. Once a project site has been selected, the project design process must give consideration to the minimisation of impacts on receptors. It will seldom be possible that a project results in no impact to all receptors, and therefore project site selection and design must focus on balancing conflicts and impacts in an acceptable manner. It is clear that navigational issues are just one of a number of important factors that need to be considered.

It is standard practice that developers, during their development work for the project, consider a large amount of information and consult with a large range of stakeholders to ensure the relevant issues/potential impacts are identified and mitigation provided where necessary. Many of the PFOW developers are already doing this and all are committed to carrying out a thorough assessment of, and stakeholder consultation on, their proposed projects.

3.4 Consent Applications

3.4.1 Rochdale Envelope

This approach allows flexibility when planning projects where the specifics are not yet known. It works on the basis of planning for a 'worst case' set of parameters that allow for consent to be given so long as the final specification of a project are within the worst case

The use of the 'Rochdale Envelope' approach in consent applications provides the basis upon which a project can be described by a series of maximum extents - the 'worst case' scenario - allowing the detailed design of the scheme to vary within this 'envelope' without invalidating the corresponding EIA.

This is a pragmatic approach to the consent application. It balances the details required when scoping and designing a wave or tidal project with the cost of survey work, necessary to inform the design. The Crown Estate have recognised the usefulness of this method and produced guidance (TCE, 2012b) specifically for wave and tidal projects within the PFOW Strategic Area. This clarifies where the flexibility of this approach lies and where firm details are still required for the consent to be determined.

3.4.2 Consultation

Stakeholder consultation is built into legislation of the statutory process of obtaining permissions to construct and operate a generating station, namely the Marine Licence and 'Section 36 Consent' from the regulator, Marine Scotland.

Stakeholder consultation is established in several stages of the EIA process. Once a project reaches the application stage, public consultation takes place in the form of public notices in local and national newspapers with the provision of Environmental Statements in the locality of potentially affected areas to inform the public's views.

3.5 Conclusion

While the different projects are at a relatively early stage of planning there are many uncertainties. The status of the distinct phases may alter if backers change technologies/devices, wish to alter the AfL area or layout within the current AfL area or encounter other delays associated with projects of this scale. However it is possible to assess the general condition of potential hazards and risks to navigation and stakeholders, based on a ‘worst case’ approach to aspects of locations/technologies, and identify mitigation measures for the purpose of this Discussion Paper.

4. Data and Analyses

4.1 Guidance

A wide range of guidance is available concerning the potential risks to navigation, safety and the standard methods of mitigation used to ensure these risks are as low as reasonably practicable (ALARP). There is also guidance and data specifically concerning the PFOW Strategic Area (Figure 4-1). All the documents detailed within Appendix B have been used, in addition to the knowledge and experience of the authors, to inform this Discussion Paper.

4.2 Existing Data

While some data must be gathered within a specified period before the submission of the Environmental Statement (see Section 4.2.2), other data is already available and has assisted the production of this Discussion Paper. Data for the PFOW Strategic Area exists from previous surveys or assessments that have already taken place. This information and the benefits of the types of data gathered are detailed in the section below.

4.2.1 Recent Data by Source

A Strategic Environmental Assessment (SEA) to examine the environmental effects of developing wave and tidal power - Section C15 Shipping and Navigation (MS, 2007a)

- Automatic Identification System (AIS) survey (winter - 2 weeks in January 2006 and summer - 2 weeks in August 2006)

Draft Report on ScotMap - The Inshore Fishing Study Pilot in Pentland Firth and Orkney Waters (MS, 2012c)

- Commercial fishing vessels (under license) based locally (2007 - 2011)

Shipping Study of the Pentland Firth and Orkney Waters (MS, 2012e)

- Scrabster harbour vessels callings (2009 - 2012 (2012 partial - to 31st August))
- Orkney Marinas (Kirkwall, Stromness and Westray) vessels callings (2010 - 2011)
- Wick Harbour vessels callings (2006 - 2011)
- AIS survey (winter - 4 weeks in January to early February 2012 and summer - 4 weeks in July 2012)

4.2.2 Marine Traffic Analysis

Following an AIS survey undertaken in 2012 (MS, 2012e) for Marine Scotland, an analysis of both commercial vessels and recreational craft was undertaken for the PFOW Strategic Area. This was organised under the Scottish Government Framework Contract for Provision of Strategic Environmental Assessment (REF: 17895), which focused on the study of commercial shipping and recreational vessels.

The Marine Scotland study details commercial shipping and recreational vessel activity observed in the PFOW Strategic Area. This Marine Scotland report highlights the type and volume of traffic, excluding vessels engaged in fishing, within the area. Assessment of commercial fishing (under license) activity was not part of this study.

However Marine Scotland also carried out a study of commercial fishing (under license), which took place in 2011, and is published in a draft pilot study (MS, 2012c). This interview based survey gathered data on inshore fishing activity from active stakeholders.

Previously another Marine Scotland study (MS, 2007a) of commercial shipping and recreational vessels took place in 2006, utilising AIS data. This study examined the environmental effects associated with developing marine renewable energy within Scottish waters. It included analysis of shipping and navigation, which was considered a key consideration to marine energy developments, because of the possible opportunity for interaction with wave and tidal devices.

Figure 4-1 shows the strategic area of PFOW that is considered by these surveys.

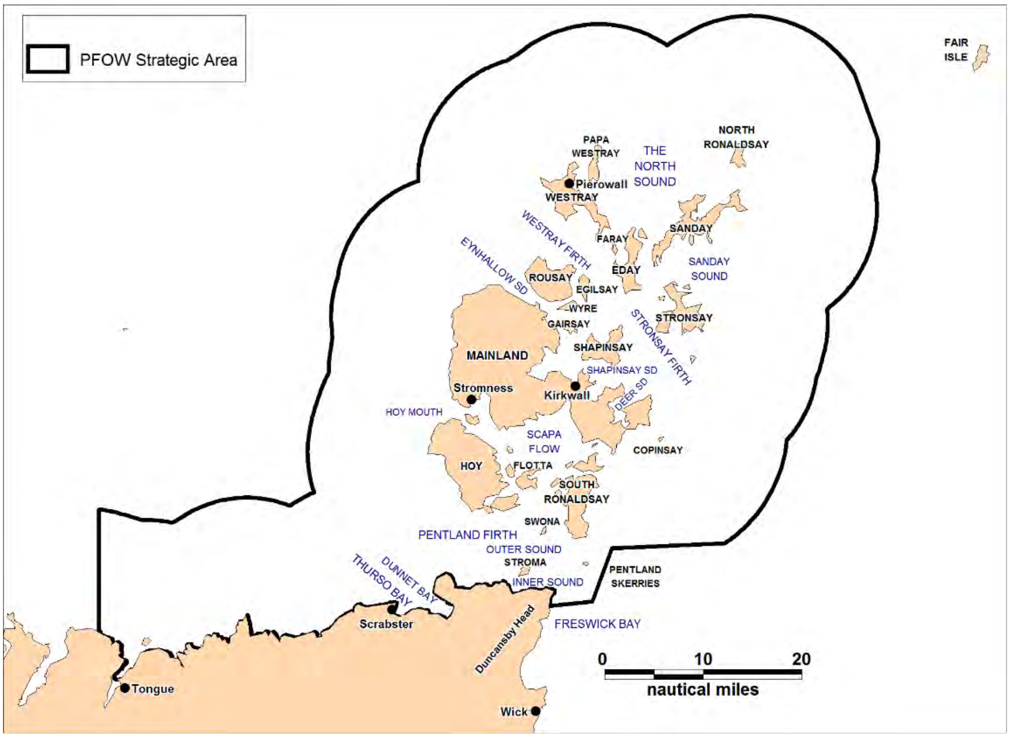


Figure 4-1 PFOW Strategic Area

4.3 Data Types

4.3.1 AIS

Tracking vessels by automatic identification system (AIS) is a useful way to map maritime traffic, however there are limitations. These include the carriage requirement and also range. All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size are required to be fitted with AIS. Smaller vessels are not mandated to carry AIS and if the distance from the receiver is too great then the signal will not be receivable.

However, for the section of ships covered by AIS, this survey is very effective, providing accurate information for a large area. It captures specific information contained within the AIS transmission that can build a fuller picture of the traffic situation.

The Marine Scotland study (MS, 2012e) made note that while AIS could confidently be used to assess commercial shipping within the PFOW, it is of less use to assess recreational vessels. Few local recreational vessels are equipped with AIS. Cruising traffic visiting the Islands is more likely to be utilising AIS.

The data used within Section 4.4 is from the same study (MS, 2012e). This data was gathered in 2012 over four weeks in winter (January to early February) and summer (July). To enhance understanding, the data has been split, with commercial shipping and recreational vessels being assessed separately.

4.3.2 RAdio Detection And Ranging (Radar)

Data from a Radar survey of a proposed site can be very valuable, it provides insight into vessels not carrying AIS equipment. Therefore smaller vessels can be plotted and the data used to assess navigation and safety risks that may otherwise be missed. Alone it only allows for the counting of vessels, but combined with a visual watch it can help identify tracks and user vessel types.

There is currently no published Radar data available for the PFOW Strategic Area. However this is simply collected from a traffic survey or other Radar coverage. Orkney Islands Council has recently upgraded the VTS Radar system and is in the process of adding new sites to their operation, in line with their development plan.

4.3.3 Visual Observations

This is useful when quantifying data gathered by other means. It is best utilised in combination with other observations (AIS/Radar). It allows the identification of traffic that would not otherwise be recorded. In particular fishing vessels, when not required to carry AIS and recreational users, who neither have the requirement to carry AIS or in the case of small craft, have no capacity for voluntary adoption of this technology. These users may otherwise not be assessed by other means.

There is currently no published visual observation data for vessels within the strategic area.

4.3.4 Maritime Records

Records are kept for a number of purposes that may benefit the analysis of traffic or identifying users within a maritime area. Local coastguard, ports, harbours and marinas will capture traffic data and this can be used to fill gaps in analysis or benchmark survey data. Likewise recreational associations and clubs may be able to inform about activity in an area of interest.

The MCA/Coastguard records were used within the Marine Scotland study (MS, 2012e) to validate the AIS data. The same study also utilised the port and harbour callings data to better quantify the vessels calling there.

4.3.5 Maritime Incidents

Incidents taking place in or around a proposed development offer insight into potential hazards. Analysis of these may indicate trends and assist when choosing the most suitable risk mitigation methods. Incidents and accidents taking place in the area in question will be documented by either the MAIB, which is responsible for investigating incidents that occur within UK waters or on board UK registered ships or the RNLI, when attending the incident.

None of the studies completed have yet looked at incidents or the trends they may highlight.

4.4 Vessel Analysis

For the purpose of this Discussion Paper the most recent information is reviewed below.

The study carried out recently in 2012 (MS, 2012e) by Anatec for Marine Scotland includes a full analysis of the vessels present during the survey period. So instead of repeating this information we will highlight the issues these may present.

The figure below illustrates the volume of traffic operating within the PFOW Strategic Area. All of the current AfL areas experience traffic in some form.

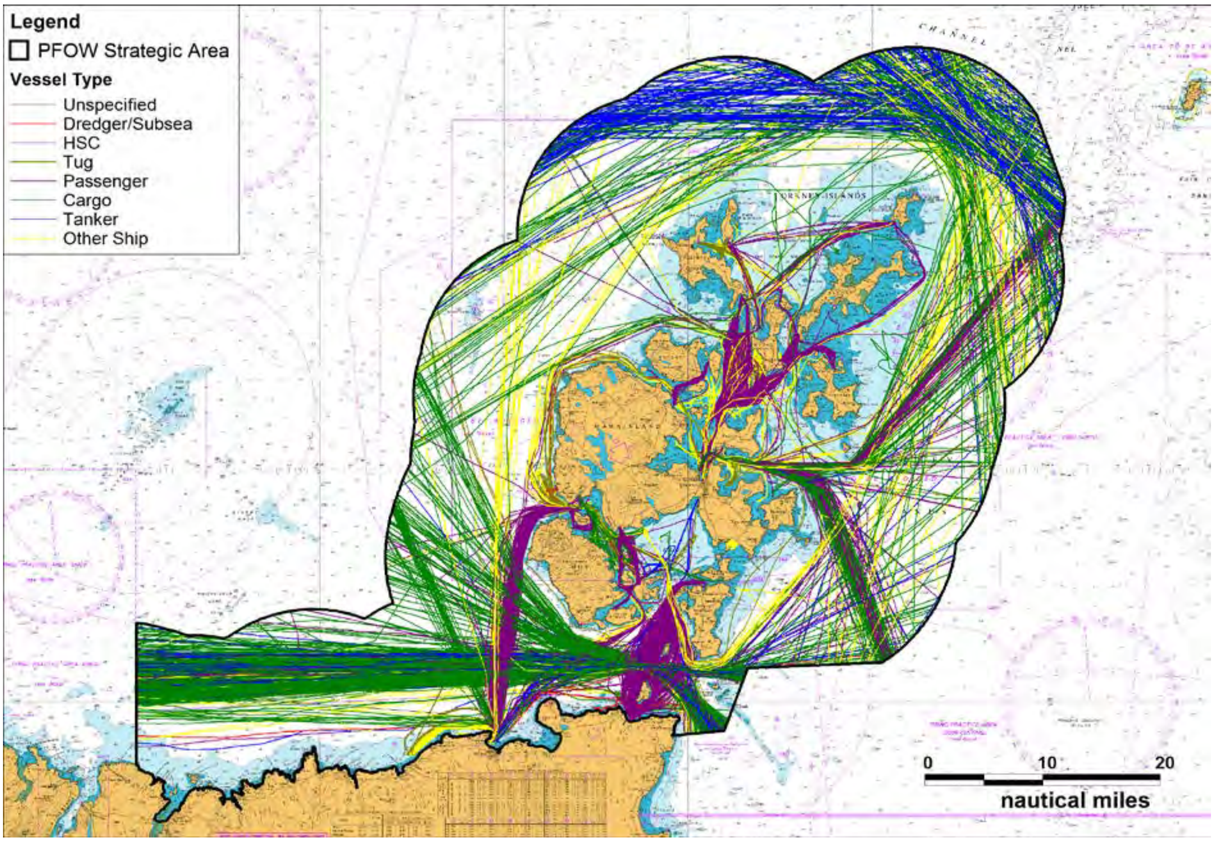


Figure 4-2 Combined Output of Marine Traffic Survey Data (Summer and Winter)

4.4.1 Commercial Vessels

Confidence in the 2012 AIS data gathered from the PFOW is good. The vessel classification used has been refined to better group the AIS data using the International Classification of Ship Types for use in assessing the risks presented by them.

- Tanker (Oil/Chemical/Gas Carrier)
- High-Speed Craft
- Cargo (including RoRo/Container)
- Passenger (Ferry and Cruise Ship)
- Offshore (Oil & Gas and Renewables Support Vessels)
- Tug
- Dredger/Subsea Operations
- Other (research vessels, underwater operations vessels, light tenders, fish carriers, RNLI lifeboats and miscellaneous/other vessels)

Figure 4-3 summarises the breakdown of vessel movements (tracks) within the PFOW Strategic Area by vessel type during the summer and winter periods over which data was collected.

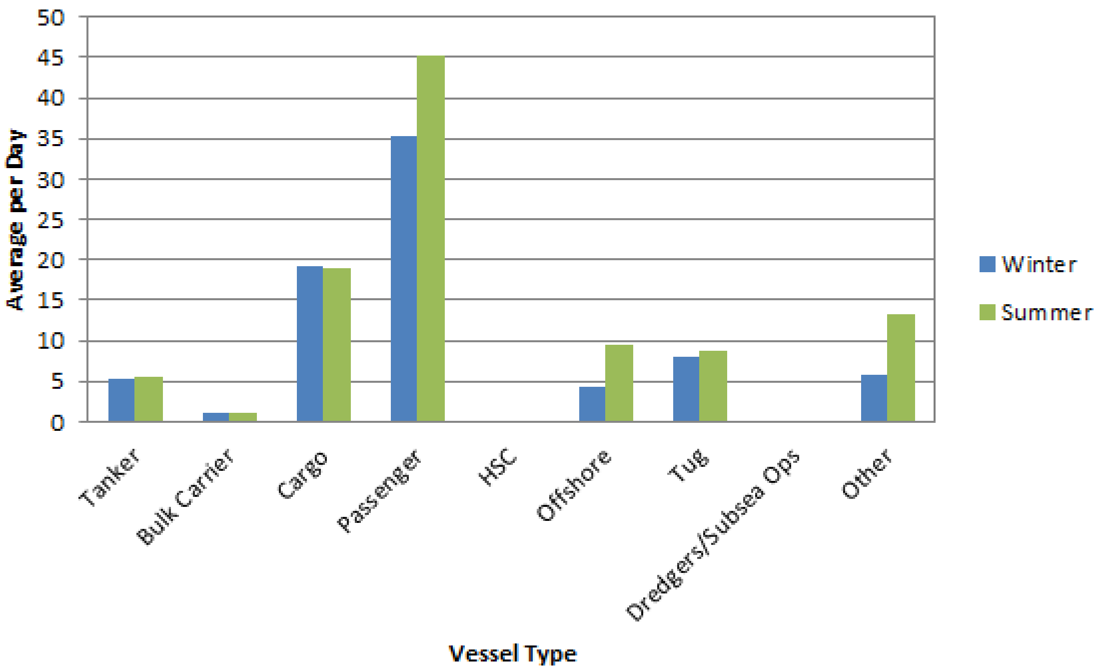


Figure 4-3 AIS Vessel Type Distribution per Season

Passenger ships were the most frequent vessel recorded during the survey. This is due both to the high number of ferries operating within the strategic area and the number of cruise ship callings.

4.4.2 Licensed fishing vessels

Table 4-1 contains data from ScotMap (MS, 2012c) concerning the number of interviews with skippers/owners of licensed fishing vessels. It is indicative of the number and type of fishing vessel operating at the time of the survey.

Table 4-1 Size/Type of Licensed Fishing Vessels (ScotMap)

Gear	**< = 9.99 m**	**10 - 14.99 m**	**> = 15 m**	**Total**
Bottom Seine	0	0	1	1
Dredges	1	1	0	2
Gill net	1	0	0	1
Long lines	1	0	0	1
Creels	109	32	5	146
Scallop divers	11	3	0	14
Towed dredges	1	1	1	3
Trawls	0	3	5	8
Total	124	40	12	176

It is clear from the size of these vessels, that many will not be required to carry AIS. The AIS carriage requirement currently applies to fishing vessels of 18 metres length and above (extending to 15m and above from 31st May 2014), so without these data or a radar/visual survey they may not be accounted for.

4.5 Key Shipping Areas/Routes

4.5.1 Commercial Shipping

Figure 4-4 and Figure 4-6 present the vessel tracks recorded in each period in the PFOW Strategic Area, thematically mapped by vessel type.

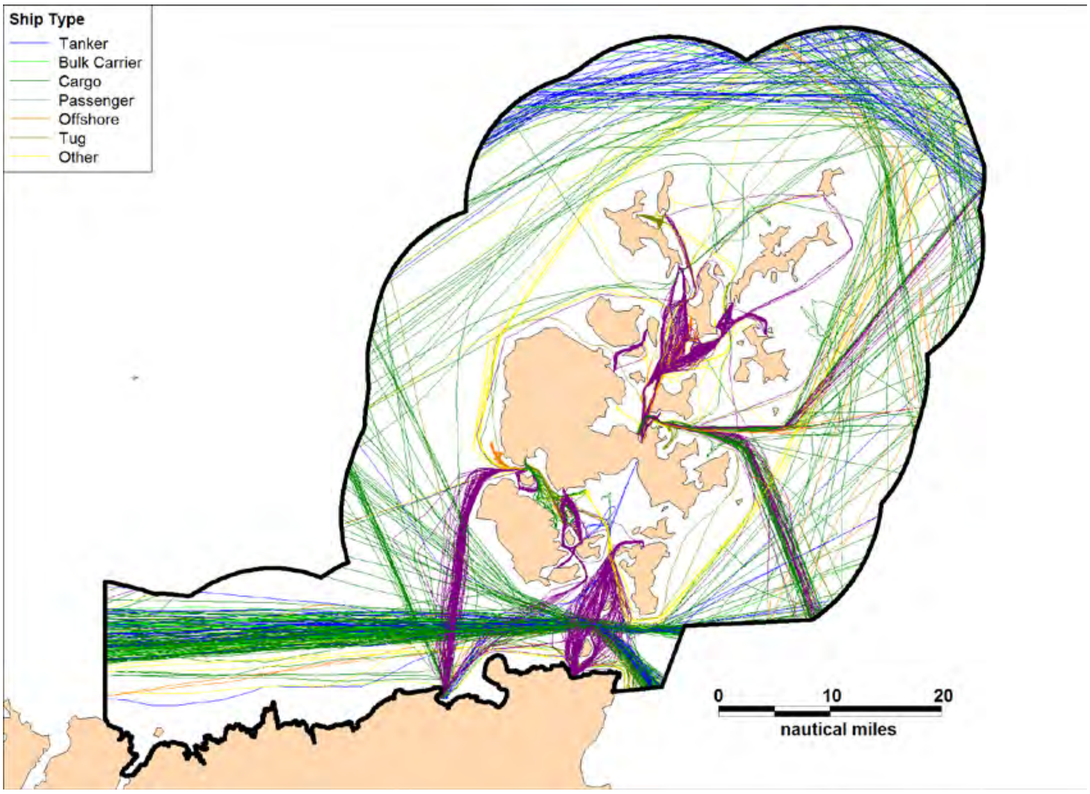


Figure 4-4 Winter 2012 AIS Track Analysis by Vessel Type

Figure 4-5 and Figure 4-7 below present the seasonal density of AIS ship plots, each cell represents an area of 0.5nm^2.

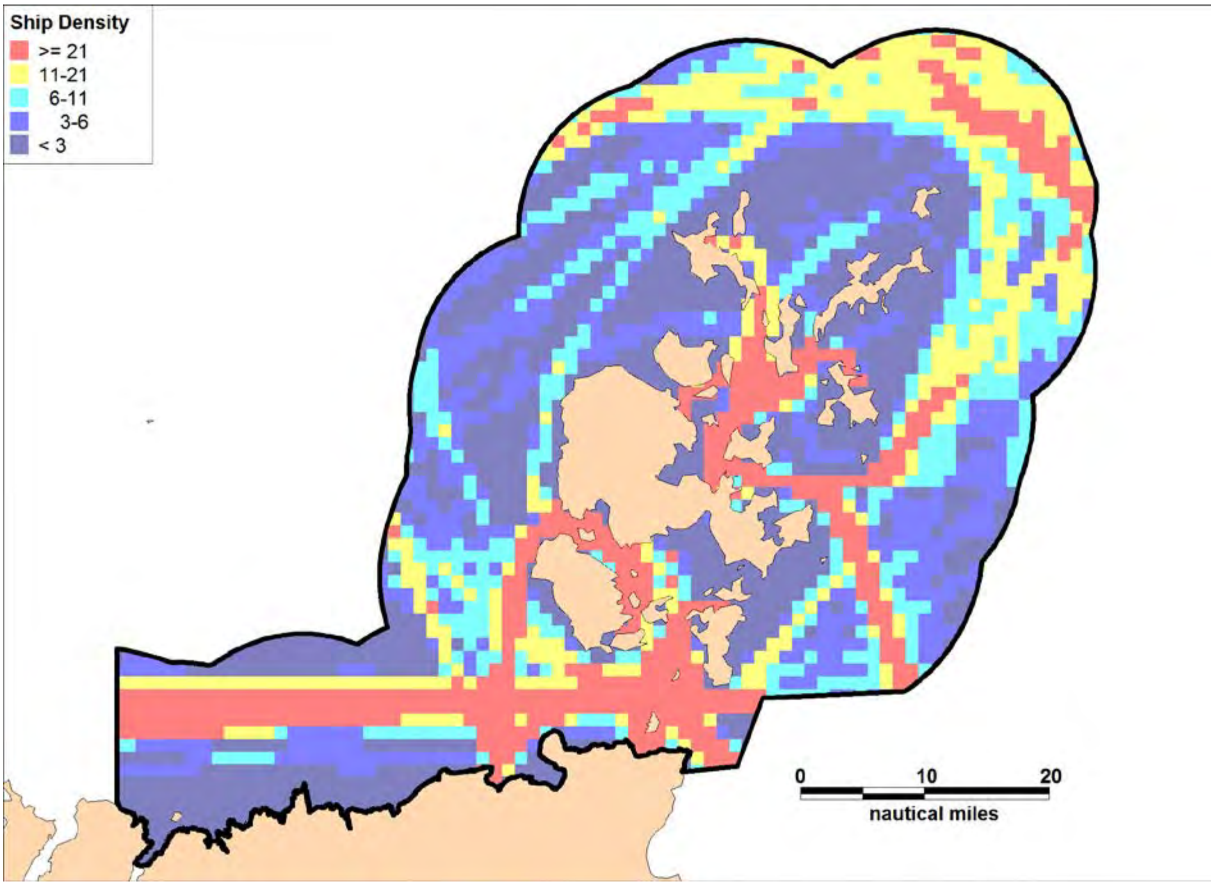


Figure 4-5 Winter 2012 AIS Track Analysis by Overall Ship Density

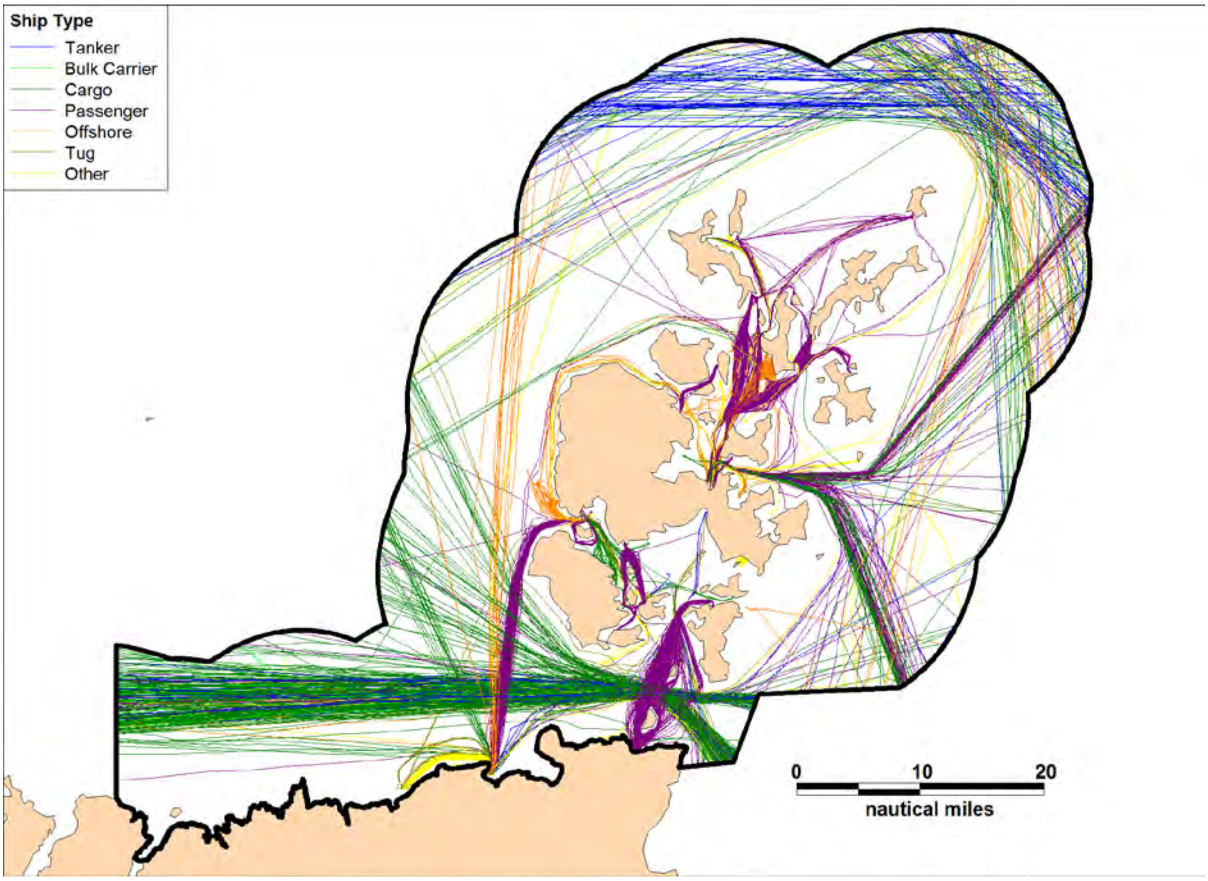


Figure 4-6 Summer 2012 AIS Track Analysis by Vessel Type

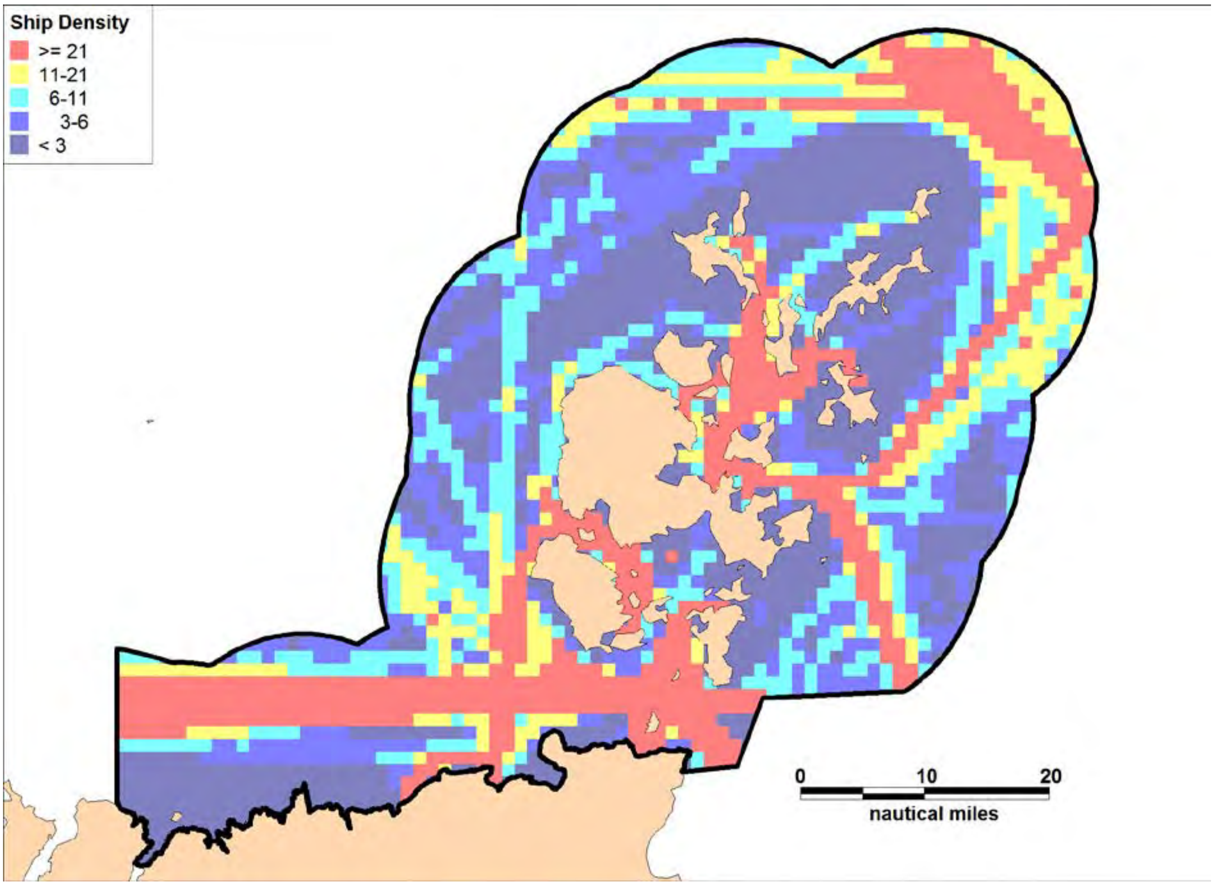


Figure 4-7 Summer 2012 AIS Track Analysis by Overall Ship Density

Tracks indicate the heavy flow of traffic transiting the PFOW Strategic Area both to the north of the islands and south, through the Pentland Firth. The northerly traffic is a mix of ship types, although this does include a large amount of the tanker traffic assessed in the area, which in keeping with good seamanship is passing clear of the 'area to be avoided' that surrounds Orkney. The southerly traffic is denser and more mixed, including more cargo/bulk carrier traffic. This southerly area, between Orkney and mainland Scotland, acts as a pinch point for the traffic, where the area available to navigate is reduced and offers less sea room. The hazard this can present may become exacerbated by heavy seas, strong tidal conditions and the frequency of crossing traffic.

The passenger (ferries) traffic between the mainland Scotland/Orkney Mainland and the other islands is also clear. As is the passenger traffic (NorthLink ferry) calling at Kirkwall before continuing on its voyage either to the northeast (Lerwick) or southeast (Aberdeen).

4.5.2 Recreational Vessels and Other Small Craft

The figure below (Figure 4-8) identifies the density of recreational vessels along with an overlay of the RYA Cruising Routes.

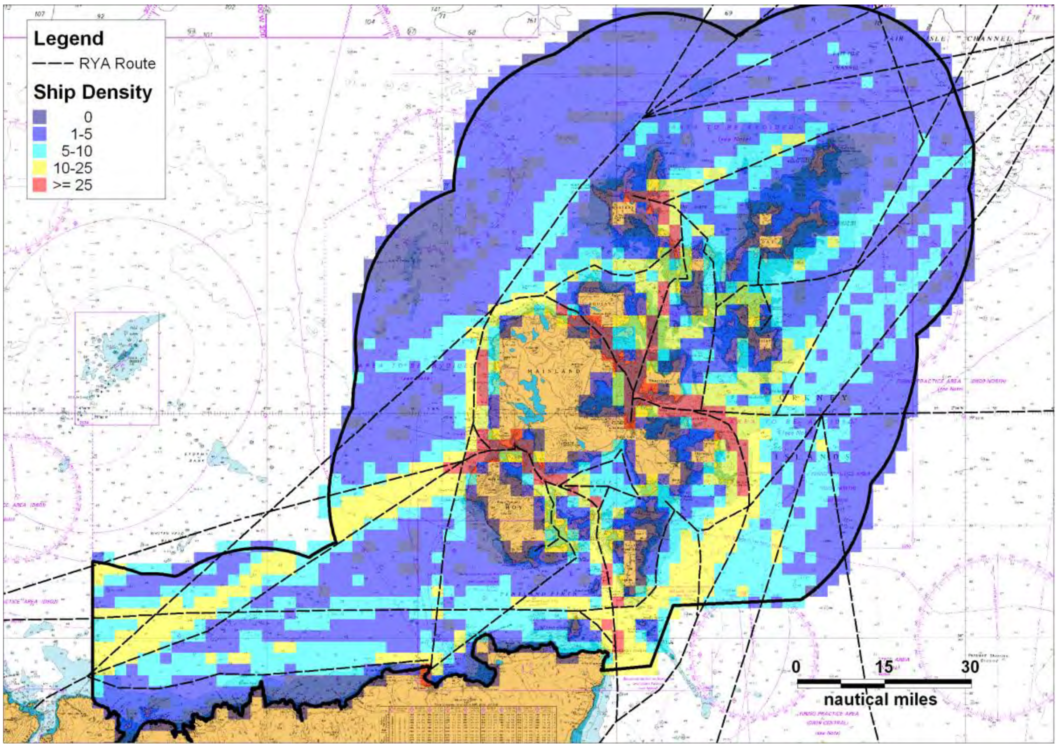


Figure 4-8 Recreational Vessel Density Plot Based on AIS Data (RYA Routes Overlaid)

These vessels are focused around the harbours, marinas and anchorages of Orkney and the islands nearby. Routes show clearly the density of traffic is greatest where these vessels are transiting between these points of interest. There are also high traffic levels close to the coast, where shelter and favourable conditions encourage recreational vessels to transit. These levels are affected by seasonality and weather conditions.

Small craft, which includes dive boats and the aquaculture boats are also included. These navigate between the points of interest specific to their trade.

The routes assessed by the RYA are differentiated by the amount of recreational traffic utilising them. This is illustrated in Figure 4-9.

It is noted that there are only medium use and light use routes within the PFOW Strategic Area. These are found in proximity to all the AfLs. However these routes are consolidated and indicative only (not precise), but do provide insight into where recreational traffic will be found and in what density.

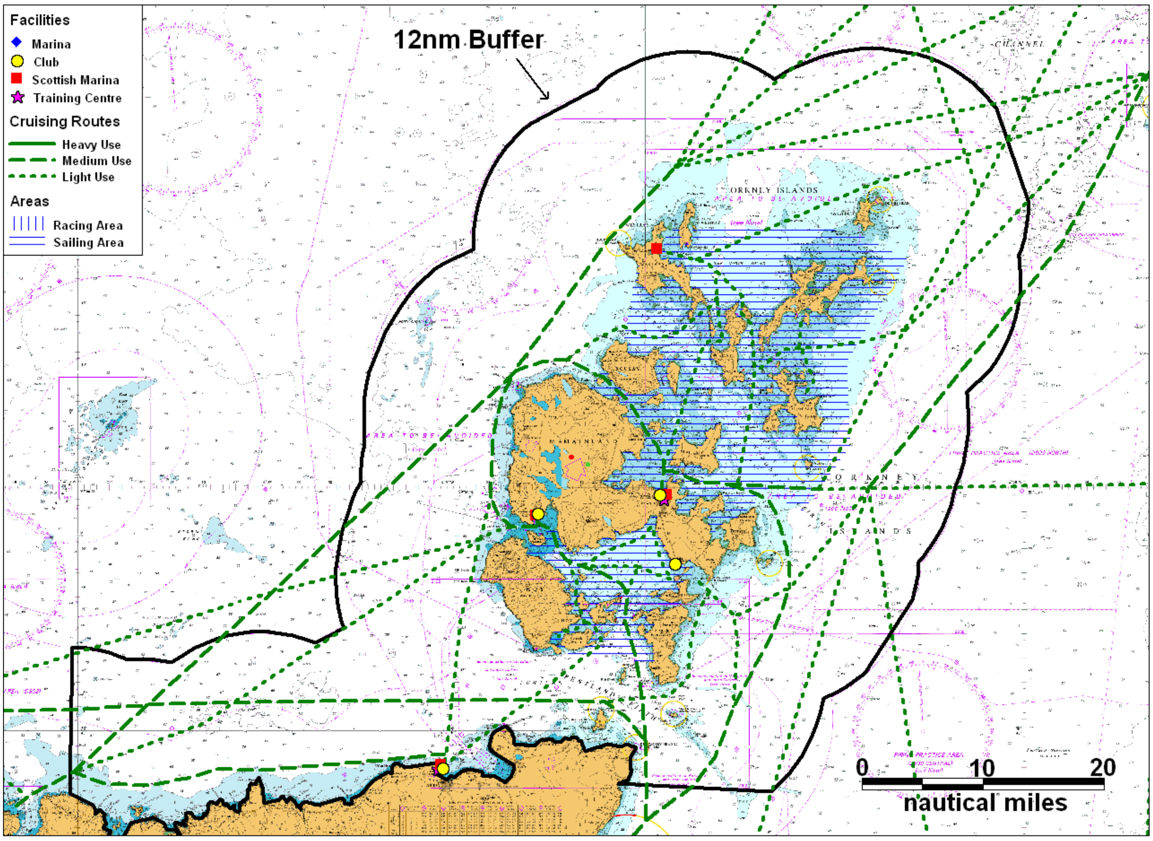


Figure 4-9 Recreational Routes based on RYA Data

It is noted that these RYA routes are currently being updated.

4.5.3 Fishing Vessels (licensed)

The ScotMap data (Figure 4-10) illustrates the areas used by fishing vessels. This accounts for the 130 licensed fishing vessels operating within the PFOW Strategic Area, all of which were interviewed for the assessment.

The draft report highlights those areas where traffic is likely to be greatest. This clearly shows that the number of vessels operating is greatest among the islands, especially so in Wide Firth. There are also a number of vessels operating along the coastline at Brough Head. There are some similarities here with the locations utilised by recreational vessels and small craft, favouring sheltered and/or near coastal waters.

A study by Orkney Fishermen's Society (OSF), including funding by The Crown Estate and Marine Scotland, will provide more locational information on inshore fisheries in Orkney and Caithness. This data will go to the developers and assist discussions between the sectors and with developers siting their projects.

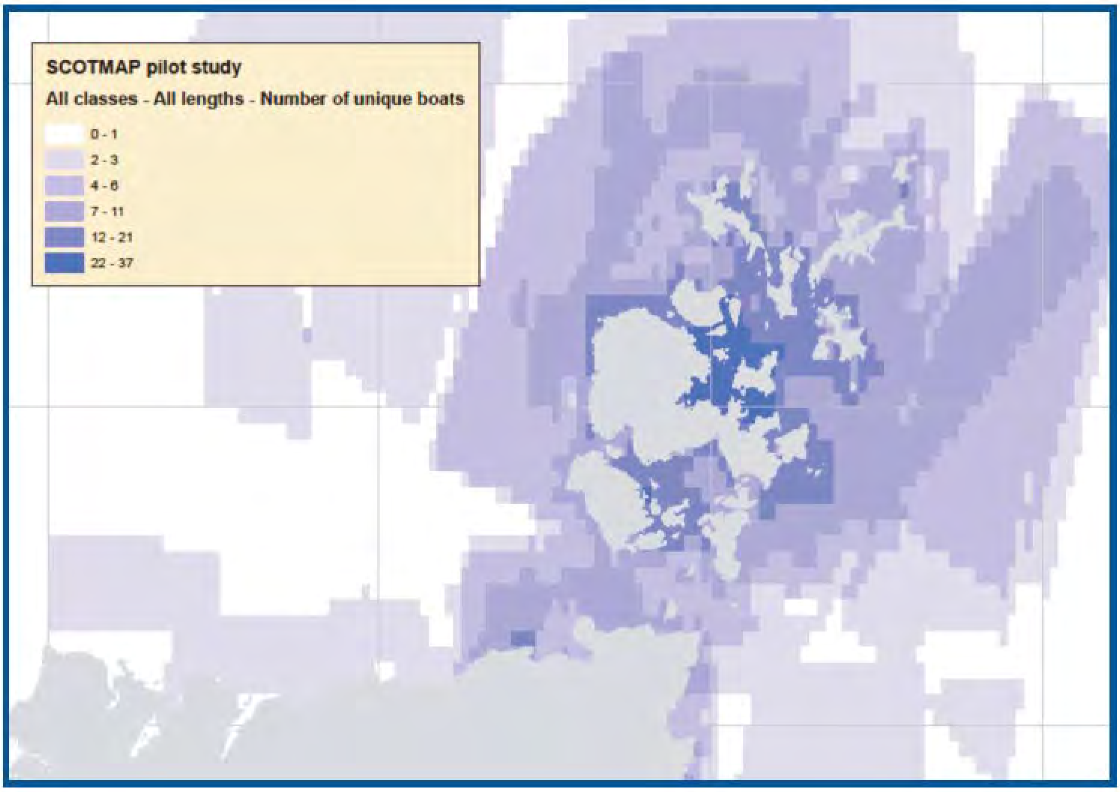


Figure 4-10 Licensed Fishing Vessel Density

4.6 Marine Traffic Analysis by Individual AfL Area

This section assesses the traffic recorded by the AIS survey data (MS, 2012e), collected during winter and summer 2012 (winter – 4 weeks in January to early February 2012 and summer – 4 weeks July 2012). This has been used to analyse the types and numbers of vessels passing through each of the 6 wave energy developments and 6 tidal energy sites developments.

During the time of the AIS survey only vessels that were 24m and greater were required to carry AIS. This will limit the number of small craft carrying AIS near or within the AfLs.

Here follows the marine traffic analysis of individual AfL areas.

4.6.1 Brough Head

Brough Head wave farm is located on the north west coast of Orkney, with an area of approximately 6.7nm^2. The location of the site can be seen in Figure 4-11 with a 2nm buffer placed around the site for context.

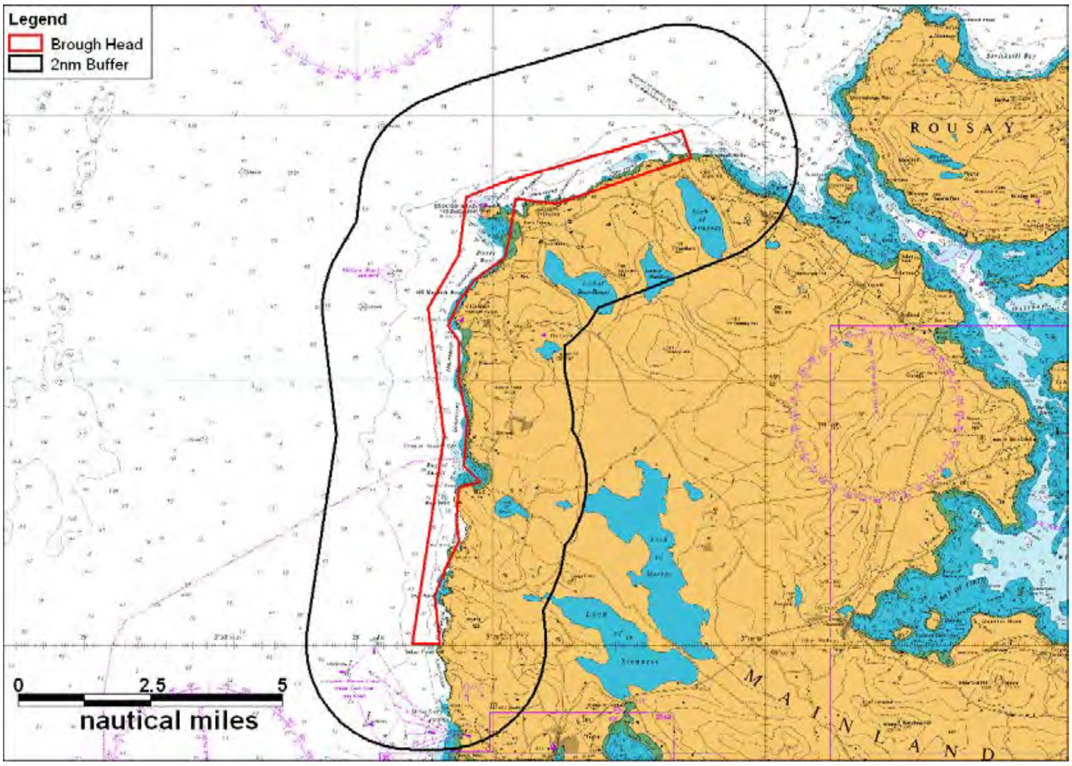


Figure 4-11 Brough Head Wave Farm Location

An overview of all the combined tracks recorded throughout the survey period, colour-coded by vessel type, is presented in Figure 4-12.

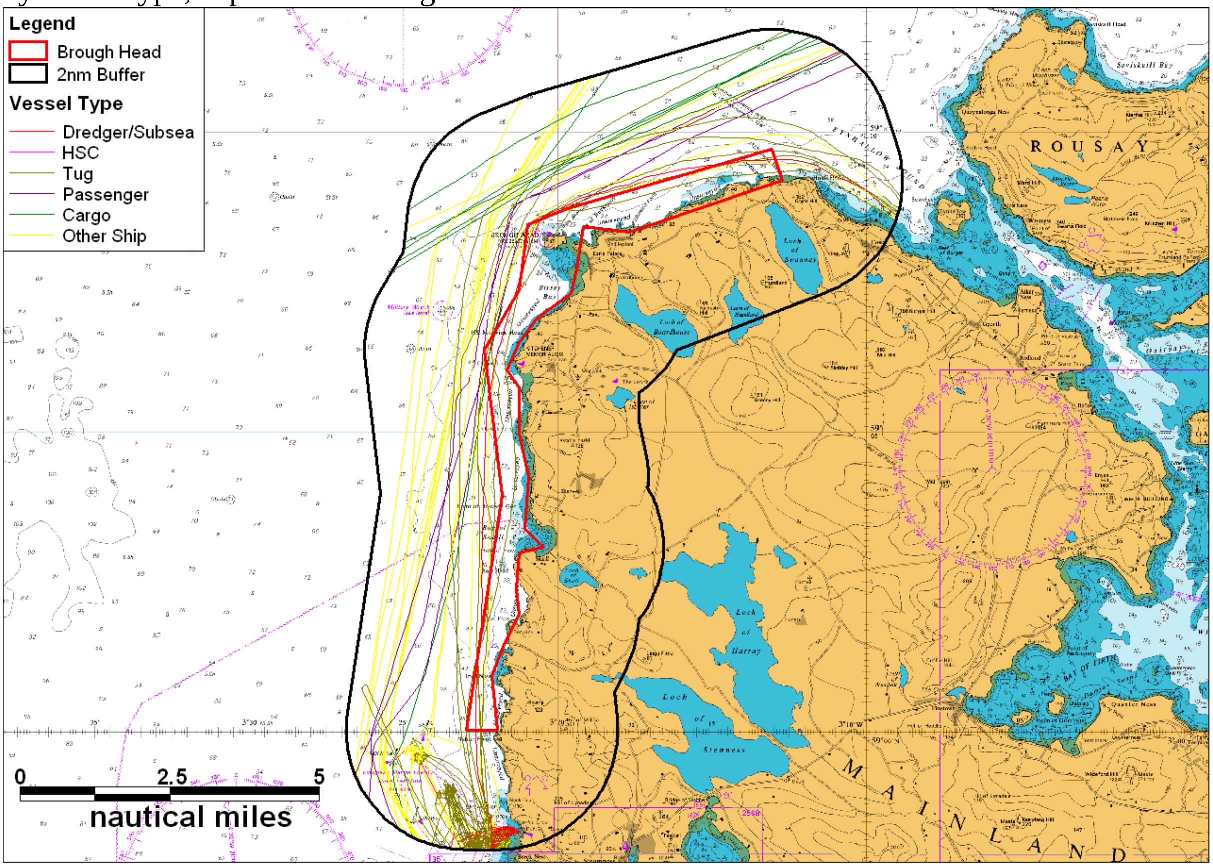


Figure 4-12 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Brough Head Site

The distribution of vessel types recorded within 2nm of the Brough Head site during the combined traffic survey period is presented in Figure 4-13.

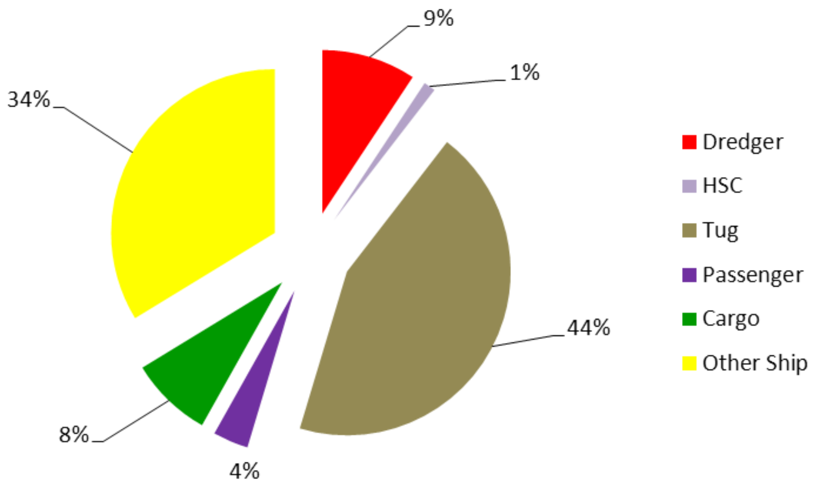


Figure 4-13 Vessel Type Distribution Identified during the Combined Survey Period

The most common vessel types recorded within 2nm of the Brough Head wave farm during the combined 56 day period were tugs (44%) and other ships (34%). The average number of unique vessels per day passing within 2nm of the site was approximately two vessels per day. During the survey period, 12 vessels were tracked passing through the Brough Head site.

The largest vessel recorded passing within 2nm of the site during the combined survey period was the general cargo vessel *Eendracht*. This vessel was recorded on two days passing to the north of the site with a length of 105m and a draught of 5.5m. The vessel with the deepest draught to pass through the Brough Head site was the fish carrier *Gerda* Saele with a draught of 4.7m and a length of 36m and the longest vessel to pass within the site was the passenger vessel *Pentalina* with a length of 70m. It is noted that this is not the usual route for the vessel *Pentalina* (ferry) and this vessel may not regularly transit this route. The tracks of these vessels can be seen in Figure 4-14.

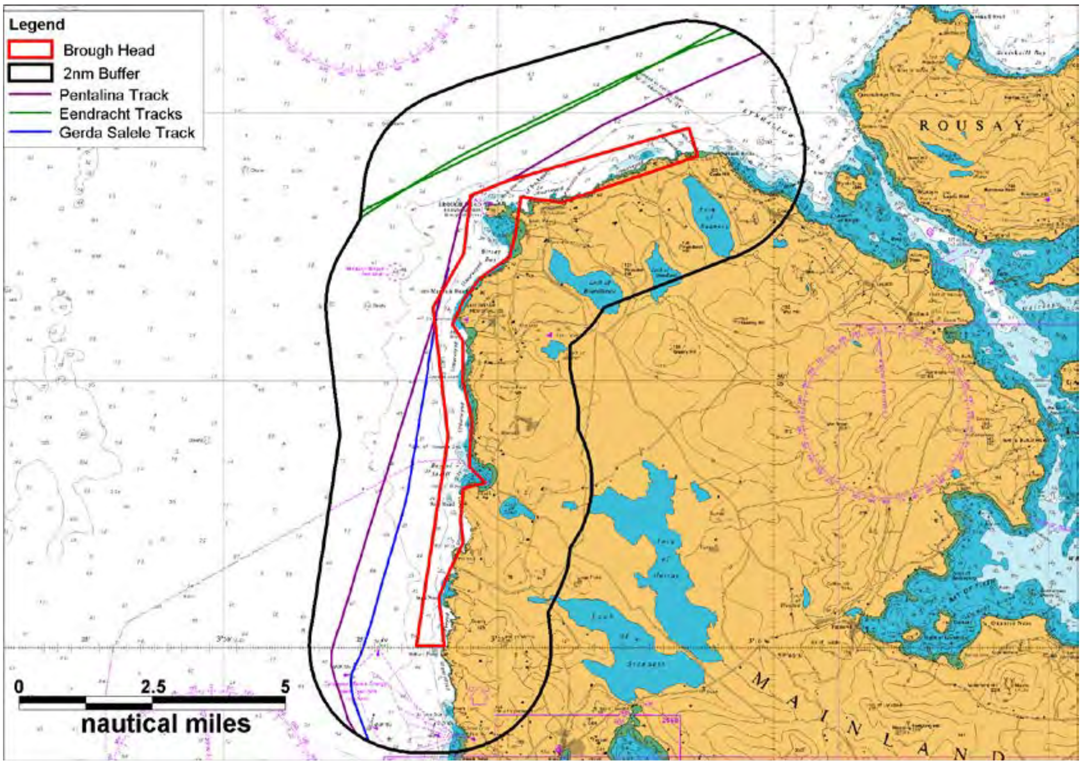


Figure 4-14 Overview of *Largest* Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-15.

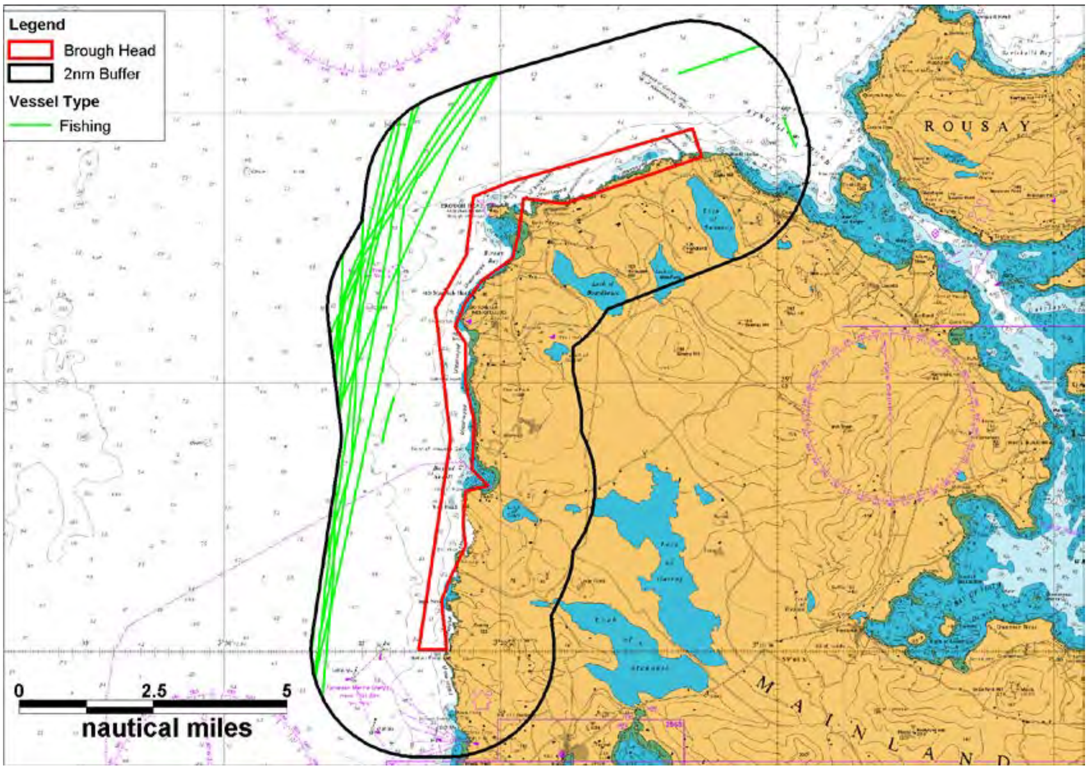


Figure 4-15 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Brough Head Site

During the survey period 11 unique fishing vessels were recorded passing within 2nm of the Brough Head site, the majority travelling to fishing grounds north of the proposed site. There were no fishing vessels recorded within the site. The longest vessel to pass within 2nm of the site was the *F/V Brisan* at 36m with a broadcasted draught of 4m.

4.6.2 Costa Head

Costa Head wave farm is located approximately 2nm north of the coast of Orkney with an area of 7.1nm^2. Figure 4-16 presents the location of the site with a 2nm buffer in place.

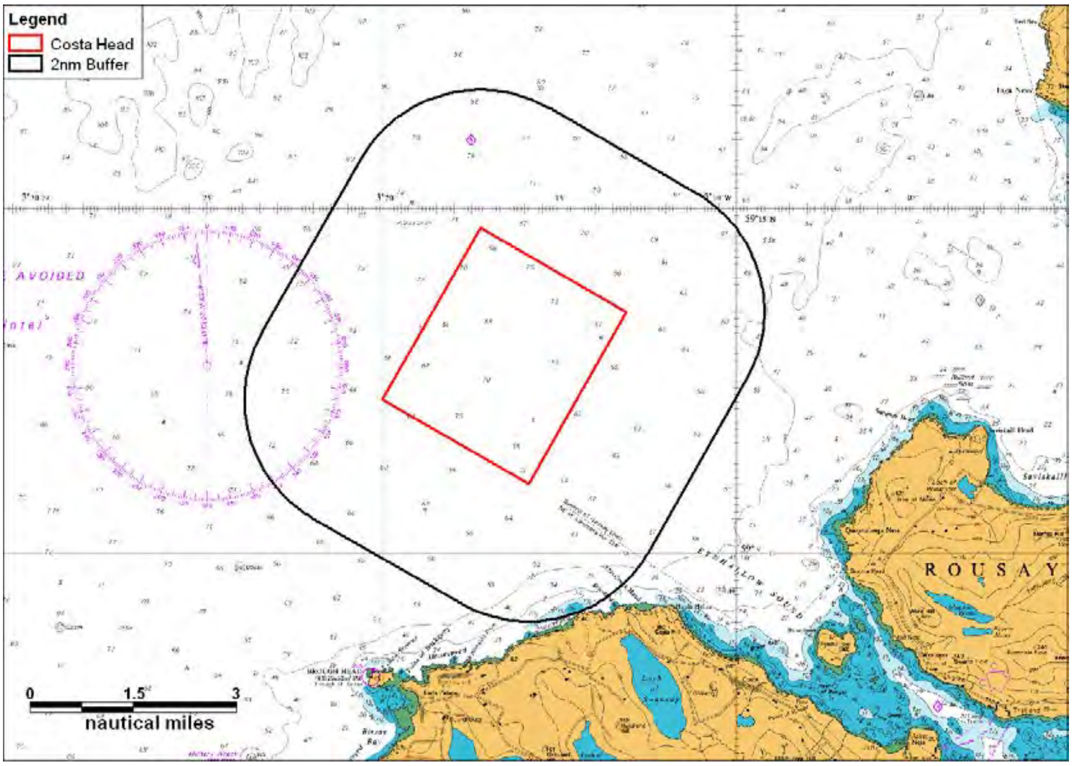


Figure 4-16 Costa Head Wave Farm Location

An overview of the combined 56 days winter and summer 2012 days, colour-coded by vessel type and cropped within 2nm of the Costa Head wave farm can be seen in Figure 4-17.

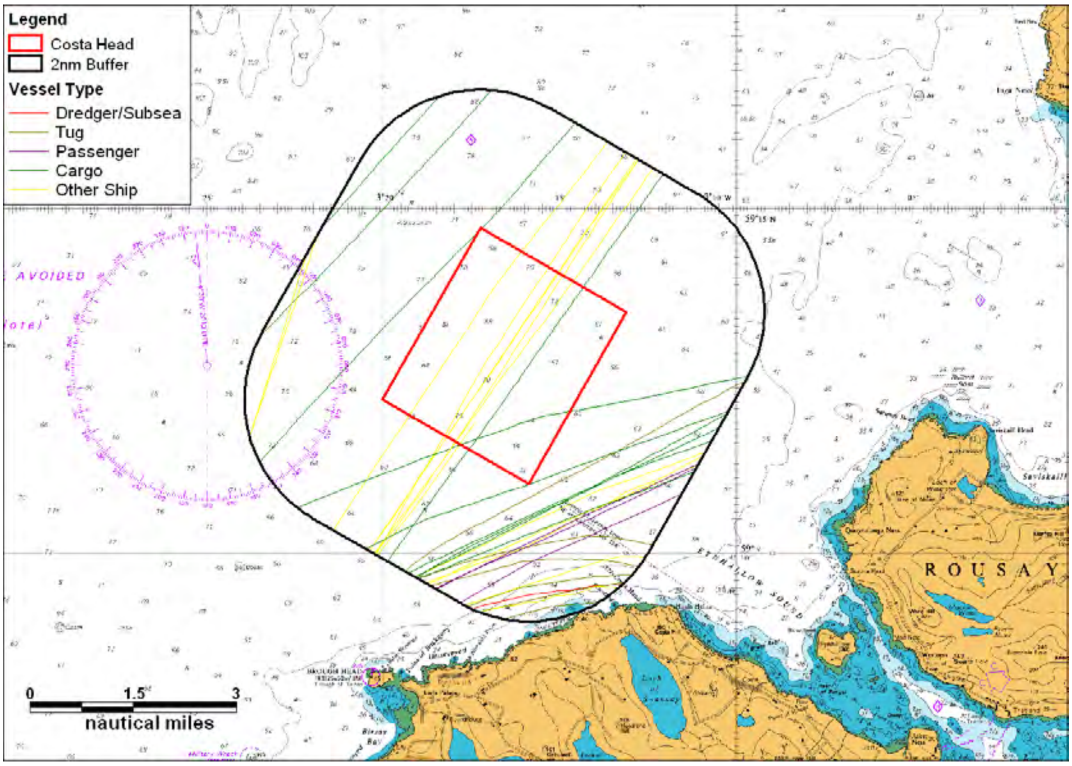


Figure 4-17 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) Relative to Costa Head Site

The distribution of vessel types recorded within 2nm of the Costa Head site during the combined traffic survey period is presented in Figure 4-18.

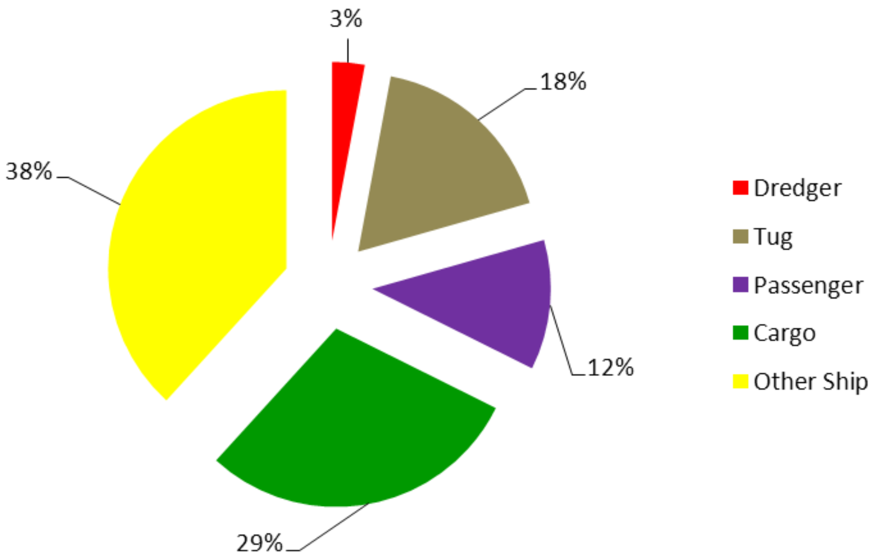


Figure 4-18 Vessel Type Distribution Identified during the Combined Survey Period

During the combined 56 day period, the most common types of vessel passing within 2nm of the Costa Head wave farm were other ships (38%), cargo vessels (29%) and tugs (18%).

There was an average of one unique vessel passing within 2nm of the site per day, ten vessels were identified as passing through the Costa Head Site during the survey period.

The largest vessel recorded within 2nm of the site was the cruise ship *Princess Daphne* (track on the very edge of the buffer/obscured by line). This vessel was recorded on 24th July 2012 crossing the very north of the 2nm buffer destined for Reykjavik (Iceland) with a length of 161m and a recorded draught of 7.8m. The longest vessel recorded passing within the Costa Head site was the general cargo vessel *Valborg* with a length of 65m and the vessel with the deepest draught to pass through the site during the survey period was the fish carrier *Ronja Settler* with a draught of 4.8m recorded on seven occasions. The tracks of these vessels can be seen in Figure 4-19.

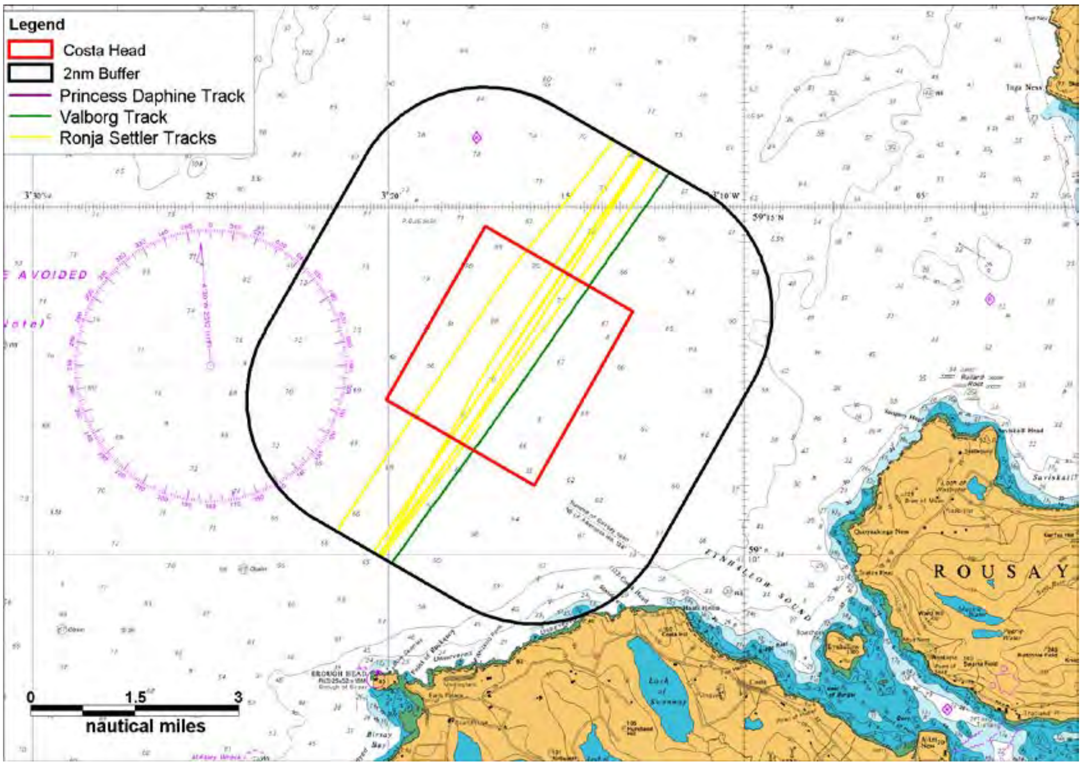


Figure 4-19 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-20.

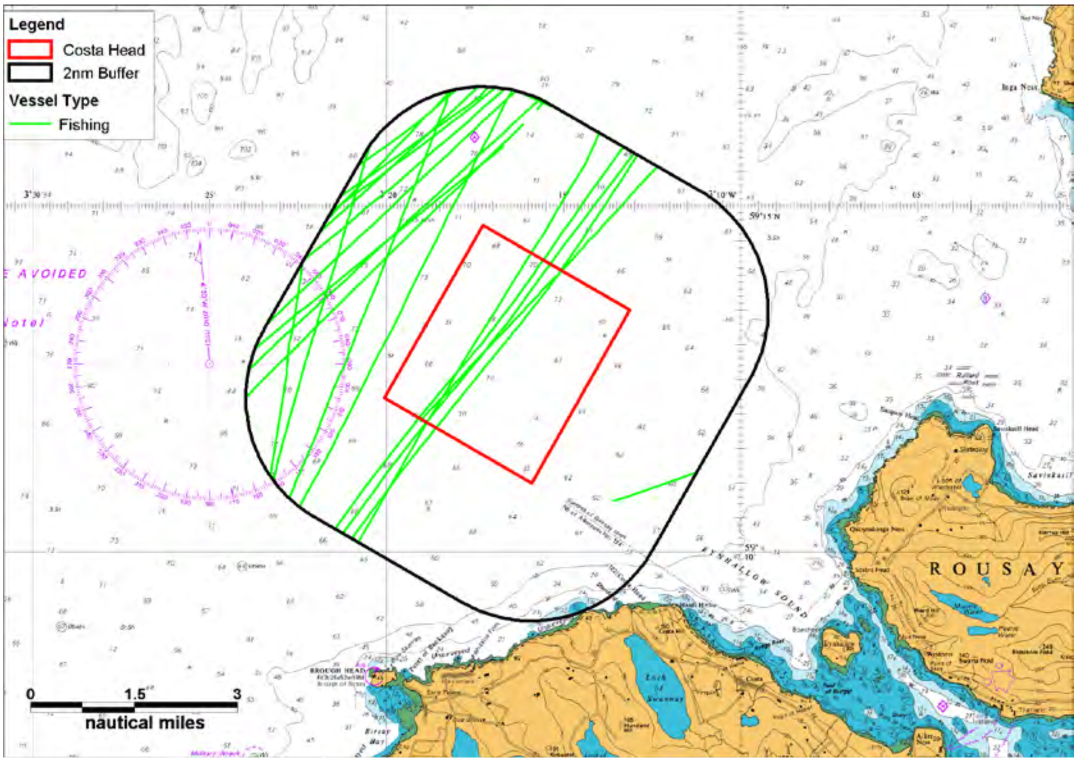


Figure 4-20 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Costa Head Site

There were 22 tracks of fishing vessels steaming within 2nm of the proposed wave site during the 56 day survey period, of these vessels 5 were recorded within the site travelling between Scrabster and fishing grounds to the NE of the site. The longest fishing vessel to pass within 2nm of the site was the *Altaire* at 73m with a broadcasted draught of 5m.

4.6.3 Marwick Head

The proposed Marwick Head wave farm is approximately 1.2nm west of Orkney Mainland, occupying an area of 2.3nm^2. The location of the site can be seen in Figure 4-21, with a 2nm buffer placed around the site for context.

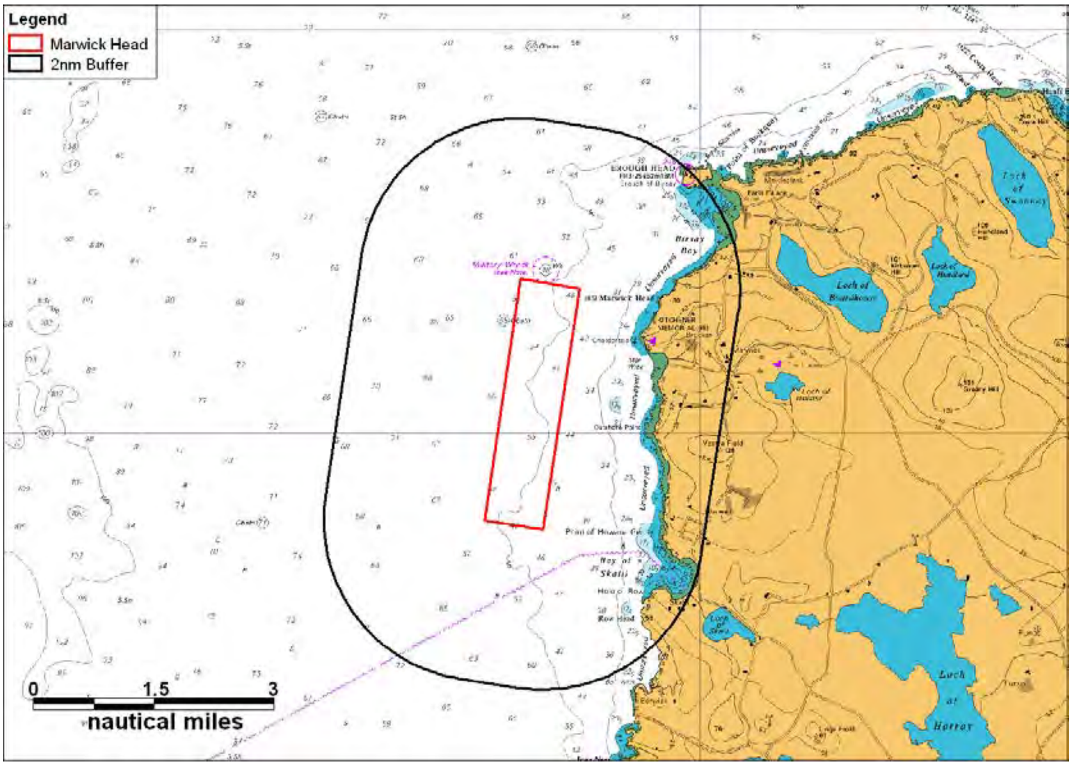


Figure 4-21 Marwick Head Wave Farm Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of Marwick Head wave farm and the vessel type distribution can be seen in Figure 4-22 and Figure 4-23 respectively.

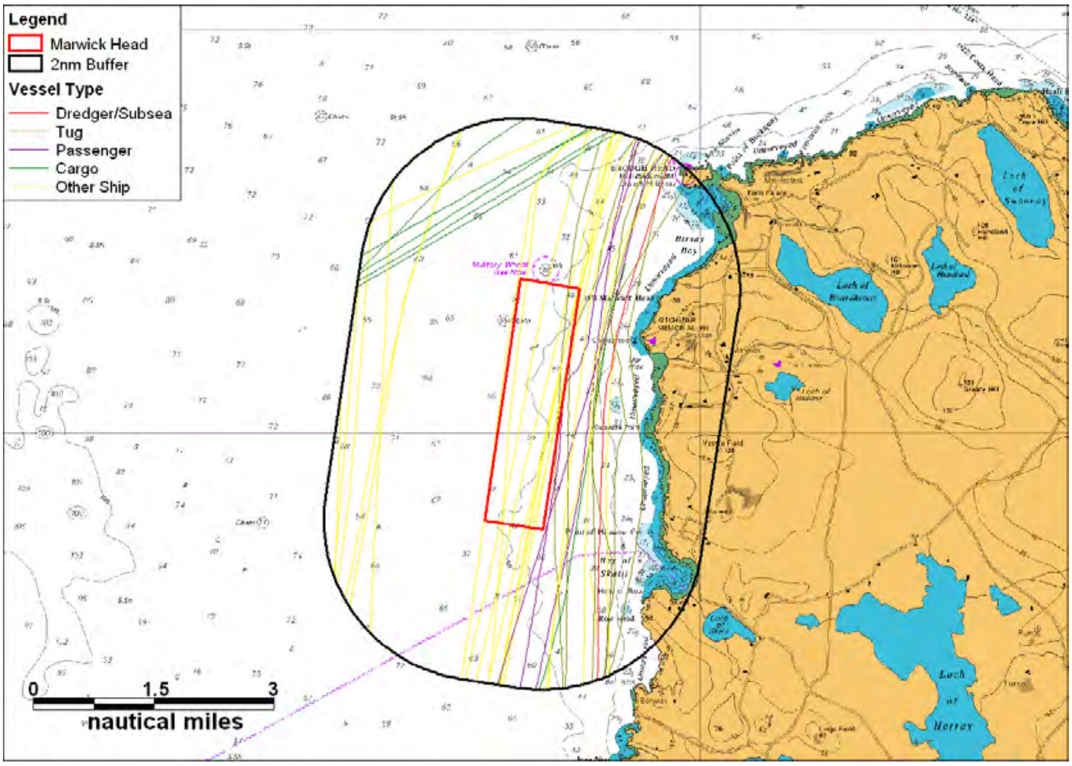


Figure 4-22 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Marwick Head Site

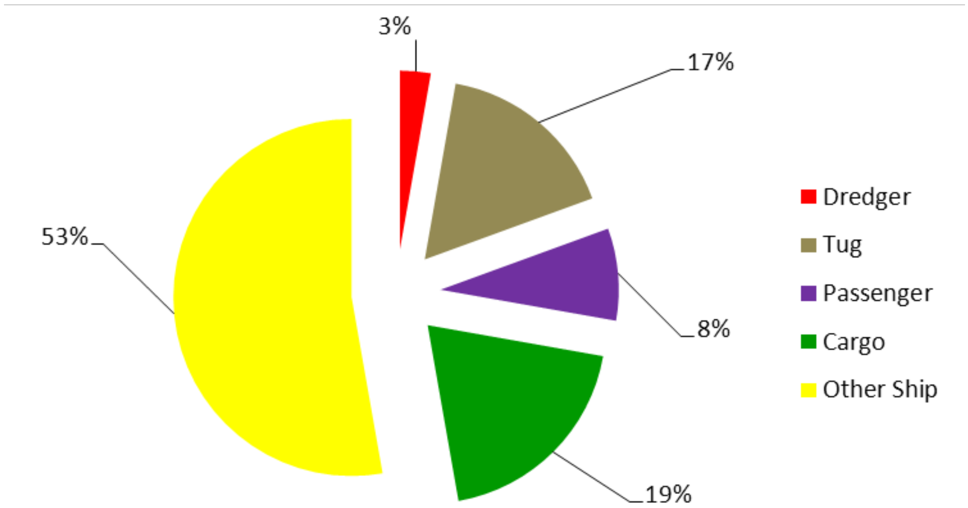


Figure 4-23 Vessel Type Distribution Identified during the Combined Survey Period

The most common vessel types recorded within 2nm of the Marwick Head wave farm during the combined 56 day period other ships (53%), cargo vessels (19%) and tugs (17%). The average number of vessels per day passing within 2nm of the site was less than one vessel per day. During the survey period, 10 vessels were recorded passing through the proposed Marwick Head site.

The longest vessel recorded passing within 2nm of the site during the combined survey period was the general cargo vessel *Eendracht* with a length of 105m and the vessel with the deepest draught to pass within 2nm was the survey vessel *Geco Topaz* with a draught of 7.4m. The longest vessel recorded passing through the Costa Head site was the cruise ship *Hebridean Princess* with a length of 72m and the vessel with the deepest draught to pass through the site during the survey period was the fish carrier *Ronja Settler* with a draught of 4.8m recorded on 6 occasions. The tracks of these vessels can be seen in Figure 4-24.

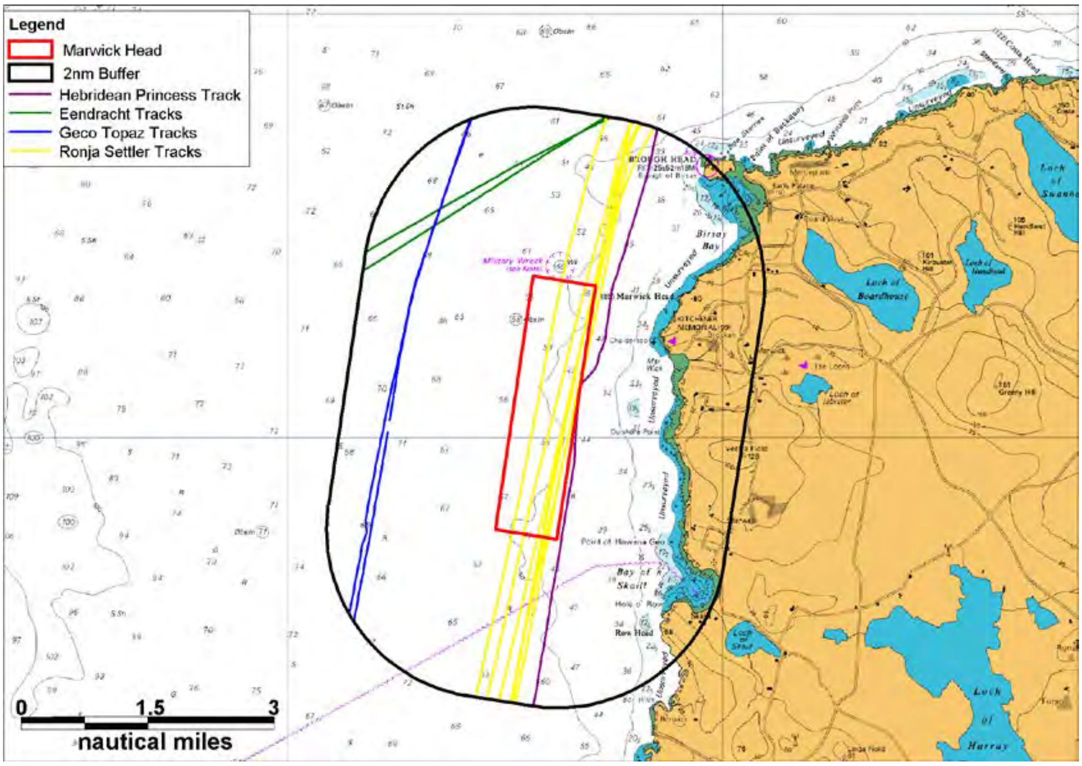


Figure 4-24 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-25.

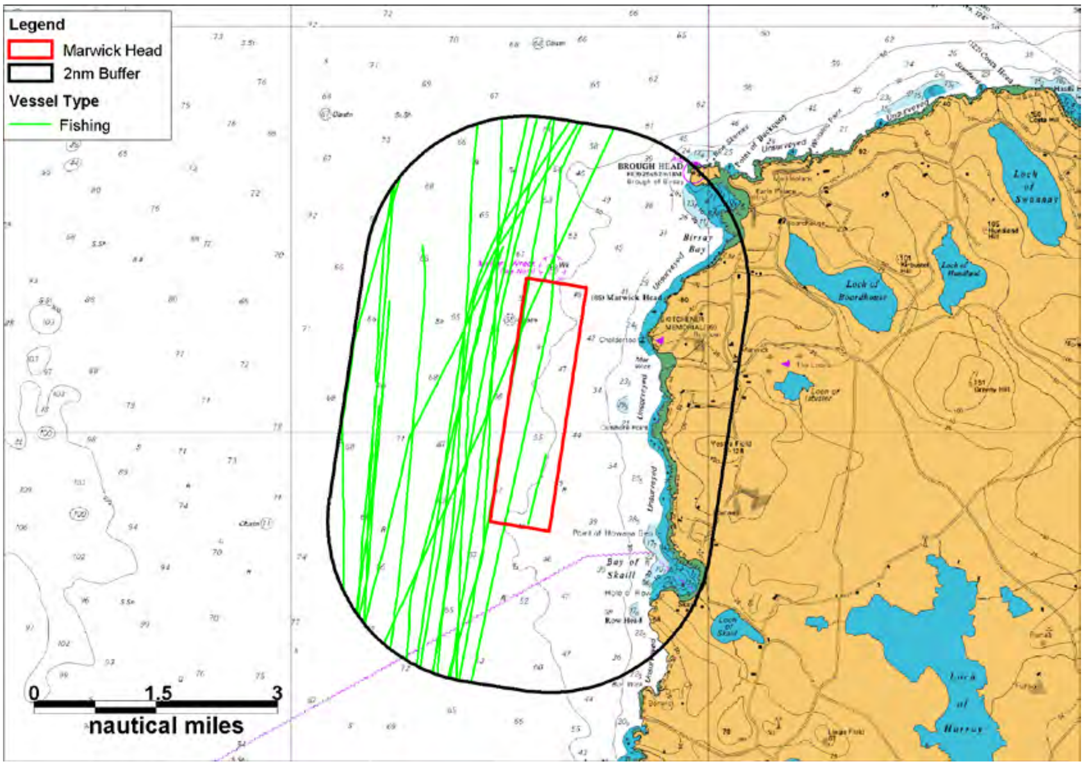


Figure 4-25 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Marwick Head Site

During the 56 day survey period, no vessels were recorded engaged in fishing within 2nm of the proposed development site. There were 20 vessel tracks recorded on passage between fishing grounds to the north and ports such as Scrabster. Of these vessels, three were recorded to pass within the proposed site. The longest vessel to pass within 2nm of the site was the *Sandettie* at 86m with a broadcasted draught of 6m.

4.6.4 West Orkney Middle South

The West Orkney Middle South wave farm is located approximately 1.6nm west of Orkney Mainland, occupying an area of 8.7nm^2. The following Figure 4-26 shows the location of the site.

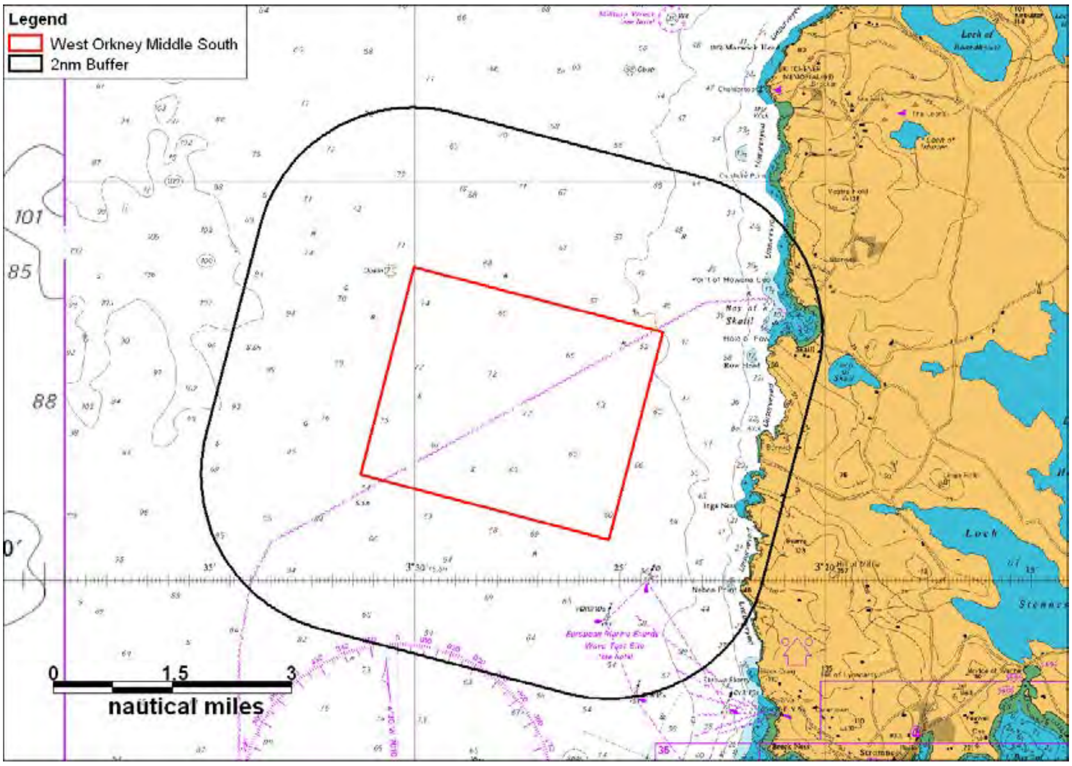


Figure 4-26 West Orkney Middle South Wave Farm Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of West Orkney Middle South wave farm and the vessel type distribution can be seen in Figure 4-27Figure 4-26 and Figure 4-28 respectively.

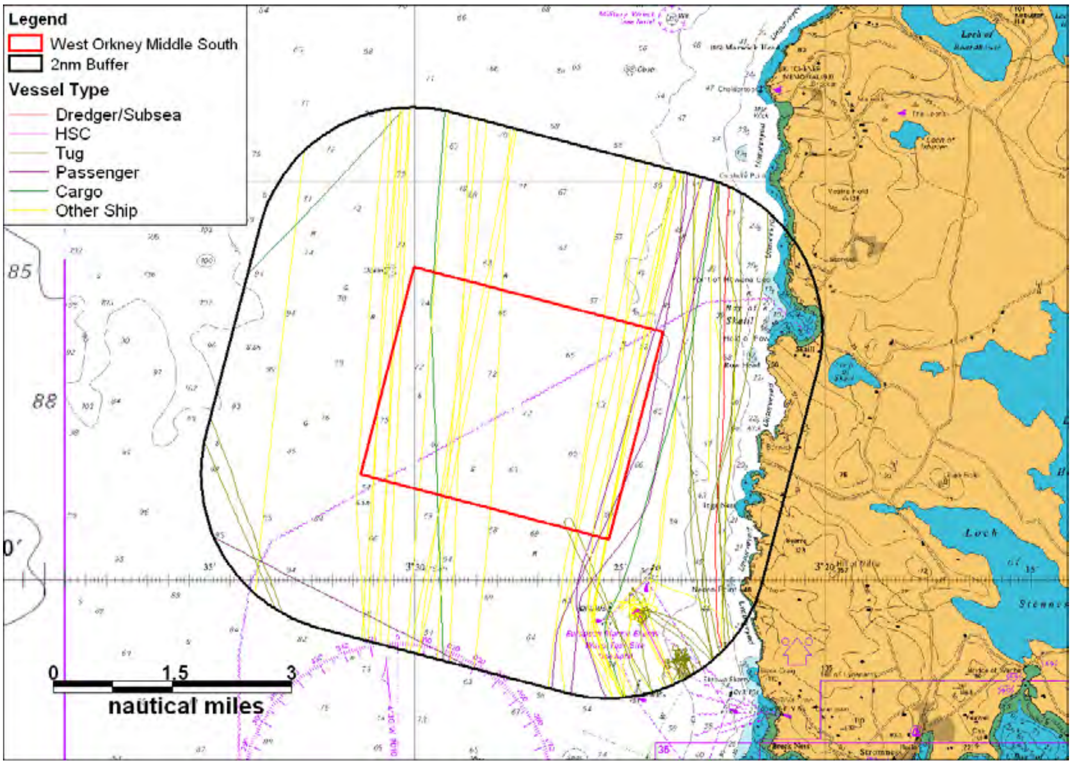


Figure 4-27 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to West Orkney Middle South Site

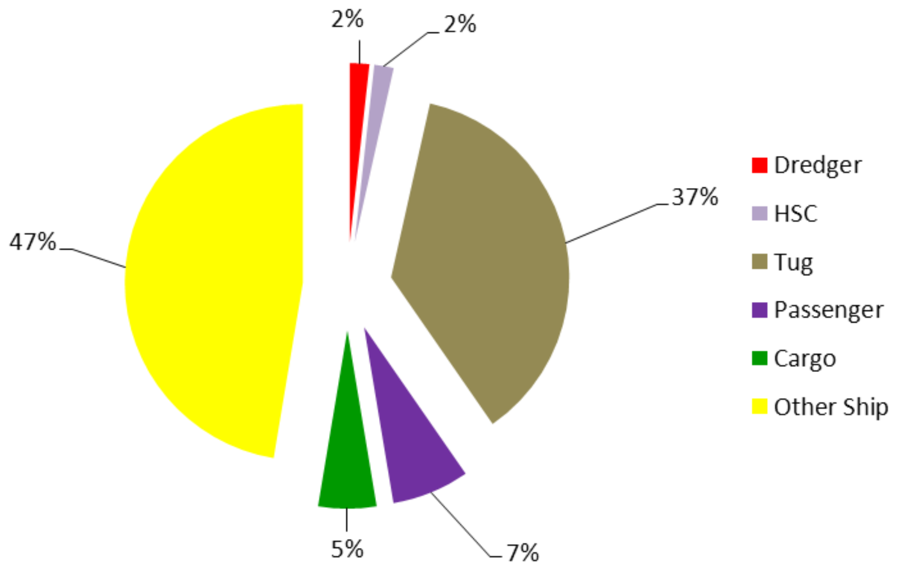


Figure 4-28 Vessel Type Distribution Identified during the Combined Survey Period

It can be seen that the majority of vessels passing within 2nm of the West Orkney Middle South site were found to be other ships (47%) and tugs (37%). The average number of vessels per day passing within 2nm of the site was between 1 and 2 vessels per day. During the survey period, 22 vessels were recorded passing through the proposed West Orkney Middle South site.

The longest vessel passing within 2nm of the site during the combined survey period was the passenger vessel *MS Hamburg* with a length of 144m destined for Stromness and the vessel with the deepest draught to pass within 2nm was the survey vessel *Geco Topaz* with a draught of 7.4m, which also passed within the site. The longest vessel to pass within the site was the containership *Swani* with a length of 90m. The tracks of these vessels can be seen in Figure 4-29.

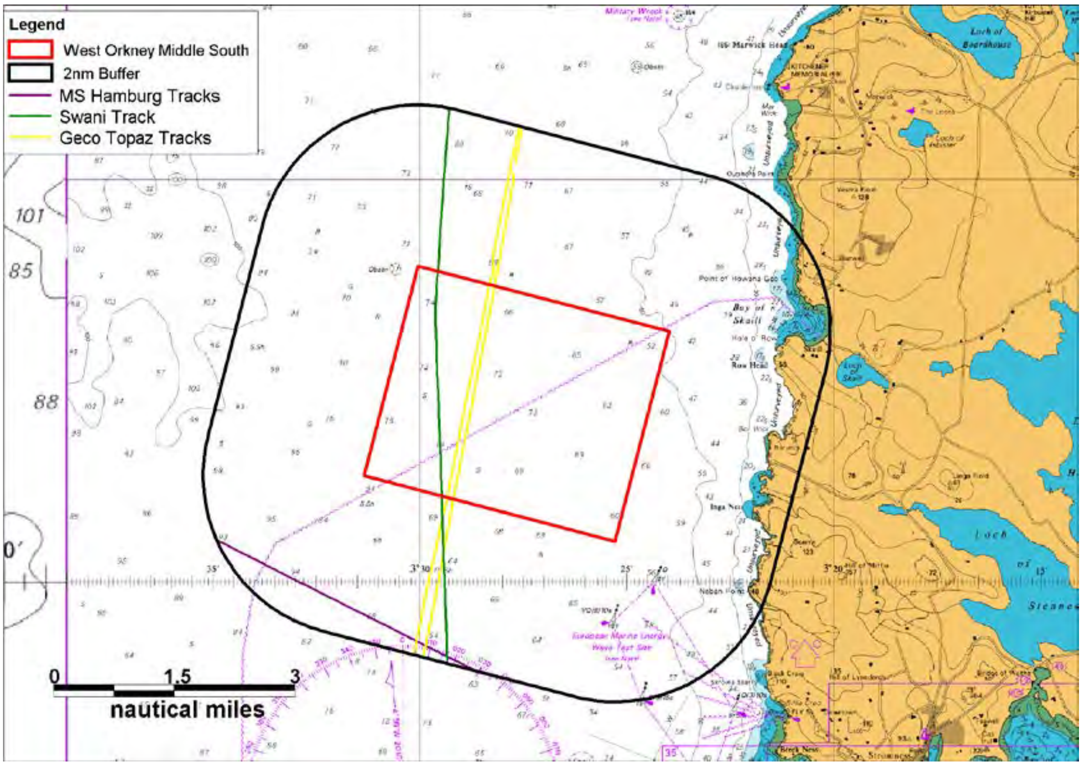


Figure 4-29 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-30.

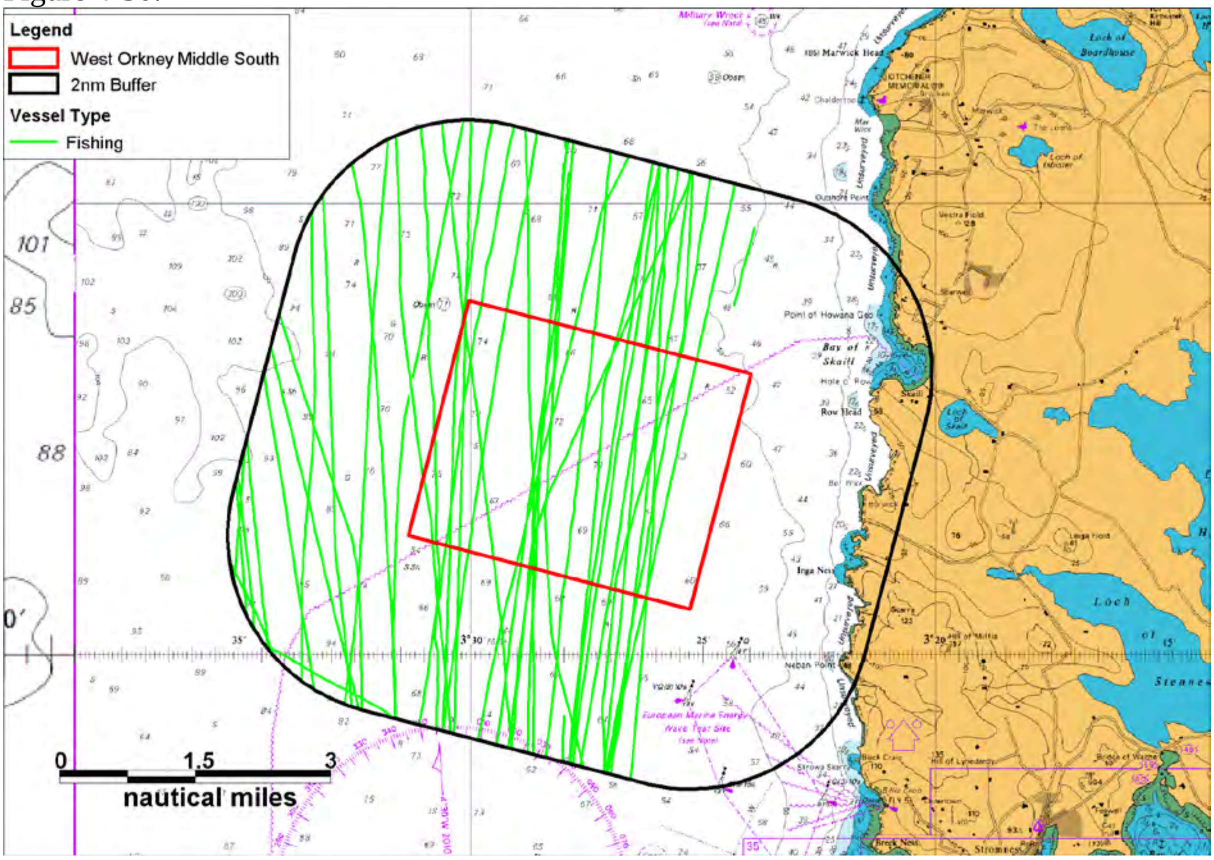


Figure 4-30 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to West Orkney Middle South

During the 56 day survey period, vessels were recorded only steaming within 2nm of the West Orkney Middle South site. There were 40 vessel tracks recorded within 2nm of the site, of which 25 passed within the site. These vessels were travelling between fishing grounds to the north and ports such as Scrabster. The longest vessel to pass within 2nm of the site was the *Sandettie* at 86m with a broadcasted draught of 6m.

4.6.5 West Orkney South

The West Orkney South wave farm is located approximately 2.1nm west of Orkney Mainland, occupying an area of 8.7nm^2. Figure 4-31 presents the location of the wave farm site.

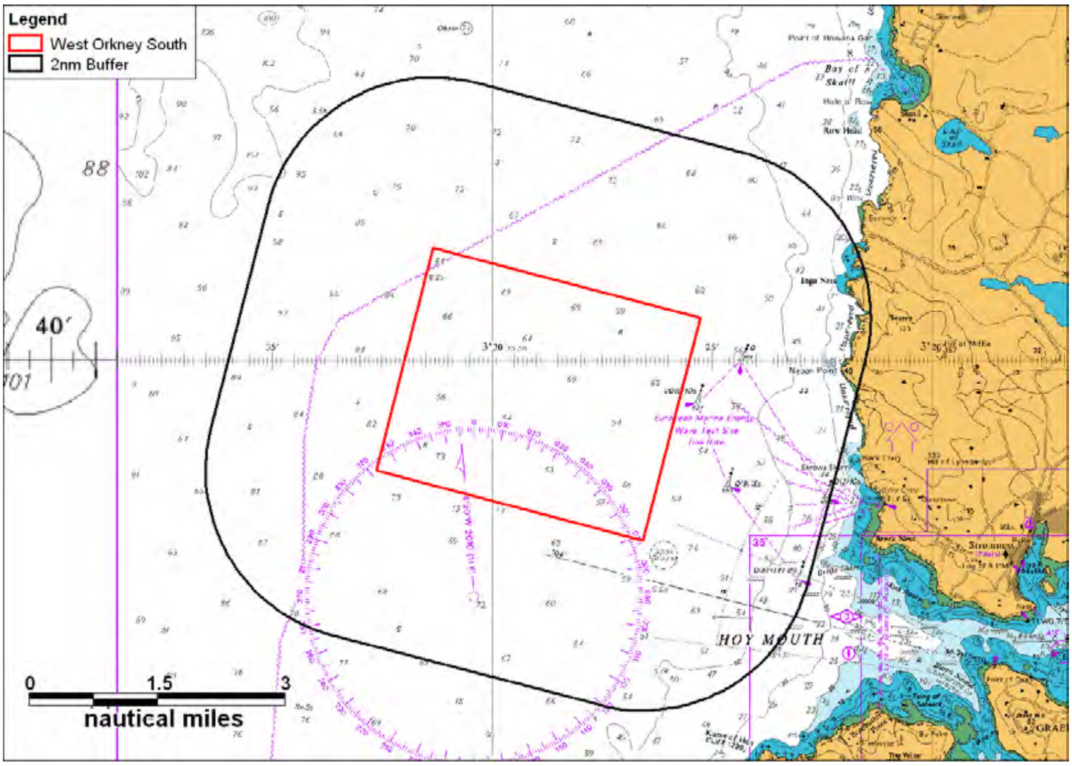


Figure 4-31 West Orkney South Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of West Orkney South wave farm and the vessel type distribution can be seen in Figure 4-32 and Figure 4-33 respectively.

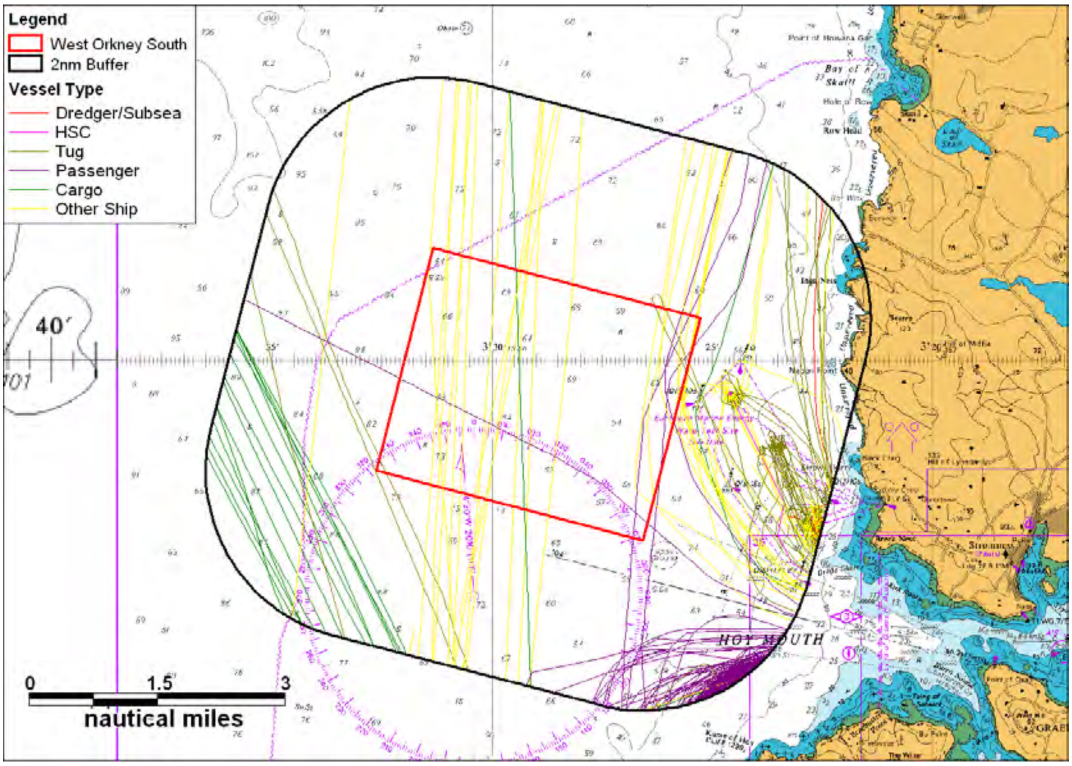


Figure 4-32 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to West Orkney South Site

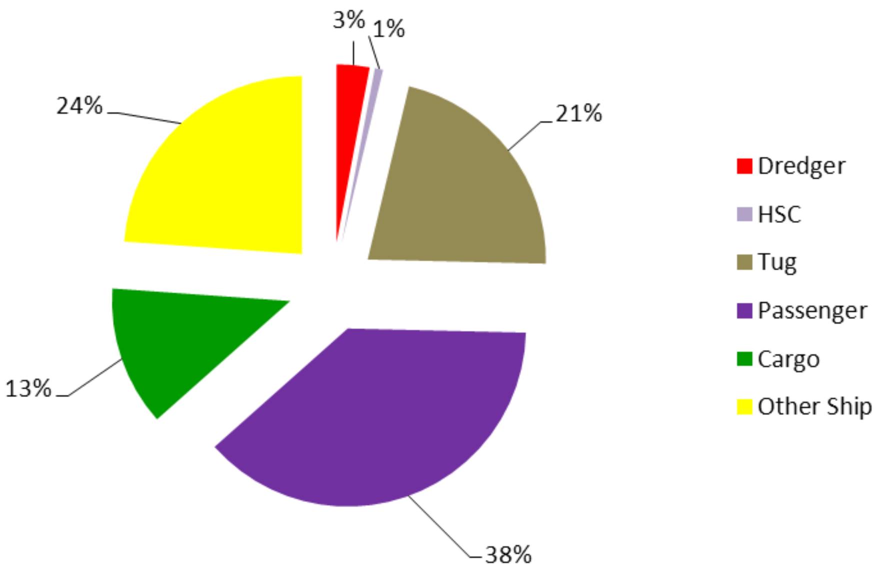


Figure 4-33 Vessel Type Distribution Identified during the Combined Survey Period

The majority of vessels recorded within 2nm of the West Orkney South wave farm site were found to be passenger vessels (38%), other ships (24%) and tugs (21%). The passenger vessels *Hamnavoe* and *Hjaltland* were recorded towards the south east of the 2nm buffer. These ferries operate between the Orkney Islands. The average number of vessels recorded within 2nm of this site was between 2 to 3 vessels per day, with 25 vessels during the survey period passing through the proposed site

The largest vessels recorded during the 56 day combined period within 2nm of the site were the cargo vessels *Godafoss* and *Dettifoss*. These vessels were recorded on seven separate occasions destined for Rotterdam, with a length of 165m and 166m respectively and broadcast draughts between 7.8m and 8.9m. The longest vessel to pass within the site was the containership *Swani* with a length of 90m and the vessel with the deepest draught to pass within the site was the survey vessel *Geco Topaz* with a draught of 7.4m. The tracks of these vessels can be seen in Figure 4-34.

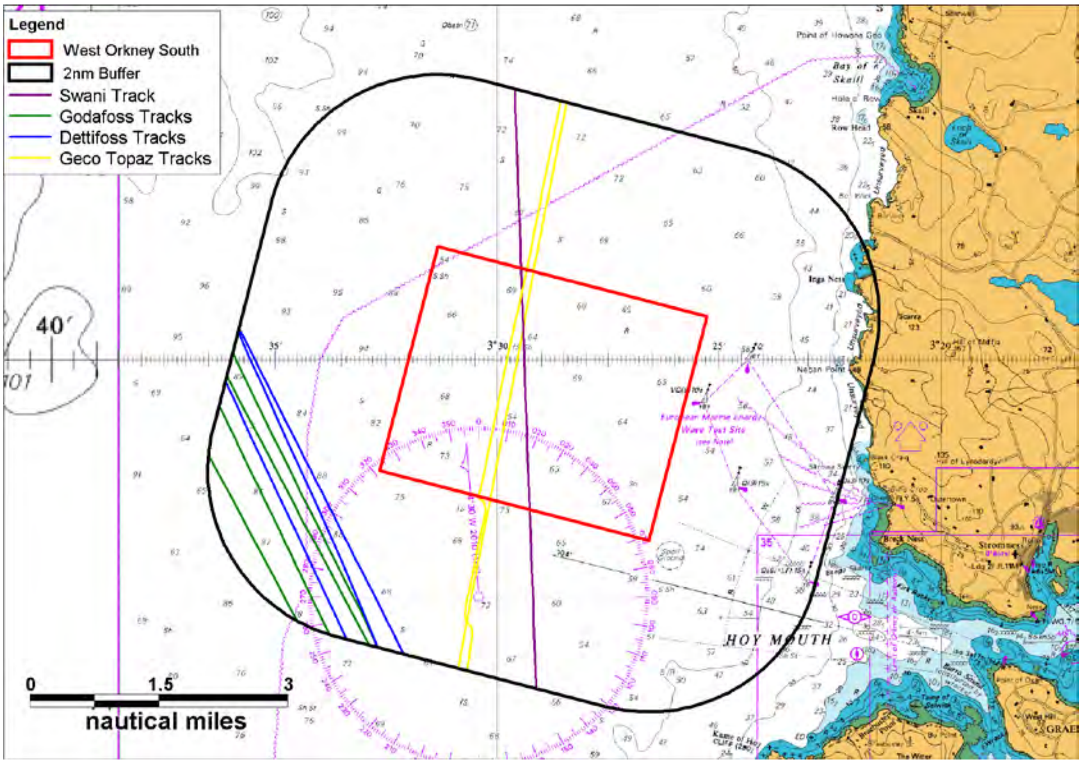


Figure 4-34 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-35.

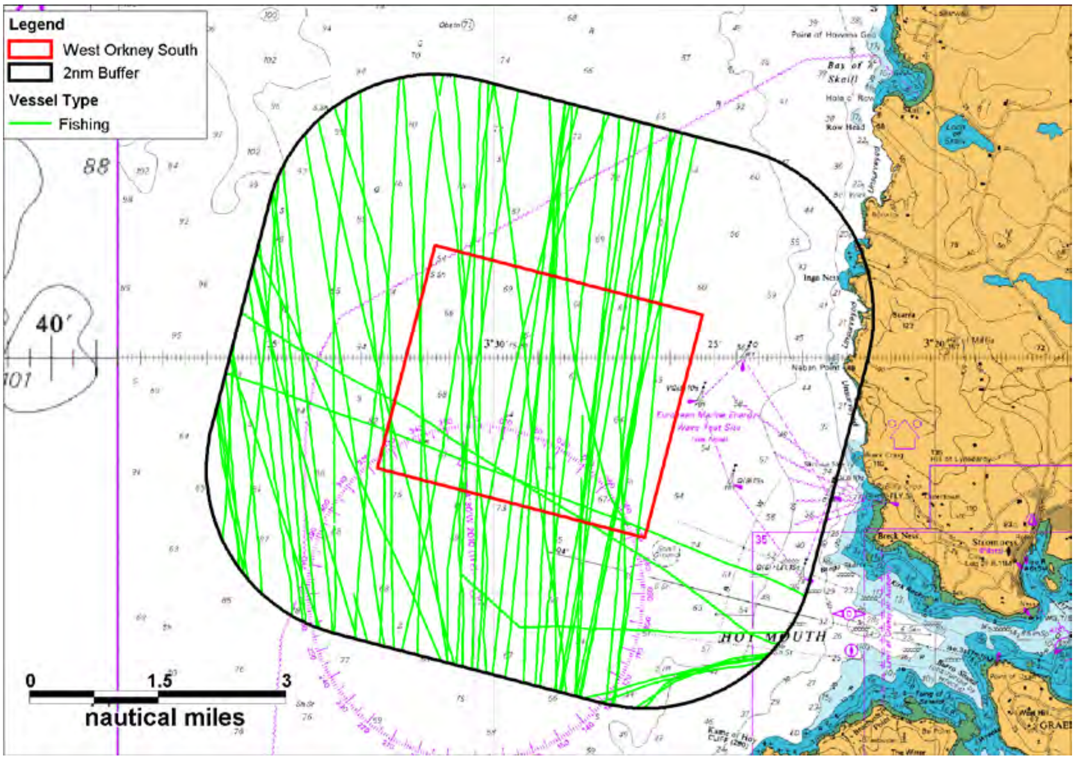


Figure 4-35 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to West Orkney South

There were 53 recorded tracks of fishing vessels steaming within 2nm of the proposed site during the survey period, of which 33 passed through the proposed site. The majority of vessels were travelling between fishing grounds to the north and fishing ports such as Scrabster. The longest vessel to pass within 2nm of the site was the *Sandettie* at 86m with a broadcasted draught of 6m. A small number of vessels were recorded operating out of Stromness.

4.6.6 Brough Ness

Brough Ness tidal site is located approximately 0.2nm south of South Ronaldsay, covering an area of approximately 0.9nm^2. This site can be seen in Figure 4-36.

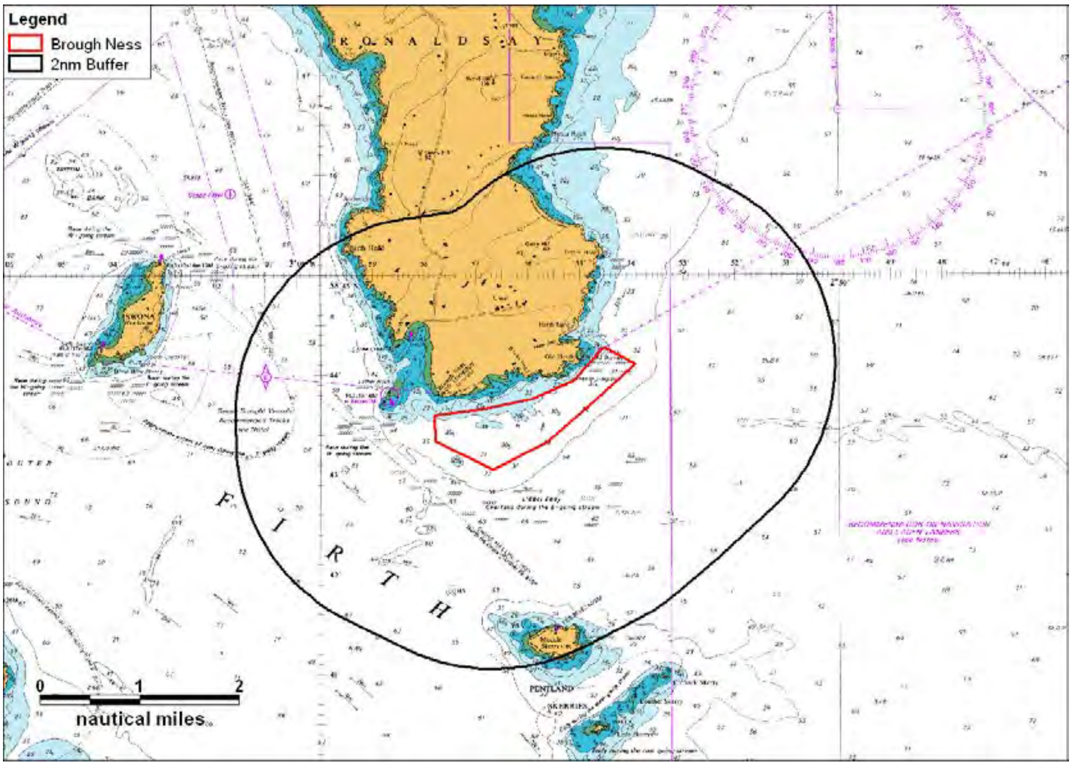


Figure 4-36 Brough Ness Tidal Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of the Brough Ness site and the vessel type distribution can be seen in Figure 4-37 and Figure 4-38 respectively.

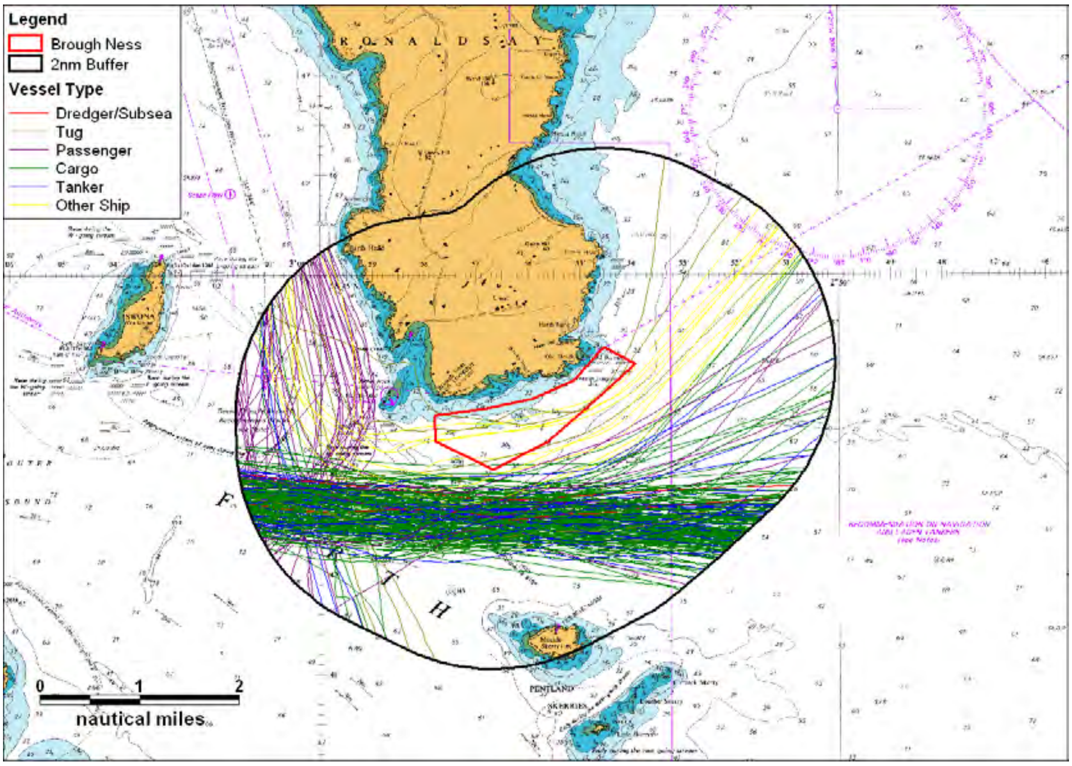


Figure 4-37 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Brough Ness Site

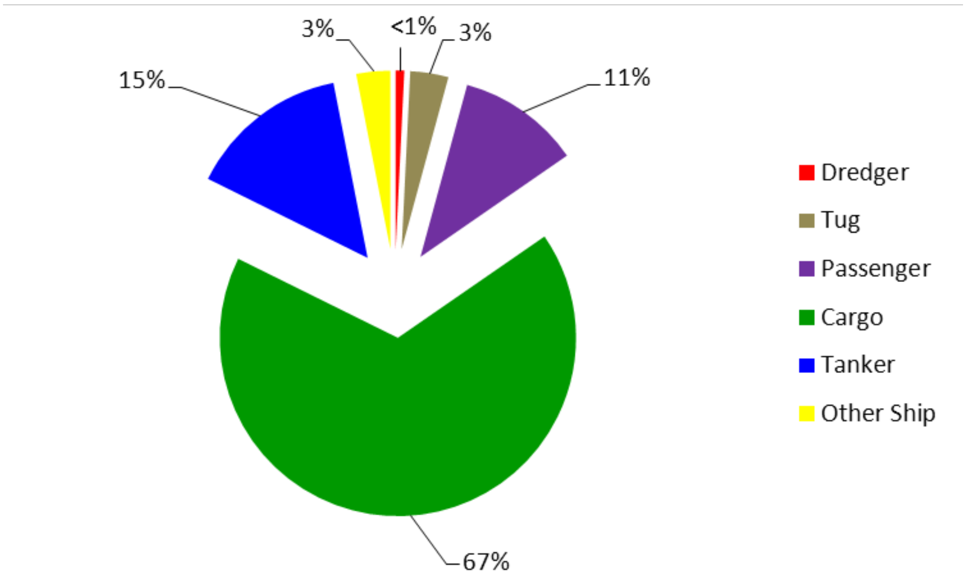


Figure 4-38 Vessel Type Distribution Identified during the Combined Survey Period

The vast majority of vessels recorded within 2nm of the Brough Ness site during the combined 56 day period were cargo vessels (67%) followed by tankers (15%) and passenger vessels (11%). This is due to the busy shipping lane passing to the south of the site in which a large amount of tankers and cargo vessels travel to destinations including Dublin, Glensanda, Londonderry, Runcorn, St Petersburg and Warrenpoint. The passenger vessel *Pentalina* is also found transiting to the west of the site, travelling between mainland Scotland and Orkney.

The average number of vessels passing within 2nm of the Brough Ness site is approximately five per day, with nine vessels passing within the site during the survey period. The largest vessel recorded within 2nm was the container vessel *Atlantic Companion* with a length of 292m and the vessel with the deepest draught was the crude oil tanker *SC Sara* with a broadcasted draught of 14.7m. The largest vessel to pass within the Brough Ness site was the general cargo vessel *Flinterbirka* with a length of 81m and a draught of 5.1m. The tracks of these vessels can be seen in Figure 4-39.

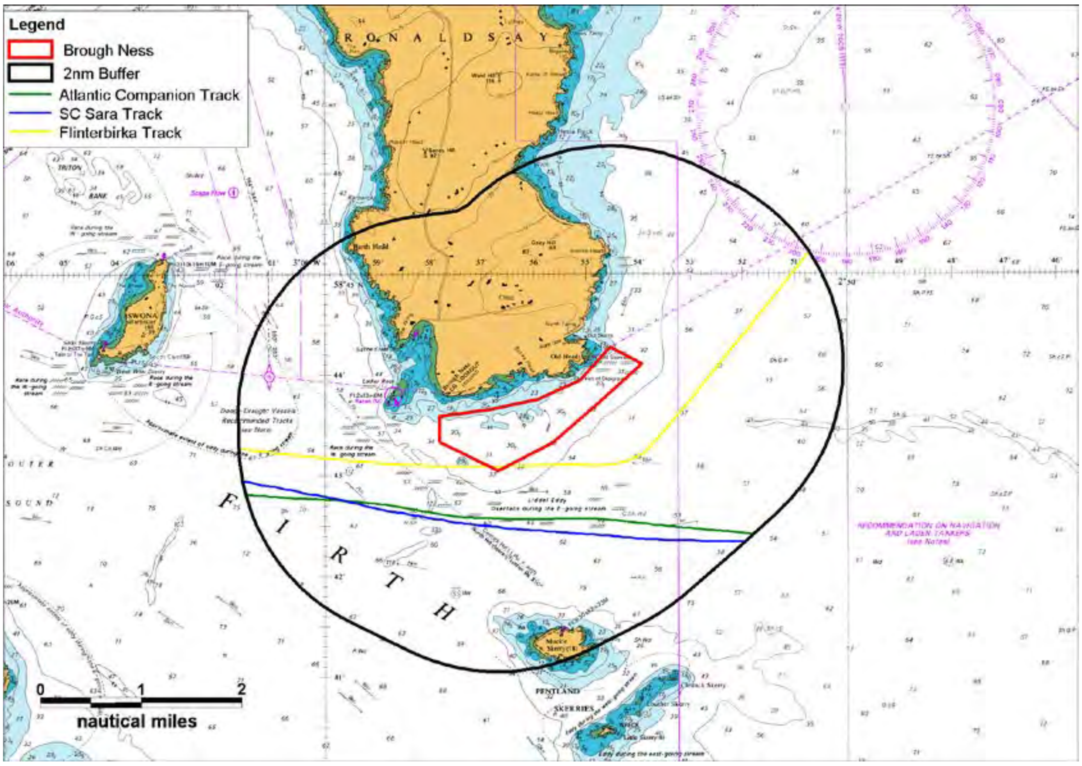


Figure 4-39 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-40.

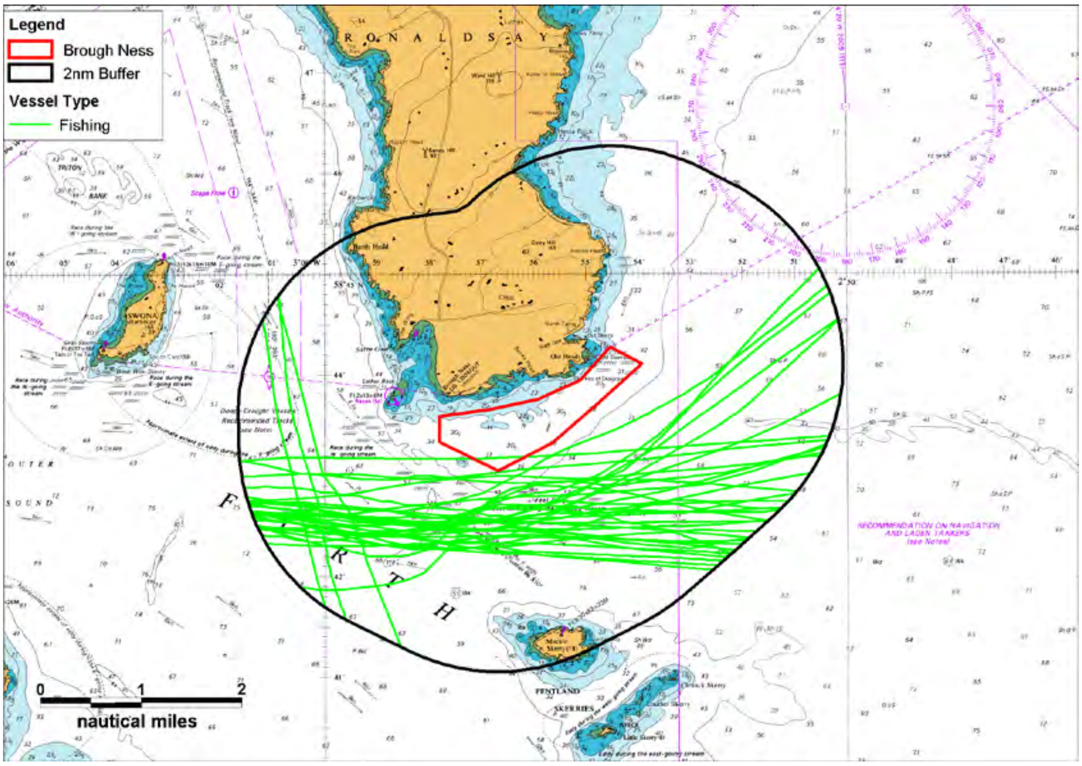


Figure 4-40 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Brough Ness

During the survey period only one fishing vessel was recorded passing within the proposed site, a further 35 vessels were recorded passing to the south of the site during the 56 day period. The longest of these vessels was the *Voyager* at 75m recorded on three occasions passing within 2nm of the site.

4.6.7 Brims Tidal Array

The Brims Tidal Array site is located off the South Walls Coast, covering an area of approximately 3.2nm^2. This site can be seen in Figure 4-41.

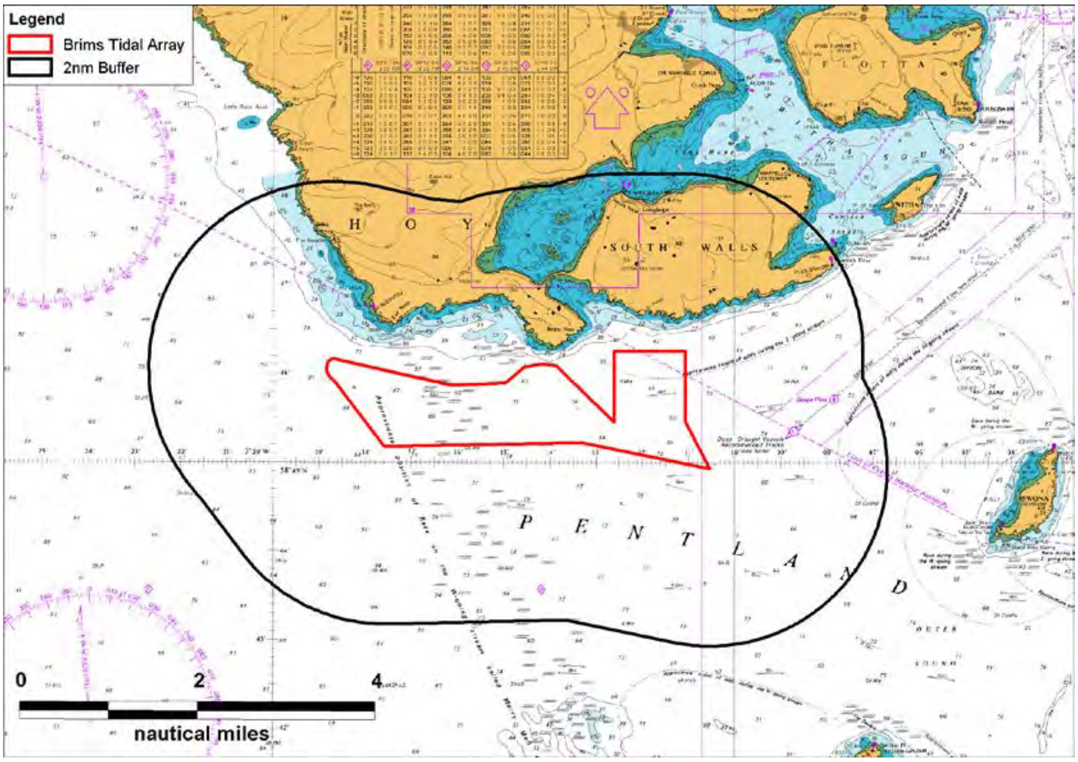


Figure 4-41 Brims Tidal Array Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of the Brims Tidal Array site and the vessel type distribution can be seen in Figure 4-42 and Figure 4-43 respectively.

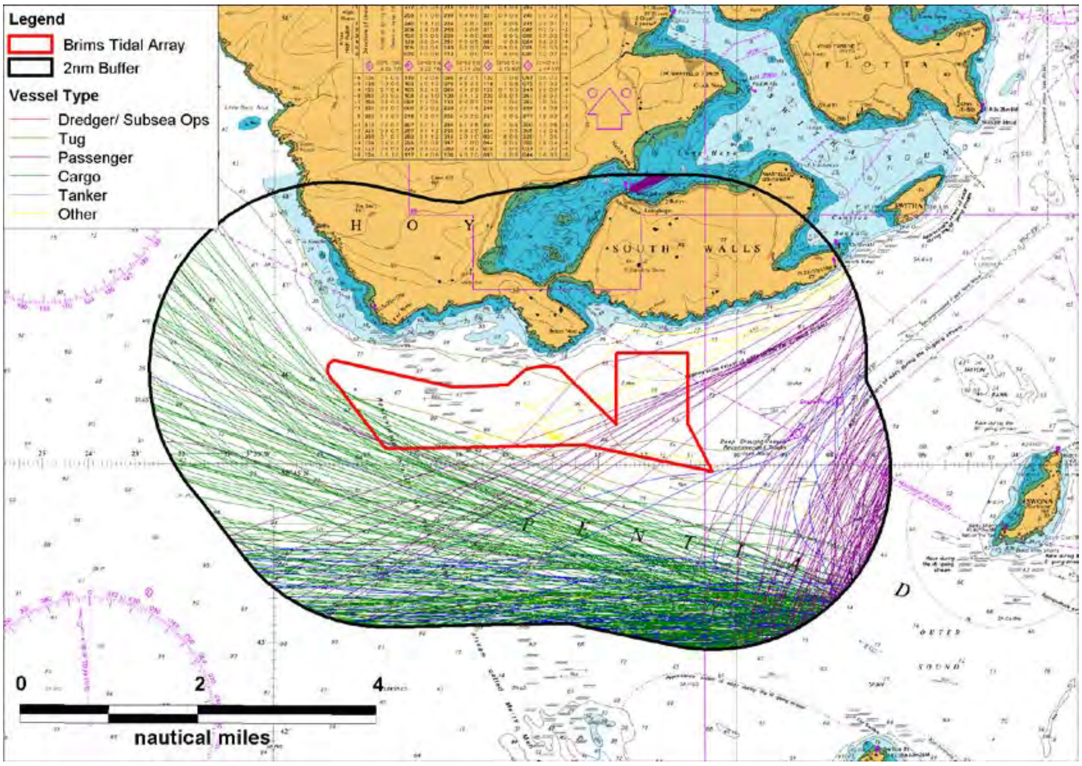


Figure 4-42 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Brims Tidal Array Site

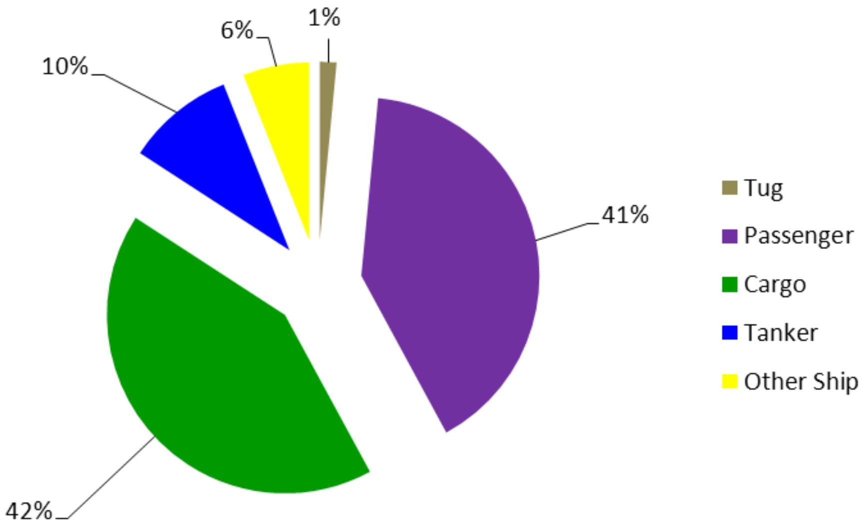


Figure 4-43 Vessel Type Distribution Identified during the Combined Survey Period

The majority of vessels recorded within 2nm of the Brims site during the combined summer and winter period were cargo vessels (42%) and passenger vessels (41%). This distribution is due to the location of the site within close proximity to the passenger vessels *Pentalina*, *Hamnavoe* and *Hoy Head* travelling between the Orkney Islands. There is also a relatively large proportion of cargo vessels located towards the south west of the 2nm buffer.

The average number of unique vessels passing within 2nm of the Brims site during the summer and winter 2012 survey period was five per day, with 38 vessels passing within the proposed tidal site. The longest vessel to pass within 2nm of the site was the bulk carrier *China Triumph* which passed towards the south of the 2nm buffer with a length of 300m. The vessel with the deepest draught to pass within 2nm was the bulk carrier *Mineral New York* with a broadcast draught of 17.2m. The longest vessel to pass through the site was the passenger vessel *Aidmar* with a length of 253m travelling towards Invergordon and the vessel with the deepest draught to pass through the site was the containership *Godafoss* with a broadcast draught of 8.9m. The tracks of these vessels can be seen in Figure 4-44.

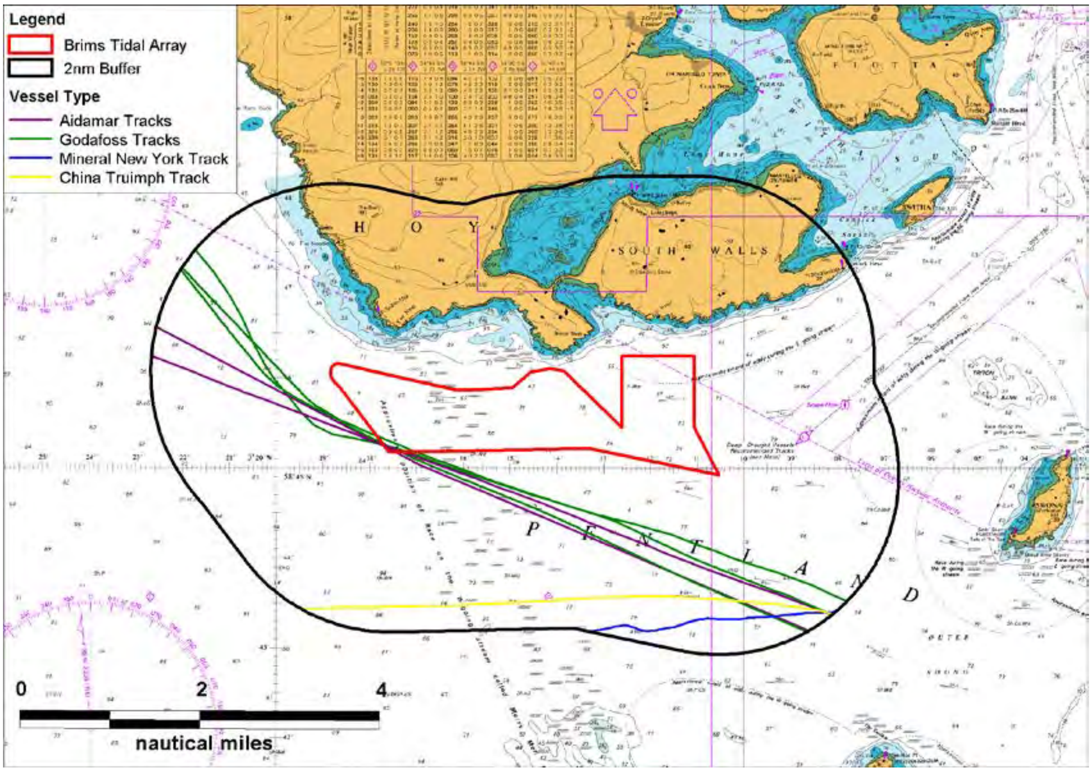


Figure 4-44 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-45.

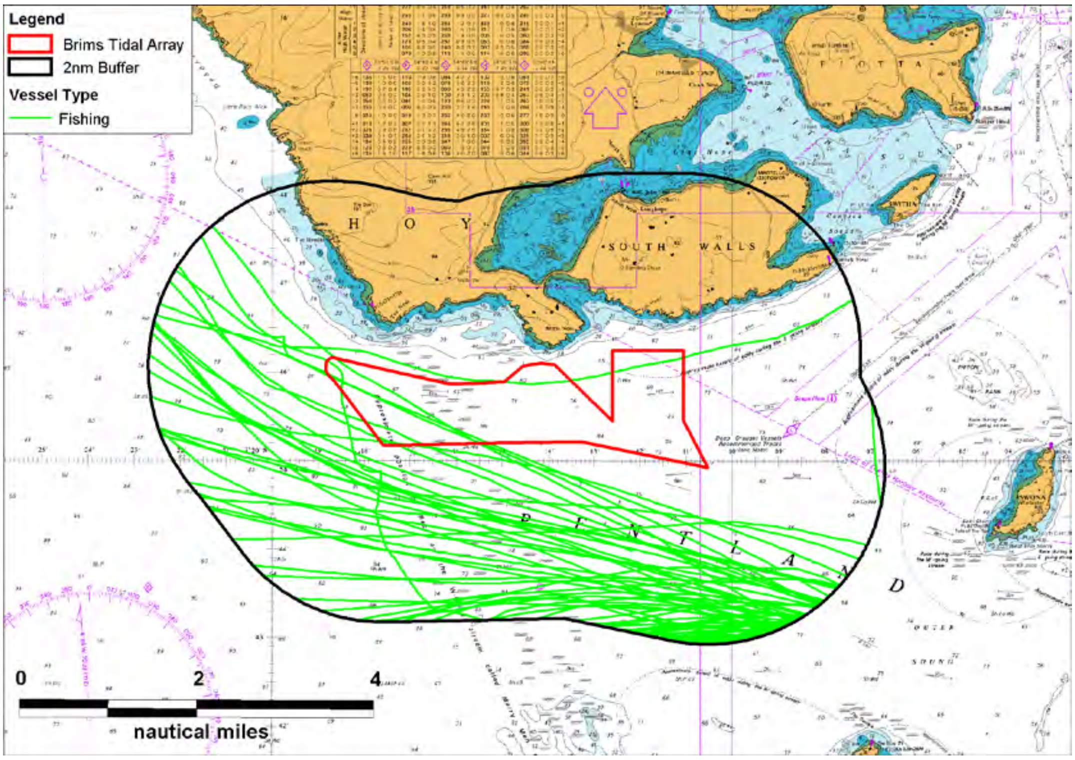


Figure 4-45 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Brims Tidal Array

During the survey period fishing vessels were recorded passing within 2nm of the site travelling between fishing grounds NW of Orkney and mainland Scotland fishing ports including Peterhead and Fraserburgh. Over the 56 day period, 66 vessels were recorded within 2nm of the site with eight of the vessels passing within the proposed site. The longest vessel to pass within 2nm of the site was the *Jan Maria* at 125m with a broadcasted draught of 6.3m. One vessel which passed within the site was recorded travelling from Scapa Flow towards fishing grounds.

4.6.8 Inner Sound

Inner Sound tidal site is located approximately 0.6nm off the Sutherland Coast, with an area of 0.96nm^2. The location of this site can be seen in Figure 4-46.

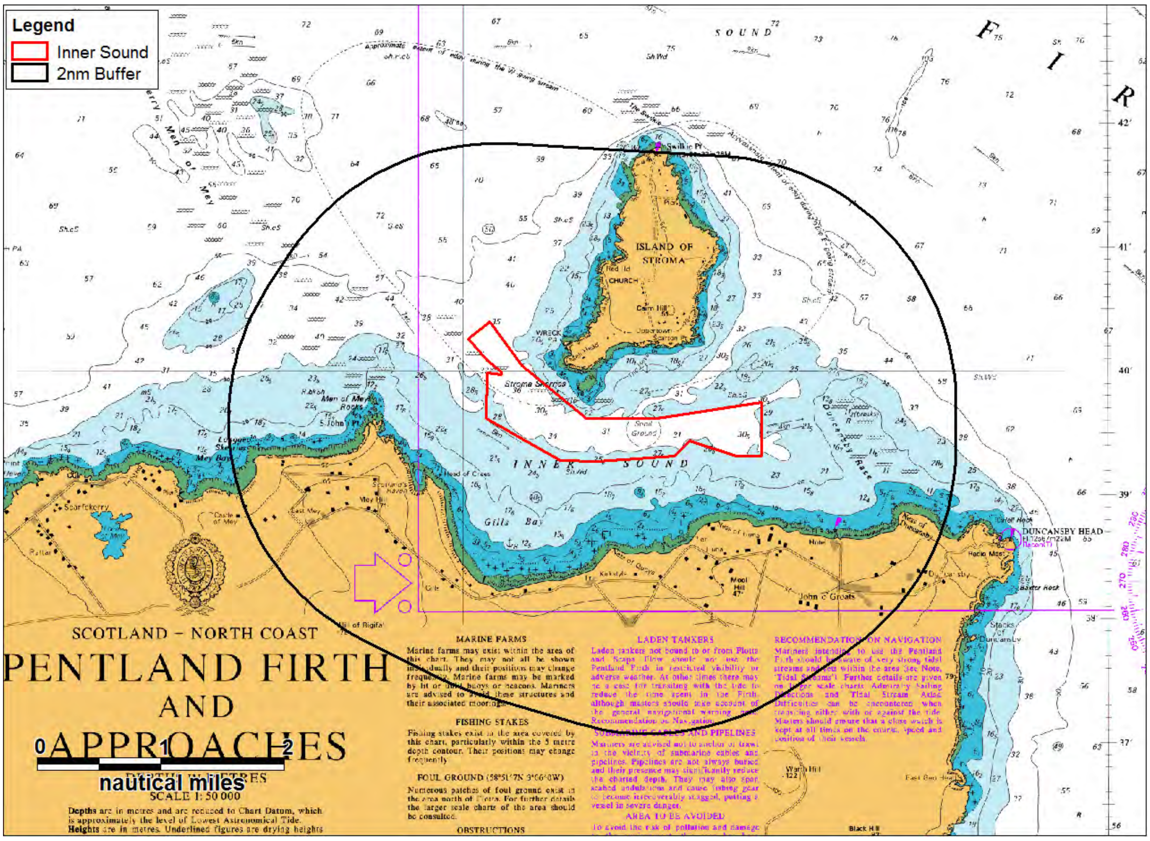


Figure 4-46 Inner Sound Tidal Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of Inner Sound tidal site can be seen in Figure 4-47, with the vessel type distribution presented in Figure 4-48.

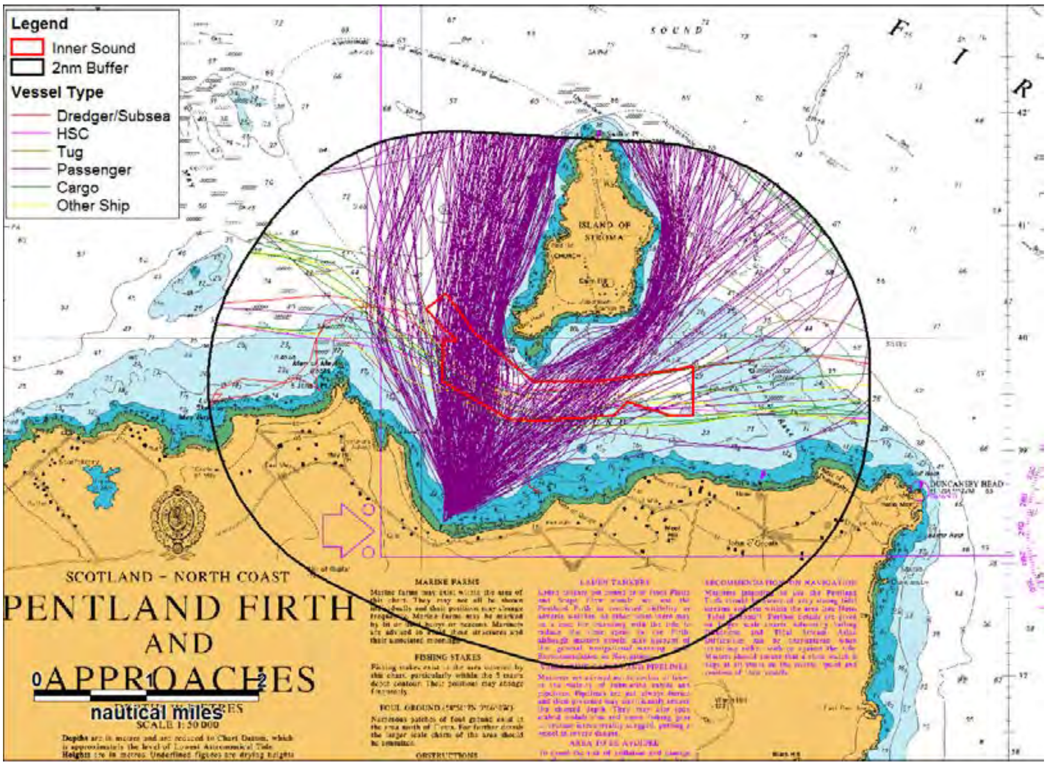


Figure 4-47 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Inner Sound Site

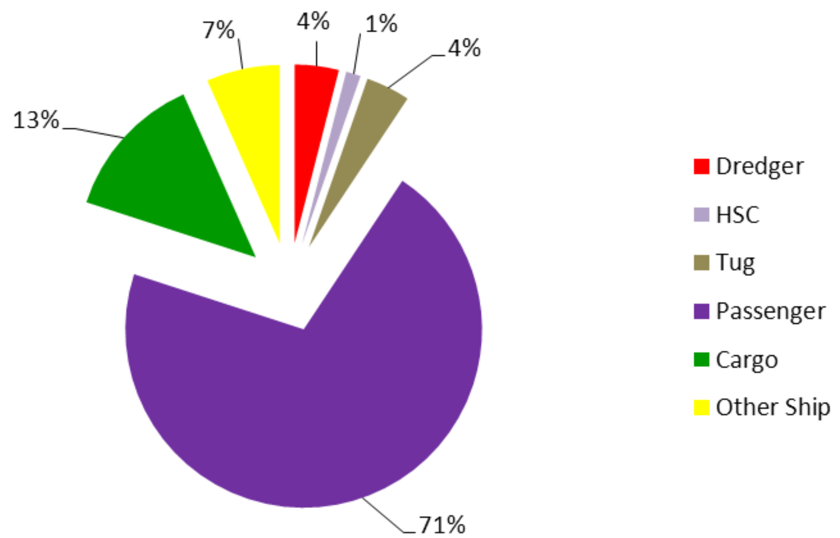


Figure 4-48 Vessel Type Distribution Identified during the Combined Survey Period

The vast majority of vessels recorded within 2nm of the Inner Sound tidal site were passenger vessels (71%). It was found that the passenger vessel *Pentalina* transited through the site daily on route between Gills Bay and St. Margaret's Hope.

The average number of unique vessels passing within 2nm of the Inner Sound site during the 56 day period was 1 vessel per day, with 257 vessels passing within the site. The longest vessel recorded within 2nm of the site was the container ship *Selfoss* which was recorded on two occasions within the study area destined for Reykjavik (Iceland) with a length of 127m. The longest vessel to pass within the site was the passenger vessel *Hamnavoe* with a length of 112m. The vessel with the deepest draught to pass within the site was the general cargo vessel *Arklow Raider* destined for Warrenpoint with a broadcast draught of 6.6m. The tracks of these vessels can be seen in Figure 4-49.

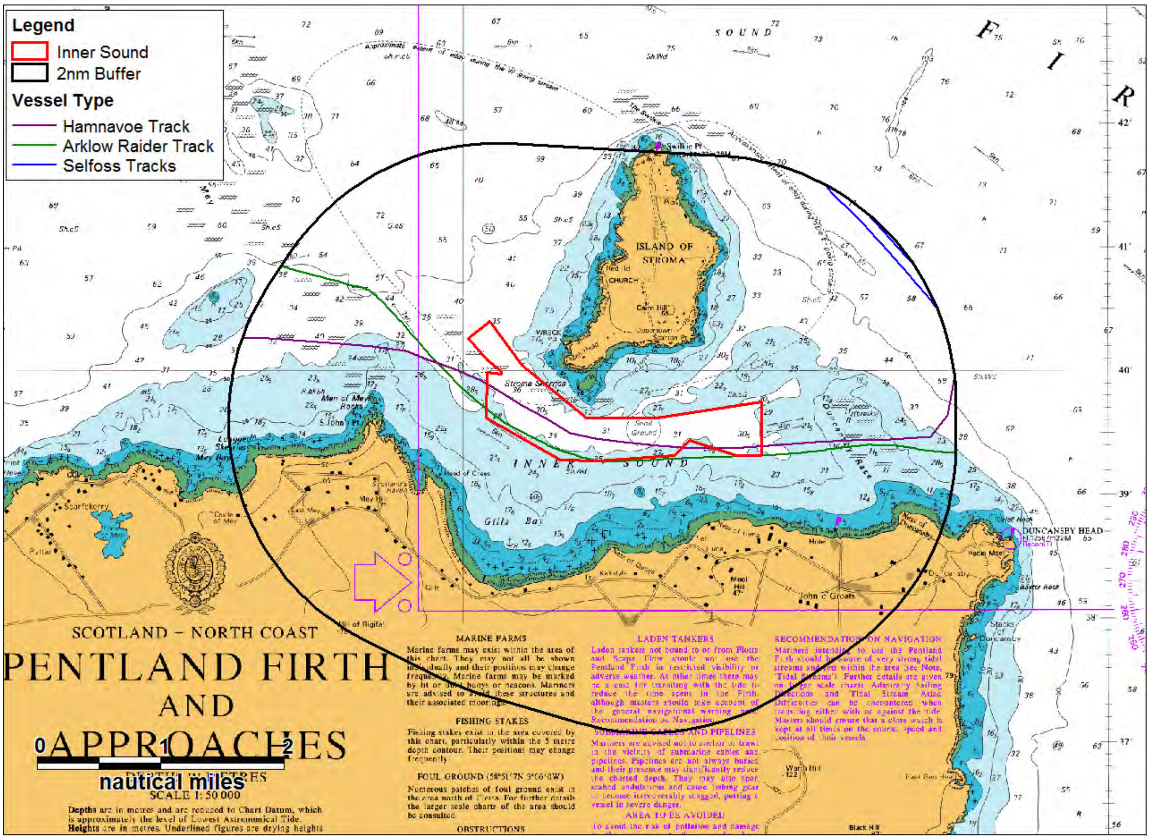


Figure 4-49 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-50.

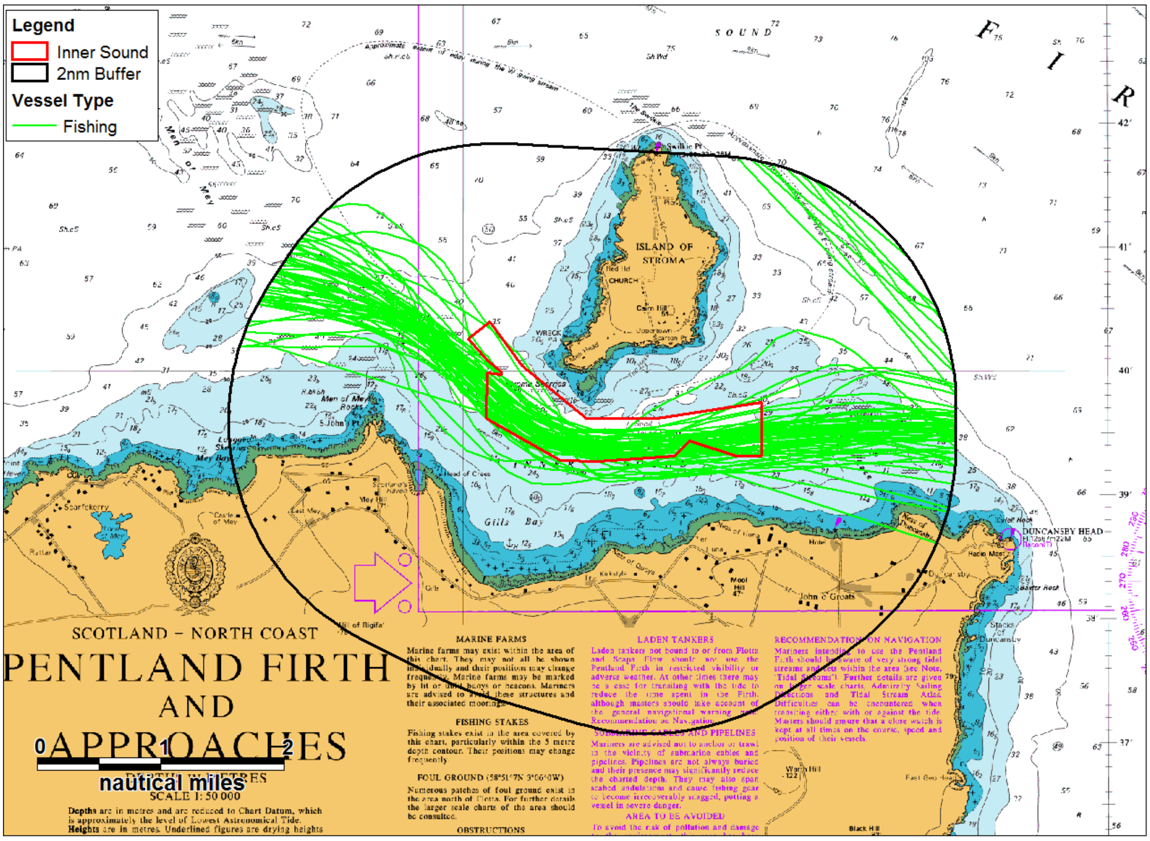


Figure 4-50 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Inner Sound

During the 56 day period it was recorded that 55 vessels passed through the site while on passage. The longest vessel to pass within 2nm of the site was the *Lunar Bow* at 71m with a broadcasted draught of 6.3m.

4.6.9 Ness of Duncansby

Ness of Duncansby tidal site is located approximately 0.4nm north of the Sutherland Coast and 1.5nm east of the Island of Stroma, with an area of 0.7nm^2. The location of this site can be seen in Figure 4-51.

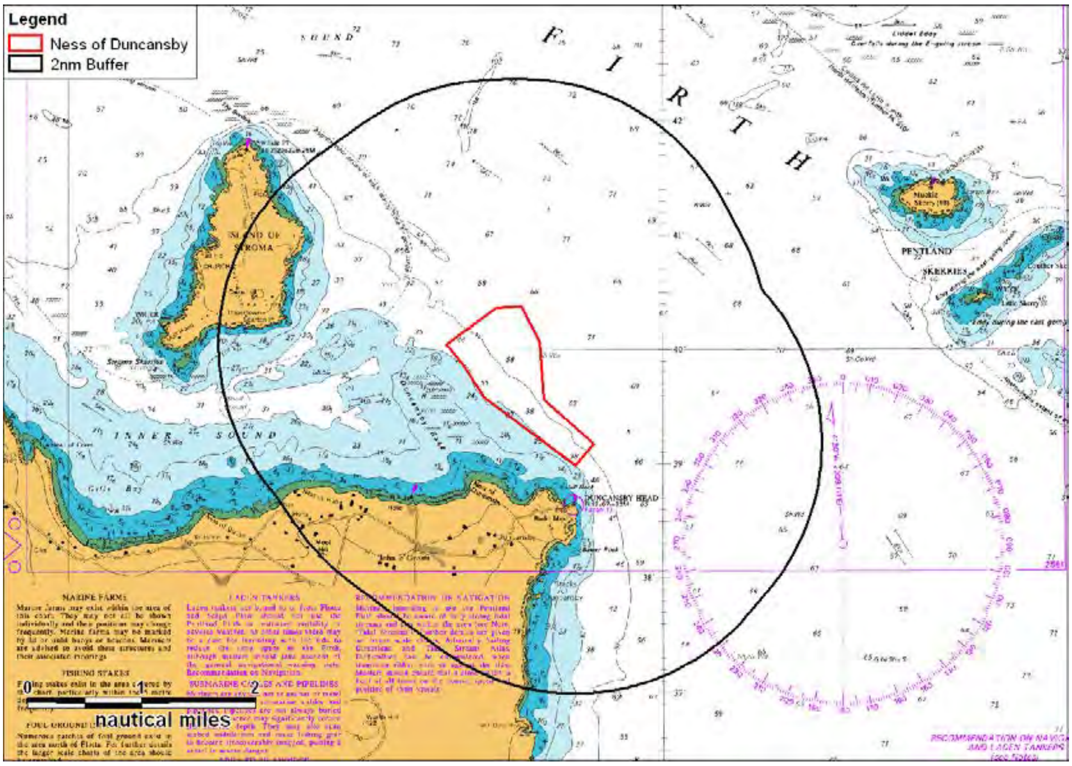


Figure 4-51 Ness of Duncansby Tidal Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of Ness of Duncansby tidal site and the vessel type distribution can be seen in Figure 4-52 and Figure 4-53 respectively.

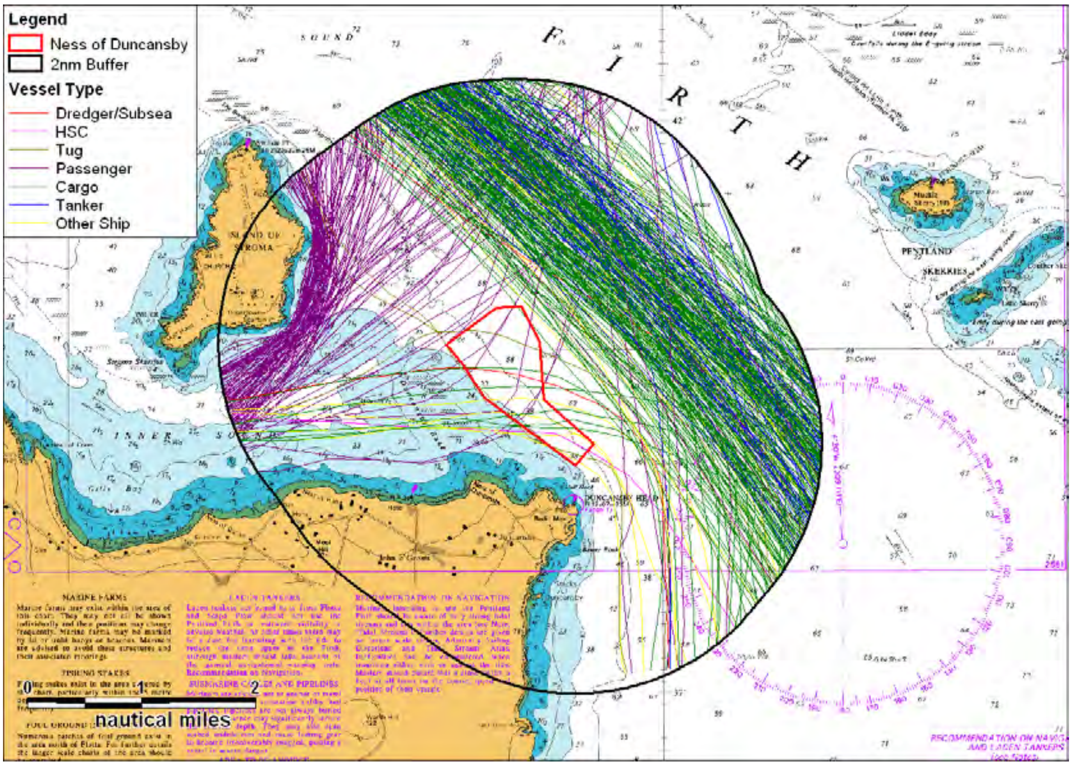


Figure 4-52 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Ness of Duncansby Site

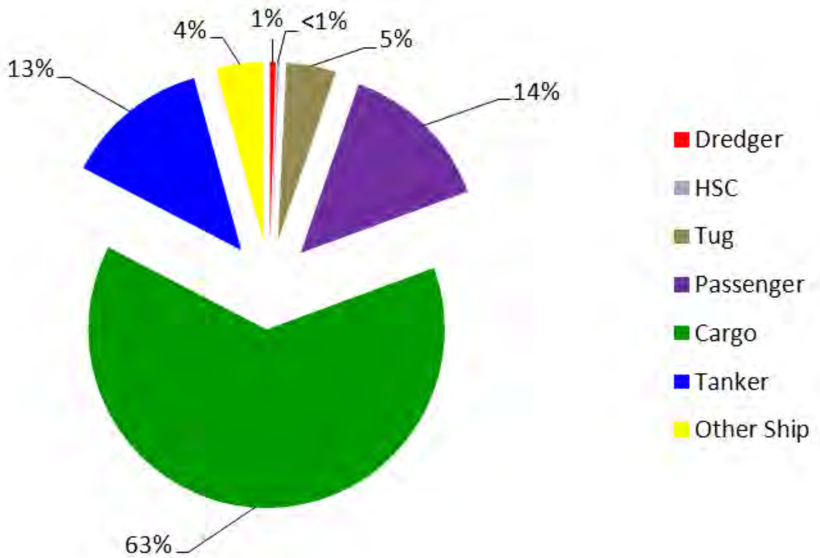


Figure 4-53 Vessel Type Distribution Identified during the Combined Survey Period

It can be seen from the above figures that the most common vessel types recorded within 2nm of the site during the survey period were cargo vessels (63%), passenger vessels (14%) and tankers (13%). This is due to the busy shipping lane located to the north east of the site which is mainly used by cargo vessels and tankers travelling to ports such as Aberdeen, Belfast, Bremerhaven, Grangemouth, Immingham and Rotterdam. The passenger vessel *Pentalina* was also recorded west of the site travelling between Gills Bay and St Margaret's Hope on a regular basis (using the route east of Stroma).

The average number of unique vessels recorded within 2nm of this site was seven per day, with 19 vessels passing through the proposed tidal site during the survey period. The longest vessel recorded passing within 2nm of the site during the 56 day period was the bulk carrier *China Triumph* which was recorded passing to the east of the site with a length of 300m. The vessel with the deepest draught within 2nm was the bulk carrier *Mineral New York* with a broadcasted draught of 17.2m. The longest vessel to pass through the site was the container ship *Selfoss* with a length of 127m and the vessel with the deepest draught to pass through the site was the general cargo vessel *Arklow Field* with a draught of 6.6m. These vessels can be seen in Figure 4-54.

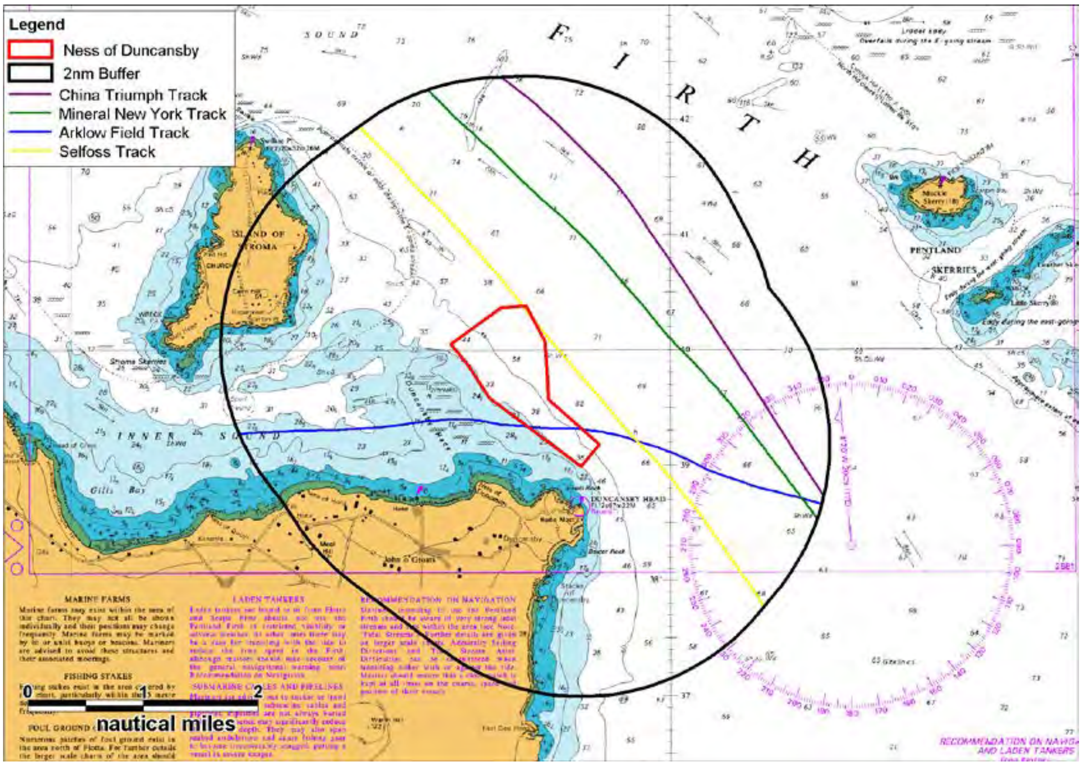


Figure 4-54 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-55.

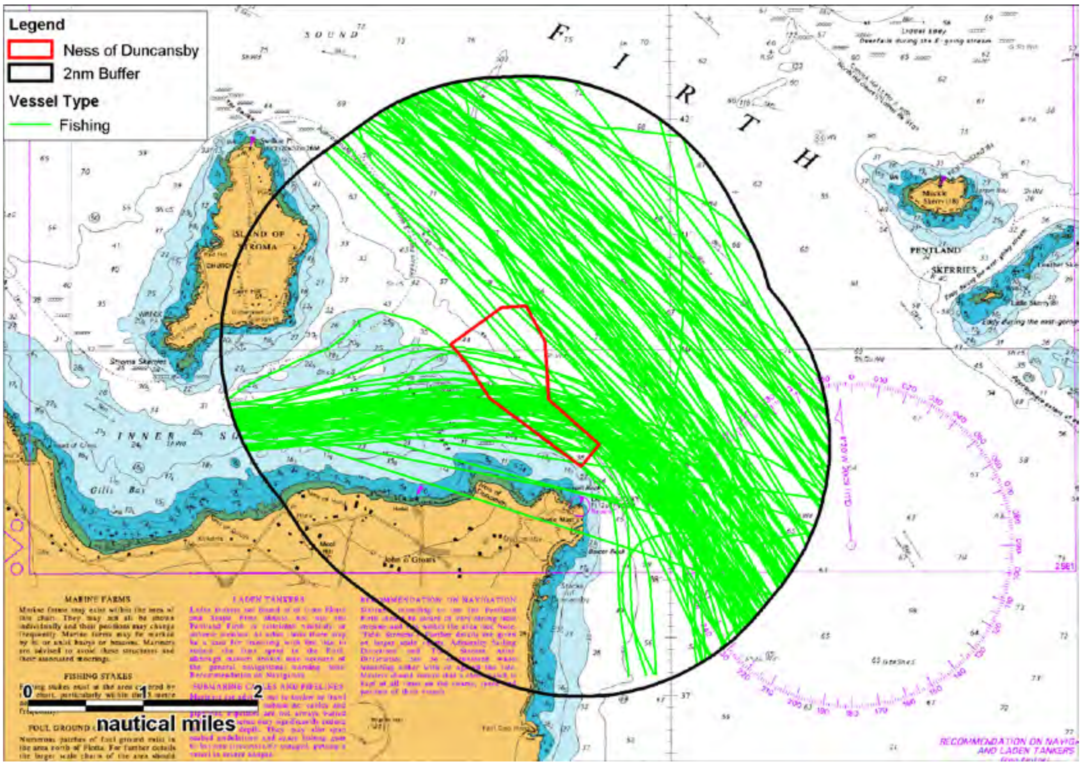


Figure 4-55 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Ness of Duncansby

During the 56 day period it was recorded that 55 fishing vessels passed between Stroma and the mainland Scotland and a further 71 vessel were recorded within 2nm of the site passing north of Stroma. The longest vessel to pass within 2nm of the site was the *Jan Maria* at 125m with a broadcasted draught of 7.2m.

4.6.10 Westray South

The Westray South tidal site is located in the Westray Firth between Egilsay and Eday, north of the Fall of Warness tidal test site operated by EMEC. It occupies an area of 3.7nm^2, as shown in Figure 4-56.

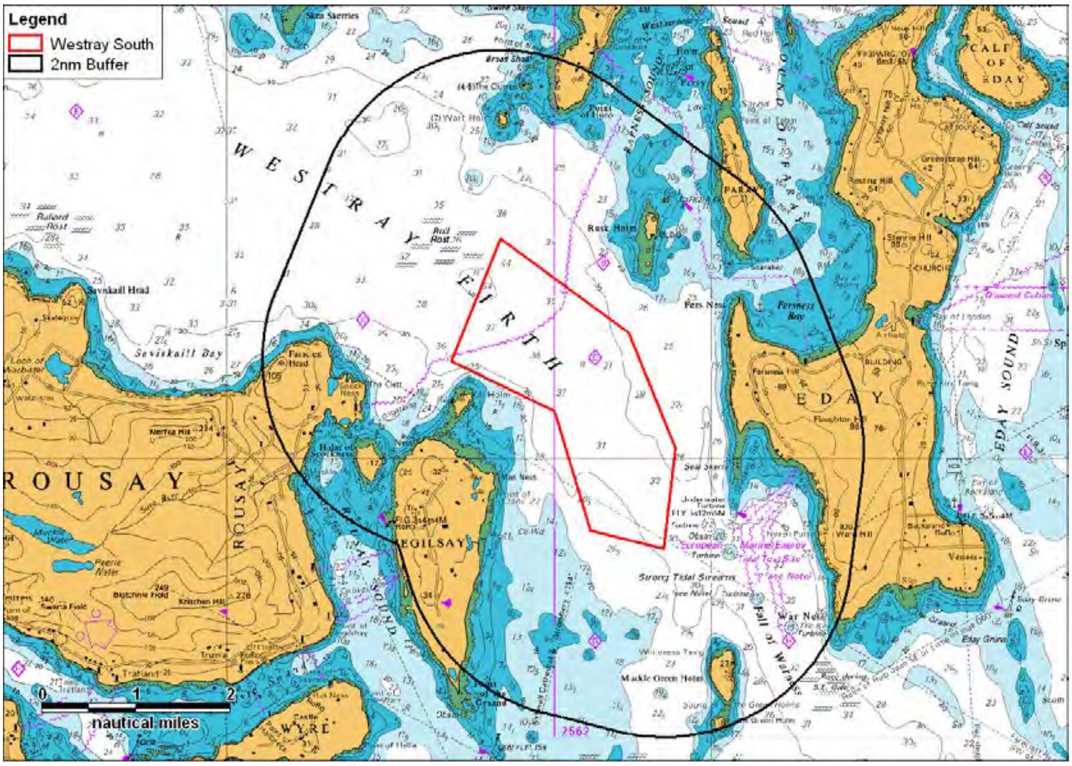


Figure 4-56 Westray South Tidal Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of Westray South tidal site and the vessel type distribution can be seen in Figure 4-57 and Figure 4-58 respectively.

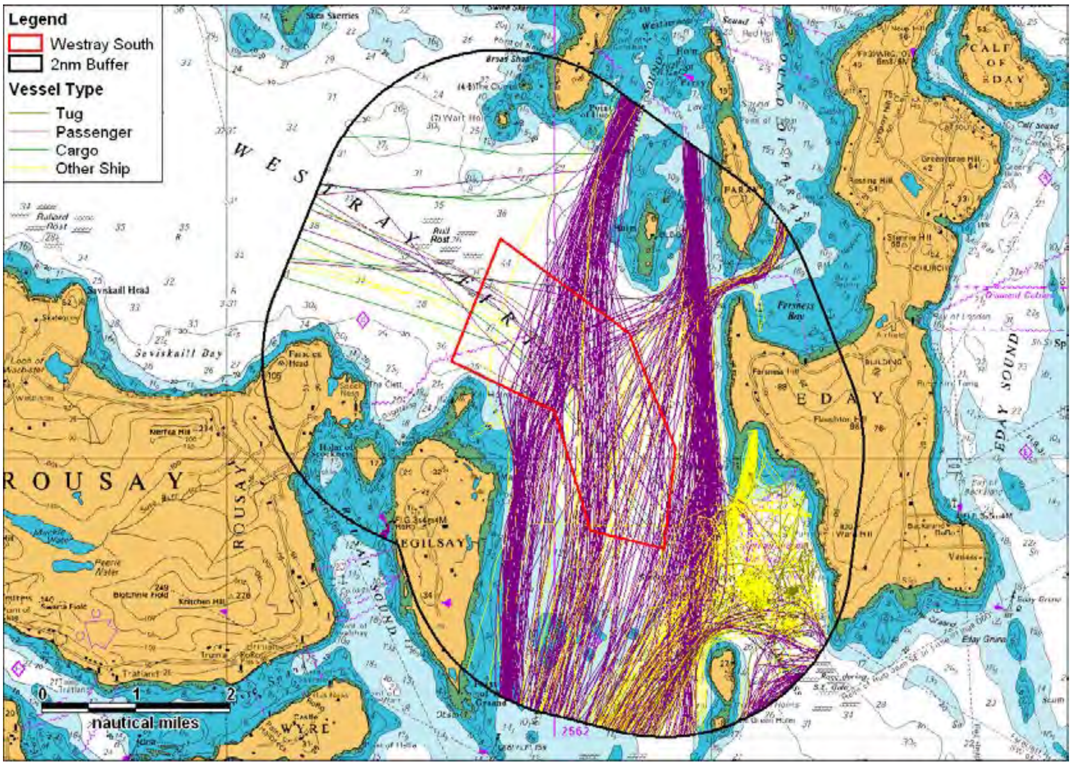


Figure 4-57 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Westray South

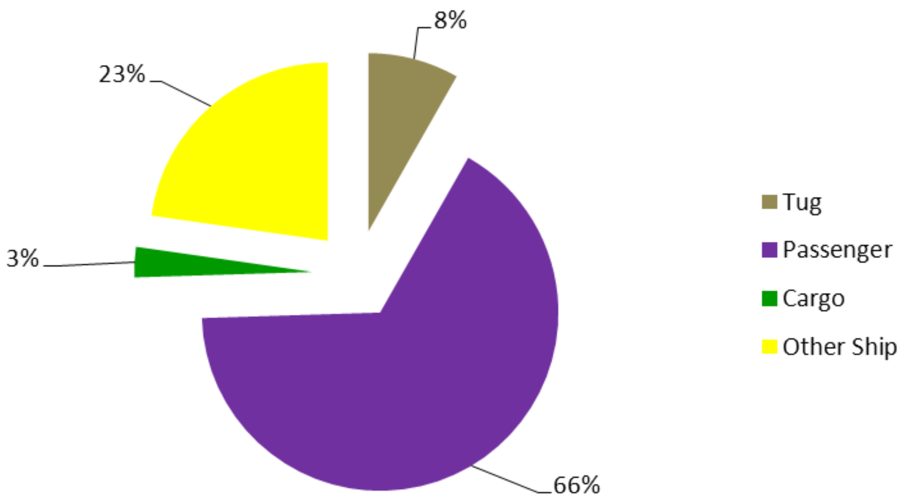


Figure 4-58 Vessel Type Distribution Identified during the Combined Survey Period

Passenger vessels were found to be the most common type of vessel identified within 2nm of the Westray South site (66%), followed by other ships (23%). This is due to ferries such as the *Varagen, Earl Thorfinn* and *Earl Sigurd* travelling between Kirkwall and the North Isles. These vessels were recorded transiting through the site and to the east of the site.

The average number of vessels passing within 2nm of Westray South site during the 56 day period was five per day, with 127 vessels recorded passing through the proposed tidal site.

The largest vessel recorded passing through the proposed tidal site was the cruise ship *Mein Schiff 2* destined for Kirkwall. This vessel has a length of 264m and broadcast a draught of 8.5m. The track of *Mein Schiff 2* recorded during the combined survey period can be seen in Figure 4-59.

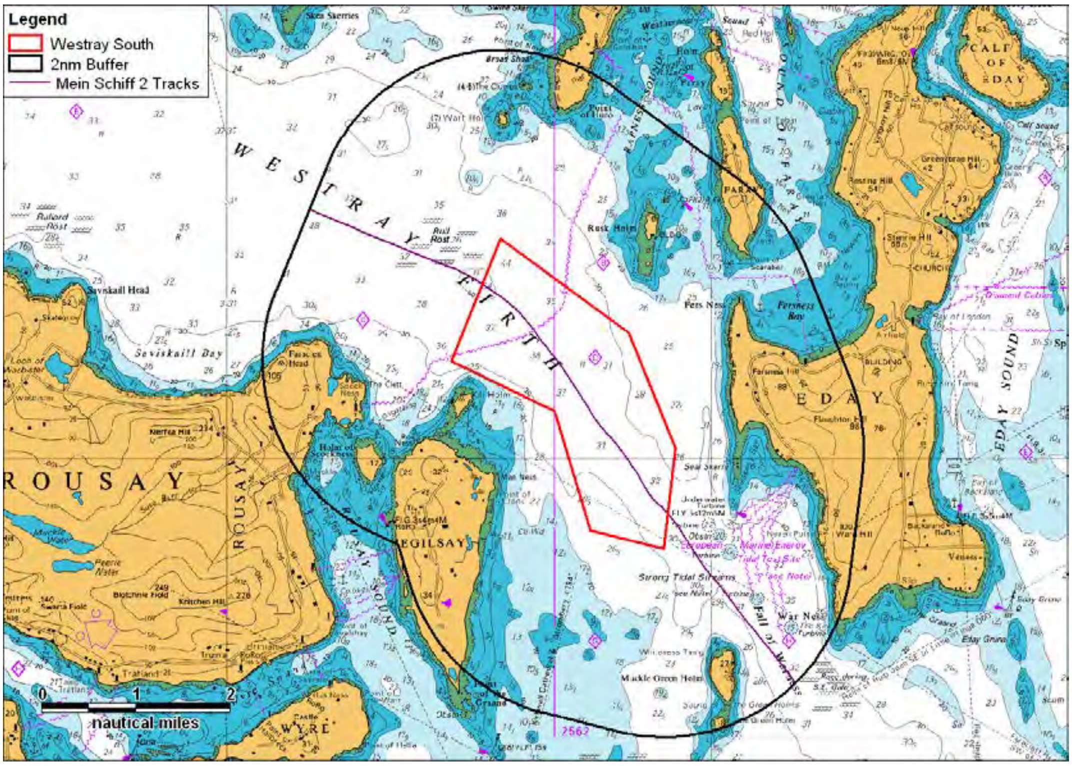


Figure 4-59 *Mein Schiff 2* Vessel Track

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-60.

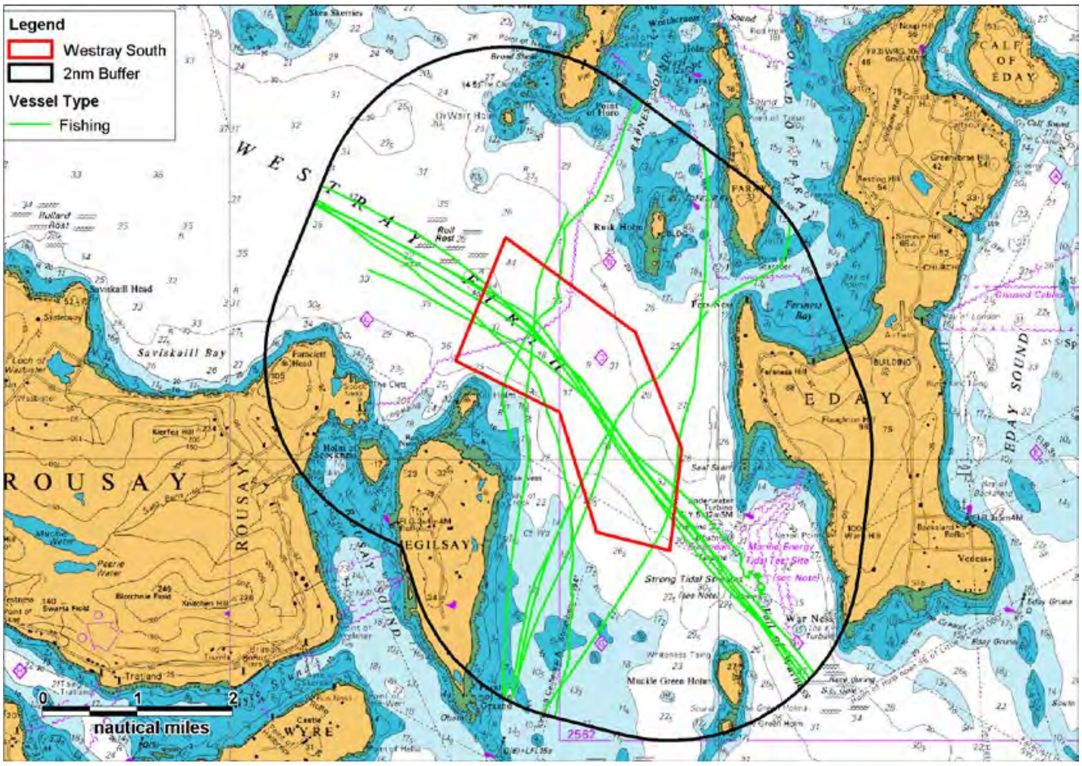


Figure 4-60 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Westray South

During the survey period 31 fishing tracks were recorded passing within the proposed site. The longest fishing vessel to pass through the proposed site was the *Norlantean* with a length of 30m.

4.6.11 Lashy Sound

Lashy Sound tidal site is located in between the islands of Sanday and Eday and occupies an area of 7.6nm^2. This Lashy Sound site can be seen in Figure 4-61.

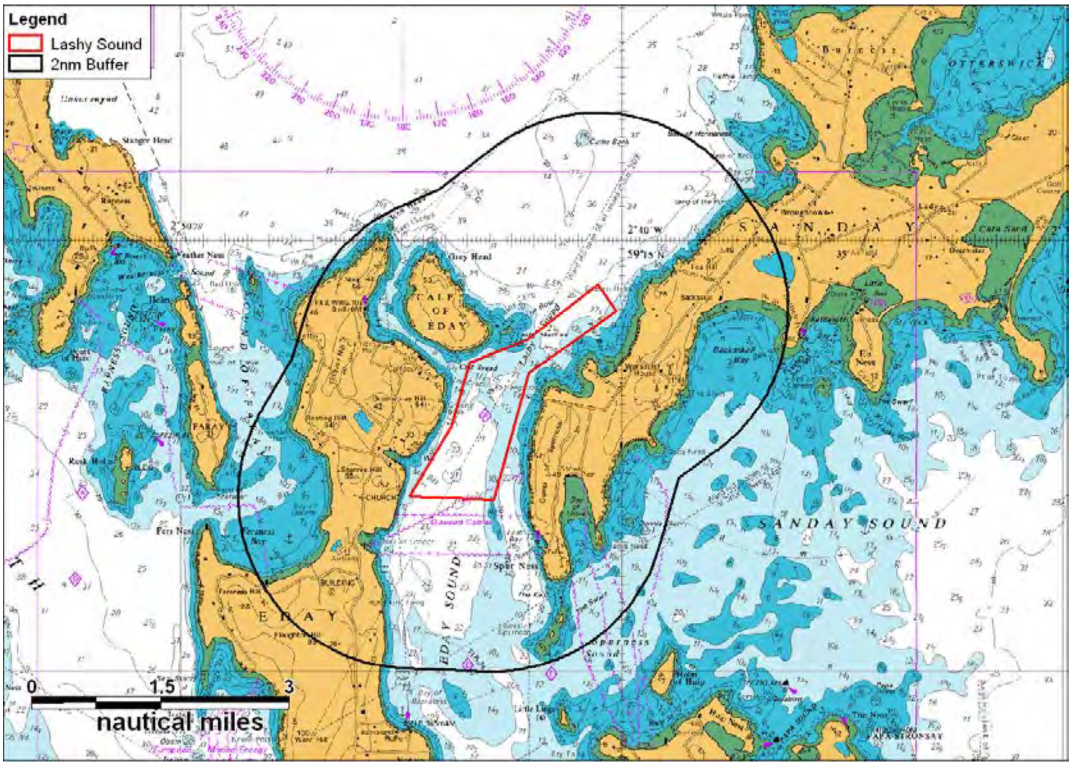


Figure 4-61 Lashy Sound Tidal Site Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of the Lashy Sound site and the vessel type distribution can be seen in Figure 4-62 and Figure 4-63 respectively.

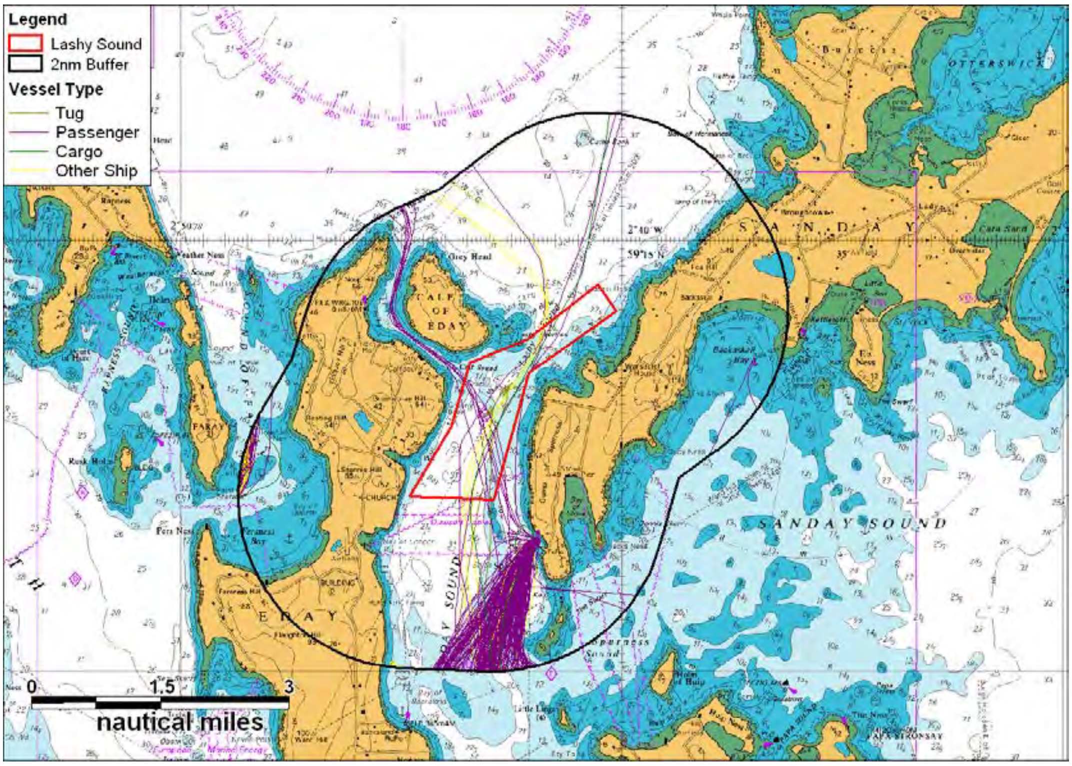


Figure 4-62 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Lashy Sound Site

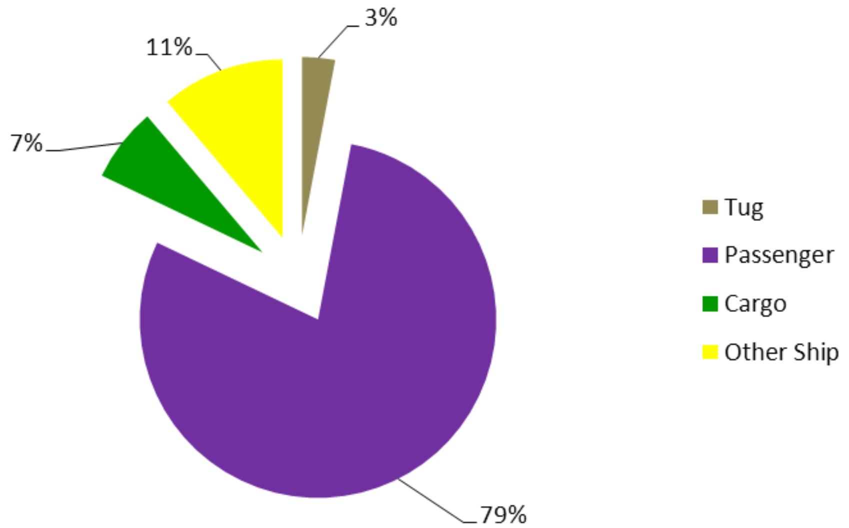


Figure 4-63 Vessel Type Distribution Identified during the Combined Survey Period

Passenger vessels were found to be the most common type of vessel identified within 2nm of the Lashy Sound site (79%). This is due to ferries such as the *Varagen*, *Earl Thorfinn* and *Earl Sigurd* travelling between Kirkwall and the North Isles. These vessels were recorded towards the south east of the 2nm buffer and also transiting through the site on occasion.

The average number of vessels passing within 2nm of the Lashy Sound site during the 56 day period was two per day, with 16 vessels recorded passing through the proposed tidal site. The largest vessel recorded passing through the site was the cargo vessel *Hildasay* destined for Lerwick. This vessel has a length of 122m and a draught of 5.5m. The tracks of the *Hildasay* recorded during the combined survey period can be seen in Figure 4-64.

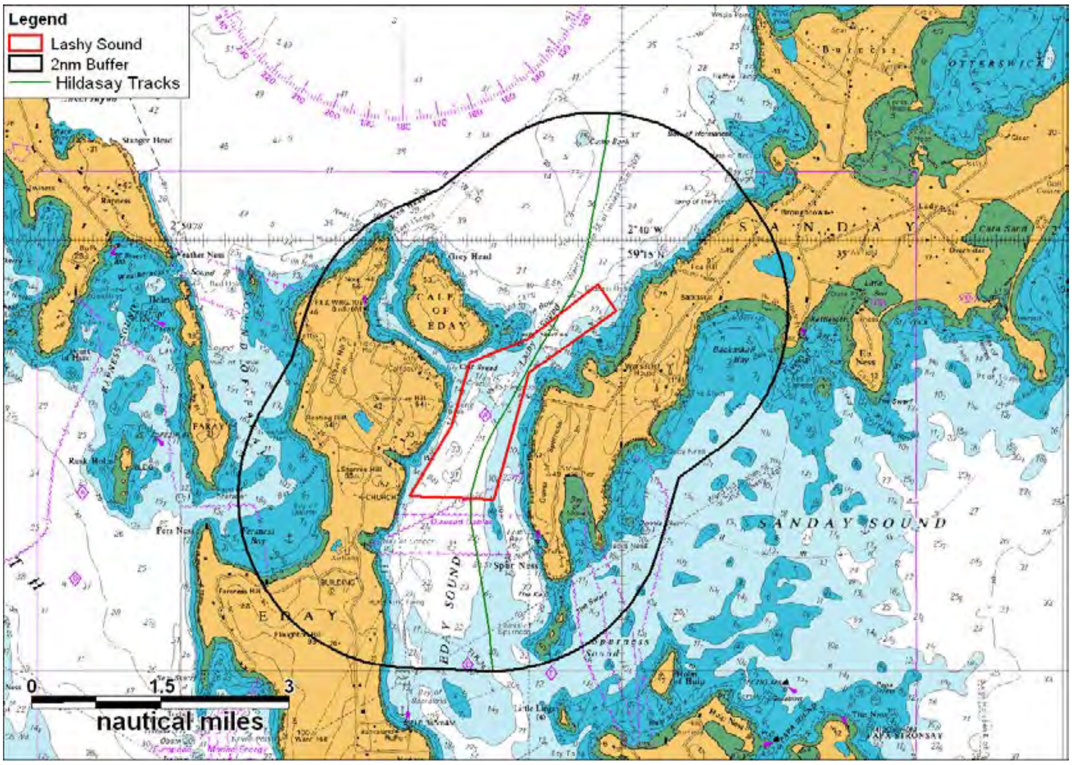


Figure 4-64 *Hildasay* Vessel Tracks

During the survey period, no fishing vessels were recorded within 2nm of the site. During the time of survey only vessels that were 24m and greater were required to carry AIS, this will limit the number of small craft assessed within the AfL area.

4.6.12 Farr Point

Farr Point wave farm is located approximately 2.2nm off the Sutherland Coast, close to Bettyhill, with an area of 28.1nm^2. The location of this site can be seen in Figure 4-65.

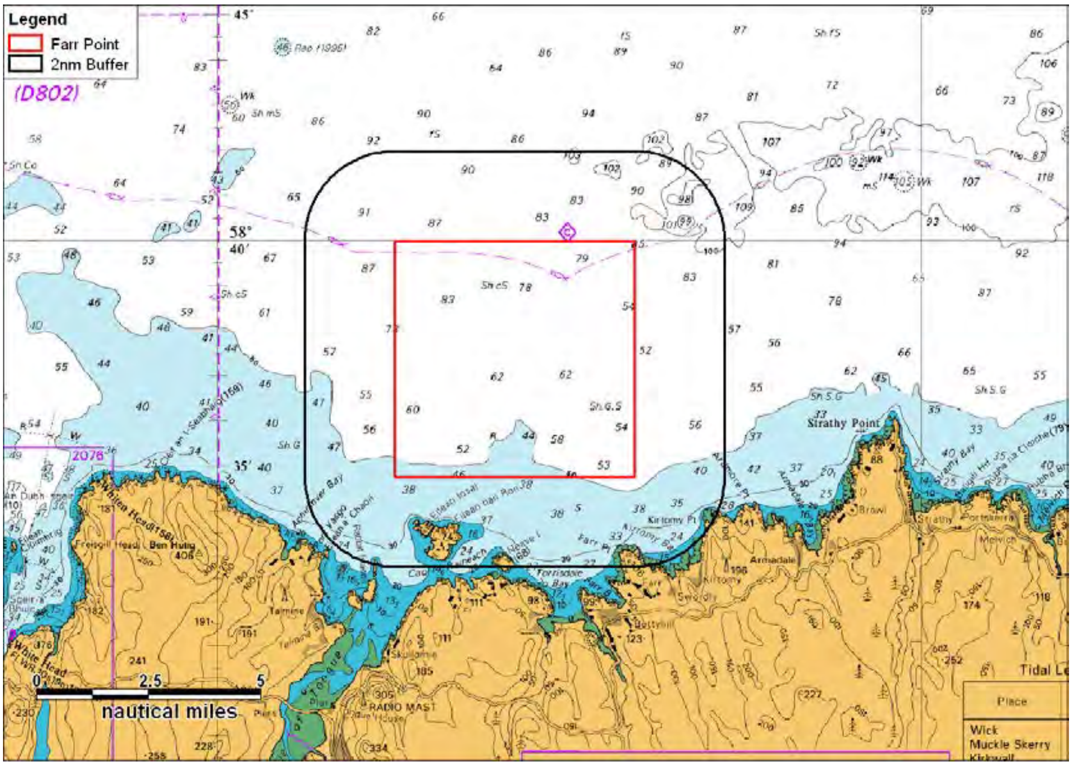


Figure 4-65 Farr Point Wave Farm Location

The vessel tracks recorded during the 56 day 2012 combined survey period within 2nm of Farr Point wave farm can be seen in Figure 4-66, with the vessel type distribution presented in Figure 4-67.

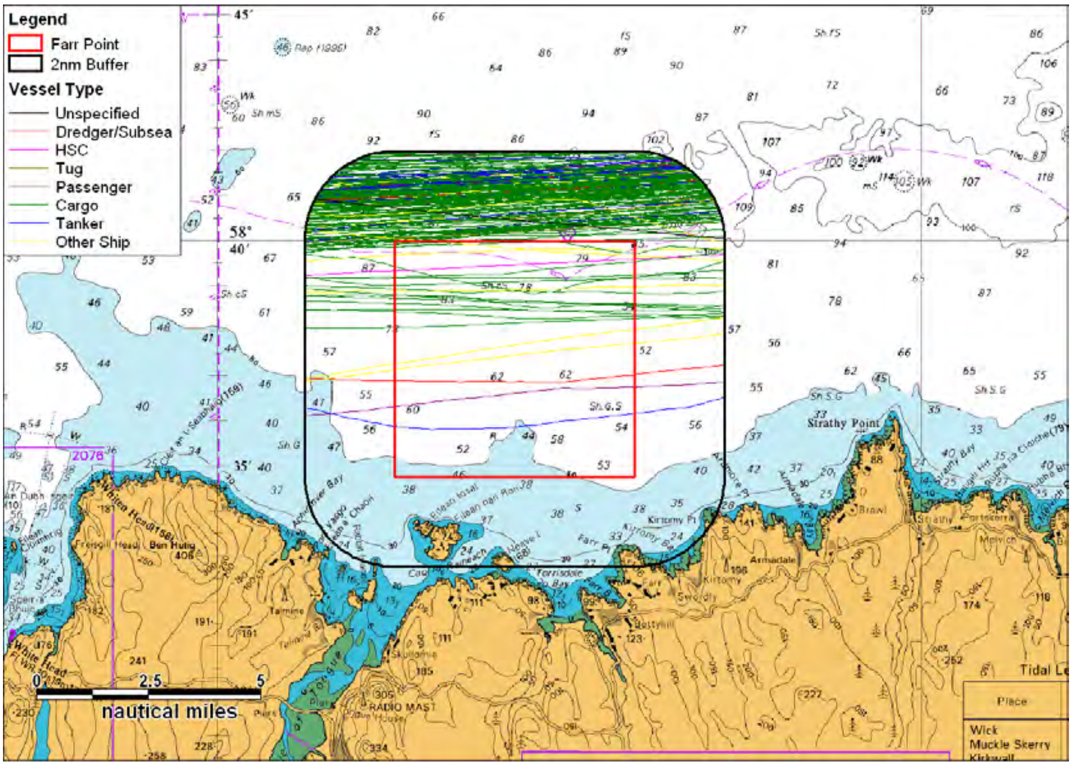


Figure 4-66 Combined Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Farr Point Site

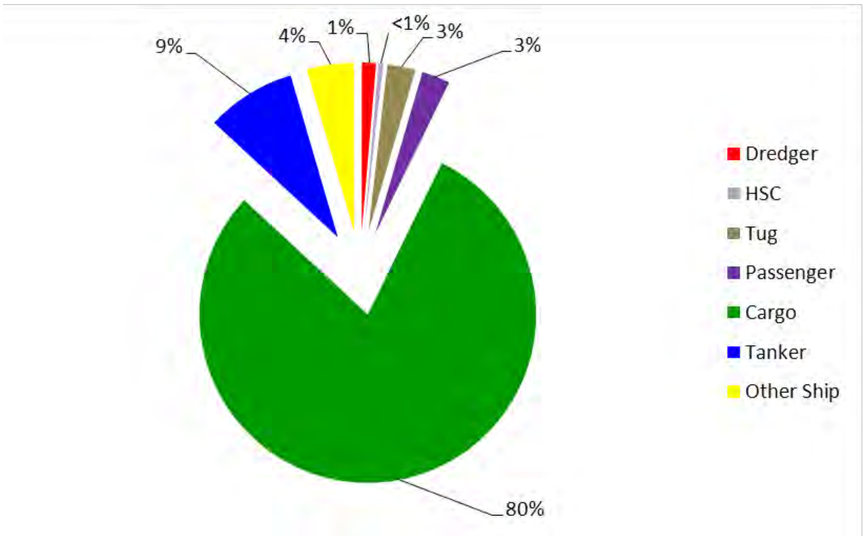


Figure 4-67 Vessel Type Distribution Identified during the Combined Survey Period

It can be seen from the above figures that the vast majority of vessels recorded within 2nm of Farr Point site were cargo vessels (80%). The large proportion of vessels were found to pass to the north of the site within the busy shipping lane heading to a variety of destinations including Belfast, Aalborg, Dublin, Esbjerg, Gotenborg, Londonderry, Runcorn and Warrenpoint.

The average number of vessels passing within 2nm of this site is approximately four vessels per day, with 26 vessels recorded passing through the Farr Point site during the survey period. The longest vessel recorded within 2nm of the site was the Ro-Ro vessel *Atlantic Companion* which was recorded on the 6th July 2012 with a length of 292m and the vessel with the deepest draught within 2nm was the bulk carrier *Yeoman Bridge* which passed the site on five occasions broadcasting draughts ranging from 12.4m to 14m. The largest vessel to passing within the site during the survey period was the offshore vessel *Skandi Seven* which has a length of 121m and a broadcasted draught of 6.6m. The tracks of these vessels can be seen in Figure 4-68.

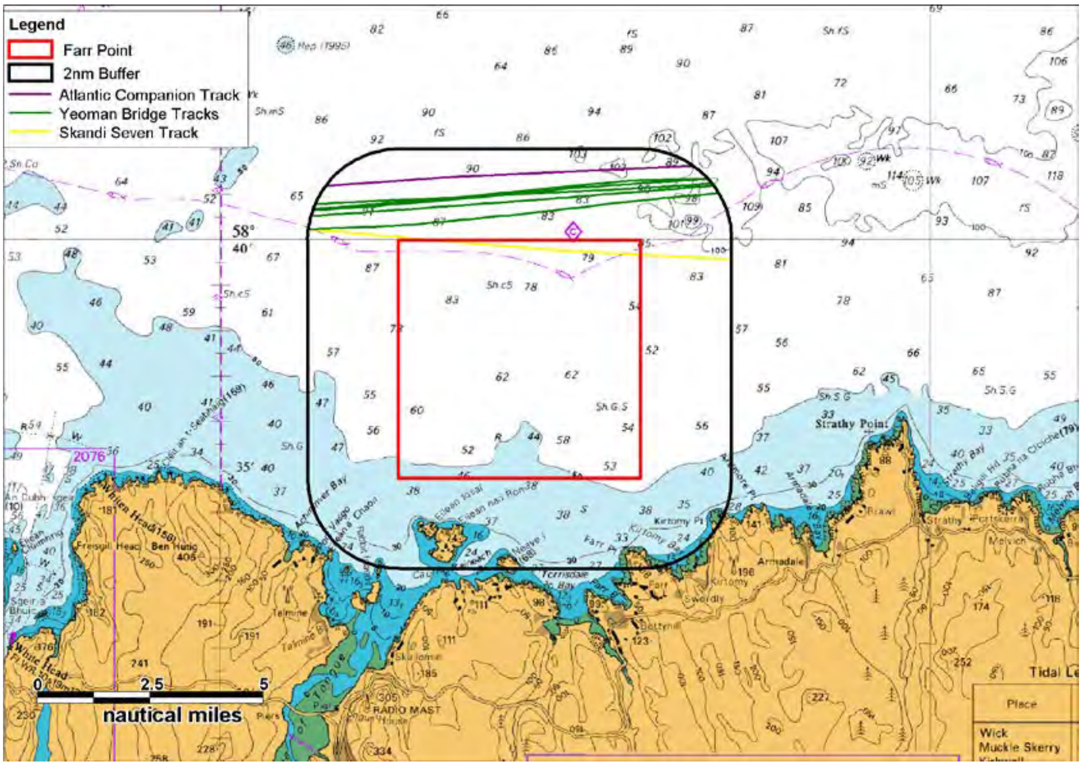


Figure 4-68 Overview of Largest Vessel Tracks

An overview of all the fishing tracks recorded throughout the survey period is presented in Figure 4-69.

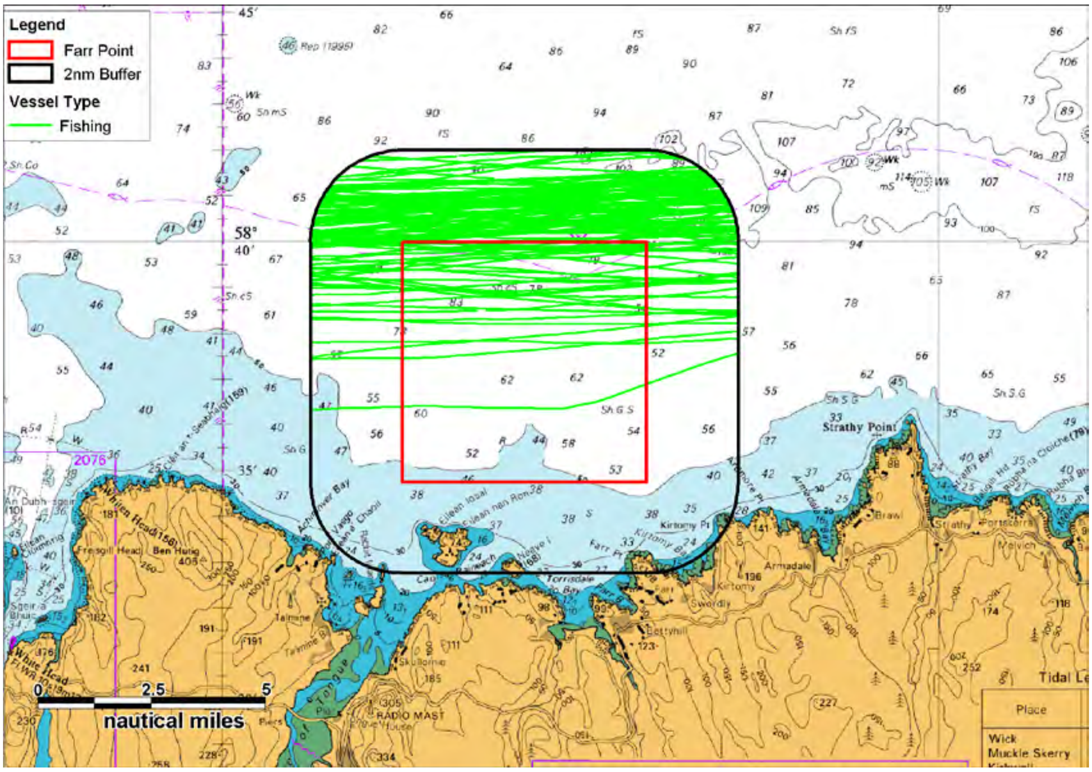


Figure 4-69 Fishing Vessel Output of Marine Traffic Survey Data (Summer and Winter 2012) relative to Farr Point Site

There were 121 recorded tracks of fishing vessels steaming within 2nm of the proposed site during the survey period, of which 36 transited the site. The longest vessel to pass within 2nm of the site was the factory trawler *Jan Maria* at 125m with a broadcasted draught of 7.3m.

4.7 Conclusion

It is evident that there is a wide range of relevant information available concerning the PFOW Strategic Area. This includes data that provides a reliable picture of the state of marine traffic in this area. This offers an insight into where the navigational hazards are likely to be.

A number of areas demonstrate high levels of traffic, in relation to the area overall. Where these are in proximity to a developers AfL area they will alter the risk posed.

The density of commercial shipping, as indicated by AIS, is consistent throughout the year. This traffic is most active within Pentland Firth, Wide Firth, Westray Firth, Shapinsay Sound, around the islands of Hoy, Graemsay and Eday. The traffic in these areas could potentially be affected by Westray South, Brims Tidal Array, Brough Ness, Inner Sound and Ness of Duncansby developments. Much less so Lashy Sound, where the traffic is reduced.

Recreational vessel density is also concentrated around a number of high density areas shared with commercial shipping, however the focus of this is notably greater toward the east of Pentland Firth, Wide Firth, Westray Firth, Shapinsay Sound, Graemsay, the northern coast of Hoy, the west side of Orkney Mainland and the northern coast of Westray. This traffic may potentially be affected by the four developments along the west side of Orkney Mainland (West Orkney South, West Orkney Middle South, Marwick Head and Brough Head), Westray South and those towards the east of the Pentland Firth (Brough Ness, Ness of Duncansby and Inner Sound).

The density of fishing vessels is also distributed along those areas already noted as main focuses for commercial and recreational vessels. Wide Firth and Gairsay Sound are the busiest, with the north west coast of Orkney Mainland, Westray and Eday also relatively densely utilised. The developments of Westray South, Brims Tidal Array, Brough Head and Marwick Head have the potential to impact on this traffic.

5. Impacts

5.1 Potential Impacts (Navigation/Safety)

The assessment of potential impacts has been drawn from experience, using the knowledge gained from past consultations with stakeholders, developers in preparing NRAs, as well as consultation with the Working Group on this project.

5.1.1 Traffic

5.1.1.1 Allision (Vessel to Structure Risk)

All surface offshore structures present the possibility of allision risk. This will be the case for all wave devices and tidal devices that have surface-piercing elements.

It will also be the case for sub-surface tidal devices that are within reach of a vessel keel at any point in the tidal cycle, taking into account dynamic motion effects such as wave and squat.

It is noted that devices with low surface visibility or sub-surface may be more difficult to mark and make conspicuous to passing vessels compared to more elevated devices above the surface.

All developments within the PFOW area will pose this impact to some extent. The significance will vary according to the technology utilised and the mitigations in place to prevent an allision taking place.

5.1.1.2 Adverse Weather Routes

The size and type of vessel will dictate the best course of action to take during severe weather. While smaller vessels may head for shelter/refuge, larger vessels may instead use alternative routes or make for adverse weather anchorages or open water. In the latter case the conditions will dictate the course taken, this is to avoid dangerous phenomena associated with riding waves or rolling motions. All of these actions may cause the vessel to operate differently, or make significant changes in course, altering the closest point of approach (CPA) to navigational hazards (including potential devices). OREIs near to the coast or between routes and shelter are most likely to be affected.

With regards to commercial vessels, the Brims Tidal Array development is distant from the normal *Hamnavoe* ferry route, operating nearby but may impact the adverse weather route used by the ferry, which is much closer to the development (Figure 5-1). This is also the case for the *Pentalina* ferry, which may be impacted by the Inner Sound and Ness of Duncansby developments during adverse weather. However, if the devices have sufficient under keel clearance (5.1.2.11) any impact would be restricted to when there is work at the site, e.g., installation and maintenance.

Recreational vessels or fishing vessels seeking shelter near the coast from adverse weather could be potentially impacted by any of the developments. Similarly all the sites pose a potential impact to recreational vessels heading to safe anchorages (Figure 5-3) in adverse weather. This is due to the relatively close proximity of the developments to nominated recreational anchorages (impacts to anchorages are noted within 5.1.4.1).

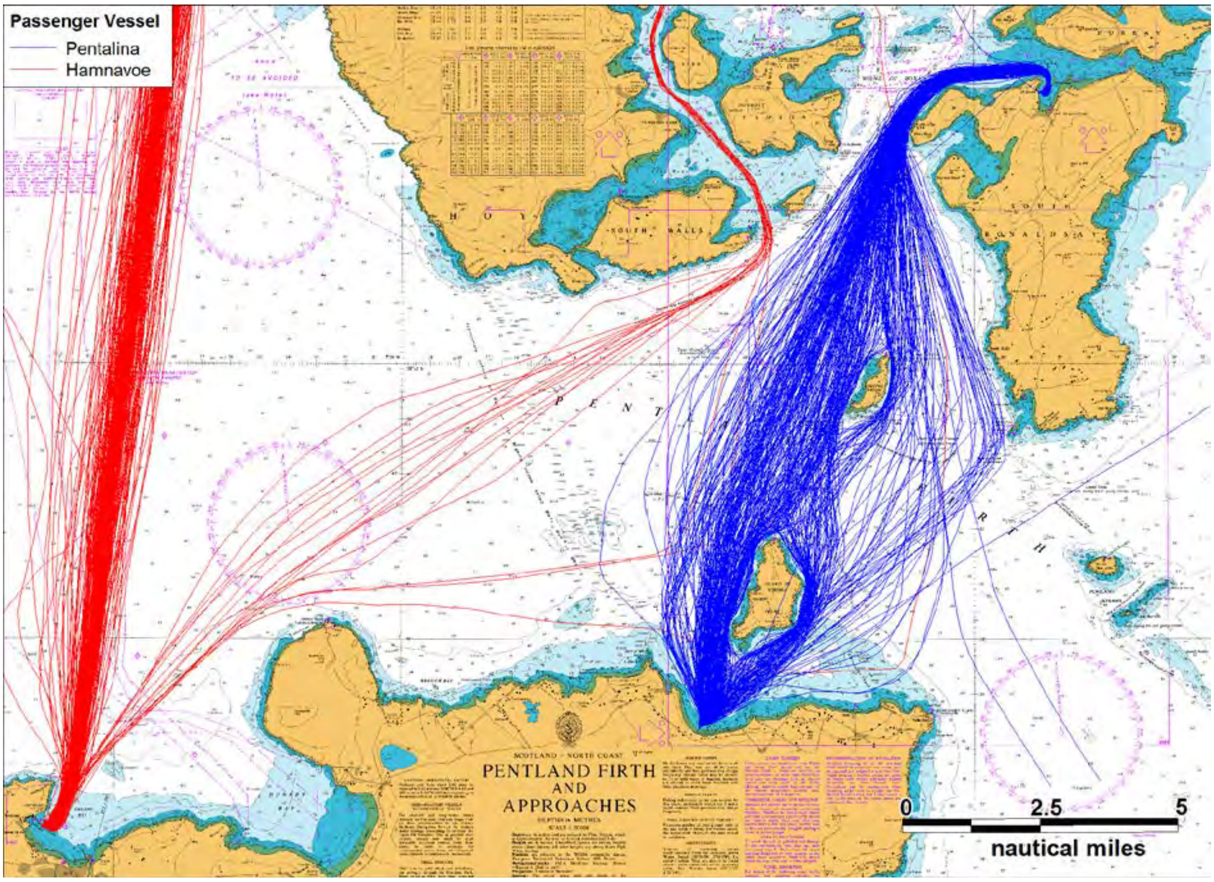


Figure 5-1 Ferry Routes Crossing Pentland Firth

5.1.1.3 Congestion

This may be caused by either reduced sea room or increased traffic. The risk this presents may increase if other developments are also causing congestion, therefore creating a cumulative effect. Likewise the effect may increase in-combination with other marine users, such as traffic involved in port development or aquaculture. Congestion may, if unmitigated, increase the risk of collision for vessels. This is likely to be at its greatest when the maximum build out is taking place, when installation and maintenance traffic will peak.

Areas that are natural pinch points may increase the possibility of congestion, as these act as natural funnels to traffic. This is however dependent on the volume of traffic in that area. The Pentland Firth is the best example of this risk, within the strategic area, which is increased by the crossing traffic. This has the potential to impact upon those developments within the Pentland Firth. This is less of the case in other areas, where the traffic is much reduced.

Similarly the geography of Westray South and Lashy Sound presents a pinch point to congestion, although there is less traffic in these locations and the depth of water may further reduce the impact.

5.1.1.4 Displacement

Vessels may be displaced by wave and tidal energy devices, both temporarily during the construction phase and permanently during the operational phase of development. This can be due to site traffic or the energy devices being utilised. This may lead to congestion in proximity to the development.

All sites have the potential to displace vessels that would otherwise operate within their AfL area. The preferred course of the Orkney Ferry that passes near to the Westray South development (Figure 5-2) is dependent on the state of the tide and weather. Displacement due to the tidal devices would reduce navigable sea room, although this depends on the technology used and under water clearances.

Similarly there is the potential for the Pentland Firth sites of Brims Tidal Array, Inner Sound, Ness of Duncansby and Brough Ness to displace ferry traffic, while Ness of Duncansby, Inner Sound and Brough Ness may also displace the east/west traffic. Again, this depends on technology, under water clearances and any surface-piercing elements.

The sites along the west of Mainland Orkney may potentially displace coastal traffic, which mostly comprises recreational vessels, fishing vessels and AIS 'other' vessels.

Farr Point may also displace the east/west traffic currently passing through the site. However this is likely to be less of an impact because of the large area of sea room approaching the development, which would allow a small alteration some distance from Farr Point to ensure vessels pass clear and wide.

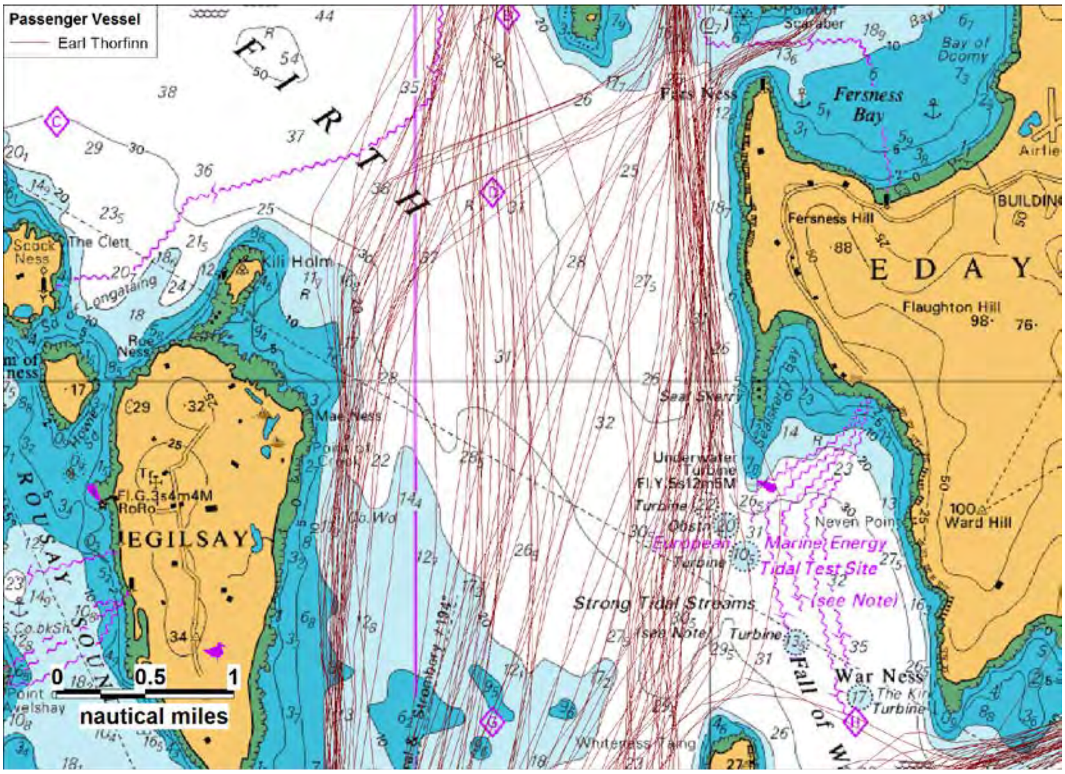


Figure 5-2 Passenger Ship Navigation within the Westray Firth

5.1.1.5 Increased Traffic Density

Vessels now operating in the site vicinity or transiting between it and elsewhere may increase the traffic locally. This may result in traffic displacement, congestion or an increased risk of collision.

The developments to the south of Orkney (Brims Tidal Array/Inner Sound/Ness of Duncansby/Brough Ness) may affect traffic in the Pentland Firth, Gills Bay or approaches to Scapa Flow.

Developments to the west of Orkney Mainland (West Orkney South/West Orkney Middle South/Marwick Head/Brough Head/Costa Head) may affect the Stromness/Scapa Flow traffic passing through Hoy Mouth.

5.1.1.6 Port Traffic Levels

The level of traffic in or around ports may alter, which will change the level of risk and impact associated to it. This would be different depending on the phase of the OREI's construction or possibly greater if the port was supporting multiple developments.

Proximity to an OREI may lead to port development, if it is utilised by the OREI or the opposite, avoidance because the port approaches are considered a higher risk with the OREI and its traffic nearby. Either of these scenarios presents a potential impact.

Those sites planned along the west coast of Orkney Mainland may potentially impact Stromness and its users. Similarly the developments to the south of Orkney may impact Gills Bay and John O'Groats because of their proximity to these ports. Ports nominated for development use include are detailed elsewhere in this Discussion Paper (Appendix A).

5.1.2 Navigation

5.1.2.1 Access

This could be affected for any other users of the area. These could be vessels transiting the location (commercial, fishing, recreational, etc.) or those which may otherwise wish to use the location (fishing vessels, dive vessels, etc.). This reduction in available access may be temporary or permanent.

All developments within the PFOW area may pose this impact.

5.1.2.2 Ease of Compliance with COLREGS

The risk to or posed by a give-way vessel if it is unable to fulfil its obligation under the IMO Convention on the International Regulations for Preventing Collisions at Sea may be elevated. This may be the result of a reduction in sea room or increased traffic (construction or displaced).

All developments may pose this impact, in particular those developments near to traffic routes. Within the Pentland Firth east/west transiting traffic may be impacted (Ness of Duncansby, Brough Ness and Brims Tidal Array), also the north/south ferry traffic (Brims Tidal Array, Inner Sound, Ness of Duncansby and Brough Ness). Similarly on the west coast the Stromness traffic may be impacted (West Orkney South) and traffic navigating the islands to the north (Westray South and Lashy Sound).

5.1.2.3 Navigable Route Depths

The depth of water in the vicinity of the site may alter due to operations taking place there. Seabed mobility, whether this is due to siltation or other causes may affect the navigable water or cause channel depth to decrease. This increases the chance of grounding and may result in the need for additional hydrographic surveys.

5.1.2.4 Phased Development of Projects

The changes that take place onsite during the installation and maintenance phases of an OREI's development may alter the site and the appreciation of its location by traffic navigating nearby. There may also be, because of increased site traffic, vessels restricted in their ability to manoeuvre (surveying/cable laying etc.), or physical changes to the layout and devices present.

All projects have indicated that they will be developed in phases and therefore potentially pose this impact. This could be during construction or the maintenance of the project.

5.1.2.5 Radar (Vessel Detection)

The detection of vessels when they are within or near an OREI with surface/surface piercing devices may be impaired. This would increase the risk of vessel encounters if the vessel remained unobserved by another means.

This will apply to those developments utilising surface piercing devices. It will have a greater bearing on the wave energy projects (Costa Head, Brough Head, Marwick Head, West Orkney Middle South, West Orkney South and Farr Point). Some tidal energy technologies may have similar qualities (e.g. Brough Ness). These along with some infrastructure (transformers etc.) may impact in the same manner. Because of the low surface aspect of these devices, this impact is unlikely to influence large commercial vessels, but it could affect small commercial vessels, recreational vessels and/or fishing vessels.

5.1.2.6 Routeing Measures and Traffic Flow

A development may influence current routing measures or traffic flows. Moreover any alteration or additional provision of routing measures may impact on marine navigation.

This may occur positively or negatively, as well thought out routing measures will aid traffic flow. They can also reduce the probability of close encounters, which improves the overall navigational safety within the area.

These will not be clearly definable until the final layouts are available.

5.1.2.7 Snagging

The submarine cables located on site, whether their purpose is mooring or export, may present a risk of snagging. These can be a hazard to anchoring vessels or trawling fishing vessels if they are not clearly marked on charts. Further parts of the site may also present a hazard, such as subsurface devices, scour protection or other objects on the seabed with similar properties.

All developments will pose this impact, as they will all require either export cables or pipelines (those devices acting as pumps for shore based hydroelectric plants). Tidal projects present the potential for the greatest impact, because of the greater number of subsurface elements.

5.1.2.8 Safety of Navigation

The safety of vessels while navigating nearby or during operational manoeuvres may be altered by the presence of the OREI. Therefore the risk presented to them may increase depending on proximity and the type of operation.

All sites pose this impact.

5.1.2.9 Use of Existing Aids to Navigation

The use of existing aids to navigation may be restricted by the proximity of these aids to the OREI site. If they disrupt the visibility of these aids then there is a greater risk present to the affected vessels navigating locally.

This is only a concern for developments in proximity to current aids to navigation. Within the strategic area these are West Orkney South, West Orkney Middle South and the southern boundary of Brough Head. All of these are close to the current EMEC wave energy test site (Billia Croo). Westray South is also near to the EMEC tidal energy test site (Fall of Warness).

5.1.2.10 Restricted Access for Emergency Response

The OREI may present a hazard to emergency responders. If this danger was considered serious enough then it would restrict their access because they would not wish to enter the OREI. This could potentially affect search and rescue, counter pollution and/or salvage operations.

This may potentially affect all near surface/surface piercing developments. It will also be addressed in part by the Emergency Response Co-operation Plan (ERCoP) required by the MCA.

5.1.2.11 Under Keel Clearance

If sufficient depth of water on a site allows for adequate availability of under keel clearance (UKC) then access for commercial and recreational users may be considered, if the risk is clearly mitigated. Clear charting and circulation of information of the assessed under keel clearance should be considered.

The MCA has produced a draft policy paper (MCA, 2012, draft) concerning under keel clearance, but the considered approach taken has yet to reach agreement with industry. This is due in part to the many variations in wave and tidal technology, these include:

- Surface piercing
- Surface device supported
- Near surface operation
- Water column operational movement

Under these circumstances, restricting access may be the preferred solution.

The RYA stance on UKC, as set out in a number of position papers (RYA, 2012a/RYA, 2012b), is that they believe that the minimum under water clearance of 4 metres is required to mitigate the risk of collision with recreational users in flat water conditions. However because of the high energy wave/tidal environments where the energy resource is likely to be located, they advise a more cautious 8 metres below chart datum.

The impact of UKC will only concern subsea devices, these are notably tidal devices. Wave devices occupy/pierce the surface and will therefore displace marine users. As noted elsewhere in this Discussion Paper, tidal devices with surface piercing elements would also not risk under keel collision (given mariner users will be displaced).

5.1.3 Design

5.1.3.1 Alignment (Structures within the Site Boundary)

Regular turbine placement allows for an improved comprehension of the OREI by navigators and search and rescue responders. Non-linear structures and boundaries that are irregular can present an increased impact due to the extra demand placed upon the mariner/responder to navigate safely. Surface-piercing devices can also impact marine radar or visual navigation, obscuring vessels and preventing early action to avoid a collision.

While all developments may pose this impact, but it is much less likely with tidal arrays in sufficiently deep water.

5.1.3.2 Site Boundary

The boundary of an OREI site and its proximity to other such sites or nearby navigational hazards may increase the probability of allision. This may be in-combination with other impacts or due to the cumulative nature of sites geographically close together. Existing shipping routes may lose sea room and become unsuitable for some vessels.

As noted above, all developments may pose this impact, but it is much less likely with tidal arrays in sufficiently deep water.

5.1.3.3 Loss of Station

Should a device lose station then it may present an impact to shipping. This may affect an entire device or just part of it.

All developments within the PFOW area may pose this impact.

5.1.4 Proximity

5.1.4.1 Anchorages (Designated/Preferred/Adverse Weather)

The proximity of the OREI to anchorages may impact users. This may affect access and the favourability of individual anchorages.

Figure 5-3 presents the anchorages used by recreation vessels noted within the Marine Scotland study of the area (MS, 2012e).

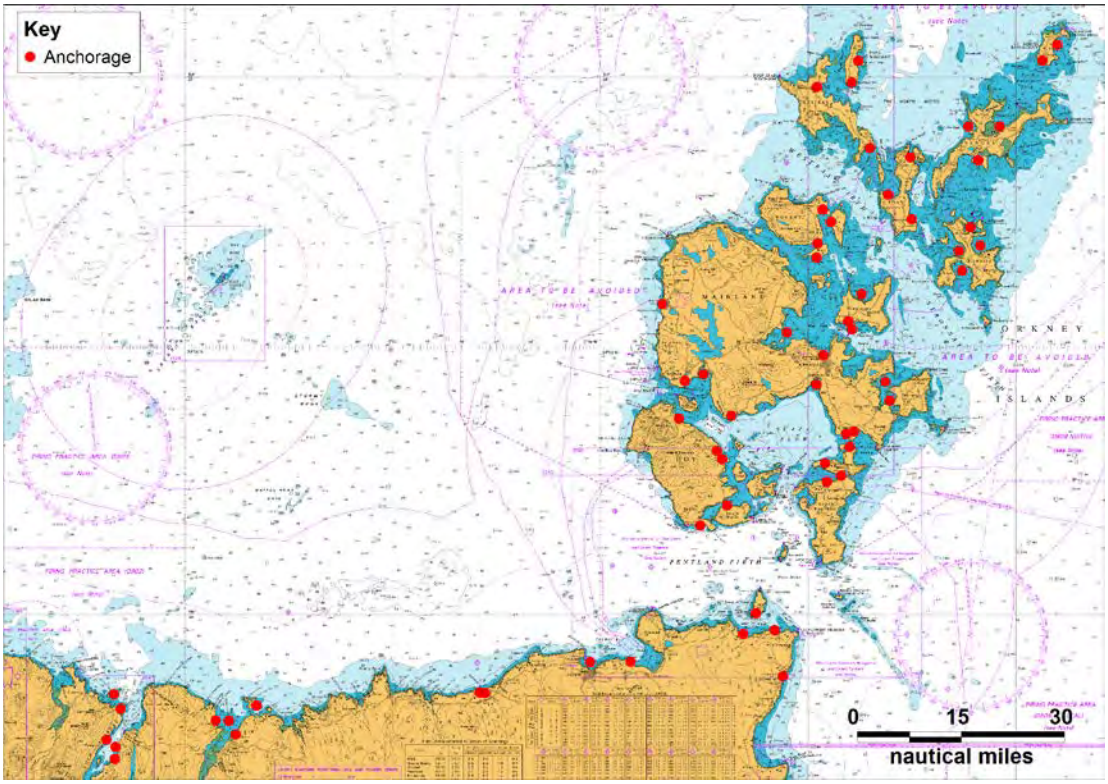


Figure 5-3 Recreational Vessel Anchorages

All the planned developments have recreational anchorages in proximity to them, although Brough Ness is the most remote. The level of impact will vary according to the distance from the anchorage of the development and whether navigation to the anchorage is complicated by the site.

5.1.4.2 Coastal Protection/Conservation Sites

Displacement of traffic towards these areas may impact on them.

All sites are near to statutory designated areas.

5.1.4.3 Disposal Sites

Displacement of traffic towards a disposal site increases the risk to the vessels should they need to anchor in an emergency.

There are few disposal sites in the vicinity of the development sites, some of which are no longer in use, further reducing the potential impact. West Orkney South, Brims Tidal Array, Inner Sound and Ness of Duncansby are in proximity to charted disposal sites.

5.1.4.4 Ship-to-Ship Transfer Operations

An OREI’s proximity to an area used for ship-to-ship transfers may raise the risk to that operation. Displacement may cause increased traffic density near to this operation, which in turn raises the potential for collision.

While none of these operations take place near to any of the proposed development sites, Scapa Flow is a well-established and sheltered location for Ship-to-Ship transfers of both oil and LNG. It is unlikely that any development would impact directly, however, access to

Scapa Flow may be affected by those developments within Pentland Firth, which could indirectly impact the operation by increasing the risk to navigation/access for the large tankers arriving for lightering operations. These impacts are already listed above under congestion and displacement.

5.1.5 Resources

5.1.5.1 Demand for Surveys

The MCA stipulates (MCA, 2008a) that a site and surrounding waters must be properly surveyed both prior to consent and as appropriate during the project lifecycle. This will increase the demand for hydrographic surveys, which are necessary because of the potential for seabed mobility. Other surveys for traffic may also take place.

All developments within the PFOW area may pose this impact.

5.1.5.2 Increase in Demand and Provision of Emergency Response Resources

The increased risk posed by the OREI may relate to the increased number of people or vessels present there or any of the other hazards already noted. If this differs greatly from the current situation then there may not yet be enough emergency assets or capability nearby. This would be true if large numbers of personnel were present in a remote location during construction and the local SAR helicopter were to be operating at or near the end of its fuel capacity if required on scene. Thus reducing the numbers of personnel it is able to recover in an emergency situation.

Conversely, the OREI site may also aid emergency responders by providing refuge and shelter to a casualty. The capability of the OREI to do this would depend on its design and suitability. There may be areas utilised for operational shelter that can, in the case of an emergency, offer a similar option to the casualty. Vessels associated with the development may also be able to assist in an emergency in the area.

All developments within the PFOW area may pose this impact.

5.1.5.3 Reduction in Available Sea Room for Defence Activities

The OREI may potentially restrict or displace MOD training if it is near to a military practice area or the sites presence is perceived as restricting the MOD navigational area.

No specific issues are known about for the PFOW sites.

5.2 Potential Significant Impacts

These can only be determined on a case by case basis. The impacts already noted may be determined to be significant if they pose a heightened risk or the effects are deemed so, whether alone, cumulatively or in-combination.

Once identified, further mitigation options can be planned to reduce the risk to be ALARP, again on a case by case basis.

5.2.1 Cumulative Impacts

An example of this for PFOW would be the high level of wave resource along the west coast of Orkney Mainland which has led to a number of developments in this area. If they all go ahead then it is possible they will have a cumulative effect on navigation. But this will not be clear until final layouts and site dimensions are available. Consideration should also be given to the phased nature of construction, which may further complicate (or ease) matters. If different phases go ahead in neighbouring locations, there is the potential for further cumulative impacts.

5.2.2 In-combination Impacts

These concern impacts associated with other developments occurring and causing a greater in-combination impact with the renewable energy development. This impact may be caused by the planned port developments at Stromness and Lyness, which may in turn cause an in-combination impact with those developments sited in the West of Orkney or Pentland Firth respectively.

Similarly the planned subsea transmission cable and the associated work vessels may cause impacts that exacerbate those of the energy developments located within Pentland Firth. It is also worth noting the intention to develop offshore wind farms within the PFOW Strategic Area, these plans are in the very early stages of development, but could also cause an in-combination impact with later phases of any wave to tidal developments in proximity to them.

In all cases this would likely cause traffic, navigation and/or resource impacts. No more can be assessed until the plans for these projects are further progressed.

5.3 Cumulative Impact Appraisal

The following appraisal of potential cumulative impacts arising from the planned wave and tidal projects in PFOW does not take account of potential mitigation measures that could be applied to the projects to, where necessary, avoid/reduce any potential cumulative effects. As stated elsewhere in this Paper, it is also important to remember that AfL areas may not be built out in their entirety. This will therefore influence the potential level of cumulative impact that may arose between the projects.

A better understanding of the projects (and therefore the potential cumulative impacts and any appropriate mitigation measures) will only be available when the design of each project is clearer/resolved. Greater detail will emerge (on a case-by-case basis) as developers near submission of their consent application and once NRAs (and other relevant assessments) are available.

5.3.1 Regional Distribution

The distribution of energy resource and AfLs leads to four geographic regions for this cumulative impact appraisal to focus on:

- Pentland Firth;
- West of Orkney;
- North East of Orkney Mainland; and
- Farr Point.

5.3.2 Pentland Firth

This group consists of the proposed tidal energy developments around the Pentland Firth, seen in Figure 5-4. These are:

- Brims;
- Brough Ness;
- Ness of Duncansby; and
- Inner Sound.

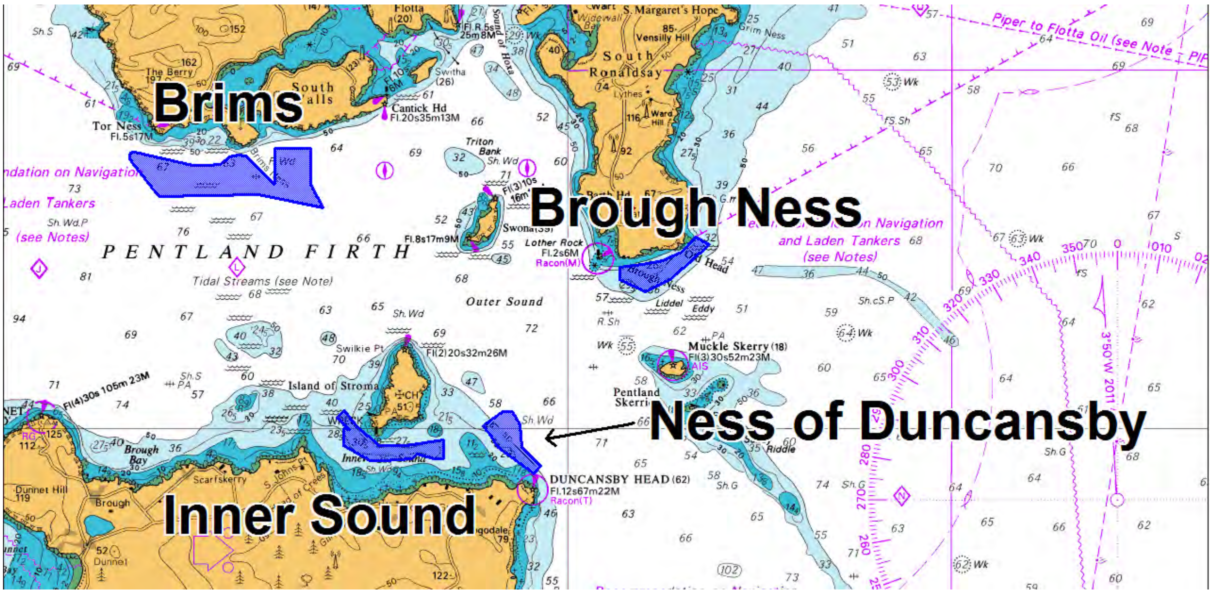


Figure 5-4 Pentland Firth Regional Group of AfLs

5.3.2.1 Traffic Impacts

There is the potential for cumulative impact on marine receptors of all kinds within this area of Pentland Firth. The heavy density of cargo vessels and tankers on east or west bound passage, combined with the regular crossing ferries travelling north or south, transiting fishing vessels and light/medium recreational traffic on passage both north or south and east or west highlights a busy and challenging navigational environment. With this level of traffic, a reduction in sea room could increase the risk of collision with development traffic or allision with structures.

Variation in the preferred routing will take place within this area during adverse weather. Regular runners, like the ferry services, have preferred routes and these currently pass in proximity to the AfLs. Similarly merchant shipping, fishing and recreational vessels may seek shelter nearer the coast under these circumstances.

Likewise congestion may be found both between and around the islands of Swona and Stroma, to the north and south of Outer Sound. This could be exacerbated by cumulative impact. As would displacement, in this area, for the same reasons.

The planned timings for construction coincide for a number of the project phases (potentially a maximum of three at one time). While these may later change or be influenced by the ports/harbours used for construction materials, it is likely that this would contribute cumulatively to an increase in traffic density.

During normal operation of the tidal devices, the cumulative impacts will vary dependent on the amount of surface piecing elements associated with these tidal developments or whether sufficient depth of water is available to allow free passage over the development.

5.3.2.2 Navigation Impacts

The AfLs pose a cumulative impact to access for all vessel types although this is potentially greatest for the ferry services, transiting recreational vessels and fishing vessels operating near or within the designated AfL area.

The only notable risk of cumulative impact concerning the ease of compliance with COLREGS would be at the southern edge of this area, which is the only place where the proximity to two AfL (Inner Sound and Duncansby) are close enough to influence vessels. This is also the only location likely to cumulatively influence the navigable route depth, inshore from Duncansby Head, past the southern side of the Island of Stroma.

Once again only the southern side poses a cumulative impact regarding the phased development of projects. Both of these may be potentially undertaking phases of construction at the same time and there is the probability maintenance will coincide too.

All of these impacts would be heavily influenced by the technology selection, seabed (navigable route depth) and development phase timing.

There is unlikely to be any cumulative impact to radar operation. Although there may be surface/surface-piercing elements to the developments in this area, these are liable to be too few to cause an impact.

The routing measures within this area are unlikely to be impacted in a cumulative manner.

A cumulative snagging impact is only probable within the southern region of this area, although this is much reduced because of the distance between AfLs. This would be influenced by the placement of the development’s submarine cables. If the laying/landing locations are well clear for each of these, this would be reduced further.

There will be no cumulative impact to existing aids to navigation. Because of the strong tidal streams no navigational buoys are found close to these AfLs and the shore based navigation lights would not likely be affected by tidal technologies. However cooperation between these developments concerning the lighting and marking of these sites will ensure that no cumulative impact occurs (see Section 6.6.6).

Both the restricted access for emergency response and under keel clearance cumulative impact will be dictated by the technology. Again this would only likely influence the southern region of the area and to a lesser degree due to site proximity.

5.3.2.3 Design Impacts

All three of the potential design impacts (alignment of structures/site boundary/loss of station) will only occur around the southern AfLs. The risk of effect is however much reduced for tidal technologies. But they may occur, to a lesser degree cumulatively.

5.3.2.4 Proximity Impacts

There is potential for a cumulative impact concerning anchorages. Again this is only likely to the south of the area, where three nominated recreational anchorages are located. This is the same for cumulative impacts to coastal protection/conservation sites. Designations exist around both Duncansby Head and the Island of Stroma.

No cumulative impacts are expected to either disposal sites or ship-to-ship transfer operations.

5.3.2.5 Resources Impacts

With the increased demand for both surveys and emergency response resources associated with the coinciding phases of construction and operation/maintenance, this area could experience a cumulative impact.

No influence to defence activities is expected, as there is no military exercise area in proximity to this area.

5.3.3 West of Orkney

This group is made up of the wave energy developments along the west coast of the Orkney Mainland, seen in Figure 5-5. These are:

- Costa Head
- Brough Head
- Marwick Head
- West Orkney Middle South
- West Orkney South

It is noted that there is also the existing wave energy test facility at EMEC Billia Croo.

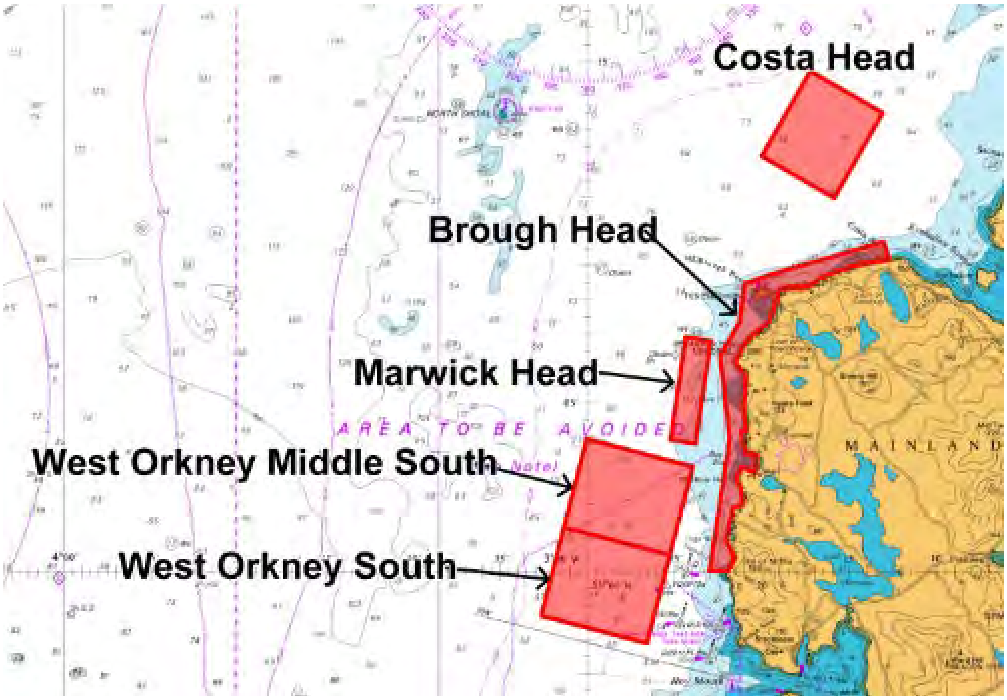


Figure 5-5 West of Orkney Regional Group of AfL Areas

5.3.3.1 Traffic Impacts

There is the potential for cumulative impact on all marine receptors in this area. The density of traffic operating within this area, both transiting and that which is navigating along the coast is noted to pass through and in proximity to the current AfLs. If all the AfLs are developed then the reduction in sea room could see an increase in the risk of allision / collision.

There is a potential cumulative impact on adverse weather routing. This is made up of all sectors of traffic using the west coast of the Orkney Mainland for shelter from the weather. This will include traffic transiting from/to Stromness, which may in future be navigating further from the coast (between the coastal/seaward AfLs). Cumulatively, this could also influence adverse weather routes.

Similarly the layouts of coastal/seaward developments will channel the traffic that was once using these areas, cumulatively increasing congestion between the AfLs (north/south). Both the extremes of the area, the north (Eynhallow Sound/Westray Firth) and south (Hoy Mouth) could see cumulative impact to the vessels navigating through these entrances. Under both these circumstances it is expected that there would be an increased traffic density cumulative impact, resulting is an increased risk of collision.

This may well displace some traffic, as the perceived risk of navigating in proximity to the AfL areas would influence vessels to avoid the coastal waters and pass seaward of the AfL areas. This would then reduce congestion and the risk of collision.

This area is liable to have a cumulative impact to port traffic. During the construction phase, two AfLs may coincide on three occasions. Whether they utilise Stromness harbour or their construction traffic passes nearby, it is likely to present a greater impact.

5.3.3.2 Navigation Impacts

The close proximity of development areas would indicate that there could be a cumulative impact to access, both near the coast and further offshore. This is most significant towards the south of the area, where the developments are greatest in number and proximity. While the technology utilised within each development will vary, it is probable that there will be more surface/surface-piercing elements associated with these wave energy projects, meaning that access within the sites is less likely or at the least not advisable for some marine traffic. Again the proximity of five AfLs would produce a cumulative impact, although this depends on how much of the areas are built out.

With the reduction in sea room, especially in the south of the area, it is reasonable to assume that the ease of compliance with COLREGS could be negatively impacted.

The type of technology utilised in wave energy generation is less likely to impact navigable route depths. There is therefore unlikely to be a cumulative impact from anything other than the laying of transmission cables, but this would only be the case if these were close together or landing in the same location. This is also true of the impact of snagging, which would only cumulatively occur if these cables were close together.

As already stated, the construction phases may overlap which indicates a cumulative impact is conceivable.

While each AfL will have surface/surface-piercing elements, these will be low in the water and not likely to cause a cumulative impact to vessel detection by radar.

The close proximity of AfLs would indicate that any routeing measures used to influence the traffic flow could cause a cumulative impact. Again this is greatest at the south of the area, but is also possible in the middle and most northerly point.

The proximity of the five sites (plus existing Billia Croo site) may cumulatively impact the safety of navigation. This is the case both for the north/south traffic, which either must navigate between the developments when inshore or alternatively choose to navigate further offshore, away from coastal shelter, and for the east/west traffic, entering the islands, at either end of the west of Orkney area.

Any impact concerning the use of existing aids to navigation is likely to occur at the south of the area, where the EMEC Billia Croo wave energy test site is located. The three AfLs here are close to this established site and a cumulative impact could occur here, unless it is mitigated through cooperation (see Section 6.6.6).

The number of surface/surface-piercing elements associated with wave energy generation would be expected to cause a cumulative impact to emergency response access, due to the scale of potential area covered. However it is not likely to affect under keel clearances, due to the technology utilised.

5.3.3.3 Design Impacts

Due to the proximity of AfLs in this area, especially in the southern part, each of the design impacts (alignment of structures/site boundary/loss of station) could result in cumulative effects. The total potential area encompassed by all the AfLs in this area will however have a greater influence to any alignment and boundary issues. Also any conditions likely to cause a loss of station, such as prolonged heavy weather, could occur to multiple developments.

5.3.3.4 Proximity Impacts

There is the possibility of a cumulative influence on anchorages, although there is only one identified recreational anchorage along this coast, so it would be limited to this area. This anchorage is in the vicinity of three AfLs, all of which may influence the use of the anchorage.

The closest coastal protection/conservation sites are found along the coast of the Island of Hoy and a northern section of Orkney Mainland. These areas are in proximity to only two AfLs, in both cases so any cumulative impact is most probably a minor influence.

There are no disposal sites situated along this coastline, so no impacts are foreseen. This is also the case concerning ship-to-ship transfer sites.

5.3.3.5 Resources Impacts

Due to the number of AfLs within this area and the potential for coinciding phases of construction and operation/maintenance, a cumulative impact on both surveys and emergency response resources is possible.

Due to the distance to military exercise areas, no impact (cumulative or otherwise) is expected to defence activities.

5.3.4 North East of Orkney Mainland

This group consists of the two tidal energy developments amongst the islands to the north east of Orkney Mainland seen in Figure 5-6. These are:

- Westray South
- Lashy Sound

There is also the existing EMEC Fall of Warness tidal energy test site in this area.

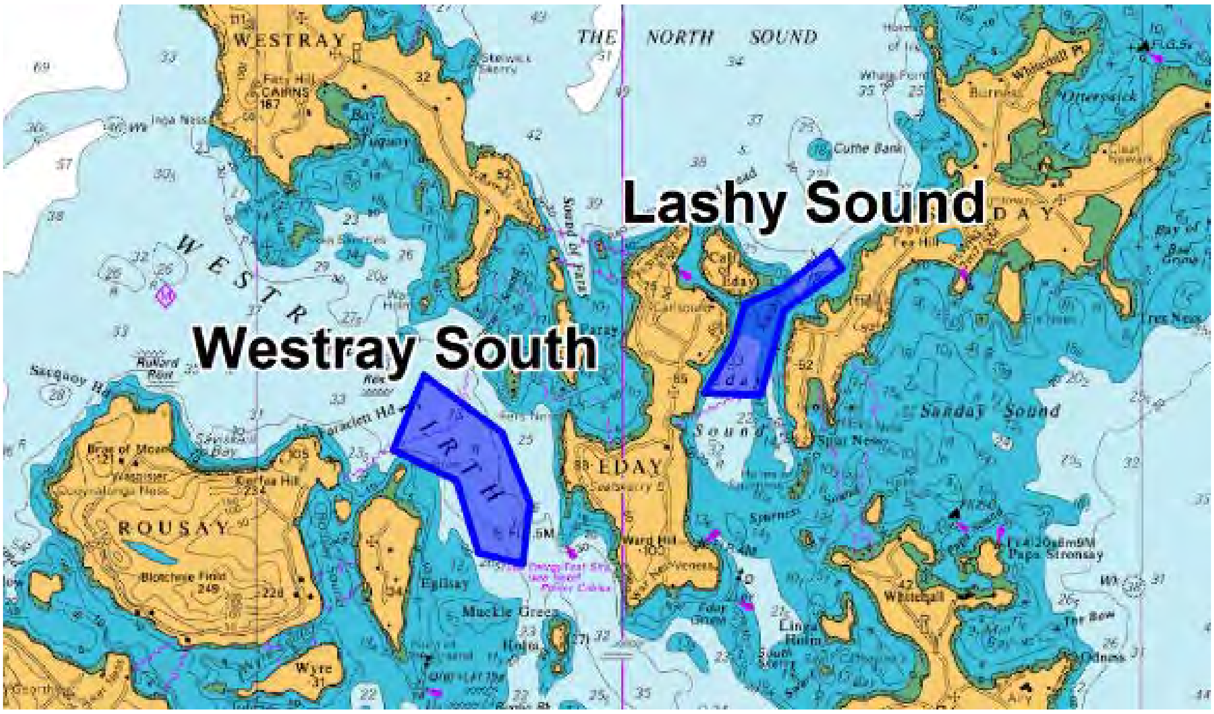


Figure 5-6 North East of Orkney Regional Group of AfL Areas

5.3.4.1 Traffic Impacts

A reasonable proportion of the traffic passing between the islands to the north east of Orkney Mainland uses both of the passages of Westray Firth and Lashy Sound. This is influenced by the condition of the tide and prevalent weather. Whilst this will be greatly influenced by the number of surface piercing elements, depth of water and under keel clearance, it is possible that the AfL areas found within this area may cause a cumulative impact to the risk of allision. This would be less than that encountered with wave energy technology, but would still be present.

In the same manner it is possible that the adverse weather routing of traffic in this area would likely be cumulatively impacted. The traffic is greatly influenced by the tidal flow and any alteration to the sea room available would affect the marine traffic operating here.

While the AfLs are separated by the Island of Eday, the routes through here (north/south) account for a large proportion of the traffic passing through this area and would influence congestion cumulatively. However, the extent of this will depend on the type of device deployed. Similarly it is reasonable to assume that displacement could occur here too, although it likely that this will be greatly affected by the tides and type of devices deployed. It is noted that Scotrenewables plan to utilise surface piercing technology at Lashy Sound, if this is the case then this will contribute to these impacts.

These AfLs do potentially share a coinciding construction phase, so a cumulative increase in traffic density is foreseeable. Traffic density would also be influenced by the transiting traffic, whose routing choices are impacted by displacement or congestion at different states of the tide.

While unlikely to affect any nearby port traffic, the construction traffic may well cause a cumulative impact to port traffic levels, if they occur at the same time (as currently planned) and/or utilise the same port resources.

5.3.4.2 Navigation Impacts

Access is likely to be cumulatively impacted, for those vessels transiting north/south between the islands, as the passages potentially impacted affect a sizable proportion of the marine traffic navigating through these routes.

Any surface piercing element of these developments will further reduce the available sea room, in what is a challenging (narrow with a strong tidal race) passage. This could in turn impact the ease of compliance with COLREGS.

The use of surface piecing technology at Lashy Sound will reduce the impact to the navigable route depth. This floating technology will cause alternative impacts and not cause a cumulative impact along with the AfL area at Westray Sound.

The phased development of these projects may cause a cumulative impact if they undertake construction at the same time.

There is unlikely to be a cumulative impact to vessel detection by radar. This is due to the reduced number of surface/surface-piercing elements associated with tidal energy developments and the distance between the AfLs.

A cumulative impact could be experienced by the marine traffic transiting the area in regards to routeing measures and traffic flow. As already noted the traffic using these areas is influenced by the tides and weather.

While both AfLs present an individual risk of snagging, the distance between them would indicate that they would not do so cumulatively.

While the risk of cumulative impact to the safety of navigation is reduced by the distance between the AfLs, it is still present. This is due to the already noted use of these north east passages by the same traffic. Therefore any impact to the safety of navigation caused by the introduction of surface piecing technology or reduction in route depth would impact across the area.

No cumulative impact regarding the use of existing aids to navigation is foreseen, due to the distance between the AfLs. However cooperation between these developments concerning the lighting and marking of these sites will ensure that no cumulative impact occurs (see Section 6.6.6). Similarly this distance would also ensure that no cumulative impact is experienced in access for emergency responders.

With regards to under keel clearance, as noted above where route depth is concerned, this is not likely to cause a cumulative impact, because of the type of technology to be employed at Lashy Sound.

5.3.4.3 Design Impacts

It is doubtful that any of the design impacts (alignment of structures/site boundary/loss of station) could cause a cumulative impact due to the distance between these AfLs.

5.3.4.4 Proximity Impacts

Because of the strong tidal race that provides the resource for these tidal energy AfLs, the area in proximity is unsuitable for anchoring. The closest anchorages are sheltered and at a distance where any impact would be much reduced. This, along with the distance between the AfLs, indicates that there would be no cumulative impact to the anchorages here.

No impact to either disposal sites or ship-to-ship transfer operations is expected due to these not occurring in proximity to the AfL areas.

The distance between the AfLs and the coastal protection/conservation site designations found on the northern most parts of the islands of Rousay and Eday are such that there is no risk of cumulative impact.

5.3.4.5 Resource Impacts

The concurrence of construction phases could point to the possibility of a cumulative impact from the demand for surveys and could therefore increase the demand for emergency response resources.

There would be no cumulative impact to defence activities, none are known to occur within this area.

5.3.5 Farr Point

This wave energy development site situated off the Sutherland coast of mainland Scotland, at the most western end of the PFOW Strategic Area, is considered to be sufficiently remote from the other sites that no cumulative impacts will take place with other planned wave or tidal projects in PFOW.

Similarly the location and proximity from other receptors indicates that it would likely not present any in-combination impacts.

5.4 Conclusion

All areas, except Farr Point, pose the risk of cumulative impacts on various aspects of shipping and navigation in PFOW. The potential frequency and severity of any of the above mentioned potential cumulative impacts will differ greatly depending on the actual percentage area used of the total AfL areas. Until the site size and design is known, it is not possible to make an accurate estimation of these possible impacts, hazards or the most suitable mitigation methods. It is also important to note that this appraisal has not taken account of potential mitigation measures that could be applied to individual projects.

Instead it is better to utilise the insight gained from undergoing a preliminary examination of possible cumulative impacts in guiding the analysis for the NRA. This will ensure a fuller understanding of the impacts, particularly with the greater detail available during this state of preparation for consent.

To aid the understanding of impacts a table has been produced in Appendix D (Potential Impacts by Development Site). This allows a better overview of the many impacts in relation to the different AfL areas.

This list is not exhaustive, there may be further impacts, specific to the development. The site-specific NRA will identify these and the level of impact they are likely to present.

6. Mitigation Options

6.1 Guidance

Industry has developed a number of standard mitigations. These are detailed within the following:

DECC guidance (DECC, 2005) details the methodology and techniques suggested to assess risks to offshore wind farms. While specifically written with offshore wind farms as the focus of this guidance it is relevant to all OREIs. It also details many applicable hazards and risk controls. This document is currently under review, updated guidance is expected to be published.

The IALA recommendation (IALA, 2008) clearly states their recommendations concerning the marking and lighting of offshore structures including offshore wave and tidal energy devices. Variations for the different technologies and the different risks they may present are specified.

The MCA has produced two Marine Guidance Notes (MCA, 2008a and MCA, 2008b). The first notes the current guidance from MCA concerning OREI navigation, safety and emergency response. It emphasises the concerns that must be taken into consideration when assessing the impacts to these issues. It also specifically highlights issues relating to sites, navigation, shipping routes, phases of development and search and rescue. While the second guidance note is aimed at mariners operating near to an OREI. It highlights the risks and the standard mitigations that are utilised, ensuring familiarity with these. This assists marine traffic in making an informed decision with regard to passage planning in the vicinity to OREIs.

When seeking consent for a development it is assumed that the standards detailed above are followed. This should be noted, while anything that exceeds these standard mitigation methods should also be detailed. These will be site/technology specific.

6.1.1 MCA Guidance

As mentioned above, the MCA makes a number of recommendations within its guidance (MCA, 2008a), Annex 4, concerning Offshore Renewable Energy Installations (OREI) and the appropriate mitigation and safety measures to follow.

- Promulgation of information and warnings through notices to mariners and other appropriate media.
- Continuous watch by multi-channel Very High Frequency (VHF) radio, including Digital Selective Calling (DSC).
- Safety zones of appropriate configuration, extent and application to specified vessels.
- Designation of the site as an area to be avoided (ATBA).
- Implementation of routeing measures within or near to the development.
- Monitoring by Radar, AIS, closed circuit television (CCTV) or other agreed means.
- Appropriate means for OREI operators to notify, and provide evidence of, the infringement of safety zones or ATBA’s.

- Any other measures and procedures considered appropriate in consultation with other stakeholders.
- Creation of an Emergency Response Cooperation Plan with the relevant Maritime Rescue Coordination Centre from Construction Phase onwards.

This list is not exhaustive and consideration should also be given to the following:

- Marking/Charting.
- Identification of development free channels where appropriate/if necessary.
- Vessel traffic management.
- Site boundary design and device alignment.

6.2 Safety Zones

The conditions of utilising safety zones around renewable energy installations are laid out within the Energy Act 2004 (section 95/schedule 16), as amended and The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007 (S.I. 2007 No. 1948). There is also guidance available from DECC (DECC, 2011a) concerning the application process for a safety zone. This guidance makes clear the stipulations concerning the application and conditions for the successful establishment of a safety zone.

The use of a safety zone around construction operations is advised. This reduces the navigational risks to the vessels and personnel involved in this task. The benefit of employing the safety zone during the site's operational phase should be assessed against passing and site traffic.

The standards concerning safety zones are noted within both the regulation (DECC, 2007) and guidance. Most notable of these is that the dimensions do not exceed 500 metres. This is considered the standard size during construction/extension/decommissioning phases. This is in-line with the stipulations of UNCLOS (UN, 1982), which dictate that the safety zone shall not exceed 500 metres.

In narrow channels, there may be a case for using smaller dimension safety zones than the standard 500m to maintain adequate sea room whilst still protecting vessels and workers at the site. This has been proposed in the MeyGen NRA, to take account of the features of the Inner Sound. This may also be appropriate for other PFOW projects in channelled waters, such as Westray and Lashy Sound, as well as where sites are in proximity and construction periods could overlap, such as west Orkney Mainland.

During the operational phase the safety zone radius would be reduced to 50 metres, if it is required. The use of safety zones as risk mitigation during the operational phase must be justifiable and is not currently used as a standard measure in UK Renewables projects, although advisory zones are being discussed for a number of offshore wind farm projects.

This measure is suitable for all developments during the construction, maintenance and decommissioning phases. The use during the operational phase must be judged against the navigational safety of the area and impact to marine traffic on a case by case basis. For example, if the technology employed provides adequate under keep clearance for transiting vessels, then safety zones would be a needless restriction to navigation.

6.3 Routeing Measures

Thought should be given to traffic operating or transiting the area. Depending on the technology employed it is possible that either the devices or the site may displace some or all the traffic. The traffic survey, required by the MCA, will assist in outlining the types and sizes of vessels likely to be affected.

The influence displacement has on vessels, as noted previously, varies by location. It may warrant mitigation if it is identified as causing a hazard to navigation. For example, reduction in sea room may heighten the risk to transiting vessels. This may affect all vessels or a particular group. This in turn can create in-combination effects with other stakeholders or cumulative effects with other nearby developments.

The MCA have published guidance (MCA, 2008b) to mariners operating in the vicinity of OREIs). The guidance suggests three options, in simple terms, for mariners operating in OREI areas:

- Avoid the area completely;
- Navigate around the edge of the OREI; or
- Navigate, with caution, through the array.

The choice will be influenced by a number of factors including the vessel's characteristics (type, tonnage, draught, manoeuvrability, etc.), the weather and sea conditions. The guidance suggests that where there is sufficient sea room it is prudent to avoid the area completely.

The choice will also depend on the navigational features of the area, for example, the sea room and water depth available at the edges of the development.

If routeing is perceived as a hazard that requires mitigation, then it may be appropriate to identify a development free channel, in an appropriate location. This would allow the safe transit of vessels rather than displacing them. An example being allowing the safe navigation of coastal traffic, rather than displacing it into the main shipping channel with larger transiting vessels. It may be possible to satisfy this demand with the design of the layout of structures on a site. Where a number of sites are located closely together, such as off the west coast of Orkney Mainland, co-operation on the layout/boundaries may create more sea room between the sites and allow the safe transit of traffic. This would alleviate the necessity of considering a development free channel. The possibility would be dictated by the amount of the AfL area required to be developed and whether the resource or seabed allowed for this amount of flexibility.

All developments, depending on the technology used and surface/surface- piercing elements, may wish to use routeing measures to advise marine traffic to navigate around the edge of the OREI. The proximity of AfLs and the traffic within the area assessed as West of Orkney indicates that this area may benefit from a development free channel running north-south parallel to the coast. This would reduce the impact to vessels displaced from the coast and could reduce the risk posed by congestion to vessels navigating between the AfLs.

6.4 Area to be Avoided

This routeing measure can be utilised if the area poses a particular hazard to navigation or the avoidance of casualties in it is important. The area must be defined and can exclude all or particular classes of ships. This will take time to achieve, consultation and justification to the MCA must be made. Which must satisfy both them and ultimately the IMO, who they must convince to enact this routeing measure. After which notes concerning the specific conditions should preferably be given on charts and always noted in sailing directions. For this purpose the United Kingdom Hydrographic Office (UKHO) should be consulted, who in turn will amend their Admiralty charts.

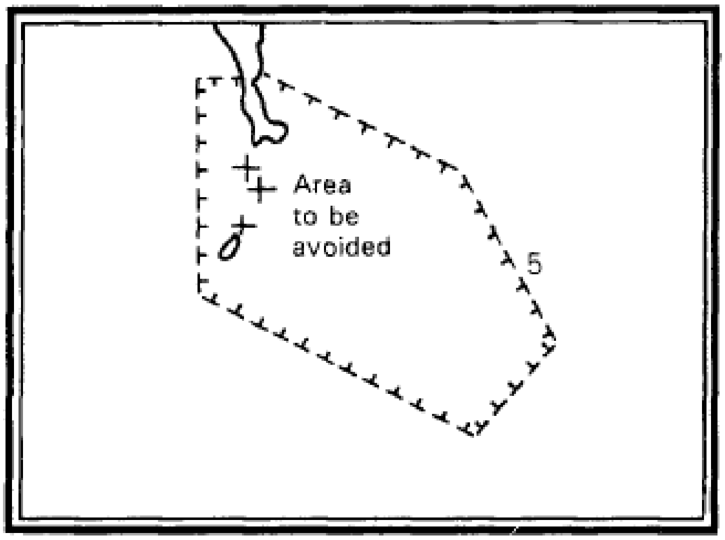
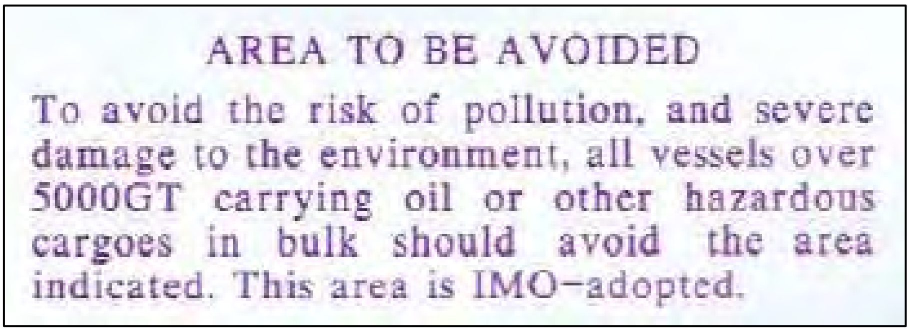


Figure 6-1 Example Chart Marking of Area to be Avoided

The ATBA surrounding Orkney is a good example of a charted ATBA. The explanatory note details the type of vessels advised to avoid the area and the reason for doing so.



AREA TO BE AVOIDED

To avoid the risk of pollution, and severe damage to the environment, all vessels over 5000GT carrying oil or other hazardous cargoes in bulk should avoid the area indicated. This area is IMO–adopted.

Figure 6-2 Example Note from Chart

This mitigation measure is not likely to be employed by any of the developments, because of the low likelihood of there being a risk significant enough to warrant its use. The time and justification required to implement this measure would only be practical if the risk was significant and no other mitigation method was suitable. Some of the tidal AfL areas may still wish to consider this method, to ensure the safety of particular vessels, but alternative methods are likely to be as effective, specifically the use of a safety zone.

6.5 Monitoring/Watchkeeping

Monitoring of VHF/Radar/CCTV/AIS or other means either locally or remotely can assist in preventing incidents and improving response times to a developing situation. The ability/benefit of some form of monitoring should be considered through the different phases of a wave and tidal project.

Vessel traffic services can be utilised to monitor and regulate navigation. Alternatively recommended routes may be agreed to ensure works construction/transfer traffic operates in a safe and organised fashion.

All developments will utilise this mitigation method in some form. Construction traffic, both engaged in operations and those standing by, will be carrying out this watchkeeping in some form by VHF/Radar/AIS. This can be formalised within an operational guidance document, to ensure good use of local resources and that all parties are working in a standardised approach.

Liaison should also take place with the local Port Authorities who may have existing traffic monitoring, such as the Vessel Traffic Service operated by Orkney Harbours from Scapa, which has recently been upgraded to extend coverage of renewable sites.

6.6 Marking/Charting

6.6.1 Marking

The marking of wave and tidal energy devices is well documented within the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) recommendations (IALA, 2008). The current recommendation (O-139) incorporates and supersedes the previously issued IALA Recommendations (114, 116, 117 and 131), which are now withdrawn. The marking of offshore wave and tidal energy devices is now incorporated into a section (2.4) of this guidance.

Whatever the type of renewable energy installation, the area should be marked in accordance with the IALA maritime buoyage system. Depending on the amount of traffic and level of risk due consideration should be given to the following:

- Buoyage;
- Lighting;
- Sound signals;
- Colour markings;
- Leading lights;
- AIS as an Aid to Navigation; and
- Radar beacons.

Marking in these waters (outside of port limits) is the responsibility of the NLB. They will consider this issue on a case-by-case basis. The location, type and number of devices will alter from site to site to ensure optimal marking. Other influences will include:

- Proximity of other wave and tidal projects;

- OREI buoyage planned/in place;
- Buoyage already in the area;
- The technology used (surface located/surface piercing);
- Variation in different project phases; and
- The suitability of the area to specific marks (strong tides/depth of water).

Flexibility is key during phased developments, where the marking of a partly developed site for the final navigational situation is not suitable and phasing the marking may be more useful to mariners.

Sites close together may find it better to plan the marking of their developments together (in consultation with NLB), or in the case of a development beginning after the construction of another, they may both find that they need to adapt the buoyage to suit the current situation.

There is a requirement to develop arrangements for the maintenance of marks and having contingency plans in place to deal with the loss or replacement of marks. Again, cooperation between developers would be encouraged to share resources and costs.

There is also guidance on marking from DECC (DECC, 2011b). This highlights the points they consider important. It remains in line with the standards expressed in the IALA recommendation, providing more detail concerning specific requirements for UK installations.

6.6.2 Charting

The UKHO provides hydrographic services for waters of UK national responsibility. The charting of OREIs and their associated hazards or dimensions is carried out to the specification as detailed within the international regulations (IHO, 2012) produced by the International Hydrographic Organization (IHO).

6.6.3 Examples of Current Site Markings within the PFOW

Figure 6-3 is an example of the chart at the Billia Croo wave test site.

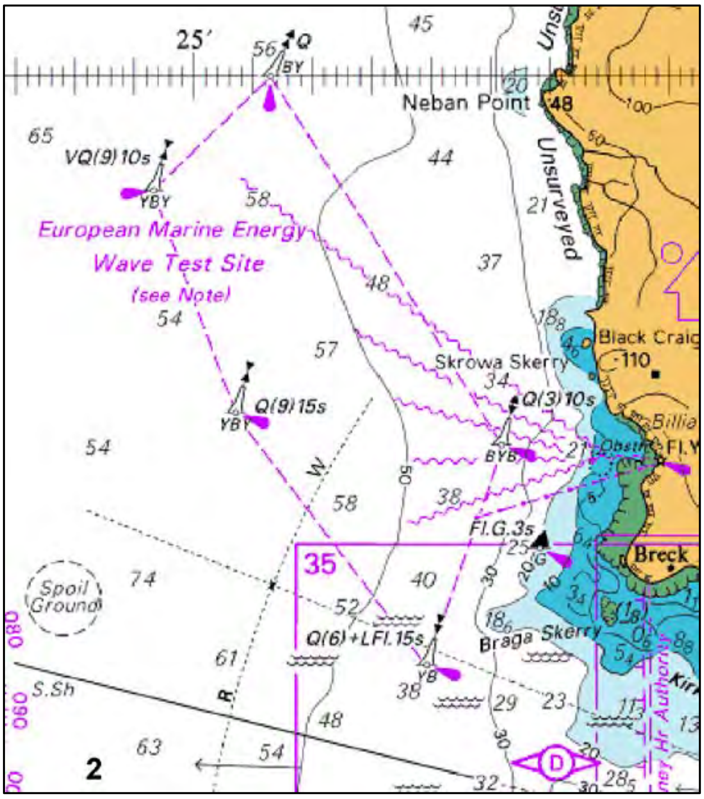


Figure 6-3 European Marine Energy Centre (EMEC) Wave Test Site (Billia Croo)

The area presenting a hazard to navigation because of the wave energy devices within it is marked by cardinal buoys. These indicate where the safe navigable water is found and mark the edge of the site. The submarine cables used on site are also charted to the individual berths. As it is a test site with berths not permanently occupied and types of devices changing, individual devices are not charted. The guidance (IALA, 2008) does not require individual devices within a site to be marked if the boundary is sufficiently marked.

As indicated there is also a chart note concerning the site (Figure 6-4). This elaborates on the specific hazards present, clearly stating the local circumstances to be expected.

EUROPEAN MARINE ENERGY
WAVE TEST SITE
58°58′·5N 3°23′·5W

Mariners should avoid passing within the test area marked by cardinal buoys. Experimental devices, usually marked by yellow buoys and lights with daymarks, are temporarily established in the area. Devices marked by buoys may also be deployed between this area and the coast.

Figure 6-4 Chart Note Concerning Wave Test Site

Figure 6-5 is an example of the chart at the Fall of Warness tidal test site.

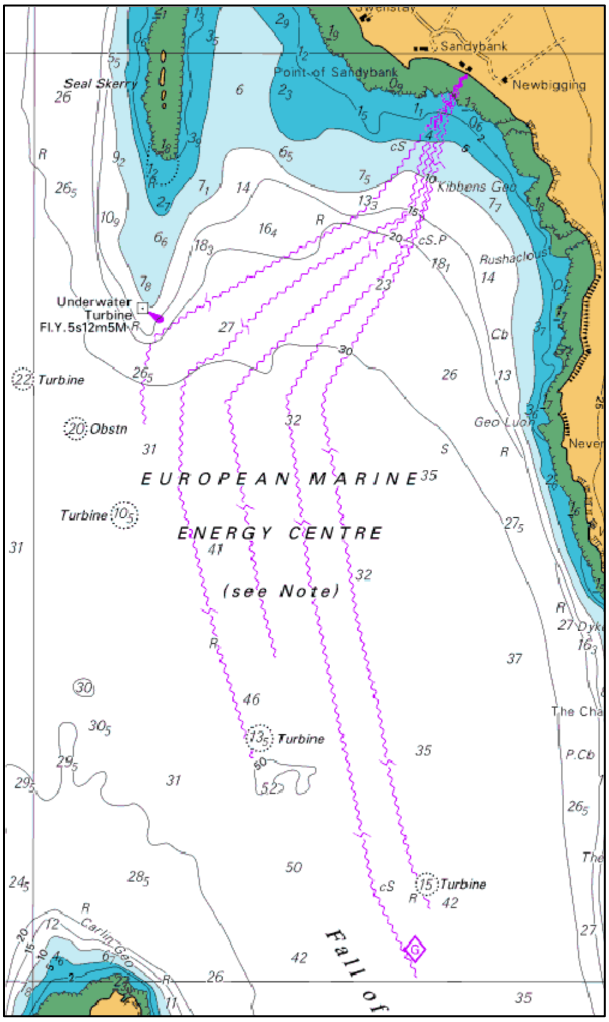
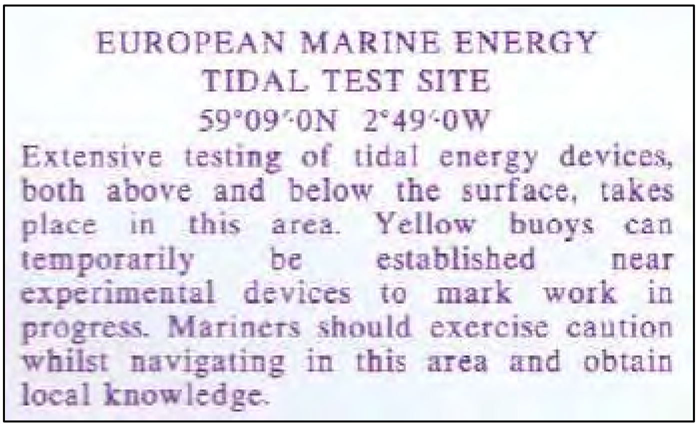


Figure 6-5 EMEC Tidal Test Site (Fall of Warness)

Neither the site nor individual underwater turbines are buoyed in this location. This is due to the strong tides and depth of water. The NLB has expressed grave concerns about buoys keeping station in areas with strong tides. The loss of a buoy presents a greater danger to traffic if navigators are expecting to see it. The hazard presented by the solo underwater turbine in shallow water is mitigated by a special mark. This yellow buoy warns of the hazard presented by this device, which has a surface piecing platform supporting the subsea turbine. The underwater turbines in deeper water are marked with a danger circle, along with the least depth that has been found by sounding only. Once again the submarine cables are charted.

This site (Figure 6-6) also has a chart note detailing specific considerations useful to those navigating nearby.



EUROPEAN MARINE ENERGY
TIDAL TEST SITE
59°09'·0N 2°49'·0W
Extensive testing of tidal energy devices, both above and below the surface, takes place in this area. Yellow buoys can temporarily be established near experimental devices to mark work in progress. Mariners should exercise caution whilst navigating in this area and obtain local knowledge.

Figure 6-6 Chart Note Concerning Tidal Test Site

It is worth noting that the IALA recommendation 0-139 is currently under review and a revised edition may be available from December 2013 or thereabouts.

6.6.4 Virtual Aids to Navigation

A virtual aid to navigation (AtoN) is information presented digitally to maritime users of compatible equipment. It does not physically exist. There are draw backs, mainly due to the limitations in using an AtoN that is not receivable by all marine traffic. Therefore it should only be used to supplement already sufficient marks. However, because of the types of vessels capable of receiving this, the use of virtual AtoN do lend themselves to providing additional AtoN to SOLAS vessels.

Consultation with NLB noted that virtual AtoN can add to/cause clutter, especially if overused, so caution in their use is advised and the marking of all devices on a site would not be recommended. AIS may have a role in marking the significant periphery structures of a site.

6.6.5 Standardised Approach to Marking and Charting

Anatec has consulted closely with the NLB to consider the issue of marking OREIs. It is clear that international guidance is only a series of recommendations, not standards. This allows for national variation, so those responsible, the General Lighthouse Authorities (GLA), are able to ensure the methods employed are suitable for the waters for which they are responsible.

The GLA, which in the case of PFOW is the NLB, is responsible for authorising (outside of port limits) the marking of the OREI. When looking at variation throughout the phased construction of an OREI the method is to be pragmatic, identifying the requirement on a case-by-case basis, ensuring flexibility with the phases of the build out. To plan for the variations during the phased build of a development a marking and lighting schedule/programme should be prepared by the developer. It will detail the marking/lighting for each phase, where variations are planned, completed in advance of construction, enabling approval by the NLB and MCA to be sought.

The height of the light should be considered when planning the lighting of devices, especially for floating devices operating at sea level. Lights at sea level are more likely to be obscured by waves and are particularly difficult to observe by recreational vessels, in adverse weather because of the similar height of eye of the sailor.

The IALA (IALA, 2008) recommendation should be regarded as the standardised approach to marking. It is a pragmatic approach to marking the devices/site according to the type of hazard to navigation they pose and specific to the different types of devices. Its production and revision also benefits from the technical skills available within IALA and the GLAs represented there.

This should be used in combination with the DECC guidance (DECC, 2011b) which further defines the standards required within UK waters. Appraisal of the approach is documented in an appendix to this report (11. Appendix C PFOW Approach to Marking).

The standard approach to the charting of OREIs and turbines should always be by agreement with UKHO and to the international standards clearly documented by IHO (IHO, 2012).

6.6.6 Mitigating Cumulative Impact to Existing Aids to Navigation

Where sites are in close proximity to existing aids to navigation, such as the southern edge of the west of Orkney area, as assessed in Section 5.3.3, it is best to co-ordinate any marking to avoid the overuse of marks or cause an impact to current Aids to Navigation.

The greater the distance the development is from existing aids to navigation, the less the potential impact/cumulative impact is likely to be. This can be further reduced if the developments are able to co-ordinate marking, potentially reducing the number of aids to navigation required.

6.6.7 Civil Aviation Authority

While the dimensions and therefore risk posed by surface piercing devices to aircraft do not currently exist, it should be noted that if any of these structures are 60 m or more in height, above the highest astronomical tide, then there is a CAA obligation to light the obstacle.

6.6.8 AfL Marking

All developments will mark and chart their sites. The approach may vary, as indicated within the examples above (6.6.3). Wave energy developments would utilise more marks, whereas tidal developments may, depth of water/route/surface element depending, instead use fewer marks and rely on charting.

6.7 Notices

The promulgation of information to the maritime sector is done through a ‘Notice to Mariners’. These come in a number of forms, the type of information dictating which notice is best suited for use. The most common notices in use are:

- Admiralty Notices to Mariners;
- NAVTEX (Navigational Telex or Radio Navigational Warnings); and
- Notice to Mariners.

6.7.1 Admiralty Notices to Mariners

These are produced by UKHO. The Admiralty Notices to Mariners (NM) contain safety critical information for mariners, there are also Temporary and Preliminary Notices to

Mariners (T&P NM). These contain information still considered sufficiently significant to require communication by NM, but are thought to be transient/temporary (e.g. works taking place for a specific period) or as advanced warning, either for a change affecting navigation in the near future or if information concerning the change is either not fully available or too complex (e.g. a port/coastal development). The significance of the impact to safe navigation will dictate if UKHO consider it worthwhile producing an NM or if a private Notice to Mariners (5.7.3) would be more suitable.

When the construction phase is near and/or once the markings are agreed then UKHO should be informed to enable charting of the layout and promulgation of a NM. This can be done using Hydrographic Note H102 (UKHO, 2013), which once completed should be sent to UKHO. They should also be informed of safety critical information concerning navigation of the area. The UKHO will decide, based on the significance of the hazard to navigation, if this information will be published either by NAVTEX, in the weekly Notices to Mariners bulletin and/or added to the area Sailing Directions (UKHO, 2012), also known as the Pilot.

6.7.2 NAVTEX

If the navigation risk is significant and timely promulgation of the information is required then a NAVTEX may be utilised. This navigation warning is broadcast by radio and received on the bridge of vessels within the area (NAVAREA I is the NE Atlantic) on special equipment. The information transmitted is similar to Admiralty NM.

6.7.3 Notice to Mariners

These are produced by other bodies for the promulgation of navigation safety information. Ports and developers will issues these before and during construction and maintenance work. This is where less significant but still locally important information will be passed to mariners. A developer may publish these notice to mariners on their website, but should also distribute them to national and local stakeholders, this should include but is not limited to:

- MCA (via the local MRCC);
- UKHO;
- The General Lighthouse Authority (NLB);
- Marine Scotland;
- Local Port Authorities;
- RYA; and
- Kingfisher Fortnightly Bulletin.

Local port/harbour authorities, such as Scrabster and OIC Marine Services, may wish to note this information within Local Notices to Mariners and Seafish may include in their Kingfisher Fortnightly Bulletin.

Circulating this information or specifically prepared guidance to recreational clubs and associations (with their agreement on the frequency and format) will help to inform local/leisure users and mitigate the risks posed to them. This is especially true of the potential impacts present in the construction and maintenance phases of the projects, where increased works traffic may present a hazard.

The promulgation of these notices should be in good time to warn marine stakeholders of any hazards, such as the construction area and traffic, ahead of the work beginning.

All developments would, by necessity of ensuring the safety of navigation, produce notice to mariners. Both Admiralty NM for significant information and their own notice to mariners for operational impacts to navigation. This is particularly important prior during construction/maintenance/decommissioning phases.

6.8 Guard Vessel

A guard vessel can be used to protect site vessels or structures from other traffic. It is able to intervene in developing situations where other site vessels would not be able because they are conducting specialist operations. This is useful to guard other vessels that are 'restricted in their ability to manoeuvre' (survey vessels/construction vessels etc.), which are engaged in operations that prevent them from manoeuvring freely. Therefore this method of mitigation is most suitable to the construction phase of development.

Any vessel considered for the task of guard duties in offshore renewable work should be certified fit to do so. In the UK vessels in commercial use of up to 24 metres in load line length are built to MCA code standards and certified. This ensures they are fit for purpose and meet the standards required to operate, detailing the manning, passenger capacity, carriage of equipment (navigation and lifesaving) and the capability of the vessel.

There are other considerations, some of which go beyond the mandatory standards. The following should be considered:

- Adverse weather capability;
- Automatic Identification System (AIS class A enhances safety);
- Wheelhouse visibility;
- Cruising speed (faster transits and emergency response);
- Passenger welfare (weathertight shelter/seating);
- Passenger effects (weathertight storage of bags/tools etc.);
- Cargo/supplies storage (sufficient deck space to make fast expects cargo);
- Recovery of persons from the water (enhanced waterline/lifting capability);
- Casualty welfare (extra thermal protective aids/medical supplies); and
- Quality management system (including development specific operations).

The use of guard vessels is suitable for all developments and the vessel may perform other tasks, whilst ensuring it is attending the site. However the suitability of this measure will be dictated be the size/number of vessels on site and the type of operations that they are carrying out, with vessels that are unable to respond quickly to a developing situation most likely to warrant support from a guard vessel.

6.9 Site Specific

The design of the site boundary and the layout of the devices within the site can mitigate issues involving the risk of collision/allision. Regular shaped boundaries and device placement assist navigators in avoiding known hazards. Also minimising the footprint of the actual area used will reduce the potential impact the OREI may have.

Maximising the under keel clearance will also assist in reducing the potential risk of allision by ensuring there is room enough to avoid accidental contacts with vessels.

The burial or protection of cables can also mitigate the risk of snagging upon them. Whether this comes from accidental snagging from dragging anchor or an action more purposeful, like trawling or emergency anchoring.

The use of 3rd party verifications/supervisory control and data acquisition (SCADA)/class standards can assist in mitigating the risk of the technology losing station. Also preparing for such an eventuality within the developments emergency response plan or safety management system will ensure the problem is rapidly resolved and the potential hazard to navigation is reduced.

6.10 Overview of Mitigation

While many of these mitigation methods are discussed in general terms, suitable for the entire strategic area, it should be noted that when they are considered it must be on a site-specific basis. Only then can their suitability be judged against the relevant site-specific hazards and controls.

A summary of the different mitigation measures, in comparison to the various impacts is produced within Appendix E (Potential Impacts and Suitable Mitigation Methods).

7. Stakeholder Engagement

7.1 Communications

The benefit of enabling two-way communications about renewable energy projects is noted and the likely commonality of issues that affect the developments taking place in PFOW is acknowledged.

There are a number of options to help further better communications, in addition to the necessary project-specific consultations that take place as part of the NRA and ES preparation. To summarise these, they are:

- Virtual group (digital or otherwise);
- Working group; and
- Information distribution group.

7.1.1 Virtual Group

It is noted that The Crown Estate already facilitates the exchange of information in wave and tidal energy, with their knowledge network (TCE, 2013). There is opportunity to utilise this resource, complete with its message forum (exchange board) and data hosting for documentation, etc. However, this site is aimed at the entire UK wave and tidal industry, which may distract from the focus of PFOW developers.

7.1.2 Working Group

Consideration could be given to a PFOW-specific forum. With so many developers now having offices locally on Orkney, close to other key stakeholders, there is the opportunity to convene these in an industry group. Periodic meetings could be supplemented with a nominated organising member promulgating shared information as it becomes available. This could be supported by and organised through a LinkedIn group or similar network, which would offer a free and secure forum on a professional network. This would ensure that PFOW stakeholders are able to better communicate, while not losing touch on a more general communications forum.

The benefit of separating forums into particular stakeholder interests may also be more useful for the end user. Helping to ensure discussions are focused on the topics most important to the forum user.

7.1.3 Information Distribution Group

Commitment to another group may be seen by some as a distraction from their primary work. If stakeholders preferred a less demanding group then, through mutual agreement, they could nominate one stakeholder to coordinate the promulgation of information for all members. This would need less communication and commitment, instead just requiring a nominate focal point for information deemed useful to other developers and stakeholders.
There are a number of examples of successful groups working in this way within the offshore wind sector:

- Moray Firth Offshore Wind Developers Group
- Forth and Tay Offshore Wind Developers Group

- Southern North Sea Offshore Wind Developers Forum

Further discussions on this are recommended as part of any workshop that is held.

7.2 Workshop

The focus of any workshop following the production of this Discussion Paper could be on the issues identified within this Discussion Paper and undertake to:

- Actively engage a wider set of relevant stakeholders;
- Coordinate the approach to identify activities that, when combined with wave and/or tidal projects, have the potential to pose significant impacts to shipping and navigational risk;
- Identify if these possible significant impacts have the potential to be cumulative or in-combination impacts;
- Define issues that may constrain development and the mitigation measures that can address them; and
- Agree the process for communications between developers and key stakeholders.

To inform discussion at any such workshop, materials could be prepared from the data provided in this Discussion Paper. These may include charts of the developments in relation to each other/navigational features and examples of the phased stages and how they may potentially interact.

8. Conclusion

This Discussion Paper intends to inform consideration of the potential impacts (alone and cumulative) of the PFOW wave and tidal projects on shipping and navigation. While there are a number of uncertainties concerning the twelve current developments taking place within the PFOW Strategic Area, it is possible to assess the potential strategic issues faced.

Those sites close together in the north (Westray South and Lashy Sound), west (Costa Head, Brough Head, Marwick Head, West Orkney Middle South and West Orkney South) and south (Brims, Brough Ness, Ness of Duncansby and Inner Sound) may each influence the other to some extent and potentially result in cumulative effects.

They will all be built to a phased schedule and currently these phases do not overlap greatly. No more than two construction phases are currently due to take place in any one area (north/west/south) at a time, except for the developments to the south of Orkney. Here three may potentially be built during 2020 (Brims, Brough Ness and Ness of Duncansby, if these phases take place as planned. Although Brough Ness has already warned that their development timescale is dependent on the availability and timing of a grid connection.

The area to be utilised during each phase or overall build out has the potential to affect various aspects of shipping and navigation in the area. Although subsequent phases will confirm the level of any potential impact, it is possible to make assumptions based upon the current size of the AfL areas. This is in keeping with the principles of the using the Rochdale Envelope approach, allowing for some flexibility within the maximum extents of these developments.

While there may be great differences in the types of technologies utilised by both wave and tidal devices, they tend to have a number of similar qualities. The majority currently have some surface piercing element. This does differ by type, with tidal devices most likely to be subsurface. But there are exceptions that have surface piercing elements or support structures that pierce the surface.

The current state of maturity of the renewable energy sector has ensured that there is a great deal of guidance available from both the regulating bodies and key stakeholders. This clearly informs developers as to their obligations. Likewise the amount of recent data gathered concerning navigational stakeholders is sufficient to inform developers as to what potential impacts that may need to be considered and whether mitigation will be required. It makes clear which vessels will most likely be encountered and where. This should also help future surveys focus on getting quality data, ensuring future work captures the variations found between commercial, recreational and fishing vessels.

Sites close to high volumes of traffic are discussed within this Discussion Paper and it is clear that there are AfL areas that are well utilised by all traffic types. The influence this will have on the potential impacts will be better understood once the final layouts of the phases/site boundaries are known.

The potential impacts presented by the PFOW developments share many similarities to other offshore energy developments. However there are unique aspects presented by the distinctive nature of the technologies utilised within developments. This is also true of the methods of mitigating the hazards to navigation, which will vary according to the technology implemented at these developments.

The most effective approach to the marking and subsequently the charting of PFOW developments continues to be the IALA (IALA, 2008) recommendation. This is the benchmark against which proposed site markings continue to be assessed against.

9. Appendix A Development Information

Project	Area Consistent with Crown Estate Award Map	NRA Commenced	Risk Assessment Stage	PHA Completed	NRA Completed	EIA Scoping Completed	Port/ Harbour Requirements	Vessels Involved in Construction / Operation Activities	Technology Deployed at Site	Inshore / Offshore Area Potentially Required	Project Phases						
											Phase	Size (MW)	Area Covered	Cable Route	Application Date	Offshore Construction Start Date	Expected Operation Start Date
Farr Point	Yes	No	Scoping (including PHA) issued in April 2011; Comments Received Back via formal scoping response in August 2011 http://www.scotland.gov.uk/Resource/Doc/295194/0119633.pdf	Yes; available as appendix to soping report (carried out by David Cantello from ARC)	No	Yes	Yes; potentially waters within Loch Eriboll, O&M facilities at Lyness in Hoy or port facility at Scrabster	PWP has demonstrated the installation of mooring components using a variety of vessels including; 4-point moored barge, multi-cat (multi-category) work boat and handler tugs (AHT), in order to make installaton programmes responsive to vessel availability and market conditions. Given the proximity to the North Sea it is likely that PWP would look to use an AHT for the majority of the moorings installation work during the construction phase. AHT's have integrated GPS dynamic positioning capabilities and therefore do not require mooring hardware themselves to stay on station while installing equipment but are kept on station by propulsion. AHT's range in size but a vessel envisioned for Pelamis mooring installations may be >50m length, 16M beam, 6m draft with gross/deadweight tonnage exceeding 2000 tonnes. It is also likely that PWP will seek to use a multi-cat vessel for lighter parts of the onsite construction and commissioning and operational work. Multi-cats are highly versatile work vessels used throughout UK waters. A standard multi-cat for use within a Pelamis wave farm would be around 25m in length, 11m beam and 3m draft with gross weight/tonnage ~500 tonnes. Pelamis is specifically designed to avoid the need for specialist equipment such as divers or Remotely Operated Vehicles (ROV). It is likely that the installation vessel will not have sufficient storage space to hold all the anchors, chains and tethers for the entire wave farm so "load out" trips likely where componenets will be loaded out onto the installation vessel from a quayside facility/lay down area in the local vicinity, or potentially transited to site using a barge or multi-category. Given the positional accuracy required for anchor and component placing within the onsite construction works, in addition to on boards procedurs and risk assessments onsite construction will beweather sensitive accoding to wave conditions. It is likely that AHT's will have larger operating windows, potentially up to 2m wave height for some operations as well as an ability to be onsite constantly for a number of days (as they have sleeping quarters)	Pelamis P2 Wave Energy Converter	The maintenance strategy for pelamis is to have no manned intervention with a machine at sea. This requires a machine to be recovered to harbour, or sheltered water facilities, for all inspection, maintenance and repair work. Therefore, the availability of a suitable harbour, or sheltered is required for all inspection, maintenance amd repair work. There are a number of suitably sheltered water sites close to the area of interest including within Loch Eriboll, exisiting O&M facilities at Lyness, Hoy and a port facility at Scrabster. The location would have to be accessable for a Pelamis structure and associated tow spread, with adequatearea to perform manouvering of machines and give appropriate depth clearance through full tidal cycles (min. 3-4m at LAT) Further details can be provided	1	Up to 10	2-3km	Confidental- to discuss	Q2 2014	Q3 2015	2015-2016
											Uncertainty: the area of sea occupied is defined by the mooring spread, which is dependant on depth of deployment. These figures are not definative. Timescales for build out beyond 10 MW will be defined subject to experience of phase 1.						
Lashy Sound	Yes	No	Not Started	No	No	No	Sanday Harbour; Hatston Pier, Kirkwall	Multi Cat Work Vessel; Heavy Lift Barge; Cable Lay Barge	Floating horizontal axis tidal turbine	Yes- Lashy Sound	1	1	Approx 0.06	Not known	Q1 2015	2016	2016
											2	10	Approx 0.3	Not known	Q1 2015	2018	2018
											3	30	Aprox 1.2	Not known	2018	2020	2020
Brough Ness	No; plans to carry out further resource assessment to determine a potential shift of the development area	No	Not Started	No	No	No	Not Yet Known	This is still unclear and remains subject to change but if mixture of SeaGen-S and SeaGen-U deployed then vessels required would be: During construction a cable lay vessel, Dynamc Positioning (DP) vessel, Crane Vessel, Dive Support (possibly), Support vessel/Guard vessel (possibly) and a tug would be required. During operation a crew transfer vessel such as a standard offshore wind catamaran or possibly a small (12-15m) pilot boat would be required as well as the occaisonal use of a work boat and DP vessel.	Surface piercing devices, SeaGen-S 2.0MW and subsea devices, SeaGen-U 3.0MW; Site potentially populated with a mix of surface piercing devices and subsea devices; dependant on water depth and navigation and marking constraints	Yes- vessels would be located at device positions in the project area site during installation and removal of subsea devices (if required)	1	33	TBD	Depends on grid	Depends on grid	Stated in AfL as 2017, but dependant on grid connection	Stated in AfL as 2018, but dependant on grid connection
											2	33	TBD	Depends on grid	Depends on grid	Stated as 2019 but will slip due to previous Project Phase Slip	Stated as 2019 but will slip due to previous Project Phase Slip
											3	33	TBD	Depends on grid	Depends on grid	Stated as 2020 but will slip due to previous Project Phase Slip	Stated as 2020 but will slip due to previous Project Phase Slip
Marwick Head	Yes	No	Not Started	Not Started; to commence 2014	No	Yes	No specific details provided in response to questionaire but scoping report indicates harbour with water depth greater than 8m is required	No specific details provided in questionnaire but Pelamis is proposed technology therefore can expect same vessel equipment as Farr Point. Additionaly, the scoping report mentions cargo barges	Pelamis	Yes- Lyness	Demonstration	9	Unknown	Unknown	Sep-16	Jan-19	Jan-21
											1	13.5	Unknown	Unknown	Sep-16	Jun-21	Jun-23
											2	17	Unknown	Unknown	Sep-16	Oct-22	Oct-24
Ness of Duncansby	Yes	Yes	Not started	Not Started; to commence 2014	No	Yes	No specific details provided in response to questionaire but scoping report indicates that the harbour used will require the ability for cargo barges accepting trailer load outs to moor stern to the quay and the water depth will need to be at least 8m to handle larger construction vessel / anchor handlers.	ynamic positioning and heave compensation may be used. Cargo barges are also mentioned ans likely to be re	Andritz Hydro Hammerfest HS1000	Yes- yet to be confirmed	1	30	Unknown	Unknown	Sep-16	Dec-20	Dec-22
											2	30	Unknown	Unknown	Sep-16	Nov-23	Nov-25
											3	35	Unknown	Unknown	Sep-16	Mar-25	Mar-27
Cantick Head	No	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	No- aim to issue scoping report by 16th August	For OpenHydro the requirement of Quayside length is 70-140m. Quay capacity >500 t. Available draft >10. Service infrastructure etc (Port/ Harbour requirements is as yet to be confirmed for alternative technology solutions). Currently considering a range of port and harbour facilities including Lyness, Stromness, Kirkwall and facilities on the Caithness coast. At this stage the details have nnot been further refined.	OpenHydro specialised heavy-lift deployment barge, towed by commercial tug likely with >70 t bollard pull capability. Support vessels for crew transfer purposes. Cable laying vessels and associated support. (Vessels that may be required in the case of alternative technology concepts may include tugs, moored or tugged barges, DP vessels or heavy-lift construction vessels).	OpenHydro Open-Centre Turbine. Horizontal axis turbine with enclosed blades, installed on the seabed using a gravity style foundation. Not surface piercing, max height above seabed ~28m, low rotational speed. (The Scoping process will also request feedback on additional technology concepts which may include open-rotor turbine with fixed or variable pitch. Alternative foundations may inlcude drilled monopoles or floating structures in addition to gravity base solutions. While devices themselves may not be surface piercing there may be a requirement to have one or more surface piercing support equipment, such as a platform for connecting a number of devices together electrically for example).	Perhaps some tow trials required prior to deployment but not confirmed at this point. Prefferred location to carry out will depend on mobilisation location	1	Up to 60	Not Identified	Melsetter and Aith Hope identified	Q4 2014	Q1 2020	Q2 2021
											2	Up to 140	Not Identified	Melsetter and Aith Hope identified	TBC	Q1 2022	Q2 2024
Brough Head	No; development area for 1st phase identified but development area for remaining 150MW unknown (could be anywhere in remaining lease area)	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Yes- Xodus	Stromness Main Pier, Stromness Lighthouse pier, Lyness, Hatston Pier, Kirkwall. Ongoing w2e would consider Stromness Harbour providing that there was access to more crane-age (e.g. 500te). If the new quay is developed as has been mentioned then a large Gantry type crane for heavy lifting would be of significant benefit. Increased storage is also required, inclusive of warehousing facilities for operational spares and equipment and wet storage for WECs awaiting installation or maintenance. Ideally offices and warehouses would be at the same location, which is not currently feasible at Stromness. Large outside assembly areas are also required and quay side facilities with adequate water depth. Wet storing of WECs at Stromness prior to towing to site for installation is not currently feasible and possibly never will be. Ireland Bay is close and relatively sheltered so could be considered for this purpose. Overall, Stromness is a key port for Aquamarine Power and BHWF due to its location, but does require upgrading to meet our full requirements. A second option would be Lyness however this is a significant distance from out phase 1 site (transit time from Lyness to Billia Croo is approx. 2.5 hours compared with 45 mins from Stromness and the Brough Head phase 1 site is even further (~12km north than Billia Croo).	Installation of the Oyster devices and associated seabed infrastructure is likely to utilise a mixture of jack-up barges, tugs, multi-cat vessesl and dive boats. A sequential list of likely operations is provided. Seabed Preparation- kelp clearance, installation of anchors and potential for infilling of gullies and gaps with rock or small amounts of rock removal; Monopile Foundation Installation- a jack-up barge and a drilled piling method as per Oyster 800. Each Oyster device will be wet towed to site positioned over the monopile foundation using a guide system and lowered over the pile to be secured; Installation of interconnecting pipelines/ umbilicals- installed on the seabed between devices and the closed loop pipeline system to connect to the onshore hydro-electric plant. Stabilising rock anchor supports or concrete mattresses may be used for protection; Commissioning- to involve hook-up of pipelines, pressure testing, electrical componenet testing, visual examinations and functional testing of the mechanical, electrical and instrumentation componenets, and de-ballasting to allow the flap to rise to its vertical position. The methods and number and type of vessels used for intallation will be further refined following learning from EMEC wave test site and as part of the ongoing design and developemnt of the Oyster technology. Installation of the 1st 10MW is likely to take place in 2 phases throughout the summer months; consisting of a first pile installation phase, requiring a jack up rig, and a second device installation phase, requiring a spread of vessels comprising a number of tugs and dive support vessesl (multi-cats). These phases would run concurrently though the device installation phase would lag behind the piling phase, starting and finishing a little later. For a larger build out phase, such as Phase 1b, two or three vessel teams as described above may be needed.	Oyster is a near shore wave energy device, typically deployed in 10-15m water depth. The depth oscillating action of the waves against the wave energy converter (WEC) (or 'flap') drives hydraulic pistons which pump pressurised freshwater back to shore through a closed lopp pipeline system. The onshore hydro-electric plant converts the hydraulic pressure and flow into electrical power via Peltonwheel turbines which in turn drive electrical generators. Individual Oyster devices will be installed on monopile foundations and linked by sets of interconnecting pipelines (high pressure, low pressure and a control umbilical) to eachother and to the onshore hydro electric plant, forming a closed loop hydro-electric system. A combination of composites including Fibre Reinforced Polymer (FRP), elastomers, marine grade rubber and steel are used to make Oyster WECs. Each WEC has been designed according to the Load and Resistance Factor Designmethod (LRFC) as defined by Det Norske Veritas has a 20 year design life. The surface piercing flap moves forwards and back in a fixed position on a horizontal axis and is activated by the surge forces of the nearshore wave climate. The draft project envelope paramters for the Outshore Point developemnt is available.	Only the areas of transit between the development area and the port/harbour base (likely to be Stromness) and the port/ harbour facility itself.	1	40-50 (initially 10)	TBC	HDD Lines onshore to offshore then surface laid along length of array	2014/2015	2016/2017	2018/2019 (dependant on grid)
											2 onwards	TBC	TBC	TBC	TBC	TBC	TBC
Westray South	No	Working with Anatec on this	Working on Anatec with this	Working with Anatec on this	Working with Anatec on this	Yes http://www.sse.com/WestraySouth/ProjectInfo/	No specific details were provided in questionnaire but scoping report indicates that Kirkwall (Hatston or Kirkwall Pier), Stromness and Lyness may be utilised.	No specific details provided in questionnaire but the Scoping report indicates that the vessels utilised will involve jack up barges, moored and tug barges, anchored crane barges and dynaically positioned (DP) heavy lift construction vessels. DP vessels are likely to be utilised for installing monopiles and braced monopiles although jack up barges are also being considered for both. The Gravity Base structure will be installed using DP vessels or purpose built deployment vessels. Subsea cables will be installed using a specialised vessel or multiple vessels if necessary.	No specific details were provided in questionnaire but the Scoping Report indicates that unless dictated otherwise fpr navigational reasons the technology involved will be a non surface piercing horizontal axis turbone (HAT type device). Two main groupings of HAT are currently under consideration, shrouded and unshrouded devices. Examples of unshrouded devices under consideration include Rolls Royce/ TGL and Voith Hydro. Shrouded examples under consideration include Clean Current/ Alstrom and Openhydro devices. Based on current technology, devices with a rotor diameter of up to 20m capable of generating at least 1MW will be proposed for installation.	No specific areas have been identified apart from the obvious one of Scapa Flow although sheltered areas with sufficient water depth (>20m) in the Westray Firth area would also be potential locations. The purpose and timescale is hard to define beyond it being a potential requirement from construction onwards throughout the operational lifetime of the project. Usage would be expected to be greatest during construction in terms of both areal extent and frequency.	1	60	TBC	Map Provided	Q2 / Q3 2014	2018	2020
											2	140	TBC	As per Phase 1	2020	2022	2024
											Uncertainties Include: finance and economics, grid connection and technology readiness						
West Orkney Middle South	At time of data collection future uncertain																
West Orkney South	At time of data collection future uncertain																

Costa Head	Yes	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Yes- Xodus	At present specific locations are not known. Port facilities at Kirkwall, Lyness and Stromness have recently benefitted from significant investemnt in anticipation of development of commercial scale wave and tidal power projects. Given the proximity of these facilities to the proposed Costa Head devlopment and considering the potential impact of weather windows on construction and O&M schedules, it is anticipated that at least one of these local ports would be utilised.	No specific details were provided in the questionnaire response but the scoping report suggests that ocean going tugs with appropriate bollard pull capacity will be used for the tow-out of each device and separate anchor handling vessels will be required for the installation and pre-tensioning of the mooring and anchoring system. Installation of a seabed mounted central offshore substation required for phase 2 could involve the use of heavy lift vessels. If the substation is on a floating structure then this could be towed into place without the need for heavy lift vessels, although anchor handling tugs will be required for the installation and pre-tensioning of the mooring and anchoring system. Except in exceptional circumstances (e.g. very large and heavy items) the procedures for replacing any equipment would most likely require use of multi-cat type vessels in conjunction with the onboard cranes of the substation platform. For replacement of very large and/or heavy lift cranes it may be necessary to utilise heavy lift cranes mounted on large offshore type heavy lift vessels/ barges.	Although not specified in the questionnaire the scoping report states that AWS-III wave energy convertors will be installed.	It is anticipated that the wave energy converters will be assembled at a shipyard or similar facility located close to the coast. Once a device has been constructed and undergone initial commissioning it is expected that it will be floated to a local lay up or safe haven close to the site. Towage speeds are expected to be relatively low and weather windows suitable for installation can be infreqent so to maximise installation opportunities (shortest journey) a temporary lay-up close to the site, such as Scapa Flow, will be important. The units would be safely anchored in a similar fashion to a ship until required for installation.	1	~10	TBC following mooring studies	Potential landfall to be in close proximity to Costa Hill (North of Mainland Orkney)	Q4 2014 / Q1 2015	Q2 Q3 2019	Q2/ Q3 2020
											2	Up to 200	TBC following mooring studies	Potential landfall at the proposed Bay of Skaill substation on the West Mainland of Orkney	Q4 2018 /Q1 2019	Q4 2021 / Q1 2022	Q2 / Q3 2023
Inner Sound	Yes	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Working with Anatec on this	Yes- Metoc	Phase 1a will be constructed and maintained from Scrabster Habour. For future phases MeyGen will look at other ports as well as Scrabster, including Wick and Lyness. Gills Bay Harbour has the potential to be used as a safe haven for vessels and for any small vessel operations.	Dynamic Positioning (DP3) vessel for substructure, cable and turbine installation	Each turbine is fully submerged, seabed mounted and will consist of a rotor and a nacelle. Each turbine will be supported by a Turbine Support Structure (TSS). The devices will be single rotor, horizontal axis turbines with a rotordiameter of between 16 and 20m. The turbines will always have a minimum clearance from the blade tip to sea surface at LAT of 8m.	No	1a	2-10		Phase 1 area to Ness of Quoys	Applied in July 2012	Q2 2014	Q4 2014
											1b	2-10		Phase 1 area to Ness of Quoys	Applied in july 2012	2016	2016
											1c	56-74 (86MW total)	1.1km2	Phase 1 area to Ness of Quoys	Applied in July 2012	2017	2017
											2	312	2.2km2	Ness of Quoys and Ness of Huna	2017	2018	2018-2020
											Uncertainty: MW installed is dependant in each year of phase 1 is dependant on the rated capacity of the turbines and other factors. All construction start and operational dates are indicative.						

10. Appendix B Guidance

The following guidance has been referenced throughout this Discussion Paper.

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11. Appendix C PFOW Approach to Marking

This is an excerpt from Recommendation O-139 - The Marking of Man-made Offshore Structures (IALA, 2008). It is combined with advice on its application within the PFOW Strategic Area.

2.4 MARKING OF OFFSHORE WAVE AND TIDAL ENERGY DEVICES 2.4.1 General	**Advice on the approach to marking within PFOW.**
Wave and Tidal Energy Devices include: Tidal Generator, Tidal Generator field, Wave Generator, Wave Generator field, as defined in Appendix 1. In general, any risk assessment of offshore wave and tidal extraction devices will likely determine that, when compared to gas and oil structures, there is a lower risk of either pollution or loss of life should a vessel foul such an installation. Consequently, the marking requirements can be mitigated. It should be born in mind that many wave and tidal devices are low freeboard floating structures that are moored to the seabed. They may be moored in deep or shallow water and some may be located on the seabed or just below the surface. Surface piercing and subsurface elements may extend laterally beyond the surface elements. This could include shared moorings and mid-water connections between units which may also carry electricity, control signals, hydraulics or pneumatics associated with the units. It should also be noted that many tidal concepts have fast-moving sub-surface elements such as whirling blades, and these should be taken into account when identifying the marking requirements.	As noted within the Discussion Paper (5.6), this recommendation represents the consolidated best practice decided by the international technical association IALA, whose members include the statutory bodies responsible for Aids to Navigation within UK waters. As such, this recommendation should be the basis for planning the marking of either a wave or tidal development. Where experience indicates a departure from this, or caution in implementation, then comments are indicated below.
Consultation between the stakeholders such as Developers, National Administrations, Aids to Navigation Authorities, Competent Authorities and wave and tidal contractors should take place at an early stage. In general, development of offshore energy structures should not prejudice the safe use of Traffic Separation Schemes, Inshore Traffic Zones, recognised sea lanes and safe access to anchorages, harbours and places of refuge. On a case-by-case basis, National Authorities may consider establishing Exclusion or Safety Zones, which would prohibit or restrict vessels from entering Offshore Wave and Tidal Energy fields. Such information should be shown on the navigation chart, as appropriate.	Consultation with statutory stakeholders, in the case of marking the hazard to navigation this is the GLA, is a requirement of the consent application. For the strategic area of PFOW this is the NLB. Therefore they must be consulted on plans concerning the marking, this is best done early on in the process because they have a great deal of expertise and their advice can save time when planning the marking or approach to navigational hazards. Approval will not be given until the final layout of a phase/development is available to the NLB.
In order to avoid confusion from a proliferation of Aids to Navigation in a high-density wave and tidal energy extraction field, full consideration should be given to the use of synchronised lighting, different light characters and varied light ranges.	Assessment of navigation aids in proximity to the AfL is required to determine any if there may be possible conflict between current marks and their lighting. As recommended here, ensuring that lighting is synchronised and ensuring that only necessary marking is conducted will ensure that the area is easily understood by navigators.
There has been some evidence that sea-bed scouring at the bases of offshore renewable energy installations in areas of strong tides or currents has resulted in significant deposits of material in other locations. Some authorities have insisted on fitting depth monitoring devices to such installations to measure scour. This may need to be considered when approving wave and tidal energy extraction	This would be dictated by the probability of scouring, where depth of water was a perceived impact. Protection and monitoring devices would also present a snagging hazard, which may influence navigational hazards.

proposals/locations.	
2.4.2 Marking	
Wave and Tidal energy extraction devices should be marked as a single unit or as a block or field as follows:	No additional comments.
1 When structures are fixed to the seabed and extend above the surface, they should be marked in accordance with the recommendations contained in Section 2.3, Marking of Offshore Windfarms.	Marking surface piercing structures that are fixed to the seabed in the same manner as wind turbines is best practice and will ensure that the navigational hazard is easily recognisable to marine stakeholders. This is most likely to concern tidal devices, which may have surface piercing structures that when painted suitable act as a warning of the hazard present.
2 Areas containing surface or sub-surface energy extraction devices (wave and/or tidal) should be marked by appropriate navigation buoys in accordance with the IALA MBS, fitted with the corresponding topmarks and lights. In addition, active or passive radar reflectors, retro reflecting material, racons and/or AIS transponders should be fitted as the level of traffic and degree of risk requires.	This is hazard dependent. The phase, water depth and the under keel clearance will dictate the necessity of marking the area. The marking of the development site during construction may differ from the marking for the completed phase or fully operational development. As mentioned before, the final layout will be required for a proper assessment of the appropriate marking.
3 The boundaries of the wave and tidal energy extraction field should be marked by lighted navigational buoys, so as to be visible to the Mariner from all relevant directions in the horizontal plane, by day and by night. Taking the results of a risk assessment into account, lights should have a nominal range of at least 5 (five) nautical miles. The Northerly, Easterly, Southerly and Westerly boundaries should normally be marked with the appropriate IALA Cardinal mark. However, depending on the shape and size of the field, there may be a need to deploy lateral or special marks.	Buoyage concerning a site is likely best served with Cardinal marks (Figure 5-4), these make clear where the safe water lies. Alternatively lateral marks may be sufficient (Figure 5-4 concerning the inshore test site) if the navigational situation allow. Caution is advised when considering buoyage for tidal devices. The conditions associated with the best tidal resources are detrimental to ensuring buoyage remains on station. This may also be the case for wave developments, but loss of buoyage there is often associated with adverse weather. While strong tidal conditions increase the probability of the loss of station significantly. In these circumstances alternatives like leading lights (coastal waters) or charting along (deep water) may be safer than buoyage.
4 In the case of a large or extended energy extraction field, the distance between navigation buoys that mark the boundary should not normally exceed 3 (three) nautical miles.	No additional comments.
5 Taking into account environmental considerations, individual wave and tidal energy devices within a field which extend above the surface should be painted yellow above the waterline. Depending on the boundary marking, individual devices within the field need not be marked. However, if marked, they should have flashing yellow lights so as to be visible to the mariner from all relevant directions in the horizontal plane. The flash character of such lights should be sufficiently different from those displayed on the boundary lights with a range of not less than 2 nautical miles.	No additional comments.
6 Consideration should be given to the provision of AIS as an Aid to Navigation on selected peripheral wave and/or tidal energy devices.	Caution is advised concerning electronic aids to navigation because the proliferation of this type of marking can cause screen clutter for navigators, defeating their purpose. The number of electronic aids should be a weighed against the potential for complicating the navigational situation (5.6.4).
7 A single wave and/or tidal energy extraction structure, standing alone, that extends above the surface should be painted black, with red horizontal bands, and should be marked as an Isolated Danger as described in the IALA	No additional comments.

MBS.	
8 In the case of a single wave and/or tidal energy device which is not visible above the surface but is considered to be a hazard to surface navigation, it should be marked by an IALA special mark yellow buoy with flashing yellow light with a range of not less than 5 nautical miles, in accordance with the IALA MBS. It should also be noted that many tidal concepts have fast-moving sub-surface elements such as whirling blades.	This is dependent on the water depth and under keel clearance. If these are sufficient then charting alone would be acceptable. As noted previously, buoyage within a strong tidal area risks losing station, which in turn is more hazardous than alternative methods.
9 The Aids to Navigation described herein should comply with IALA Recommendations and have an appropriate availability, normally not less than 99.0% (IALA Category 2 – see IALA NAVGUIDE).	No additional comments.
10 The relevant Hydrographic Office should be informed of the establishment of an energy extraction device or field, to permit appropriate charting of same.	In the instance of PFOW this is the UKHO.
11 Notices to Mariners should be issued to publicise the establishment of a wave and/or tidal energy device or field. The Notice to Mariners should include the marking, location and extent of such devices/fields.	No additional comments.
2.4.3 Considerations During Construction / Decommissioning	No additional comments.
During the construction / decommissioning of an offshore wave and/or tidal energy extraction device or field, working areas should be established and marked in accordance with the IALA MBS. National Authorities should also consider the use of guard ships in areas of high traffic density.	The raised risk presented by changes during the construction / decommissioning phases poses many of the same issues as the operational phase and can be mitigated in the same manner, so long as additional risks are also moderated. They may necessitate additional buoyage or a guard vessel (5.8).
Notices to Mariners, Radio Navigational Warnings – NAVTEX and/or broadcast warnings must be promulgated in advance of and during any offshore wave and/or tidal energy extraction device construction.	No additional comments.
During construction, power cables between wave and tidal generators, between such generators and the transformer station, and between the transformer station and the shore should be sufficiently trenched to avoid exposure from scouring / sand migration or trawling activities.	No additional comments.
Where individual wave and/or tidal energy devices extend above the surface careful consideration needs to be given to any additional temporary marking that may be required during the construction / decommissioning phase.	No additional comments.
When decommissioning such devices, the Authority should ensure that the operator / contractor is obliged to remove all obstruction so the sea bed is returned to its original depth and topography. In the event that any residue or obstruction remains that, in the opinion of the Aids to Navigation Authority, constitutes a danger to navigation, then the residue or obstruction shall be marked according to the authority's requirements.	No additional comments.
2.4.4 Contingency Plans	
1 Operators of wave and/or tidal energy extraction devices or fields should develop contingency plans and emergency response plans which address the possibility of individual devices breaking loose and becoming floating hazards. Automatic location and tracking devices should be	Non-functioning or missing aids to navigation present a hazard to navigation. These should be rectified quickly.

considered.	
2 Developers and/or operators should have a reliable maintenance and casualty response regime in place to ensure the required availability targets are met. This will include having the necessary AtoN spares on hand, with provision made at the design stage, where necessary, to ensure safe access.	No additional comments.
2.4.5 Additional Considerations	No additional comments.
Depending on the marking, lighting and lateral separation of the field boundary, the additional marking of the individual structures within an energy extraction field, visible above the surface of the sea, may be considered as follows: · Lighting of each structure. · Individual structures unlighted with retro-reflective areas. · Individual structures illuminated with down-lights on ladders and access platforms. · Use of flashing yellow lights with a range of not less than two (2) nautical miles. · Identifying numbers on each individual structure, either lit or unlit.	No additional comments.
An electrical transformer station or other structure, if considered to be a composite part of the energy extraction field, should be included as part of the overall marking. If not considered to be within the boundaries of the field, it should be marked as a single stand alone device as described in Section 2.4.2 (paragraph 7 refers).	No additional comments.

12. Appendix D Potential Impacts by Development Site

Impacts		Tidal Projects						Wave Projects					
		Ness of Duncansby	Inner Sound	Cantick Head	Brough Ness	Westray South	Lashy Sound	Farr Point	West Orkney South	West Orkney Middle South	Marwick Head	Brough Head	Costa Head
Traffic	Allison	*	*	*	*	*	*						
	Adverse Weather Routes	*	*	*	*	*	*						
	Congestion	*	*	*	*	*	*						
	Displacement												
	Increased Traffic Density												
	Port Traffic Levels												
Navigation	Access												
	Ease of Compliance with COLREGS												
	Navigable Route Depths	*	*	*	*	*	*	*	*	*	*	*	*
	Phased Development of Projects												
	Radar												
	Routeing Measures and Traffic Flow	**	**	**	**	**	**	**	**	**	**	**	**
	Snagging												
	Safety of Navigation	*	*	*	*	*	*						
	Use of Existing Aids to Navigation												
	Restricted Access for Emergency Response	*	*	*									
	Under Keel Clearance	*	*	*	*	*	*						
Design	Alignment of Structures within the Site Boundary	*	*	*	*	*	*						
	Site Boundary	*	*	*	*	*	*						
	Loss of Station												
Proximity	Anchorages												
	Coastal Protection/Conservation Sites												
	Disposal Sites												
	Ship-to-Ship Transfer Operations												
Resources	Demand for Surveys												
	Increase in Demand and Provision of Emergency Response Resources												
	Reduction in Available Sea Room for Defence Activities												

Notes: * Technology/depth of water dependent ** Final layout dependent

13. Appendix E Potential Impacts and Suitable Mitigation Methods

Impacts		Mitigation Measures										
			Routeing Measures						Site Specific			
		Safety Zones	Development Free Channel	Area to be Avoided	Monitoring / Watchkeeping	Marking / Charting	Notices	Guard Vessel	Boundary	Layout	UKC	ERCoP
Traffic	Allison	■	■	■	■	■	■	■	■	■	■	
	Adverse Weather Routes		■						■	■	■	
	Congestion		■				■		■	■	■	
	Displacement		■						■	■	■	
	Increased Traffic Density		■						■	■	■	
	Port Traffic Levels		■				■		■	■	■	
Navigation	Access		■						■	■	■	
	Ease of Compliance with COLREGS		■		■	■		■	■	■	■	
	Navigable Route Depths				■						■	
	Phased Development of Projects	■	■	■	■	■	■	■			■	
	Radar				■				■	■	■	
	Routeing Measures and Traffic Flow		■		■	■			■	■	■	
	Snagging	■	■	■	■	■	■	■				
	Safety of Navigation	■	■	■	■	■	■	■	■	■	■	
	Use of Existing Aids to Navigation		■			■	■		■	■		
	Restricted Access for Emergency Response											■
	Under Keel Clearance	■	■	■		■	■		■	■	■	
Design	Alignment of Structures within the Site Boundary					■				■	■	
	Site Boundary	■	■	■		■	■	■	■	■	■	
	Loss of Station	■		■	■		■	■			■	
Proximity	Anchorages		■						■	■	■	
	Coastal Protection/Conservation Sites		■						■	■	■	
	Disposal Sites		■						■	■	■	
	Ship-to-Ship Transfer Operations		■								■	
Resources	Demand for Surveys											
	Increase in Demand and Provision of Emergency Response Resources											■
	Reduction in Available Sea Room for Defence Activities		■									

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