SeaGeneration (Kyle Rhea) Ltd

The Kyle Rhea Tidal Stream Array

Volume III

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Marine Current Turbines
A Siemens Business

Royal HaskoningDHV
Enhancing Society Together

iema EIA

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The Scottish Government

Marine Current Turbines Commercial Demonstrator - Kyle Rhea

Scoping Opinion

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SCOPING OPINION FOR THE PROPOSED SECTION 36 APPLICATION FOR THE MARINE CURRENT TURBINE COMMERCIAL DEMONSTRATOR, KYLE RHEA

1. Introduction

I refer to your letter of 01 April 2010 requesting a scoping opinion under the Electricity Works (Environmental Impact Assessment) (Scotland) (EIA) Regulations 2000 enclosing a scoping report.

Any proposal to construct or operate an offshore power generation scheme with a capacity in **excess of 1 megawatt** requires Scottish Ministers' consent under section 36 of the Electricity Act 1989.

Schedule 9 of the Act places on the developer a duty to "have regard to the desirability of preserving the natural beauty of the countryside, of conserving flora, fauna and geological and physiological features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest". In addition, the developer is required to give consideration to the Scottish Planning Policy on Renewable Energy other relevant Policy and National Policy Planning Guidance, Planning Advice Notes, the relevant planning authority's Development Plans and any relevant supplementary guidance.

Under the Electricity Works (Environmental Impact Assessment)(Scotland)(EIA) Regulations 2000, Scottish Ministers are required to consider whether any proposal for an offshore device is likely to have a significant effect on the environment. Scottish Ministers have considered your request for an opinion on the proposed content of the ES in accordance with regulations and in formulating this opinion; Scottish Ministers have consulted with the relevant organisations.

Please note that the EIA process is vital in generating an understanding of the biological and physical processes that operate in the area and may be impacted by the proposed tidal array. We would however state that references made within the scoping document with regard to the significance of impacts should not prejudice the outcome of the EIA process.

It is important that any development of renewable energy sources should be accompanied by a robust assessment of its environmental impacts. The assessment should also consider how any negative environmental impacts could be avoided or minimised, through the use of mitigating technologies or regulatory safeguards, so that the quality and diversity of Scotland's wildlife and natural features are maintained and enhanced. Scottish Ministers welcome the commitment given in the report that the EIA process will identify mitigation measures in order to avoid, minimise or reduce any adverse impacts. We would suggest that the range of options considered should be informed by the EIA process in order that these objectives can be achieved. Consultation with the relevant nature conservation agencies is essential and it is advised that this is undertaken as appropriate.

2. Aim of this Scoping Opinion

Scottish Ministers are obliged under the EIA regulations to respond to requests from developers for a scoping opinion on outline design proposals.

The purpose of this document is to provide advice and guidance to developers which have been collated from expert consultees whom the Scottish Government has consulted. It should provide clear advice from consultees and enable developers to address the issues they have identified and address these in the EIA process and the Environmental Statement associated with the application for section 36 consent.

3. Description of your development

From your submitted information it is understood, the proposed development is for four tidal energy devices with the approximate electrical output of up to 5MW as an array in Kyle Rhea, located between the Isle of Skye and the Scottish mainland.

4. Land Use Planning

The Scottish Government's planning policies are set out in the National Planning Framework, Scottish Planning Policy, Designing Places and Circulars.

The National Planning Framework is the Scottish Government's Strategy for Scotland's long term spatial development.

Scottish Planning Policy (SPP) is a statement of Scottish Government policy on land use planning and contains:

- The Scottish Government's view of the purpose of planning,
- The core principles for the operation of the system and the objectives for key parts of the system,
- Statutory guidance on sustainable development and planning under Section 3E of the Planning etc. (Scotland) Act 2006,
- Concise subject planning policies, including the implications for development planning and development management, and
- The Scottish Government's expectations of the intended outcomes of the planning system.

Other land use planning documents which may be relevant to this proposal include:

- PAN 42: Archaeology–Planning Process and Scheduled Monument Procedures
- PAN 45: 2002 Renewable Energy Technologies
- PAN 50: Controlling the Environmental Effects of Surface Mineral Workings
- PAN 51: Planning, Environmental Protection and Regulation
- PAN 56: Planning and Noise
- PAN 58: Environmental Impact Assessment
- PAN 60: Planning for Natural Heritage
- PAN 62: Radio Telecommunications
- PAN 68: Design Statements
- PAN 69: Planning and Building Standards Advice on Flooding
- PAN 75: Planning for Transport
- PAN 79: Water and Drainage
- Marine Guidance Note 371 (M)
- The Highland Structure Plan
- West Highland and Islands Local Plan (WHILP).

5. Natural Heritage

Scottish Natural Heritage (SNH) has produced a service level statement (SLS) for renewable energy consultation. This statement provides information regarding the level of input that can be expected from SNH at various stages of the EIA process. Annex A of the SLS details a list of references, which should be fully considered as part of the EIA process. A copy of the SLS and other vital information can be found on the renewable energy section of their website – www.snh.org.uk

6. General Issues

Economic Benefit

The concept of economic benefit as a material consideration is explicitly confirmed in the consolidated SPP. This fits with the priority of the Scottish Government to grow the Scottish economy and, more particularly, with our published policy statement "Securing a Renewable Future: Scotland's Renewable Energy", and the subsequent reports from the Forum for Renewables Development Scotland (FREDS), all of which highlight the manufacturing potential of the renewables sector. The application should include relevant economic information connected with the project, including the potential number of jobs, and economic activity associated with the procurement, construction operation and decommissioning of the development.

7. Contents of the Environmental Statement (ES)

Format

Developers should be aware that the ES should also be submitted in a user-friendly PDF format which can be placed on the Scottish Government website. A description of the methodology used in assessing all impacts should be included.

It is considered good practice to set out within the ES the qualifications and experience of all those involved in collating, assessing or presenting technical information.

Non Technical Summary.

This should be written in simple non-technical terms to describe the various options for the proposed development and the mitigation measures against the potential adverse impacts which could result. Within an ES it is important that all mitigating measures should be:

- Clearly stated;
- Fully described with accuracy;
- assessed for their environmental effects;
- assessed for their effectiveness;
- Their implementation should be fully described;
- How commitments will be monitored; and
- If necessary, how they relate to any consents or conditions.

Given that the layout and design are still developing and evolving, the exact nature of the work that is needed to inform the EIA may vary depending on the design choices. The EIA must address this uncertainty so that there is a clear explanation of the potential impact of each of the different scenarios. It should be noted that any subsequent components/scenario's procured after the ES is submitted would be subject to further environmental assessment and public consultations period if deemed to be significant.

Baseline Assessment and Mitigation

Refer to Annex 1 for consultee comments on specific baseline assessment and mitigation.

8. Archaeology and Cultural Heritage

General Principles

The ES should address the predicted impacts on the historic environment and describe the mitigation proposed to avoid or reduce impacts to a level where they are not significant. Historic environment issues should be taken into consideration from the start of the site selection process and as part of the alternatives considered.

National policy for the historic environment is set out in:

- Scottish Planning Policy *Planning and the Historic Environment at:* http://www.scotland.gov.uk/topics/built-environment/planning/National-planning-policy/themes/historic
- The Scottish Historic Environment Policy (SHEP) sets out Scottish Ministers strategic policies for the historic environment and can be found at: http://www.historic-scotland.gov.uk/index/heritage/policy/shep.htm

Amongst other things, SPP paragraph 110–112, Historic Environment, stresses that scheduled monuments should be preserved *in situ* and within an appropriate setting and confirms that developments must be managed carefully to preserve listed buildings and their settings to retain and enhance any features of special architectural or historic interest which they possess. Consequently, both direct impacts on the resource itself and indirect impact on its setting must be addressed in any Environmental Impact Assessment (EIA) undertaken for this proposed development. Further information on setting can be found in the following document: Managing Change in the Historic Environment http://www.historic-scotland.gov.uk/managing-change-consultation-setting.pdf.

Historic Scotland recommend that you engage a suitably qualified archaeological/historic environment consultants to advise on, and undertake the detailed assessment of impacts on the historic environment and advise on appropriate mitigation strategies.

Baseline Information
Information on the location of all archaeological/historic sites held in the National Monuments Record of Scotland, including the locations and, where appropriate, the extent of scheduled monuments, listed buildings and gardens and designed landscapes can be obtained from www.PASTMAP.org.uk.

Data on scheduled monuments, listed buildings and properties in the care of Scottish Ministers can also be downloaded from Historic Scotland's Spatial Data Warehouse at
http://hsewsf.sedsh.gov.uk/pls/htmldb/f?p=500:1:8448412299472048421::NO .
For any further information on those data sets and for spatial information on gardens and designed landscapes and World Heritage Sites which are not currently included in Historic Scotland's Spatial Data Warehouse please contact hsgimanager@scotland.gsi.gov.uk. Historic Scotland would also be happy to provide any further information on all such sites.

9. Navigation

The Environmental Statement should supply detail on the possible the impact on navigational issues for both Commercial and Recreational craft, viz.

<u>Collision Risk</u>
<u>Navigational Safety</u>
<u>Risk Management and Emergency response</u>
<u>Marking and lighting of Tidal Site and information to mariners</u>
<u>Effect on small craft navigational and communication equipment</u>
<u>Weather and risk to recreational craft which lose power and are drifting</u>
<u>In adverse conditions</u>
<u>Evaluation of likely squeeze of small craft into routes of larger</u>
<u>Commercial vessels.</u>
<u>Visual intrusion and noise</u>

10. Ecology, Biodiversity and Nature Conservation

Refer to Annex 1 for consultee comments on ecology, biodiversity and nature conservation.

Species

The ES needs to show that the applicants have taken account of the relevant wildlife legislation and guidance namely, Coast Protection Act 1949 section 34, Council Directives on The Conservation of Natural Habitats and of Wild Flora and Fauna, and on Conservation of Wild Birds (commonly known as the Habitats and Birds Directives), the Wildlife & Countryside Act 1981, the Nature Conservation (Scotland) Act 2004, the Protection of Badgers Act 1992, the 1994 Conservation Regulations, Scottish Executive Interim Guidance on European Protected Species, Development Sites and the Planning System and the Scottish Biodiversity Strategy and associated Implementation Plans. In terms of the SG Interim Guidance, applicants must give serious consideration to/recognition of meeting the three fundamental tests set out in this Guidance. **It may be worthwhile for applicants to give consideration to this immediately after the completion of the scoping exercise.**

It needs to be categorically established which species are present on the site, and where, <u>before</u> the application is considered for consent. The presence of protected species such as Schedule 1 Birds or European Protected Species must be included and considered as part of the application process, not as an issue which can be considered at a later stage. Any consent given without due consideration to these species may breach European Directives with the possibility of consequential delays or the project being halted by the EC. Likewise the presence of species on Schedules 5 (animals) and 8 (plants) of the Wildlife & Countryside Act 1981 should be considered where there is a potential need for a licence under Section 16 of that Act.

11. Water Environment

Developers are strongly advised at an early stage to consult with SEPA as the regulatory body responsible for the implementation of the Controlled Activities Regulations (CAR), to identify 1) if a CAR license is necessary and 2) clarify the extent of the information required by SEPA to fully assess any license application.

All applications (including those made prior to 1 April 2006) made to Scottish Ministers for consent under section 36 of the Electricity Act 1989 to construct and operate a electricity generating scheme will require to comply with new legislation. In this regard we will be advised by the Scottish Environment Protection Agency (SEPA) as the regulatory body responsible for the implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2005, and will have regard to this advice in considering any consent under section 36 of the Electricity Act 1989.

SEPA produces a series of Pollution Prevention Guidelines, several of which should be usefully utilised in preparation of an ES and during development. These include SEPA's guidance note PPG6: Working at Construction and Demolition Sites, PPG5: Works in, near or liable to affect Watercourses, PPG2 Above ground storage tanks, and others, all of which are available on SEPA's website at http://www.sepa.org.uk/guidance/ppg/index.htm. SEPA would look to see specific principles contained within PPG notes to be incorporated within mitigation measures identified within the ES rather than general reference to adherence to the notes.

Prevention and clean-up measures should also be considered for each of the following stages of the development;

- Construction.
- Operational.
- Decommissioning.

Construction contractors are often unaware of the potential for impacts such as these but, when proper consultation with the local fishery board is encouraged at an early stage, many of these problems can be averted or overcome.

- Increases in silt and sediment loads resulting from construction works.
- Point source pollution incidents during construction.
- Obstruction to upstream and downstream migration both during and after construction.
- Disturbance of spawning beds during construction - timing of works is critical.
- Drainage issues.
- Sea Bed and Land Contamination

The ES should identify location of and protective/mitigation measures in relation to all private water supplies within the catchments impacted by the scheme, including modifications to site design and layout.

Developers should also be aware of available CIRIA guidance on the control of water pollution from construction sites and environmental good practice (www.ciria.org). Design guidance is also available on river crossings and migratory fish (SE consultation paper, 2000) at http://www.scotland.gov.uk/consultations/transport/rcmf-00.asp.

12. Other Material Issues

Traffic Management

The Environmental Statement should provide information relating to the preferred route options for delivering equipment etc. via the trunk road network. The Environmental Impact Assessment should also address access issues, particularly those impacting upon the trunk road network; in particular, potential stress points at junctions, approach roads, borrow pits, bridges, site compound and batching areas etc.

Where potential environmental impacts have been fully investigated but found to be of little or no significance, it is sufficient to validate that part of the assessment by stating in the report:

- the work has been undertaken, e.g. transport assessment;
- what this has shown i.e. what impact if any has been identified, and
- Why it is not significant.

13. General ES Issues

In the application for consent the applicant should confirm whether any proposals made within the Environmental Statement, e.g. for construction methods, mitigation, or decommissioning, form part of the application for consent.

Consultation

Developers should be aware that the ES should also be submitted in a user-friendly PDF format which can be placed on the Scottish Government website. Developers are asked to issue ESs directly to consultees. Consultee address lists can be obtained from the Energy Consents Unit. The Energy Consents Unit also requires 8 hardcopies to be issued internally to Scottish Government consultees.

Where the developer has provided Scottish Ministers with an environmental statement, the developer must publish their proposals in accordance with part 4 of the Environmental Impact Assessment (Scotland) Regulations 2000. Energy consents information and guidance, including the specific details of the adverts to be placed in the press can be obtained from the Energy Consents website; http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-Consents

Gaelic Language

Where s36 applications are located in areas where Gaelic is spoken, developers are encouraged to adopt best practice by publicising the project details in both English and Gaelic (see also Energy consents website above).

OS Mapping Records

Developers are requested at application stage to submit a detailed Ordinance Survey plan showing the site boundary and all turbines, access tracks and onshore supporting infrastructure in a format compatible with the Scottish Government's Spatial Data Management Environment (SDME), along with appropriate metadata. The SDME is based around Oracle RDBMS and ESRI ArcSDE and all incoming data should be supplied in ESRI shape file format. The SDME also contains a metadata recording system based on the ISO template within ESRI ArcCatalog (agreed standard used by the Scottish Government); all metadata should be provided in this format.

Difficulties in Compiling Additional Information

Developers are encouraged to outline their experiences or practical difficulties encountered when collating/recording additional information supporting the application. An explanation of any necessary information not included in the Environmental Statement should be provided, complete with an indication of when an addendum will be submitted.

Application and Environmental Statement

A developer checklist is enclosed with this report to help developers fully consider and collate the relevant ES information to support their application. In advance of publicising the application, developers should be aware this checklist will be used by government officials when considering acceptance of formal applications.

Consent Timescale and Application Quality

In December 2007, Scottish Ministers announced an aspirational target to process new section 36 applications within a 9 month period, provided a PLI is not held. This scoping opinion is specifically designed to improve the quality of advice provided to developers and thus reduce the risk of additional information being requested and subject to further publicity and consultation cycles.

Developers are advised to consider all aspects of this scoping opinion when preparing a formal application, to reduce the need to submit information in support of your application. The consultee comments presented in this opinion are designed to offer an opportunity to consider all material issues relating to the development proposals.

In assessing the quality and suitability of applications, Government officials will use the enclosed checklist and scoping opinion to scrutinise the application. Developers are encouraged to seek advice on the contents of ESs prior to applications being submitted, although this process does not involve a full analysis of the proposals. In the event of an application being void of essential information, officials reserve the right not to accept the application. Developers are advised not to publicise applications in the local or national press, until their application has been checked and accepted by SG officials.

Judicial review

All cases may be subject to judicial review. A judicial review statement should be made available to the public.

Signed
Fiona Thompson

Authorised by the Scottish Ministers to sign in that behalf

Enclosed - Developer Application Checklist

14. Annex 1

Consultee Comments Relating To Marine Current Turbines Commercial Demonstrator, Kyle Rhea

The following organisations were asked for their comments in relation to Marine current Turbines Commercial Demonstrator, Kyle Rhea

Statutory Consultees

Scottish Environment Protection Agency (SEPA)
The Highland Council
Scottish Natural Heritage (SNH)

Non Statutory Consultees

Maritime & Coastguard Agency
NATS (EN Route) Ltd.
Northern Lighthouse Board
Fisheries Committee
RYA Scotland
Chamber of Shipping
Ports and Harbours
Scottish Government - Planning
Marine Scotland
Historic Scotland
Trunk Road Network Management Directorate

Scottish Environment Protection Agency (SEPA)

We would welcome meeting with the applicant at an early stage to discuss any of the issues raised in this letter. We consider that the following key issues should be addressed in the EIA process:

- Impacts upon coastal processes
- Potential pollution risks
- Water Framework Directive
- Flood risk to proposed buildings such as the substation

Please note that all of the issues below should be addressed in the Environmental Statement (ES), but there may be opportunities for several of these to be scoped out of detailed consideration. The justification for this approach in relation to specific issues should be set out within the ES.

In addition to the below scoping we note that Marine Scotland are currently reviewing the draft scoping opinion template for marine developments. We would be grateful for the opportunity to provide detailed comments on this to ensure our interests are fully addressed. Please contact Jamie Burke at Jamie.Burke@sepa.org.uk or telephone 0131 449 7268 who will be able to provide detailed comments on what should be covered.

1. Scope of the ES for marine developments

1.1 From the information submitted we understand the application will involve development onshore and offshore. The development will therefore be subject to a range of different consenting regimes. We would encourage you to consider producing a single ES which covers all aspects of the proposed development. This will enable a full assessment of the potential effects of the development as a whole, rather than just parts of it.

2. Site layout and nature of construction for marine developments

2.1 The ES should contain maps giving detailed information on the site layout, including details of all onshore and offshore components such as access tracks, buildings, cabling and marine devices. These maps should be supported by a statement detailing the development and reasons for the choice of site and design of the development.

2.2 We welcome the proposals to utilise existing grid infrastructure, directional drilling for cabling and to import materials by way of the sea as this may help reduce the environmental impacts of the proposal.

2.3 Background information which will help inform the ES process is available from EMEC (www.emec.org.uk/index.asp). The purpose of these guidelines is to encourage and assist developers to consider as fully as possible the range and scale of impacts - positive as well as negative - that might result from the testing of their device/s at EMEC. Generally if this standard industry guidance for scoping, preparing and undertaking an EA for marine renewables is followed then we are likely to be satisfied with the assessment.

2.4 There maybe a need to address the cumulative effects of devices/arrays on coastal processes depending upon array density and location with respect to existing renewable and coastal developments. This should include a baseline assessment to identify the coastal and sedimentary processes operating in the area. The baseline assessment should identify the following features and processes in the environment:

- Sediments (e.g. composition, contaminants and particle size);
- Hydrodynamics (waves and tidal flows);
- Sedimentary environment (e.g. sediment re-suspension, sediment transport pathways, patterns and rates and sediment deposition);
- Sedimentary structures (e.g. protected banks);
- Typical suspended sediment concentrations.

2.5 Developers will then be able to ascertain if they are required to supplement or quantify the available data with in-field surveys and what mitigation measures are required. Impoundments and tidal barrages are considered to have the potential to have the biggest impact upon coastal processes and hydromorphology and the habitats and species that these support. There is therefore likely to be a need to carry out hydrodynamic modelling to predict the impacts of the structure/s on water quality during construction and coastal processes in the longer term.

3. Marine environment and the water framework directive

3.1 We welcome the scoping reports reference to The Water Framework Directive. We are the lead authority with regard to the River Basin Management Planning process in Scotland. This includes the consideration of hydromorphological pressures in coastal water bodies from the MHWS mark out to 3 nautical miles. If any aspects of this specific application include works within 3 nautical miles we request that the ES address the following issues.

3.2 The River Basin management Planning (RBMP) Web Mapping Application available on SEPA's website (http://gis.sepa.org.uk/rbmp/) shows the Water Framework Directive (WFD) water body boundaries for transitional and coastal waters and provides further water body information.

3.3 The cumulative impact assessment should consider the footprint of the cabling and onshore works alongside the existing coastal development and activities already present within the water body in which landfall occurs. A map and information should be included in the ES showing the areas of seabed likely to be affected by the development landwards of 3nm offshore limit and the area of intertidal zone that is likely to be affected by shoreline infrastructure development.

3.4 The ES should demonstrate that the proposals will not compromise WFD objectives. A methodology to assess cumulative impacts in line with WFD objectives has been developed. The methodology uses a concept of 'system capacity' to measure impacts to morphological conditions. Please contact us for further guidance on the assessment methodology.

4. Onshore engineering activities in the water environment

4.1 In order to meet the objectives of the Water Framework Directive, developments should be designed wherever possible to avoid engineering activities in the water environment. The water environment includes burns, rivers, lochs, wetlands, groundwater and reservoirs. We prefer the water environment to be left in its natural state with engineering activities such as culverts, bridges, watercourse diversions, bank modifications or dams avoided wherever possible. Where watercourse crossings are required, bridging solutions or bottomless or arched culverts which do not affect the bed and banks of the watercourse should be used. If the proposed engineering works are likely to exacerbate flood risk then a flood risk assessment should be submitted in support of the planning application and we should be consulted.

4.2 Scottish Planning Policy states "Culverts are a frequent cause of local flooding, particularly if the design or maintenance is inadequate. Watercourses should not be culverted as part of a new development unless there is no practical alternative and existing culverts should be opened whenever possible. If culverts are unavoidable, they should be designed to maintain or improve existing flow conditions and aquatic life. A culvert may be acceptable as part of a scheme to manage flood risk or where it is used to carry a watercourse under a road or railway" (Paragraph 211). Planning applications should be determined in line with this planning policy.

4.3 A site survey of existing water features and a map of the location of all proposed engineering activities in the water environment should be included in the ES or planning submission. A systematic table detailing the justification for the activity and how any adverse impact will be mitigated should also be included. The table should be accompanied by a photograph of each affected waterbody along with its dimensions. Justification for the location of any proposed activity is a key issue for us to assess at the planning stage. The detailed design of engineered structures in the water environment will be considered under regulations administered by us. Where flood risk may be an issue, this will need to be addressed at the planning stage.

4.4 Further guidance on the design and implementation of crossings can be found in our *Construction of River Crossings* Good Practice Guide. Best practice guidance is also available within the water engineering section of our website.

5. Offshore water abstractions and discharges

5.1 Sensitive water uses, such as fish farms, bathing waters and shellfish growing waters, and associated potential impacts should be assessed. The proximity to existing discharges and designated areas i.e. estuarine abstractions and cooling water discharges (where relevant), should also be assessed.

5.2 Where a proposal involves shipping or port developments, it may be necessary to submit a detailed description of the actions to be taken to prevent the introduction of non-native marine species from ballast water transfers or hull-fouling which can result in a deterioration of a water body under The Water Framework Directive. Ships should carry and implement a ballast water management plan. Further guidance that is based on IMO (www.imo.org/index.htm) and OSPAR guidance is available at www.mcga.gov.uk/c4mca/mgn_363.pdf.

5.3 It might be useful for the developer to refer to the joint SOAEFD, DoT/MSA and SNH collaborative project which sampled ballast water docking at Scottish Ports (Macdonald, E. and Davidson, R. 1997. Ballast water project - final report, spring 1997. Fisheries Research Services Report No. 3/97. Aberdeen: MLA).

5.4 Further guidance can be found at www.thegreenblue.org.uk/youandyourboat/alienspecies.asp with regard to leisure craft and www.mcga.gov.uk/c4mca/bw_newsletter_september_2005_final.doc with regard to vessels arriving in Scottish ports in North West European waters.

6. Onshore water abstraction

6.1 Where water abstraction is proposed we request that the ES, or planning submission, details if a public or private source will be used. If a private source is to be used the information below should be included. Whilst we regulate water abstractions under The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (as amended) we require the following information to determine if the abstraction is feasible in this location;

- Source e.g. ground water or surface water;
- Location e.g. grid ref and description of site;
- Volume e.g. quantity of water to be extracted;
- Timing of abstraction e.g. will there be a continuous abstraction;
- Nature of abstraction e.g. sump or impoundment;
- Proposed operating regime e.g. details of abstraction limits and hands off flow;
- Survey of existing water environment including any existing water features;
- Impacts of the proposed abstraction upon the surrounding water environment.

6.2 If other development projects are present or proposed within the same water catchment then we advise that the applicant considers whether the cumulative impact upon the water environment needs to be assessed. The ES or planning submission should also contain a justification for the approach taken.

7. Borrow pits

7.1 Detailed investigations in relation to the need for and impact of such facilities should be contained in the ES or planning submission. Where borrow pits are proposed, information should be provided regarding their location, size and nature including the depth of the borrow pit floor and the final reinstated profile. The impact of such facilities (including dust, blasting and impact on water) should be appraised as part of the overall impact of the scheme. Information should cover, in relation to water, at least the information set out in PAN 50 *controlling the environmental effects of surface mineral workings* (Paragraph 53) and, where relevant, in relation to groundwater (Paragraph 52).

7.2 Details of the proposed depth of the excavation compared to the actual topography, the proposed restoration profile, proposed drainage and settlement traps, turf and overburden removal and storage for reinstatement should be submitted. The reinstatement of borrow pits can raise significant waste management issues and it is essential that any proposals are discussed with our regulatory teams as part of the development of the scheme to ensure that such proposals are feasible in terms of cost and regulatory requirements.

8. Air quality

8.1 The local authority is the responsible authority for local air quality management under the Environment Act 1995; however we recommend that this development proposal is assessed alongside other developments that are also likely to contribute to an increase in road traffic. This increase will exacerbate local air pollution and noise issues, particularly at busy junctions and controlled crossing points. Consideration should therefore be given to the cumulative impact of all development in the local area in the ES or supporting information. Further guidance regarding these issues is provided in NSCA guidance (2006) entitled *Development Control: Planning for Air Quality*.

8.2 Excavation works, particularly through drilling and blasting, may cause nuisance to adjacent land users due to the generation of dust and noise. Comments from the local authority environmental health officers should be sought on the potential nuisance to adjacent land users during the construction and decommissioning phases of the project.

9. Pollution prevention and environmental management

9.1 We request that a dedicated pollution prevention section is provided in the ES. All potential pollution risks associated with the proposals and all aspects of site work that might impact on the environment should be systematically identified, as well as preventative measures and mitigation. This information is necessary to assess the environmental impact of the proposals prior to determination. This information can also usefully provide the basis for a more detailed environmental management plan and construction method statements, which may be requested as planning conditions or required under environmental regulation.

9.2 The dedicated pollution prevention section should incorporate the principles of all proposed pollution prevention and mitigation measures for all construction elements potentially capable of giving rise to pollution during all phases of construction, reinstatement after construction and final site decommissioning. This approach provides a useful link between the principles of development which need to be outlined at the early stages of the project and the method statements which are usually produced following award of contract (just before development commences). Further guidance on producing an environmental management plan can be found on our website.

10. Flood Risk

10.1 The site should be assessed for flood risk from all sources in line with Scottish Planning Policy (Paragraphs 196-211). In particular any proposed buildings such as the substation should be located outwith the functional flood plain.

10.2 Further information and advice can be sought from your Local Authority technical or engineering services department, Scottish Water and from our website. Our Indicative River & Coastal Flood Map (Scotland) is also available to view online. If a flood risk is identified then a flood risk assessment (FRA) should be carried out following the guidance set out in the Annex to the SEPA Planning Authority flood risk protocol. Our *Technical flood risk guidance for stakeholders* outlines the information we require to be submitted as part of a FRA, and methodologies that may be appropriate for hydrological and hydraulic modelling. Further guidance on assessing flood risk and planning advice can be found at our website.

11. Marine ecological interests

11.1 A baseline assessment of existing intertidal and subtidal habitats and species. This should include any UK Biodiversity Action Plan habitats and species e.g. maerl, sea pens, eel grass, horse mussels (www.ukbap.org.uk/UKPlans.aspx?ID=35). Developers will then be able to ascertain if they are required to supplement or quantify the available data with in-field surveys.

11.2 We also recommend information on how the development will contribute to sustainable development. Opportunities to enhance marine habitats in line with Water Framework Directive and The Nature Conservation (Scotland) Act 2004 objectives and Scottish Planning Policy guidance should be explored. Examples might include coastal realignment, the incorporation of naturalistic features in the design of shoreline works or planting with salt tolerant species. These could be used as examples of best practice and demonstration sites under SEPA's Habitat Enhancement Initiative (HEI).

11.3 It is important that during the construction phase good working practice is adopted and that habitat damage is kept to a minimum and within defined acceptable parameters and controlled through an environmental management plan.

11.4 Advice on designated sites and European Protected Species should be sought from SNH. For marine and transitional Special Areas of Conservation (SAC) and Special Protected Areas (SPA), these are WFD Protected Areas. Therefore, their objectives are also RBMP objectives. In this case, SNH may contact us for input on the consultation.

12. Regulatory advice

12.1 Details of regulatory requirements and good practice advice for the applicant can be found on our website at www.sepa.org.uk/planning.aspx. If you are unable to find the advice you need for a specific regulatory matter, please contact a member of the Environmental Protection and Improvement Team in your local SEPA office at:

Carr's Corner Industrial Estate, Lochybridge, Fort William PH33 6TL Tel: 01397 704426

The Highland Council

Highland Council request that any Environmental Statement (ES) submitted in support of an application for development should be presented as three distinct elements including a full Description of the Development, Significant Effects on the Environment and a Schedule of Mitigation – summarising a full list of what is being offered (this helps with discharging of conditions, when approved, etc.)

The Council will consider any application as if it was a planning application which requires to be considered on the basis of the current the Development Plan of Highland Council including:-

- The approved Structure Plan
- West Highland and Islands Local Plan (WHILP).
- Emerging Plans including the Highland Wide Development Plan expected publication in August 2010
- Other relevant policy documents including Highland Renewable Energy Strategy

The application should include relevant economic information connected with the project, including the potential number of jobs, and economic activity associated with the procurement, construction operation and decommissioning of the development.

With regard to the description of the development for EIA purposes. While the consultation looks comprehensive and extensive there are a number of points which may need clarified: -

Generator: - It is noted that fabrication will be off site and the unit towed into position. Is this the completed unit or will the basic model be towed to near the site and then the extras fitted? Will these extras be at a significant nearby harbour or from the attendant tug or from some nearby shore station? If the latter we will need details of location, delivery weight statistics and proposals which may then lead onto traffic management requirements etc.

Servicing: - No real reference has been made on how this will be undertaken i.e. from a nearby shore station if so where and will that require planning permission or from some nearer established significant harbour again if the former we may require details of how that will operate?

Generator Building: - Re any cables from the unit to be laid on the seabed. We require details of the trenching etc once the location of the station has been determined. We will need details of the generating station which will obviously be the subject of a separate planning application. It would be useful to have the location, construction type and infrastructure detail with an estimated number of loads which will be accessing the premises during the construction phase. Depending on this information it will highlight if we need to consider a section 96 agreement under the Roads (Scotland) Act for access to this remote location.

Grid Connection It is not clear as to the extent of the required grid connection and whether this will be overland or underground. I strongly recommend that it forms part of this submission. This information could impact significantly on our interests with particular regard to access during construction for materials i.e. concrete, is it poles or is it towers; will they have a set down base and use helicopters? This requires to be fully understood / sorted out as part of this submission.

Identify all public roads affected by the development. In addition to transportation of all abnormal loads & vehicles (delivery of components) this should also include routes to be used by local suppliers and staff. It is expected that the developer submits a preferred access route for the development. All other access route options should be provided, having been investigated in order to establish their feasibility. This should clearly identify the pros and cons of all the route options and therefore provide a logical selection process to arrive at a preferred route.

Establish current condition of the roads. This work which should be undertaken by a consulting engineer acceptable to the Council and will involve an engineering appraisal of the routes including the following:

- Assessment of structural strength of carriageway including construction depths and road formation where this is likely to be significant in respect of proposed impacts, including non-destructive testing and sampling as required.
- Road surface condition and profile
- Assessment of structures and any weight restrictions
- Road widths, vertical and horizontal alignment and provision of passing places
- Details of adjacent communities

Determine the traffic generation and distribution of the proposals throughout the construction and operation periods to provide accurate data resulting from the proposed development including: -

- Nos. of light and heavy vehicles including staff travel
- Abnormal loads
- Duration of works
- Current traffic flows including use by public transport services, school buses, refuse vehicles, commercial users, pedestrians, cyclists and equestrians.
- Impacts of proposed traffic including
- Impacts on carriageway, structures, verges etc.
- Impacts on other road users
- Impacts on adjacent communities

Swept path and gradient analysis where it is envisaged that transportation of traffic could be problematic

Provision of Trial Runs to be carried out in order to prove the route is achievable and/or to establish the extent of works required to facilitate transportation

Cumulative impacts with other developments in progress and committed developments including other Renewable Energy projects.

Proposed mitigation measures to address impacts identified above including

Carriageway strengthening
Strengthening of bridges and culverts
Carriageway widening and/or edge strengthening
Provision of passing places
Road safety measures
Traffic management including measures to be taken to ensure that development traffic does not use routes other than the approved routes.
Details of residual effects.

Photographic Images

Should the application be supported by photographic images attention is drawn to the advice and guidance offered by Highland Council for developments within the area of that Authority. Visualisation Standards advice see web link: -

http://www.highland.gov.uk/yourenvironment/planning/energyplanning/renewbleenergy/

Submissions generally: -

Application which are submitted on-line or in electronic form on CD must ensure that files are presented in manageable a sizes >3MB and in widely used formats, JPEG files / acrobat adobe and pdf. Developers should be aware that Environmental Statements can be placed on the Council website therefore submissions in a user-friendly PDF format are strongly recommended.

Non electronic applications will require additional copies of all plans and documents to support your application which recognise the expected consultations to be undertaken by the Council. The final number of plans and documents and the arrangements for submitting these documents should be agreed with the Planning and Development Service.

You will be aware that the submission of an ES requires the preparation of a non -technical summary of the information provided. Such documents help provide an easy to read summary of the key elements of the project and its expected environmental impact. Such submissions should not be used to promote or advertise the development. The Council encourages the development of the full ES report in a concise, easy to read and understandable style, technical (with explanations) but free of jargon. A description of the methodology used in assessing all impacts should be included.

The Council and other statutory consultees also welcome from applicant's an indication of any difficulties (technical deficiencies or lack of know-how) encountered by the applicant or appellant in compiling the required information. Such honest approaches help authorities understand that all best practical steps may have been undertaken to examine a particular issue, rather than it being regard as an oversight by the applicant.

Finally it is considered good practice to set out within the ES the qualifications and experience of all those involved in collating, assessing or presenting technical information.

SNH Comments

POSITION STATEMENT

In principle SNH supports the development of marine renewable energy devices where sensitively designed and sited (SNH Policy Statement 04/01). In this case we advise that while there is no reason in principle why development should not take place in Kyle Rhea, the European importance of the site means that, in order to do so, there is a requirement for the developer to demonstrate beyond reasonable scientific doubt that the proposals will not adversely affect the designated features. If we consider that the developer has failed to make that case we would be likely to object to the application. It follows that we expect the EIA process for this application to be particularly rigorous.

The applicant has produced a useful and detailed assessment of the potential impacts of the proposal and the issues that the EIA needs to cover. However the scoping document contains a number of internal inconsistencies and generalisations which have not been backed up by scientific references which gives us cause for concern. We do not agree with all of the conclusions in table 6.1 and can provide specific comments if requested. Key issues are detailed below.

BACKGROUND

The proposal is to construct four tidal turbines in Kyle Rhea, each rated at 1.2MW. Each device has two 16-20m diameter rotors mounted on a cross-beam which is in turn mounted on a tubular tower. The tower extends 10m above the surface at mean sea level and is secured to the seabed by four piles. Ancillary development, including a substation and electrical cabling, is also proposed.

KEY SCOPING ISSUES

The key issues that we consider to be of high significance and that we expect the developers to give the most thorough attention are:

- Lochs Duich, Long and Alsh Reefs Special Area of Conservation (SAC) and the Kinloch and Kyleakin Hills SAC and Site of Special Scientific Interest (SSSI).
- European Protected Species (EPS), particularly cetaceans and otters.
- Cumulative impacts on protected sites and EPS.

However, there are additional issues which are noted in the main text below.

We also recommend that the EIA includes all of the terrestrial aspects of the proposals, such as grid connection, sub-station, construction compound, laydown areas and access tracks because these may also be key aspects, particularly if development takes place within Kinloch and Kyleakin Hills SAC.

We have recently updated our Service Level Statement which explains how we will engage in the development of renewable energy projects:

http://www.snh.gov.uk/planning-anddevelopment/renewable-energy/our-approach-to-renewables/managing-applications/

DETAILED COMMENTS

a) European designated sites

The list of sites of European importance in table 4.1 is inconsistent and incomplete (for example Canna and Sanday SPA is not listed and most of the features of Rum SPA have been omitted, although they are listed in section 4.3.1). We recommend that the designated sites that are considered is based upon the biology of the qualifying interests (e.g. foraging ranges of seabirds). While it is important to consider all such sites, it is likely that some may be scoped out following initial assessment. The sites most likely to be impacted on, and therefore where most effort should be directed are Lochs Duich Long and Alsh SAC and Kinloch and Kyleakin Hills SAC. The legislative requirements for European sites are provided in Annex 1. The Conservation Objectives for these sites can be found in Annex 2 and Annex 3 respectively. The ES should provide sufficient detail to inform any future appropriate assessment which would be carried out by Marine Scotland as competent authority.

Lochs Duich, Long and Alsh Reefs Special Area of Conservation
Lochs Duich, Long and Alsh SAC is designated for its reef habitat. The entire study area lies within the SAC. The majority of the habitats within Kyle Rhea are predicted to be qualifying reef habitat, amongst which are some of the most interesting and diverse habitats within the SAC (described in section 4.2.1 of the scoping document).

The applicant proposes to carry out acoustic seabed mapping to develop indicative biotype distribution maps. A baseline survey is available for the SAC: Entec (2000) Broad scale survey and mapping of the seabed and shore habitats and biota: Lochs Duich Long and Alsh pSAC. Scottish Natural Heritage Commissioned Report F97PA05 (unpublished). This includes shore type maps and predictive mapping of benthic life forms. It provides useful broad scale information but the underlying data is not sufficiently detailed to allow accurate biotope mapping. We agree that more detailed development specific surveys will be required. We also understand that Marine Scotland is planning to visit, or has recently visited, Kyle Rhea to undertake survey work of the seabed.

We agree that detailed surveys of the benthic habitats around the proposed device locations will be a critical part of the EIA and support proposals to collect seasonal data. The applicant has suggested using drop down video and/or diver surveys to provide detailed data; we recommend that ROV video transects and still photography using a weighted drop frame also be considered. We look forward to discussing the detail of the survey techniques with the applicant and Marine Scotland. It would also be useful to schedule in a review after early analysis in case further work is required.

It is worth highlighting that the reef feature includes rocky, stony and biogenic reef. JNCC have recently clarified what constitutes stony reef: Irving, R, (2009), The identification of the main characteristics of stony reef habitats under the Habitats Directive, JNCC Report 432, and ISSN 0963 8091 available via the JNCC website at:

http://www.jncc.gov.uk/page-5023

Most of the aspects that the EIA should consider are detailed in the main text (section 4.2.2) and 'key potential effects' table (section 6.1), but there are a number of inconsistencies between these sections. We agree that the aspects in section 4.2.2 should be given particular attention. In addition particular attention should be given to the site's conservation objectives and the following aspects should also be considered:

- Damage/disturbance caused by boat moorings, cables and other ancillary aspects;
- Consideration of hydrodynamic changes;
- Accidental release of hydraulic fluids and potential pollutants including the use of anti-foulants and sacrificial anodes.

In principle, we support proposals for directional drilling for cables because this offers an opportunity to minimise the benthic impacts of cable laying. Providing best practise is followed and a pollution prevention package is drawn up, the effects from potential pollutants may be minimised. We advise that environmental practices and management for hydraulic fluids and potential pollutants are detailed within the ES.

At this early stage, given the details provided, we consider this proposal is likely to have a significant effect on the qualifying interest (reef habitat) of the site. As a consequence we advise that it is likely that an appropriate assessment will be required to be carried out by Marine Scotland as competent authority in view of the site's conservation objectives for its qualifying interest. We advise that the following aspects should be given particular attention:

- Smothering effects caused by installation of the array;
- Direct and indirect loss of reef habitat (and possible recovery);
- Consideration of changes to the tidal regime;
- Effects on community composition and species associated with the reef;
- Accidental release of hydraulic fluids and potential pollutants.

Kinloch and Kyleakin Hills Special Area of Conservation

Kinloch and Kyleakin Hills SAC includes all ground to the west of the study area, extending to Mean Low Water Springs. It is designated for its upland and woodland habitats and otters. The type, location and extent of the land-based parts of the proposed development have not yet been decided and may be located within or close to this SAC, having the potential to impact on the site. The coastal area of the SAC within/adjacent to the study area is primarily designated for its otters, although it also supports patches of qualifying woodland and heathland habitats. The otters forage outwith this SAC and have the potential to be affected by the marine aspects of the development.

SNH has detailed baseline data on otters within the SAC: Cottis, R (2000) Kinloch otter Lutra lutra survey. SNH commissioned Report F00/LD/19 (unpublished report) and will make this information available to the developer on request.

Otter use of areas can vary considerably over time and therefore there will be a need to update the above survey in areas where otters maybe affected. We advise that coastal areas within 250m of significant disturbance (such as the substation, construction compounds, and Seagen devices) should be resurveyed by an experienced otter surveyor in order to identify the location and level of activity at breeding and resting sites. Paths, freshwater pools and spraint sites should also be identified. Further information on survey methodologies for otters is available in the SNH publication "Otters and Development" as listed in section 4.4.2 of the scoping document. The ES should also identify and map suitable otter foraging habitat - otters are known to forage in depths of 10-15m of water, and the scoping report states that otters "are known to cross the Kyle".

At this early stage, given the details provided, our view is that this proposal is likely to

have a significant effect on the qualifying interest (otters) of the site. As a consequence we advise that it is likely that an appropriate assessment will be required to be carried out by Marine Scotland.
In assessing the impact of the proposals, particular attention should be given to the site's conservation objectives and the following aspects should be considered in detail and may form the basis for an appropriate assessment:

- Disturbance to otters caused by the installation, maintenance, operation and decommissioning of the project;
- Damage to otter breeding and resting sites from the terrestrial development;
- Direct and indirect loss of otter foraging habitat and prey species;
- Collision risk to otters caused by the device (we suggest the assessment in section 4.4.2 should be reconsidered).

It is unclear whether the terrestrial habitats within the SAC will be affected by the proposal and in principle it would be desirable if terrestrial development occurred outwith the SAC. If development is proposed within the SAC we have copies of an NVC survey which was commissioned by Forestry Commission Scotland. Averis, B & James, P (2002). A Botanical assessment for the Kinloch Hills Wilderness Forest Project, Isle of Skye, Scotland. FCS commissioned report contract 02/17 (unpublished report). This should be used to inform the siting of any onshore developments.

b) European Protected Species

All species of European Protected Species (EPS) are protected under the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) and the legislative requirements for EPS are provided in Annex 4.

Cetaceans
Section 4.5 of the scoping document covers marine mammals including cetaceans. It contains a useful summary of the cetacean species present in the area but the 'identification of key issues' tends to focus on seals rather than cetaceans. We advise that 2 years' data collection is likely to be required in this case because the proposal is an array of 4 devices (each with two rotors), and because they are proposed within the Kyle Rhea narrows which is known to be used by cetaceans, where options for avoidance are restricted, and where cetacean usage is likely to vary considerably between years. However, we consider that reviews are an important part of the data collection process and advise that the developer should carry out a review of the techniques at 3 months and data at 12 months. Detailed data on species present, group make-up, temporal and spatial distribution and behaviour is necessary to inform siting, mitigation and licensing.

There is no standard method for collection of data on cetaceans (the guidance that Royal Haskoning is currently writing for SNH has not been completed or consulted on) and although the applicant has provided some details of the proposed methodology there is not enough detail to allow us to advise on its appropriateness. We agree that vantage point watches are likely to be a key component, but the number and location should be determined by the visibility of the study area. Use of C or T pods should also be considered, particularly to address potential data gaps when the sea state is unsuitable for VP watches.

We agree that as well as cetaceans the applicant should also record birds, seals and basking sharks. We look forward to further dialogue with the applicant and Marine Scotland regarding the methodology. In addition to disturbance, noise and collision aspects listed in section 4.5.2 the assessment should also consider pollution. Cumulative aspects will also be important.

When considering the potential impacts of noise on cetaceans and other marine mammals we recommend the applicant refer to the following references:

- Marine Mammals and Noise, Richardson et al 1995 Academic Press
- Marine Mammal Noise Exposure Criteria: Initial Scientific recommendations, Southall et al 2007, Aquatic Mammals Vol 33, Issue 4

Otters
As well as being a qualifying feature of Kinloch and Kyleakin Hills SAC, otters are also EPS. SNH does not have any survey data for the mainland side of the narrows but otters are known to be present. As stated above we advise that all areas within 250m of any areas of significant disturbance should be surveyed for otters and assessed in the same manner as the SAC.

Bats/Turtles/Great Crested Newt
All species of bats are EPS and consideration should be given to whether a bat survey is required in relation to the terrestrial development aspects as part of the proposed walkover surveys. Marine turtles and Great Crested Newts are also EPS however we advise that it is unlikely that they will be adversely affected by this development.

c) Cumulative Impact Assessment

A cumulative impact assessment is likely to be required as part of the EIA process and would best be achieved by collaboration between known marine developers in Kyle Rhea. We recommend that a discussion should take place between Marine Scotland, the relevant developers and stakeholders to agree the topics to be covered and methodology; we would be happy to contribute to that discussion.

d) Nationally designated sites

Kinloch and Kyleakin Hills (Monadh Chaol Acainn is Cheann Loch) SSSI is notified for similar features as the SAC but with the addition of lichens and bryophytes. The SSSI boundary is contiguous with the boundary of Kinloch and Kyleakin Hills SAC. This designation does not present any additional issues to marine/intertidal aspects of this proposal which are not already covered in the SAC section above. If terrestrial development is proposed within the SSSI then these additional interests should also be considered.

Other SSSIs and GCR sites are listed in the scoping document and we agree that no further consideration is required in the ES.

e) Local and regional interests

Birds
The ornithological data currently available for this area is sparse. This is a new technology, the impacts of which are poorly understood and the proposed tidal stream development could impact birds in the following ways:

- indirect loss of habitat through displacement/disturbance if birds avoid the devices and surrounding area due to construction, operation and maintenance;
- death of diving birds through collision or interaction with the devices;
- potential contamination by leakage of hydraulic fluids and pollutants.

Should MCT seek to deploy similar devices elsewhere, it will be in their interest to be able to refer to monitoring of this development to support any claims regarding the significance or otherwise of such impacts upon birds. Such evidence could inform and may simplify the consenting process for any such developments. We therefore recommend that it would be useful and to MCT's own benefit to collect additional bird data.

The methods proposed have not been agreed with SNH and insufficient detail has been provided to allow us to advise on their appropriateness. The survey should record bird species, numbers of each species, and behavioural data in order to characterise the use of the site. Particular attention should be paid to diving behaviour and where and when (state and flow speed of tide) it occurs and for which species. These data may help to inform any potential collision risk to birds. We would be happy to provide advice on survey methodology (which could be integrated with the marine mammal surveys).

Additional consideration needs to be given to:

- potential collisions with above surface structures;
- disturbance arising from operation and maintenance;
- lighting effects;
- indirect effects (e.g. reef effects), both positive and negative.

Seals

Sea Mammal Research Unit reports from 2001 and 2008 (Survey of harbour seals on the west and east coast of Scotland (2001) & Surveys of harbour (common) seals around Scotland (August 2008)) indicates that the nearest harbour seal haul-out is at the north end of Kyle Rhea, which is in close proximity to the proposed development. Furthermore, they are known to forage in Kyle Rhea, utilise the whole water column and are inquisitive animals. It is therefore possible that seals may interact with the proposed tidal stream device at this location.

We advise that the applicant establishes the distribution and usage throughout the year of the proposed deployment area by harbour and grey seals as part of the marine mammal surveys. In particular, consideration of whether this area is important as a feeding area for either species. This data should be used to make an assessment of any potential adverse impacts. It would be helpful to interpret the significance of those impacts in the context of the recently published Special Committee On Seals advice on the management of seal populations: http://www.smru.st-and.ac.uk/documents/341.pdf
We do not consider aerial surveys and tagging of seals (as proposed in section 4.5.3) to be necessary in this case.

Basking sharks

Basking sharks are known to use the area and are protected against reckless disturbance under Schedule 5 of the Wildlife and Countryside Act (1981) (as amended) and the Nature Conservation (Scotland) Act 2004. They are also listed under CITES Appendix III in UK waters.

We recommend that distribution and use of the area by basking sharks should be incorporated within the marine mammal surveys, and an assessment made of any potential adverse impacts.

Badgers

There are no recent records of badgers on Skye but they do occur on the mainland. Therefore we agree that walkover surveys to confirm presence/absence of badgers would be required for terrestrial development on the mainland.

Terrestrial habitats

We agree that a phase 1 habitat survey would be sufficient for areas outside the SAC. Surveying areas that may be directly impacted by the proposals, such as the footprint of onshore infrastructure and laydown areas, would be sufficient.

Landscape/seascape and visual impact

We agree that the proposal will not affect any formally designated sites of national or regional landscape importance. However, the proposed turbines will rise 10m from the water and will probably be marked to increase their visibility. These are industrial structures in a relatively remote rural location and the Kylerhea ferry is an important tourist route. The ancillary development including substation, access tracks, power lines and construction compound all have the potential to add to the landscape and visual impact.

We disagree that a review of existing documents will be sufficient and recommend that a seascape, landscape and visual impact assessment be carried out by a chartered landscape architect (preferably a team of two). This should be a focussed assessment but should generally follow the guidance and advice set out in the "Guidelines for Landscape and Visual Impact Assessment" (LI-IEMA, 2002) and the Guidance on Landscape/Seascape Capacity for Aquaculture. Natural Heritage Management, SNH (2008) which is available at:

http://www.snh.org.uk/pdfs/publications/heritagemanagement/aquaculture.pdf.

The zone of visual impact should be calculated and representative viewpoints selected accordingly. This assessment should be used to inform the siting and design of the development, particularly the land-based aspects. Noise and lighting should also be considered as part of this assessment. SNH is in the process of reviewing both our own guidance and that commissioned by others in order to draw up a list of recommendations for carrying out seascape, landscape and visual assessment in relation to marine renewables. In advance of that being available we can provide further detailed advice on request.

f) Proposed development details

The ES should provide details on the rationale for the array location, cable routes, substation location and the alternatives considered. We would also expect to see the following details:

- Details of type, amounts and containment of any oils or fluids to be used and details of any pollution prevention protocols.
- Speed of the blades and any other moving parts.
- Frequencies and levels of noise associated with the operation of the device.
- Full details of cable installation.
- Site preparation including details on any seabed levelling or clearance at the device site and cable route, together with size and depth of proposed piling, method used and a calculation of the type, level and duration of the noise expected.
- The amount and type of maintenance and how this will be undertaken (number/type of vessels, number of days, etc).
- Any temporary construction compounds, laydown areas, access tracks, access points and power cable routes.
- Lighting and marking of the turbines.
- Details of the construction process and timing including duration of stages.

g) List of stakeholders

The developer has asked for feedback on the list of stakeholders. We advise that recreational stakeholders should also be contacted including the Scottish Canoe

Association and Inverness Diving Club. The Skye and Lochalsh Environment Forum would also be a useful contact.

RSPB Comments

Kyle Rhea provides habitat for a variety of bird species, although numbers are thought to be generally low: those potentially most at risk are correctly identified in Para 4.3.2 as diving birds. These are liable to potential collision, disturbance and displacement from the development. RSPB Scotland advises that the assessment should consider how this proposal would be likely to impact upon these species at different times of the year – since their numbers vary seasonally. Those species most likely to be impacted would include cormorant, shag, eider which have all been reported from the otter hide at Kyle Rhea but other species including auks and divers are also possible.

Few data exist on the actual usage & densities of diving birds within Kyle Rhea and we advise that a comprehensive survey be undertaken as part of the EIA process. Recording bird locations and behaviour, including diving duration and approximate distance covered, through surface-based vantage point survey work could provide some indication of preferred feeding areas. Sub-surface monitoring is more difficult but may be required to assess the potential of collision, should usage of the area by diving birds be greater than suspected. Reference should be made to findings at Strangford Lough where a single device of the type proposed was located although account must be paid to the different species, bathymetry, tidal regime, the fact that four turbines, and not one are proposed at Kyle Rhea, etc.

RSPB may hold some data on bird life in the Kylerhea area, which may be accessed through formal application to this email address. In addition, contact should be made with the Highland bird recorder, Kevin Davies (14 Forsyth Place, Cromarty, Ross-shire, IV11 8XW **E-mail** kevjandkaren@hotmail.com for additional bird records. Reference should also be made to the Scottish Marine Renewables SEA although this lacks the fine detail required for the EIA.

We note that the scoping report mentions the possibility of collisions with mammals, fish and birds and recognise that turbines within a water medium have very different physical parameters in comparison to wind-turbines, as do the birds that may collide with them. The concept of comparing the rotor speed of a sea-turbine with the usage of the underwater environment by a diving bird is currently a novel one. It is a concept which, as for other marine organisms, is intimately tied up with a species behaviour/response to a number of variables, principle amongst these must be marine currents & distribution of food resource within an area, which will determine their diving depth, location and period. Needless to say, underwater turbines will be a totally novel structures to organisms using the marine environment and how they react to them is not known. Although they will emit some noise, their visibility will alter depending on both the quality of visibility within the water column & behavioural factors such as birds/cetaceans awareness of their surroundings being reduced when pursuing prey.

It is noted that in considering potential impacts from contamination via leakage from the structure that no mention is made of the likely quantities of oil/anti-fouling and other potential contaminates contained within a structure (nacelle & base). Yet, in table 8 its potential effects are assessed as unlikely to be significant. We would advise that this should be kept as significance unknown at this stage and further consideration given to its impacts based on the escape of the full quantities likely to be contained within one structure. Even a small release of oil can impact on seabirds and anti fouling material could have a localised effect dependant on rate of dilution. Fuller consideration needs to be given to the anti-fouling technique employed for the blades/nacelle/tower – i.e. will it be coated with anti-fouling agent and then left for marine organisms to colonise with regular maintenance, or will a spray type system be used to keep structures free of growth?

Whilst the prime consideration is likely to be the potential for damage to the SAC, which is acknowledged in the Scoping report, it is essential that the full range of designated sites which may be affected is considered. Indeed, the tests set out by the Conservation (Natural habitats &c.) Regulations 1994 (as amended) will require that the absence of an adverse effect on site integrity be ruled out, beyond reasonable scientific doubt, for all Natura sites for which a significant effect is likely. Table 4.1: Summary of designated sites omits Canna & Sanday SPA (qualifying features Breeding Seabird Assemblage, breeding guillemot, herring gull, puffin and shag) which is hardly any more distant than Rum. For Rum SPA, the qualifying features list in that table omits breeding seabird assemblage and guillemot, kittiwake and Manx shearwater, although such details are included in Para 4.3.1. Table 4.1 needs thorough checking for other potential omissions.

The report seeks to scope out some issues prematurely, without the benefit of adequate data on which to do so. It seems likely that surveys will be necessary to confirm species present in the area and that until that step is taken, loss of foraging habitat/food availability, e.g. indirectly via effects of noise on prey species, cannot be ruled out, albeit they will most likely be of a temporary nature and unlikely to lead to a significant impact. However, unlikely significance of effect is not the same as no significant effect and I doubt the data are available to conclude the latter at this stage.

Species identified so far seem relevant, although scoping out terns at this stage may or may not be appropriate, subject to confirmation of the tern species present, given the minimum of 3m beneath the water surface for the rotors.

The claim that birds use vision for prey capture and therefore will see and so avoid underwater turbines may be flawed as their field of vision may be short-range, and focus on prey may lead to failure to "see" or react to a turbine (G. Martin pers. comm), e.g. cormorants it is suggested use close-quarter prey detection or flush-foraging, rather than pursuit (Martin, G.R., White, C. R. & Butler, P.J. 2008. Vision and the foraging technique of Great Cormorants Phalacrocorax carbo: pusuit or close-quarter foraging? Ibis 150: 485-494.).

This is a novel technology with very little known about potential impacts so it will be important to conduct a thorough EIA, collecting baseline data to inform this process, as necessary, and to monitor the project post-construction.

Whilst the actual timing of installation (estimated to last six months) is likely to be determined largely by factors such as weather, availability of equipment etc, consideration should be given to whether there is any necessity to avoid certain periods to minimise disturbance to important wildlife at vulnerable periods

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Maritime & Coastguard Agency

Navigation

Section 5.3 Shipping and Navigation: On the information provided we do not agree with the subsequent assessment in Table 6.1 b for Shipping and Navigation. For construction and installation we would consider the "disruption to search and rescue" as red with "increased journey time" and "collision with array as orange"

A comprehensive Preliminary Hazard Analysis, Vessel Traffic Study and Navigational Risk Assessment will be expected to fully address these issues.

West Highland Anchorages and Moorings

Kyle Rhea is a narrow passage and subject to strong tides which is exactly why one might wish to utilise it or the generation of power. Indeed tides run at up to 8 knots We believe this proposal requires very careful examination. The positioning of the 4 turbines, if the proposal goes ahead, will be critical.

Small vessels require to navigate this passage with care. The strength of the tidal flow is such that small vessels cannot always maintain a steady course due to current eddies and wind strength. Given the minimum width of the channel-about 1.5 cables-their room for manoeuvre is severely constrained and, if a larger vessel is encountered during passage, great care has to be exercised to navigate safely. While most small craft use the tide to their advantage and transit with the tide, larger vessels usually have enough power to ignore this constraint, if needed. The clearance of 3m above the blades may be just adequate for small craft but it is not adequate for larger vessels. However, smaller vessels with a lifting keel would be in difficulty. The survey period chosen of 14 days in March is inadequate as recreational traffic does not build up till end April/early May and continues to end September. AIS is only fitted to vessels over 300te and is not a guide to recreational use. While it is true that local recreational craft may follow an erratic course and return to harbour the majority of summer recreational traffic is on passage north or south to save time rounding Skye. We contend that much more study of traffic patterns and examination of the effect of currents on the passage of small craft is required, taking into account the proposed siting of these turbines.

NATS (EN Route) Ltd.

The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Limited has no safeguarding objections to this proposal. Please be aware that this response applies specifically to the above consultation based on the information supplied at the time of this application. If any changes are proposed to the information supplied to NERL in regard to this application (including the installation of wind turbines) which become the basis of a full, revised, amended or further application for approval, then as a statutory consultee NERL requires that it be further consulted on any such changes prior to any planning permission or any consent being granted.

Northern Lighthouse Board

We would advise that the following should be considered as our initial response to the Scoping Opinion request and that any formal recommendations for lighting and marking will be given through the Coast Protection Act 1949 – Section 34 process, and will be based on IALA Recommendation O-139. All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.

With regard to the consultation and the scope of assessment, we would only comment on that part relating to Shipping and Navigational Safety contained within several sections of the consultation document. We also note that Notices to Mariners, Radio Navigation Warnings and publication in appropriate bulletins will be required stating the nature and timescale of any works carried out in the marine environment relating to this project due to the international use of this area of UK sea. The warnings should be promulgated before any commencement of any installation, operation, maintenance and decommissioning periods.

We note that the Scoping document makes a number of assumptions regarding Shipping and Navigation, which we do not consider to be a full and accurate depiction of these activities:

- section 5.3.1 refers to very light traffic volumes, presumably based on AIS data, without noting that AIS is generally only fitted to larger vessels.
- section 5.2 dismisses the risk to leisure traffic, without noting that Kyle Rhea is a significant transit route for such craft, whose ability to manoeuvre in strong tidal conditions is very limited.
- section 5.2 also refers to a local ferry operating June-August, when it actually operates April-October. The ferry also has restricted manoeuvrability, and will be set into the optimum array area by any North-going tide during transit.

- section 5.3.2 notes that the exclusion of vessels from Kyle Rhea during construction would cause ‘increased journey times and distances’. In many cases, however, closure of Kyle Rhea would render journeys impractical in view of the far greater exposure to adverse weather in the Minch.
- section 5.3.2 also predetermines the outcome of the NRA by assessing that ‘collision of vessels with the installed array is unlikely’.
- section 5.5.1 notes that no naval routes are shown through Kyle Rhea, however we know that the route is used by naval and auxiliary vessels.

We do not agree with these statements. We consider that any increase in hazard to surface navigation in a constrained area with strong tidal flows is unwise, and requires a robust NRA that reflects such risk. In the absence of such an assessment, we would not consider this project to be viable. We note that the optimum position for installation is likely to be in the centre of this constrained channel and that installation, maintenance and decommissioning will all significantly further impede the channel. We would stress the importance of Safety of Life, which must be given due consideration in any development.

We would anticipate that a Method Statement would form part of the CPA Application, and note that any devices deployed either as part of your technology assessment, permanent installation and eventual de-commissioning will require careful planning to minimise the hazards posed by any permanent moorings, or temporary moorings deployed during any installation and de-commissioning activities.

The requirement to install cables to shore would need separate comment contained within the Navigational Risk Assessment. We would ask that the Hydrographic Office be informed of the route and landfall location in order that the Admiralty Chart is updated to give information of the installation.

We note that the array will certainly have an impact on the existing navigation light at Kyle Rhea Lighthouse as the sectors may become obscured by the structures. We would therefore welcome any early opportunity to meet with the developers to discuss the navigational impact and any required marking.

The Statutory Sanction of the Commissioners of Northern Lighthouses must be sought to deploy, exhibit and subsequently remove any proposed navigational lighting or buoy stations required within any conditions of the consent to establish the Marine Current Turbine array or for any preparatory work.

Fisheries Committee

The scheme is out with the Fisheries (Electricity) Committee remit and they will not be submitting any comments.

RYA Scotland

Section 5.3 of the Scoping report clearly identifies the fact that you have included recreational navigation as an issue to be included into the Environmental Statement. The RYA is encouraged by this recognition and has a few further points that should be considered when gathering additional data for the ES.

In section 5.3.1, the report states that MCT has recently commissioned vessel surveys for the study area and that *'During a 14 day period in March 2010, 94 vessel tracks were recorded'*. The RYA feels that this survey period provides an inadequate representation of recreational vessel movements in the area as March is very early in the season when many recreational vessels will still be laid up after the winter. The RYA would therefore expect another survey to be carried out during the high season, May to September, to gauge the full extent of vessel numbers in Kyle Rhea.

Also in section 5.3.1, the report states, when referring to the types of recreational vessels that use the area, that '*such craft will not normally be undertaking point-to-point passages but will be on out and return activities and may appear to be sailing in random direction…*' While it is true that local recreational craft may follow an erratic course and then return to harbour, the RYA would like to make the developers aware that the majority of summer recreational traffic in the area is on a passage north or south for safety reasons and to save time rounding Skye.

In section 5.3.2 of the report it is assumed that *'the minimum depth of 3m will allow passage of small vessels, of the size expected to use a narrow strait, directly over the rotors*.' The RYA believes that the threat to recreational yachts by underwater turbine blades can be minimised by specifying a **minimum underwater clearance of 3.5m below mean low water springs**.

The RYA has put together a position statement regarding the development of offshore renewable energy developments and I have enclosed a copy of this for your information. All the points mentioned above are expanded on in more detail within the statement. The RYA's concerns regarding recreational boating and offshore energy developments are included in this statement and we would expect these to be addressed in an ES for a project such as this.

In addition to the position statement, the RYA has also produced the UK Coastal Atlas of Recreational Boating. The Atlas contains maps of recreational cruising routes, racing and sailing areas as well as locations of RYA affiliated clubs, training centres and also marinas (independent) around the UK. I see that the data from the Atlas has been referred to within the Shipping and Navigation section of the Scoping report. The RYA is encouraged that the GIS data is being considered at this early stage and as with the position statement, would expect this information to also be taken into account and represented within the ES.

Additional detailed information for the ES can also be provided by RYA Scotland through its network of local experts.

In summary the RYA's concerns with offshore energy developments and recreational boating relate to:

1. Navigational safety
    - Collision risk
    - Risk management and emergency response
    - Marking and lighting
    - Effect on small craft navigational and communication equipment
    - Weather
2. Location
    - Loss of cruising routes
    - Squeeze into commercial routes
    - Effect on sailing and racing areas
    - Cumulative effects
    - Visual intrusion and noise
3. End of life
    - Dereliction
    - Decommissioning
4. Consultation

These are detailed in our position statement, referenced above and attached to this email

Chamber of Shipping

At this stage, on reviewing the report we would like to advice you that we have no further comments to submit in return.

Ports and Harbours

Comments incorporated onto Marine Scotland Response

Scottish Government – Planning

The developers should also note that the Highland Wide Local Development Plan will set out The Highland Council's policies on planning for renewable energy. The Main Issues Report for this plan was subject to consultation late last year, and the proposed plan is expected in the summer.

Marine Scotland

The Tidal Device
Each device has two axial flow rotors 16-20m in diameter and can turn at a maximum rate of 14.3rpm with a tip speed of 12m/s. The tubular tower is likely to extend a maximum of 11m above the sea surface. The device is secured to the seabed via 4 pin piles drilled into the seabed to support the quadropile foundation.

Layout and Navigation
The exact location and layout of the devices and cable route have not been selected. From a navigation perspective this proposal would appear, although not specifically stated, to be seeking an exclusion zone throughout the Kyle Rhea area, which may not be appropriate and would require a private act similar to Robin Rigg to achieve this. There is no indication of where within the red site area identified on the various charts the devices would actually be sited and this information will be vital to proper consideration of the navigational impacts. The single chart showing vessel traffic will require full analysis in the NRA which should be carried out according to the guidance and methodology in MGN 371. Cumulative impacts of this and other proposals in the same area will require full assessment in the NRA in relation to vessel traffic diversion/exclusion.

Impacts on Special Area of Conservation (SAC)
The scoping document seems to be very comprehensive and has identified the key impacts with regard to the development. Some surveys and data from other sources have been noted for inclusion in the Environmental Statement (ES). The evidence presented, either new or existing, should ensure that the surveys conducted satisfactorily establish the location of any reef habitats, including biogenic reefs such as *Modiolus modiolus*, and any listed species in respect to the proposed positions of the 4 turbines. It would be extremely useful to know if the quality of the reef structures associated with Kyle Rhea represents the very best of the habitats within the SAC. If they are, it should be considered how this would change the assessment, if at all, in terms of site suitability, additional data collection, array design, installation methodology, etc. This information will also guide the methodologies for site preparation and the installation of the devices and associated cabling. Alterations to the current methodologies will be required as a result of newly acquired information. The re-assessment will have to be designed to ensure their potential for impact on the environment is properly addressed.

Further assessment will need to be made to rule out any detrimental effects, either permanent or temporary, of installation of the devices and changes in current regime on the reef habitat and species present on the reef, particularly those reliant on strong tidal currents. Smothering is one of the key detrimental effects listed but in Kyle Rhea the sediments are all fairly coarse and therefore re-suspension and smothering should be minimal. The installation, replacement and maintenance of undersea cables have the potential to cause direct loss of reef habitat as well as local deterioration of reef habitats and communities.

We note that the developers has considered the SNH advice in the Regulation 33 document for the Kyle Rhea SAC and the required appropriate assessment should also provide information for the ES.

Hydrography
The hydrodynamic regime is process driven and if altered will have an impact on those parameters that are influenced or controlled by the local hydrography e.g. suspended load or habitat alteration. However, the effect significance of the hydrodynamic regime is currently unknown for each phase of the development. Therefore to scope out those parameters that are influenced by the hydrodynamic regime may be a little premature particularly since the array design is unknown.

Potential Impacts
The scoping document seems to have identified the key impacts with regard to the development. The combination of video survey and benthic grabs is essential to adequately determine the dominant habitat types and species present in the development area as large epifauna are generally under sampled by grab and trawl sampling. Existing surveys or data may be acceptable if they can provide sufficient detail of the species and habitats present. An impact matrix would be a good idea to layout the potential impacts of each phase of the development. In the Environmental Statement (ES) it would be helpful for the applicant to include the following information in respect of each phase of windfarm development:

Construction
There should be an assessment of the extent and degree of damage likely to be expected on the intertidal mudflats during the construction of the turbine and the laying of the cable. The developer should provide evidence of the presence or absence of qualifying habitats or species in the vicinity of the marine turbines and cable routes especially *Modiolus modiolus* beds. Existing surveys or data may be acceptable if they can provide sufficient detail of the species and habitats present. Considerable disturbance to benthic habitats will occur from laying the inter-turbine cables by trench. Other less disturbing methods should be considered in the ES.

Details of any noise pollution due to construction and its possible effects seem sufficient for the environmental statement. Marine mammals in the area are likely to be affected by disturbance and noise, which have been identified as issues of concern in the scoping document; the proposed inclusion of species distribution and noise studies should be sufficient for an assessment to be made.

Operation
The proposed plans for the studies into the effects of noise during the operation phase should be sufficient to enable an assessment of impacts. The proposed plans for the studies into the effects of the presence of the turbines on birds should be sufficient to enable an assessment of impacts.

Biological Parameters
In table 4.3.3 where analysis of the use of the area by resident bird populations is detailed, flight height may not be relevant as the developer should focus on the birds spotted flying through the area close to the sea surface to assess interaction. Kyle Rhea is a relatively small area and can be well covered from the beach or boats and therefore aerial surveys for marine mammals and sea tagging may not be required. Baseline noise data is useful provided the developer repeats the surveys once the device is in situ for comparison. Potential limitations to fishing opportunity and effects on catches should be emphasised in section 4.6.

The proposed development will need to consider potential impacts on migratory fish including salmon, sea trout, lamprey and Sandeels during all phases of the project. The potential for offshore renewable projects to impact on migratory fish will vary depending on the design and location of the development in relation to migratory routes for adults and juveniles. Potential impacts may include physical or avoidance reactions at both the individual and population level and there may also be avoidance due to electromagnetic sensitivity at both adult and juvenile stages.

In cases where there is uncertainty over potential impacts it may be necessary for the developer to implement a monitoring strategy to assess the influence on salmonid fish populations. The expected levels of noise production must be identified within the ES and by using published literature, decide what impact, if any, this will have on fish movements through the area. Will it result in avoidance of the area? And, if so, what does this mean for migrating fish? Please refer to Appendix A.

Data collection
The document does not include information based on video footage and digital stills collected by Marine Scotland Science or the tidal stream atlas produced by the Admiralty for the North Coast of Ireland and West Coast of Scotland. In addition, SNH have a lot of seabed survey data for this area which MCT should take into account.

Section 6 takes an adaptive approach based on the collection of baseline data. Data should be made available to the consultees as it is collected to ensure the focus of the survey strategy remains on the main concerns.

The data collection outlined in section 3 is appropriate although additional information specific to the methods proposed such as area extent of bathymetric survey and ADCP deployment duration, etc would be useful. This work will be critical for further assessment and the refinement of an adaptive management approach.

In addition, Marine Scotland would be very reluctant to see physical, biological and human activities that may impact on the marine SAC scoped out until all data collected pertinent to the SAC have been interrogated and the layout of the array confirmed. In Appendix 1 the use of backscatter data to assist habitat identification is not mentioned.

Appendix A

Scoping comments in relation to information requirements on diadromous fish of freshwater fisheries interest

Offshore renewable developments have the potential to directly and indirectly impact diadromous fish of freshwater fisheries interest including Atlantic salmon, anadromous brown trout (sea trout) and European eel. These species use the coastal areas around Scotland for feeding and migration and are of high economic and / or conservation value. As such they should be considered during the EIA process. Developers should also note that offshore renewable projects have the potential to impact on fish populations at substantial distances from the development site.

In the case of Atlantic salmon information will be required to assess whether there is likely to be any significant effect of developments on rivers which are classified as Special Areas of Conservation (SAC's) for Atlantic salmon under the Habitats Directive. Where there is the potential for significant impact then sufficient information will be required to allow Marine Scotland to carry out an Appropriate Assessment.

In order that Marine Scotland is able to assess the potential impacts of marine renewable devices on diadromous fish and meet legislative requirements the developer should consider the site location (including proximity to sensitive areas), type of device, and the design of any array plus installation methodology. Specifically we request that developers provide information in the following areas:

1. Identify use of the proposed development area by diadromous fish (salmon, sea trout and eels)

a. Which species use the area? Is this for feeding or migration?
b. At what times of year are the areas used?
c. In the case of salmon and sea trout what is the origin / destination of fish using the area?

2. Identify the behaviour of fish in the area

a. What swimming depths do the fish utilise
b. Is there a tendency to swim on or offshore

3. Assess the potential impacts of deployed devices on diadromous fish during deployment, operation and decommissioning phases. Potential impacts could include:

a. Strike
b. Avoidance (including exclusion from particular rivers and subsequent impacts on local populations)
c. Disorientation that could potentially affect behaviour, susceptibility to predation or by- catch, or ability to locate normal feeding grounds or river of origin
d. Delayed migration

4. Consider the potential for cumulative impacts if there are multiple deployments in an area.

5. Assess 1-4 above to determine likely risk.

a. If there are insufficient data to determine use of the development area, these should be obtained
b. If there are insufficient data on the origin / destination of fish using the area then these should be obtained
c. Where it is not possible to obtain site specific data, the developer should make a convincing argument why this is the case and apply appropriate expert judgement based on published information.

6. If there is any remaining doubt as to the potential impacts of a particular development, then the developer should recommend a scientifically robust monitoring strategy to assess any impacts either on stocks as a whole, or on particular rivers as necessary.

Marine Scotland Science has just completed a review of migratory routes for Atlantic salmon, sea trout and eels relevant to Scotland, which should be available in June 2010. This will assist the developers in identifying what pre-existing information is available and what supplementary site specific data will be required.

Historic Scotland

Without prejudice and based on the information provided, we consider that it is unlikely that there will be significant adverse impacts on historic environment features within our statutory remit. However, should the proposed development be subject to any significant amendments or revisions, we would be happy to provide further information/advice. We would also need to see the ES to provide our final view on the proposals.

Potential impacts for consideration
We generally advise for such developments that the following potential issues are taken into account in the assessment of the likely impacts:

- on-shore effects
- off-shore effects (including potential effects outside the development site)

On-shore effects

An offshore development has the potential to impact on the setting of on-shore scheduled monuments, category A listed buildings and Inventory designed landscapes. In line with the Government's policy on the protection of the historic environment, any ES produced must assess the significance of these impacts. Our technical guidance note on setting provides information about this issue. This is available at: http://www.historic-scotland.gov.uk/managing-change-consultation-setting.pdf

As noted above, we consider that in this case it is unlikely that there will be significant adverse impacts on historic environment features within our statutory remit.

Off-shore effects

The assessment should also consider the significance of potential impacts that might be caused by elements of the development on any archaeological features, such as:

- direct impacts to marine historic assets within the proposed development site which could result from the construction, operation and decommissioning of the tidal array and associated operations, such as the laying of power and control cables etc.

- indirect impacts to historic assets on the seabed or at the coast edge within the proposed development area, and possibly beyond, which may be caused by alteration to tidal currents and sedimentary regimes and by changes to the chemical balance of the water and seabed sediments.

We note that an unscheduled wreck is located in the search area for the proposed scheme. We recommend that the impact on this, and the potential for discovery of unknown sites and artefacts located in the vicinity of the development area, be assessed within the ES with the appropriate involvement of archaeological expertise and in consultation with the Highland Council's Archaeological Service. Our Senior Inspector of Marine Archaeology, Philip Robertson (Tel: 0131 668 8843) would also be happy to provide information/advice if required.

General information and advice
The developer may wish to seek specific advice on the treatment of cultural heritage in the marine environment in The Joint Nautical Archaeology Policy Committee (JNAPC) *Code of Practice for Seabed Development*. This can be found at: http://www.thecrownestate.co.uk/jnapc_code_of_practice_2

Information on the location of all historic environment features can be obtained from PASTMAP at: http://www.pastmap.org.uk This is a free, interactive website produced jointly by ourselves and RCAHMS and allows anyone with internet access to display and search data on Scotland's historic environment.

National Policy for the Historic Environment can be found here:

- Scottish Planning Policy (SPP) at: Scottish Planning Policy
- The Scottish Historic Environment Policy (SHEP) sets out Scottish Ministers strategic policies for the historic environment and can be found at: http://www.historic-scotland.gov.uk/index/heritage/policy/shep.htm

Trunk Road Network Management Directorate (Transport Scotland)

The proposed development represents an intensification of the use of this site however the percentage increase in traffic on the trunk road is such that the proposed development is likely to cause minimal environmental impact on the trunk road network. On this basis TRNMD have no comment to make.

Annex 2.

DEVELOPER APPLICATION AND ENVIRONMENTAL STATEMENT CHECKLIST

	Enclosed
1. Developer cover letter and fee cheque	□
2. Copies of ES and associated OS maps	□
3. Copies of Non Technical Summary	□
4. Confidential Bird Annexes	□
5. Draft Adverts	□
6. E Data – CDs, PDFs and SHAPE files	□

Environmental Statement	Enclosed	ES Reference (Section & Page No.)
7. Development Description	□	
8. Planning Policies, Guidance and Agreements	□	
9. Economic Benefits	□	
10. Site Selection and Alternatives	□	
11. Baseline Assessment data – air emissions	□	
12. Design, Landscape and Visual Amenity	□	
13. Construction and Operations (outline methods)	□	
14. Archaeology	□	
15. Designated Sites	□	
16. Habitat Management	□	
17. Species, Plants and Animals	□	
18. Water Environment	□	
19. Sub-tidal benthic ecology	□	
20. Hydrology	□	
21. Waste	□	
22. Noise	□	
23. Traffic Management	□	
24. Navigation	□	
25. Cumulative Impacts	□	
26. Other Issues	□	

N.B. Developers are encouraged to use this checklist when progressing towards application stage and formulating their Environmental Statements. The checklist will also be used by officials when considering acceptance of formal applications. Developers should not publicise applications in the local or national press, until their application has been checked and accepted by officials.

Kyle Rhea Tidal Stream Array

Appendix 5.1

International®

Intersleek®900

Fluoropolymer foul release coating

Product Description

Intersleek®900 is a fluoropolymer foul release coating designed for all vessel types. Intersleek®900 is suitable for use at Maintenance & Repair or Newbuilding.

Features	Benefits
Ultra smooth, glossy surface with excellent foul release properties	Control of fuel efficiency and subsequent emissions (up to 9% saving*).
Biocides are not used to control fouling	Freedom from biocide restrictions Control of treatment and disposal costs for wash water/blasting abrasive at subsequent drydockings
Can be applied over existing antifouling systems in good condition (via Intersleek® Linkcoat)	Control of conversion costs to the Intersleek®900 system
Excellent long term fouling resistance	Flexibility in drydocking schedule
Flexible with good resistance to mechanical damage	Hull roughness control
Excellent colour retention	Vessel appearance
Good hold-up with reduced overspray	Remove the need for double application, reduces yard rework and clean-up

* Depending on in service conditions

Product Information

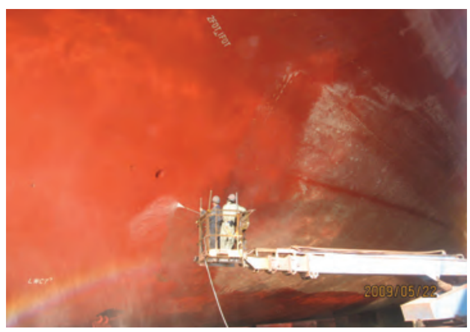
Colour	FXA970 White, FXA971 Grey, FXA972 Blue, FXA977 Red, FXA979 Black
Surface preparation	Intersleek®900 must be applied over Intersleek®737 or Intersleek®731
Volume solids	74% ±2% (ISO 3233:1998)
Typical film thickness	150 microns
Hard dry	20 hours @ 25ºC
Minimum application temperature	0ºC
Method of application	Airless Spray, Brush, Roller

For each of our products the relevant Product Data Sheet, Material Safety Data Sheet and package labelling comprise an integral information system about the product in question. Copies of our Product Data Sheets and Material Safety Data Sheets are available on request or from our website.

In Service Performance

'Ikuna' achieved a 10% increase in speed with no increase in fuel consumption, effectively meaning one free trip for every ten trips undertaken

Queen Mary II achieved operational speed using less power compared to previous SPC system

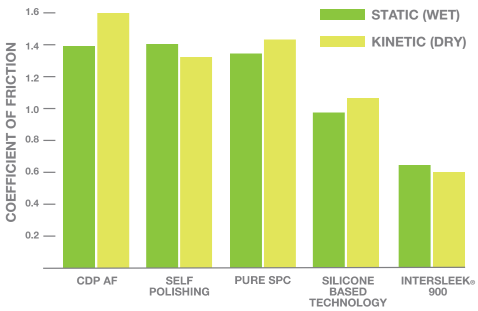


Corona Ace after 31 months in service. Excellent condition, 8% fuel saving reported

AkzoNobel

Intersleek®900

Drag Reduction



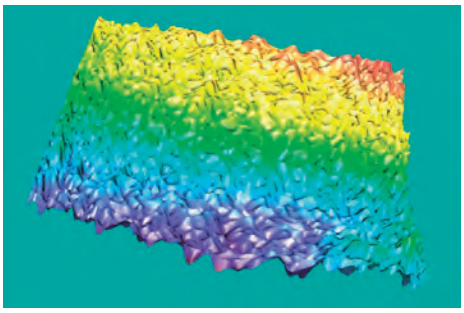
Intersleek®900 gives a significant reduction in coefficient of friction when compared to silicone based technology and more conventional Self Polishing Copolymer (SPC), Self Polishing Antifouling and Controlled Depletion Polymer (CDP) antifoulings. This relates to the amount of drag experienced by the vessel; lower coefficient of friction results in reduced energy requirements to propel the vessel.

Measured coefficient of friction

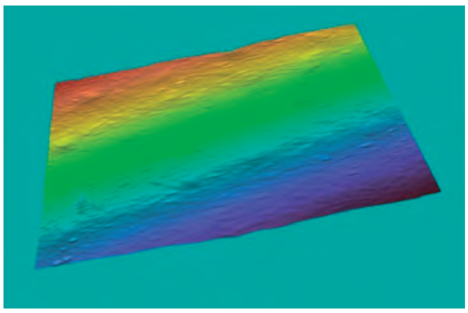
*Reference: ASTM D1894-06 'Static and Kinetic Coefficient of Friction'

Smoother Surface

Intersleek®900 - shows superior smoothness compared to Self Polishing Copolymer (SPC). Average Hull Roughness (AHR) is reduced.



Typical condition of SPC after 2 years in-service. AHR 160-180 microns



Typical condition of Intersleek®900. AHR around 70 microns

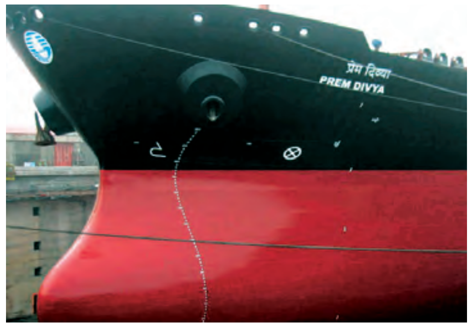
Improved Slime Resistance

Test patches of Intersleek®900 show significantly improved resistance to slime build-up compared to silicone foul release technology over long service intervals.

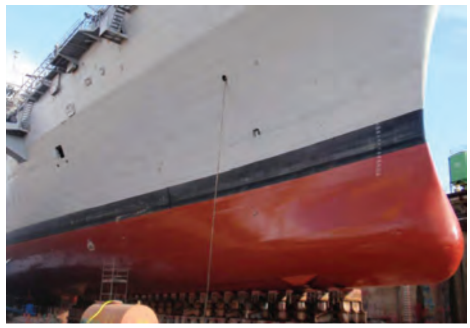
Intersleek 900 test patch on LNG after 30 months

Intersleek 900 test patch on VLCC after 59 months

In Service Performance

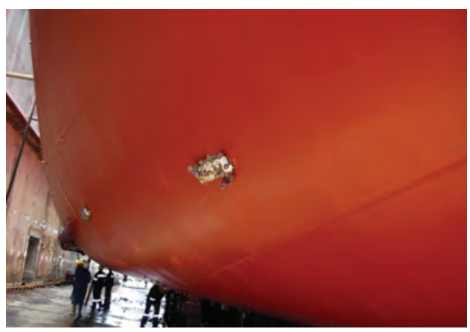


Mercator Lines report 9% fuel savings with subsequent greenhouse gas emission reductions



Principe de Asturias reported a speed increase of 3 knots after Intersleek®900 application

Seismic research vessel after 44 months in the Gulf of Mexico showing excellent antifouling performance



Research vessel after 31 months in service off West Africa and 5 weeks static in Walvis Bay, before washing

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August 2010

Kyle Rhea Tidal Stream Array

Appendix 6.1

APPENDIX 6.1: Public exhibition 11/07/11 Feedback

	Do you think that investing in sustainable energy projects such as tidal stream technology is a practical way to reduce carbon emissions abd increase energy security?	Would the presence of the proposed tidal stream array reduce your personal enjoyment and appreciation of the immediate area?	Do you think the development of potentially the world's first array of tidal stream energy devices would encourage or discourage people to visit the area?	Are you interested in opportunities to become involved in the project, either in helping provide services, or exploring possibilities for community investment?	Do you wish to receive email updates on the project's progress?	General Comments
Response	yes	yes	encouraged	yes	yes	(none provided)
	yes	yes	discouraged	yes	yes	Main reservations are impact on scenery and wildlife. Would wish that if it goes ahead there is substantive and long lasting benefit to the community
	yes	no	encouraged	yes	yes	Delighted excellent project, 100% support. Concerned re local jobs, community benefits, investment financally in Glenelg and Kyle Rhea. Good work, lot of good will and backing
	no	yes	discouraged	yes	yes	Glenelg is an are of outstanding natural beauty and a haven for wildlife. Is was this that fist brought us to glenelg some 24 yeargs ago. Ia am concerned of the impact of this scheme on the wildlife in the area and the potential knock-on effects for tourism in the area - which we ar heavily dependant on. also concerned that glenelg folk will not benefit from the electricity generated
	yes	no	neither	yes	yes	Concerned that the local community should benefit from the project
	yes	no	encouraged	yes	yes	Very favourable
	yes	no	neither	no	no	Good idea, would like local participation
	yes	yes	don't know	yes (ironically)	yes	(none provided)
	yes	yes	discouraged	no	yes	Interested
	yes	yes	encouraged	yes	yes	(none provided)
	yes	no	encouraged	no	yes	(none provided)
	yes	no	encouraged	yes	yes	Good luck
	yes	yes	don't know	yes	yes	I would like to be involved in any group discussions. I have 3 tourism business
	yes	no	don't know	yes	yes	Would like to see it go ahead
	yes	no	encouraged	yes	yes	Very interested in the possiblity of employment during build/maintenance of project
	no	yes	discouraged	yes	yes	An eye sore to the wonderful scenic views. Will it really create "local" jobs. I don't see the benefits if not an asset to the community
	yes	no	neither	yes	yes	(none provided)

Kyle Rhea Tidal Stream Array

Appendix 10.1

Kyle Rhea Tidal Stream Array Extended Phase 1 Habitat Survey Report

Marine Current Turbines

10th December 2012

Final Report

9V5627

Royal HaskoningDHV

Enhancing Society Together

HASKONING UK LTD.
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Document title	Kyle Rhea Extended Phase 1 Survey Report Technical Report To Inform the Kyle Rhea Tidal Array Development ES
Document short title	
Status	Final Report
Date	10th December 2012
Project name	Kyle Rhea Tidal Stream Array
Project number	9V5627
Client	Marine Current Turbines
Reference	9V5627/R/303922/Edin

Drafted by	David Tarrant / Jen Trendall	
Checked by	Jen Trendall	
Date/initials check	JT…………………	12/12/2012…….
Approved by	Frank Fortune	
Date/initials approval	FF…………………	12/12/2012…….

CONTENTS

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1 INTRODUCTION

Marine Current Turbines Ltd (MCT), a wholly owned subsidiary of Siemens, intends to develop a demonstration tidal energy conversion array in Kyle Rhea located in the north-west of Scotland. The kyle is a narrow body of tidal water that separates mainland Scotland from the Isle of Skye between the villages of Glenelg and Kylerhea. Royal HaskoningDHV have been commissioned by MCT to assist in applications for consent of the project and as part of this support are conducting an Environmental Impact Assessment (EIA) for the Project. This document reports on the Extended Phase 1 Habitat survey conducted by Royal Haskoning which will be used to inform the EIA.

All place names within this document are taken from Ordnance Survey maps, either 1:25000 scale or 1:10,000 as these maps are used in the figures presented in this report.

1.1 The Project

The location for the proposed array is north of the seasonal Skye ferry (the MV Glenachulish) crossing from Glenelg to the village of Kylerhea. The array will be deployed in water depths of approximately 30 to 35 metres (m) in the western side of the tidal narrows and will consist of four SeaGen devices with a combined capacity of up to 8MW.

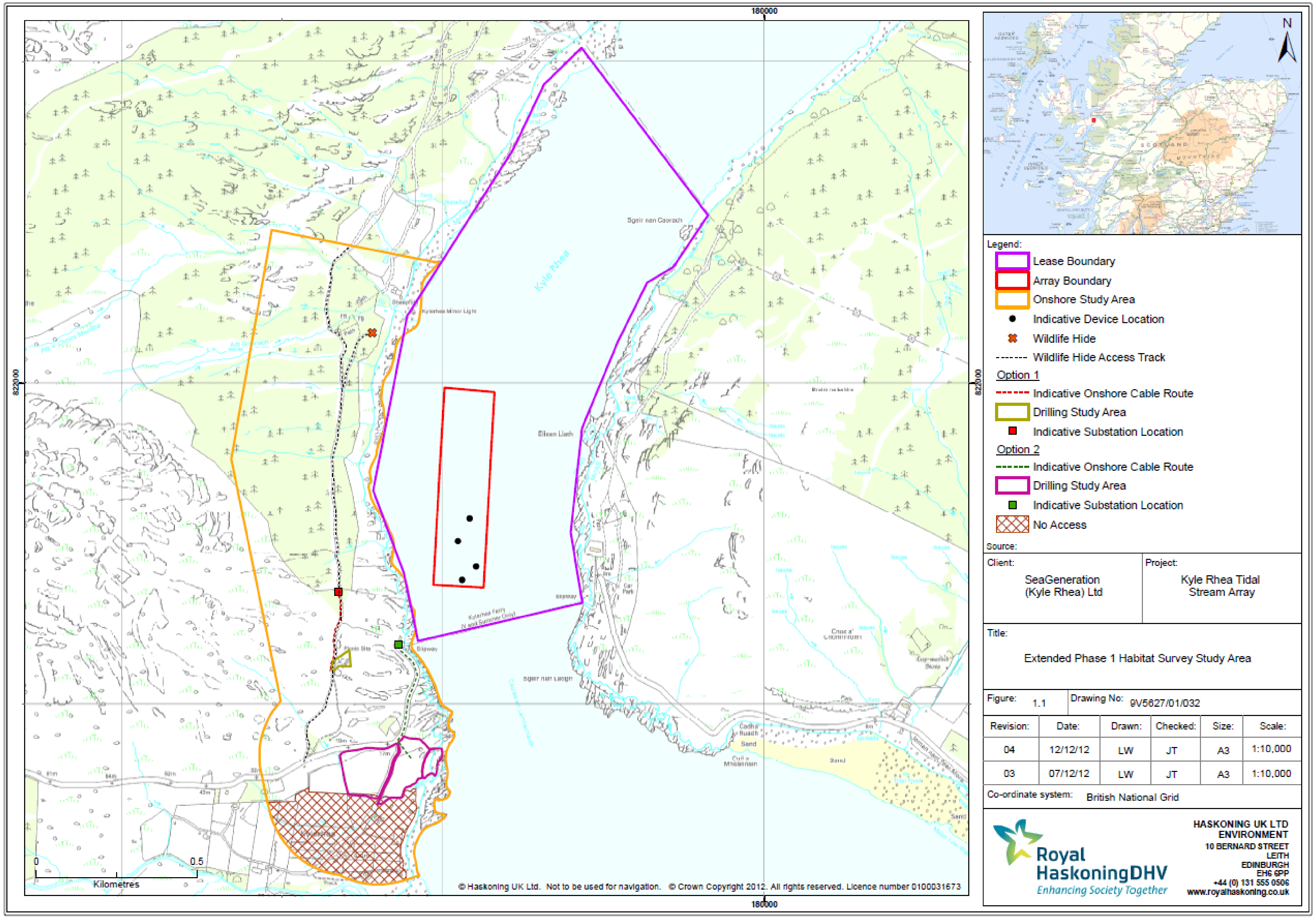
Currently the preferred option is to bring the export cables onto Skye using a technique called horizontal directional drilling (HDD). This will involve drilling a borehole that extends from an inland location, through the bedrock to break out underwater in the vicinity of the tidal turbine structures. To date, two options are being considered to locate the potential drilling area and substation. These are called Option 1 and Option 2. The locations of the potential drilling area and substation for each option can be viewed in **Figure 1.1**. These locations, plus a buffer of 250m together form the total area surveyed for the Project. Hereafter, this area shall be referred to as the study area.

1.2 Objectives

The objectives of the survey were to:

- Identify the habitat of each parcel of land within the onshore study area (**Figure 1.1**);
- Digitally map all habitats as per standard Phase 1 habitat symbols and colours (JNCC, 2010); and
- Provide target notes of each habitat, including characterising, rare, protected and non-native species encountered.

This survey was completed in conjunction with an intertidal survey of coastal areas adjacent to the development site (Royal Haskoning, 2012a). A dedicated otter survey (Royal Haskoning 2012b) has also been produced, which, due to the sensitive nature of data regarding the location of protected species, is confidential.



Legend:
Lease Boundary
Array Boundary
Onshore Study Area
Indicative Device Location
Wildlife Hide
Wildlife Hide Access Track
Option 1
Indicative Onshore Cable Route
Drilling Study Area
Indicative Substation Location
Option 2
Indicative Onshore Cable Route
Drilling Study Area
Indicative Substation Location
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Source:
Client: SeaGeneration (Kyle Rhea) Ltd
Project: Kyle Rhea Tidal Stream Array
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Figure: 1.1
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Revision: 03 Date: 07/12/12 Drawn: LW Checked: JT Size: A3 Scale: 1:10,000
Co-ordinate system: British National Grid
HASKONING UK LTD ENVIRONMENT
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1.3 Conditions of survey

The survey required two separate visits to assess Option 1 and Option 2. The surveys were completed by two experienced Royal HaskoningDHV ecologists on both occasions. The first survey, for Option 1, was undertaken during the 7th and 8th of May 2012. The second survey, for Option 2, was undertaken on the 27th November 2012. Throughout the first survey, the weather was variable, ranging from moderate north westerly winds with short periods of heavy rain during the afternoon of the 7th, to calm sunny periods on the 8th. During the second survey, conditions were predominantly clear, with some patches of cloud and short, light showers and a gentle breeze. One both occasions the conditions did not inhibit the surveyors.

Within the coniferous plantation north of the slipway, relatively uniform habitat was noted to be present. The survey paid particular attention to the watercourses, wet habitats and forest breaks through the plantation where greater species diversity would be present, and the area in the vicinity of the access track, substation and drilling rig, where disturbance was anticipated.

1.4 Limitations

On the second survey access was unavailable between the track towards the A87 and the picnic site. Access was also unavailable for parts of Kylerhea village. Areas where access was not permitted are shown in **Figure 1.1**. Although these areas were inaccessible by foot, the habitats could be viewed from the roadside sufficiently to characterise them.

The optimal time to undertake Phase 1 Habitat Surveys is from April to September. The second survey was undertaken in November, which is considered to be a sub-optimal. Therefore, species identification of plants in particular, was generally more difficult, as many plants had ‘gone-over’, i.e. were no longer in flower. However, given that the first survey was undertaken within the optimal period, the species recorded for this survey is more comprehensive, and is anticipated to be representative of the study area.

2 METHODOLOGY

2.1 Phase 1

Standard methods were used as described in Joint Nature Conservation Committee (JNCC) Phase 1 Handbook for Habitat Survey (2010).

Each parcel of land in the survey area was systematically visited by the surveyors and the vegetation was mapped on to an Ordnance Survey map (at a scale of 1:10,000) by hand and then digitised using ArcGIS 10.1. Habitats were mapped as far as Mean High Water Springs (MHWS). A separate survey was undertaken to assess the intertidal zone and results presented in an accompanying report (Kyle Rhea Tidal Stream Array Intertidal Survey Report, Royal HaskoningDHV 2012). Global Positioning System (GPS) waypoints were recorded at target note positions, and digital photographs were taken to visually illustrate the study area.

The final habitat map was electronically colour coded with standard symbols and colours (JNCC, 2010) to illustrate the dominant habitats, and annotated with target notes detailing the species and communities found in each parcel. As a guide to the importance of habitats, the standard colour coding is arranged so that the brighter or more intricate the colour, the greater the value of the habitat. Species were identified using standard references books, including Fields Studies Council (1998), Rose (1991) and Fitter (1995).

Species not in flower were identified by other plant characteristics such as leaf form and arrangement; however, there is the potential for some perennial plants, (particularly summer and autumn flowering plants), not to have germinated at the time of survey.

To assist with accurate mapping of the habitats, aerial imagery was purchased by MCT and cross referenced with the hand-drawn maps from the field and GPS waypoints. A National Vegetation Classification (NVC) Survey of the Kinloch Hills, which includes the onshore study area, was previously commissioned by the Forestry Commission and the resultant report (Averis & James, 2002) was used as a reference point when completing the maps and current report.

2.2 European protected species (EPS)

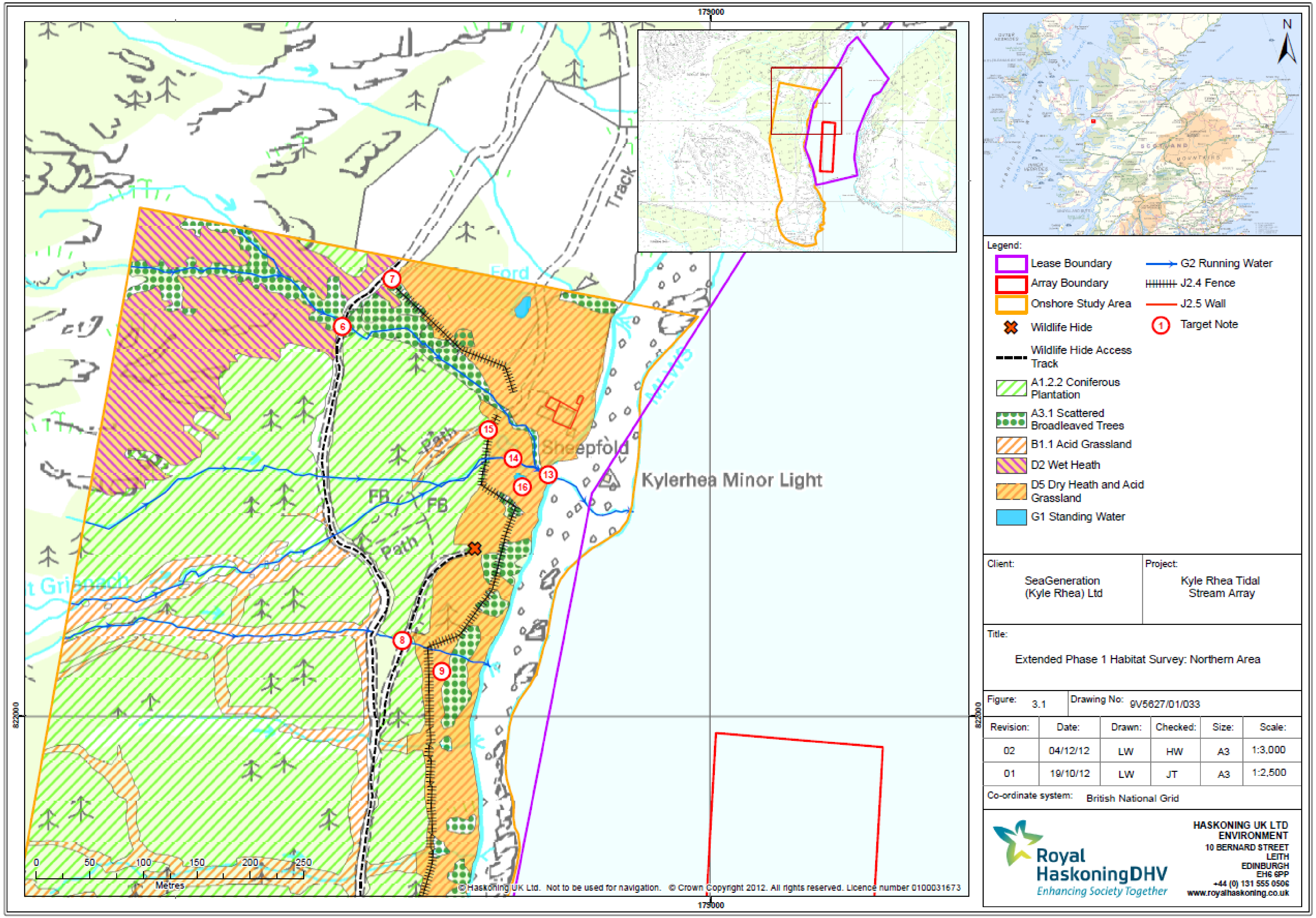
A dedicated otter survey was completed during the same period as the Extended Phase 1 survey (Royal HaskoningDHV, 2012b); however, the findings of that report are confidential and will only be made available to regulators and their conservation advisors.

A detailed search of the study area for evidence of any other EPS was also conducted as part of the Phase 1 (see above) and intertidal survey (Royal HaskoningDHV, 2012a).

3 RESULTS

3.1 Main findings of Phase 1 Survey

Maps identifying the habitat of each parcel of land are presented in **Figures 3.1** to **3.3**. An accompanying description is also provided in the form of an extended version of the field target notes. A full list of all target notes as recorded by the surveyors when in the field can be found in *Appendix A: Target notes*. This appendix also includes information about each target note (TN) including the position and a list of the photographs taken at each location.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Array Boundary
Onshore Study Area
Wildlife Hide
Wildlife Hide Access Track
A1.2.2 Coniferous Plantation
A3.1 Scattered Broadleaved Trees
B1.1 Acid Grassland
D2 Wet Heath
D5 Dry Heath and Acid Grassland
G1 Standing Water
G2 Running Water
J2.4 Fence
J2.5 Wall
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Project:
Kyle Rhea Tidal Stream Array
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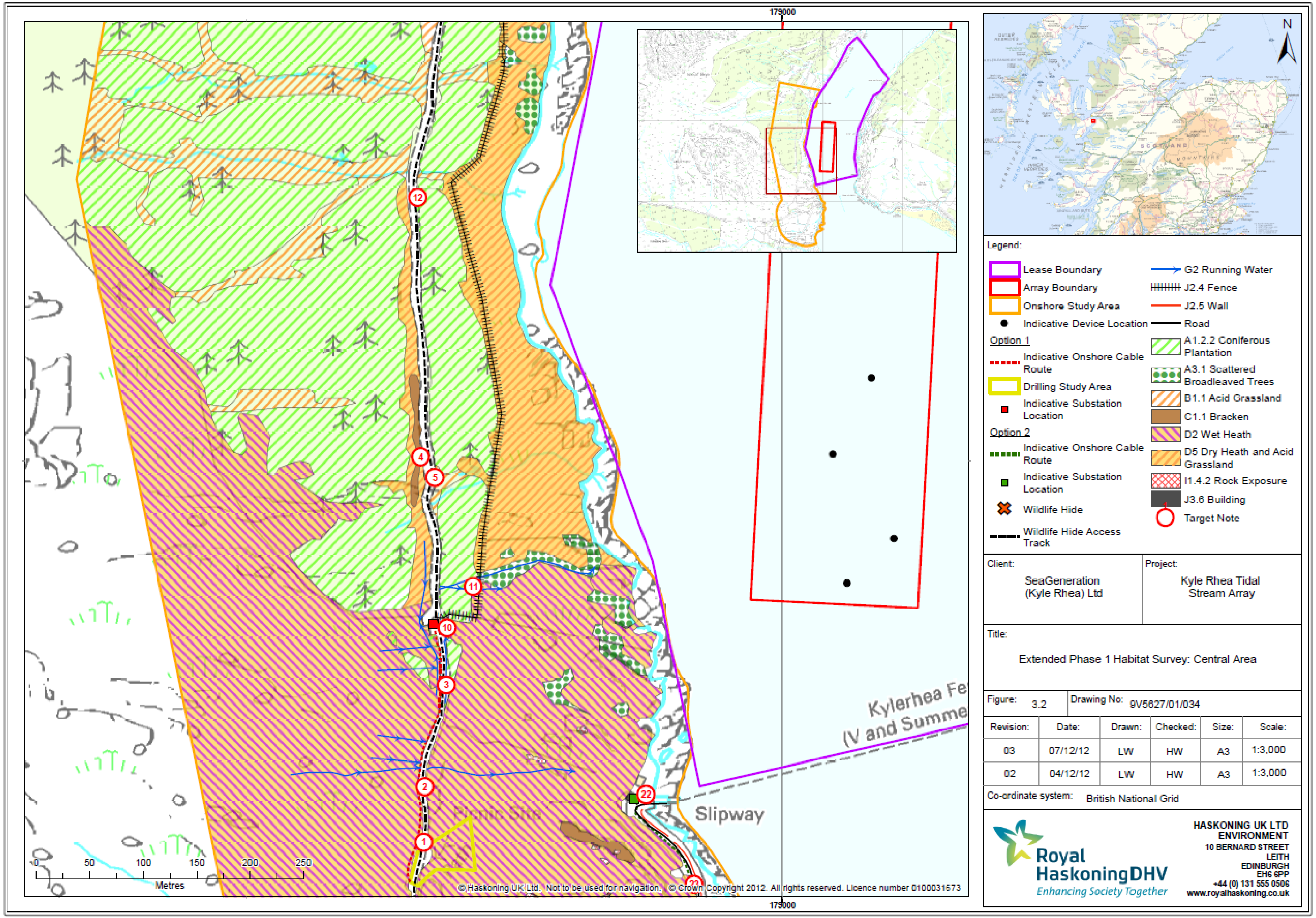

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Drilling Study Area
Indicative Substation Location
Option 2
Indicative Onshore Cable Route
Indicative Substation Location
Wildlife Hide
Wildlife Hide Access Track
G2 Running Water
J2.4 Fence
J2.5 Wall
Road
A1.2.2 Coniferous Plantation
A3.1 Scattered Broadleaved Trees
B1.1 Acid Grassland
C1.1 Bracken
D2 Wet Heath
D5 Dry Heath and Acid Grassland
I1.4.2 Rock Exposure
J3.6 Building
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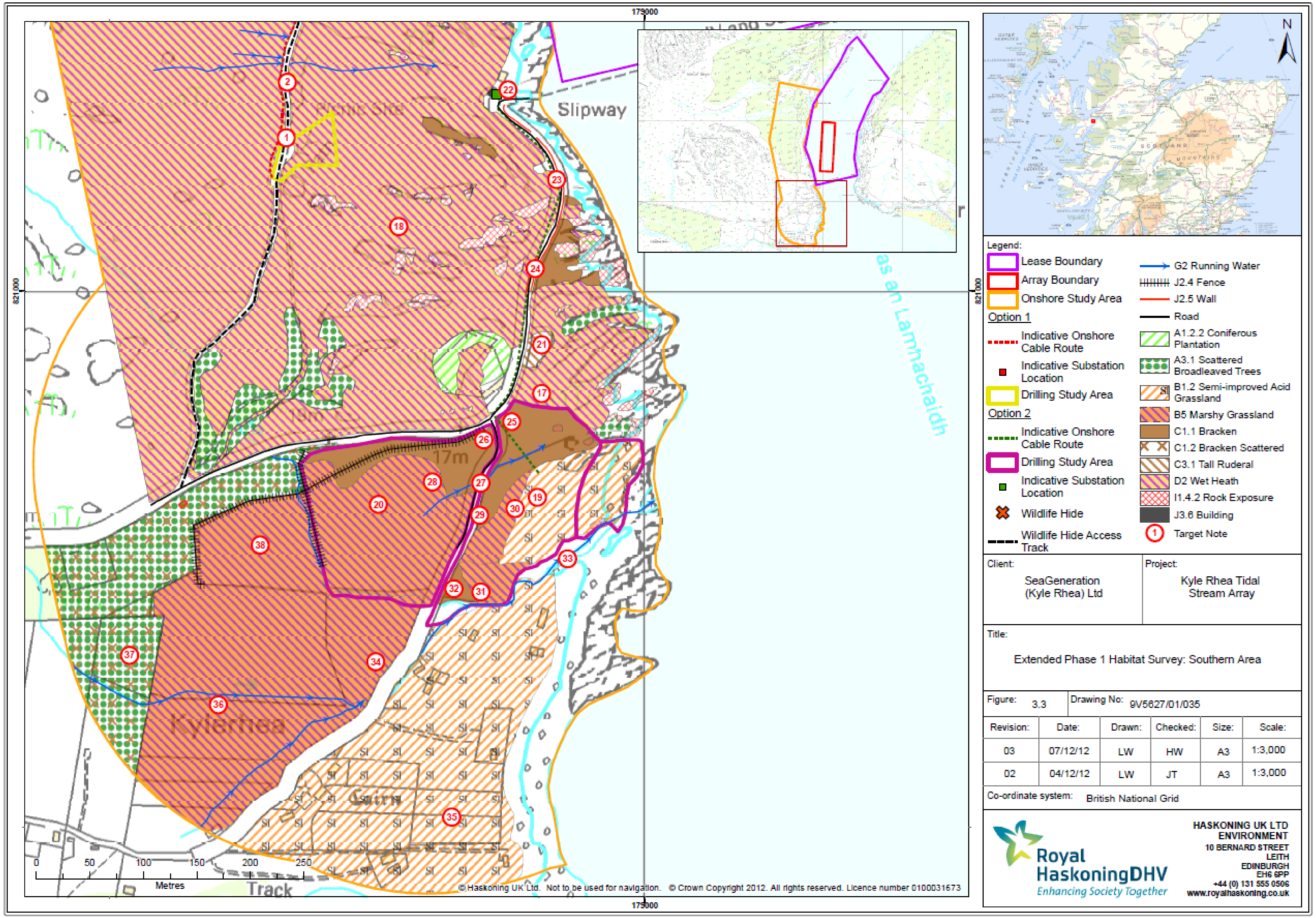
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Indicative Onshore Cable Route
Drilling Study Area
Indicative Substation Location
Wildlife Hide
Wildlife Hide Access Track
G2 Running Water
J2.4 Fence
J2.5 Wall
Road
A1.2.2 Coniferous Plantation
A3.1 Scattered Broadleaved Trees
B1.2 Semi-improved Acid Grassland
B5 Marshy Grassland
C1.1 Bracken
C1.2 Bracken Scattered
C3.1 Tall Ruderal
D2 Wet Heath
I1.4.2 Rock Exposure
J3.6 Building
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General study area

A summary of the terrestrial ecology of the proposed study areas is described below:

The study area was on a very steep hillside sloping from Beinn Bhuidhe in the west, down to the western shore of Kyle Rhea. A number of small burns flow down the slope, and at the time of survey water levels in these burns were low. An access track runs north – south approximately through the middle of the study area, and provides access for the public through Forestry Commission land to a wildlife hide. A small car park and public toilets are located along this track. The track is serviced by benches and information boards located at regular intervals along its length. Coniferous plantation was present across much of the northern part of the study area, with wet heath and scattered deciduous trees also present.

The track continues down to a junction with a small road which runs east to west from the slipway to the A87. There is a second junction along this road towards the slipway. Here another small track runs south into the main part of Kylerhea village. This area is much lower in topography, and is characterised by marsh, bracken, young deciduous trees and small patches of heath. This habitat was confined to fenced areas that are used for agricultural purposes.

Coniferous plantation

Much of the study area (terrestrial habitats north of the road to the Skye Ferry) is owned by the forestry commission and currently contains a plantation that is mostly pine species *Pinus sp*. but also includes spruces *Picea sp*. and larch *Larix* with a number of different deciduous species such as silver birch *Betula pendula*, goat willow *Salix caprea* and rowan *Sorbus acuparia* growing on the periphery of the main plantation, lining the existing access track to the wildlife hide and lining small burns flowing down towards to the coastline.

The pines are tightly packed and planted on a relatively steep hillside, which made access difficult; however, from a number of vantage points it was observed that no real understory was present between the pines. This was attributed to the lack of light penetrating down to ground level.

Dry heath, with areas of bracken and scattered deciduous trees

Much of the habitat between the plantation and the coastline is characterised as due to the steep nature of the terrain this habitat was well drained and a number of small burns crossed it; however several species moss were present including sphagnums which define the habitat as wet heath. Many of the burns were found to have dried up, which was surprising as the survey followed a period of heavy rain.

Marshy grasslands

In the north of study area evidence was found that the water courses were being managed, particularly the Allt Grainach burn which had been diverted to direct water away from a recently dried out pond to a newer pond.

Across parts of this habitat clumps of deciduous trees were clustered loosely together and these are displayed on the habitat map. Beneath the trees grasses and wild flowers were common amongst an acid grass land habitat.

This habitat also occurred in narrow strip along either side of the track which was occasionally too small to map. It was more evident on the western side of the track as shown on **Figures 3.1** to **3.3**.

The dominant habitat south of the road, near Kyle Rhea, was marshy grassland. Dominant plants included purple moor grass, and *Juncus* species. Scattered, young birch trees were present occasionally, and small patches of heath were interspersed.

Wet heath with scattered trees.

The remainder of the study area north of the road was a wet heathland habitat that was scattered with young rowan, silver birch and willow trees, however the steep slopes of the hillside provided good drainage. Heathers (mainly bell *Erica cinerea* and ling *Calluna vulgaris* with *Erica Tetrilix* also present) dominated this habitat but many other species were also present including purple moor grass *Molinia caerulea* and bog asphodel *Narthecium ossifragum*. Areas of bracken were also present across the wet heath area.

In small areas grasses were prevalent and a heathland grassland mosaic did occur, particularly in the northern part of the study area, however such areas were too small (under 50m^2) to map and therefore are not shown in **Figures 3.1** to **3.3**.

Acid grassland.

South of the road and adjacent to the shore in the east of the study area, acid grassland was dominant. Bent *Agrostis sp.* was abundant along with several moss species.

3.2 Phase 1 Target Notes

Target Note one (TN1)

A small car park exists just to the south of TN1 (**Figure 3.3**). The car park consists of an area of hard standing from which a track runs north (Plate 1) providing access to toilets and a newly refurbished wildlife hide. To the east of the track at this point the ground slopes steeply down towards the sea (Plate 2) and to the west the ground slopes upward towards the summit of Beinn Bhuidhe. Young silver birch, goat willow and rowan tress were scattered, along either side of the track. The ground flora consisted of bell heather *Erica cinerea* and ling heather *Calluna vulgaris* with cross leaf heather *Erica tetrilix*, starry moss *Polytrichum commune*, common tormentil *Potentilla erecta*, *Cladonia impexa*, bramble *Rubus fructicosa*, hard fern *Blechnum spicant*, sphagnum moss, marsh gentian *Gentiana pneumonanthe*, lousewort *Pedicularis sylvatica*, purple moor grass *Molina caerulea* and bog asphodel *Narthecium ossifragum*. Sapling conifer trees were also present which had potentially propagated from the nearby plantation.

Plate 1: South east from TN 1 towards the car park

Plate 2: looking north east across the track towards Kyle Rhea

Target note 2

A very small drain which is not marked on the OS survey 1:10,000 map was identified on the south side of the track. Bilberry bushes *Vaccinium myrtillus* and bracken *Pteridium aquilinum* were present in small patches, and soft rush *Juncus effusus* was found growing in and around the drain. Foxglove *Digitalis purpurea* and bluebell *Hyacinthoides non-scripta* lined the drain banks and small holly *Ilex aquifolium* trees were also present. Several varieties of broom were also present *Cytisus scoparius* and *Cytisus spp*. These were potentially garden escapees or had been planted in the area.

Target note 3

This target note was recorded at the southern end of the conifer plantation where small fragments of plantation are present close to the south of the main plantation (Figure 3.3). At this point the plantation is composed of mixed pine species mainly scots pine *Pinus sylvestris* (Plate 3). A drain is present that runs along the west side of the track. Small isolated *Rhododendron ponticum* plants were identified on the east side of the track at this target note.

Plate 3: Scots pine at the southern end of the plantation

Plate 4: Patch of dead bracken above track

Target note 4

A narrow strip of bracken was present between the western edge of the track and the plantation (Plate 4). The patch is about 200m long and between 2 and 20m wide. Eyebrights *Euphrasia spp.*, violets *Viola spp*., wood sorrel *Oxalis acetosella* and wood anemone *Anemone nemorosa* were identified as present here on the eastern side of the track.

Target note 5

At this TN there is an area to the east of track where felling of the plantation trees has taken place (Plate 5), although this was not thought to have occurred recently. In the cleared area soft rush, primrose *Primula vulgaris*, foxgloves, common tormentil and bluebells were all present. The track is shown in Plate 6.

Plate 5: Area of felled plantation

Plate 6: Access Track to wildlife hide

Target note 6

At this point in the track a bridge spans a small gorge which is approximately 15m deep. A small burn, Allt a'Choire Bhidhe, has carved the deep cut gorge which has high sheer rock sides waterfalls and pools (Plates 7 & 8). The riparian habitat contains birch, rowan, wild garlic *Allium ursinum*, bracken, ivy *Hedera helix*, wood sorrel, moss, holly, larch *Larix spp.*, bluebells, common broom *Cytisus scoparius* and hard fern.

Dog Lichen *Peltigera spp*. was identified on the east side of the track just south of the bridge (Plate 8).

Pine marten *Martes martes* scat was present to next to the track to the south of this target note and other pine marten scat was also present at other locations along the track

Bracken is present on the top of the northern bank of the burn in a break between the trees. Small birch and rowan are present within the bracken.

Plate 7: view down from bridge into gorge

Plate 8: view down from bridge into gorge

Target note 7

Near to the northern edge of the study area *Juncus sp*. were present on heathland which also exhibited scattered trees and bracken (Plate 9). At the northern end of the plantation a single red deer *Cervus elaphus* was present and directly down the hill from this point an otter *Lutra lutra* was identified in the water very close to the shore line.

Target note 8

The track forks just to the south of this TN with the eastern fork providing access to the wildlife hide. Here bracken, holy, rowan, larch, primrose, lesser celandine *Ranunculus ficaria*, wood sorrel, bluebell, bramble, foxglove, starry moss are present at a location where a small burn passes under the track by a culvert (Plate 10).

Plate 9: view down towards the kyle from the northern Edge of the study area

Plate 10: view east from track, at a point where a small burn passes under the track.

General observation

Viewed from the otter hide at least 35 seals hauled out on rock islets north of the hide, up to 10 more seals were in the water, the majority of which were thought to be grey seals *Halichoerus grypus* however harbour seals *Phoca vitulina* were also thought to be present. One hooded crow *Corvus cornix* was present on the shore.

Target note 9

A patch of dense young silver birch with a bracken understory was present on lower hill approximately 50m above the shore (Plate11). Large selfheal *Prunella grandiflora* and ground ivy *Glechoma hederacea* were present. Spear thistle *Cirsium vulgare*, foxglove, bramble, scattered rowan, Yorkshire fog *Holcus lanatus* and other grasses, wood sorrel and lesser celandine were found under the trees or around the edges copse. In parts where the tress were densely packed the bracken was absent and on other parts of the hillside where the bracken was absent an unidentified pink orchid was found (Plate 12).

Plate 11: birch with a bracken understory just to the east of TN9

Plate 12: Unidentified orchid

Target note 10

As a potential drilling site TN10 represents a more detailed look at the species and habitats present as these have greater potential to be impacted by the development. A wooden toilet block and shelter have been recently constructed here on an area of hard standing (Plate 13, 14) that is approximately diamond shape and is 30m long by 25 wide, with steeply sloping ground to the east and west. It was noted that there was very limited bat potential at this location as there are no old buildings and no mature trees which could be used as bat roosts. A clear mammal run was present on the eastern side of the hard standing next to a bench. A further run was present leaving the eastern side of the approximately 30m north along the track from TN10 at a point where a small burn passes under the track.

Plate 13: Toilets and sheltered area

Plate 14: View Southeast from the area of hard standing

Target note 11

A *rhododendron ponticum* bush was found growing across the burn. The bush was approximately 4m high by 6m wide.

Target note 12

This TN is located at a designated view point on the access track to the wildlife hide. A clearing exists between patches of mixed coniferous plantations providing a view across the kyle. Bracken, bluebells, small rowan and birch were present in the clearing. A vole was identified transiting the grassy ramp below the view point.

When accessing land to the south of this TN a heronry with approximately six nests was observed located on the eastern edge of the plantation approximately 50m to the northeast of TN12.

Target note 13

At the mouth of the Allt Grianach burn: yellow flag iris *Iris pseudacorus,* wild garlic *Allium ursinum,* goat willow *Salix caprea* lesser celandine, ling, primrose, silver birch, creeping buttercup *Ranunculus repens,* violets, orchids (indet), tormentil, thistle and dog rose *Rosa canina* were recorded, all within close proximity of the burn.

Target note 14

A small pond which was mostly dry was present at this TN. Small patches of stunted rushes were evident growing out of the remaining water (Plate 15), broom, tormentil and creeping buttercup were also present around the edges (Plate 16).

Plate 15 centre of dry pond

Plate 16 Bank of mostly dry pond

Target note 15

To the west of the dry pond evidence was found that the water courses were being managed, diverting water away from the pond at TN14 and into the pond at TN16 (see below). On the margin of the woodland west of the dried up pond, bluebell soft rush and cuckooflower were all present.

Target note 16

About 25m to the south of the dried up pond (TN14) a newly created pond was found. The water contained large amounts of moss and stringy vegetation (Plate 17), which was presumed to be dead matter possibly due to the fact that the pond had recently been filled. Surrounding the pond were lesser celandine, yellow flag iris and small clumps of bracken and wild garlic.

A clear otter run into the pond with spraint (see OT 14 and Plate 18 below) was also present.

Plate 17 recently filled pond

Plate 18 Clear otter run with spraint

Target note 17

At the southern end of the study area to the east of the ferry access road (**Figure 3.1**) Outcrops of bed rock with heath habitat on top were recorded (Plate 19). Patches of bracken were present between the exposed patches of rock but heather species dominated. Ling heather, bramble, tormentil, mosses, bluebell, foxglove and scattered trees (willows and rowan) were all present here.

Target note 18

A large area situated between the wildlife hide access track and the ferry access road was identified as wet heathland. Although the area was reasonably well drained the presence of a number of moss species meant that it was falls into the wet heathland phase 1 category. Outcrops of rock, were present throughout this habitat (**Figure 3.3**) with other species including bilberry rowan, willow, scattered soft rush, bracken, starry and sphagnum moss (Plate 20).

Plate 19: Outcrops of bed rock with heath habitat

Plate 20: Outcrops of rock with heath habitat west of the ferry access road

Target note 19

The location of TN19 was not accessed as permission had not been granted and therefore the habitat was identified from the road west (**Figure 3.3**) of the TN. Therefore no individual species were formally identified. The area was however recorded as marshy grassland with elements of improved grassland existing within a matrix (Plate 21).

Target note 20

As with TN19 (above) this area was not accessed, but was identified as marshy grassland with soft rush, wavy hair grass, hawthorn, rowan, birch, bracken and heath plants all identified from the road to the north (Plate 22 and **Figure 3.3**).

Plate 21: Outcrops of bed rock with heath habitat

Plate 22: Outcrops of rock with heath habitat west of the ferry access road

Target note 21

A small patch of tall ruderal habitat was identified growing in a hollow next to the ferry access road. This contained bracken, bramble, docks, goat willow, bluebell.

Target note 22

A small, green shed was located adjacent to slipway. The building was made of corrugated steel. The shed was inaccessible from the inside and so the building was inspected externally. The north side of building was surrounded by damp conditions and vegetation associated with such conditions. A stone wall was adjacent to the east side of the shed with many nooks and crannies. Vegetation was comprised of bracken, dog-rose, gorse, rowan, *Juncus sp*., bramble. The shed was within approximately 20 metres of another building, appearing to be residential.

Target Note 23 & 24

Small road south from green building. Here a stone wall was present on the eastern side of road, and beyond the wall the land slopes down towards the kyle. The wall had various nooks and crannies and was colonised by frequent maidenhair spleenwort *Asplenium trichomanes*. The western side of the road was constrained by a steep, sheer rock face. The rock face was damp and had been colonised by numerous mosses, bracken, hard fern, ling, fescue sp., bent sp., *Juncus* sp., and bramble. Further south the road is constrained by stone walls and steep slopes either side going down towards the kyle.

Target Note 25, 26 & 32

Bracken was dominant at the top of the slopes to the south of the road. Bracken was also present interspersed with heath in the south-west of the study area.

Target Note 27
A small drain was present in the field to the west of the track which runs down into Kylerhea. The drain appeared to be culverted underneath the track and flowed towards the shore on the eastern side of the track. The substrate of the drain could not be seen amongst the dense vegetation that grew within in it; the dominant vegetation being *Juncus* species. The drain was very shallow, appearing less than 5cm deep.

Target Note 28, 31, 34, 36,& 38
Marshy grassland was characteristic of the southern part of the study area, and was the dominant habitat. Species recorded here included frequent compact rush and sharp or jointed rush, soft rush, purple moor grass, occasional goat willow, birch sp., common alder, creeping buttercup. These areas commonly had occasional patches of heath including ling, bell heather, *Cladonia sp*., *Sphagnum sp.* and other occasional moss species.

Target Note 29
This area of marshy grassland had a slightly different species composition from other marshy grassland as described above. Species recorded here included frequent soft rush, Yorkshire fog and occasional devil's-bit scabious, ling and tormentil.

Target Note 30
Semi-improved acid grassland was located in flat area at the bottom of a gentle slope towards a track in the west, and the shore in the east. Species included frequent to abundant bent sp., occasional purple moor grass, broad-leaved dock, ribwort plantain, *Poa annua*, yarrow *Achillea millefolium*, common sorrel *Rumex acetosa*, creeping buttercup and several mosses.

Target Note 33
An outcrop with exposed bedrock was present south of the area of marshy grassland (TN 31). The outcrop was vegetated with ling, purple moor grass, soft rush and numerous moss species.

Target Note 35
This area appears to be used for crofting. The habitat is poor semi-improved acid grassland that had been drained, and grazed. A horse and llamas were observed in the field.

4 CONCLUSIONS

4.1 Habitats

The study area contains three dominant habitats, the marshy grasslands in the south and the conifer plantation and wet heath in the central and northern areas. The presence of the plantation and active forestry illustrates that this is a modified and changing landscape. The two main running water bodies, the Allt Grianach and the Allt a'Choire Bhidhe cross the study area in the north of the site and several smaller drains, many of which were dry at the time of survey, flow across the site in a west to east direction. The topography of the study area is characterised by the steep slopes of Beinn Bhuidhe with areas of flatter ground in the most southern parts of the study area.

No particular habitats of conservation interest were present within the study area however the running water bodies appear to provide corridors for mobile terrestrial species and the standing water bodies in the north of the site are surrounded by an acid grassland/wet heathland complex that supports a wide variety of flowering plants and a number of different micro habitats in a small area. Acid grassland was also present in the south of the study area.

The forestry plantation appears to provide good habitat for pine marten and herons also nest on its eastern edge.

4.2 Protected habitats

4.2.1 European Protected Sites

Part of the terrestrial section of the study area overlaps the Kinloch and Kyleakin Hills Special Area of Conservation (SAC) and the Kinloch and Kyleakin Hills (Monadh Chaol Acainn is Cheann Loch) Site of Special Scientific Interest (SSSI). The features of these sites are presented in Table 4.1 and their locations in relation to the onshore study area are displayed in Figure 4.1. In addition the intertidal and subtidal parts of the study area are within the Lochs Duich, Long and Alsh Reefs SAC, and this designated site is discussed in Royal HaskoningDHV (2012a).

Table 4.1: Features of the protected sites that overlap with the study area.

Designated Site	Features	Location
Kinloch & Kyleakin Hills SSSI	• Alpine heath • Blanket bog • Bryophytes • Lichen • Otter • Subalpine dry heath • Subalpine wet heath* • Torridonian geology • Upland oak woodland	On the Skye, including the north west shore of Kyle Rhea. Approximately 24.55 ha of SSSI is within the onshore study area
Kinloch & Kyleakin Hills SAC	• Old sessile oak woods with Ilex and Blechnum in the British Isles (primary reason for site selection) • Northern Atlantic wet heaths with *Erica tetralix* • European dry heaths • Alpine and Boreal heaths* • Otter*	On the Isle of Skye, including the north westshore of Kyle Rhea. Approximately 24.55 ha of SSSI is within the onshore study area

*Indicates features that were identified as present during the survey

SACs (Also known as Natura 2000 sites) are areas which have been given special protection under the European Union's Habitats Directive. They provide increased protection to a variety of wild animals, plants and habitats and are a vital part of global efforts to conserve the world's biodiversity.

The Conservation (Natural Habitats, &c.) Regulations 1994 as amended, (the "Habitats Regulations") apply to European Sites. The requirements are summarised in Circular 6/1995 as amended June 2000 and include, at paragraph 12.

"The Regulations (48) require that, where an authority concludes that a development proposal unconnected with the nature conservation management of a Natura 2000 site is likely to have a significant effect on that site, it must undertake an appropriate assessment of the implications for the conservation interests for which the area has been designated."

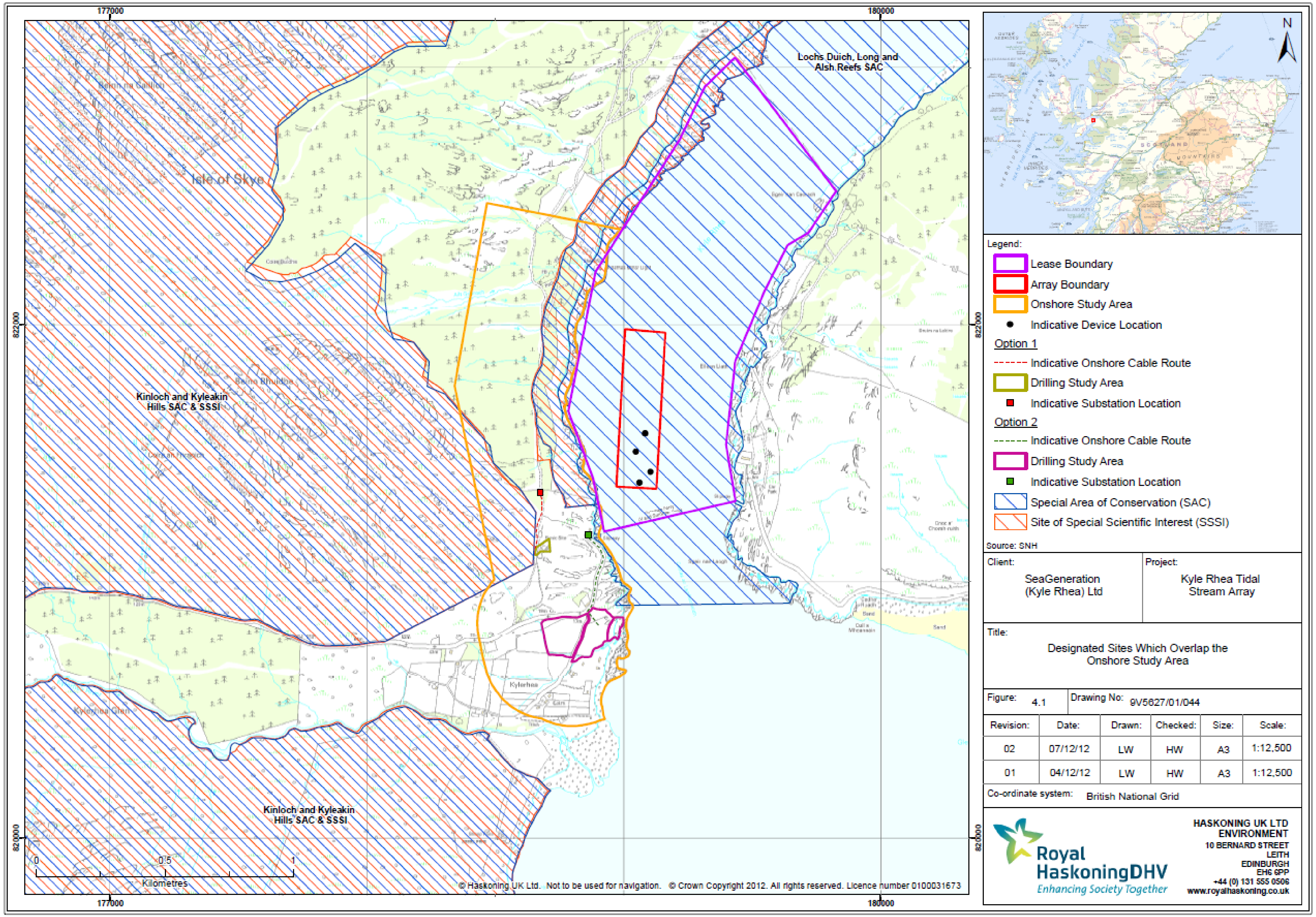
4.2.2 United Kingdom Biodiversity Action Plans (UK BAP)

The UK BAP describes the biological resources of the UK and provides detailed plans for conservation of these resources, at national and devolved levels. Action plans for the most threatened species and habitats have been set out to aid recovery. A large number of UK BAP species and habitats have been identified as present in the Skye and Lochalsh area. Those of relevance to the study area are shown in Table 4.2.

Table 4.2 Habitats and Species for which action plans have been prepared within the National Biodiversity Action Plans that have been identified as potentially relevant to the study area.

National BAP species		National BAP habitats
Birds: Reed bunting *Emberiza schoeniclus,* skylark *Alauda arvensis,* linnet *Carduelis cannabina,* corncrake, *Crex crex,* spotted flycatcher *Muscicapa striata,* bullfinch *Pyrrhula pyrrhula,* song thrush *Turdus philomelos* **Mammmals:** European otter *Lutra lutra*, red squirrel *Sciurus vulgaris,* brown hare *Lepus europaeus,* pipistrelle bat *Pipistrellus pipistrellus,* water vole *Arvicola terrestris*; **Insects**: Scottish wood ants *Formica aquilonia*; **Butterflies and Moths**: Pearl-bordered fritillary *Boloria euphrosyne,* argent and sable *Rheumaptera hastate,* narrow-bordered bee hawk-moth *Hemaris tityus,*and barred tooth-striped *Trichopteryx polycommata;*	**Fungi:** an Earth tongue *Microglossum olivaceum,* and pink meadow waxcap *Hygrocybe calyptriformis;* **Lichens:** *Arthothelium macounii, Bacidia incompta, and Pseudocyphellaria norvegica;* **Mosses and Liverworts:** Wilson's Pouchwort, *Acrobolbus wilsonii* Atlantic lejeunea *Lejeunea mandonii,* Stabler's rustwort *Marsupella stableri,* Scottish beard moss *Bryoerythro-phyllum caledonicum,* silky swan-neck moss *Campylopus setifolius,* bog moss *Sphagnum skyense;* **Vascular plants:** Eyebright *Euphrasia heslop-harrisonii,* eyebright *Euphrasia marshallii,* Wilson's filmy fern *Hymenophyllum wilsonii,* small cow-wheat *Melampyrum sylvaticum,* juniper *Juniperus communis,* marsh clubmoss *Lycopodiella inundata*	Lowland heathland

Of the species listed in Table 4.2 only the group of vascular plants eyebrights were identified within the onshore study area, however these were not identified to species in the field and therefore it cannot be confirmed if they were one of the BAP species (see Table 4.2).



Lochs Duich, Long and Alsh Reefs SAC
Isle of Skye
Kinloch and Kyleakin Hills SAC & SSSI
Kinloch and Kyleakin Hills SAC & SSSI
Kilometres
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Legend:
Lease Boundary
Array Boundary
Onshore Study Area
Indicative Device Location
Option 1
Indicative Onshore Cable Route
Drilling Study Area
Indicative Substation Location
Option 2
Indicative Onshore Cable Route
Drilling Study Area
Indicative Substation Location
Special Area of Conservation (SAC)
Site of Special Scientific Interest (SSSI)
Source: SNH
Client: SeaGeneration (Kyle Rhea) Ltd
Project: Kyle Rhea Tidal Stream Array
Title: Designated Sites Which Overlap the Onshore Study Area
Figure: 4.1
Drawing No: 9V5627/01/044
Revision: 02 Date: 07/12/12 Drawn: LW Checked: HW Size: A3 Scale: 1:12,500
Revision: 01 Date: 04/12/12 Drawn: LW Checked: HW Size: A3 Scale: 1:12,500
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4.2.3 Local Biodiversity Action Plans (LBAP)

The Skye and Lochalsh Local Biodiversity Action Plan identifies several priority terrestrial plants and animals which may be encountered within the study area, those that were identified as present include: Eyebrights (*Euphrasia frigida or Euphrasia ostenfeldii*), orchids (*Dactylorhiz incarnate*, *Dactylorhiza lapponica* and *Dactylorhiza purpurella*) bluebell, yellow flag iris, lesser celandine and otters.

Eyebright species were identified at one location near to the track in the central part of the study area at TN4 (Figure 3.2). Bluebells and lesser celandine were present at many locations within the study area (see Section 3.2 Phase 1 target notes) and yellow flag iris were identified in the extreme north east of the study area at TNs 14 and 16 (Figure 3.1). Orchids were identified at target notes 9 and 13. Evidence of otter was restricted to the coastline along the western bank of Kyle Rhea (Royal HaskoningDHV, 2012b).

LBAP habitats of relevance to the study area include upland streams, rocky shores coastal woodlands and acid grassland

4.2.4 Ground water dependant terrestrial ecosystems (GWDTEs)

Following the guidance 'A Functional Wetland Typology for Scotland' (Sniffer, 2009) ground water dependant terrestrial ecosystems were identified in the wet heathland in the southern half of the study area on the south – eastern slopes of Beinn Bhuidhe. A National Vegetation Classification (NVC) survey of the hillside (Averis and James, 2002) identified the following habitats to be present in this area:

- *M15a Scirpus cespitosus – Erica tetralix* wet heath *Carex panacea* sub-community
- *M15b Scirpus cespitosus – Erica tetralix* wet heath *Typical* sub-community
- *M15c Scirpus cespitosus – Erica tetralix* wet heath *Cladonia spp.* Sub community
- *U20 Pteridium aquilinum - Galiumsaxatile* community
- *H10a Calluna vulgaris – Erica cinerea* heath

Marshy grassland was also present in the very south of the study area between the road and the village of Kylerhea (Figures 3.1-3.3).

4.2.5 Summary of habitats within the study area

Table 4.3 provides a summary of the habitats found within the study area along with information concerning their importance with regard to UK BAP plans and their dependence on groundwater.

Table 4.3 Summary of habitats within the study area and associated relevant information.

Community type	Phase 1 classification (JNCC, 2010)	EC Habitats Directive	UKBAP (Brig 2008)	Groundwater Dependant Terrestrial Ecosystem (Sniffer 2009)
Marshy grassland/ rush and pasture	Marshy grassland	N/A	N/A	*yes*
Wet heath communities	Wet heath	4010 Northern Atlantic wet heaths with *Erica tetralix*	Priority UK BAP habitat	*yes*
Woodland and scrub	Coniferous plantation	N/A	N/A	*No*
Bracken	Bracken	N/A	N/A	*No*
Acid grassland communities	Semi improved acid grassland, coastal grassland	N/A	N/A	*No*
Tall herb and fern	Tall Ruderal	N/A	N/A	*No*
Rock exposure	Basic Exposed rock	N/A	N/A	*No*

4.3 Protected species and notable species

4.3.1 Plants

A number of protected and notable species were identified during the survey, including bluebell, (partially protected under schedule 8 of the Wildlife and Countryside Act 1981) eyebright (of conservation importance as a UKBAP and LBAP species) yellow flag iris and lesser celandine (of conservation importance as LBAP species). Notably, eyebright was not identified to species level in the field. Bluebell was located in the vicinity of the drilling pad and substation for Option 1.

4.3.2 Otter

Otters are a European Protected Species (EPS) and are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland).

It is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;

- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection or to otherwise deny the animal use of that place;
- disturb an otter in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species;
- disturb an otter in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007 (as amended) enhanced this protection such that, in summary, it is now illegal to:

- deliberately or recklessly kill, injure or take (capture) an otter
- deliberately or recklessly disturb or harass an otter; or
- damage, destroy or obstruct access to a breeding site or resting place of an otter (i.e an otter shelter) (note that this does not need to be deliberate or reckless to constitute an offence).

Otters are also a UK and local Biodiversity Action Plan (BAP) species. Thus, otter shelters are legally protected whether or not an otter is present. If otter shelters are located within 50m or, breeding area within 200m of potential development, a European Protected Species licence must be applied for from the Scottish Government.

The European otter *Lutra lutra* is a semi-aquatic mammal, which is common around the freshwater and coastal areas of Scotland. UK populations are internationally important, especially since their widespread decline across much of their western European range (JNCC, 2004). Populations in coastal areas utilise shallow, inshore marine habitats for feeding and require fresh water for bathing and terrestrial areas for resting and breeding holts (JNCC, 2004). Where otters live in coastal areas (particularly in Scotland) they tend to have a largely diurnal habit, live in group territories, and have home ranges below 5km (Kruuk, 1996). The Isle of Skye together with the Western Isles provides an important stronghold for otters in the British Isles (Barne *et al*., 1997), and the otter is a qualifying feature of the Kinloch and Kyleakin Hills SAC and a notified feature of the Kinloch and Kyleakin Hills (Monadh Chaol Acainn is Cheann Loch) SSSI, both of which encompass the study area.

Otters are known to use the onshore study area and the surrounding region (Royal Haskoning 2012b, a confidential report). At the time of survey, the otter activity was focused on the coastal fringe. The watercourses and area around the proposed drilling rig were searched for signs of otter, however at the time of search no evidence was found of otters coming up this section of the hillside.

The survey methodology used conformed to Scottish Natural Heritage (SNH) guidance (Scottish Wildlife Series: Otters and Development) and was designed to inspect potential resting site locations (i.e. burn banks, exposed peat faces or rock piles) throughout the core survey area.

4.3.3 Pinnipeds

Pinnipeds found within Scottish waters are protected by a range of national and international obligations. On the 1st February 2011 it became an offence to kill, injure or take a seal at any time of year except to alleviate suffering or where a licence has been issued to do so by Marine Scotland under Part 6 of the Marine (Scotland) Act 2010. Furthermore under the same act it will also be an offence to intentionally or recklessly harass seals at significant haul-out sites under the Marine (Scotland) Act 2010.

The Sea Mammal Research Unit (SMRU) are currently working on defining significant seal haul-outs based on their aerial seal counts, currently a period of consultation is underway before significant haul-outs are designated. Grey seals *Halichoerus grypus* and harbour or common seals *Phoca vitulina* are protected under Annex 1 and 2 of the Bonn Convention, and Annex II, IV and V of the Council Directive 92/43/EC on the Conservation of Natural Habitats and of Wild Fauna and Flora, Annex IV (the 'Habitats Directive'). They are also listed under Conservation Regulations Schedule 3 of the Conservation (Natural Habitats and c) Regulations 1994. Common seals are also classed as a UK Biodiversity Action Plan (BAP) species.

During the survey a number of both grey and harbour seals totalling approximately 40 individuals were observed milling close to the shore near to the study area, feeding within the kyle or hauled out on the rocks to the north of the lighthouse / study area. They were regularly observed fishing, porpoising and travelling along the coastline, crossing tidal narrows and appearing to fish in the channel when the tide was running (although not during peak flows). These sightings will be considered within the marine mammal assessment work for this project.

4.3.4 Birds

The Wildlife and Countryside Act 1981 implements the Birds Directive and the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). In Scotland the amendments made by the Nature Conservation (Scotland) Act 2004 apply. All wild birds (apart from *Schedule 2* species) are protected from killing, injury, or taking form the wild; taking, damage or destruction of their nests, and taking or destroying of their eggs. Additionally, birds listed in Schedule 1A are protected from disturbance.

A heronry was present within the central section of the study area located to the east of TN12 on the eastern edge of the plantation (Figure 3.2). At least four nests were observed high in the pine trees and at least four different herons *Ardea cinerea* were seen during the survey. Anecdotal evidence, provided by Andy Law, a local resident at Kylerhea employed by MCT to conduct marine mammal, basking shark and bird surveys for the Project, indicates that golden plover *Pluvialis apricaria* breed on the hillside above the study area, however none were identified during the current survey.

The following species were also observed during the Phase 1 survey: Oystercatcher *Haematopus ostralegus*, herring gull *Larus argentatus*, great black-backed gull *Larus marinus*, cormorant *Phalacrocorax carbo* and wheatear *Oenanthe oenanthe*. A white-tailed sea eagle *Haliaeetus albicilla* was also observed by the surveyors whilst leaving the site via the Skye Ferry on the 9th June.

4.3.5 Pine marten

Pine marten are present in the Forestry Commission plantation within the study area, and scat was recorded during the survey along the track to the wildlife hide. Pine martens are listed on Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). Various methods of capturing or killing pine martens are also listed in the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

4.3.6 Bats

Bats are known to be in the area (as Identified by Andy Law), however no roost potential were found to be present within the survey area. All bat species found in Scotland are classed as European protected species and are fully protected under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

4.4 Invasive species

The study area was assessed for presence of terrestrial invasive species giant hogweed *Heracleum mantegazzianum*, Japanese knotweed *Fallopia japonica*, Himalayan balsam *Impatiens glandulifera* and *rhododendron sp.* during the Phase 1 Habitat survey.

A small number of isolated *Rhododendron ponticum* bushes were recorded at number of locations within the study area whilst the other terrestrial invasive species were not present on the site.

Rhododendron ponticum has been identified in the kyle and Loch Alsh biodiversity action plan as an invasive species. The plan states that "*The spread of invasive species such as Rhododendron ponticum present a threat to biodiversity, and rhododendrons should be controlled where they are found in the natural environment*."

No assessment was made of freshwater aquatic invasive species.

5 RECOMMENDATIONS

5.1 Habitats

1) An aquatic invasive species survey was not completed during the Phase 1 Habitat Survey, and is not considered necessary for the Project;

2) A 'no build' buffer of 50m should be placed either side of the two main burns in the north of the study area, in order to minimise risk of pollution to the watercourses or disturbance to otters using the burn to transit the hillside;

3) For the burn in the south of the study area, the 'no build' buffer should be 25m either side, since this burn has some natural buffer from the rocky outcrop to the north of it;

4) A pre-construction survey will record locations of *Rhododendron ponticum* within the construction footprint area and invasive plants will be removed following current best practice. Native species of local provenance will be replanted;

5) Any landscape planting schemes will aim to improve the existing value of the study area through increasing the species diversity. The use of species of local provenance is recommended;

6) If there are any impacts on stone walls during the works, the stone should be retained in-situ and replaced on completion;

7) During construction, good working practices and following published SEPA site management protocols should eliminate risk from oil, chemicals and other harmful materials. Construction areas should be left in a safe condition during periods of inactivity, with chemicals and construction materials stored safely, with appropriate bunding, in accordance with SEPA's Pollution Prevention and Chemical Guidelines (PPG2 - Above ground oil storage tanks, and PPG5 – Works in, near or liable to affect watercourses);

8) A healthy population of native bluebell was present across the surveyed area, including the vicinity of the drilling pad and substation. The current proposed locations of the drilling rig and substation are located with areas of made ground and track, however (depending on the area required for construction) the periphery of the footprint may overlap with ground supporting bluebell. It is recommended that native species of local provenance (including bluebell) are replanted following construction.

9) For option 2 be taken forward, it is recommended that the works are sited outside of the marshy grassland recorded in TNs 28, 29, 31, 34, 36,& 38. Should works be sited here further consultation with SEPA, SNH and the Highland Council will be necessary as a number of factors may need to be considered for the feasibility of the works. Of ecological concern will be a potential impact on a potential GWDTE habitat.

10) Should option 2 be taken forward in the area of acid grassland, then this habitat will be re-instated to existing conditions or better following construction.

5.2 Otters

11) Construction activities should maintain a strict footprint of works, and construction vehicles and equipment should not be active on, or stored by, the coastline for longer than is essential. It is appreciated that equipment may need to travel to site by sea and may require the slipway used by the Skye Ferry but if possible the equipment should be stored further up the hill. This will minimise disturbance to the shore;

12) Any temporarily exposed open pipe system should be capped in such a way as to prevent otters gaining access at the end of each working day;

13) Open trenches should have a ramp constructed in at least one place, especially if water filled, to provide an escape route;

14) If any otter fatalities occur during construction, carcases should be retained and SNH should be notified, if non-fatal injuries occur as a result of construction than SNH should be notified immediately;

15) Construction work will be undertaken during agreed daylight working hours. Where artificial light is required, lights should be directed away from the coastal area and watercourses to allow otters to migrate through the area undisturbed.

16) Although no resting sites of otters have been identified in the vicinity of the Project sites (the proposed drilling pad location and proposed the proposed substation location), there remains the potential for the baseline situation to change before construction works commence. Prior to the commencement of operations an otter survey should be undertaken, within the proposed footprint of construction plus a 200m buffer zone around it, to determine current use at the time of construction (otters may increase their use of the site in the interim period between the current survey and the commencement of construction). A European Protected Species (EPS) Licence may be required to undertake work on this site;

17) All otter mitigation measures for the site will be agreed with SNH prior to construction and will be detailed within the Environmental Statement for the Project;

18) It may be necessary to install otter fencing around the construction area; and this may be dependent on the final location and design of the works

19) Further information and advice is available from SNH Otters and Development[1], Nature Conservation and Roads: advice in relation to otters (2001), by A Grogan, C Philcox and D Macdonald, and the Design Manual for Roads and Bridges (DMRB)[2];

20) Construction should adhere to The Scottish Wildlife Series publication ‘Otters and Development’.

21) There is limited potential for otter shelters along the coast line south of the ferry slip and around the village of Kylerhea. Local resident and wildlife observer, Andy Law, otters are creating holts under upturned boats and in sheds. It is suggested for creation of otter habitat along this stretch of coastline. This will not only provide shelter for otters away from construction noises so the otters could move along the coastline, but will also draw the otters away from the village where they are at potential risk of injury from road traffic or machinery.

5.3 Birds

22) If construct activities are planned for the breeding season (beginning of April to the end of August) a breeding bird survey should be carried out by a qualified person focusing on the potential development areas as well as an agreed buffer prior to construction.

[1] http://www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

[2] http://www.dft.gov.uk/ha/standards/dmrb/index.htm

23) The breeding bird survey should be undertaken between the beginning of April and the end of June and the methods agreed with SNH.
24) Construction activities should avoid the heronry located on the eastern boundary of the coniferous plantation.

5.4 Other fauna

25) Further consultation will be required with SNH to determine if further surveys/ mitigation are required for pine martin.

6 SPECIES LIST

Common name	Scientific Name
Yarrow	*Achillea millefolium*
Bent	*Agrostis sp.*
Wild garlic	*Allium ursinum*
Wood anemone	*Anemone nemorosa*
Maidenhair spleenwort	*Asplenium trichomanes*
Silver birch	*Betula pendula*
Hard fern	*Blechnum spicant*
Ling heather	*Calluna vulgaris*
Cuckoo-flower	*Cardamine pratensis*
Spear thistle	*Cirsium vulgare*
Lichen	*Cladonia portentosa*
Common broom	*Cytisus scoparius*
Wavy hair grass	*Deschampsia flexuosa*
Foxglove	*Digitalis purpurea*,
Bell heather	*Erica cinerea*
Cross-leaved heather	*Erica tetralix*
Bog cotton	*Eriophorum angustifolium*
Eyebright	*Euphrasia spp*
Marsh gentian	*Gentiana pneumonanthe*
Ground ivy	*Glechoma hederacea*
Ivy	*Hedera helix*
Yorkshire fog	*Holcus lanatus*
Bluebell	*Hyacinthoides non-scripta*
Holly	*Ilex aquifolium*
Yellow flag iris	*Iris pseudacorus*
Sharp-flowered rush	*Juncus acutiflorus*
Compact rush	*Juncus conglomeratus*
Soft rush	*Juncus effusus*
Perennial ryegrass	*Lolium perenne*
Great wood rush	*Luzula sylvatica*
Purple moor grass	*Molina caerulea*
Bog asphodel	*Narthecium ossifragum*
Crab eye lichen	*Ochrolechia parella*
Unidentified pink orchid	*Orchidaceae*
Wood sorrel	*Oxalis acetosella*

Lousewort	*Pedicularis sylvatica*
Dog lichen species	*Peltigera sp*
Common butterwort	*Pinguicula vulgaris*
Ribwort plantain	*Plantago lanceolata*
Annual meadow grass	*Poa annua*
Common tormentil	*Potentilla erecta*
Primrose	*Primula vulgaris*
Large selfheal	*Prunella grandiflora*
Bracken	*Pteridium aquilinum*
Sea ivory	*Ramalina siliquosa*
Lesser celandine	*Ranunculus ficaria*
Creeping buttercup	*Ranunculus repens*
Rhododendron	*Rhododendron ponticum*
Dog rose	*Rosa canina*
Bramble	*Rubus fructicosa*
Common sorrel	*Rumex acetosa*
Curled dock	*Rumex crispus*
Goat willow	*Salix caprea*
Rowan	*Sorbus accuparia*
Devil's-bit scabious	*Succisa pratensis*
Deer grass	*Trichophorum cespitosum*
Bilberry	*Vaccinium myrtillus*
Violet	*Viola spp*.
Common orange lichen	*Xanthoria parietina*

Hooded crow	*Corvus cornix*
Red deer	*Cervus elaphus*
Otter	*Lutra lutra*
Heron	*Ardea cinerea*
Golden plover	*Pluvialis apricaria*
Oystercatcher	*Haematopus ostralegus*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Cormorant	*Phalacrocorax carbo*
Wheatear	*Oenanthe oenanthe*
White-tailed sea eagle	*Haliaeetus albicilla*
Grey seal	*Halichoerus grypus*
Harbour seal	*Phoca vitulina*

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APPENDIX A: Field Target Notes for Phase 1

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
1	178665	821143	Gravel track heading north from the carpark. Either side of the track the ground slopes steeply down towards the sea and was fairly firm underfoot. Scattered silver birch *Betula pendula,* goat willow *Salix caprea*, Rowan *Sorbus acuparia.* along either side of the track. Bell heather *Erica cinerea* and ling heather *Calluna vulgaris*, starry moss *Polytricum commune*, tormentil *Potentilla* erecta, lichen *Cladonia impexa*, bramble *Rubus fructicosa*., hard fern *Blechnum spicant*, sphagnum mosses *Sphagnum spp*, marsh gentian *Gentiana pneumonanthe*, very young mixed conifer trees, lousewort *Pedicularis sylvatica*, purple moor grass *Molina caerulea*, bog asphodel *Narthecium ossifragum.*	Wet dwarf shrub heath	Medium	SC465, 466
2	178666	821195	Drain on the west side of the track were bilberry bushes *Vaccinium myrtillus*, bracken *Pteridium aquilinum* (small patches), and great woodrush *Luzula sylvatica,* and soft rush *Juncus effusus* present in and around the drain. Small burn lies to the north with foxgloves *Digitalis purpurea*, bluebells *Hyacinthoides non-scripta* lining the small burn and holly *Ilex aquifolium.*	Running water	Medium	
3	178686	821290	Pine plantations on the west side track. A drain runs along the west side. Small *Rhododendron* sp. on the east side of the track. Further north there are toilets and a view point.	Conifer plantation	Low	SC468,469 SC471-473

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
4	178662	821503	Strip of bracken between the western edge of the track and the plantation. The patch is about 200m long and between 2 and 20m wide. Eyebrights *Euphrasia spp.*, violets *Viola spp*., wood sorrel *Oxalis acetosella* and other wood anemone *Anemone nemorosa* were present on the eastern side of the track.		Medium	SC474-76
5	178675	821484	Area to the east of track were tree felling has taken place. soft rush, primrose *Primula vulgaris*, foxgloves, tormentil, bluebells.	Wet dwarf shrub heath	Medium	SC477 and 479
			Along much of the track is a strip of heath on sides, heathers and butterwort *Pinguicula vulgaris* are present.	Wet dwarf shrub heath	Low	SC478
6	178656	822363	Bridge (15m above burn) where track crosses deep cut gorge with high sheer rock sides waterfalls and pools. Riparian habitat contains birch, rowan, wild garlic *Allium ursinum*, bracken, ivy *Hedera helix*, sorrel, moss, holly, larch *Larix spp.*, bluebells, common broom *Cytisus scoparius*, hard fern. Dog lichen *Peltigera* spp. on the east side of the track just south of the bridge. Bracken is present on the top of the northern bank of the burn in a brake between the trees. Small birch present within the bracken.	Running water/ inland cliff	High	SC482, SC487,488 birch on hillside SC489 Orchid JT SLR 072-074
7	178703	822408	Soft rush and heath and scattered trees at the northern end of the plantation. Red deer were present here and directly down the hill an otter was present in the sea.	Scattered trees/wet dwarf shrub heath	Medium	

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
8	178712	822070	Bracken, holly, rowan , larch , primrose, Lesser celandine *Ranunculus ficaria*, wood sorrel, bluebells, bramble, foxglove, starry moss. The burn is culverted under the track.	Coniferous Plantation	Low	
General Note			Viewed from the otter hide- at least 35 mostly or all grey seals hauled out on the skerries north of the hide, up to 10 more seals in the water. 1 hooded crow on the shore.			
9	178749	822041	Area of bracken between dense silver birches on lower hill. Pine plantation on the upper. Large selfheal *Prunella grandiflora,* ground ivy *Glechoma hederacea*. spear thistle *Cirsium vulgare*, foxglove, bramble, scattered small silver birch and rowan, Yorkshire fog *Holcus lanatus* and other grasses, wood sorrel and lesser celandine. Below the bracken is more dense birch in which a pink orchid (indet.) was found.	Scattered trees/wet dwarf shrub heath	Medium	
10	178687	821343	Closer look at the potential drilling site: very limited bat potential, no old buildings, no mature tress mainly birch or pine. There is a mammal run on the east side of the track approximately 30m north along the track from the toilets. Near to where the first small burn passes under the track. The view point in front of the toilets has a mammal track descending from its most easterly point.	N/A	Low	DT SLR 119-121
11	178711	821382	Rhododendrons next to the burn that descends from	N/A		

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
			near the toilets. The bush is 4m high by 6m wide. Photos taken from the point at which the burn that passes near to the toilets enters the sea.			SLR 115
12	178660	821745	Clearing between patches of mixed coniferous plantations. Bracken, bluebells small rowan and birch present in the clearing. Vole spotted transiting grassy ramp below view point Herony recorded east of this waypoint (4 individual active herons nests observed on coastal edge of plantation).	Coniferous plantation	Medium	
13	178848	822225	Mouth of burn: yellow flag iris *Iris pseudacorus,* wild garlic, goat willow lesser celandine, ling, primrose, silver birch, creeping buttercup *Ranunculus repens,* violets, pink orchids, tormentil, thistle and dog rose *Rosa canina*		High	
14	178816	822240	Small pond mostly dry, small soft rush growing out of the remaining water, broom, tormentil and creeping buttercup around the edges.	Standing water	Low	DT SLR 140 SC 530
15	178793	822267	Margin of the woodland west of the dried up pond, bluebells soft rush and Cuckoo-flower *Cardamine pratensis.*	Acid grassland	High	
16	178824	822214	About 25 m to the south of the dried up pond- newly made pond. Contains a lot of moss and stringy vegetation, which is possibly dead. Surrounding the pond were lesser celandine, yellow flag iris small clumps of bracken and wild garlic.	Standing eater	High	DT SLR 143-144

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
			Clear otter run into the pond with spraint (see OT 14).			
17	No access, assessed from Road		Rocky outcrops of bed rock with heath habitat on top of the bedrock and bracken in between. Heath ling, bramble, tormentil, mosses, bracken, bluebell, foxglove, scattered trees, willows rowan.	Rock exposure	Medium	DT SLR 90
18	Viewed from the road and above from track		Heath with outcrops of rock, bilberry rowan, willow scattered soft rush and bracken starry moss on sloping hillside.	Wet dwarf shrub heath	Medium	DT SLR 91
19	No access, assessed from Road		Marshy grassland and improved grassland matrix.	Marshy grassland	Medium	DTSLR 96
20	No access, assessed from Road		Marshy grassland soft rush, wavy hairgrass, hawthorn, rowan, birch, bracken and heath.	Marshy grassland	Medium	
K021	No access, assessed from Road		Tall ruderal bracken bramble docks, goat willow, bluebells.	Tall ruderal	Low	
22	178863	821182	Shed adjacent to slipway. Green building made of corrugated steel. Locked and inaccessible from the inside. North side of building surrounded by damp conditions and associated vegetation. Stone wall adjacent to east side of the shed with many nooks and crannies. Vegetation comprised of bracken, dog-rose, gorse, rowan, *Juncus sp.*, bramble. Shed very close to another building, appears residential either a home or holiday let. Telephone box next to shed on south side.	Building	Low	SLR 1592 - 1600
23	178918	821104	Road south from green building. Stone wall on eastern side of road with slope down towards the kyle on the east-side of rocky outcrop and boulders and the	Wall	Low	SLR 1600 - 1602

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
			intertidal zone. Numerous nooks and crannies and colonised by frequent maidenhair spleenwort. Western side of road constrained by steep, sheer rock face. Width of road approximately 5m. Rock face damp and colonised by numerous mosses, bracken, hard fern, ling, fescue sp., bent sp., *Juncus sp.*, and bramble.			
24	178898	821021	Road south from slipway constrained either side by stone walls and steep slopes going down towards the kyle.	Wall	Low	SLR 1603 - 1604
25	178876	820878	Area of bracken on steep slope going from dwelling at the top of the road down towards the kyle.	Bracken	Low	SLR 1605 - 1609, 1613
26	178850	820861	Bracken.	Bracken	Low	SLR
27	178847	820821	Drain in area of marshy grassland (TN 28).	Marshy grassland	Medium	SLR 1610 - 1611
28	178802	820822	Dominant marshy grassland with frequent compact rush and sharp or jointed rush, purple moor grass *Molinia caerulea*, occasional goat willow and birch sp., common alder, soft rush, creeping buttercup. Occasional patches of heath including ling, bell heather, *Cladonia sp.*, *Sphagnum sp.* and other occasional moss species.	Marshy grassland	Medium	SLR 1611 - 1612
29	178846	820791	Potential drilling area. Frequent mosses including starry moss and other frequent species. Frequent soft rush, Yorkshire fog and occasional devil's-bit scabious, ling and tormentil.	Marshy grassland	Medium	SLR 1618 - 1620
30	178879	820797	Semi-improved acid grassland. Species included frequent to abundant bent sp., occasional purple moor	Semi-improved acid grassland	High	SLR 1614 - 1617

Target Note	Grid Ref		Description	Phase 1 habitat classification	Value	Photos (N)=north (E)=West etc*
	Easting	Northing				
			grass, broad-leaved dock, ribwort plantain, annual meadow grass *Poa annua*, yarrow, common sorrel, creeping buttercup and numerous mosses.			
31	178847	820719	Marshy grassland with abundant *Juncus* species.	Marshy grassland	Medium	SLR 1674 - 1675
32	178822	820722	Bracken.	Bracken	Low	SLR 1673
33	178928	820750	Rocky outcrop vegetated with ling, purple moor grass, soft rush and numerous moss species. Small burn south of outcrop Shallow <5cm deep. Pebble substrate, fairly fast-flowing. Upstream, towards Kylerhea, watercourse widens (approx 1m) and has grassy banks. Unable to go further upstream due to access restrictions.	Other	Medium	
34	No access, assessed from road		Purple moor grass dominated grassland with some rushes but not as many as TN 28.	Marshy grassland	Medium	
35	No access, assessed from road		Well drained grassland, croft, horses, llamas.	Semi-improved acid grassland	Medium	
36	No access, assessed from road		Marshy grassland similar to TN 28. Dip in the middle of the field, with scattered semi-mature birch and frequent rushes.	Marshy grassland	Medium	
37	No access, assessed from road		Bracken and heath, with scattered, semi-mature birch.	Bracken/heath mosaic, scattered broad-leaved trees	Low	
38	Viewed from the road		Similar to TN 28, with more young, scattered deciduous trees.	Marshy grassland	Medium	SLR 0001 - 0004

Kyle Rhea Tidal Stream Array

CONFIDENTIAL Appendix 10.2

Provided separately to Marine Scotland

Kyle Rhea Tidal Stream Array

Appendix 10.3

Kyle Rhea Tidal Stream Array Intertidal Survey Report

Marine Current Turbines

29th November 2012

Final Report

9V5627

Royal HaskoningDHV
Enhancing Society Together

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Document title	Kyle Rhea Tidal Stream Array Intertidal Survey Report
Document short title	
Status	Final Report
Date	29th November 2012
Project name	Kyle Rhea Tidal Array
Project number	9V5627
Client	Marine Current Turbines
Reference	9V5627/R/303922/Edin

Drafted by	David Tarrant / Jen Trendall	
Checked by	Jen Trendall	
Date/initials check	JT…………………	12/12/2012…………
Approved by	Frank Fortune	
Date/initials approval	FF……………….	12/12/2012…………

CONTENTS

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1 INTRODUCTION

Marine Current Turbines Ltd. (MCT), a wholly owned subsidiary of Siemens intends to develop a demonstration tidal energy conversion array in Kyle Rhea, located in the north west of Scotland. The kyle is a narrow body of tidal water that separates mainland Scotland from the Isle of Skye near to the villages of Glenelg and Kylerhea). Royal HaskoningDHV have been commissioned by MCT to assist in applications for consent of the project and as part of this support are conducting an Environmental Impact Assessment (EIA) for the Project. This document reports on the intertidal survey conducted by Royal HaskoningDHV which will be used to inform the EIA.

All species names, both scientific and common, are taken from the Marine Life Information Network MarLIN (www.marlin.ac.uk) unless otherwise stated.

1.1 The Project

The location for the proposed array is north of the seasonal Skye ferry (the MV Glenachulish) crossing from Glenelg to the village of Kylerhea. The array will be deployed in water depths of approximately 30 to 35 metres (m), in the western side of the tidal narrows, and will consist of four SeaGen devices with a combined capacity of up to 8MW.

Currently the preferred option is to bring the export cables onto Skye using a technique called horizontal directional drilling (HDD). This will involve drilling a borehole that extends from an inland location, through the bedrock under the shore, and then breaking out on the seabed near to the turbines. By using this method it is hoped that there will be very little or no impact upon the intertidal habitats.

There are two potential locations for the location of the drilling pad and substation (**Figure 1.1**).

Option 1: located on the existing access track to the wildlife hide. Equipment and plant will be delivered via the existing ferry slipway and up the road to the construction site.

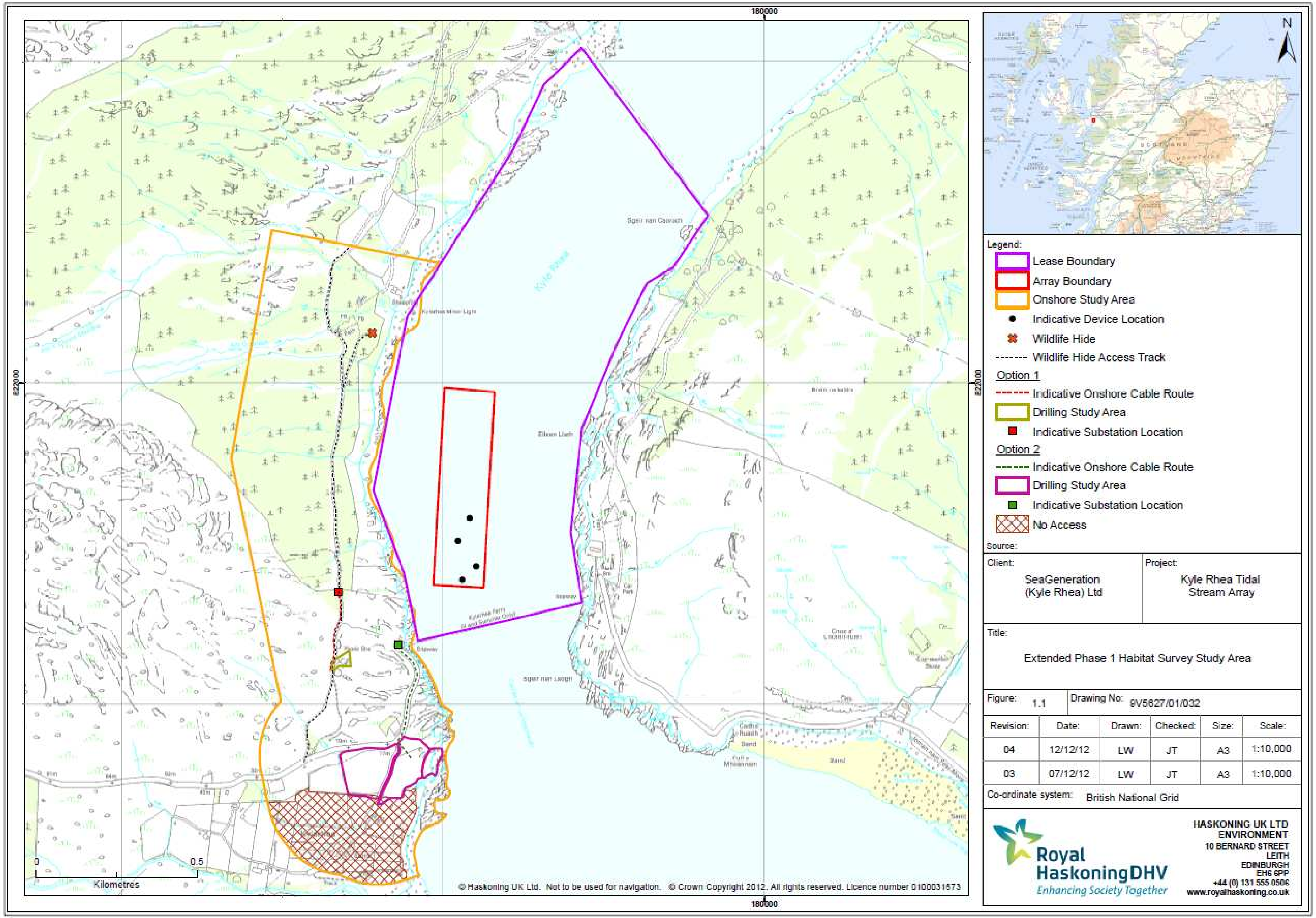
Option 2: substation located in the existing boatshed at the ferry slipway, with drilling rig on grassland north of Kylerhea village. Equipment and plant may be delivered via the existing ferry slipway and along the road, or may be brought to site by barge landing on the beach in front of the proposed drilling rig site.

1.2 Objectives

The objectives of the survey were to:

- Identify the habitats and communities present within the survey area (**Figure 1.1**);
- Identify and locate the presence of any rare or protected species within the study area boundaries, and
- Provide target notes of each biotope, including characterising, rare, protected and non-native species encountered.

This survey was completed in conjunction with an Extended Phase 1 Survey (Royal HaskoningDHV, 2012a) which assesses the terrestrial habitats inshore of the intertidal survey (**Figure 1.1**). A dedicated otter survey was also conducted, and is reported in (Royal HaskoningDHV 2012b).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Option 2
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Source:
Client:
SeaGeneration (Kyle Rhea) Ltd
Project:
Kyle Rhea Tidal Stream Array
Title:
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Figure: 1.1
Drawing No: 9V5627/01/032
Revision: | Date: | Drawn: | Checked: | Size: | Scale:
04 | 12/12/12 | LW | JT | A3 | 1:10,000
03 | 07/12/12 | LW | JT | A3 | 1:10,000
Co-ordinate system: British National Grid
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1.3 Conditions during survey

The survey north of the ferry slip was completed by two experienced Royal HaskoningDHV ecologists during low water spring tides on the 7th and 8th of May 2012. Weather was variable throughout the survey period ranging from moderate north westerly winds with heavy rain during the afternoon of the 7th to calm sunny periods on the 8th. The conditions did not inhibit the surveyors.

The survey south of the ferry slip was completed by two experienced Royal HaskoningDHV ecologists during low water spring tide on the 27th November 2012. Weather was cold but dry throughout the survey, with a light breeze. The conditions did not inhibit the surveyors.

Sea state during the survey remained calm (sea state 1 or 2) throughout the surveys and tidal conditions during the survey are shown in Table 1.1.

Table 1.1 Tidal conditions experienced during the intertidal survey

	Low water		High water	
	Time	Height (m)	Time	Height
7th May	14:57	0.5	7:39	4.9
8th May	15:43	0.6	9:15	4.5
27th Nov	11:42	1.0	-	-

2 METHODOLOGY

The survey was completed by two experienced ecologists operating on foot, using a number of methods and techniques, based upon those specified in the Countryside Council for Wales (CCW) report 'CCW Handbook for marine intertidal Phase 1 mapping' (Wyn *et al.*, 2000) and the 'Marine Nature Conservation Review: Rationale and methods' (Hiscock, 1996).

Target notes were recorded and photos taken wherever a change in either the biological zonation or physiological conditions appeared to occur. A hand held Garmin Global Positioning System (GPS) was used to provide positioning data for each target note which were then mapped using ArcGIS 10.1 after the survey was completed.

3 RESULTS

3.1 Main findings

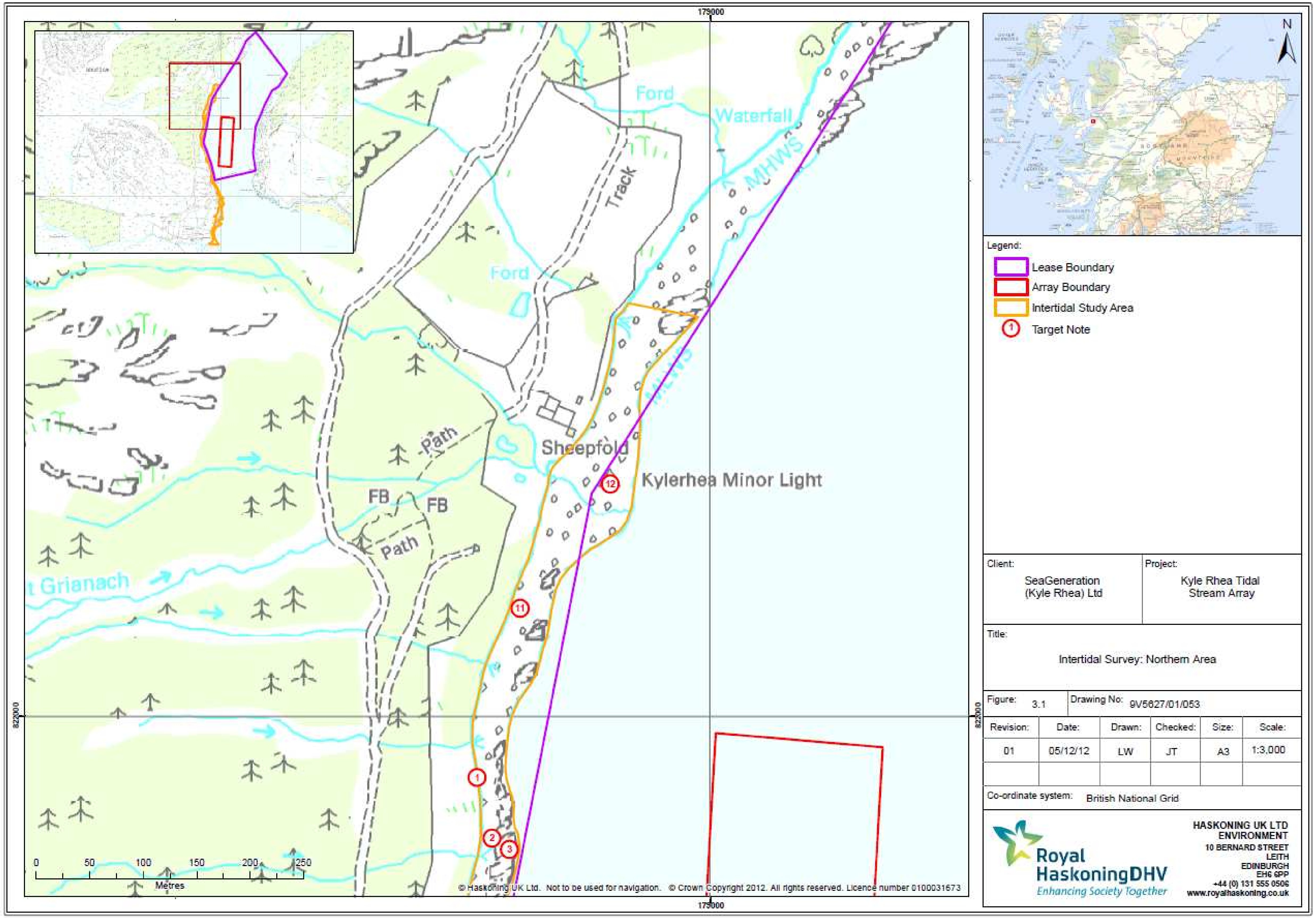
A total of 23 target notes were recorded within the study area during the intertidal surveys, the locations of which are presented in **Figures 3.1** to **3.3**.

No features or habitats regarded as being rare or particularly sensitive were recorded during either survey.

The intertidal zone, in the north of the study area, was relatively uniform throughout the site. The substrates ranged from solid bedrock in the more exposed locations, through to cobbles and pebbles in more sheltered areas. The most common substrate however was a mixture of boulders and bedrock.

Where algal communities were present clear biological rocky shore zonation was observed, typically comprising of a lichen zone at the top of the shore followed by *Pelvetia canaliculata* and then fucoid zones in the mid shore, with a kelp zone in the lower shore. This zonation was present across much of the study area and was generally only absent where the substrate was steep exposed bedrock or mobile gravel and/ or shingle.

South of the ferry slipway, a series of steep bedrock outcrops were present, often fauna dominated, interspersed with more sheltered geo features, with boulder and cobble, dominated by algae communities. Further south, the shore opens into a wide embayment of pebbles, with small areas of sand in the lower shore.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Array Boundary
Intertidal Study Area
Target Note
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Project: Kyle Rhea Tidal Stream Array
Title: Intertidal Survey: Northern Area
Figure: 3.1
Drawing No: 9V5627/01/053
Revision: 01
Date: 05/12/12
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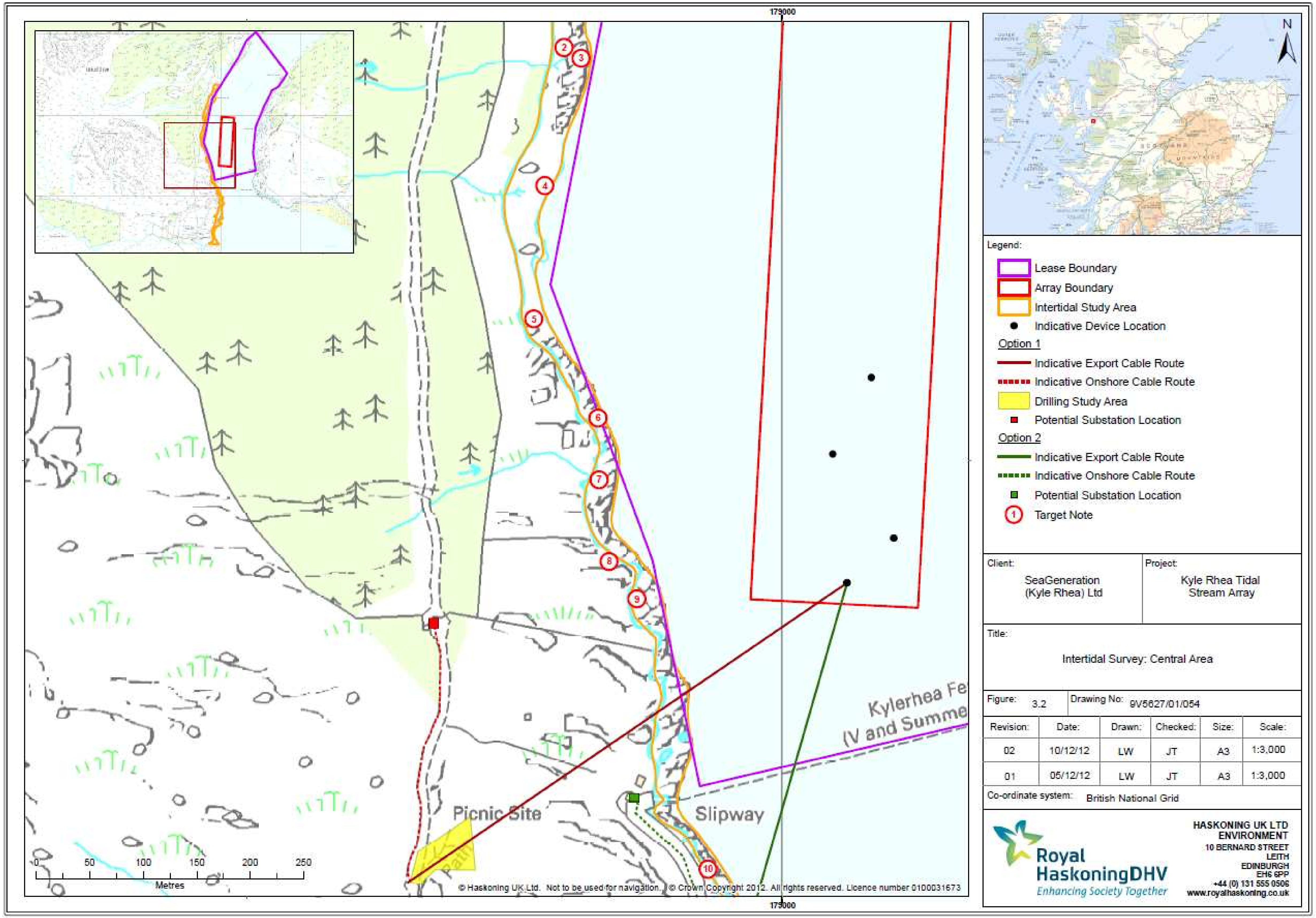

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Target Note
Client: SeaGeneration (Kyle Rhea) Ltd
Project: Kyle Rhea Tidal Stream Array
Title: Intertidal Survey: Central Area
Figure: 3.2
Drawing No: 9V5627/01/054
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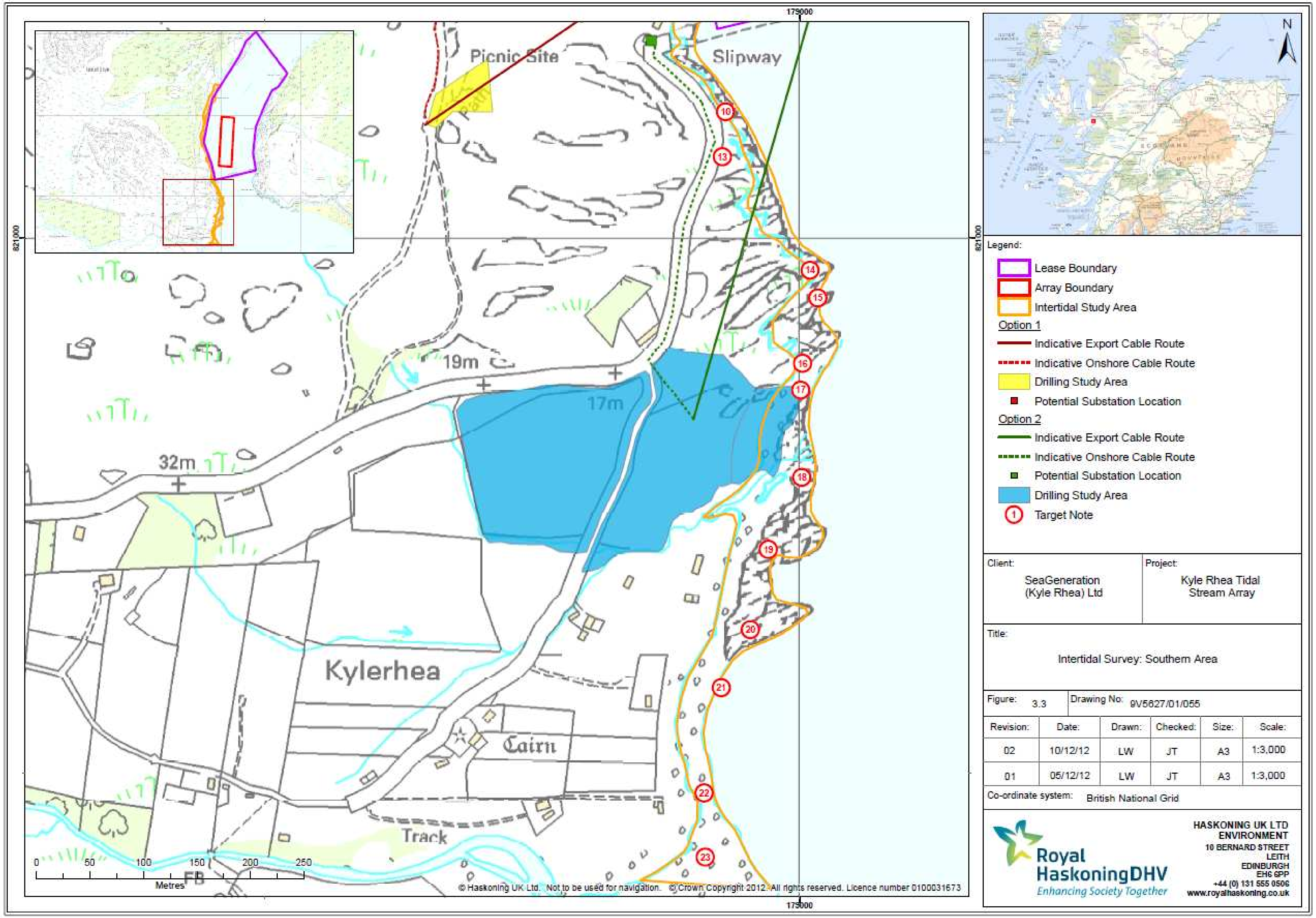
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Target Note
Client:
SeaGeneration (Kyle Rhea) Ltd
Project:
Kyle Rhea Tidal Stream Array
Title:
Intertidal Survey: Southern Area
Figure: 3.3
Drawing No: 9V5627/01/055
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3.2 Target notes

All target notes recorded during the survey are provided below, along with photos to help illustrate the findings. The positioning of each target note (TN) is displayed in **Figures 3.1** and **3.2** above. Further details on each TN can be found in **Annex A**. The intertidal survey was undertaken during three different low tides on three days and the numerical label attached to the target notes does not follow the geographically logical pattern. However for the purposes of reporting the descriptions of the target notes are provided in geographical order from north to south across the survey area.

The descriptions of each target note typically start in the upper shore and progress down towards the lower shore.

Target note 12

On the shore near to the Kyle Rhea minor lighthouse (**Plate 1**) a small burn runs down the shore and horned wrack *Fucus ceranoides* is present near to the fresh water. Small groups of common mussel *Mytilus edulis* were found growing on rocks. The shore here is gradually sloping and the intertidal zone is larger here than at any other point within the study area.

Plate 1: Kyle Rhea minor lighthouse

Target note 11

The shore here continued to be relatively easy angled and was dominated by boulders in the upper shore which became are more sparse in the mid shore.

A lichen zone was clearly defined at this location with grey and yellow lichens at the top of the zone and tar lichen *Verrucaria maura* at the bottom.

Below the lichen zone a dense but narrow band (3m) of channelled wrack *Pelvetia canaliculata* was present.

Below the *Pelvetia* zone a large fucoid zone which was composed of spiral wrack *Fucus spiralis* was present (**Plate 2**); within which occasional acorn barnacles *Semibalanus balanoides*, occasional common limpets *Patella vulgata* and rare black-footed limpets *Patella depressa* were present mostly on the underside of rocks, grey top shell *Gibbula cineraria* and dog whelks *Nucella lapillus* were also present.

The mid shore at this location supported both toothed wrack *Fucus serratus* and bladder wrack *Fucus vesiculosus* which were covered by a mat of purple laver *Porphyra umbilicalis* and gut weed *Ulva intestinalis* (**Plate 3**), also present were beadlet anemones *Actinia equina* and carrageen *Chondrus crispus* and a number of unidentified filamentous brown and green seaweeds. Numerous areas of algal free gravel and pebble were also a feature of this mid shore (**Plate 2**).

Plate 2: View across shore at TN 11

Plate 3: Fucoids covered by purple laver and gut weed

The upper mid shore exhibited approximately 40% cover in seaweeds and the lower mid shore 90%. Also in the lower mid shore the China limpet *Patella ulyssiponensis* was also present. There was far less biomass of fauna on this shore than was present further south.

Target note 1

The lichen zone at this location featured large boulders and small outcrops of bedrock, between which a cobble substrate was present. Species identified in the upper shore included sea ivory *Ramalina siliquosa*, crab eye lichen *Ochrolechia parella*, and other white and grey lichens all present at the top of the lichen zone. Tar lichen and orange lichen *Xanthoria spp.* were more prevalent at the bottom of the lichen zone.

Within the *Pelvetia* zone small boulders and cobbles with angular shingle formed the substrate and the species present included: channelled wrack and rough periwinkle *Littorina saxatilis*. Small patches of spiral wrack which were mixed in with the channelled wrack became more common lower in the *Pelvetia* zone.

The fucoid zone at TN1 featured boulders and large pebbles on which knotted wrack *Ascophyllum nodosum* supporting *Polysiphonia lanosa* dominated (**Plate 4**). Abundant spiral wrack, sea lettuce *Ulva lactuca*, grey top shell, beadlet anemone, dog whelk, the green seaweed *Cladophora rupestris*, carrageen, common periwinkle *Littorina littorea*, the red seaweed *Membranoptera alata*, Montagu's stellate barnacle *Chthamalus montagui* and unidentified mollusc eggs were all recorded. Lower down in the fucoid zone toothed wrack *Fucus serratus*, common limpet and acorn barnacles were also present as well as sea beech *Delesseria sanguinea*, carrageen, thongweed *Himanthalia elongata* (**Plate 5**), the tube worm *Spirorbis spirorbis,* the red seaweed *Plumaria plumosa* and the red seaweed *Ceramium spp*.

At the top edge of the kelp zone the substrate was composed mostly of boulders. Here the following species were present: thong weed, star ascidian *Botryllus schlosseri*, shredded carrot sponge *Esperiopsis fucorum*, the tubeworm *Pomatoceros triqueter*, sugar kelp *Saccharina latissima*, the sea squirt *Morchellium argus,* common starfish *Asterias rubens*, sea lemon *Archidoris pseudoargus*, beadlet anemone and common shore crab *Carcinus maenas.*

Plate 4: Fucoid zone at TN1

Plate 5: *Himanthalia elongata* in the lower shore at TN1

The understory of the lower intertidal had a diverse range of red and brown seaweeds. It was not possible to access properly the kelp zone as the tide was not low enough but dense Oarweed *Laminaria digitata* could be seen with red rags *Dilsea carnosa* and coral weed *Corallina officinalis* identifiable from a distance.

Small outcrops of rock with patches of trapped sand were also present in the lower shore and on these rock outcrops the breadcrumb sponge *Halichondria panicea* was identified.

Target note 2

A rib of rock running north east across the shore was present at this location. Shingle was present either side is of the rock providing two very different habitats. Very little fauna and flora were present on the shingle as it is an unstable substrate that would be easily disturbed. Channelled wrack and tar lichen were present at the top of the rock rib with small patches of knotted wrack, common limpet, barnacles, dog whelk, beadlet anemone, grey top shell, and *Cladophora rupestris* also present on the rock surface. Many of the same species found in the lower shore at TN1 were also present on parts of the rock closest to the shore although at much lower abundance. In addition the red algae *Hildenbrandia rubra* and false Irish moss *Mastocarpus stellatus* were also identified at TN2.

Target note 3

The lichen zone at this TN was less steep than at previous TN2, with boulders cobble and shingle forming the substrate. Tar lichen was dominant in this zone with no other species recorded.

The *Pelvetia* zone was quite narrow here (compared to other locations along the shore), spanning a band approximately 2m wide.

The first fucoid zone was also narrow, approximately 1m. It was composed almost exclusively of spiral wrack with no other species recorded. Beneath this zone was a strip of bare substrate.

A second fucoid zone, much wider than the first was dominated by knotted wrack (**Plate 6**) with: beadlet anemone, carrageen, common limpet, rough periwinkle, acorn barnacle, rare spiral wrack, grey topshell and dog whelk all present.

Plate 6: Fucoid zone at TN3 dominated by *Ascophyllum nodosum*

Plate 7: Small patched of Algae growing on boulders in a sandy matrix at TN3

Lower on the shore a sandy shingle zone was also recorded with small patches of algae growing on boulders embedded within the shingle (**Plate 7**). Carrageen, knotted wrack, purple laver and common limpet were all present within this zone.

The lower shore was dominated by large oarweed. Unidentified eggs (likely mollusc) on serrated wrack fronds were found here. Moving south red rags and *Cladophora rupestris* were present along with many of the red and green seaweeds identified at previous target notes albeit in less dense aggregations at this location.

Target note 4

The shore here is similar to that at TN3 with the exception of a large exposed area of oarweed (kelp) on the lower shore (**Plate 8**).

Plate 8: Exposed *Laminaria digitata* on the lower shore at TN 4

Target note 5

At this location the shore becomes steeper and the biological zones become very narrow as a result. Although similar species to previous TNs are present, a zone exists below the fucoid zone that is dominated by barnacles *Cirripedia spp*, (**Plates 9** and **10**) dog whelks, grey top shells and common limpets. The seaweed community is less diverse at this TN than at previous, however thongweed is very abundant on the lower shore and sea lettuce and sea oak *Halidrys siliquosa* are also present in the lower shore.

Plate 9: Looking south from TN5. Steep boulder shore with narrow biological zones

Plate 10: Looking north from TN 5. A faunal dominated zone below compressed fucoid zone

Target note 6

This target note was recorded to describe the habitat within a small bay between two rock outcrops. At this location the *Pelvetia* zone contained patchy channelled wrack and spiral wrack at the top of the shore. The mid shore was characterised by fucoids covered by a mat of purple laver (**Plate 11**). Very large common and black footed limpets were present in this zone.

In the lower shore the oarweed was present forming a fragmented kelp zone. It was noted that here was a limited understory beneath the kelp which included occasional red rags, sea lettuce, coralline algae, and a mix of other red and green seaweeds, including *Ceramium spp*. and *Membranoptera alata*.

The rock outcrops on either side of the bay were mainly devoid of algae, and barnacles and gastropods dominated with occasional limpets (**Plate 12**). The rocky outcrop on the southern side of the bay continued along the shore and remained dominated by barnacles (**Plate 13**), limpets with small clumps of algae, dog whelks and large beadlet anemones were also present.

Plate 11: Midshore fucoid zone at TN 6. Fucoids covered by a mat of purple laver

Plate 12: Rock outcrop that forms the southern boundary of the bay at TN6

Plate 13: Rocky ledges to the south of TN6

Target note 7

Further south a second slightly larger bay was encountered. The bay at this TN was characterised by two small burns running into the bay, one at its northern (**Plate 14**) and one at its southern extent. Bedrock and boulders dominated the high shore (**Plate 15**) and shingle was the primary substrate at the bottom of the shore.

Algae dominated much of the shore supporting the biological zones identified at previous TNs (**Plate 16**). However, areas of bare shingle were also present and horned wrack and gut weed were encountered where the fresh water entered the bay. Beadlet anemones were notably common at this location.

Plate 14: Mouth of small burn that enters the bay at TN7

Plate 15: Boulder and bedrock dominated the upper shore at TN7

Target note 8

This target note marks the southern edge of the bay described in TN7 which ends in a rock ledge and small cliff (**Plate 17**).

Plate 16: Algal dominated shore with areas of bare shingle at TN7

Plate 17: Southern edge of the bay defined by a rock ledge and small cliff

Target note 9

To the south of the rock ledge/cliff at TN9 another bay which was similar in species and zonation to the previous bay described in TN7 was encountered. Here thrift *Armeria maritima* was abundant on the upper rock ledges. The substrate in the mid shore was composed of angular cobbles and gravel. This supported sparse algal communities of fucoids.

The lower shore substrate comprised of rock ledges and the southern edge of the bay was again boarded by a small cliff and rock ledge which forms the northern edge of an extensive rock outcrop (**Plate 18**).

Plate 18: Rocky ledges dominated by barnacles to the south of TN9

Plate 19: Rock outcrop becomes more broken further south of TN9

The rock outcrop was dominated by barnacles limpets and dog whelks. Sand had been deposited in crevices in the rock and patches of carrageen were present. The outcrop became more broken toward the southern end (**Plate 19**) but remained dominated by the same species, with beadlet anemones becoming more common.

Target notes 10 - 16

To the south of the ferry slipway (**Figure 3.2**) the shore became steep and was mostly composed of bed rock ledges or ribs that sloped from an apex down towards the south and towards the north, the northern edges of the ribs were dominated by barnacles (**Plate 20**), with dogwhelks and limpets also present. The southern edge displaying the typical rocky shore zonation seen in previous TNs i.e. a lichen zone, a *Pelvetia* zone, and a fucoid zone, however below that there was a zone dominated by barnacles (**Plate 21**) pockets of sandy beach also existed (**Plate 22**). Towards the south, larger geo features are present between the ribs, often of cobble, and fucoid dominated (**Plate 23**).

Plate 20: Rocky ribs dominated by barnacles.

Plate 21: Rocky ribs with algal communities on the southern sides

Plate 22: Steep fauna dominated rocky rib and small area of sand

Plate 23: Fucoid dominated boulder geo

Target Note 17
The shore opens to a wide mobile pebble beach (**Plate 24**) with bedrock outcrops, supporting thrift and yellow and grey lichens in the upper shore.

The pebble beach has limited flora and fauna, with rare bladder wrack, thongweed, serrated wrack, sugar kelp and purple larver on scattered cobbles, with grey top shells and common periwinkle.

Target Note 18
Large bedrock outcrops were present at the end of the beach, with a peaty stream (**Plate 25**) between 2 bedrock outcrops. Abundant common periwinkles were present on pebbles and boulders adjacent to the stream, with wracks common to occasional on pebbles and cobbles. Blue mussels were occasionally present on bedrock, with abundant acorn barnacles.

Plate 24: Mobile pebble beach

Plate 25: Stream through bedrock outcrops

4 DISCUSSION

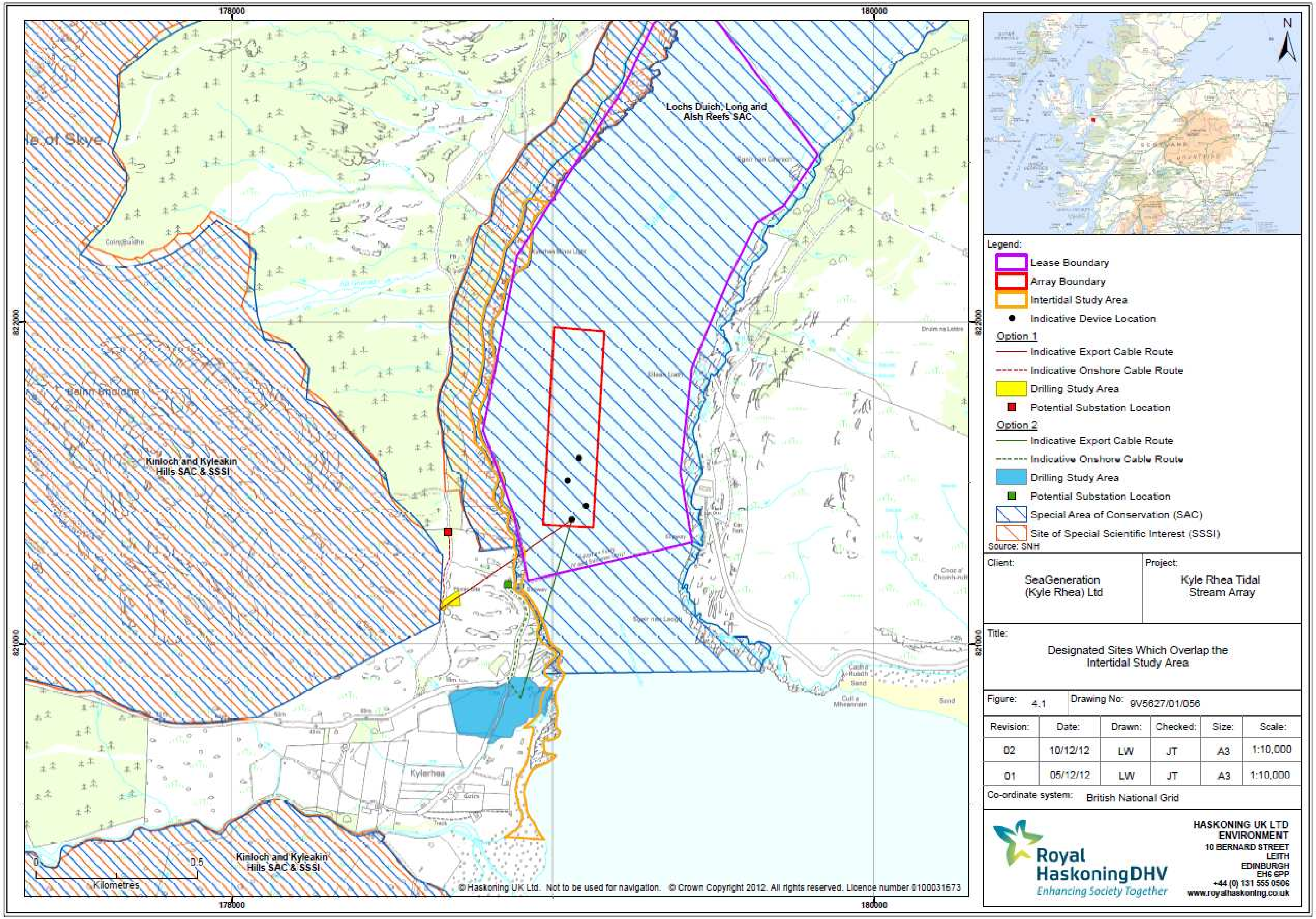
4.1 Habitats

The intertidal habitats encountered during the intertidal survey were typical of rocky shores in the north-west of Scotland that are not exposed to wave action. A number of different substrate types were present within the study area ranging from angular pebbles and shingle in the north and in small bays throughout the study area, to rocky outcrops and ledges leading to steep bedrock outcrops and then pebble beach in the south.

The two main factors that appear to dictate the faunal and floral assemblages are substrate and level of exposure. Where the substrate was relatively stable i.e. large boulders or broken bedrock algal species dominated and exhibited a clear zonation which is found on many rocky shores in the UK. On exposed rock outcrops or rock ledges, algae was sparse or completely absent and here barnacles and associated faunal communities dominated.

4.2 Protected sites

The intertidal study area overlaps with the Lochs Duich, Long and Alsh Reefs Special Area of Conservation (SAC) (which includes the intertidal reef within its designation) and the Kinloch and Kyleakin Hills SAC (which is also a Site of Special Scientific Interest (SSSI)) (**Figure 4.1**).



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Indicative Onshore Cable Route
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Special Area of Conservation (SAC)
Site of Special Scientific Interest (SSSI)
Source: SNH
Client: SeaGeneration (Kyle Rhea) Ltd
Project: Kyle Rhea Tidal Stream Array
Title: Designated Sites Which Overlap the Intertidal Study Area
Figure: 4.1
Drawing No: 9V5627/01/056
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The Lochs Duich, Long and Alsh Reefs SAC has 7 conservation objectives (EMU 2006). The only objective that is pertinent to the intertidal habitats within the study area is:

"The community diversity, extent and plant density of the fucoid dominated intertidal reef biotopes are maintained".

Furthermore, of biotopes of conservation importance recorded within the SAC it is only the Biotope LR.LLR.FVS.AscVS (*Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock) that has potential to be present within the study area. *Fucus vesiculosus* was recoded as present within one location (TN11) within the study area however at this location the substrate was sparse boulders, shingle and cobble. Furthermore the salinity at this site is unlikely to vary considerable due to being a distance from significant freshwater input. In conclusion no biotopes of conservation importance are likely to be present within the study area.

No designated features of the Kinloch and Kyleakin Hills SAC or SSSI occur within the intertidal study area.

The habitats and species found are typical of sheltered rocky shore with limited wave action. The presence of the tidal turbines in the kyle during operation is not anticipated to change the level of wave action or exposure, and therefore there is unlikely to be an impact the coastline or change the community distribution.

5 RECOMENDATIONS

Due to the fact that the power export cables will be installed using HDD (see Section 1.1) it is unlikely that the project will have a significant impact upon intertidal habitats within the study area.

If drilling plant is brought to site by barge, there will be some disturbance of the mobile pebble beach, however, this area supports limited species and would be quick to recover once activity on the beach is completed.

During construction, good working practices and SEPA protocols should eliminate risk of exposure to oil, chemicals and other harmful materials. Construction areas should be left in a safe condition during periods of inactivity, with chemicals and construction materials stored safely, with appropriate bunding, in accordance with SEPA's Pollution Prevention and Chemical Guidelines (PPG2 - Above ground oil storage tanks, and PPG5 – Works in, near or liable to affect watercourses). Adherence should also be made to CIRIA's coastal and marine environmental site guide and pocket book (C584 as amended). An Environmental Management Plan should be produced prior to construction.

6 SPECIES LIST

All common names are sourced from the marine life information network (MarLIN) website (Marlin, undated.)

Common Name	Latin Name
Animalia	
beadlet anemone	*Actinia equina*
sea lemon	*Archidoris pseudoargus*
Sand eel	*Ammodytes spp*
Lug worm	*Arenicola marina*
common starfish	*Asterias rubens*
star ascidian	*Botryllus schlosseri*
common shore crab	*Carcinus maenas*
shredded carrot sponge	*Esperiopsis fucorum*
grey top shell	*Gibbula cineraria*
breadcrumb sponge	*Halichondria panicea*
Sand mason worm	*Lanice conchilega*
common periwinkle	*Littorina littorea*
rough periwinkle	*Littorina saxatilis*
sea squirt	*Morchellium argus,*
Blue mussel	*Mytilus edulis*
dog whelks	*Nucella lapillus*
black-footed limpets	*Patella depressa*
china limpet	*Patella ulyssiponensis*
common limpets	*Patella vulgata*
tubeworm	*Pomatoceros triqueter*
tube worm	*Spirorbis spirorbis*
Acorn barnacle	*Semibalanus balanoides*
Orange sponge indet.	
Plantae	
thrift	*Armeria maritima*
red seaweed	*Ceramium spp*.
carrageen	*Chondrus crispus*
Green seaweed	*Cladophora rupestris*
coral weed	*Corallina officinalis*
sea beech	*Delesseria sanguinea*
red rags	*Dilsea carnosa*
horned wrack	*Fucus ceranoides*
toothed wrack	*Fucus serratus*
spiral wrack	*Fucus spiralis*
bladder wrack	*Fucus vesiculosus*
sea oak	*Halidrys siliquosa*
red algae	*Hildenbrandia rubra*
thongweed	*Himanthalia elongata*
oarweed	*Laminaria digitata*
Red seaweed	*Lomentaria articulata*

Common Name	Latin Name
false Irish moss	*Mastocarpus stellatus*
red seaweed	*Membranoptera alata*
Rugose squat lobster	*Munida rugosa*
crab eye lichen	*Ochrolechia parella*
Channelled wrack	*Pelvetia canaliculata*
Red seaweed	*Polysiphonia spp.*
Red seaweed	*Polysiphonia lanosa*
red seaweed	*Plumaria plumosa*
purple laver	*Porphyra umbilicalis*
sea ivory	*Ramalina siliquosa*
sugar kelp	*Saccharina latissima*
gut weed	*Ulva intestinalis*
Sea lettuce	*Ulva lactuca*
tar Lichen	*Verrucaria maura*
orange lichen	*Xanthoria* parietina
sea lettuce	*Ulva lactuca*

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Wyn, G, Brazier, P and McMath, A J (2000). *CCW handbook for marine intertidal Phase 1 survey and mapping.* CCW Marine Sciences Report: 00/06/01.

Royal HaskoningDHV (2012a) Kyle Rhea Extended Phase 1 Survey Report: Technical Report To Inform the Kyle Rhea Tidal Array Development ES

Royal HaskoningDHV (2012b) Kyle Rhea Otter survey report: Technical Report To Inform the Kyle Rhea Tidal Array Development ES

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8 ANNEX A: TARGET NOTES AS RECORDED IN THE FIELD.

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
1	178782	821942	Lichen Zone- Large Boulders, small outcrops of bedrock with cobble between. Species: Sea ivory *Ramalina siliquosa*, Crab eye lichen *Ochrolechia parella*, and other white and grey lichens all present at the top of the lichen zone, Tar lichen *Verrucaria maura* and Orange lichen *Xanthoria spp*. more prevalent at the bottom of the lichen zone. *Pelvetia* zone- Small boulders and cobbles with angular shingle: Rough periwinkle *Littorina saxatilis*, small patches of spiral wrack *Fucus spiralis* dense channelled wrack *Pelvetia canaliculata*. Lower in the zone the presence of spiralis increases. Fucoid zone- Boulders and large pebbles: Knotted wrack *Ascophyllum nodosum* dominating with *Polysiphonia lanosa,* unidentified mollusc eggs, abundant spiral wrack, sea lettuce *Ulva lactuca*, grey top shell *Gibbula cineraria*, beadlet anemone *Actinia equina*, dog whelk *Nucella lapillus, Cladophora rupestris*, carrageen *Chondrus crispus,* common periwinkle *Littorina littorea*, *Membranoptera alata* and Montagu's stellate barnacle *Chthamalus montagui*. Lower down in the fucoid zone: Toothed wrack *Fucus serratus*, common limpet *Patella vulgata*, acorn barnacle *Semibalanus balanoides* Sea beech *Delesseria sanguinea*, *Chondrus crispus,* Thongweed *Himanthalia elongata* and *Spirorbis spirorbis, Plumaria plumosa* and *Ceramium spp*. Top edge of the kelp zone- mostly boulders: thong weed, Star ascidian - *Botryllus schlosseri*, shredded carrot sponge *Esperiopsis fucorum*, *Pomatoceros triqueter*, Sugar kelp *Saccharina latissima*, *Morchellium argus,* Common starfish *Asterias rubens*, Sea lemon *Archidoris pseudoargus*, beadlet anemone and common shore crab *Carcinus maenas.* The understory of the lower intertidal has a diverse range of red and brown seaweeds. It was	SC 494, 495

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
			not possible to get properly into the kelp zone as the tide was not low enough but dense Oarweed *Laminaria digitata* could be seen with red rags *Dilsea carnosa* and Coral weed *Corallina officinalis* identifiable from a distance. Small outcrops of rock with patches of trapped sand are present in the lower shore and on these outcrops the breadcrumb sponge *Halichondria panicea* exists.	
2	178796	821885	A rib of rock running north east across the shore with shingle either side, very little fauna and flora on shingle, probably due to the fact that it is more mobile. Channelled wrack and tar lichen present at the top of it with small patches of knotted wrack, common limpet, barnacles, dog whelk, beadlet anemone, grey top shell, Cladophora. Most of the same species as TN1 are present with the addition of *Hildenbrandia rubra* and false Irish moss *Mastocarpus stellatus.*	
3	178812	821875	Lichen zone – less steep than at previous TN, with boulders cobble and shingle. Tar lichen dominant. Pelvetia zone- is quite narrow (2m). Fucus spiralis zone also narrow (1m). 2nd Fucoid zone much wider: dominated by knotted wrack with: beadlet anemone, carrageen, common limpet, rough periwinkle, acorn barnacle, rare *Fucus spiralis*, grey topshell and dog whelk. Sandy shingle zone- small patches of seaweed growing on boulders. Carrageen, knotted wrack, purple laver *Porphyra umbilicalis* and Common limpet. Lower shore- large kelp, oarweed *Laminaria digitata* unidentified eggs on serrated wrack fronds.	SC 497, 498

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
			Moving south red rags and Cladophora were present along with many of the red and green seaweeds identified at previous TNs however they are less dense.	
4	178778	821756	Shore similar to TN3 with the exception of a large exposed area of kelp on the lower shore.	SC499 500(S) 501 (N) from this WP
5	178768	821632	Shore steepens here and biological zones become very narrow and although similar species to previous TNs are present, a zone exists below the fucoid zone that is dominated by barnacles *Cirripedia spp.*, dog whelks and grey top shells and common limpets. The seaweed community is less diverse at this TN than previous but thongweed is very abundant on the lower shore and sea lettuce and sea oak *Halidrys siliquosa* is also present.	SC 506 N and 507(S)
6	178828	821539	Small bay between two rock outcrops. Pelvetia zone -Patchy channelled wrack and spiral wrack at the top of the shore. Mid shore characterised by fucoids covered by a mat of purple laver. Very large limpets are common both *Patella vulgata* and *Patella depressa*. Kelp Zone- limited understory with redrags, sea lettuce coralline algae, and a mix of other red and green seaweeds, *Ceramium spp*. and *Membranoptera alata.* The rock outcrops are devoid of algae, and barnacles and gastropods dominate with occasional patelids. The rocky outcrop on the southern side of the bay continues along the shore and continues to be dominated by barnacles and limpets with small clumps of algae, dog whelks and large beadlet anemones also present.	SC511 DT SLR 47,48 SC513
7	178829	821481	Small Bay with a burn running into both the northern and southern ends. Bedrock and boulders dominate the high shore and shingle and dictates the primary biotope at the bottom of the shore.	SC 515 DT SLR 50-51

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
			Algae dominated shore showing the biological zones identified at previous TN where algae were dominant. Horned wrack *Fucus ceranoides* and gut weed *Ulva intestinalis* are present where the fresh water enters the bay. Beadlet anemones are notably common.	
8	178838	821405	Southern edge of the bay described in TN7 ends in a rock ledge and small cliff.	
9	178864	821370	To the south of the rock ledge/cliff is another bay which is similar in species and zonation as the previous bay described in TN7. Thrift *Armeria maritime* abundant on the rock ledges. Sparse algae present in the mid shore as the substrate becomes more broken with angular cobbles and gravel. The lower shore has a substrate of rock ledges and the southern edge of the bay is boarded by a small cliff and rock ledge which forms the northern edge of an extensive rock outcrop. This is dominated by barnacles limpets and dogwhelks. Sand is deposited in crevices in the rock and patches of carrageen were apparent. The outcrop becomes very ledgey but is still dominated by the same species, with beadlet anemones becoming more common.	DT SLR 60 SC 520-522
10	No access assed from road above		South of the ferry slipway the shore becomes steep and is mostly composed of bed rock ledges or ribs that slope from an apex down to the south and north, the northern edges of the ribs have a midshore dominated by barnacles with dogwhelks and limpets present and the southern edge display the typical rocky shore zonation of algae seen in previous TNS i.e Lichen zone, Pelvetia zone, fucoid zone, however below the fucoid zone there is a zone dominated by barnacles (see photo) pockets of sandy beach also exist further to the south.	DT SLR 68, 69 and 89
11	178822	822100	Easy angled shore, boulders dominate the uppershore but are more sparse in the mid shore. The lichen zone is clearly defined with grey and yellow lichens at the top of the zone and tar lichen at the bottom. A dense but narrow band (3m) of channelled wrack is below.	SC 525, 526

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
			Large fucoid zone with occasional acorn barnacles, occasional limpets of both *P. vulgata and P. depressa* present mostly on the underside of rocks, grey top shell and dog whelks present. Mid shore has toothed wrack and bladder wrack *Fucus vesiculosus* which are covered by a mat of purple laver and gut weed. Also present are beadlet anemones and carrageen. There are large areas of algal free gravel and pebble. Filamentous brown and green seaweeds are also present. The upper mid shore is about 40% covered in seaweed and the lower mid shore 90%. The china limpet *Patella ulyssiponensis* was also present. There is far less fauna on this shore than further south.	
12	178907	822216	Shore around the lighthouse. A small burn runs down the shore here and horned wrack is present near to the fresh water. Small groups of Common mussel *Mytilus edulis* were found growing on rocks.	
13	178928	821076	Steep exposed slanting bedrock fins. Thrift in splash zone, leading to grey and yellow lichens to tar lichen. Dense zone of channelled wrack, leading to narrower spiral wrack zone with beadlet anemones, acorn barnacle *Semibalanus balanoides*, common limpet, dog whelk, common periwinkle. Mid shore consisted of knotted wrack, supporting the epiphyte *Polysiphonia lanosa*, with dense barnacles, common limpet, beadlet anemone and dog whelk. Low shore with scattered boulder and cobble on coarse shelly gravelly sand. Species in the low shore include grey top shell, green seaweed *Cladophora rupestris*, sea lettuce *Ulva lactuca*, oarweed, tube worm, false Irish moss, *Polysiphonia spp, Ceramium spp*., carrageen *Chondrus crispus*, *Cladophora rupestris*, breadcrumb sponge, *Membranoptera alata*, red seaweed *Lomentaria articulata*, pink coralline algae, orange sponge indet, thongweed,	SLR 152 – 160

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
			rugose squat lobster *Munida rugosa.*	
14	179010	820970	Series of slanting bedrock fins, with geos between, supporting dense fucoids (knotted and bladder wrack) and rough periwinkle. The rocky outcrops delineating the geos support a faunal dominated community, with dense acorn barnacle, dog whelk and common limpet, however channelled wrack and spiral wrack is present.	SLR 161 – 165
15	179017	820944	Geo of boulder and cobble with dense wracks: Channelled wrack, leading to spiral wrack, leading to knotted and bladder wracks to oarweed in the low shore. Upper shore bedrock fins with grey and yellow lichens, rock is still mainly faunal dominated, with a zone of channelled wrack. Rockpools in midshore on bedrock fins, mainly wracks, with some red seaweeds and *Cladophora rupestris*.	SLR 166 – 168
16	179003	820883	Large blue mussels embedded in gravel in geo, with scattered knotted wrack with *Polysiphonia lanosa*.	SLR 169
17	179001	820858	Wide pebble beach with bedrock outcrops, supporting thrift and yellow and grey lichens. Pebble beach with limited flora and fauna, rare bladder wrack, thongweed, serrated wrack, sugar kelp and purple larver on scattered cobbles, with grey top shells and common periwinkle. Gutweed also present.	170 – 179
18	179002	820776	Large bedrock outcrop at the end of the beach. Peaty stream between 2 bedrock outcrops. Abundant common periwinkle on pebbles and boulders adjacent to the stream, with wracks common to occasional on pebbles and cobbles. occasional blue mussels present on bedrock, with abundant acorn barnacles. Knotted wrack with *Polysiphonia lanosa*, spiral wrack, channelled wrack and yellow and grey lichen zones on the bedrock.	SLR 180 - 183
19	178971	820709	Series of rocky fins on a shore of cobble and pebble.	SLR 184 - 185

Target Note	Grid Ref		Description (common names taken from MarLIN)	Photos (N) = North (S)= South etc.
	Easting	Northing		
			Upper shore of cobble and pebble. Mid shore with dense bladder wrack, thongweed and rough periwinkle, dog whelk and common limpets, sea lettuce, gut weed, carrageen, purple larver, *Cladophora rupestris* and sand eel *Ammodytes s*pp. Bedrock is dominated by faunal communities with common limpet, acorn barnacle, beadlet anemone and grey top shells. A sheltered embayment is caused by 2 fins of bedrock creating shelter from wave action. Coarse sand has accumulated with lug worm *Arenicola marina* and sand mason worm *Lanice conchilega*. The red seaweed *Hildenbrandia rubra* was also present.	
20	178954	820634	Large bedrock outcrop with frequent blue mussel clumps, dense barnacles with common limpets and occasional bladder wrack. Small areas of muddy sand are present, supporting sand mason(10/m^2) and lug worm (5/m^2), just up shore of the bed rock in the low to mid shore. Upper shore consists of large cobbles.	186 – 188
21	178927	820580	Cobble and pebble shore with rare bedrock outcrops in the upper shore. Abundant common periwinkle on substrata. Lower shore supporting bladder wrack, serrated wrack, sugar kelp, gutweed and beadlet anemones, with some purple larver present in the mid shore.	
22	178911	820482	Small patch of sand in the lower shore, with scattered pebble and cobble and occasional lug worm casts.	189
23	178912	820422	From here south, sandy substrata with a top layer of gravel and pebble with scattered fucoids on larger rocks. Cobbles in upper shore, with small outcrops of limpet and barnacle dominated bedrock.	192 - 194

Kyle Rhea Tidal Stream Array

Appendix 11.1

Kyle Rhea Marine Turbine Array

Year 1 Birds Technical Report

September 2012

NRP NATURAL RESEARCH PROJECTS LIMITED

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Kyle Rhea Tidal Array Project

Year 1 Birds Technical Report

September 2012

Kyle Rhea Sound looking west to Skye. Photo copyright Andy Law

natural
RESEARCH (PROJECTS) LTD

Digger Jackson

Introduction

This report presents the findings of the first year of bird surveys undertaken at Kyle Rhea sound to inform the environmental impact assessment (EIA) of the proposed Kyle Rhea Tidal Array development. The surveys were undertaken by Natural Research Projects Ltd (NRP) on behalf of Marine Current Turbines Ltd (MCT). Although marine mammal and basking shark were surveyed as part of the same programme of fieldwork, the results for these species are reported separately (Appendix 12.3, Year 1 Marine Mammal and Basking Shark Report).

Survey work commenced on 6 July 2011. This report covers the whole of Year 1 plus July 2012. July is potentially an important month, coinciding with peak harbour seal activity and is also a time when breeding terns, divers and white-tailed eagle could potentially be foraging for dependent young. Therefore it was considered useful to report the results for July 2012 alongside the Year 1 results even though the results for that month form part of a Year 2 period. For convenience, the 13-month period reported on is hereafter simply referred to as Year 1 in this report.

The survey work is on-going at the time of writing this report. Marine Scotland (MS) and Scottish Natural Heritage (SNH) will review of the results collected to date (through this report) and will then advise as to whether the data collected to date are sufficient to characterise the site for EIA purposes. Following their advice a decision will be made as to how long baseline survey work should continue.

The proposed development

The proposed MCT Tidal Array development is located in Kyle Rhea, the narrow northern most part of the sea channel between the Island of Skye and the Scottish Mainland (Map 1). The proposed sites lies between approximately 200m and 800m north of the Kylerhea - Glenelg ferry route (Map 2). Four twin rotor 2MW SeaGen devices are proposed, providing an 8MW installed capacity.

Survey scope and aims

The aims of the baseline survey work are to provide quantitative and qualitative information to serve two purposes:

1. To characterise baseline conditions to inform the assessment of impacts for the Environmental Statement.
2. To establish baseline conditions against which results of future (post-consent) monitoring studies can be compared.

The survey work programme was designed to quantify the year-round use of Kyle Rhea sound and adjacent coasts by; birds, marine mammals and basking shark. This includes:

- Identification of species;
- Estimation of absolute or relative numbers of each species (as appropriate for the species concerned);
- Mapping distribution of each species' activity;

- Measuring seasonal changes in species occurrence;
- Identifying the stages of a species' life-cycle and behavioural activities that utilise Kyle Rhea.

Survey design and programme

Prior to the commencement of fieldwork, a survey programme was designed to provide year-round baseline information on the distribution and abundance of birds, marine mammals and basking shark present in the proposed development search area and a surrounding buffer area (Map 2). The survey design took into consideration the draft SNH guidance on survey and monitoring for wet renewable developments (Jackson and Whitfield 2011, Macleod *et al.* 2011, Sparling *et al.* 2011). The design has many similarities with the fieldwork programme used for studies at the Sound of Islay (undertaken by NRP and SMRU Ltd) to inform EIA work for the proposed tidal turbine array there. The Sound of Islay has a similar geography to Kyle Rhea Sound, albeit at a somewhat larger scale.

Kyle Rhea Sound is approximately 700m wide and is bounded by steeply rising shores on either side (title page photo). With the aid of binoculars and a spotting-scope all species of interest can be identified relatively easily at distances up to at least 1 km away. For this reason it is practical to conduct surveys of the entire width of the sound from one shore only. Indeed, the site is ideally suited to visual surveys from shore vantage points.

The survey design integrates the shore-based survey of birds, marine mammals and basking shark into a single programme based on using a single observer to collect data. The Development Site (the location of the four proposed turbines) covers an area measuring approximately 500m x 200 m and lies approximately mid channel (Map 2). The whole of this area and a surrounding buffer of 500 m can be viewed from a single vantage point (VP1) on the Skye side of the sound (Map 2, Photo 1). A similarly sized area immediately to the north is also included in the study and this is viewed from a second vantage point (VP2) positioned approximately 1.6 km north of VP1 (Map 2, Photo 2). From the two VPs, the almost the whole of the Kyle Rhea sound is covered. The monthly programme of survey work from these VPs provides repeated information on the numbers, activity and fine-scale distribution of animals using the sound.

Habitat zones

In addition to recording the estimated location of species seen in surveys the broad habitat where they were seen was also recorded. The Kyle Rhea sea channel was divided into four habitat zones (Map 3), defined according to the position across the channel. These were:

- West Side Zone (WSZ),
- West Central Zone (WCZ),
- East Central Zone (ECZ),
- East Side Zone (ESZ)

The WCZ was defined as a 150m-wide strip whose eastern edge was mid line of the channel. The ECZ was the corresponding and adjoining 150m-wide strip to the east of the mid line. The WSZ was a strip between the WCZ and the west shore, and the ESZ was the strip between the ECZ and the eastern shore. The WSZ and ESZ were approximately the same width as the central zones, but the actual width at any place varied according to the local variation in shorelines and the state of the tide. The proposed Development Site lies almost entirely within the WCZ (Map 3). Assigning a record to a particular habitat zone was based on the observer's judgement.

In addition to the four sea habitat zones defined above, east and west edge zones (EEZ and WEZ respectively) were also used for species that came ashore to use exposed intertidal ground and adjacent shoreline habitats (Photo 3).

Survey methods

Vantage point watches

Watches were made from the two VPs. VP1 overlooked southern half of Kyle Rhea, including the proposed development site, and VP2 overlooked the northern half (Map 2, Photos 1 and 2 respectively). These VP locations were carefully selected during a reconnaissance visit to the site to give optimal views of the areas of interest. The area of sea and the shorelines that were clearly visible from the VPs out to 1 km is referred to as the area of VP coverage and is shown in Map 2. Coverage from the two VPs overlapped by about 300m in the western half of the channel (Map 2.)

VP watch session lasted for three hours or slightly more and consisted of short bouts of three separate activities, namely Marine Mammal Watches (MMWs), Snap-shot Scans (SSSs) and Flying Bird Watches (FBWs) (Table 1); these are the same activities that were undertaken in the Sound of Islay surveys.

Each VP had a total of 15 hours planned watch effort per month (5 x 3-hour sessions). Watches from the two VPs were scheduled so that, as far as is practicable, each month's sampling effort was evenly distributed with respect to tidal cycle (six periods per ebb-flow cycle). VP watches were scheduled to be spread over 10 days each month; but the actual number can varied due to constraints caused by weather conditions and fieldworker availability.

A three-hour VP watch typically comprised three snap-shot scans (one per hour and each taking on average 24 minutes to complete) and three 5-minute flying bird watches (one per hour). The remaining time of the three-hour session was spent watching for marine mammals, with watches broken down into fixed periods of 15 minutes (see below). In addition the number of seals present on haul-outs is counted at least four times per month (see MMTR).

Snap-shot scans

Snap-shot scans primarily aim to measure the instantaneous distribution of birds using the sound. Any cetaceans and basking shark noted when searching are also recorded. Each scan took about 15-30 minutes to complete (mean 24 minutes), depending on how many birds and marine mammals were present and the weather conditions. Snapshot scans were only conducted in conditions of sea state 4 or below (over the majority of the visible area). Flying birds passing through the sound, except those that were obviously actively searching for food, were ignored. Scans are undertaken by systematically examining the arc of the search area from one side to other, going sufficiently slowly so as to reduce the likelihood of overlooking actively diving birds or cetaceans because they are underwater (dives by birds typically last less than one minute).

The following details were recorded for all birds and cetaceans seen during snapshot scans: species, age/size, group size, activity when first seen, location, habitat and travel direction. The survey recording form also had space for the observer to record additional comments on an animal's behaviour etc.

The position of birds was recorded in terms of an estimated distance and compass bearing from the VP. Distance was estimated with the aid of graticule binoculars and with reference to specially prepared large scale field maps marked with concentric 100m distance-zones and notable landmarks. In addition to the compass and graticule bins, the good elevation of the VPs (approximately 30m) combined with the narrowness of the sound and abundance of easily recognisable landmarks meant that estimating distance to an accuracy of around 10% was easily achieved (note, this exceeds the accuracy typically achieved at sites without these advantages such as open coast situations).

Flying bird watches

Flying bird watches (FBW) were periods of five minutes observation during which time the number of flying birds passing a notional line across the sound straight out from the VP are recorded. These watches aimed to quantify the rate of seabird bird passage through the sound. The species, age, distance band and direction of travel are recorded. Any cetaceans or basking shark seen during FBW were also recorded in the same way described above.

Flying bird watches are conducted approximately every hour during each VP session; this means that approximately thirty 5-minute watches are completed each month.

Marine mammal watches

Marine mammal watches (MMW) were fixed periods of 15-minute watching. These aimed to measure the activity of marine mammals and basking sharks using the survey area or passing through the sound during each period. These watches are designed to measure a rate of occurrence and therefore were of fixed duration. As many 15-minute bouts were completed as possible in a VP session subject to completing the other survey activities. Marine mammal watches are only conducted in conditions of below sea state 4 (over the majority of the visible area). The sheltered situation of Kyle Rhea meant that sea state conditions were not a major constraint on field work.

The following details are recorded for all marine mammals and basking sharks seen: time, species, age/size, group size, activity when first seen, location and travel direction. Location is recorded in terms of a compass bearing, estimated distance from VP. Locations were recorded with the aid of graduated compass binoculars (i.e. fitted with a vertical graticule and an internal compass). The habitat/position in the channel at the location where an animal is seen is also recorded.

Additional information

Scarce species of high conservation value were recorded whenever they were seen irrespective of the survey activity being undertaken at the time. They were also recorded if seen incidentally, e.g., whilst walking to VPs. Scarce species included all cetaceans, basking shark and any bird species listed on Annex 1 of the EU Birds Directive or Schedule 1 of the Wildlife and Countryside Act. Similarly, any notably large flocks of birds seen were recorded irrespective of the survey activity being undertaken at the time. Notable flocks were any flocks >20 individuals, with the exception of cormorant, shag, herring gull and great black-backed gull.

In addition to the VP work, the survey programme included walkover surveys of the stretches of coast close (within approximately 1 km) to the Development Search Areas. Coast walkover surveys were undertaken at approximately bi-monthly intervals through the year.

All survey work was undertaken by Andy Law who, conveniently, lives in the village of Kylerhea, within walking distance of the VPs.

The ferrymen who operate the seasonal Glenelg-Kylerhea ferry (Photo 4) kindly agreed to record any cetaceans, basking sharks or notable birds they saw whilst operating the ferry. They were provided with identification charts of cetaceans and a notebook to be kept on the ferry bridge to facilitate this. Andy Law regularly liaised with them.

Data Analyses

The snap-shot scan results for bird species with less than ten snap-shot scan records through the year are summarised by simple textual summaries in Tables 10, 11, 13, 17, 18 and 19. For species with ten or more snap-shot scan records through the year summary statistics are presented month-by-month in species specific results table. For each species, three summary statistics were calculated (using the pivot table function in Excel software) for each month for each VP. These are, the percentage of snap shot scans that the species was recorded, the mean numbers of individuals recorded that month and the maximum numbers of individuals recorded that month.

The results of the 5-minute flying bird watches for each species were summed month-by-month and then divided by the total watch time for each month to give a mean rate of passage through the sound per hour for each species. This was done for all species with ten or more flying-bird-watch records through the year. Flight activity by species with fewer than ten flying-bird-watch records is summarised in the textual summary tables (Tables 10, 11, 13, 17, 18 and 19).

On five occasions poor light meant it was not possible to obtain precise counts of the number of cormorant and shag in mixed feeding flock located relatively far (ca. 1km) from the observer. For these occasions the total flock size was counted and an estimate made of the proportional make up of each species based on the birds that could be seen well enough to be identified and the ratio seen in counts earlier in the session.

Species priority

The survey work at Kyle Rhea was undertaken to inform the EIA of potential effects arising from the proposed tidal array. It is therefore useful for this report to consider how important

Kyle Rhea is for each species and what priority each species should receive in the EIA. With this in mind, each species is given a provisional priority rating of high, medium or low. The basis of each species' rating is a combination of information on it's frequency of occurrence and abundance, the importance of the site to regional populations and the conservation status of the species.

Species rated as high priority are those that merit the greatest level of scrutiny in the EIA, potential effects on these species could lead to significant changes to a species regional population status.

Species rated as medium priority also merit detailed EIA consideration nevertheless it is clear that potential effects are unlikely to lead to significant changes to regional populations even under pessimistic scenarios because the numbers using the site are simply too low. Nevertheless, effects on these species still need to be assessed and it will be best practice where possible to reduce any adverse effects through mitigation.

Low priority species are those for which Kyle Rhea clearly has negligible importance and there is no plausible likelihood that the proposal could lead to adverse effects on populations. Low priority species do not merit detailed consideration within EIA. A cautious approach has been taken in deciding priority ratings, choosing a higher priority category where a species is border line or if there is uncertainty.

The priority rating is not intended to stray into the process of assessment itself, this will be done in the ES. The EIA priority ratings suggested in this report are provisional and will be revised as appropriate if new information becomes available before the ES is written.

Results

Survey effort

The VP fieldwork completed during the Year 1 survey work (early July 2011 to end July 2012) is summarised in Tables 1 - 3.

The field work programme was broadly completed as planned (Table 1). In some months periods of wet or windy weather resulted in unsuitable conditions for surveys (either poor visibility or high sea states) and this sometimes resulted in a small shortfall of planned effort by the end of some months. For example in December and February only 80% of the planned visits were completed (i.e., 8 of the 10 planned VP sessions). Where possible any shortfall was made good in the following month.

The small shortfall in effort in some months is not considered to be a significant issue because of the relatively high consistency of results obtained from replicate survey bouts. Indeed, in the case of birds, the amount of snap-shot effort expended was far greater than was required to achieve a reasonable and consistent measure of a species use of the study area each season.

In total 365 snap-shot scans were undertaken in the 13 month period taking 144.6 hours to complete (averaging approximately 24 minutes per snapshot scan). A total of 398 five-minute flying bird watches were completed in the same period, adding up to 33.2 hours of cumulative effort. A further 144.3 hours was spent undertaking marine mammal watches and 64.8 hours undertaking counts of hauled seals.

VP watches were undertaken on a total of 121 different days in the 13 month period (Table 3). Typically, each month's VP fieldwork was spread over approximately 10 days, with a single 3-hour session completed on each day.

97% of VP fieldwork was conducted when conditions in the sound were sea state of 0 or 1 (Table 4). As a result, conditions were typically extremely favourable for achieving high levels of detection of all species. The narrowness of the sound (750m at its widest) also contributed to high detection rates.

VP fieldwork was approximately evenly spread throughout the tidal cycle (Table 5). There was a slight bias in favour of the low tide period (Tidal periods 2 to 4), reflecting the desire for watches to coincide with when seals were most likely to be hauled out, so that an accurate count of seals could be made.

Walkover surveys of the coasts were completed in Nov 2011, then Jan 2012, March 2012, May 2012 and July 2012.

Numerous incidental records of cetaceans (summarised in MMTR) and sea eagle (summarised in this report) were reported to Andy Law by Glenelg ferrymen. This help is gratefully acknowledged.

Results

Overview of birds recorded

The range of bird species seen and their abundance were in all case in line with broad expectations based on a combination of published information (e.g., Forrester and Andrews 2007), discussion with local RSPB staff and local residents and the first-hand experience of NRP staff with the area. The results show that, with the exception of shag and cormorant the survey area is generally of low importance for seabirds, waders and wildfowl species. Nevertheless, several species of high conservation value were recorded, but in all cases relatively infrequently and in small numbers. Also of note was the frequent use of the site for feeding by white-tailed sea eagle (Photo 5) during the breeding season.

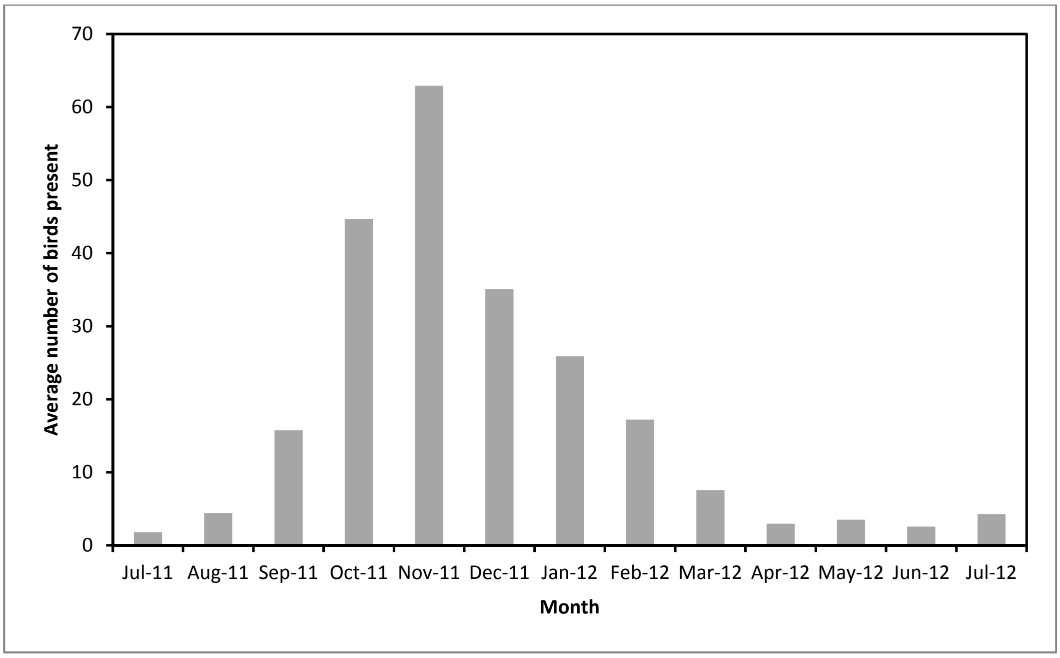
It's worth noting the high importance of the skerries to the north of the lighthouse situated on the western shore between VP1 and VP2 (Photos 3 and 7). These rocks are the social hub of the narrows for many species, as they act as the centre for roosting birds and as the haul out areas for the seals. White-tailed eagles also perch on these skerries occasionally. These skerries are very important to wildlife as they provide sanctuary from the strong tidal currents. The sheltered intertidal ground in the vicinity of the skerries, particularly where a burn enters below the otter hide (Photo 3), are also the most important part of the sound for feeding gulls, wildfowl and waders.

Cormorant

Only two diving seabird species commonly occur in moderate numbers, cormorant and shag (Photos 6 and 7). These two species commonly occurred together in mixed feeding flocks and roosts. On five occasions poor light meant it was not possible to obtain precise counts of each species in feeding flocks located relatively far from the observer (700 m-. 1km). On these occasions the total flock size was counted and an estimate made of the proportional make up of each species based on the birds that could be seen well enough to be identified and the ratio seen in counts earlier in the session.

Cormorant was recorded throughout the year but showed a marked seasonal variation in abundance; numbers were much greater in the non-breeding part of the year (September to February) (Fig. 1). From late July 2011 numbers steadily increased from less than 10 birds to reach a peak of 74 birds (maximum count) in November. Thereafter they steadily declined to less than 10 birds (maximum counts) by mid-March and then remained low through to July 2012 The much lower abundance of birds during the breeding season was presumably caused by some birds moving to breeding colonies.

Figure 1. The average number of cormorants recorded during snap-shot scans at Kyle Rhea survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Interestingly almost all the cormorants recorded in the breeding seasons (April to July) were in adult summer plumage. However, there was no evidence that these individuals were engaged in breeding.

Cormorants were seen both on the sea (Map 5), where they were commonly seen foraging, and on roost sites such as rocky skerries along the Kyle Rhea shores (Map 7). Nearly 80% of cormorants seen during snap-shot scans were birds roosting on land. All cormorant roost sites were located on the west shore of Kyle Rhea, most between the two VPs.

Cormorants were recorded on the sea (n=576) throughout the survey area but not uniformly so. They were commonest in the WSZ habitat zone (the zone formed by the west side of the channel). Cormorants on the sea that were noted as actively engaged in diving behaviour (n=333) used the WCZ, ECZ and ESZ channel zones approximately equally (Map 5); together these three zones accounted for 36% of records of diving birds. The remaining 64% of records of diving cormorant were in the WSZ part of the sound. Diving cormorant showed an almost complete avoidance of the deepest parts of the sound (approximately >25m) including most of the development site (Map 5). This result suggests that cormorants preferred the relatively shallow areas along the western shore (i.e., the WSZ) for foraging, rather than the deeper main channel areas. Whereas the WSZ probably had the most suitable foraging habitat as it was also closest to the roost sites and this is likely to have affected the birds' habitat choice. The WSZ is the closest zone to the VPs and so it is possible there was some distance related bias in the detection of birds. However, the magnitude of any bias is likely to be small for such a large bird especially given the modest maximum further distance of search (ca. 1 km) and the lack of any obvious distance bias in smaller species such as auks.

Cormorant was one of the species most frequently recorded in flying bird watches (Table 6). Over the year as a whole there was an average of 7.3 cormorant flights past the VPs per hour. As far as could be ascertained by the observer, the great majority of flying cormorants were birds making short-distance flights relocating between feeding areas, or between feeding areas and roost sites, within the Kyle Rhea area.

Cormorant is a relatively uncommon breeding species on the west coast of Scotland and Inner Hebrides. They are also a relatively sedentary species (Wernham *et al.* 2002). The breeding cormorant population for Skye and Lochalsh is 166 pairs only (Seabirds 2000 count, Mitchel *et al.* 2004). Therefore, it is likely that the Kyle Rhea sound supports in the region of 10-15% of the Skye and Lochalsh population in the autumn and winter.

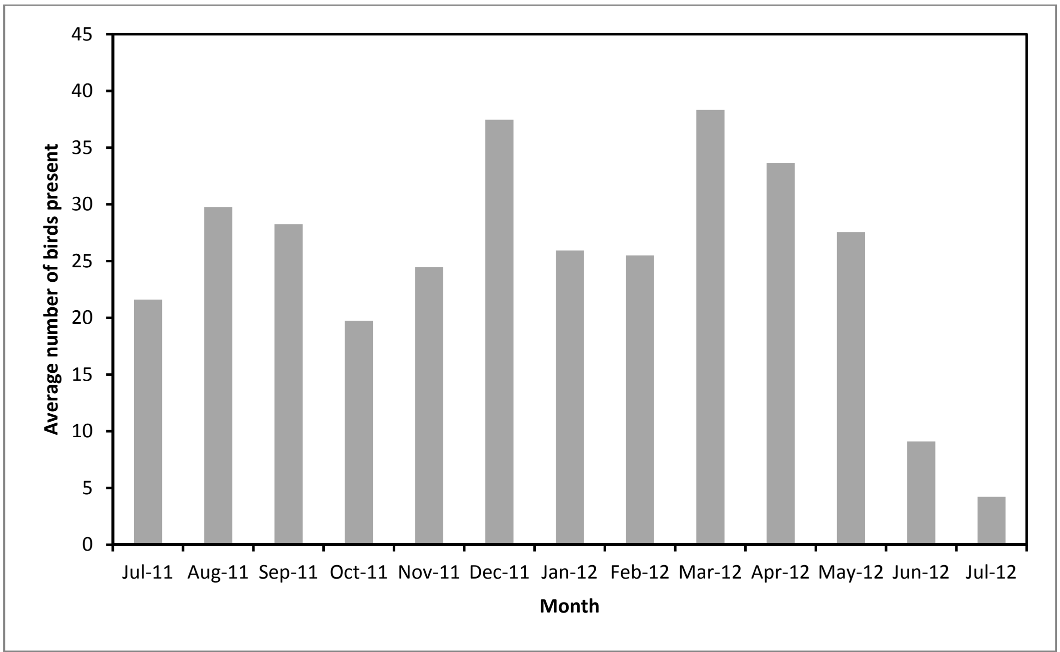
Agreement is required with SNH regarding the appropriate boundaries for defining the regional cormorant population for assessment purposes. It is suggested that an area comprising north-west Scotland excepting the Outer Hebrides would be appropriate. For practical purposes this would be defined as the north-west coast of Sutherland, the west coast of Ross, Skye and Lochalsh and Lochaber. This area has a relatively geographically discrete cormorant population (see map on page 134 in Mitchell *et al* 2004). Seabird 2000 showed that this area had 347 pairs breeding at sixteen colonies (north-west coat of Sutherland, 76 pairs in three colonies; west coast of Ross, 82 pairs and in three colonies; Skye and Lochalsh in nine colonies, 166 pairs; and Lochaber, 23 pairs in one colony.)

Assuming that about one third of birds in the region are non-breeding immature birds, this would give a regional population of around 1000 individuals. Further assuming that this population remains in the region through the year and is not joined by individuals from other regions, this would mean that in autumn and winter Kyle Rhea on average support around 5% of the regional population, and around 7% when peak numbers are present. On this basis Kyle Rhea clearly has moderate importance for the regional cormorant population. Indeed, the regular presence of relatively large numbers of cormorant is arguably the most important ornithological feature of the survey area. For this reason cormorant is rated as high priority for the EIA.

Shag

Shags were commonly recorded from both VPs in all months through the year (Figure 2, Tables 6 and 9). The maximum count was 54 birds in February, and at least 25 individuals were present in most months. There was no clear seasonal pattern in abundance, though numbers were particularly low in June and July 2012. Interestingly, the numbers present in July 2011 were approximately four times greater than in July 2012. The reason for this difference is unknown, but may reflect better feeding conditions elsewhere. There was no evidence of reduced abundance during the breeding season (April to mid-July), as occurred for cormorant. However, many individuals present in the breeding season were in immature plumage. There was no evidence that birds present in the breeding period that were in adult summer plumage were engaged in breeding.

Figure 2. The average number of shags recorded during snap-shot scans at Kyle Rhea survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Shags were seen both on the sea, where they were commonly seen foraging, and on roost sites such as rocky skerries along the Kyle Rhea shores (Map 6, Photos 6 and 7). 73% (n=4306) of shags seen during snap-shot scans were birds roosting on land. 98% of shag roost sites were located on the western shore of Kyle Rhea sound, mostly between the two VPs and were the same sites used by cormorants. The remaining 2% of records of roosting birds were from sites on the east shore.

Shags were recorded on the sea (n=1153) throughout the survey area but not uniformly so (Fig 2). They were commonest in the WSZ habitat zone (the zone formed by the west side of the channel). Diving shags (n=779) were not uniformly distributed across the four habitat zones forming the channel (Fig 2). The sides of the channel (the WS and ES zones) were used much more than the central part of the channel (WC and EC zones). The WSZ accounted for 40.4% of diving birds and the ESZ for 28.2%. In contrast, the WCZ (the zone where the tidal devices are proposed) accounted for only 10.3% of diving records and the ECZ for 20.7%. This result suggests that foraging shags showed a slight preference for the shallow parts along the west and eastern sides of the channel for foraging. However, in contrast to cormorant, shags were seen on several occasions diving in the deepest part of the channel including some records in the vicinity of the proposed development area (Map 6). Shags on the sea that were not actively engaged in diving showed a broadly similar distribution to diving birds except that more were in the WSZ and less in the ESZ (Map 6).

The disproportionately high use of the WSZ compared to the ESZ is likely to be linked to its proximity to the main shag roost sites. The WSZ is also closest zone to the VPs and it is possible there was some distance related bias in detection of birds. However, for the same reasons discussed earlier for cormorant, the magnitude of any bias is likely to be small.

Shag was the most commonly recorded in flying bird watches (Table 6). Over the year as a whole there was an average of 7.0 shag flights past the VPs per hour. As far as could be ascertained by the observer, the majority of flying shags were birds making short-distance flights relocating between feeding areas or between areas and roost sites within the Kyle Rhea area (but often to and from the survey area).

Although there is likely to be considerable movement of shags between different parts of Kyle Rhea sound and further afield (i.e., outwith the survey area) the results indicate that in the late summer, autumn and winter there are typically approximately 30-50 individuals present in Kyle Rhea Sound. The breeding population for Skye and Lochalsh is 866 pairs (Seabirds 2000 count, Mitchel *et al*. 2004), and so it is likely that the site supports in the region of 2% of the Skye and Lochalsh population.

Agreement is required with SNH regarding the appropriate boundaries for defining the regional shag population for assessment purposes. Shag effectively has a continuous breeding distribution along the western coast of Scotland (see map on page 150in Mitchell *et al* 2004) and so there are no obvious natural regional divisions, for example, based on the species' distribution or movements patterns. However, given that the species is believed to be relatively sedentary, like cormorant, it is suggested that the same 'north-west Scotland' regional boundary suggested for cormorant is also appropriate, i.e., north-west coast of Sutherland, the west coast of Ross, Skye and Lochalsh and Lochaber. Seabird 2000 showed that this area had 3224 pairs (north-west coat of Sutherland, 880 pairs; west coast of Ross, 505 pairs; Skye and Lochalsh, 866 pairs; and Lochaber, 973 pairs.)

Assuming that about one third of birds in the region are non-breeding immature birds, this would give a regional population of around 10,000 individuals. Further assuming that this population remains in the region through the year and is not joined by individuals from other regions, this would mean that Kyle Rhea on average support around 0.4% of the regional population, and around 0.5% when peak numbers are present. On this basis, the numbers of shag present at Kyle Rhea is clearly well below 1% of the assumed regional population and would therefore be considered to be of low importance. Shag is rated as a medium priority species for the EIA.

Diver and grebe species

Records of diver and grebe species in the study were scarce and were confined to the winter period (Table 10). The records show that a single red-throated diver (presumably the same individual) and two little grebes overwintered in the general area of Kyle Rhea sound. These birds were regularly seen during the period they were present. All diving activity observed occurred in the WSZ and ESZ habitat zones, i.e., towards the sides of the channel, though four records of non-diving divers were from the central zones of the channel (Map 8). There were no records of divers or grebes during the breeding season.

The numbers of red-throated divers wintering in north-west Scotland is imprecisely known and in any case the size of the regional population will depend on where geographic divisions are made. O'Brien *et al*. (2008) estimated the number wintering in the north-west Scotland (excluding the Outer Hebrides) to be in the order of 50 individuals, but this may be an underestimate as there has been no systematic survey work undertaken in the region. However, under any criteria the occasional presence by a single red-throated diver is unlikely to be sufficient for the Kyle Rhea to be considered as having more than local importance for this species.

Red-throated divers wintering in western Scotland are likely to be from sub-arctic and arctic breeding grounds such as Greenland, rather than from Scottish breeding population which winters further south (Wernham *et al*. 2002). Although, small numbers of red-throated divers breed in Skye and Lochalsh and could theoretically forage in Kyle Rhea during the breeding season, the Year 1 survey work provided no evidence that they do so.

The single black-throated diver seen in February was most likely to originate from Scottish breeding population.

There were no records of great northern diver. This was surprising as Kyle Rhea sound appears to be suitable habitat and this is a relatively common and widespread overwintering species along the sheltered coasts of north-west Scotland.

All species of diver are listed on Annex 1 of the EU Birds Directive.

It is concluded on the basis of the Year 1 survey results that the Kyle Rhea survey area is of low importance for all diver and grebe species. However, given that divers are listed on Annex 1, diver species are rated as medium priority for the EIA. Grebe species are rated as low priority for the EIA.

Auk species

The Year 1 results show that Kyle Rhea has very low importance for all auk species. Three species of auk were recorded; razorbill, common guillemot and black guillemot but only occasionally and then just in small numbers (Table 11).

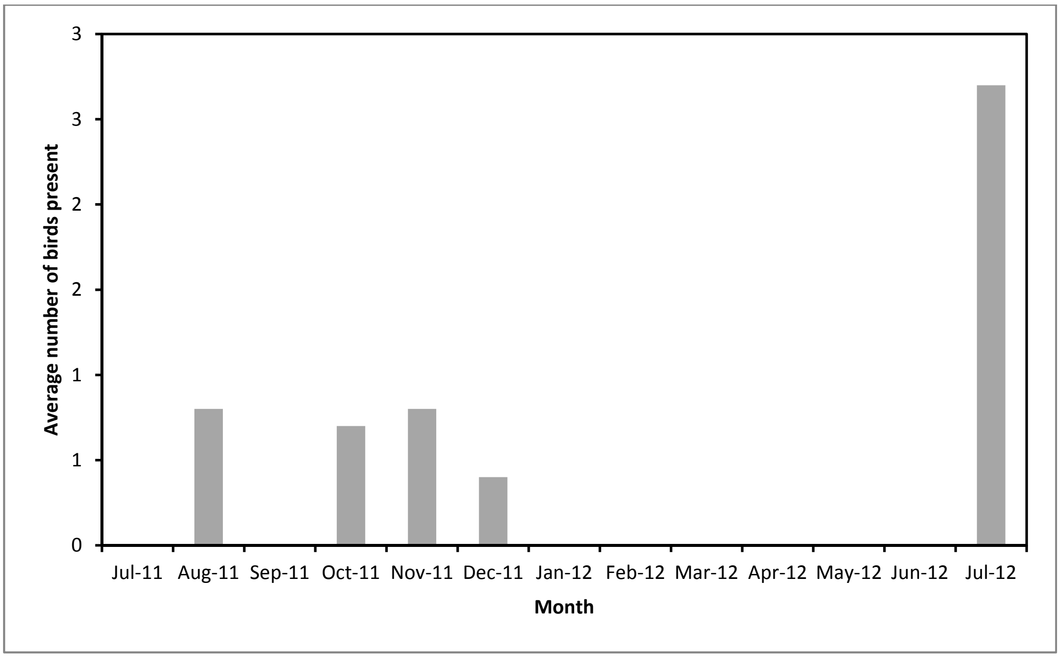
The few recorded observations of razorbill were spread through the year, and were most common in the summer. Black guillemot and common guillemot were only recorded in the winter. Records of actively diving auks were spread approximately evenly across the sound (Map 9).

In all cases the numbers of auks using Kyle Rhea represent a tiny proportion of the numbers of these species in western Scotland; all three species recorded have breeding and wintering populations containing many thousands of individuals. It is concluded that the survey area is of very low importance for all auk species and on this basis these species are rated as low priority. For this reason they are not discussed in further detail.

Gannet

Gannet were seen irregularly and in low numbers only during snap-shot scans (Table 12, Map 10). From July to December up to 11 but typically <5 birds were occasionally present, but there were no records from January to June. In the period of occurrence they were recorded in about a quarter of snap-shot scans. Gannets were occasionally recorded during flying bird watches, with a total of 24 individuals recorded, mostly in August and September (Table 6). There was no evidence of a net passage of birds through the sound in any month.

Figure 3. The average number of gannets recorded during snap-shot scans at Kyle Rhea survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Incidental records of flocks of approximately 60 individuals were noted on the 9th and 23rd of July 2012. These were feeding on the ebb tide in the vicinity of Kyle Rhea ferry (the narrowest part of the channel), and appeared to be targeting mackerel.

There were 21 records of gannet plunge-diving or on the sea in the survey area, some of these involving several birds. These records were distributed across the sound and there is evidence that the deeper parts (>30m), i.e. the area where tidal devices are proposed, were less used than shallower areas (Map 10). The narrowest part of the sound in the vicinity of the ferry route was particularly used by diving flocks (Map 10), something that was also noted in a number of incidental records

The closest gannet breeding colony to Kyle Rhea is Sula Sgeir which lies approximately 170 km to the north and had an estimated 10,440 pairs in Seabird 2000 counts. Gannets are a very common species in the seas off western Scotland (Mitchell *et al.* 2004, Pollock *et al.* 1995) and also occur in small irregular numbers in coastal inlets and sea lochs. It is concluded that Kyle Rhea has low importance for gannet and this species is therefore rated as low priority for the EIA.

Gull species

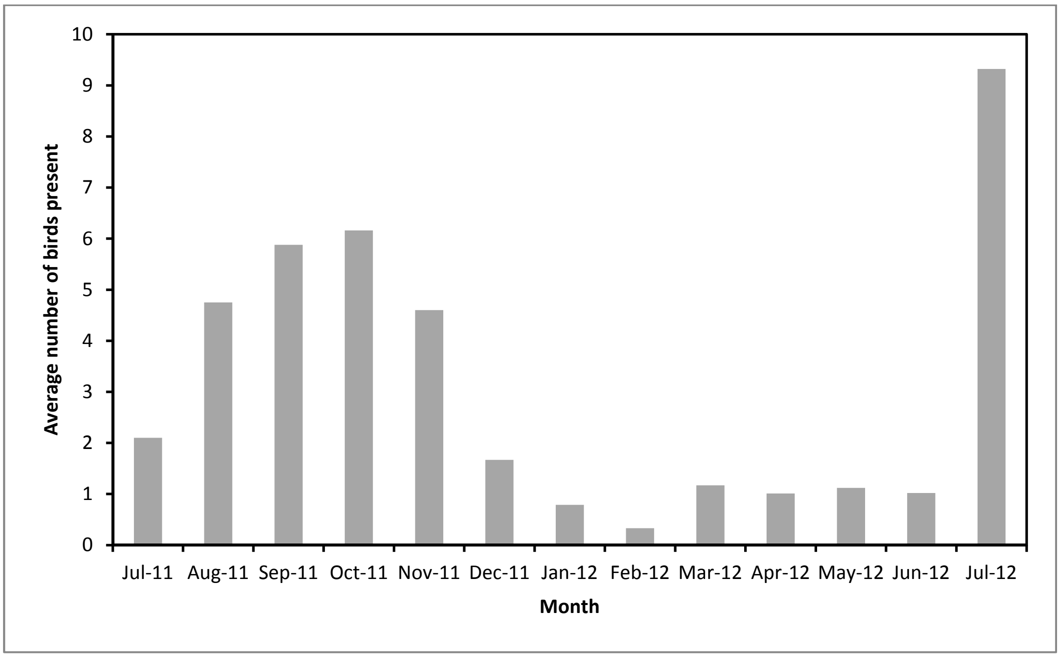
Three gull species, common gull, herring gull, and great black-backed gull were regularly recorded in small to moderate numbers through the year (Tables 6, 13, 14, 15 and 16). These three species are discussed in further detail below.

Kittiwakes were fairly frequently recorded in small numbers (typically groups of 1-4, but on one occasion a flock of 32) from late July to March (Table 6 and 13). They were most frequently seen in the late summer and autumn (Tables 6 and 13). The majority of kittiwakes seen were transiting through the sound and did not showing any foraging activity, but some were seen to forage by dip-feeding. The numbers observed are very low in the context of the west Scotland population. Therefore this species is rated as low priority for EIA and is not discussed further.

Black-headed gull were recorded irregularly and in very small numbers only (Tables 6 and 13). Up to two adult lesser-black backed gull were regularly present in in mid-winter and through July (both years), but were not seen at other times. The numbers of both these species are very low in the context of the West Scotland populations. It is concluded that Kyle Rhea Sound has negligible importance for black-headed gull and lesser black-backed gull and therefore these species are rated as low priority for EIA.

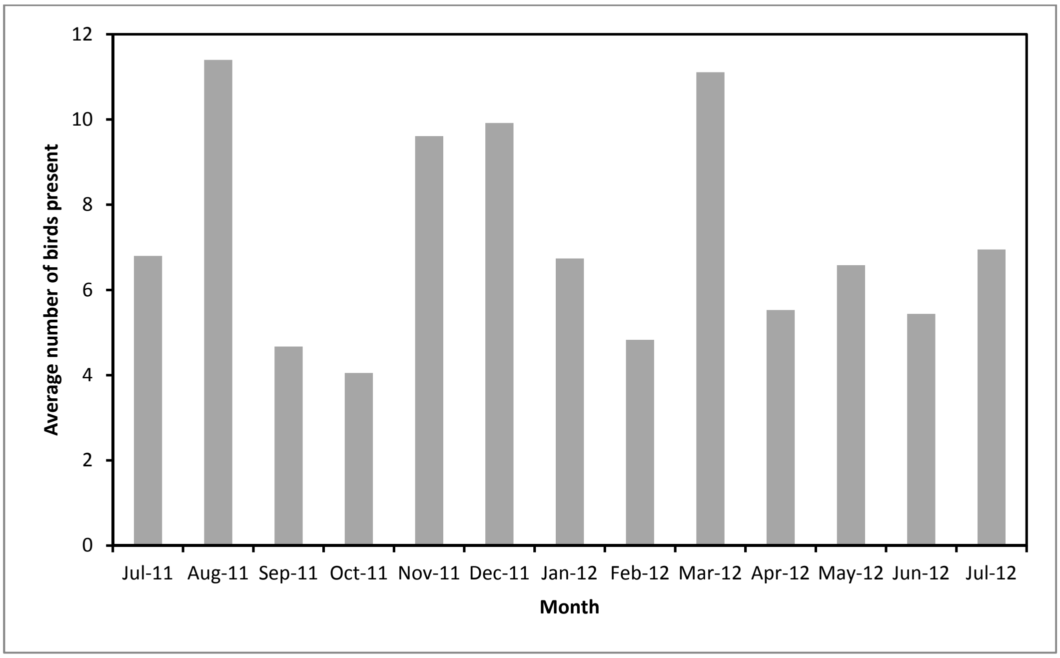
Common gull were present in small numbers through the year. They showed a marked seasonal pattern in abundance (Table 14, Fig 4). They were most common in the late summer and autumn (July to November) when typically 5-10 birds were present (peak count 22 birds). During the rest of the year (December to June) maximum monthly counts did not exceed five birds. Common gulls were seen foraging and resting throughout the survey area but showed a marked preference for the shorelines and the WSZ and ESZ habitat zones of the channel. Common gull is a very common breeding and overwintering species in north-west Scotland. Seabird 2000 counted 235 breeding pairs for coastal Skye and Lochalsh (Mitchell *et al.* 2004), though many more breed at inland colonies. In this context, the small numbers using Kyle Rhea are of negligible importance and for this reason common gull is rated as having low priority for EIA.

Figure 4. The average number of common gulls recorded during snap-shot scans at Kyle Rhea survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Herring gulls were also present in small numbers through the year and showed no marked seasonal pattern (Table 15, Fig 5). Typically there were less than ten birds present in the sound but occasionally larger numbers were present. The maximum count was 47 birds in November. It is likely that many of these gulls were of the local breeding populations and largely resident in the Kyle Rhea area. Herring gulls were seen foraging and resting throughout the survey area. The numbers using Kyle Rhea are a very low proportion of the number breeding in west Scotland. Seabird 2000 counted 1283 breeding pairs for Skye and Lochalsh alone (Mitchell *et al.* 2004). It is concluded that Kyle Rhea is of low importance to the regional herring gull population. Furthermore, herring gulls have an extremely high tolerance of human activities. For these reasons herring gull is rated as having low priority for EIA.

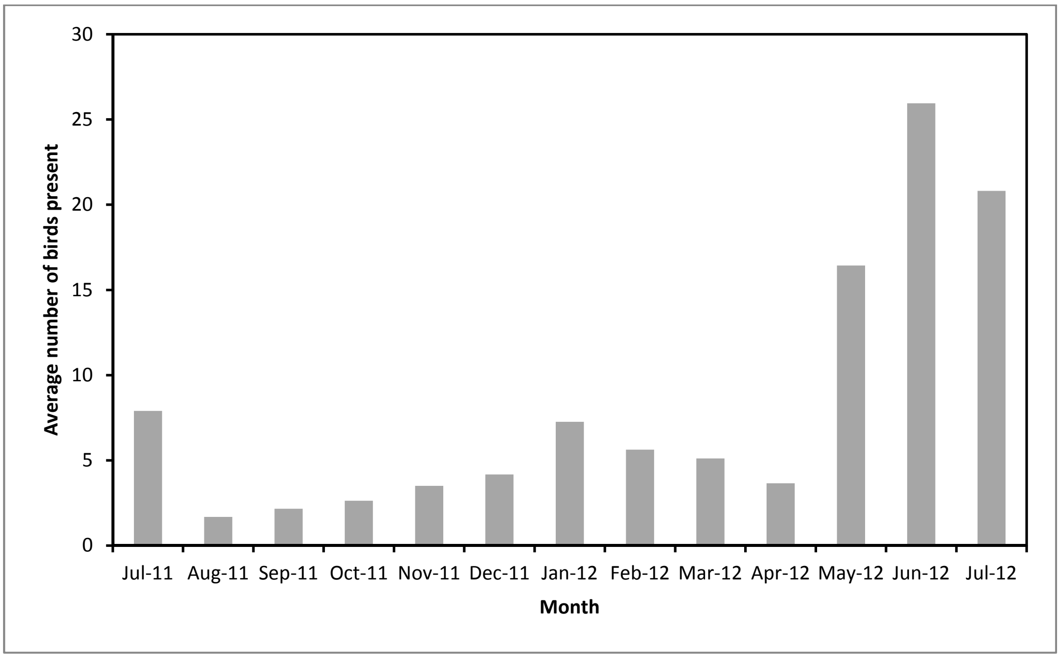
Figure 5. The average number of herring gulls recorded during snap-shot scans at Kyle Rheas survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Great black-backed gull were recorded throughout the year but showed a marked seasonal pattern of abundance (Table 16, Fig 6). Approximately six birds, mostly adults, were regularly present from August through to mid-April. Much greater numbers were present from mid-April to July, when up to 40-60 individuals were regularly seen. This period coincides with the breeding season and most of the birds present at this time were non-breeding individuals; many were in immature plumage. One pair appeared to hold a breeding territory on the western shore but breeding was not proven. Great black-backed gulls were seen foraging and resting throughout the survey area. The numbers using Kyle Rhea are a very low proportion of the number breeding in west Scotland. Seabird 2000 counted 151 breeding pairs for Skye and Lochalsh alone (Mitchell *et al.* 2004). Kyle Rhea is of low importance to the regional great black-backed gull population. Furthermore, this species has an extremely high tolerance of human activities. For these reasons great black-backed gull is rated as having low priority for EIA.

When feeding in Kyle Rhea, white-tailed eagle obtain a large per cent of their prey from great black-backed gulls, through klepto-parasitism. Observations suggest that roughly half the fish taken by white-tailed eagles in the sound are stolen from the gulls (Andy Law personal communication).

Figure 6. The average number of great black-backed gulls recorded during snap-shot scans at Kyle Rhea survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Tern and skua species

Small numbers of common tern were present throughout August 2011, but were not recorded in any other month (Tables 13). The maximum numbers present was six. These birds were likely to be passage migrants from breeding sites elsewhere in western Scotland, where the species breeds in relatively large numbers. There was no evidence of this species breeding locally. Common tern is a relatively uncommon breeding species in Skye and Lochalsh (Seabird 2000 counted 43 pairs, Mitchell *et al.* 2004).

No Arctic terns were recorded in Kyle Rhea during the survey period (July and January). Arctic tern is a relatively uncommon breeding species in Skye and Lochalsh (Seabird 2000 counted 209 pairs, Mitchell *et al.* 2004).

The only record of great skua was a single bird present for a short while one day in June that was seen harassing gulls. This was presumably a wandering bird from the large population breeding across northern Scotland. No Arctic skuas were recorded during the Year 1 surveys.

It is concluded that Kyle Rhea is of low importance for all tern and skua species and therefore all species are rated as low priority for the EIA assessment.

Wildfowl species

Up to three red-breasted merganser were occasionally present in the study area in the autumn and winter months (October to April) and in July (Table 17, Table 7, Map 11). This is a common and widespread wintering and breeding species in NW coastal Scotland. Kyle Rhea has very low importance for red-breasted merganser and therefore this species is rated as low priority.

Goosanders were generally scarce. One to three goosanders, probably the same overwintering individuals, were seen on six dates between November and April. A mixed flock of 28 female and juveniles (Photo 8) were intermittently present from 9th to 19th July 2012. Birds were seen to feed only in the WSZ and ESZ habitat zones (Map 11). Goosander is a relatively uncommon but increasing species in the region. In view of the numbers present in July goosander are rated as a medium priority species.

Eider duck was not recorded on the sea in Year 1. Small numbers (1 to 4) were occasionally recorded flying through the sound in the spring and autumn (Table 17). It is concluded that Kyle Rhea has very low importance for eider and this species is therefore rated as low priority.

A small flock of up to 10 wigeon were regularly seen from November to April. They were mostly seen in the intertidal and shallow water habitats along the western shore (Map 11). The numbers seen are small in the context of the numbers wintering in west Scotland, and for this reason wigeon is rated as low priority.

Up to four mallard were occasionally seen along the shores. The numbers seen are very small in the context of the numbers wintering and breeding in west Scotland, and for this reason mallard is rated as low priority.

Waders species

Oystercatchers were recorded in small numbers along the shores of the sound throughout the year (Table 18). Typically there were up to six individuals present. The maximum count was 13 birds seen in July 2012. Oystercatcher is a very common breeding and over wintering species in western Scotland.

Curlews were recorded only occasionally and in small numbers only along the shores of the sound throughout the non-breeding part of the year (mid July to March); none were seen in the breeding season (Table 18). Most records were of one or two birds only, but up to eight were seen in July and August 2011. Curlew is a common breeding and over wintering species in western Scotland.

At least one, possibly two pairs of common sandpiper were regularly seen along the shores from May to July (Table 18). Breeding was suspected but not proven. Common sandpiper is a common breeding species throughout western Scotland.

There were single records of whimbrel (1 bird), turnstone (2 birds) and ringed plover (1 bird) during the year.

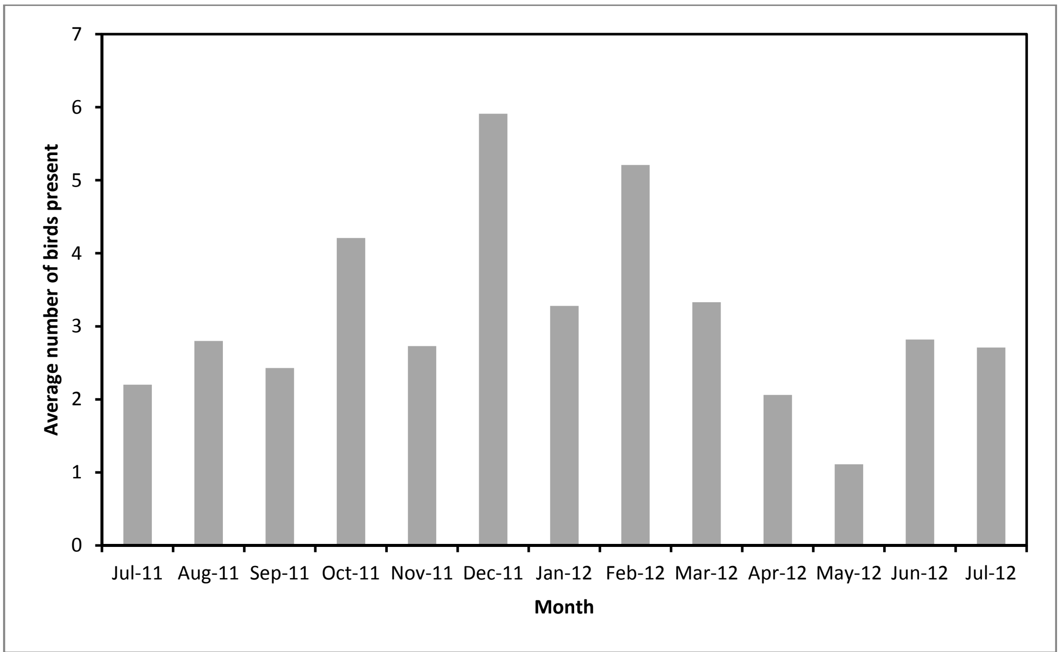
It is concluded that Kyle Rhea is of low importance for all wader species and therefore all waders are rated as low priority for the EIA.

Grey heron

Small numbers of grey heron were regularly present feeding along both shorelines throughout the year with up to eight individuals present at times. They were slightly more abundant in the winter (October to February), when the resident population is augmented by migrants from Scandinavia. A small heronry (at least six nests in 2012) is located in conifer trees close to the western shore in the southern part of the survey area (see also Kyle Rhea

Extended Phase 1 Survey Report, August 2012). Although grey heron is a common and widespread species across Scotland, the total population size is modest (Scottish population estimated at 4200 pairs, Forrester and Andrews 2007). On the basis of the number of birds regularly feeding in the sound and the presence of the small heronry it is concluded that Kyle Rhea is likely to be at least of low importance to the regional population. For this reason this species is rated as medium priority for the EIA.

Figure 7. The average number of shags recorded during snap-shot scans at Kyle Rheas survey area from July 2011 to July 2012. The number shown is the sum of the mean number seen from the two vantage points each month.



Eagle species

A single adult white-tailed eagle was recorded on seven dates through the year (Table 19, Photo 5). Two records were in winter and the others were in the 2012 breeding season, between late April and mid June. Records mostly involved birds flying over the site. On 2nd May a bird was present for approximately two hours during which it was actively foraging in the channel, and was seen to take a fish from a great black-backed gull.

The birds seen are almost certainly of the pair that breeds locally (a few km away). This pair is closely monitored by RSPB and is known to have bred successfully in 2012, rearing a single chick. It is also know that this pair regularly forages in Kyle Rhea sound and Glenelg Bay. Indeed in 2010 and 2012 (when they also bred successfully) they were observed feeding in the sound, mostly on the ebb tide, almost daily during the summer by local residents and the ferrymen. Indeed it is reported that at times an adult would take fish thrown out for it from boats. A high proportion of the fish they obtain in the sound are kleptoparisitised (stolen) from great-black-backed gulls.

White-tailed eagle is a rare breeding species in Scotland with a population of around 55 pairs. This population is the result of the successful re-introduction campaign. Kyle Rhea is clearly an important breeding season feeding area for one of the established pairs. For this reason this species is rated as high priority for the EIA.

A single golden eagle was seen hunting over neighbouring hill land on three occasions, in October, February and April (Table 19). Golden eagles were not seen to make use of Kyle Rhea sound. Given the amount of watch effort, it is concluded that Kyle Rhea has negligible importance for golden eagle and this species is therefore rated as low priority for the EIA.

All species of eagle are listed on Annex 1 of the EU Birds Directive.

Conclusions

This report presents the results of bird surveys undertaken in the first 13 months, July 2011 to July 2012 of fieldwork at Kyle Rhea undertaken to inform the EIA of the proposed tidal turbine array. Although survey work also collected information on marine mammals and basking shark the results for these species are presented separately (Appendix 12.2 and Appendix 12.3).

The survey programme was designed to give year-round information on the birds, marine mammals and basking shark using vantage point and walkover methods. The survey work covered the area of the proposed development and a surrounding buffer that occupied most of the rest of the Kyle Rhea channel and adjacent shorelines.

The monthly programme of survey work was completed for the period covered. Apart from some weather constraints no particular difficulties were encountered.

The Year 1 survey results provide a good baseline of information on the value of the Kyle Rhea survey area to bird species. Thus includes information on seasonal abundance, distribution, behaviour and habitat choice for each species. No significant data gaps have been identified.

Two bird species are rated as having high priority for the EIA, namely cormorant and white-tailed eagle. Diver species, shag, goosander and grey heron are rated as medium priority for the EIA. All other species are rated as having low priority for the EIA.

The lighthouse skerries and nearby shallow water and intertidal habitats, situated on the western shore between VP1 and VP2, are identified as the area of greatest value to birds as this area provides important roost sites and feeding areas for many species. The same area is also of particularly high value to seal species.

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Photographs

Photo 1. View from VP1 looking north. Photo copyright Andy Law.

Photo 2. View from near VP2 looking south. Photo copyright Andy Law.

Photo 3. View north from Otter Hide towards VP2, showing skerries and intertidal habitat along western shore.

Photo 4. Glenelg - Klyerhea ferry, looking west. Photo copyright Andy Law.

Photo 5. Great black-backed gull mobbing an adult white-tailed eagle.

Photo 6. Flock of feeding shags in Kyle Rhea Sound. Photo copyright Andy Law.

Photo 7. Cormorants and shags roosting on skerries between VP1 and VP2.

Photo 8. Flock of 28 female and juvenile goosander present in July 2012

Table 1. The number of bouts of each survey activity completed each month between July 2011 and July 2012.

Survey activity	2011						2012						
	7	8	9	10	11	12	1	2	3	4	5	6	7
Snap-shot scan	22	25	31	29	27	24	33	20	36	27	31	28	32
Flying bird watch	10	31	41	36	34	30	38	19	36	30	30	29	34
Haul-out count	5	8	9	11	8	7	12	6	12	31	44	47	47
Marine mammal watch	19	39	59	61	48	45	52	35	60	37	40	40	42

Table 2. The number of snap-shot scans completed at each VP each month between July 2011 and July 2012.

Vantage Point	2011						2012						
	7	8	9	10	11	12	1	2	3	4	5	6	7
VP1	10	13	18	13	15	12	15	12	18	12	16	15	17
VP2	12	12	13	16	12	12	18	8	18	15	15	13	15

Table 3. The dates each month between July 2011 and July 2012 when VP watches were undertaken

Day of month	2011						2012						
	7	8	9	10	11	12	1	2	3	4	5	6	7
1													
2									x		x		x
3					x						x		x
4		x			x		x			x			
5		x	x				x		x				
6	x			x				x				x	
7			x	x	x	x	x	x	x			x	
8	x				x						x		
9		x					x						x
10	x		x			x				x			
11		x			x		x			x	x		
12	x			x			x	x	x		x		
13				x			x			x		x	x
14			x		x				x	x		x	
15			x			x							x
16		x				x	x	x			x	x	
17					x		x						
18											x		
19		x	x										x
20			x									x	
21						x					x	x	
22					x				x		x		
23				x		x			x	x			
24			x					x	x	x		x	x
25		x	x	x					x				
26												x	
27			x	x		x		x	x				x
28	x		x	x	x		x						x
29	x					x		x	x	x			x
30		x		x						x		x	
31				x			x		x		x		
No. days	6	8	11	10	9	8	11	7	12	9	10	10	10

Table 4. The number of snap shot scans broken down by sea state undertaken between July 2011 and July 2012.

Sea state				Total
0	1	2	3	
297	57	7	4	365
81%	16%	2%	1%	100%

Table 5. The number of snap shot scans broken down by tide period undertaken between July 2011 and July 2012.

Tide Period						Total
1	2	3	4	5	6	
65	76	73	69	42	40	374
17%	20%	20%	18%	11%	11%	100%

Table 6. Summary of flight activity in Kyle Rhea sound by seabirds recorded during 5-minute flying bird watches undertaken from July 2011 to July 2012. Birds were only counted that flew past a notional line across the sound straight out from a vantage point. Data are for both vantage points combined.

Species	Year >	2011						2012							Total
	Month >	7	8	9	10	11	12	1	2	3	4	5	6	7	
	No. 5-min FBW >	10	31	41	36	34	30	38	19	36	30	30	29	34	388
	Total mins FBW >	50	155	205	180	170	150	190	95	180	150	150	145	170	1940
Gannet	Total seen	0	8	9	3	3	0	0	0	0	0	0	0	1	24
	No. per hr.	0.0	3.1	2.6	1.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7
Cormorant	Total seen	5	8	17	23	70	31	37	9	8	18	1	3	5	235
	No. per hr.	6.0	3.1	5.0	7.7	24.7	12.4	11.7	5.7	2.7	7.2	0.4	1.2	1.8	7.3
Shag	Total seen	1	22	23	30	18	35	29	9	23	17	9	5	4	225
	No. per hr.	1.2	8.5	6.7	10.0	6.4	14.0	9.2	5.7	7.7	6.8	3.6	2.1	1.4	7.0
Common gull	Total seen	4	38	52	108	30	22	11	0	7	4	11	5	25	317
	No. per hr.	4.8	14.7	15.2	36.0	10.6	8.8	3.5	0.0	2.3	1.6	4.4	2.1	8.8	9.8
Lesser black-backed gull	Total seen	0	0	1	0	1	1	3	0	0	0	0	0	7	13
	No. per hr.	0.0	0.0	0.3	0.0	0.4	0.4	0.9	0.0	0.0	0.0	0.0	0.0	2.5	0.4
Herring gull	Total seen	7	43	33	35	69	84	66	23	57	22	36	19	20	514
	No. per hr.	8.4	16.6	9.7	11.7	24.4	33.6	20.8	14.5	19.0	8.8	14.4	7.9	7.1	15.9
Great black-backed gull	Total seen	5	8	13	14	7	14	26	16	20	9	23	12	14	181
	No. per hr.	6.0	3.1	3.8	4.7	2.5	5.6	8.2	10.1	6.7	3.6	9.2	5.0	4.9	5.6
Kittiwake	Total seen	0	0	26	13	4	2	4	0	0	0	0	0	2	51
	No. per hr.	0.0	0.0	7.6	4.3	1.4	0.8	1.3	0.0	0.0	0.0	0.0	0.0	0.7	1.6
Common tern	Total seen	0	51	0	0	0	0	0	0	0	0	0	0	0	51
	No. per hr.	0.0	19.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Guillemot	Total seen	0	0	0	5	4	5	0	0	0	0	0	0	0	14
	No. per hr.	0.0	0.0	0.0	1.7	1.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Razorbill	Total seen	0	0	1	0	0	0	0	0	1	0	0	0	0	2
	No. per hr.	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1
Black guillemot	Total seen	0	0	0	0	0	3	20	1	0	0	0	0	0	24
	No. per hr.	0.0	0.0	0.0	0.0	0.0	1.2	6.3	0.6	0.0	0.0	0.0	0.0	0.0	0.7

Table 7. Summary of flight activity in Kyle Rhea sound by heron, wildfowl, white-tailed eagle and waders recorded during 5-minute flying bird watches undertaken from July 2011 to July 2012. Birds were only counted that flew past a notional line across the sound straight out from a vantage point. Data are for both vantage points combined.

Species	Year >	2011						2012							Total
	Month >	7	8	9	10	11	12	1	2	3	4	5	6	7	
	No. 5-min FBW >	10	31	41	36	34	30	38	19	36	30	30	29	34	388
	Total mins FBW >	50	155	205	180	170	150	190	95	180	150	150	145	170	1940
Grey heron	Total seen	0	12	12	6	7	5	8	4	12	3	4	3	6	82
	No. per hr.	0.0	4.6	3.5	2.0	2.5	2.0	2.5	2.5	4.0	1.2	1.6	1.2	2.1	2.5
Wigeon	Total seen	0	0	0	0	0	0	5	2	6	0	0	0	0	13
	No. per hr.	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.3	2.0	0.0	0.0	0.0	0.0	0.4
Eider	Total seen	0	0	0	0	4	0	0	0	0	8	0	0	0	12
	No. per hr.	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.4
Red-breasted merganser	Total seen	0	0	0	0	0	0	2	0	0	0	0	0	0	2
	No. per hr.	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1
White-tailed eagle	Total seen	0	0	0	0	0	0	0	0	0	0	1	1	0	2
	No. per hr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.1
Oystercatcher	Total seen	2	12	18	9	12	1	0	0	8	3	5	1	9	80
	No. per hr.	2.4	4.6	5.3	3.0	4.2	0.4	0.0	0.0	2.7	1.2	2.0	0.4	3.2	2.5
Curlew	Total seen	0	1	2	1	3	2	3	3	0	0	0	0	0	15
	No. per hr.	0.0	0.4	0.6	0.3	1.1	0.8	0.9	1.9	0.0	0.0	0.0	0.0	0.0	0.5
Common sandpiper	Total seen	0	0	0	0	0	0	0	0	0	0	0	0.8	0	1
	No. per hr.	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	2.5	0.7	0.0

Table 8. The numbers of cormorant recorded in snap-shot scans each month from July 2011 to July 2012. The total number present in the sound is less than the sum for the two VPs combined because there was spatial overlap in coverage, and this coincided with the location of an important roost site.

		VP1				VP2				Both VPS
Month	Year	No. snap shots	% +ve	Average	Maximum	No. snap shots	% +ve	Average	Maximum	Sum of average
7	2011	10	20%	0.2	1	13	100%	7.6	16	7.8
8	2011	14	36%	0.8	4	12	62%	1.3	6	2.1
9	2011	19	89%	6.3	25	14	67%	3.6	13	9.9
10	2011	13	100%	22.8	38	17	93%	8.8	22	31.6
11	2011	15	87%	22.2	54	12	94%	20.6	56	42.8
12	2011	12	92%	22.1	52	12	100%	40.7	74	62.8
1	2012	16	100%	11.6	24	18	100%	12.9	29	24.5
2	2012	12	100%	9.6	22	8	100%	14.2	26	23.8
3	2012	18	100%	4.1	14	19	95%	3.3	9	7.4
4	2012	12	92%	2.4	5	15	33%	0.5	3	3.0
5	2012	16	88%	1.4	4	15	73%	2.1	5	3.5
6	2012	15	53%	0.9	4	14	86%	1.6	4	2.4
7	2012	17	94%	2.4	5	16	75%	1.8	8	4.2

Table 9. The number of shag recorded in snap-shot scans each month from July 2011 to July 2012. The total number present in the sound is less than the sum for the two VPs combined because there was spatial overlap in coverage, and this coincided with the location of an important roost site.

		VP1				VP2				Both VPS
Month	Year	No. snap shots	% +ve	Average	Maximum	No. snap shots	% +ve	Average	Maximum	Sum of average
7	2011	10	90%	10.2	23	13	100%	8.0	17	18.2
8	2011	14	93%	12.7	31	12	92%	9.7	23	22.4
9	2011	19	94%	13.3	33	14	100%	16.1	31	29.4
10	2011	13	100%	12.3	25	17	86%	13.9	35	26.2
11	2011	15	93%	15.7	37	12	71%	7.0	18	22.7
12	2011	12	100%	20.4	47	12	100%	8.7	16	29.1
1	2012	16	100%	12.1	22	18	100%	17.1	47	29.2
2	2012	12	100%	17.5	54	8	100%	12.9	31	30.4
3	2012	18	100%	15.8	37	19	100%	21.4	36	37.2
4	2012	12	100%	18.3	34	15	93%	15.3	46	33.6
5	2012	16	94%	9.7	30	15	100%	17.9	31	27.6
6	2012	15	87%	4.3	9	14	86%	4.4	12	8.7
7	2012	17	53%	1.4	5	16	69%	2.7	9	4.1

Table 10. Summary of records of diver and grebe species seen during vantage point watches at Kyle Rhea from July 2011 to July 2012.

Species	Status in Year 1	Records summary
Great northern diver	Not recorded	Unexpectedly not recorded.
Black-throated diver	Very scarce winter visitor	A single adult in summer plumage was seen once on 29 February, on the sea mid channel. It was not seen diving. This was likely to be a passage bird and coincided with the time when Scottish breeding birds are returning to their breeding grounds
Red-throated diver	Very scarce winter visitor	A single bird, probably the same individual, was seen on 13 occasions from 8 November to 31 March. Seen loafing and diving in the shallow water zones on both sides of the sound, mostly from VP1. No breeding season records.
Little grebe	Scarce winter visitor	Up to two birds, probably the same individuals, recorded on 11 occasions between 23 October and 7 February. Seen loafing and diving in the shallow water zone on the west side of the sound, mostly from VP2. No breeding season records.

Table 11. Summary of records auk species seen during vantage point watches at Kyle Rhea from July 2011 to July 2012.

Species	Status in Year 1	Records summary
Razorbill	Scarce transitory visitor through the year, but mainly in summer.	Recorded in only six snap-shot scans through the year, mainly single birds on the water. Maximum count of 5 birds seen on the sea in July 2012. Most records from central channel and eastern shallows habitat zones. Only two records of birds actively diving, both in the central part of the sound. Only 18 razorbills were recorded flying past VPs during the year in FBWs, mostly from June to September (Table 6).
Common guillemot	Scarce winter visitor	Up to two birds recorded, probably the same individuals, on 11 snap-shot scans between 7 October and 29 December. Records were approximately evenly distributed in the central channel and shallow habitat zones on both the east and west halves. Over half the records were of actively diving birds. Two thirds of records were from VP1. Only 14 guillemots were recorded flying past VPs during the year in FBWs, all from October to December (Table 6).
Black guillemot	Scarce mid-winter visitor	Recorded in small numbers on eight dates between 23 December and 12 February. Numbers gradually increased from one initially to a maximum of 6 individuals on 16 January. Then declined with no further records apart from a single bird in mid-February Records were approximately evenly distributed in the central channel and shallow habitat zones on both the east and west sides and between both VPs. All birds were actively diving when seen, apart from the single bird seen flying through the sound. Only 24 black guillemots were recorded flying past VPs during the year in FBWs, all from December to February (Table 6).

Table 12. The numbers of gannet recorded in snap-shot scans each month from July 2011 to July 2012. The total number present in the sound is less than the sum for the two VPs combined because there was spatial overlap in coverage.

		VP1				VP2				Both VPS
	Year	No. snap shots	% +ve	Average	Maximum	No. snap shots	% +ve	Average	Maximum	Sum of average
7	2011	10	0%	0.0	0	10	0%	0.0	0	0.0
8	2011	13	21%	0.8	9	12	0%	0.0	0	0.8
9	2011	18	0%	0.0	0	13	0%	0.0	0	0.0
10	2011	13	23%	0.4	3	16	14%	0.3	3	0.7
11	2011	15	7%	0.1	1	12	18%	0.7	7	0.8
12	2011	12	8%	0.1	1	12	17%	0.3	3	0.4
1	2012	15	0%	0.0	0	17	0%	0.0	0	0.0
2	2012	12	0%	0.0	0	8	0%	0.0	0	0.0
3	2012	18	0%	0.0	0	18	0%	0.0	0	0.0
4	2012	12	0%	0.0	0	15	0%	0.0	0	0.0
5	2012	16	0%	0.0	0	15	0%	0.0	0	0.0
6	2012	15	0%	0.0	0	13	0%	0.0	0	0.0
7	2012	17	29%	1.6	11	15	19%	1.1	10	2.7

Table 13. Summary of records gull, skua and tern species seen during vantage point watches at Kyle Rhea from July 2011 to July 2012.

Species	Status in Year 1	Records summary
Common gull	Small numbers present through the year	See Table 6 (FBW) and Table 14 (SSS)
Herring gull	Small numbers present through the year	See Table 6 (FBW) and Table 15 (SSS)
Great black-backed gull	Small numbers present through the year	See Table 6 (FBW) and Table 16 (SSS)
Lesser black-backed gull	Uncommon, mainly summer visitor	See Table 6 (FBW)
Black-headed gull	Very scarce winter visitor	Two birds flew through on 28 November, and a single on the sea on 10 Dec were the only records.
Kittiwake	Uncommon, in non-breeding period transiting through sound	Small numbers (flocks of 1-7 birds, totalling 123 birds) were regularly recorded from 24 July to late January. Single record of 32 birds N through sound on 7 March. No breeding season records. All birds seen during SSS were flying; the majority (95%) were apparently just transiting through with only 5% showing feeding behaviour. See Table 6 for FBW transit rates
Common tern	Scarce migrant, late summer only	Only recorded between 4th and 25th of August 2011, when between 1 and 6 individuals were present on six survey dates. Some birds were actively feeding, others flying through. One individual was seen carrying a small sprat-like fish. No evidence that this species was breeding locally
Great skua	Very scarce summer visitor	A single bird was present for over an hour on 16 June. It was seen to kleptoparisitise a great black backed gull.

Table 14. The numbers of common gull recorded in snap-shot scans each month from July 2011 to July 2012. The total number present in the sound is less than the sum for the two VPs combined because there was spatial overlap in coverage, and this coincided with the location of an important roost site.

		VP1				VP2				Both VPS
Month	Year	No. snap shots	% +ve	Average	Maximum	No. snap shots	% +ve	Average	Maximum	Sum of average
7	2011	10	40%	0.7	3	10	60%	1.4	4	2.1
8	2011	13	92%	3.0	7	12	75%	1.8	4	4.8
9	2011	18	94%	4.1	13	13	69%	1.8	6	5.9
10	2011	13	92%	3.9	9	16	81%	2.3	6	6.2
11	2011	15	87%	3.6	10	12	50%	1.0	4	4.6
12	2011	12	58%	1.0	5	12	33%	0.7	3	1.7
1	2012	15	47%	0.7	2	17	6%	0.1	1	0.8
2	2012	12	8%	0.3	4	8	0%	0.0	0	0.3
3	2012	18	11%	0.3	3	18	33%	0.9	5	1.2
4	2012	12	8%	0.1	1	15	40%	0.9	5	1.0
5	2012	16	19%	0.3	2	15	33%	0.9	4	1.1
6	2012	15	33%	0.9	5	13	15%	0.2	1	1.0
7	2012	17	100%	6.1	22	15	73%	3.2	10	9.3

Table 15. The numbers of herring gull recorded in snap-shot scans each month from July 2011 to July 2012. The total number present in the sound is less than the sum for the two VPs combined because there was spatial overlap in coverage, and this coincided with the location of an important roost site.

		VP1				VP2				Both VPS
Month	Year	No. snap shots	% +ve	Average	Maximum	No. snap shots	% +ve	Average	Maximum	Sum of average
7	2011	10	100%	4.8	16	10	70%	2.0	5	6.8
8	2011	13	100%	6.2	27	12	100%	5.2	12	11.4
9	2011	18	78%	2.4	6	13	77%	2.2	5	4.7
10	2011	13	85%	1.9	4	16	75%	2.1	6	4.1
11	2011	15	80%	6.5	44	12	100%	3.1	4	9.6
12	2011	12	92%	3.3	8	12	83%	6.7	26	9.9
1	2012	15	93%	3.3	9	17	88%	3.5	12	6.7
2	2012	12	58%	1.8	6	8	88%	3.0	6	4.8
3	2012	18	100%	6.6	47	18	83%	4.5	10	11.1
4	2012	12	67%	2.0	4	15	80%	3.5	15	5.5
5	2012	16	94%	4.4	12	15	73%	2.2	4	6.6
6	2012	15	80%	2.7	8	13	85%	2.8	7	5.4
7	2012	17	94%	3.9	20	15	87%	3.1	10	7.0

Table 16. The numbers of great black-backed gull recorded in snap-shot scans each month from July 2011 to July 2012. The total number present in the sound is less than the sum for the two VPs combined because there was spatial overlap in coverage, and this coincided with the location of an important roost site.

		VP1				VP2				Both VPS
Month	Year	No. snap shots	% +ve	Average	Maximum	No. snap shots	% +ve	Average	Maximum	Sum of average
7	2011	10	60%	1.3	6	10	70%	6.6	26	7.9
8	2011	13	62%	0.9	2	12	67%	0.8	2	1.7
9	2011	18	78%	1.4	5	13	69%	0.8	2	2.2
10	2011	13	77%	1.7	4	16	75%	0.9	3	2.6
11	2011	15	87%	2.3	6	12	58%	1.2	3	3.5
12	2011	12	92%	2.3	5	12	83%	1.9	5	4.2
1	2012	15	100%	3.7	5	17	88%	3.5	14	7.3
2	2012	12	100%	3.3	5	8	75%	2.4	6	5.6
3	2012	18	89%	2.7	7	18	89%	2.4	5	5.1
4	2012	12	75%	1.3	3	15	67%	2.4	17	3.7
5	2012	16	63%	7.6	43	15	80%	8.9	52	16.4
6	2012	15	67%	13.3	61	13	46%	12.6	41	26.0
7	2012	17	76%	12.9	55	15	73%	7.9	60	20.8

Table 17. Summary of records wildfowl species seen during vantage point watches at Kyle Rhea from July 2011 to July 2012.

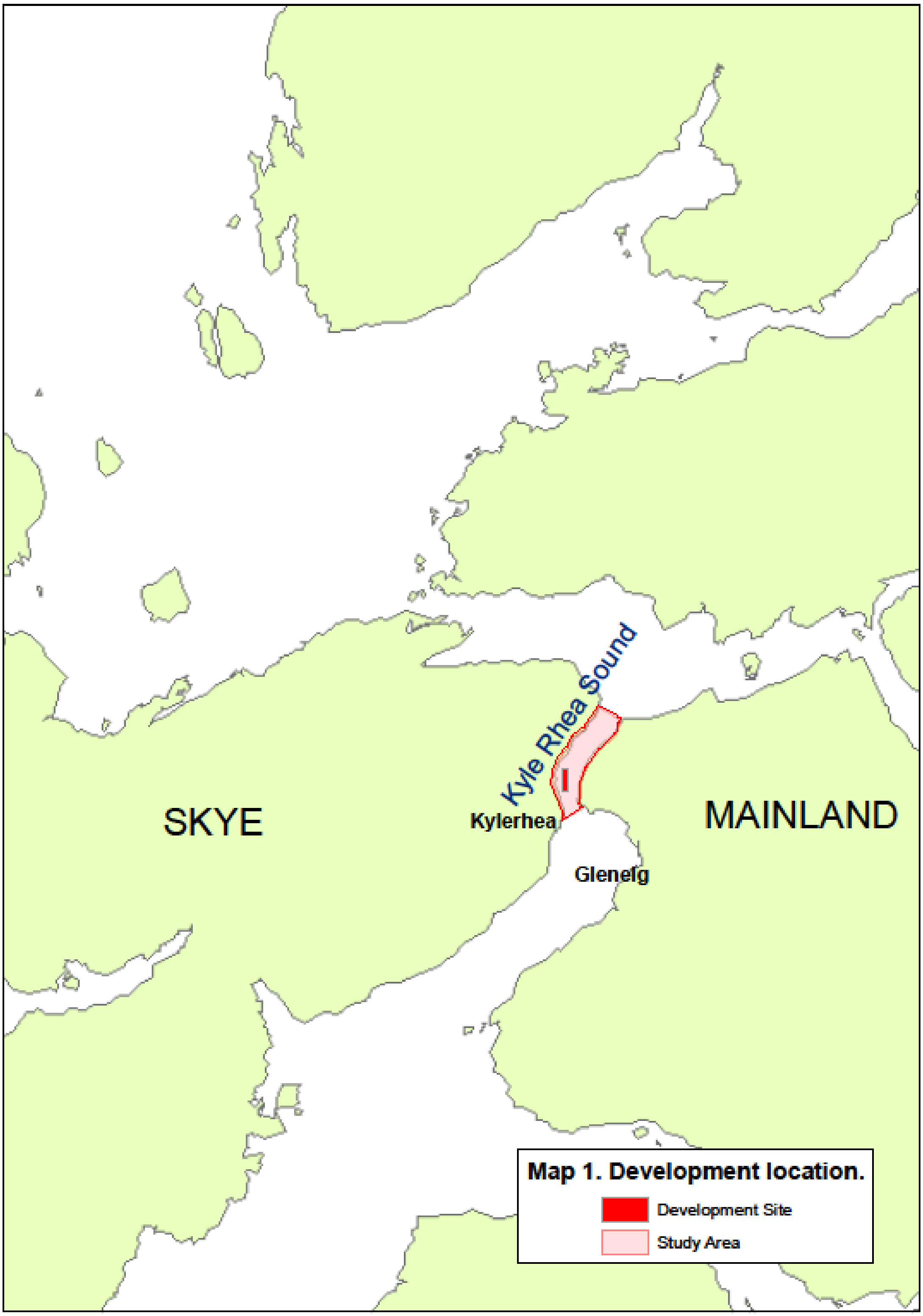
Species	Status in Year 1	Records summary
Greylag goose	Scarce	Pair seen flying through sound in March
Eider	Scarce passage migrant (in flight only)	Recorded on four occasions, three times in April and once in November. All records were 1-4 individuals flying through the sound. Not seen on the water.
Mallard	Uncommon, year round	Up to four occasionally recorded along shores.
Wigeon	Small numbers overwintering	Up to 10 birds present from November to April.
Goosander	Uncommon, winter, and late summer	Up to three birds overwintered, flock of 28 birds regularly present in July 2012.
Red-breasted merganser	Uncommon, winter, and late summer	Up to three birds overwintered.

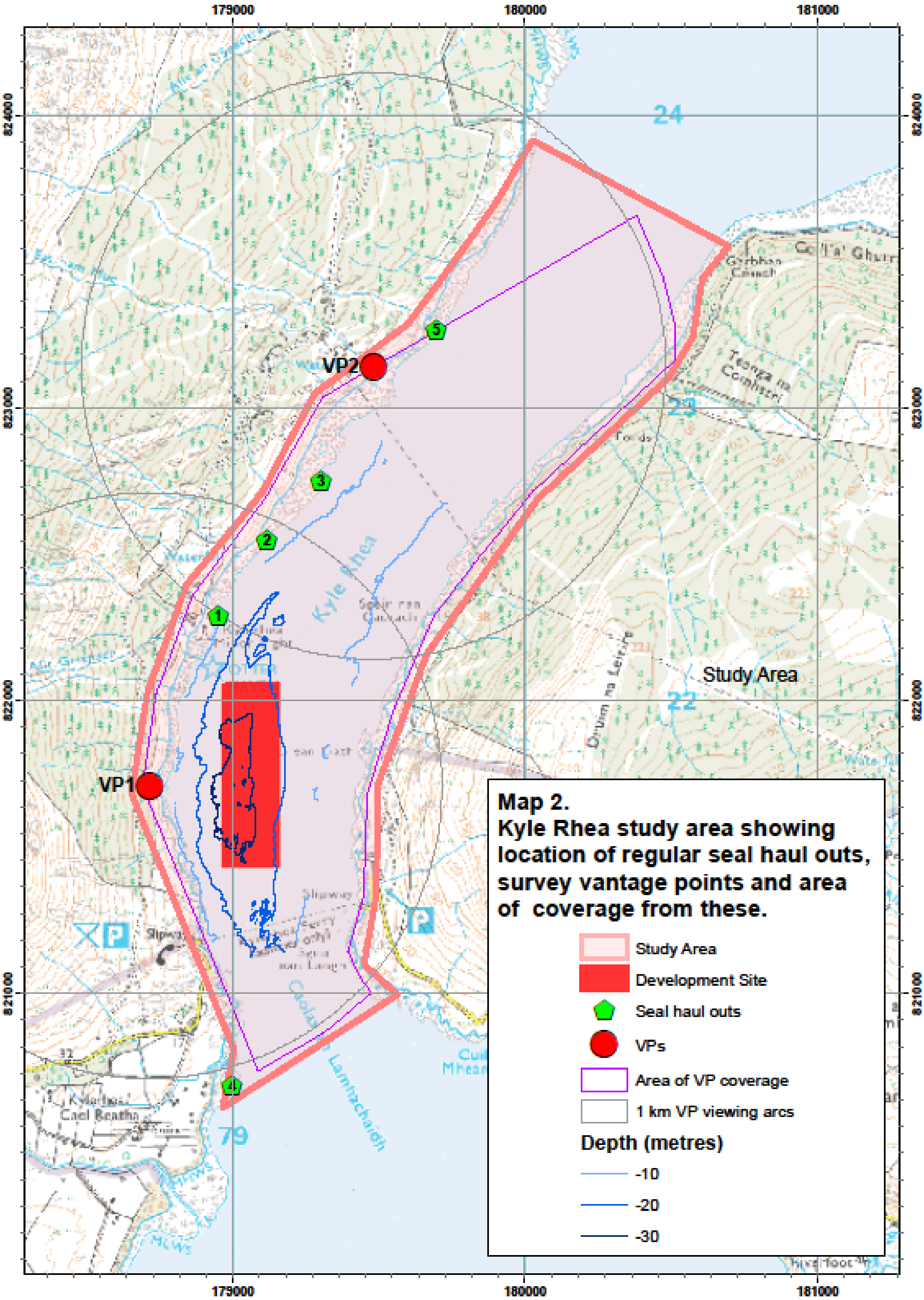
Table 18. Summary of records wader species and grey heron seen during vantage point watches at Kyle Rhea from July 2011 to July 2012.

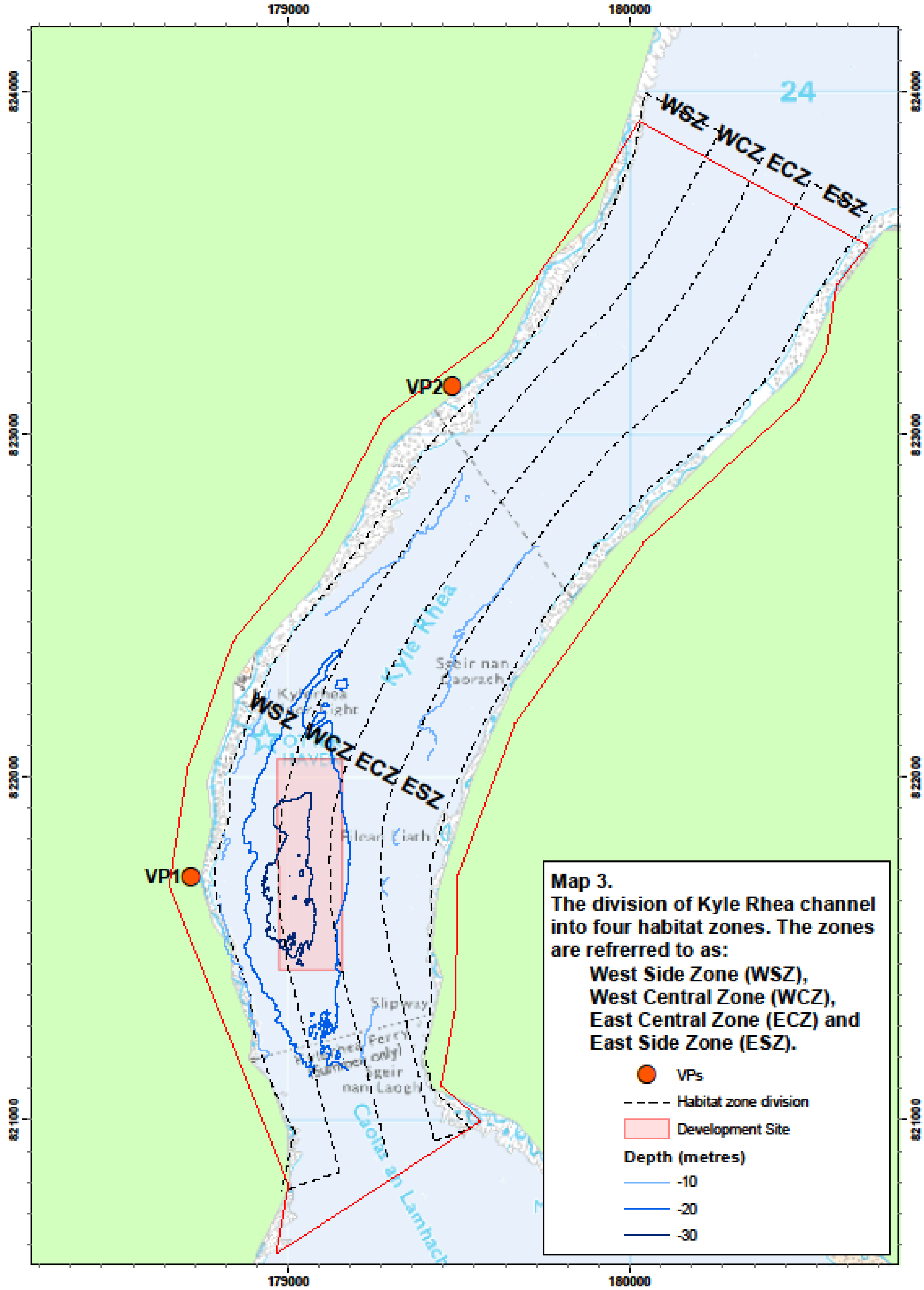
Species	Status in Year 1	Records summary
Oystercatcher	Common in small numbers throughout year. Breeding	Typically 1-6 birds present. Maximum of 13 present in July 2012.
Curlew	Late summer and winter visitor	Typically 1-2 birds occasionally present. Up to 8 present in July and August 2011
Common sandpiper	Common, summer visitor. 1-2 pairs breeding.	1 – 2 regularly seen May to July. Suspected breeding.
Grey heron	Common in small numbers throughout year. Breeding	Typically 1-8 birds present. At least 6 pairs bred.

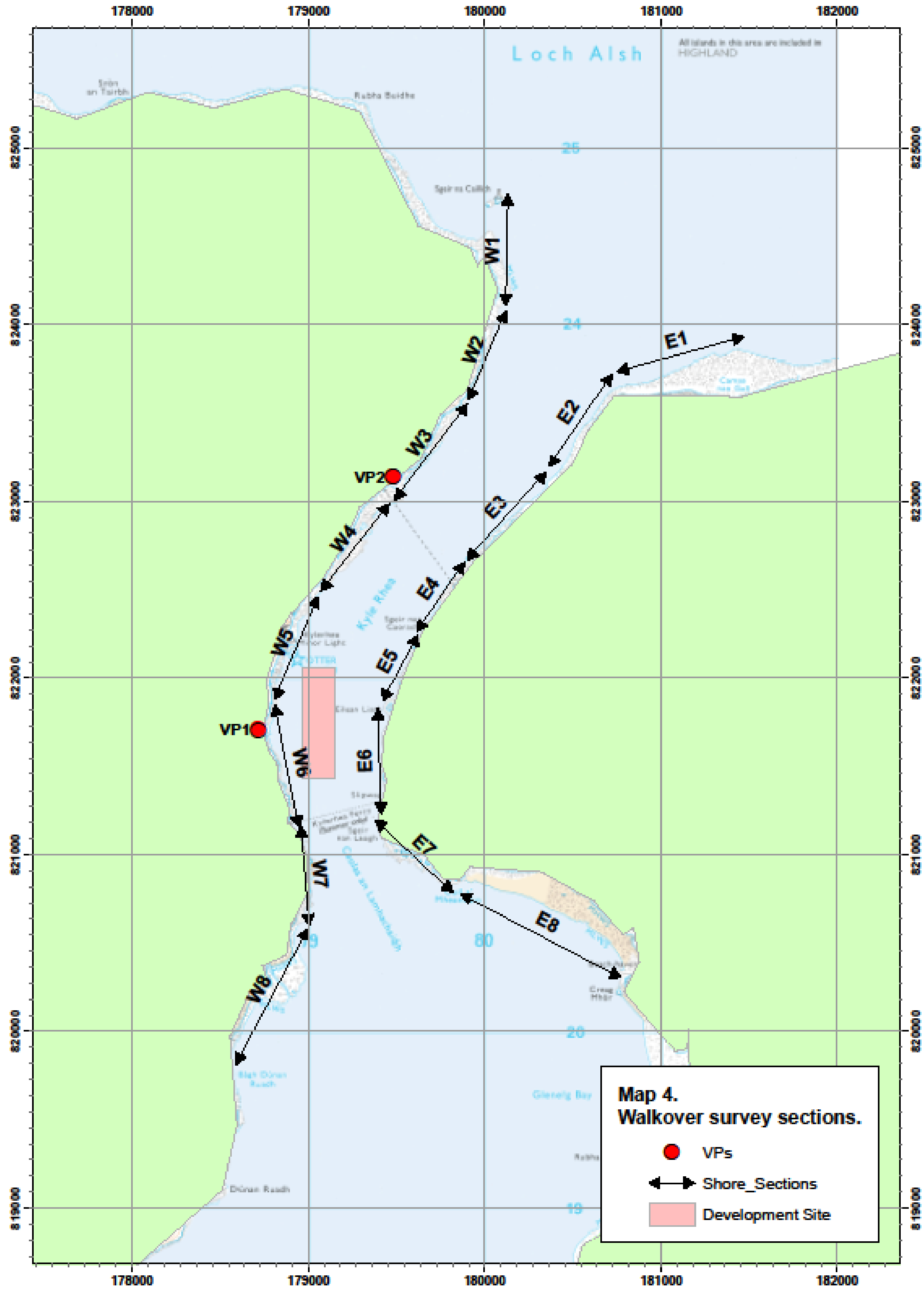
Table 19. Summary of records eagle species seen during vantage point watches at Kyle Rhea from July 2011 to July 2012.

Species	Status in Year 1	Records summary
White-tailed eagle	Uncommon throughout year. Breeds locally	Six fieldwork records through year of a single adult. Numerous incidental records of adult feeding in the breeding season on ebb tide. Often steals food from gulls.
Golden eagle	Scarce, hunts over adjacent hills	Three records (October, February and April) of single birds flying over neighbouring hills,

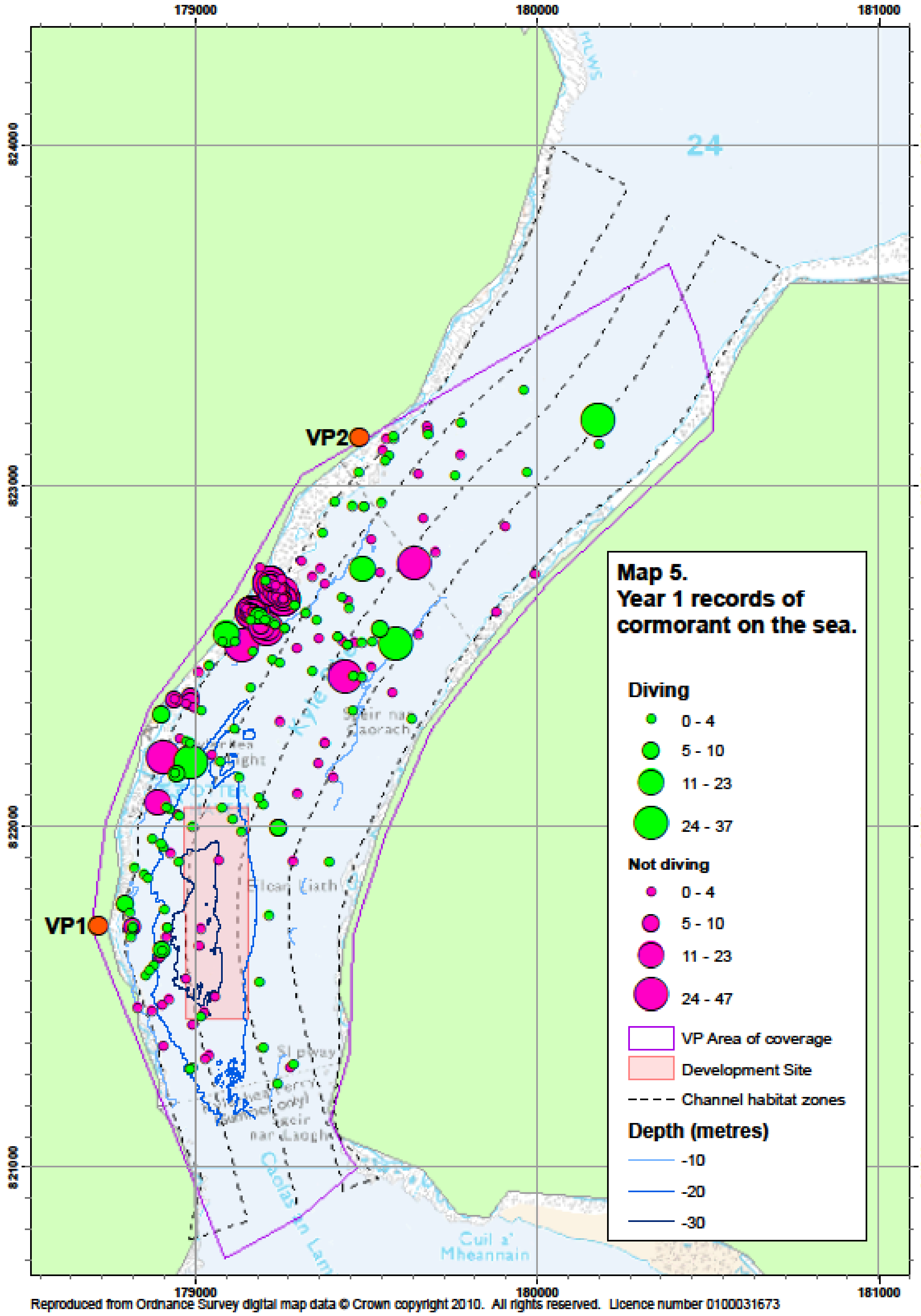

Kyle Rhea Sound
SKYE
Kylerhea
MAINLAND
Glenelg
Map 1. Development location.
Development Site
Study Area

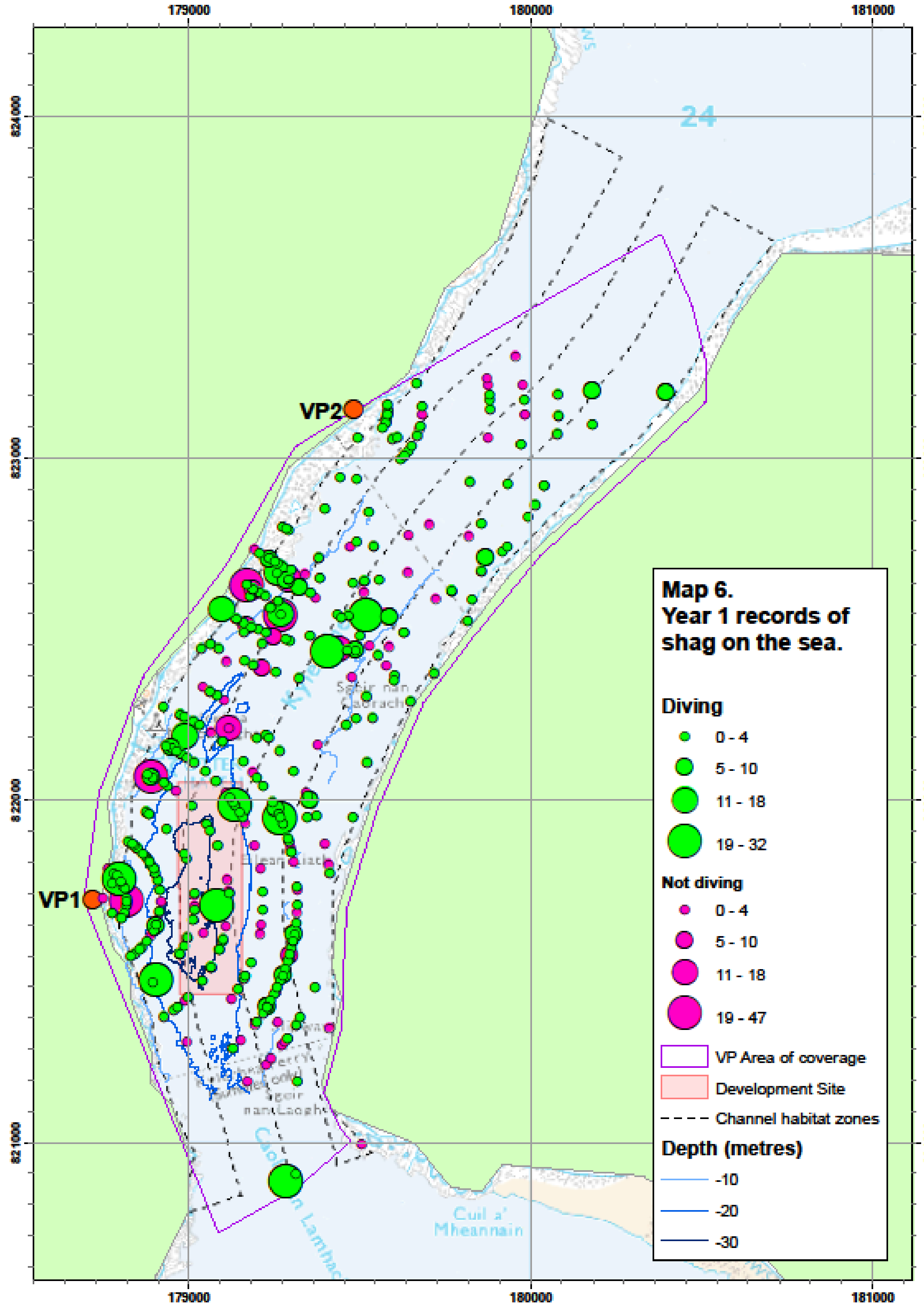

Map 2.
Kyle Rhea study area showing location of regular seal haul outs, survey vantage points and area of coverage from these.
Study Area
Development Site
Seal haul outs
VPs
Area of VP coverage
1 km VP viewing arcs
Depth (metres)
-10
-20
-30
VP1
VP2
Study Area
179000
180000
181000
824000
823000
822000
821000


179000
180000
824000
823000
822000
821000
24
WSZ WCZ ECZ ESZ
VP2
VP1
Kyle Rhea
WSZ WCZ ECZ ESZ
Slipway
Map 3.
The division of Kyle Rhea channel into four habitat zones. The zones are refrerred to as:
West Side Zone (WSZ),
West Central Zone (WCZ),
East Central Zone (ECZ) and
East Side Zone (ESZ).
VPs
Habitat zone division
Development Site
Depth (metres)
-10
-20
-30

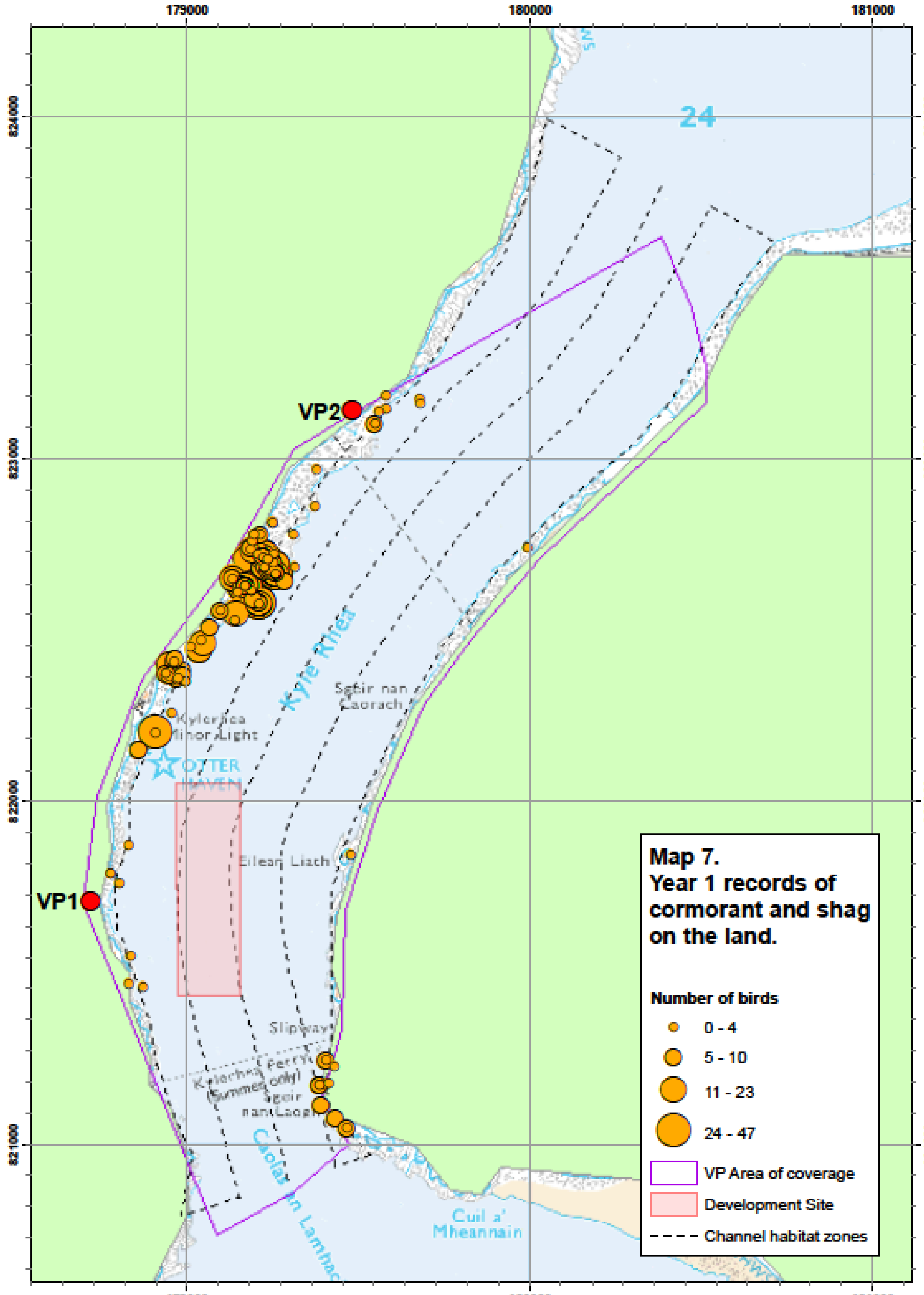


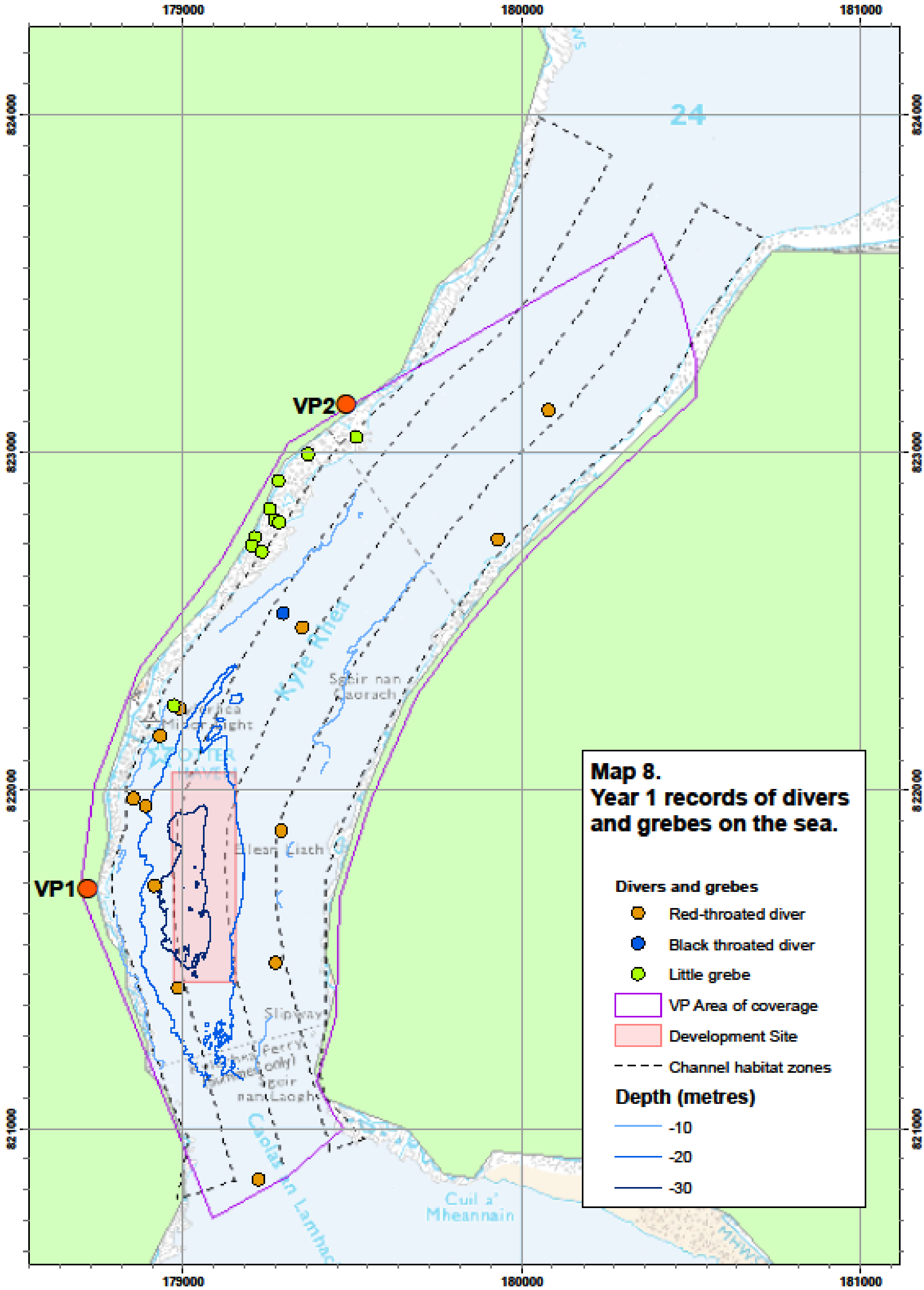
178000
179000
180000
181000
182000
825000
824000
823000
822000
821000
820000
819000
Loch Alsh
W1
W2
W3
W4
W5
W6
W7
W8
E1
E2
E3
E4
E5
E6
E7
E8
VP1
VP2
Kyle Rhea
Map 4.
Walkover survey sections.
VPs
Shore_Sections
Development Site

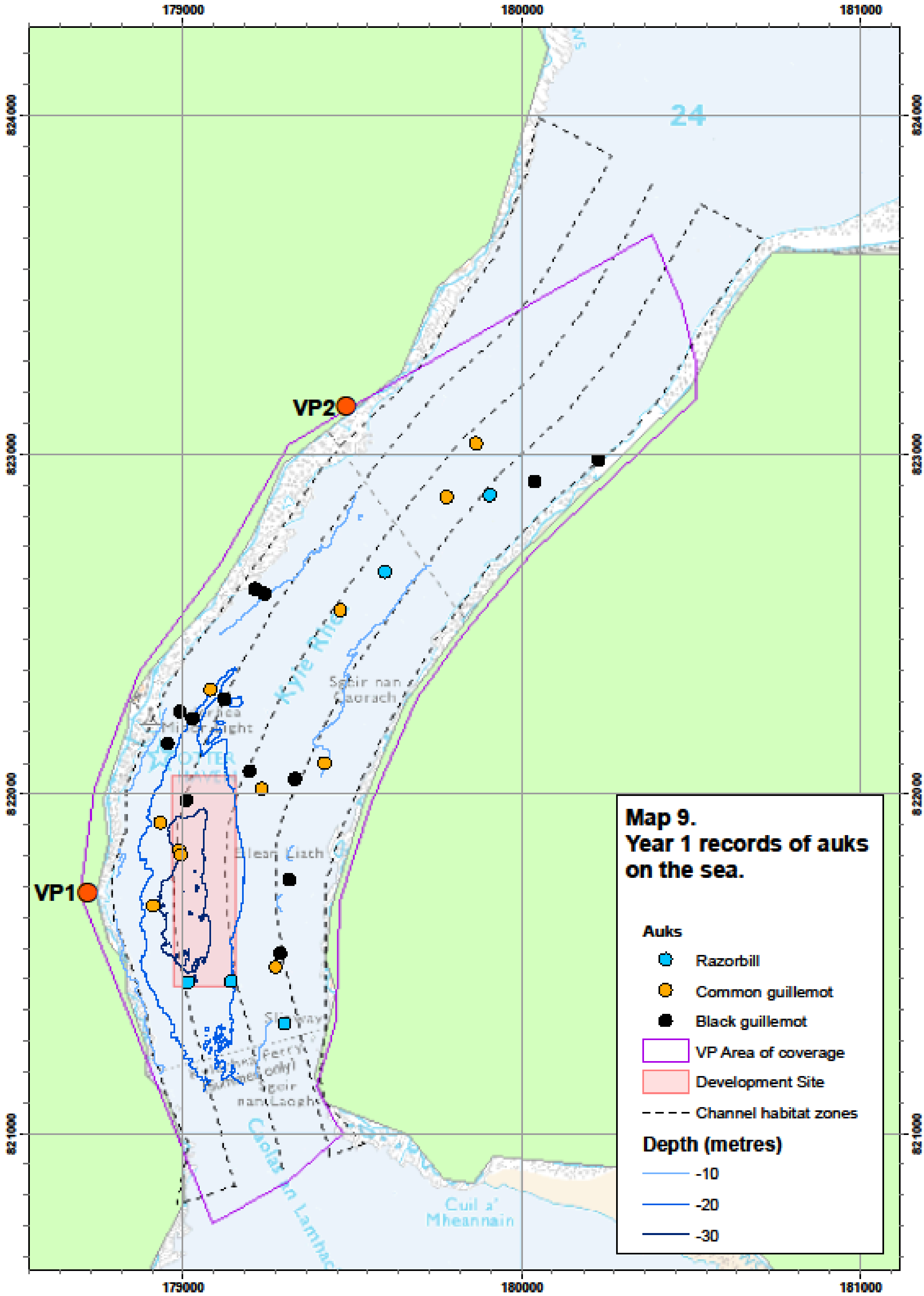

Map 5.
Year 1 records of cormorant on the sea.
Diving
0 - 4
5 - 10
11 - 23
24 - 37
Not diving
0 - 4
5 - 10
11 - 23
24 - 47
VP Area of coverage
Development Site
Channel habitat zones
Depth (metres)
-10
-20
-30
VP1
VP2
179000
180000
181000
824000
823000
822000
821000

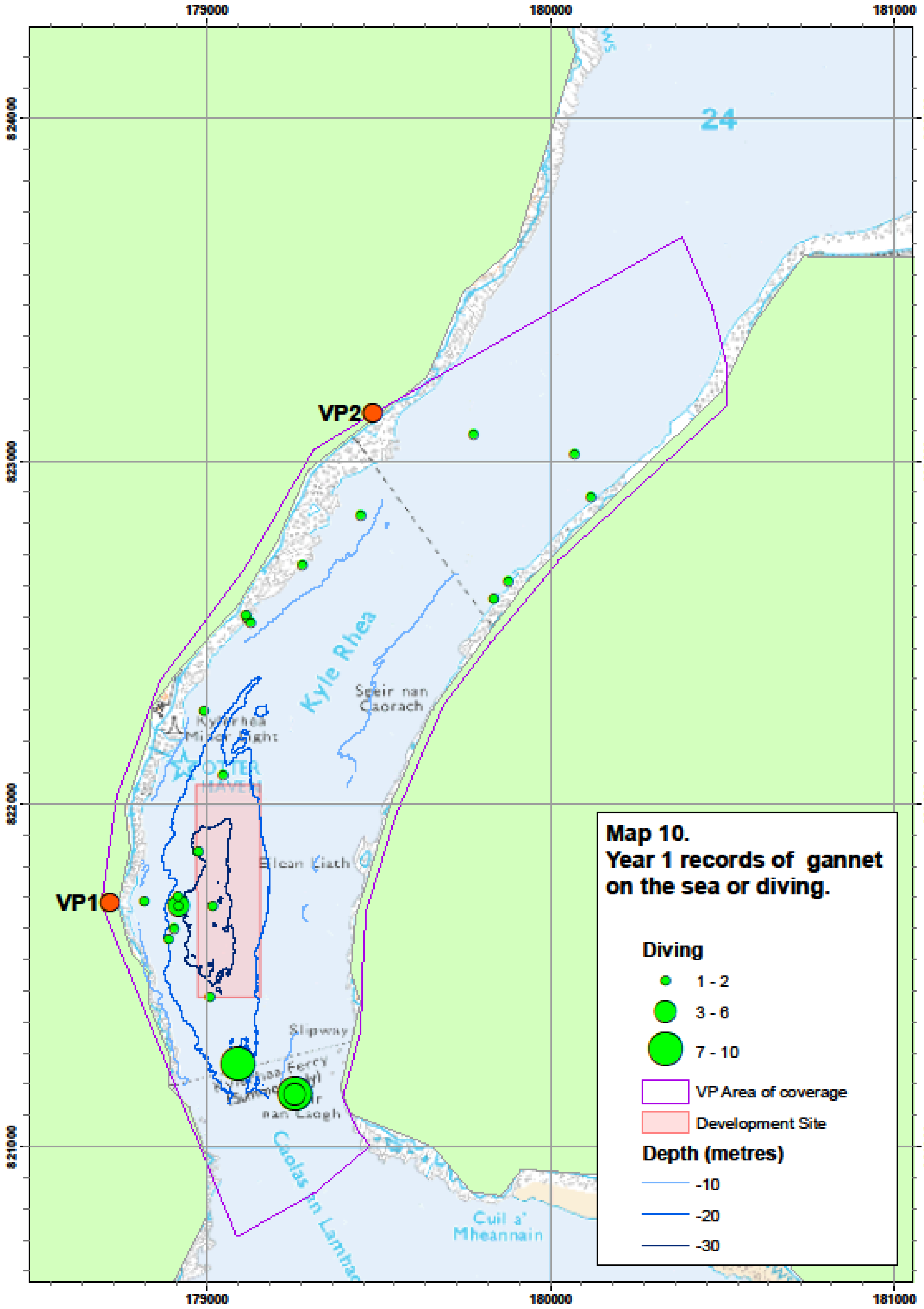


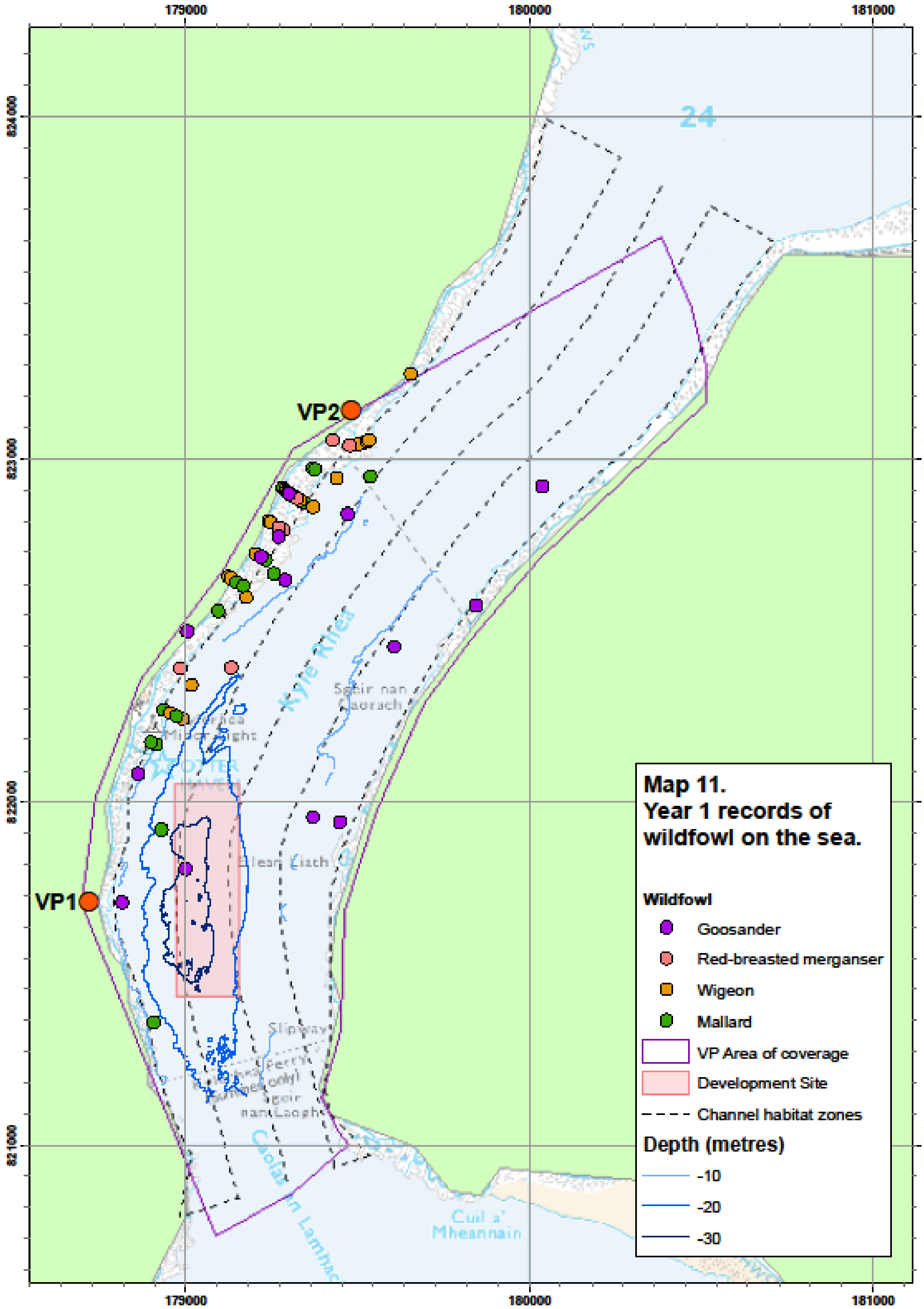
179000
180000
181000
824000
823000
822000
821000
VP1
VP2
Map 6.
Year 1 records of shag on the sea.
Diving
0 - 4
5 - 10
11 - 18
19 - 32
Not diving
0 - 4
5 - 10
11 - 18
19 - 47
VP Area of coverage
Development Site
Channel habitat zones
Depth (metres)
-10
-20
-30


179000
180000
181000
824000
823000
822000
821000
24
VP2
VP1
Kyle Rhea
Kylerhea
Minor Light
OTTER
HAVEN
Sgeir nan
Caorach
Eilean Liath
Slipway
Ferry
(Summer only)
Sgeir
nan Laogh
Caolas an Lamhac
Cuil a'
Mheannain
Map 7.
Year 1 records of cormorant and shag on the land.
Number of birds
0 - 4
5 - 10
11 - 23
24 - 47
VP Area of coverage
Development Site
Channel habitat zones


179000
180000
181000
824000
823000
822000
821000
24
VP2
VP1
Kyle Rhea
Sgeir nan Caorach
Eilean Ciach
Slipway
Cuil a' Mheannain
Map 8.
Year 1 records of divers and grebes on the sea.
Divers and grebes
Red-throated diver
Black throated diver
Little grebe
VP Area of coverage
Development Site
Channel habitat zones
Depth (metres)
-10
-20
-30


179000
180000
181000
824000
823000
822000
821000
24
VP2
VP1
Kyle Rhea
Sgeir nan Caorach
Eilean Liath
Slipway
Ferry (Summer only)
Sgeir nan Laogh
Caolas an Lamhach
Cuil a' Mheannain
Map 9.
Year 1 records of auks on the sea.
Auks
Razorbill
Common guillemot
Black guillemot
VP Area of coverage
Development Site
Channel habitat zones
Depth (metres)
-10
-20
-30


179000
180000
181000
824000
823000
822000
821000
24
VP2
VP1
Kyle Rhea
Sgeir nan Caorach
Eilean Liath
Slipway
Ferry
Caolas an Lamhac
Cuil a' Mheannain
Map 10.
Year 1 records of gannet on the sea or diving.
Diving
1 - 2
3 - 6
7 - 10
VP Area of coverage
Development Site
Depth (metres)
-10
-20
-30



179000
180000
181000
824000
823000
822000
821000
VP1
VP2
Kyle Rhea
Map 11.
Year 1 records of wildfowl on the sea.
Wildfowl
Goosander
Red-breasted merganser
Wigeon
Mallard
VP Area of coverage
Development Site
Channel habitat zones
Depth (metres)
-10
-20
-30

Kyle Rhea Tidal Stream Array

Appendix 11.2

Appendix 11.2:

Kyle Rhea Tidal Stream Array

HRA Screening of Ornithology

SUMMARY

This appendix presents the results of an screening exercise to determine if there is potential for the Kyle Rhea Tidal Stream Array to cause a Likely Significant Effect (LSE) on any qualifying ornithological features of Special Protection Areas (SPA).

The level of actual connectivity by birds using the Kyle Rhea survey area to SPA populations is considered to be either zero or extremely low for all species that regularly use the site and that could be plausibly affected by the Project. The screening exercise concludes that there are no LSE for any SPA qualifying feature and, therefore, HRA assessment is not required for the Project.

METHOD

The method described below sets out the two-step process used to determine which, if any, SPA sites/qualifying features should be taken forward for HRA.

HRA screening Step 1

Step 1 is a simple screening exercise that examines which SPAs are sufficiently close to the array area for it to be plausible that birds from that SPA use the area (in particular for foraging) and, therefore, for there to be at least theoretical connectivity with the array area. This is achieved by examining metadata of foraging range for each species (Thaxter *et al*. 2012, Birdlife International 2012) and the distance between SPAs and the Project area. The likely extent of the connectivity Is categorised as high, moderate, low or no connectivity (Table A11.2.1). Thus, Step 1 of the process addresses the question of whether it is theoretically likely that there is connectivity between an SPA and the array area and if so approximately how strong this might be.

HRA screening Step 2

In Step 2 of the exercise all SPA qualifying features with either high or moderate theoretical connectivity to the Project area identified in Step 1 are further screened against information on that species use of the survey area (i.e., results from the baseline surveys presented in Appendix 11.1) and information of the predicted vulnerability of species to the effects of tidal arrays (Furness *et al*. 2012).

Mere occurrence within the array area was not considered sufficient for a species to be selected, there had to also be evidence that a species actively used (i.e., likely foraged in) the array area or its immediate vicinity in at least one season of the year in reasonable numbers in the context of the species' population size at the SPA being considered. Birds that were flying directly over the survey area showing no evidence of foraging or searching for prey were not considered to be using the site. For practical purposes the threshold for reasonable numbers was cautiously set at 0.1% of the assumed regional population, i.e., to qualify for HRA there had to have been occasions when at least 0.1% of this population was using the Project area. The purpose of applying this abundance criterion was to prevent scarce occurrences of individuals from large populations triggering the need to undertake HRA, when it was apparent from the start that it was not possible to conclude a LSE.

To conclude that there is at least the possibility of a LSE on a SPA qualifying feature, and thereby trigger the need for HRA, the qualifying feature had to satisfy three conditions:

- Be evidence from generic foraging range information for moderate or high theoretical connectivity between the array area and the SPA concerned;
- Be a species that is considered to have at least moderate vulnerability to the effects of tidal arrays; and
- Be a species that uses the array area and its immediate surrounds in reasonable numbers in at least one season of the year.

A LSE caused by the Project was considered plausible for qualifying features that met all three conditions, in which case these require HRA to be undertaken (Table A11.2.2).

No species met these all three conditions and it is therefore concluded that HRA is not required for any SPA (Table A11.2.2).

Table A11.2.1. Criteria used to categorise theoretical connectivity between an SPA qualifying feature and the Project area.

Theoretical connectivity	Definition
High	Site within Mean Foraging Range
Moderate	Site within Mean Maximum Foraging Range +10%, (Method 1) or Site within 95% of Cumulative Foraging Distance (Method 2) (use whichever is more appropriate for a given species)
Low	Site within Maximum Foraging Range but not within Mean Maximum Foraging Range +10% (Method 1) or Site within Maximum Foraging Range but not within 95% of Cumulative Foraging Distance (Method 2) (use whichever is more appropriate for a given species)
None	Site further than the Maximum Foraging Range
Unknown	Insufficient data available.

Table A11.2.1. The theoretical connectivity between Kyle Rhea and breeding seabird SPAs based on distance to SPAs and foraging range metadata. Method 1 and Method 2 differ in how 'low' and 'moderate' theoretical connectivity is defined. Method 1 uses mean maximum foraging range plus 10% (MMFR+10%), whereas Method 2 uses 95% of the cumulative frequency distribution.

SPA	Distance by sea to SPA (km)	Species	Qualifying reason	SPA populatn. (pairs)	Foraging range metrics (km)					Theoretical connectivity Method 1	Theoretical connectivity Method 2
					Mean	Mean Max	MMFR+10%	Max	95% CFD.		
Rum	46	Kittiwake	I.I.B.A. component only	1500	25	60	66	120	60	Moderate	Moderate
		Common guillemot	I.I.B.A. component only	2680	38	84	93	135	65	Moderate	Moderate
		Manx shearwater	I.M.P. of a non-Annex 1 species	61000	172	330	363	400	375	High	High
Canna and Sanday	61	Puffin	I.I.B.A. component only	1200	4	105	116	200	65	Moderate	Moderate
		Kittiwake	I.I.B.A. component only	930	25	60	66	120	60	Moderate	Low
		Common guillemot	I.I.B.A. component only	3886	38	84	93	135	65	Moderate	Moderate
		Herring gull	I.I.B.A. component only	1300	11	61	67	92		Moderate	Low
The Shiant Isles	86	Puffin	I.M.P. of a non-Annex 1 species	76100	4	105	116	200	65	Moderate	Low
		Kittiwake	I.I.B.A. component only	1800	25	60	66	120	60	Low	Low

SPA	Distance by sea to SPA (km)	Species	Qualifying reason	SPA populatn. (pairs)	Foraging range metrics (km)					Theoretical connectivity Method 1	Theoretical connectivity Method 2
					Mean	Mean Max	MMFR+10%	Max	95% CFD.		
		Common guillemot	I.I.B.A. component only	12314.6	38	84	93	135	65	Moderate	Low
		Fulmar	I.I.B.A. component only	6820	48	400	440	580	375	Moderate	Moderate
		Razorbill	I.M.P. of a non-Annex 1 species	7337	24	49	53	95	25	Low	Low
Treshnish Isles	91	European storm-petrel	N.I.P. of an Annex 1 species	5040	60	92	101	120	0	Moderate	Low
Priest Island (Summer Isles)	95	European storm-petrel	N.I.P. of an Annex 1 species	2200	60	92	101	120	0	Moderate	Low
Mingulay and Berneray	136	Puffin	I.I.B.A. component only	4000	4	105	116	200	65	Low	Low
		Fulmar	I.I.B.A. component only	10450	48	400	440	580	375	Moderate	Moderate
Handa	144	Great skua	I.I.B.A. component only	66	36	86	95	219	0	Moderate	Low
		Fulmar	I.I.B.A. component only	3500	48	400	440	580	375	Moderate	Moderate
Cape Wrath	165	Puffin	I.I.B.A. component only	5900	4	105	116	200	65	Low	Low
		Fulmar	I.I.B.A. component only	2300	48	400	440	580	375	Moderate	Moderate

SPA	Distance by sea to SPA (km)	Species	Qualifying reason	SPA populatn. (pairs)	Foraging range metrics (km)					Theoretical connectivity Method 1	Theoretical connectivity Method 2
					Mean	Mean Max	MMFR+10%	Max	95% CFD.		
Flannan Isles	181	Puffin	I.I.B.A. component only	4400	4	105	116	200	65	Low	Low
		Fulmar	I.I.B.A. component only	4730	48	400	440	580	375	Moderate	Moderate
St Kilda	202	Great skua	I.M.P. of a non-Annex 1 species	270	36	86	95	219	0	Moderate	Low
		Manx shearwater	I.I.B.A. component only	5000	172	330	363	400	375	Moderate	Moderate
		Fulmar	I.I.B.A. component only	62800	48	400	440	580	375	Moderate	Moderate
		Gannet	I.M.P. of a non-Annex 1 species	60400	93	229	252	590	325	Moderate	Moderate
North Rona and Sula Sgeir	214	Fulmar	I.I.B.A. component only	11500	48	400	440	580	375	Moderate	Moderate
		Gannet	I.M.P. of a non-Annex 1 species	9000	93	229	252	590	325	Moderate	Moderate
Sule Skerry and Sule Stack	225	Gannet	I.M.P. of a non-Annex 1 species	4890	93	229	252	590	325	Moderate	Moderate
Rathlin Island	230	Fulmar	I.I.B.A. component only	No count given	48	400	440	580	375	Moderate	Moderate
North Caithness Cliffs	237	Fulmar	I.I.B.A. component only	14700	48	400	440	580	375	Moderate	Moderate

SPA	Distance by sea to SPA (km)	Species	Qualifying reason	SPA populatn. (pairs)	Foraging range metrics (km)					Theoretical connectivity Method 1	Theoretical connectivity Method 2
					Mean	Mean Max	MMFR+10%	Max	95% CFD.		
Hoy	269	Fulmar	I.I.B.A. component only	35000	48	400	440	580	375	Moderate	Moderate
Ailsa Craig	280	Gannet	I.M.P. of a non-Annex 1 species	32460	93	229	252	590	325	Low	Moderate
Rousay	299	Fulmar	I.I.B.A. component only	1240	48	400	440	580	375	Moderate	Moderate
Outer Ards	303	Manx shearwater	I.M.P. of a non-Annex 1 species but species not in SPA review for this site	3581	172	330	363	400	375	Moderate	Moderate
Copeland Islands	305	Manx shearwater	I.M.P. of a non-Annex 1 species but site not in SPA review	4800	172	330	363	400	375	Moderate	Moderate
West Westray	309	Fulmar	I.I.B.A. component only	1400	48	400	440	580	375	Moderate	Moderate
East Caithness Cliffs	314	Fulmar	I.I.B.A. component only	15000	48	400	440	580	375	Moderate	Moderate
Copinsay	317	Fulmar	I.I.B.A. component only	1615	48	400	440	580	375	Moderate	Moderate
Calf of Eday	319	Fulmar	I.I.B.A. component only	1955	48	400	440	580	375	Moderate	Moderate

SPA	Distance by sea to SPA (km)	Species	Qualifying reason	SPA populatn. (pairs)	Foraging range metrics (km)					Theoretical connectivity Method 1	Theoretical connectivity Method 2
					Mean	Mean Max	MMFR+10%	Max	95% CFD.		
Fair Isle	392	Fulmar	I.I.B.A. component only	35210	48	400	440	580	375	Moderate	Low
		Gannet	I.I.B.A. component only	1166	93	229	252	590	325	Low	Low
Troup, Pennan and Lion`s Heads	403	Fulmar	I.I.B.A. component only	4400	48	400	440	580	375	Moderate	Low
Foula	407	Fulmar	I.I.B.A. component only	46800	48	400	440	580	375	Moderate	Low
Sumburgh Head	423	Fulmar	I.I.B.A. component only	2542	48	400	440	580	375	Moderate	Low
Buchan Ness to Collieston Coast	440	Fulmar	I.I.B.A. component only	1765	48	400	440	580	375	Moderate	Low
Noss	462	Fulmar	I.I.B.A. component only	6350	48	400	440	580	375	Low	Low
		Gannet	I.M.P. of a non-Annex 1 species	7310	93	229	252	590	325	Low	Low
Fowlsheugh	505	Fulmar	I.I.B.A. component only	1170	48	400	440	580	375	Low	Low
Hermaness, Saxa Vord and Valla Field	507	Fulmar	I.I.B.A. component only	19539	48	400	440	580	375	Low	Low
		Gannet	I.M.P. of a non-Annex 1 species	12000	93	229	252	590	325	Low	Low

SPA	Distance by sea to SPA (km)	Species	Qualifying reason	SPA populatn. (pairs)	Foraging range metrics (km)					Theoretical connectivity Method 1	Theoretical connectivity Method 2
					Mean	Mean Max	MMFR+10%	Max	95% CFD.		
Fetlar	509	Fulmar	I.I.B.A. component only	9500	48	400	440	580	375	Low	Low
Forth Islands	589	Gannet	I.M.P. of a non-Annex 1 species	34400	93	229	252	590	325	Low	Low

Notes

1. Mean, Mean max and mean foraging ranges from Thaxter, C. B., Lascelles, B., Sugar, K., Cook, A. S. C. P., Roos, S., Bolton, M., Langston, R. H. W. & Burton, N. H. K. 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation. doi: 10.1016/j. biocon. 2011.12.009. For storm petrel no fixed values given in Thaxter 2012 et. al. for max and mean max values so equivalent values for Leach's petrel used. No mean value for Leach's petrel, so max/2 used in mean value for storm petrel. Manx shearwater mean max value in Thaxter 2012 et al. given as >330 km. Tracking data on which this figure is based suggests that 330 km is probably a reasonable value for mean max. No appropriate values for Manx shearwater max and mean range given in Thaxter 2012 et. al. so values taken from Birdlife International. 2011. Birdlife Seabird Foraging Database. Birdlife International. http://seabird.wikispaces.com. M Cumulative frequency range at which 95% of population included is estimated from plots given at: (http://seabird.wikispaces.com/)
2. Population counts for taken from JNCC 2001. The UK network: its scope and content. Volume 3. Site accounts. Joint Nature Conservation Committee. No population counts are given for I.I.B.A. component only qualifiers so in these cases counts are from JNCC. 2011. Spatial/summary data for UK Special Protection Areas (s). Joint Nature Conservation Committee. http://jncc.defra.gov.uk/page-1409. Where an I.I.B.A. component is first included at review (*) the Seabird 2000 colony count in the JNCC Seabird Monitoring Programme (SMP) online database is given. Counts of guillemot and razorbill given as 'individuals on land' in the spatial/summary data have been converted to pairs by multiplying counts by 0.67 based on Harris, M.P. 1989. Variation in the correction factor used for converting counts of individual common guillemots into breeding pairs. Ibis, 131: 85-93. This conversion is the same as that used in the JNCC Seabird Monitoring Programme (SMP) online database. Following SMP conversion parameters; puffin counts given as 'individuals on land' these were assumed to be equivalent to the number of pairs present; gulls counts given as 'individuals on land were divided by 2 to get the number of pairs.
Qualifying reason abbreviations: I.I.B.A., 'Internationally important bird assemblage'; N.I.P., 'nationally important population'; and I.M.P., 'important migratory population'.
JNCC. Notes on data parameters for SMP online database downloadable at: http://jncc.defra.gov.uk/page-4460
JNCC. 2011. Spatial/summary data for UK Special Protection Areas (s). Joint Nature Conservation Committee. http://jncc.defra.gov.uk/page-1409 . Last updated 5 September 2011. Accessed 20 November 2011.
JNCC 2001. The UK network: its scope and content. Volume 3. Site accounts. Joint Nature Conservation Committee.

Table A11.2.2. HRA screening summary of Steps 1 and Steps 2 for species regularly occurring in Kyle Rhea sound during the breeding season (full results of Step 1 screening are provided in Appendix 11.2) and which have a high or moderate theoretical connectivity to a SPA.

Species	SPA (distance away)	Theoretical connectivity (from Table A11.2.1)	<0.1% of regional population uses Kyle Rhea (from Appendix 1)	Vulnerability to tidal arrays (from Furness *et al* 2012)	Potential for a 'Likely Significant Effect'
Gannet	St Kilda (202km)	Moderate	No	Low	No
	Sule Skerry and Sule Stack (225km)	Moderate	No	Low	No
	North Rona and Sula Sgeir (214km)	Moderate	No	Low	No
Herring gull	Canna and Sanday (61km)	Moderate	No	Very low	No
Note, fulmar, European storm-petrel, Manx shearwater, kittiwake, great skua, common guillemot and puffin are excluded from the table because they were not recorded using the study area in the breeding season during baseline surveys.					

Kyle Rhea Tidal Stream Array

Appendix 11.3

NATURAL RESEARCH PROJECTS LIMITED

Appendix 11.3:

Kyle Rhea Tidal Stream Array

Collision Risk to Diving Birds

Introduction

This appendix presents the results of an exercise to estimate the potential for diving seabirds to be affected by underwater collision with operating tidal device rotors, in particular shag. Tidal devices pose a theoretical collision risk to actively diving seabirds, potentially leading to death or injury. However, there is currently no empirical evidence to indicate whether tidal devices pose a real and significant collision risk to seabirds. This information gap requires investigation (Shields, 2009). There is currently no guidance or accepted method to estimate collision risk for diving birds though it has been attempted for seals (Davies and Thompson 2011). There are some parallels (but also several differences) with the calculation of collision risk to flying birds posed by wind turbines for which there is guidance (Band 2000, SNH 2010).

Attempting to estimate collision risk to diving birds quantitatively is useful as it allows for impacts to be assessed quantitatively, which is preferable to a qualitative assessment. However, in order to quantify collision risk it is necessary to have a reasonable understanding of the important parameters that combine to the determine risk. There determinants of risk are broadly understood and the values of the parameters required can be determined at least approximately. Therefore it was considered worthwhile to attempt to quantify collision risk at least in the case of shag. Nevertheless there is inevitably uncertainty about some aspects of the mechanism causing collision risk and the magnitude of some of the parameters. Thus in places it was necessary to make assumptions and to use approximate values. In all cases assumptions made are reasonable and approximations err on the side of caution. The results of the exercise are considered to give a valuable approximation of the collision risk that is likely. At the same time it is recognised that the method is relatively crude and likely to be improved upon in future as the subject is better understood. It is suggested that the greatest uncertainty affecting the result is the lack of information on avoidance behaviour shown by diving birds to a rotor and the proportion of collisions that results in death /serious injury. The number of harmful collision strikes that is predicted is highly sensitive to the avoidance and death/serious injury rates that are used. Therefore, the results are expressed for a range of avoidance rates and death/serious injury rates.

Species at collision risk

Year 1 survey results show that the Kyle Rhea array area is relatively little used by diving seabirds and underutilised compared to other areas. In the case of cormorant, the only high priority seabird species, the array area was proportionally underutilised by a factor of approximately six, compared to the rest of the Kyle Rhea survey area. Less than 1% of all cormorant diving activity was within the array area boundary. Goosander was not recorded in the array area, and red-throated diver was only recorded once. By far the greatest potential for collision is for shag. This species was commonly seen diving in the array area, with 3.4% of all records of diving individuals within the boundary. Furthermore, shags typically forage on or near the seabed (Harris & Wanless 1991, Wanless, Burger & Harris 1991, Grémillet *et al.* 1998) so birds diving within the array area were likely to be diving to depths that will be occupied by rotors. It is concluded therefore that the potential for collision is very low for all high and medium priority species except for shag. For shag there is a clear potential for a significant theoretical risk of collision and this merits more detailed consideration.

Until devices are deployed the risk to shags at Kyle Rhea cannot be precisely quantified. However, some basic calculations are undertaken below to give an approximate indication of the number of dives that might be at risk of collision per year and how many of these might result in death or serious injury. The calculations below are necessarily basic however, until there is a better understanding of dive paths in the array area, avoidance behaviour, strike rates and effects of collisions strike there is little point in over-refining the values used and assumptions made.

Number of shag dives at risk

For the purposes of assessing collision risk it is assumed that on average there are 25 adult shags present in Kyle Rhea survey area at all times of year (based on Year 1 survey results, see Appendix 11.1), that each of these animals forages for four hours per day during which each bird undertakes 40 dives per hour and that foraging is restricted to the survey area (area of VP coverage). Under this scenario, it would mean there were 1,460,000 (25 x 4 x 40 x 365) shag dives in the Kyle Rhea survey area each year. Baseline surveys indicate that 3.4% of dives within the survey area are within the array area (Appendix 11.1), which translates to 49,640 dives each year. Whether or not a dive path undertaken in the array area will collide with a rotor will depend on the following:

- The lateral (horizontal) distance travelled at rotor depth;
- The proportion of the at-rotor-depth cross-sectional area (i.e., in the vertical west to east plane) of the array area width that is occupied by rotors;
- The collision likelihood for a bird passing through the swept area of the rotor.

The average lateral (i.e., in a horizontal dimension) distance travelled at rotor depth per dive is unknown, but can be grossly estimated based on assumed dive profiles, duration and swimming speed. It is likely to be considerably less than the total lateral distance of the dive, as much of dive will be at depths above and (for bottom-feeding individuals) below rotor depths, with individuals seeking to reach seabed from surface and vice versa as rapidly as possible. For the purposes of calculation it is cautiously assumed that dives have an average total lateral distance of 80 m and that 20 m of this is at rotor depth.

The proportion of the at-rotor-depth cross-sectional area of the array area (cross section of 155 m x 20 m = 3100 m^2) occupied by a rotor swept area of a single 20 m diameter rotor (= 314 m^2, 10 m x 10 m x pi) is 10% (314 m^2/3100 m^2).

The array area is 615 metres long, so if the average lateral distance at rotor depth of a dive is 20m and assuming dives are evenly distributed within the array area and orientated parallel to the tidal stream, then there will be a 3.2% chance (20 m /615 m) that any dive would pass a rotor located somewhere along its length.

On the basis of these assumptions it is crudely estimated that any one dive within the array area has a 0.32% chance (10% width ways x 3.2% length ways) of passing through the rotor swept area of a 20 m diameter rotor within the array area. The Project entails eight 20 m-diameter rotors, so it follows that the overall chance of a single shag dive path within the array area passing thorough the swept areas any of the rotors will be eight times greater, i.e., 2.6%. The calculations above suggest that very approximately 1290 shag dives per year (2.6% x 49,640) would pass through the swept areas of the rotors if birds showed no avoidance response.

Band collision risk

The likelihood of a bird passing through a rotor's swept area and being struck by the rotor can be estimated using the same method used to calculate this metric for flying birds and wind turbines (Band *et al*. 2007). For diving shag it is assumed that the average bird is 0.7 m long (bill to feet), 0.2 m average width, and swims at 1.8 m/s (Wanless *et al*. 1991). Using these values, it is estimated that the risk of collision is nil when rotors are stationary, 21% when rotors are at their average intermediate rotation speed (6 rpm), and 33% at the maximum rotation speed of (12 rpm).

On average, rotors are predicted to be stationary for approximately 33% of the time, operational at intermediate speeds for 60% and operational at maximum speed (12 rpm) for 7% of the time (Table A11.3.1) . Thus on average the risk of collision strike for the average dive that passes through a rotor swept area estimated at 14.9% (0% risk for 33% of time, plus 21% risk for 60% of time, plus 33% risk for 7% of time).

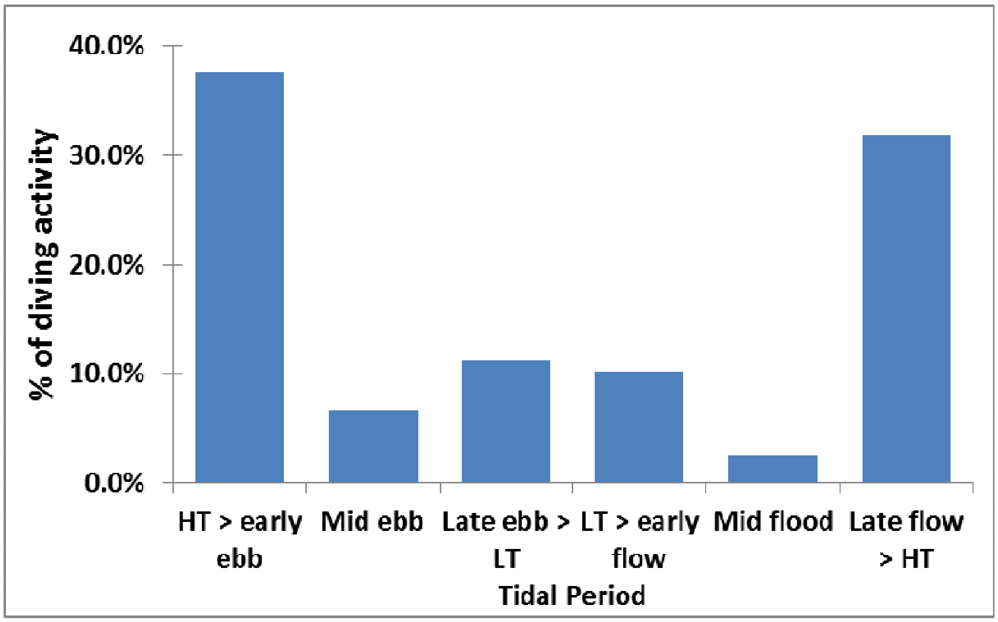
Table A11.3.1 The predicted percentage of time that low, intermediate and high current strengths will prevail at each device location.

Turbine	Low current (<1 m/s) not rotating	Intermediate current (>1 <2.5 m/s) rotating at slow speeds	High current (>2.5 m/s) rotating at full speed
Turbine 1	34.2%	61.0%	4.8%
Turbine 2	30.9%	63.6%	5.5%
Turbine 3	36.4%	56.0%	7.6%
Turbine 4	30.4%	59.5%	10.2%

Thus, if there was no avoidance behaviour, 14.9% of the dive paths that pass through a rotor swept area is predicted to result in the bird being struck. This translates to approximately 192 dives per year.

Shag diving activity and tidal cycle

This initial estimate assumes that diving activity is uniformly distributed through the tidal cycle, but this is not the case. Indeed, diving activity by shag in parts of Kyle Rhea sound that are greater than 20 m depth (chart datum) shows a strong relationship to the tidal cycle. Diving activity is at a minimum at mid tide (Graph 1) , the time when current strength is greatest, coinciding when devices would be rotating at their highest speed. Approximately 50% of the diving activity by shags occurs in the part of the tidal cycle when rotors are will not to be rotating (when current speed is below 1 m/s, conditions that prevail for about one third of the time, Table A11.3.1). Approximately 2% of diving activity is predicted to occur when devices are operating at their maximum speed (current above 2.5 m/s). During this current speed the risk of strike and the collision impact would be greatest. Assuming that 50% of diving activity occurs when the devices are not rotating, the number of shag dives that would result in collision reduces to 96 per year (192 x 50%).

11.1.1 

Graph 1. Variation in diving activity by shag in parts of Kyle Rhea sound greater than 20 m depth in relation to tidal cycle. Tidal cycle is divided into six equal periods each of approximately two hours duration. Values are corrected for variation in effort between tidal periods. Based on 161 observations of diving shags seen during 356 snapshot scans undertaken in Year 1 of baseline surveys.

Avoidance and injury rates

The extent to which shags (or other diving species) might be able to avoid collision is unknown. Underwater visibility within the array area is expected to be relatively good. Experience of the Kyle Rhea site following surveys in 2011-2012 and previous anecdotal evidence suggests that Kyle Rhea and tidal channels elsewhere in western Scotland typically have underwater visibility of between 10 and 15 m. Shags (and other diving seabirds) hunt by eyesight during the hours of daylight, so it is reasonable to assume that birds diving in the vicinity of turbines are able to see at least a short distance ahead and are visually vigilant. It is therefore, likely that diving birds are able to make some behavioural avoidance response. Nevertheless, compared to the visibility experienced by flying birds in daylight in air (typically at least several kilometres) the visibility underwater will be very limited. Therefore, far field avoidance by diving shags at a scale of tens of metres or more is unlikely. On this basis it is considered likely that the effective avoidance rate of diving shags will be far lower than the avoidance rates typically shown by flying birds to wind turbines. For flying birds SNH guidance recommends a default avoidance rate of 98% and avoidance rates of 99% for certain birds (SNH 2010). There is growing evidence that these rates are overly cautious for most bird species with studies indicating that rates of up to 99.9% are likely to be closer those actually achieved by many birds. Davies and Thompson 2011, present collision modelling results for seals for avoidance rates ranging from 95 to 99.8% but acknowledge that lack of information to validate how precautionary (if at all) these rates are.

In studies of collisions between flying birds and wind turbines all bird strikes are assumed to cause serious injury or death and there is no empirical evidence to indicate that this assumption does not broadly hold true in practice. There is currently no evidence to indicate that diving birds colliding with rotors will necessarily be killed or injured. This presents a significant information gap. Nevertheless there are good reasons to believe that some collisions will be of low impact and therefore may not be harmful. Seabirds in general are remarkably tough and have evolved in environments where they naturally experience moderate physical force, e.g., from storms. The force of strike experienced by a bird from a underwater rotor arm of 10 m rotating at 6 to 12 rpm will be modest in comparison, say, to that experienced by flying bird struck by the rotor of a large wind turbine (typically 45 m rotor length and typically rotating at around 15 rpm, thus developing much greater rotor tip velocities) and possibly insufficient to result in injury, particularly at slower rotational speeds and near the base of the rotor arm. The fluid dynamics of sea water may also prevent some collisions occurring or at least significantly reduce their intensity, when compared to strikes in a medium of air. For these reasons it is considered likely that a high proportion of collisions will have insufficient impact to cause harm to the bird. .

Estimated shag mortality per year

From the above discussion it is concluded that:

- Approximately 96 shag dives per year may result in a collision with devices if birds take no avoidance behaviour;

- There is significant uncertainty regarding the avoidance rate, nevertheless it is likely to be well above zero but below the avoidance rate shown by flying birds to wind turbines;

- There is uncertainty as to whether collisions will cause death /serious injury. There are good theoretical reasons to believe a substantial proportion of collisions will not result in death/serious injury.

For the purposes of illustration the number of collisions is predicted for four arbitrary avoidance rates, 90%, 95%, 98% and 99% (Table A11.3.2). This range is somewhat below the avoidance rate range of 95 to 99.8% suggested by Davies and Thompson (2011) for seals. For the purposes of illustration the number of deaths/serious injury are predicted for four arbitrary ‘collision harm rates’ (the proportion of collisions causing death or serious injury), 100%, 75% 50% and 25% (Table A11.3.2).

Table A11.3.2. The predicted number of collisions per year between rotors and diving shag resulting in death or serious injury for a range of combinations of avoidance rate and harm rate.

Avoidance rate	100% of collisions harmful	75% of collisions harmful	50% of collisions harmful	25% of collisions harmful
No avoidance	96	72	48	24
90%	9.6	7.2	4.8	2.4
95%	4.8	3.6	2.4	1.3
98%	1.9	1.4	0.96	0.48
99%	0.96	0.72	0.48	0.24

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Kyle Rhea Tidal Stream Array

Appendix 12.1

Baseline characterisation of seal populations in relation to Kyle Rhea

October 2012

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CONTENTS

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1 INTRODUCTION

1.1 Aim

The aim of this report is to present existing data on seal aerial surveys and satellite telemetry to describe the abundance and distribution of harbour and grey seals in the vicinity of Kyle Rhea, specifically to inform site specific and cumulative impact assessments of the likely nature and extent of potential impacts from the development.
The report:

- Provides insight into the total sizes of the relevant seal populations for the assessment.
- Highlights any important haul out sites that could be disturbed by the development
- Considers the importance of the habitat to seals which could be impacted by the development.
- Examines the potential for overlap between at sea distribution of seals and the area of potential impact.
- Examines if there is evidence for linkage between seals from SACs and the area of potential impact? and;
- Reviews information on the diet of seals in the region, to inform the assessment of potential indirect impacts from changes in prey species.

1.2 Study area and proposed tidal power development

Kyle Rhea is a narrow strait of water between the Isle of Skye and the west coast of Scotland. The proposed array site lies north of the existing ferry (MV Glenachulish) crossing from Skye to the mainland, which operates during the summer months. An array of four 2MW tidal turbines is proposed for the site, the minimum distance between the devices is 60m. (Figure 1)

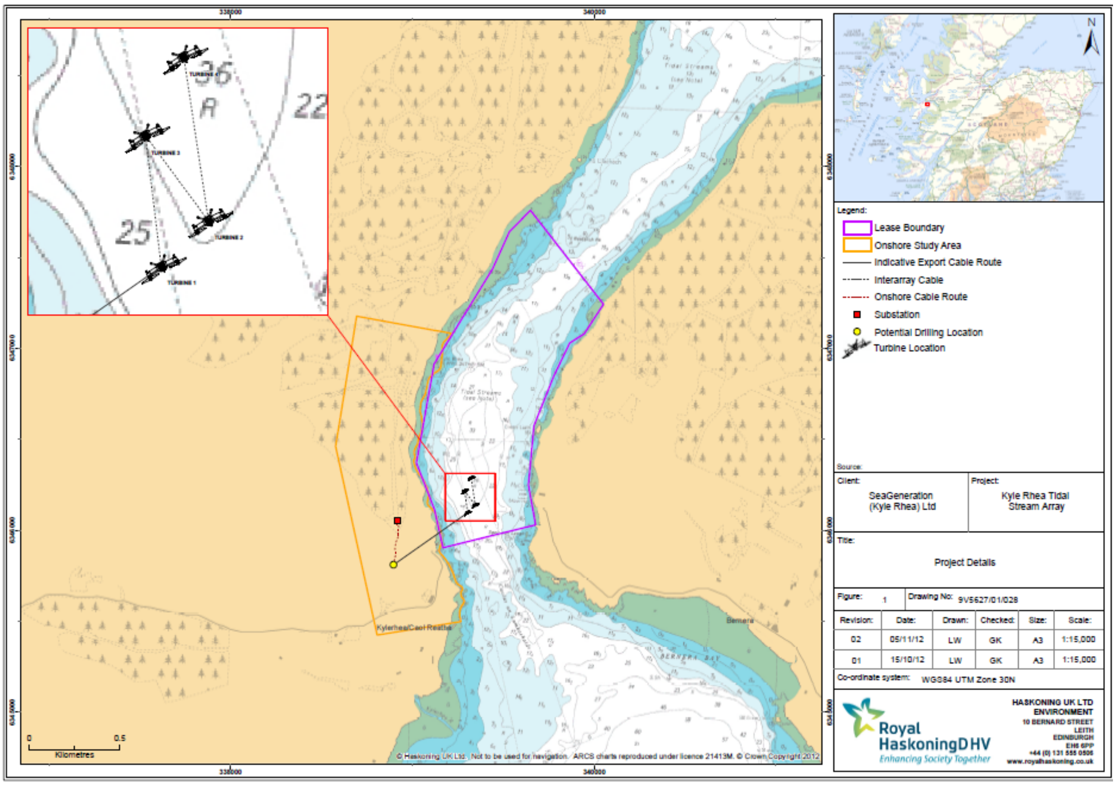

Figure 1: Map of the development site.

1.3 Seal species occurring in the UK

There are two species of seal indigenous to the UK; grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*. The harbour seal is also sometimes known as the common seal. Occasionally there may be sightings of other species of Artic seal in UK waters, but they are only incidental.

Grey seals

Grey seals occur across the north west and north east Atlantic, including the Baltic Sea. In the UK most grey seals are found around the coast of Scotland. Grey seal is the largest of the resident UK species of seal; with adult males weighing between 170-310kg. Females are smaller reaching 100-190kg when adult. Adult male grey seals have a distinctive Roman nose profile, and are generally dark brown or black in colour, adult female pelage is distinctively marked with grey patterns on a cream/white background and lighter underside. Grey seals are long lived animals; males live for more than 20 years, females more than 30. Sexual maturity is around 10 years in males, and 5 years old in females.

Grey seals spend their time alternating between periods of foraging activity in the open sea, and time spent at haul out sites on land, where they rest, moult and breed. Foraging trips can vary in duration and distance travelled, but the majority of trips average at just over 2 days in length and 40km in range (McConnell *et al*., 1999). Foraging trips can be from specific haul out sites to consistent locations at sea, but individuals can also move to new foraging areas, and new haul out sites over long distances (e.g. between the North Sea and Outer Hebrides).

Grey seals spend longer hauled out during their annual moult (December to April in the UK) and during the breeding season (August to December in the UK). Breeding typically occurs on uninhabited or remote islands or stretches of coast or caves. Adult grey seals return to the same colonies to breed each year (Pomeroy *et al.,* 1994). Pups are born on land with a white coat (lanugo) and remain with their mothers until weaning (approximately 18 days). After this time the pups moult their lanugo and then fast for a further 10 to 28 days before undertaking their first foraging trips.

Female grey seals come into oestrus towards the end of lactation and then mate. The gestation period is 8 months, but the fertilized egg is not implanted until 4 months after conception, in order to maintain the annual breeding cycle.

Harbour seals

The harbour seal are a widespread species occurring over a range of latitudes in coastal and island habitats around the North Atlantic and North Pacific regions. In the UK harbour seal populations are concentrated around the Scottish coast.

Harbour seals are smaller than grey seals, typically weighing 80-100kg, with males being slightly larger than females. Harbour seal are also longed lived, living up to 20-30 years.

Like grey seals, harbour seal alternate their time between periods of foraging at sea, and time spent at haul out sites, resting, moulting and breeding. Harbour seal generally forage within 40-50km of their haul out sites, and in comparison to grey seal have a more localised distribution at sea.

The proportion of time spent hauled out increases during their annual moult (August) and during the breeding season. Unlike grey seals, harbour seal pups shed their lanugo prior to birth, and usually enter the water within a few hours of birth. Weaning takes approximately 3 weeks, during which time the mother and pup remain in close association. Like grey seals, female harbour seals come into oestrus towards the end of lactation. The gestation period is 8 months, but the fertilized egg is not implanted until 4 months after conception, in order to maintain the annual breeding cycle.

Legislation protecting seals

In Scotland seals are protected under the Marine (Scotland) Act 2010. Section 6 of this Act prohibits the taking of seals except under licence. Licences to kill individual seals (by shooting) can be granted for the protection of fisheries and aquaculture and for scientific and welfare reasons. The Natural Environment Research Council (NERC), through the Special Committee on Seals (SCOS) and the NERC sponsored Sea Mammal Research Unit (SMRU), provides advice on all licence applications and haul out designations.

Seven 'Seal Management Areas' have been defined by Marine Scotland based on advice from SMRU (SCOS, 2011). These are East coast, Moray Firth, Orkney and North coast, Shetland, Western Isles, West Scotland (North, Central and South) and South-West Scotland. Kyle Rhea falls within the West Scotland Management Area (WSMA) which is a large area extending from Cape Wrath in the north to the Mull of Kintyre in the South (including all of the inner Hebridean Islands in between). (Figure 2)

The Seal Management Areas are used to assess the acceptable levels of licenced shooting, which The Scottish Government undertakes by considering the Potential Biological Removal (PBR) for that seal population. PBR is the number of individual seals that can be safely removed from the population without causing a significant decline in the population and is calculated annually by SMRU using the latest counts and population estimates. The PBR in 2012 for grey seals in the WSMA is 297, and for harbour (or common) seals it is 442. For grey seals in 2012 a total of 126 licenses were granted in this area, and for harbour seal 184 licences were granted (Scottish Government, 2012, http://www.scotland.gov.uk/Topics/marine/Licensing/SealLicensing).

The relatively large WSMA can be subdivided into smaller management units of North, Central and Southern regions. The Central region extends from Ardnamurchan point in the south to Rubha Rèidh in the North (between Gairloch and Loch Ewe, Figure 2).

Both grey and harbour seals are listed in Annex II of the EU Habitats Directive, requiring specific areas to be designated for their protection. To date 16 Special Areas of Conservation (SACs) have been designated specifically for seals. Seals are features of qualifying interest in seven additional SACs.

The SACs with seals as qualifying interests that could be relevant to an assessment of the likely impact of the tidal turbine array in Kyle Rhea region include:

- The Treshnish Isles (grey seal)
- The Monach Islands (grey seal)
- North Rona (grey seal)
- Ascrib, Isay and Dunvegan (harbour seal)
- Eileanan agus Sgeiran Lios mór (Lismore; harbour seal)
- South-East Islay Skerries (harbour seal)

Only four of these sites fall within the same seal Management Area as the proposed development; The Treshnish Isles, Ascrib, Isay and Dunvegan, Lismore and South-East Islay Skerries. The conservation objectives for each of these sites are provided in Appendix A.

The Marine (Scotland) Act 2010 introduced Seal Conservation Areas (replacing Seal Conservation Orders under the earlier Conservation of Seals Act 1970). This was in response to local declines in harbour seal numbers and the aim was to provide additional protection for vulnerable local populations. Ministers must not grant a licence unless they are satisfied that there is no suitable alternative and that the granting of a licence will not be detrimental to the maintenance of the harbour seal population at favourable conservation status. The two existing Conservation Orders which were introduced under the Conservation of Seals Act 1970 (the Conservation of Seals (Scotland) Order 2004 which protects both species year-round in the wider Moray Firth from Wick to Fraserburgh, and the Conservation of Seals (Scotland) Order 2007 which protects seals in the Northern Isles and the Firths of Forth and Tay) continue in the form of Seal Conservation Areas. Additional provision was made for a Seal Conservation Area for harbour seals in the Western Isles.

Section 117 of The Marine (Scotland) Act 2010 also introduced provision for the protection of seals at a number of designated haul out sites around the Scottish coast. A number of proposed protected areas have been suggested and a consultation document was produced by the Scottish Government (2011). The aim is to protect seals from harassment at these sites. Within the WSMA (Central) there are five haul out sites for harbour seal, six for grey seal, and one combined grey and harbour seal haul out that are considered as potential protected sites. These sites are listed in Table 1, below and their locations are shown in Figure 3.

Table 1: Potential protected haul out sites within the West Scotland (Central) Management Area.

Species	Site no. (see Fig 2)	Site name	Location	Approx. distance from Kyle Rhea

Species	**Site no.** **(see Fig 2)**	**Site name**	**Location**	**Approx. distance from Kyle Rhea**
Harbour	24	Luinga Bheag	Arisaig	39km
Harbour	25	Loch a'Bhraige	N. Rona Sound of Raasay	47km
Harbour	27	Pabay	SE Skye	14km
Harbour	28	Eilean an t-Snidhe	Sound of Arisaig	41km
Harbour	29	Eilean Reamhar	Loch Scavag, S Skye	54km
Harbour & Grey	26	Oigh-sgeir	SW of Canna	77km
Grey	114	Garrisdale Point	W Canna	72km
Grey	115	Fladda-chuain	Off N Skye	78km
Grey	116	Sgeir a'Phuirt	E Canna	62km
Grey	117	Sgeir nam Maol	Off N Skye	76km
Grey	118	Eilean Chathastail South	Eigg	49km
Grey	119	An Steidh	SW Canna	71km

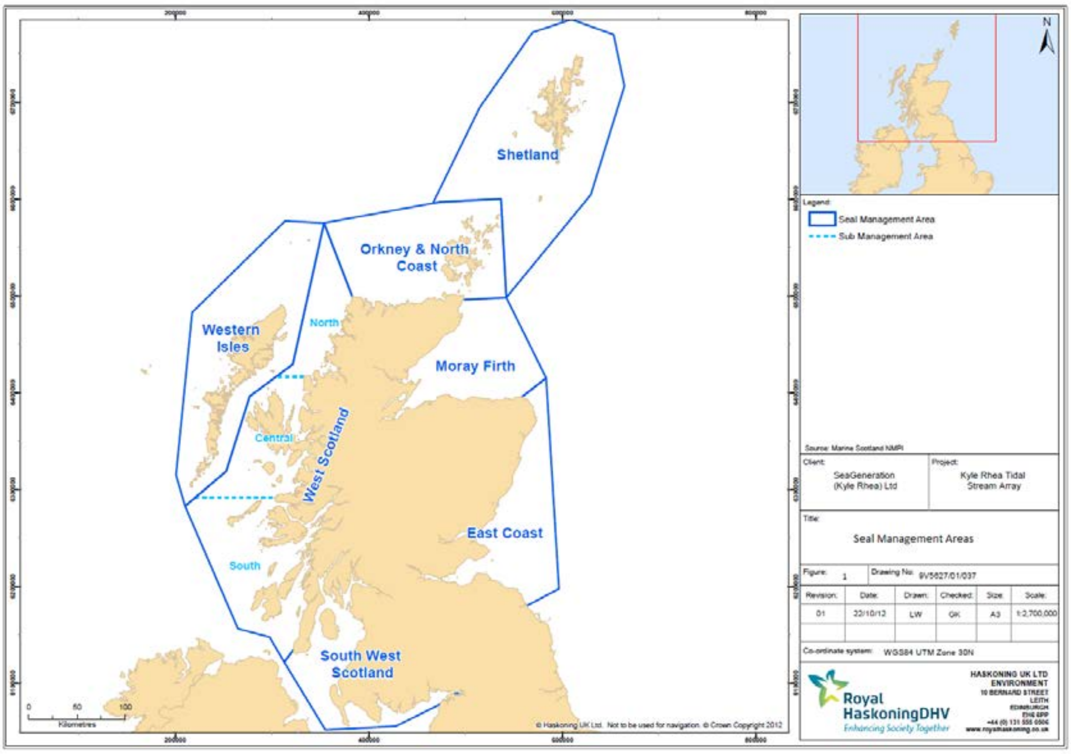

Figure 2: Seal Management Areas.

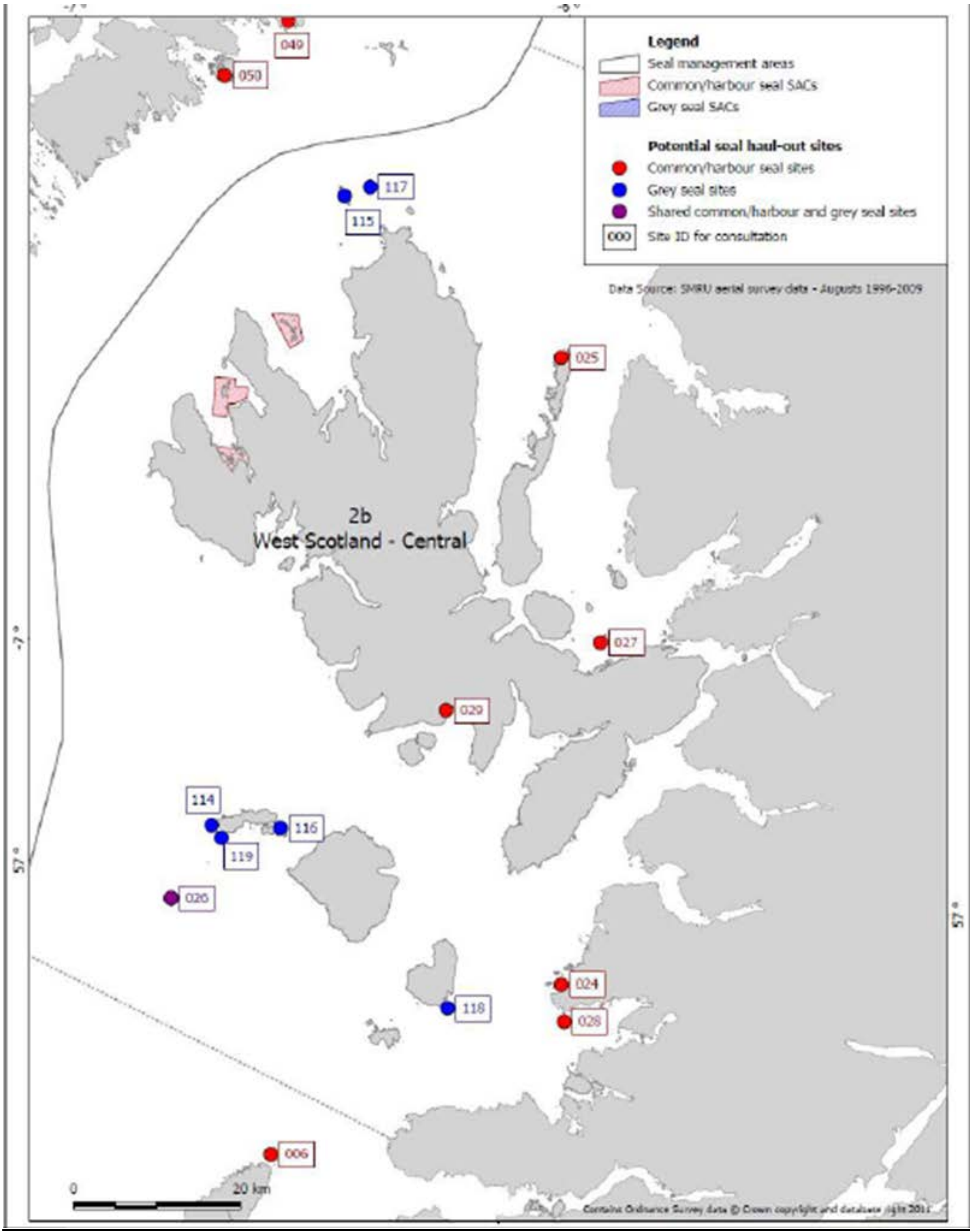

Figure 3: Potential seal haul out sites in West Coast – Central management area (Scottish Government, 2011).

Threats to UK seal populations

There have been two outbreaks of a phocine distemper virus (PDV) in European waters, one in 1988 and one in 2002 (Jensen *et al.,* 2002). Harbour seals were more dramatically affected than grey seal. Populations in mainland Europe and along the east coast of the UK suffered the greatest impacts. The 2002 impacts were estimated to result in an overall reduction in the UK population of 10% (SCOS, 2003). However evidence from Scotland pointed to a generally low level of impact, and seals from the west coast of Scotland showed no evidence of exposure based on serology results (Hall *et al*., 2003).

In the UK since 2008, large numbers of harbour and juvenile grey seal carcasses have been found with corkscrew like injuries (Thompson *et al*., 2010). Severely damaged seal carcasses with spiral lacerations have been found on beaches in eastern Scotland, as well as along the North Norfolk coast and within and around Strangford Lough in Northern Ireland.

It has been postulated that these injuries are consistent with animals having been drawn through a single, rotating right-angled blade. One potential cause that is under consideration is that the injuries may result from the seals being drawn through ducted propellers (Thompson *et al.,* 2010). Ducted propellers are one of the main types of thrusters commonly used in the dynamic positioning systems on a number of vessels.

There are also various older reports (predating the data reported in Thompson) of carcasses with wounds to the head and thorax from these and other areas around the UK, where wounds could also be consistent with a rotating blade, although details of the locations of these carcasses are not provided. It is probable that some carcases are not being washed ashore, or being found, and there is the potential for a larger (unquantifiable) number of seals to be injured or killed by the same mechanism.

2 SEAL POPULATIONS

The SMRU carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to NERC's statutory obligation under the Conservation of Seals Act 1970 '…to provide the (UK Government) with scientific advice on matters related to the management of seal populations'.

Seals spend a large portion of their time on land in order to rest, moult and breed. During this time surveys of the number of seals hauled out can be easily and routinely conducted. In the UK grey seals are monitored by surveying the number of pups born during their annual breeding season (September to December). Harbour seals are routinely monitored during their annual moult (August) in the UK by SMRU. Occasional pupping season (June/July) surveys are also conducted. During the harbour seal surveys the number of grey seal hauled-out is also counted.

The results of the surveys are reported annually as part of the SCOS advice. The reports can be found on SMRU's website (http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411).

2.1 Harbour seals

Monitoring harbour seal populations

Harbour seals haul out in the greatest and most consistent numbers during their annual moult in August. Counts of harbour seals on land represent an estimate of the minimum size of the population. They do not represent the total size of the population as a number of seals will be at sea during the surveys. Lonergan *et al.* (2011) demonstrated that flipper tagged harbour seals hauled out on average 72% of their time during the annual moult (95% confidence interval 54-88%).

The majority of harbour seal surveys are conducted using a thermal imaging camera mounted in a helicopter to facilitate the identification of cryptic seals on intertidal rocks. Surveys are conducted following a standard protocol to maximise counts and minimise environmental variation. Surveys are restricted to the first three weeks of August, 2 hours either side of local low tide times in the afternoon of days without rain.

It is possible to differentiate between the two seal species using their thermal profiles, the group structure on shore, a 'real' image from a camcorder, directly using binoculars or retrospectively from high resolution digital photographs. In some instances, however, species identity is still uncertain and the seals are classified as 'species unknown'. Seals on sandbanks in the east coast estuaries are usually surveyed from a light aircraft using conventional, oblique photography.

Where seals haul out on intertidal sandbank, surveying is more often undertaken using fixed wing aircraft and vertical of oblique photography. Seals are much easier to identify from the air when hauled out sandbanks. Thermal imaging helicopter surveys are costly and time consuming, which means the coast of Scotland is only surveyed in its entirety on a 3-5 yearly cycle. Some sites may also be surveyed more frequently; for example, annual surveys are carried out in the Moray Firth and the Wash.

Breeding season surveys have been historically carried out in a few locations to inform management decisions (such as in Orkney, and Shetland). However, the only breeding season surveys routinely carried out are on east coast sites such as in the Moray Firth, and more recently, The Wash.

Status of harbour seal populations

Nationally

The most recent complete survey of harbour seals around the coast of Scotland was competed between 2007 and 2009. The distribution of harbour seals from these surveys is shown in Figure 4. On the east coast of Scotland harbour seal occurrence is centred on the major Firths, Moray Firth, Firth of Tay and Firth of Forth. In these areas the major haul outs are on intertidal sandbanks, throughout the rest of their distribution including the Northern Isles, Western Isles and the west coast of Scotland harbour seals are common on rocky shores.

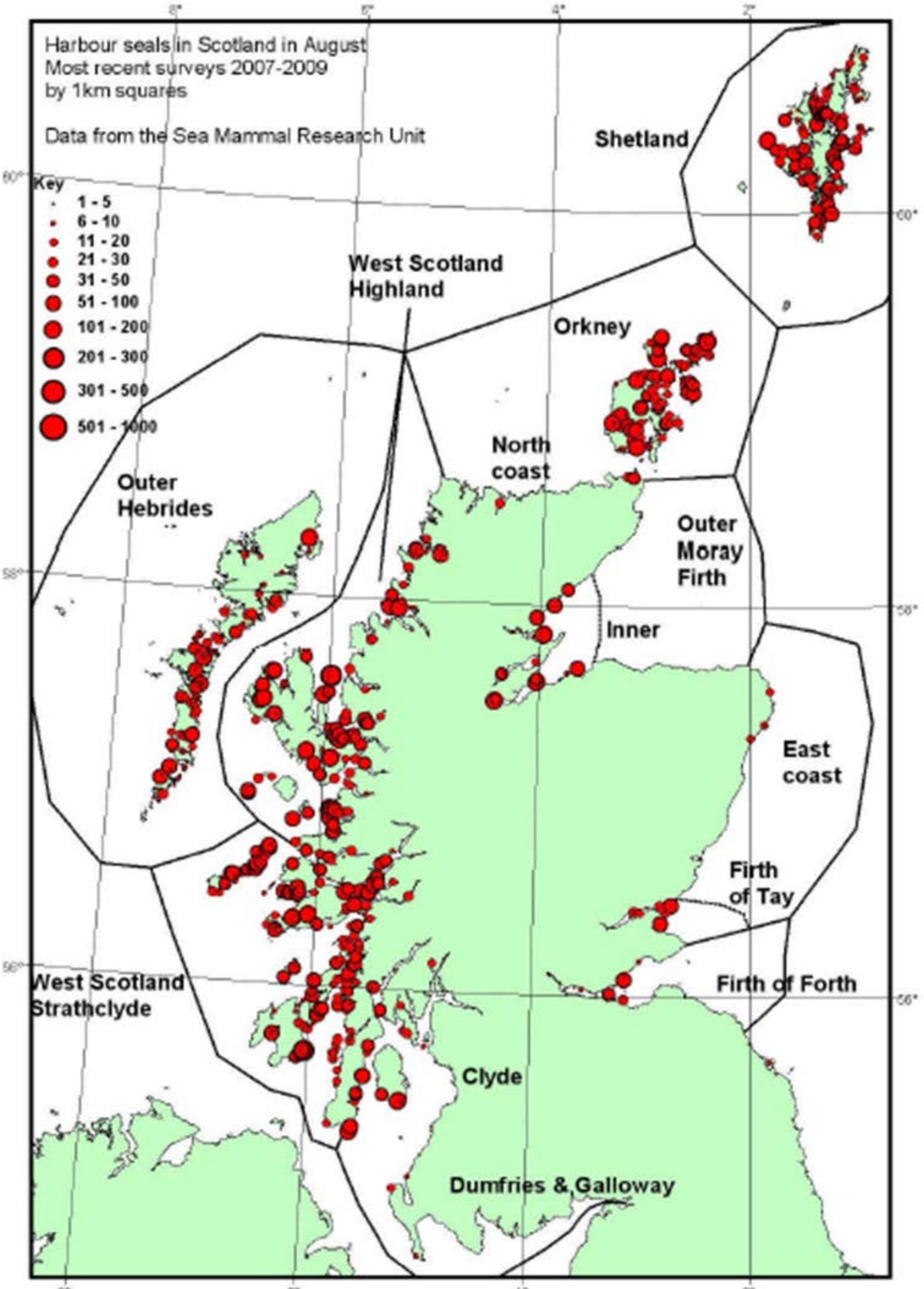

Figure 4: Distribution of harbour seals in Scotland from the most recent surveys carried out in August 2007, 2008 and 2009. Data are aggregated by 1km squares (Duck *et al*., 2011)

In recent years the number of harbour seals counted during these moult surveys has declined in many of the Management Areas around Scotland, including Orkney and the North coast, Shetland, East coast, Outer Hebrides, and West Scotland South (Strathclyde) (Figure 5, Lonergan *et al.,* 2007). Numbers counted in the wider Moray Firth and West Scotland North and Central (Highland) have shown a more stable trajectory or population growth.

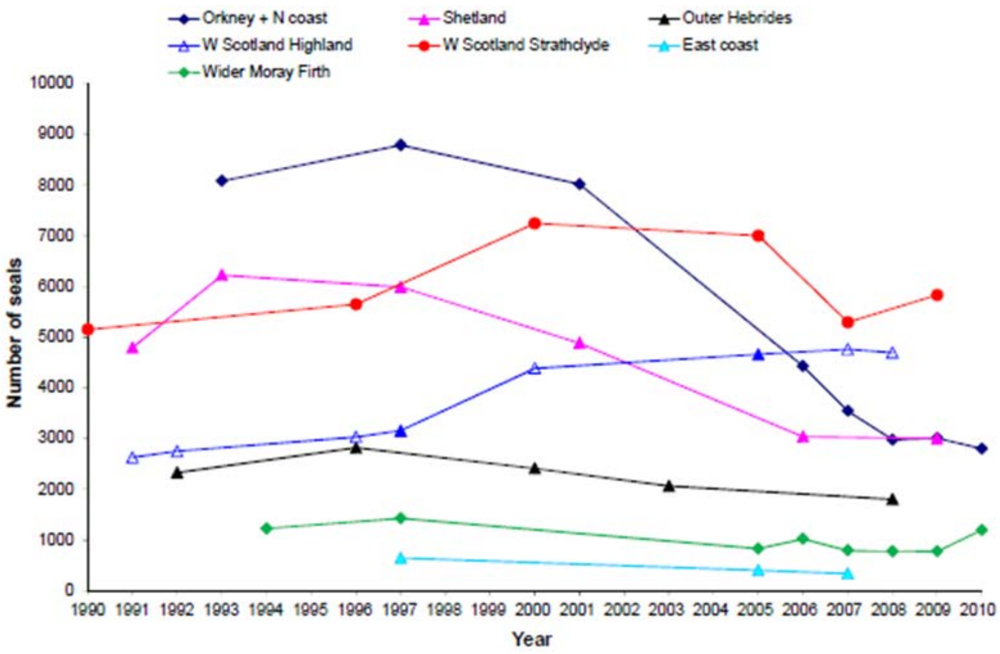

Figure 5: Trends in counts of harbour seals in Management Areas around Scotland. Solid symbols are where data was collected over one or two years, open symbols show where data were collected over more than two years (Duck *et al*., 2011).

The major and widespread declines were first observed during the 2006 surveys of the Northern Isles (Lonergan *et al*., 2007) and remain largely unexplained (SCOS, 2011). It is likely that a number of factors have contributed to the declines, such as competition for food with grey seals, anthropogenic mortality, changes in food availability.

Regionally

Despite widespread declines in harbour seals across much of Scotland, numbers in the WSMA have been more stable over recent years. The most recent surveys of the WSMA were completed in 2007 and 2008 for the Highland region, forming West Scotland North, Central and part of South Area, and in 2007 (with repeated areas in 2009) for the remainder of the West Scotland South Area.

The most recent minimum estimate of population size for the WSMA includes the current estimates from two survey regions: west Scotland Highland (Cape Wrath to Ardnamurchan Point) of 4,696 (from 2007 and 2008) and west Scotland Strathclyde (Ardnamurchan Point to Mull of Kintyre) of 5,834 (from 2007 and 2009; Duck *et al*., 2011). This gives a total minimum estimate for the WSMA for harbour seal of 10,530. The WSMA provides a suitable reference population for any impacts to be considered from the proposed development.

Counts since 1990 from the WSMA are summarised in Figure 6 for the South, Central and Northern parts of the area, while detailed counts from each of the sub-regions within the area are presented in Table 2, 3 and 4. Counts have increased in both the Central and Northern part of the Management Area since 1990. However, in the Southern part of the area the counts peaked in the year 2000 at ust below 7000 seals, with the count on the Isle of Mull (of 1616, Table 4) contributing the largest proportion of this count. The more recent 2008 and 2009 counts in this area are comparable to those made in the early and mid-1990s.

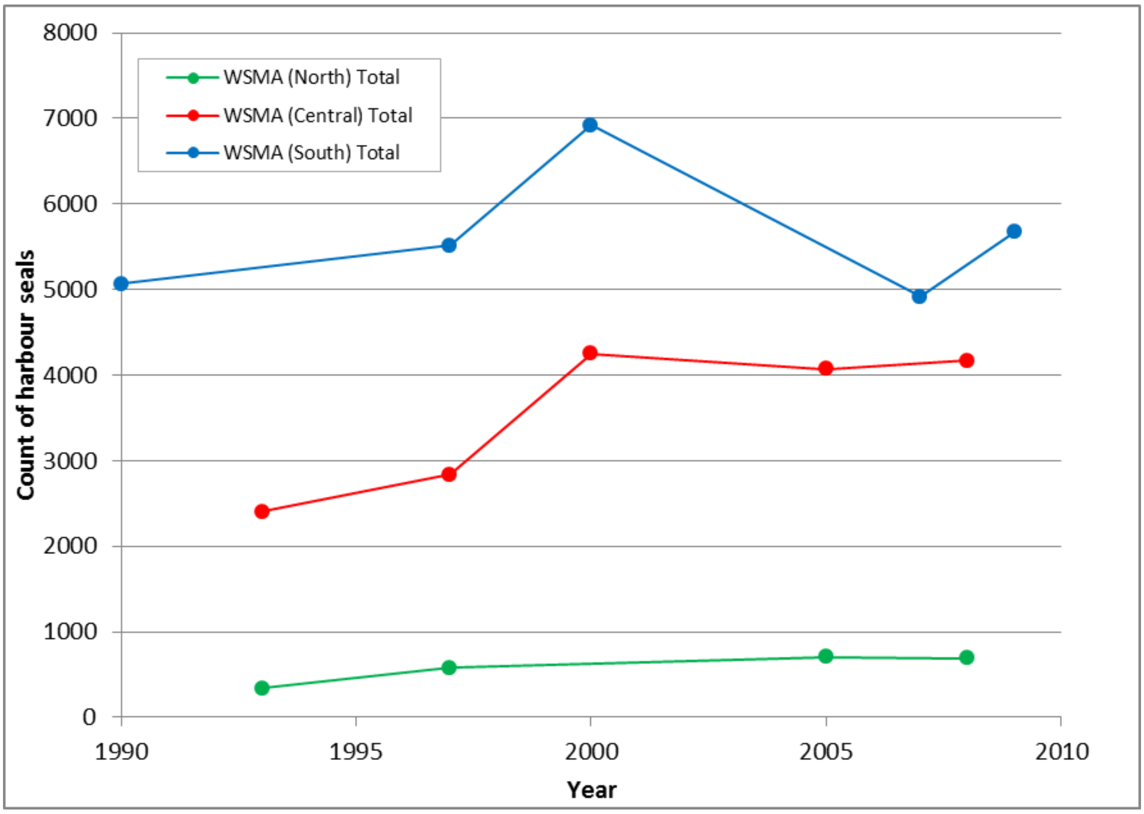

Figure 6: Total count of harbour seals within the West Scotland Management Area. Totals for North area in 1993 represent counts between 1991 and 1993; the total for 1997 represents counts made in 1996 and 1997. Totals for the central area for 1993 include counts from 1988 to 1993, the total for 1997 represents counts made in 1996 and 1997, the 2000 total includes counts from 1996 to 2000, and the 2008 total includes counts from 2007 and 2008. The south total for 1990 includes counts from 1988 to 1990, the total for 1997 represents counts made in 1996 and 1997 and the 2009 total includes counts from 2007 and 2009. Data from Duck & Morris, (2009) and Duck (2010).

Table 2: Counts of harbour seal within each Sub-region in the West Scotland (North) Management Area, Data from Duck & Morris, (2009) and Duck (2010).

Sub-region\ Survey Year	1991 to 1993	1996 and 1997	2005	2008
Kinlochbervie	33	69	22	7
Eddrachilis Bay	207	252	257	277
Enard Bay	6	13	30	38
Little L Broom		120	10	4
Gruinard		0	15	6

Loch Ewe		1	28	33
Summer Isles	80	120	347	327
WSMA (North) Total	337	575	709	692

Table 3: Counts of harbour seal within each Sub-region in the West Scotland (Central) Management Area. 1 Loch Sunart sub-region is split between the Central and Southern part of the Management Area, but has been assigned to the Central Area for ease of reporting. Data from Duck & Morris, (2009) and Duck (2010).

Sub-region\ Survey Year	1988	1989	1991 to 1993	1996 and 1997	2000	2005	2007	2008
Gairloch	2			7		0	1	
Torridon	18			3	36	20	53	
Applecross	48			45	134	86	86	
Plockton	292	158		277	271	279	335	
Raasay	3			38	155	90	151	
Rona	21			101	163	173	257	
Skye	1233	1269	1296	1728	2220	1899	1757	
Kyle of Lochalsh	43	15		9		31	23	
Sleat	43	53		76		60	83	
Loch Nevis	30	68		75	26	79	31	
Arisaig	456	499		213	597	650	692	
Loch Sunart1	118			152	443	265	313	
Rum			10	2		0		0
Eigg			29	36		77		66
Muck			25	58		140		94

Sub-region\ Survey Year	1988	1989	1991 to 1993	1996 and 1997	2000	2005	2007	2008
Canna			41	19		219		227
WSMA (Central) Total			2404	2839	4252	4068		4169

Table 4: Counts of harbour seal within each Sub-region in the West Scotland (South) Management Area.Data from Duck & Morris, (2009) and Duck (2010).

Sub-region\ Survey Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Coll			367						947				987							690		
Tiree			124						338				357							231		
Mull	607	940	1008	883	825	950			1059				1616							981		1483
Treshnish	29								41				31							14		
Lismore	535	398	491	405	340	597			611				457							326		498
Loch Creran	36				12				66				67							55		
Firth of Lorn			461						432				527							380		
Colonsay			109						83				102							59		87
Jura			375						122				548							539		601
Islay			724						605				1108							1001		792
West Kintyre			1153						1012				781					+ 15		427		629
Oronsay			24						0				75							2		
Loch Etive			35						26				31							27		0
Sound of Mull	23									36			77					64		108		
Loch Linnhe	110									135			158					125		74		
WSMA (South) Total			5069							5513			6922							4914		5569

Kyle Rhea falls within the Central portion of the WSMA and it is bordered by the survey regions of Skye, Kyle of Lochalsh and Sleat. Table 3 provides details of the counts from all of the sub-regions within this area. As can be seen from Table 3, the number of seals counted on Skye provides the greatest contribution to the total count, with 1757 animals making up approximately 42% of the 2007/2008 total count for the area. A large number of these seal, 719, were counted within the Ascrib, Isay and Dunvegan SAC (Duck & Morris, 2010). Around the coast of Skye other areas which have localised concentrations of harbour seal include, the north part of the Isle of Raasay, and the Isle of Rona (Figure 3, Site 25) in the Inner Sound, the sourth west of Skye (around Loch Eishort, Loch Slapin, Soay, Loch Scavaig (Figure 3, Site 29) and Loch Brittle) and to the west of Kyle of Lochalsh (including Scalpay, Longay, Pabay (Figure 3, Site 27) and Lower Breakish.

Between May and September in 2004 and 2005, land based counts were made at low tide haul out sites in Kyle Rhea as part of an investigation into the effects of temporal, tidal and environmental covariates on the number of seals hauled out (Table 5; Cunningham, 2007). Data were collected over 45 days in 2004 and 36 days in 2005. The maximum number of seals counted was 85 in June.

Table 5: Data collected from land-based counts of harbour seals hauled out in Kyle Rhea (Cunningham, 2007).

	Monthly Maximum	Survey days		Number of observations	
		2004	2005	2004	2005
April	42	0	3	-	12
May	82	9	6	53	31
June	85	10	1	47	8
July	57	11	3	68	14
August	65	10	23	35	111
September	23	5	0	27	-
Overall		45	36	230	176

2.2 Grey seals

2.2.1 Monitoring grey seal populations

Grey seals come ashore for prolonged periods of time to breed during the autumn. Breeding colonies are often long established on inaccessible or undisturbed coastal or island locations. Grey seals pups are born as white coats and remain on land for a period of a month or more during which they suckle from their mothers, rapidly grow are subsequently weaned and moult. During this period the white coated pups and weaned pups are often highly visible, and thus easy to count. Surveys of grey seal pups have been conducted since the 1960's.

The majority of grey seal pupping surveys in Scotland are conducted by SMRU using fixed wing aircraft, but some smaller sites across the UK are monitored from the ground by SMRU and other organisations such as SNH and The Lincolnshire Wildlife Trust, for example. The major breeding colonies (>60) are all surveyed annually; with repeat surveys being carried out at 10-12 day intervals over the breeding season. The main aim of the surveys is to use the counts of pups to estimate (model) pup production at each of the colonies. Smaller colonies (approx. 60) are surveyed less routinely, along with surveys for any potentially new breeding sites.

Grey seals are also counted during any summer harbour seal surveys carried out by SMRU. However, counts of grey seals during the summer months can be highly variable, and are not used as a population index. They do, however, provide useful information on the summer distribution of grey seals.

Status of grey seal populations – pup production

Nationally

Approximately 38% of the world's grey seals breed in the UK, and 88% of these breed at colonies in Scotland, with the main concentrations in the Outer Hebrides and Orkney.

The most up to date information on pup production at UK grey seal breeding colonies is presented in SCOS (2011). The 2010 breeding season survey provides the most recent estimate of UK wide pup production at the annual monitored colonies of 44,874, which is an increase of 6.1% on 2009 (Duck & Morris, 2011). A further 5,299 pups were estimated to be born at the less regularly monitored colonies.

The increase in pup production between 2009 and 2010 is largely driven by increases at North Sea colonies and Orkney, whereas production in both the Inner and Outer Hebrides has remained fairly constant (Table 6).

Table 6: Pup production estimates for colonies in the main island groups surveyed in 2010 (Duck & Morris, 2011)

Region	2010 production	2009 production
Inner Hebrides	3,391	3,396
Outer Hebrides	12,857	12,113
Orkney	20,312	19,150
North Sea: Isle of May, Fast Castle, Inchkeith	4,429	4,047
North Sea: Farne Islands	1,499	1,346
North Sea: Donna Nook, Blakeney Point, Horsey	2,566	2,244
Total	44,874	42,296

Since surveys began in 1960, overall production has continued to rise (Figure 7), although production in the Inner Hebrides has levelled off in more recent years. Approximately 7.5% of pup production, at regularly monitored colonies, occurs in the Inner Hebrides.

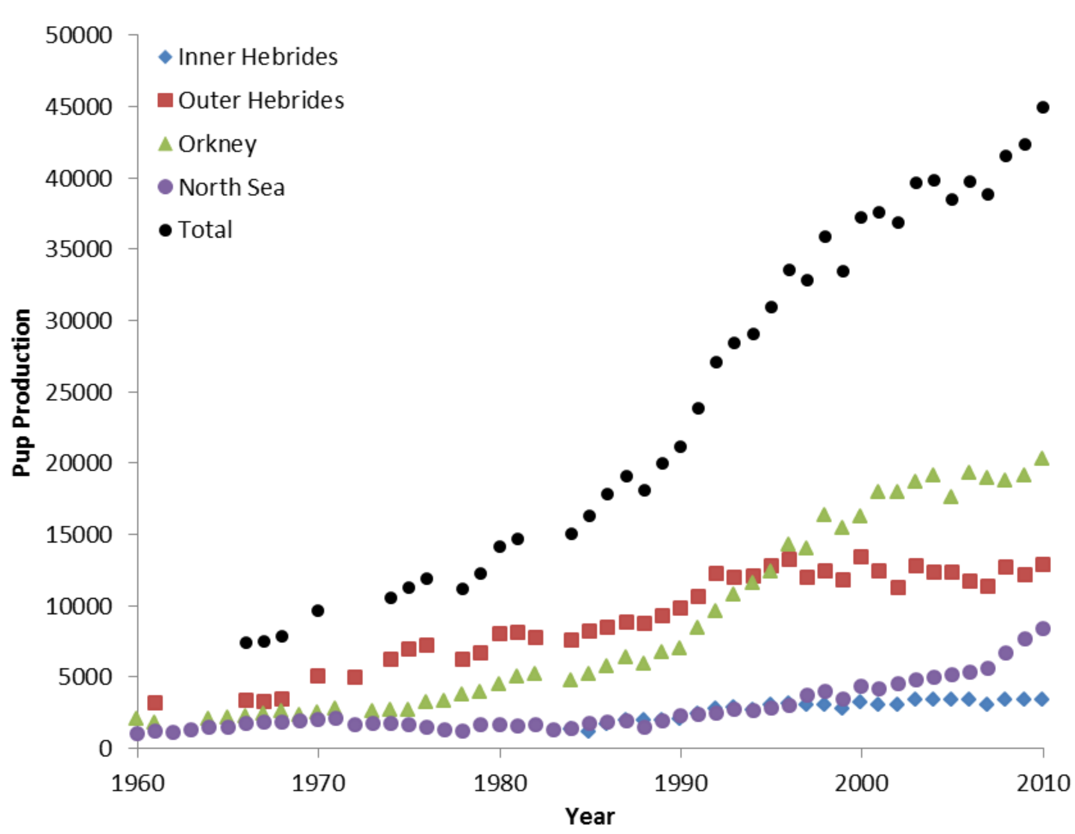

Figure 7: Estimates of grey seal pup production for colonies in the Inner and Outer Hebrides, Orkney and the North Sea, 1960 -2010.

Regionally

In the WSMA the regularly monitored grey seal breeding locations in the Inner Hebrides include ten colonies. The Treshnish Isles includes four of these colonies (Lunga, Fladda, Sgeir a'Chaisteil & Eirionnach and the Northern Treshnish Isles), there are three colonies to the south of Colonsay (Oronsay, Eilean nan Ron, and Eilean nan Eoin), Gunna (between Coll and Tiree), Soa (west of Mull), and Nave Island (off the North west coast of Islay). The regularly monitored colonies represent those with the greatest (historical) levels of pup production.

None of these regularly monitored colonies are within the Central region of the WSMA although the Treshnish Isles and Gunna are closest to Kyle Rhea, approximately 80km away to the south west. Since monitoring in the early 1980's pup production generally increased at most of the Inner Hebrides breeding colonies then in more recent years, since 2000, the increase in pup production at many of the sites has levelled off, with numbers become more stable overall. Gunna contributes the largest pup production within the Inner Hebrides, and the number of pups born at this site has continued to increase over recent years, albeit at a slower rate than observed in the 1980's and 1990's.

Pup production within the Treshnish Isles peaked in the mid 1990's, following a period of rapid increase (an average of almost 8% per annum 1984-1995). Since that time the numbers of pups produced has showed a small decline, averaging at approximately -1% per annum.

Some of the less regulatory monitored colonies are located in the Central region of the WSMA (Table 7, SCOS, 2011).

Table 7: Pups counts from Scottish grey seal breeding colonies in West Coast (Central) management area that are not annually surveyed.

Site name	Year of survey	Pup count
Muck	1998,2005	36,18
Rum	2005, annual	10 to 15
Canna	2002, 2005	54,25
Rona	1989, infrequent	Non seen
Ascrib Islands (Skye)	2002, 2005, 2007, 2008	60, 64, 42, 64
Fladda-chuain (Skye)	2005, 2007, 2008	73, 43, 129
Trodday (Skye)	2008	55

Status of grey seal populations – summer counts

The number of grey seals hauled out around the coast is also surveyed during the harbour seal moult surveys in August. These counts provide a useful insight into the use of haul out sites out with the breeding season.

Nationally

Figure 8 provides a summary of the distribution of grey seals from the August surveys in 2007, 2008 and 20009 across Scotland. The greatest concentrations of grey seal are found in Orkney and the Outer Hebrides, which are also the areas with the greatest pup production. Lonergan *et al*. (2011) used these most recent counts to provide an estimate of the grey seal population. Historical telemetry data were used to scale up the counts to allow for the proportion of seals that are at sea during the survey. The total estimate of grey seals between 2007and 2009 was 88,300 (95% confidence interval 75,400 – 105,700). The estimated population of the Inner Hebrides (including WSMA and South-West Scotland Management Area) was 9,390 (95% CI 7,100 – 12,750), approximately 10% of the Scottish population.

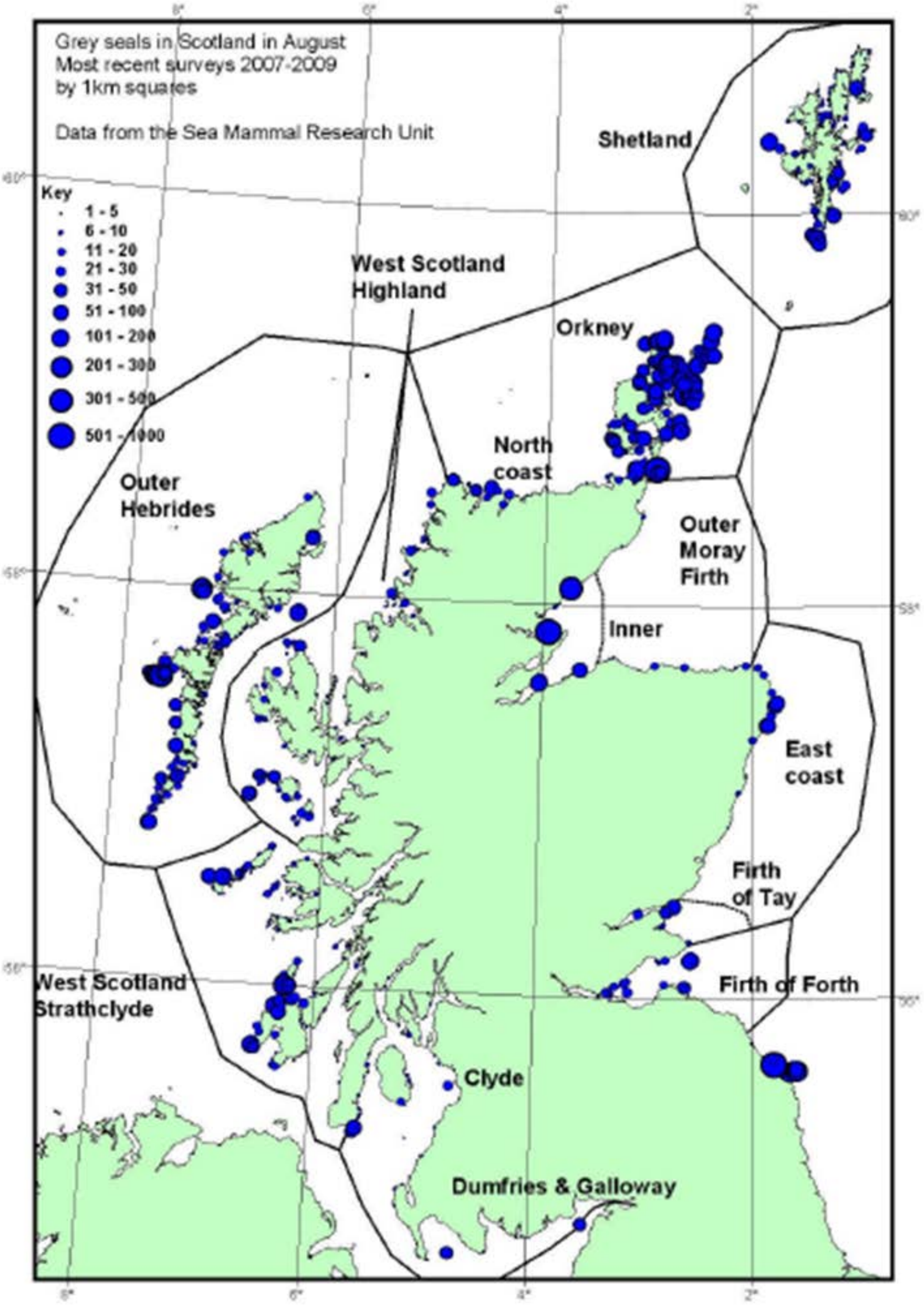

Figure 8: Distribution of grey seals in Scotland from the most recent surveys carried out in the Augusts of 2007, 2008 and 2009. Data aggregated by 1km squares (Duck *et al.*, 2011).

Regionally

The WSMA provides a suitable reference population for any impacts to be considered from the proposed development, the most recent estimate of the minimum population size is 4,956 (based on 2007 and 2009 data). This estimate has been used to inform the calculation of PBR for this management area (Scottish Government, 2012).

Within the WSMA the main concentrations of grey seal distribution are around the North coast of Islay the Isles of Colonsay and Oronsay, and Tiree in the south region of the WSMA, The Small Isles including Canna, Sanday and Eigg (Figure 3, Sites 114, 116, 119 and 118), and North West Skye (Figure 3, Sites 117 and 115; Table 9) in the central region of the WSMA.

Tables 8, 9 and 10 summarise the counts made within the North, Central and South regions of the WSMA during these surveys. Since peaking in the mid 1990's these counts have been relatively stable, reflecting the pattern observed in the pup production estimates for the region.

Table 8: Counts of grey seal within each Sub-region in the West Scotland (North) Management Area (Duck, 2010)

Sub-region\ Survey Year	1991 to 1993	1996 and 1997	2005	2007	2008
Kinlochbervie	157	136	40		45
Eddrachilis Bay	3	122	116		54
Enard Bay	9	82	7		7
Little L Broom	0	0	14		12
Gruinard	0	0	0		2
Loch Ewe	0	15	1		3
Summer Isles	21	24	73	54	0
WSMA (North) Total	**190**	**379**	**251**		**177**

Table 9: Counts of grey seal within each Sub-region in the West Scotland (Central) Management Area. 1 Loch Sunart sub-region is split between the Central and Southern part of the Management Area, but has been assigned to the Central Area for ease of reporting (Duck, 2010).

Sub-region\ Survey Year	1991 to 1993	1996 and 1997	2000	2005	2007
Gairloch	0	0		0	3
Torridon	0	0	2	5	0
Applecross	11	0	1	1	2
Plockton	0	0	1	0	0
Raasay	0	0	1	6	5
Rona	5	0	4	4	3
Skye	242	378	328	156	203
Kyle of Lochalsh	0	0		0	0
Sleat	6	2	16	2	0
Loch Nevis	0	0	5	3	1
Arisaig	20	0	9	9	4
Loch Sunart1	0	0	1	2	0
Rum	57	84		22	66
Eigg	31	9		26	66
Muck	17	22		13	18

Sub-region\ Survey Year	1991 to 1993	1996 and 1997	2000	2005	2007
Canna	38	436		113	190
WSMA (Central) Total	427	931		362	561

Table 10: Counts of grey seal within each Sub-region in the West Scotland (South) Management Area (Duck, 2010).

Sub-region\ Survey Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Coll			167						243				274							98		
Tiree			337						910				450							330		
Mull	52	47	35	32	72	103			63				86							100		55
Treshnish	0								170				65							73		
Lismore	56	3	0	0	0	0			0				25							3		10
Loch Creran					0				0				0							0		
Firth of Lorn			10						0				4							10		
Colonsay			17						35				57							21		63
Jura			38						27				19							59		39
Islay			170						441				415							551		657
West Kintyre			17						6				24							20		13
Oronsay			303						230				342							395		392
Loch Etive			0						0				0							0		
Sound of Mull					0					0			0							0		
Loch Linnhe					0					0										0		
WSMA (South) Total			1094						2125				1761							1660		

3 TELEMETRY STUDIES IN PROXIMITY TO KYLE RHEA

An understanding of where seals are foraging while at sea has been gained through the use of satellite GPS mobile phone tags. SMRU has deployed telemetry tags on grey and harbour seals in the UK since 1988 and 2001, respectively. The tags are designed to transmit information of the at sea locations either through the Argos satellite system, or through the mobile phone network. Data transmitted by modern tags which utilise mobile phone technology (known as satellite relay data loggers) provide more accurate and more frequent locations.

3.1 Deployments on harbour seals

Between September 2003 and March 2005, SMRU deployed 24 satellite relay data loggers (SRDLs) on harbour seals on the west coast of Scotland. These deployments were centred on the South-East Islay Skerries SAC (eight seals in 2003/2004 at Ardbeg Bay and Plod Sgeirean), Jura (two seals at Lowlandmans Bay) and Ascrib, Isay and Dunvegan SAC. At the latter site a total of 14 seals were tagged in 2004/2005, at Eilean Dubh, Sgeir Nam Biast and Mingay.

Each SRDL operated for approximately four months (range 31 to 243 days means 126 days). The high quality data received from these tags were examined to look at the duration and range of foraging trips, as well as the use of haul-out sites. Approximately half of the trips lasted between 12 and 24 hours, some lasted several days, and the longest was over nine days in duration (Cunningham, 2007). Seals generally ranged over greater distances during longer duration trips. When the Islay and Skye tagging deployments were compared seasonal differences were observed in the duration of trips, with trips being longer from September through the March in Skye, when compared to Islay. After March trip durations were greater for those seals tagged at Islay; although there was no seasonal difference in the trip extent over this time. Only 7.1% of the trips were made to and from a haul-out site within the SAC. Tracks of the tagged seals from Skye and Islay are shown in Figure 9(a) and (b) respectively, none of the tracks from the tagged individuals showed evidence for transits or foraging in proximity to Kyle Rhea.

Seals spent between 11 and 27% of their time hauled-out, with the amount of time varying with location and season. Females spent less time hauled out than male between October and May, but more time in June and September. The seals did not haul out every day, with less than 1 hour hauled out on 66% of the tagged days. The highest probability of hauling out occurred around midday during the spring and summer months, but from September to February this was not the case.

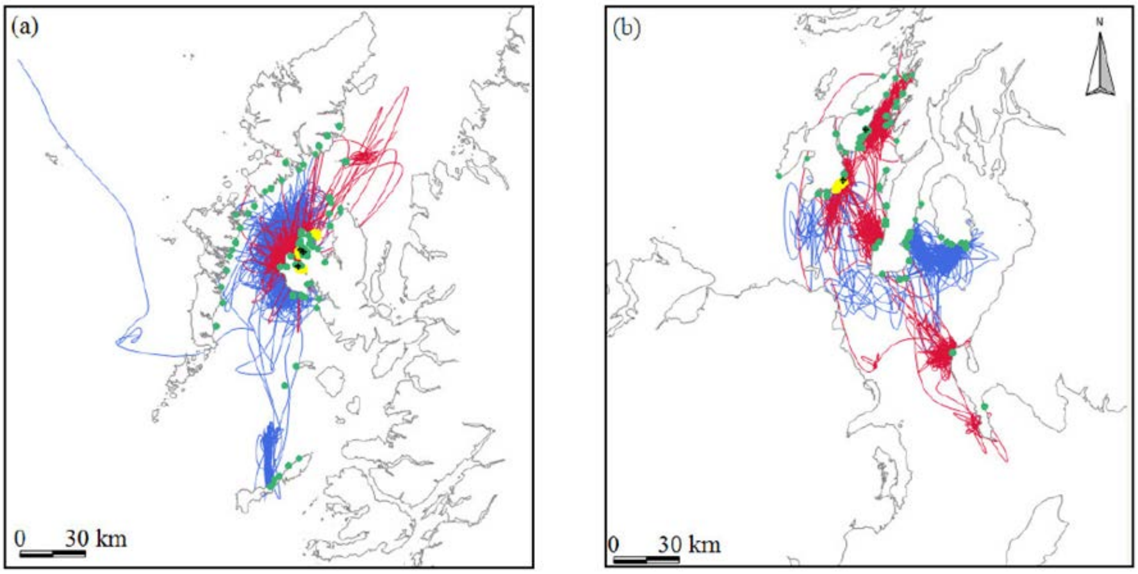

Figure 9: Individual tracks of male (blue) and female(red) harbour seals tagged off the Isle of Skye (a) and (b) Islay (Cunningham, 2007).

None of the harbour seals tagged during these deployments hauled out or had at sea locations towards Kyle Rhea, either to the south in the Sound of Sleat, or to the north in the Inner Sound or Loch Alsh.

Tagging of harbour seals in the Outer Hebrides was conducted in 2006 as part of the Strategic Environmental Assessment (SEA) process (Sharples *et al.,* 2008). Twenty one harbour seal were tagged in the Outer Hebrides, captured in The Sound of Harris (10) and the Sound of Barra (11). Animals captured in the more northerly site in the Sound of Harris tended to forage to the west of the Outer Hebrides, largely within 60km of the haul out sites. However, one female travelled 140km to haul out and forage to the east of Skye, in the Inner Sound, before returning to the Outer Hebrides (Figure 10). Animals captured in the South of Barra foraged in a focussed areas approximately 60km to the west of the Sound, and in a more dispersed area about 100km to the east.

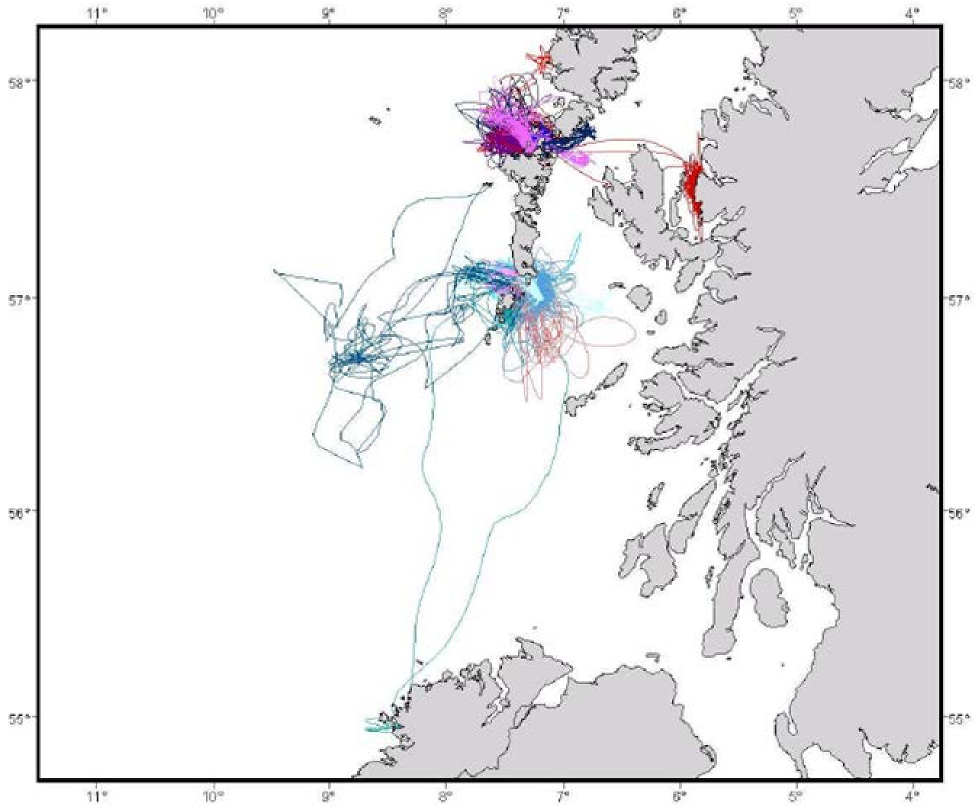

Figure 10: Individual filtered tracks of 21 harbour seals captured in the Outer Hebrides . Males in shades of blue, females in shades of red (Sharples *et al.*, 2008).

Analysis is currently underway of a more recent tagging deployment in the vicinity of Kyle Rhea and the Sound of Jura funded by The Scottish Government.

Potential for SAC connectivity

Figure 9 and 10 show the tracks of seals tagged at SACs in close proximity to the development at Kyle Rhea. None of the tagged harbour seal had locations at sea or hauled out in the vicinity of Kyle Rhea. These data suggested that there would be limited connectivity between animals that haul out at SACs on the west coast of Scotland and Kyle Rhea. Although it should be noted that additional data from a taggin study in 2012 will be available in the future, from a Scottish Government funded study being conducted by SMRU in the region.

3.2 Deployments on grey seals

Grey seals have been tagged throughout Scotland by SMRU. The studies show that grey seal undertake short-range return trips from haul-out sites to local foraging areas, but also undertake extended journeys between distant haul-out sites (McConnell *et al*., 1999). Matthiopoulos *et al.,* (2004) used telemetry data and count data to model seal behaviour in association with specific haul-out sites and to generate usage maps for grey seals (Figure 11). The usage map is dominated by the large colonies in Orkney and the Outer Hebrides. The area of sea around the west and south of Skye, including Kyle Rhea are not areas of high usage, and therefore not important foraging grounds.

Telemetry data from 1991 to 2008 were collated following methods outlined in Matthiopoulos et al., (2004) to update usage maps as part of the SEA process (Murphy et al., (2009). At sea locations for all seals included in this analysis are shown in Figure 12. These data include a large tagging deployment of grey seals in the Inner Hebrides in 2003 and 2004 (McConnell, 2006). At sea locations from at least one seal were in close proximity to Kyle Rhea (Figure 13).

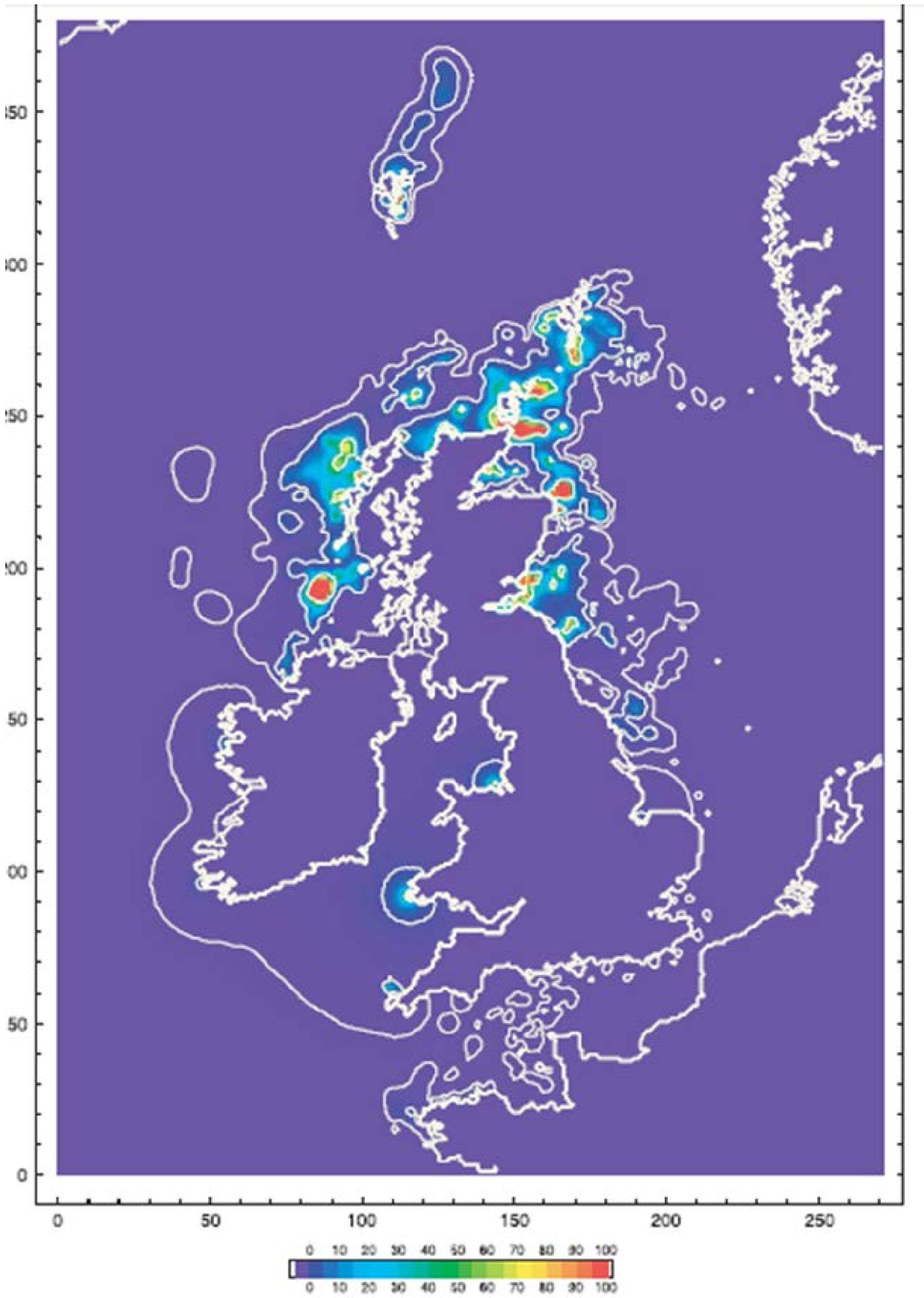

Figure 11: The estimated useage of the marine environment by the grey seal population (Matthiopoulos *et al.*, 2004). The coloured map represents the estimated number of animals using different locations at seal during the population's offshore time. Note that this is higher than total usage per time unit because seals also spend time onshore. The contours have been obtained by log-transforming useage to reveal some of the detail in the less frequently used areas.

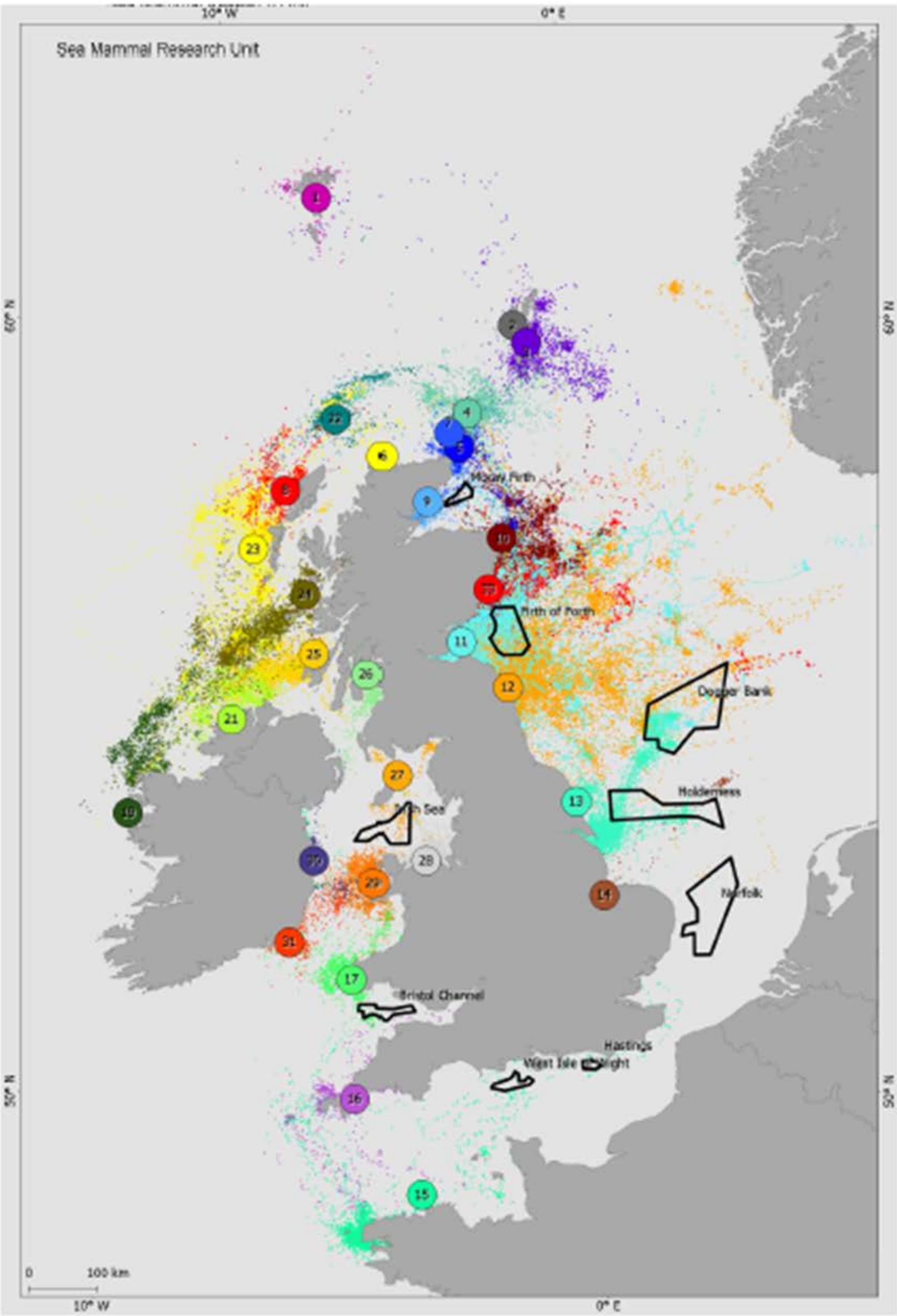

Figure 12: Map showing the locations of grey seals tagged between 1991 and 2008 on their foraging trips. Each location is colour-coded to the region (numbered circles) where the trip originated. Round 3 offshore wind farm development zones are also show.

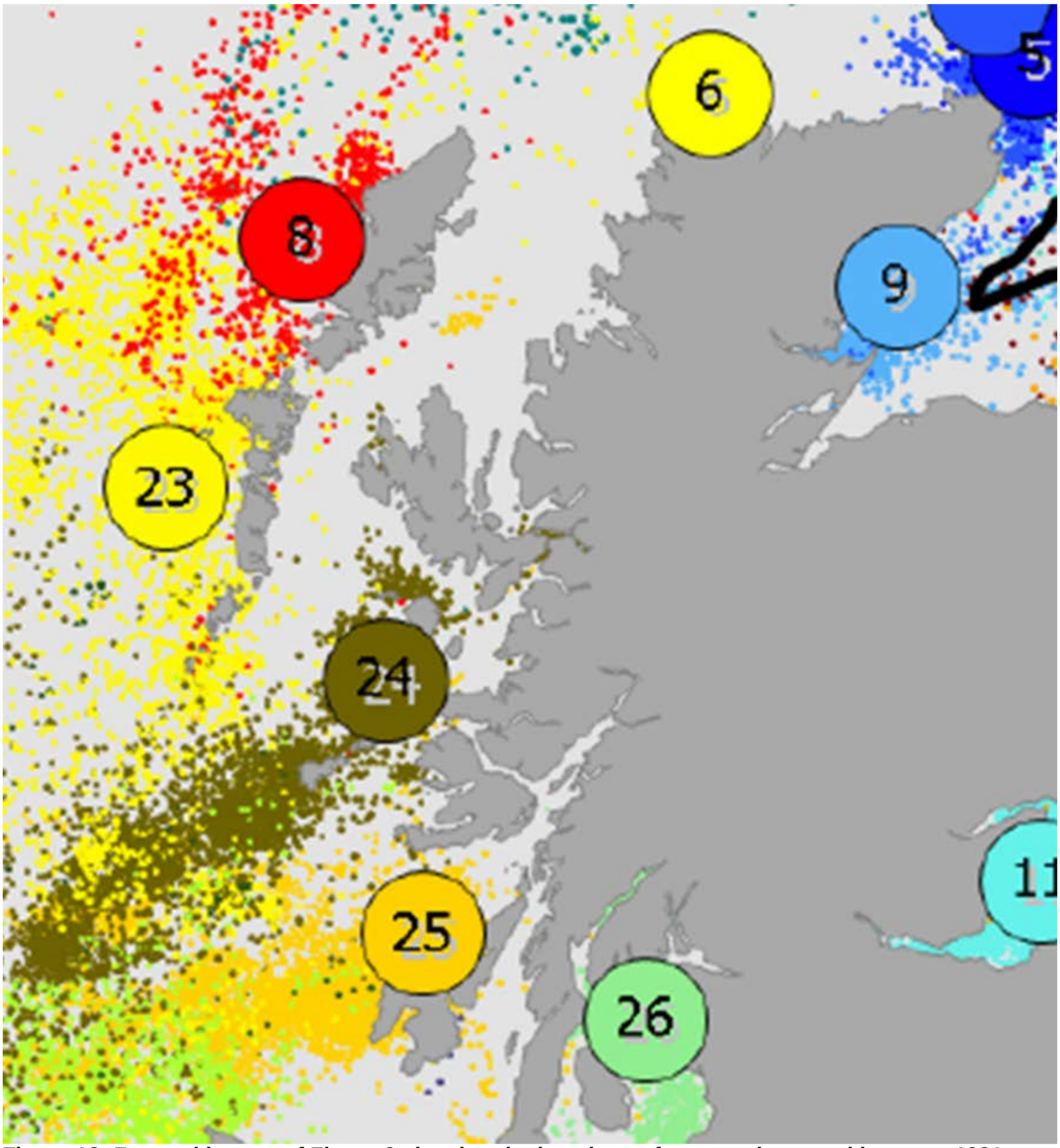

Figure 13: Zoomed in map of Figure 9 showing the locations of grey seals tagged between 1991 and 2008 on their foraging trips. Each location is colour-coded to the region (numbered circles) where the trip originated. Round 3 offshore wind farm development zones are also show.

Potential for SAC connectivity

Compared to harbour seal, grey seal can range over much wider areas and it is possible that seals which haul out at one of the SACs in the west coast of Scotland (The Treshnish Isles, The Monach Islands or North Rona) use Kyle Rhea to transit between foraging or haul out areas. However, the spatial segregation between these breeding colonies and Kyle Rhea would limit the potential for interaction during the breeding season.

3.3 Seal diet

Studies on the diet of both grey and harbour seals are limited due to the difficulties in assessing their diet. Analysis of scat is the most commonly used approached to assessing diet, through the collection of scat at seal haul out sites enables the identification of prey. The ear bones (otoliths) of fish as well as other bones from fish which are not digested and beaks of cephalopods (squid and octopus) can all be identified to species (or genus). This allows a picture to be built up of the prey species, with measurements of the hard parts being used with published regressions to estimate body size and weight of the prey.

Harbour seal

Across European waters studies on harbour seal have shown that they are largely piscivorous (Pierce *et al*., 1991) but variations occur in species composition of the diet across geographical regions and seasons. Harbour seals are generally regarded as varied and opportunistic feeders, it is possible that prey size will lead to some degree of selectivity (Brown *et al.,* 2001).

In the UK, harbour seal diet has been described most extensively in the Moray Firth, and data also exist from The Wash, Shetland and Ireland. On the west coast of Scotland, published data on harbour seal diet are confined to a single study; Pierce & Santos (2003). This study examined the diet of harbour seal in the Inner Hebrides (Skye and Mull) in 1993 and 1994. Scat samples were collected from islands in Loch Dunvegan, Skye in October and November 1993 (13 samples), June to August 1994 (12 samples) and September 1994 (93 samples). Samples were also collected from a number of islands off Mull; Eilean Reilean and Ulva in September 1994 (17 samples) and Cairns of Coll in May 1994 (10 samples). The paper also reports on three scat samples from Seal Island (near Fort William).

Pierce & Santos (2003) found that the majority of the diet of harbour seals around Skye was fish, with scad herring and whiting occurring most commonly. Other species included cod, haddock, ling, mackerel, and sandeel. Cephalopods were also found, including octopus and bobtail squid. There were differences in the site between the sampling periods, with scad only found in September, and pouting least important in October. The general diet composition on Mull was similar to Skye, but pouting and sandeels made up a higher proportion of the diet. Additional species found in the Mull samples included lemon sole, plaice, dragonet and witch. All three samples from Fort William included fish remains, including whiting in two samples.

Grey seal

Studies of grey seals diet on the west coast of Scotland are also limited. Hammond *et al*. (1994) studied the diet in the Western Isles, both Inner and Outer Hebrides in 1985. A total of 238 samples were collected from the Inner Hebrides and Minch (67% and 79% respectively). Gadoids (most commonly ling, cod and whiting) dominated the diet comprising 40% or more by percentage weight. Witch was the most common flatfish in the diet in the Inner Hebrides, while sandeel contributed less to the diets in the Hebrides than for other areas of the UK, while pelagic schooling fish (herring, mackerel and horse mackerel) contributed more.

The most recent widespread study of grey seal diet is based on scat collected in 2002 (Hammond *et al.,* 2006). A number of haul out sites across the whole of Scotland were surveyed either monthly or quarterly for scat. Fish otoliths and cephalopod beaks were recovered, identified and measured. Sandeel, gadoids and herring were the main prey, benthic species were also important in the Inner Hebrides, as well as flatfish in the summer months. In the northern Inner Hebrides dragonet, sandeel, cod and haddock were the main species in the diet. In the southern Inner Hebrides sandeel and cod were the main prey.

There was is limited evidence for a difference in diet between the two studies, only a change in the proportion of herring. The contribution of cod in the diet remained about the same, haddock increased and ling decreased in 2002. Species that featured strongly in the diet in 2002 but not in 1985 included lemon sole, rockling, bullrout and dragonet. Megrim contributed about 7% to the diet in 1985, but was virtually absent in 2002.

4 SUMMARY

Harbour and grey seal in Scotland are protected by national and international legislation, providing protection to both individuals and populations.

Due to the spatial separation between the development site and the proposed designated haul-out sites under the Section 117 of The Marine (Scotland) Act 2010 it is unlikely that a disturbance to animals at these haul-out sites would occur.

Telemetry data published to date indicate that the potential for animals from SAC populations for either species to forage or haul-out in the vicinity of Kyle Rhea is low.

Kyle Rhea falls within the central portion West Scotland Management Area, with suitable reference population sizes for the WSMA that should be used in the assessment of 10,530 for harbour seal, and 4,956 for grey seal both based on data collected during summer surveys between 2007 and 2009.

In recent years, numbers of harbour seals have been declining in many of the management areas around Scotland, but numbers in the WSMA North and Central (Highland) regions have shown a more stable trajectory or population growth.

Grey seal pup production at colonies in the Inner Hebrides has been relatively stable over recent years, as have counts made during the summer months.

Both species of seal use haul-out sites in the vicinity of Kyle Rhea, although due to the low numbers of seals at these sites they are not of local, regional, or national significance.

There are no telemetry data available to date that suggest Kyle Rhea is an important foraging area for either species of seal.

Information on the diet of both species of seal suggests they are generalists and opportunistic feeders, and are therefore likely to be able to accommodate changes in local abundance of prey species.

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APPENDIX A: CONSERVATION OBJECTIVES OF SACS IN WEST SCOTLAND (CENTRAL) MANAGEMENT AREA.

Treshnish Isles (grey seal)

The conservation objectives for the Treshnish Isles marine SAC are as follows:

To avoid deterioration of the habitats of qualifying species (Grey seal Halichoerus grypus) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.
To ensure for the qualifying species that the following are maintained in the long term:
• Population of the species as a viable component of the site
• Distribution of the species within site
• Distribution and extent of habitats supporting the species
• Structure, function and supporting processes of habitats supporting the species
• No significant disturbance of the species

Ascrib, Isay and Dunvegan (harbour seal)

The conservation objectives for the Ascrib, Isay and Dunvegan marine SAC are as follows:

To avoid deterioration of the habitats of qualifying species (Common seal Phoca vitulina) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.

To ensure for the qualifying species that the following are maintained in the long term:
• Population of the species as a viable component of the site
• Distribution of the species within site
• Distribution and extent of habitats supporting the species
• Structure, function and supporting processes of habitats supporting the species
• No significant disturbance of the species

South-east Islay Skerries (harbour seal)

The conservation objectives for the South-east Islay Skerries marine SAC are as follows:

To avoid deterioration of the habitats of qualifying species (Common seal Phoca vitulina) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.

To ensure for the qualifying species that the following are maintained in the long term:
• Population of the species as a viable component of the site
• Distribution of the species within site
• Distribution and extent of habitats supporting the species
• Structure, function and supporting processes of habitats supporting the species
• No significant disturbance of the species

Eileanan agus Sgeiran Lios mór (Lismore; harbour seal)

The conservation objectives for the Eileanan agus Sgeiran Lios mór marine SAC are as follows:

To avoid deterioration of the habitats of qualifying species (Common seal Phoca vitulina) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.

To ensure for the qualifying species that the following are maintained in the long term:
• Population of the species as a viable component of the site
• Distribution of the species within site
• Distribution and extent of habitats supporting the species
• Structure, function and supporting processes of habitats supporting the species
• No significant disturbance of the species

Kyle Rhea Tidal Stream Array

Appendix 12.2

Kyle Rhea Year 1 shore based survey results

Marine mammals and basking shark

SeaGeneration (Kyle Rhea) Ltd

08 November 2012

9V5627

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Document title	Kyle Rhea Year 1 shore based survey results Marine mammals and basking shark
Document short title	
Status	
Date	08 November 2012
Project name	Kyle Rhea Tidal Array EIA
Project number	9V5627
Client	SeaGeneration (Kyle Rhea) Ltd
Reference	9V5627/R/303719/Edin

Drafted by	Gemma Keenan
Checked by	Beth Mackey and Alistair Davison
Date/initials check	…06/11/12……… ……AD…………….
Approved by	Frank Fortune
Date/initials approval	…11/12/12……… ………FF…………

CONTENTS

1 INTRODUCTION

This report presents the results of one year (July 2011 to July 2012) of marine mammal (cetaceans and pinnipeds (seal)) and basking shark *Cetorhinus maximus* data collection during combined vantage point surveys for both birds and marine mammals

Surveys were undertaken by Natural Research Projects (NRP) Ltd to support the Kyle Rhea Tidal Array EIA.

This report and the data it contains is provided to inform and support the Environmental Impact Assessment (EIA) for the Kyle Rhea Tidal Stream Array project. It is presented as a technical Annexe to the Environmental Statement (ES) which reports the findings of the EIA.

This report should be read in conjunction with the Kyle Rhea Tidal Array Project, Year 1 Birds Technical Report (NRP, 2012) and the Statistical Analysis of Marine Mammal Data for the Kyle Rhea MCT Turbine Site (DMP, 2012). Both of these reports are also presented as technical appendices to the ES. Data on otters collected during the vantage point surveys are presented in the Kyle Rhea Otter Survey report which is a confidential appendix to the ES.

2 METHODOLOGY

2.1 Survey

A detailed survey methodology is provided in NRP (2012). In summary, two vantage points were used (see Figure 1) which provide optimal views of the majority of Kyle Rhea, and fully encompass the proposed development area.

The vantage point survey method is split between snapshot scans (primarily for birds), flying bird watches and dedicated marine mammal watches (MMW). These MMWs are designed to measure a rate of occurrence within the study area and therefore were of fixed duration of 15 minutes. The behaviour at the time that the marine mammals were first seen was recorded as well as the age category of the animals.

The survey methodology is informed by the SNH draft guidance on survey and monitoring in relation to marine renewables deployments in Scotland (MacLeod *et al.,* 2011; Sparling *et al.,* 2011).

Sparling *et al.,* 2011 states that surveys should be avoided in a Beaufort seastate of greater than 4 in order to ensure consistency in the quality of data gathered. The wave sheltered nature of the study area meant that the majority of surveys were undertaken in a sea state 0 or 1, with occasional states 2 and 3.

Data from haul out count surveys was filtered to include only 2 hours either side of low tide to provide consistent data in accordance with the guidance provided in Sparling *et al.* (2011).

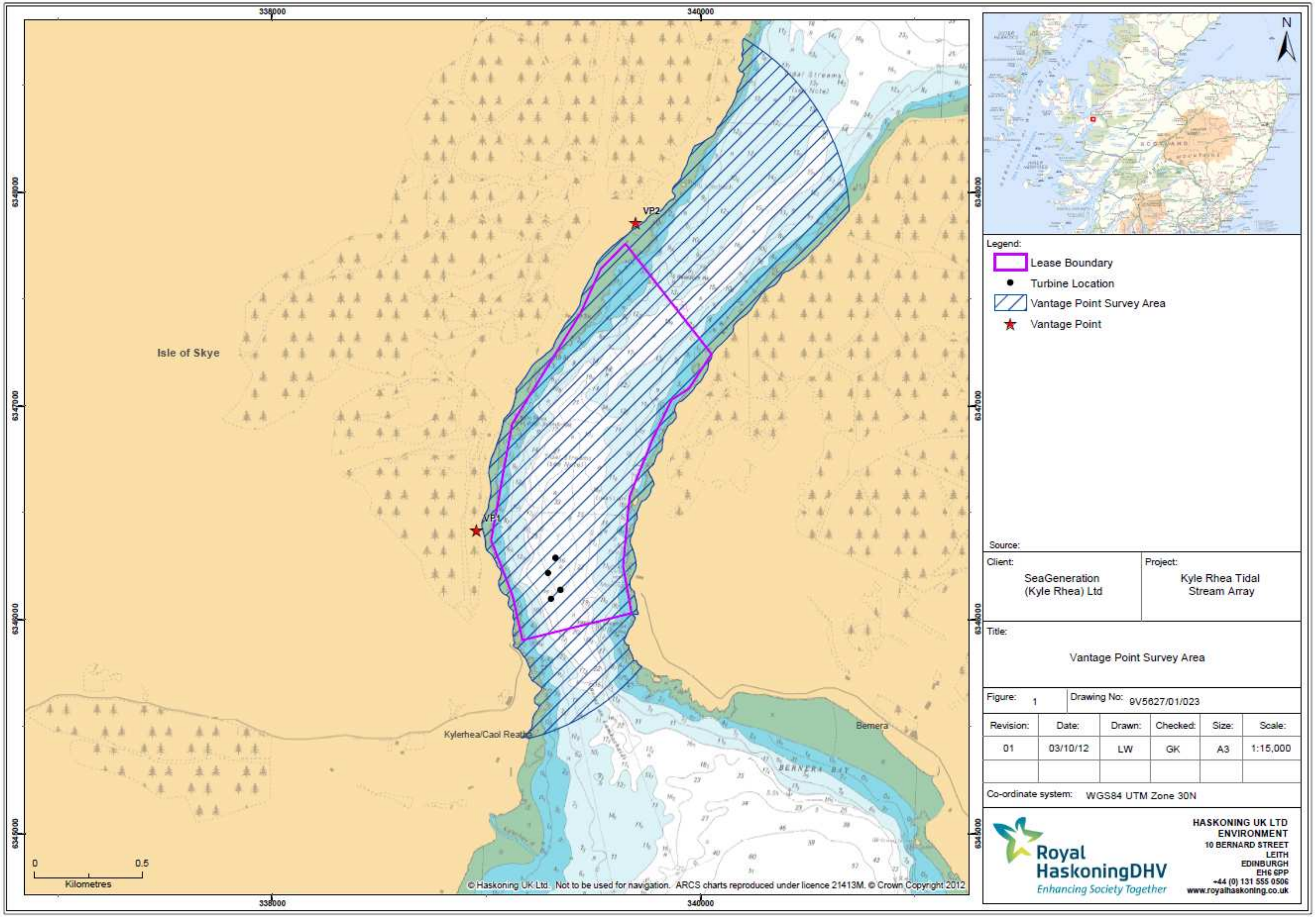
Given the narrow (approximately 700m) width of Kyle Rhea it was not expected that a significant distance bias would exist over this short range based on experience from other sites and therefore it was not deemed necessary to use concurrent vantage points with one on either side. This approach was discussed and agreed with SNH.

Within each MMW the presence of any marine mammals were recorded as a series of sighting events. Once individual marine mammals were recorded the observer used best endeavours to avoid recounting the same marine mammals in subsequent sighting events. The direction and distance of each sighting was estimated using range finder binoculars.

During non MMW surveys any sightings of cetaceans or basking sharks were recorded as incidental sightings.

In addition to MMWs, seal counts at haul out sites (shown in NRP, 2012) were carried out throughout the year. The data from these have been filtered to use only results from 2 hours either side of low water.

The survey methodology has been discussed and agreed with SNH.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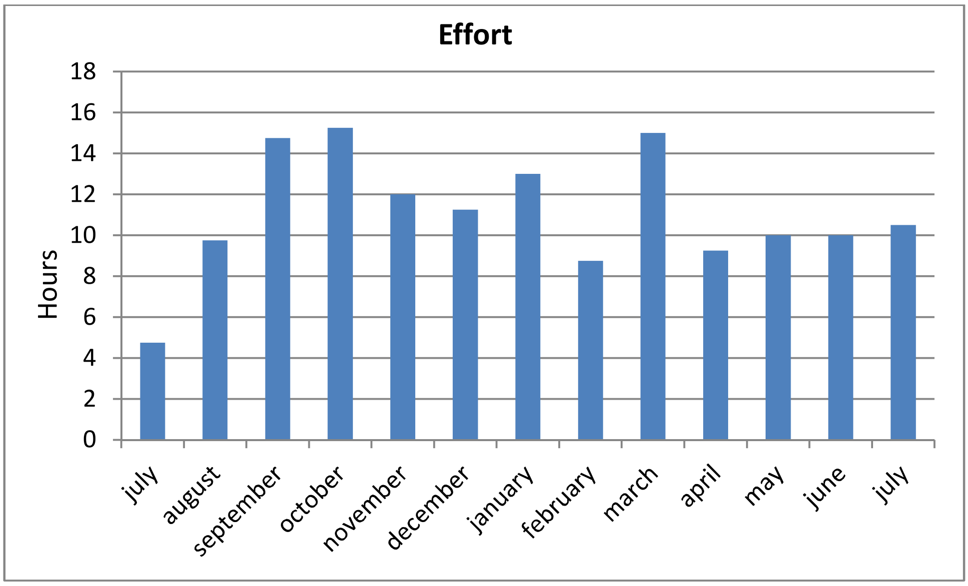
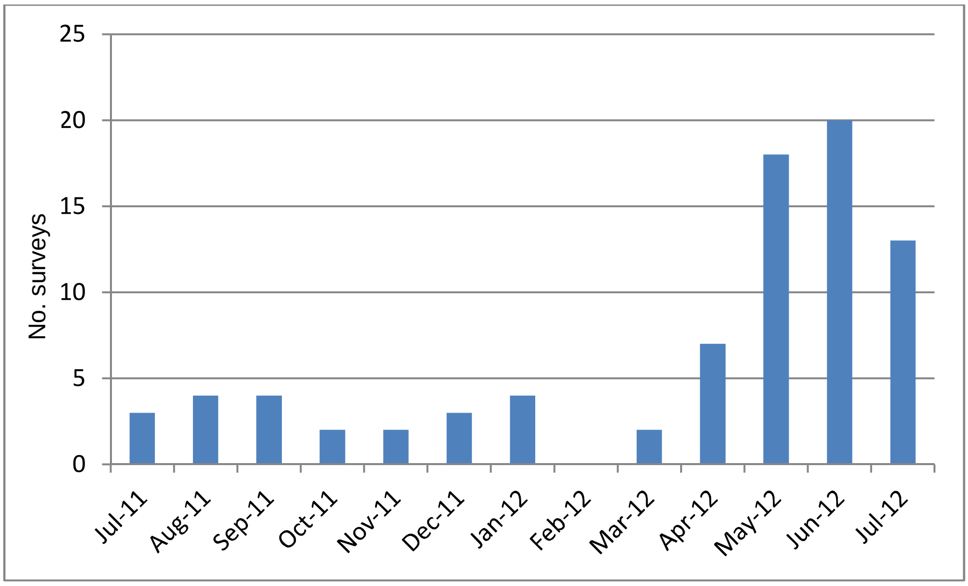
2.2 Survey effort

NRP Ltd (2012) provides detailed information on survey effort for the entire vantage point survey. Plot 1 summarises the monthly effort (observation hours) undertaken during MMWs and plot 2 shows the number of seal haul out count surveys completed.



Plot 1: MMW effort summary



Plot 2: Number of haul out count surveys completed per month

2.3 Data analysis

All marine mammal data collected from July 2011 to July 2012 was provided by NRP Ltd and this report provides a description of those data. In addition, DMP Statistical Solutions was commissioned to undertake statistical analysis for species with sufficient sightings numbers (harbour seal and grey seal). The methodology for statistical analysis is provided in DMP (2012).

Data collected during the dedicated MMWs for marine mammals and basking shark are converted into number of animals and number of sightings per hour of effort.

Investigation of the data was undertaken to determine:

- Total numbers of sightings per species;
- Effort corrected sightings rates;
- Seasonal variation in relative abundance;
- Presence of seal pups;
- Behaviour; and
- Distribution.

The locations of marine mammal sightings have been presented in distribution maps (Figures 2 to 5) however incidental sightings were generally not recorded with positional information and are therefore not included.

Seal haul out counts are presented as maximum counts for each month. Some seal haul outs were recorded more than once per day and will therefore include an unknown proportion of the same animals. The use of the maximum count avoids bias from repeated counts. The haul out count methodology is not compatible with analysis per hour of survey effort.

3 RESULTS

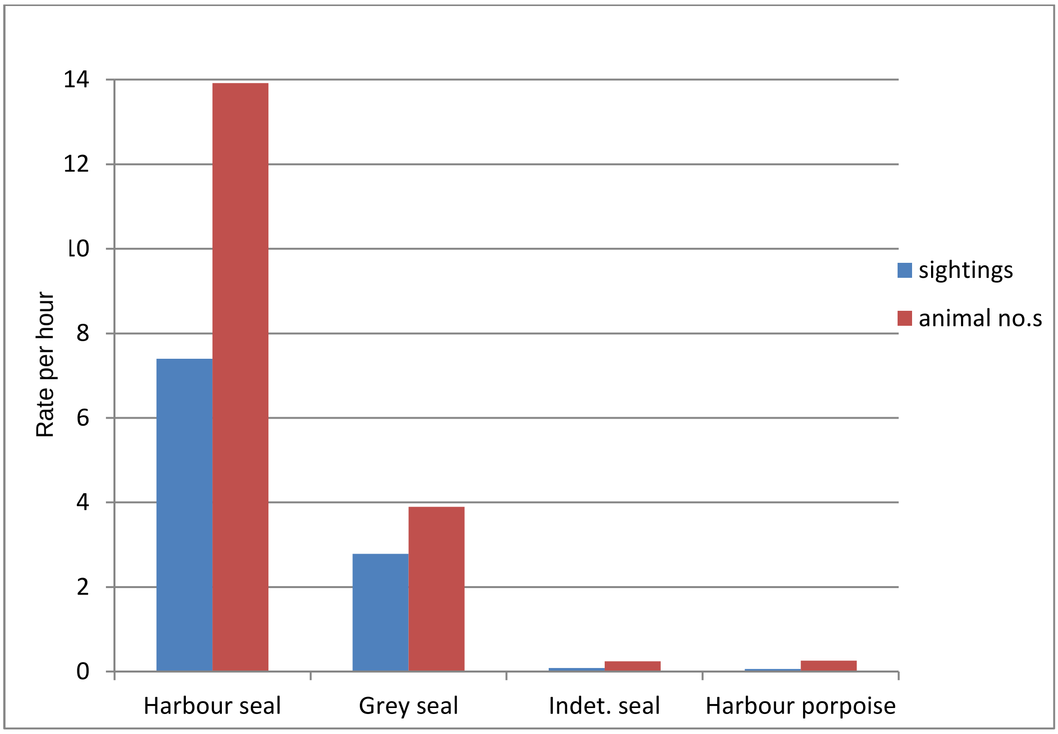
3.1 Species records

The following species were recorded during MMWs in year 1:

- Harbour seal *Phoca vitulina*
- Grey seal *Halichoerus grypus*
- Harbour porpoise *Phocoena phocoena*

Seals that could not be identified to species level are shown as indeterminate (indet.) seals.

Plot 3 shows the sightings rates and animal numbers per hour effort for seals and cetaceans recorded during MMWs.



Plot 3: Pinniped and cetacean animal numbers and sightings per hour effort

Harbour seal was the most commonly recorded species with a total of 2008 animals recorded during 1067 sightings events. 562 grey seals were recorded during 402 sightings events. A further 35 unidentified seals were recorded (12 sightings) which could be either grey seal or harbour seal. (Plot 3)

38 harbour porpoise were recorded during 9 sightings events (Plot 3). Pod sizes ranged from 2 to 5 animals.

Incidental sightings (out with MMWs) were recorded for the following species:

- Common dolphin *Delphinus delphis* (1 sighting 4 animals);
- Bottlenose dolphin *Tursiops truncatus* (1 sighting, 6 animals);
- Indeterminate. dolphins (2 sightings, recorded pod sizes 3 and 4);

- Minke whale *Balaenoptera acutorostrata* (1 animal); and
- Basking shark *Cetorhinus maximus* (3 animals, 4 sightings).

Incidental sightings are not effort corrected.

3.2 Distribution

Figures 2 to 5 show the distribution of species recorded during the vantage point surveys. Figure 4 identifies the distribution of juvenile (pups) harbour seal and grey seal.

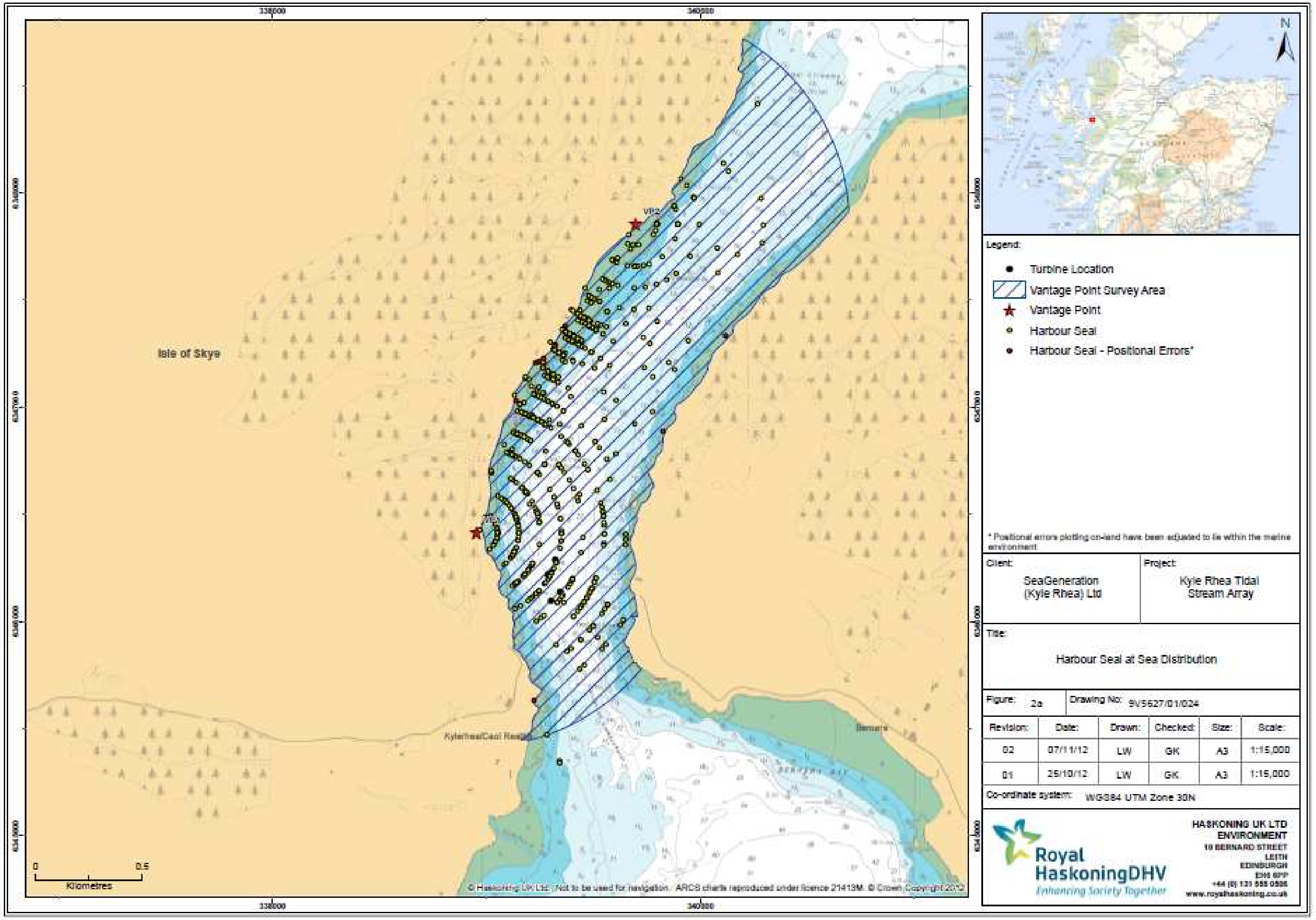
Harbour seals were recorded throughout the study area including at the proposed turbine locations but were most concentrated along the western shore (Skye side) to the north of the proposed array, where there are a number of haul out sites. As previously discussed no significant distance bias is expected within the study area given the narrow width of Kyle Rhea. Figures 1 to 5 show the visible survey area. Figure 2a provides at-sea distributions of harbour seal and Figure 2b shows the distribution of hauled out seals.

Grey seal distribution is similar to harbour seal, with highest sightings along the north west stretch of coast associated with the haul out sites. Sightings were also made throughout the study area, including at the proposed array site, but in fewer numbers. Figure 3a provides at-sea distributions of grey seal and Figure 3b shows the distribution of hauled out seals.

DMP (2012) provides spatially explicit harbour seal relative density estimates.
A small number of unidentified seal species are also shown in Figure 3 with a similar distribution pattern.

Figure 4 shows harbour seal pups have similar distributions to adult seals with sightings through the Kyle but concentrated mostly along the shore. Only 2 grey seal pups were recorded.

Harbour porpoise were recorded towards the centre of Kyle Rhea along the full length of the strait. (Figure 5)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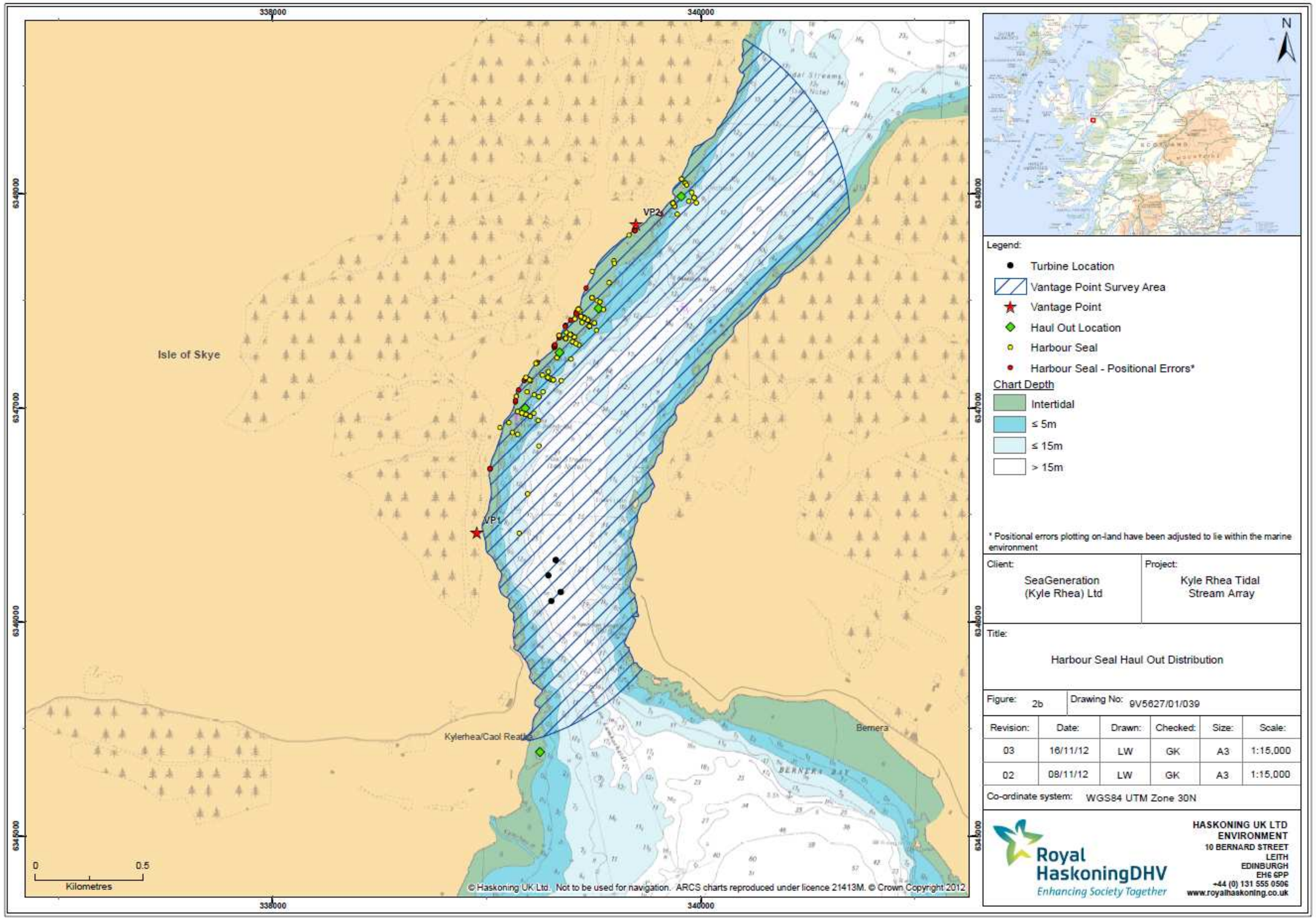
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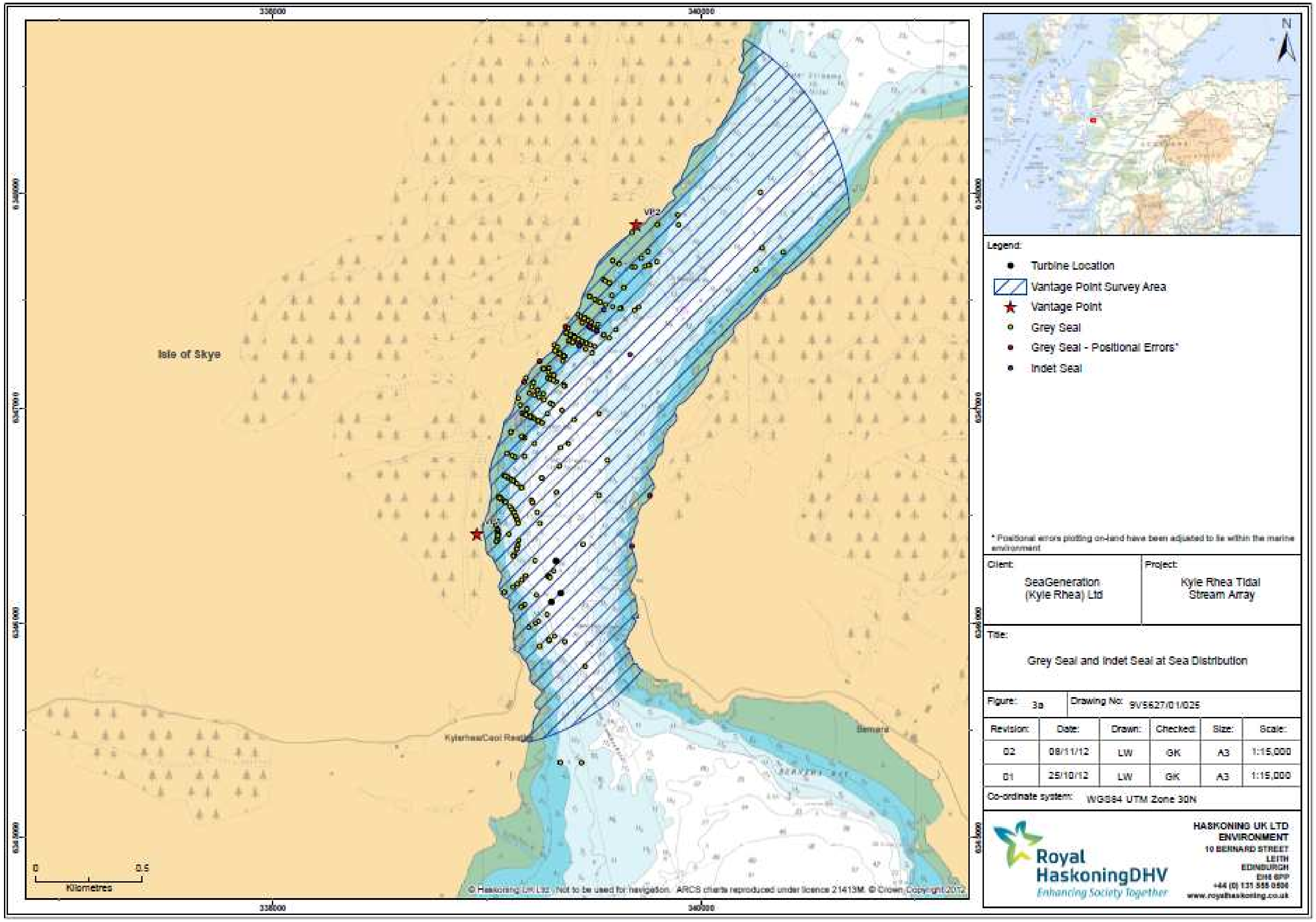
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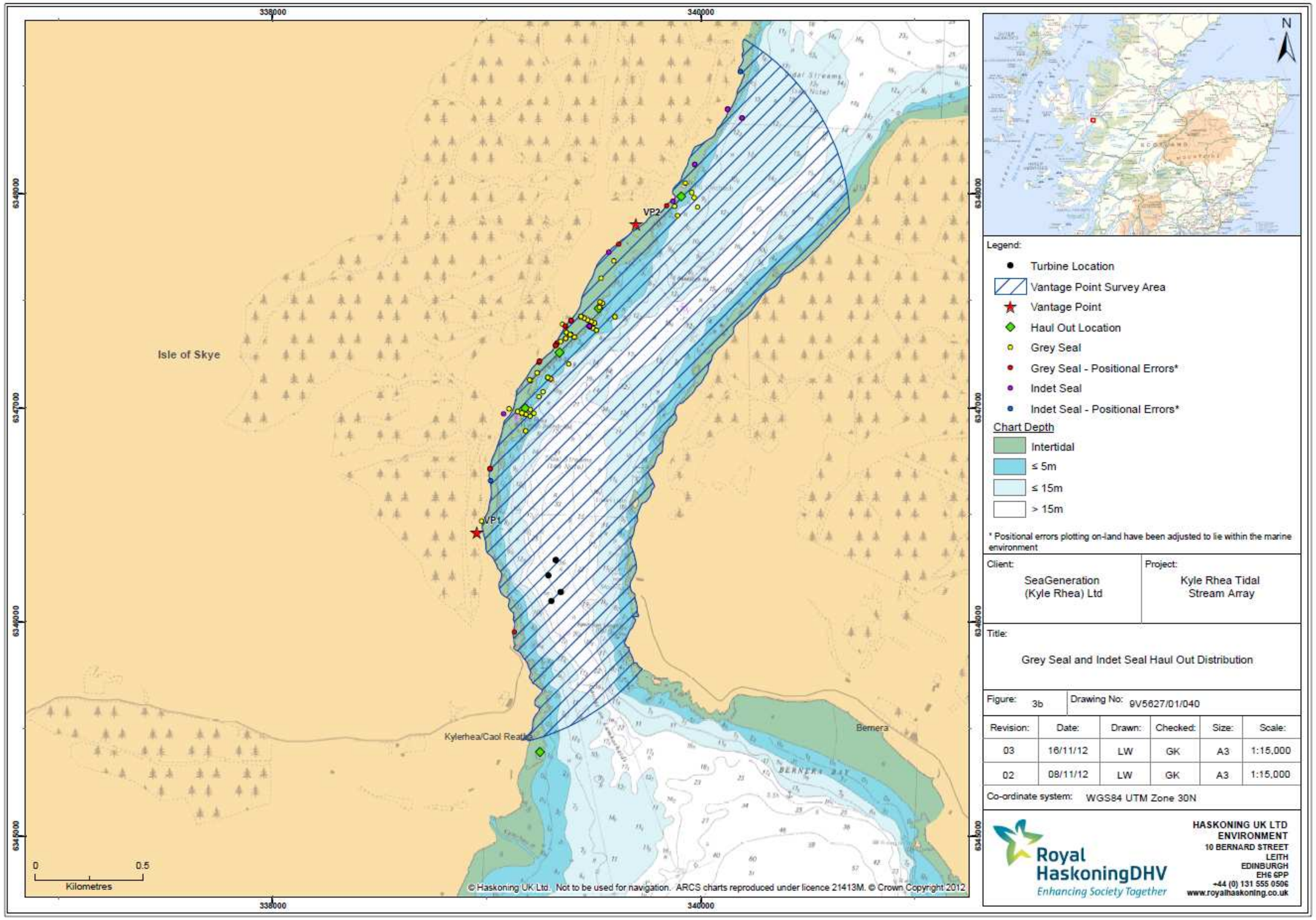
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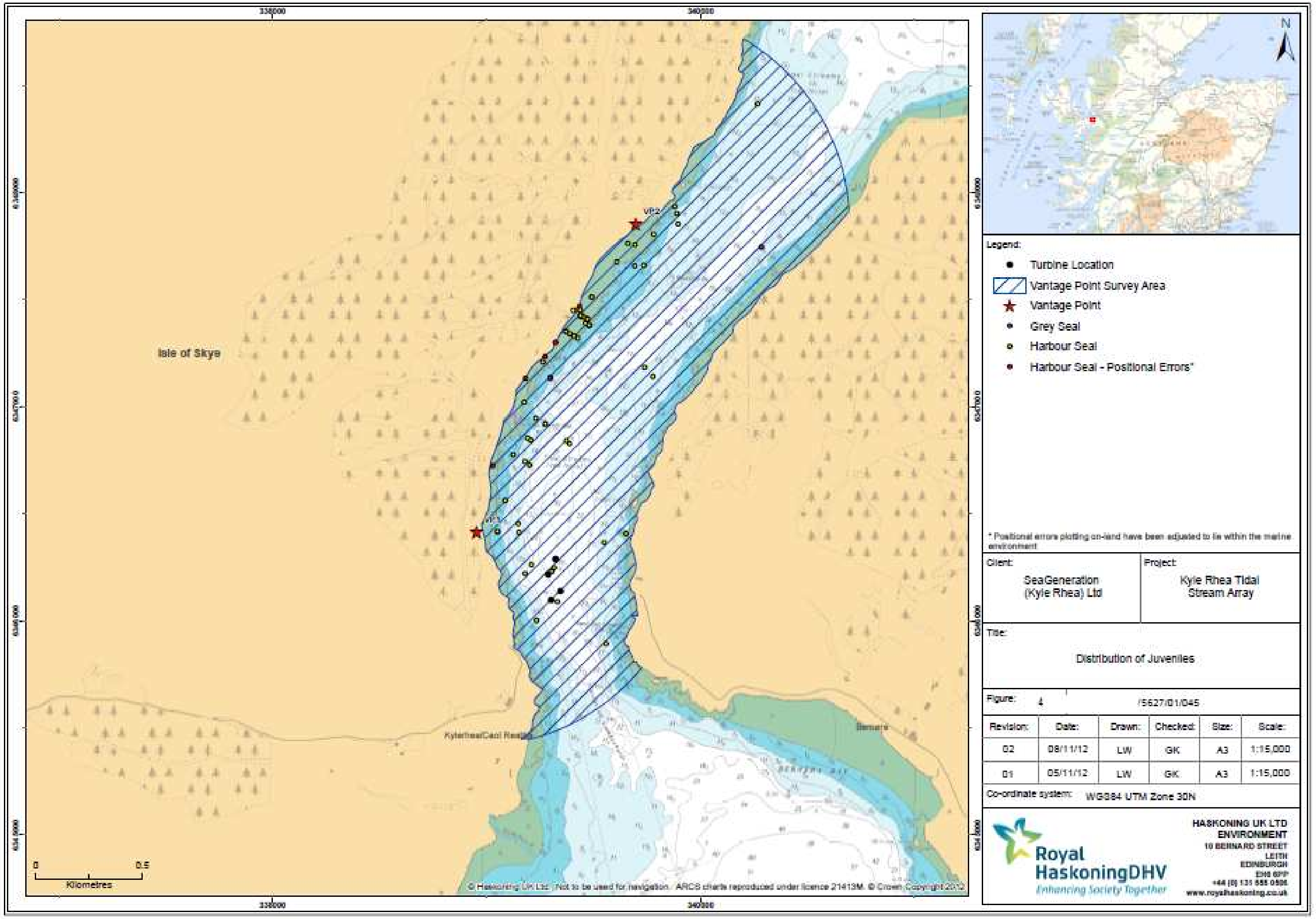
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Grey Seal
Harbour Seal
Harbour Seal - Positional Errors*
* Positional errors plotting on-land have been adjusted to lie within the marine environment
Client:
SeaGeneration (Kyle Rhea) Ltd
Project:
Kyle Rhea Tidal Stream Array
Title:
Distribution of Juveniles
Figure: 4
/5627/01/045
Revision: | Date: | Drawn: | Checked: | Size: | Scale:
02 | 08/11/12 | LW | GK | A3 | 1:15,000
01 | 05/11/12 | LW | GK | A3 | 1:15,000
Co-ordinate system: WGS84 UTM Zone 30N
HASKONING UK LTD
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EH6 6PP
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Enhancing Society Together
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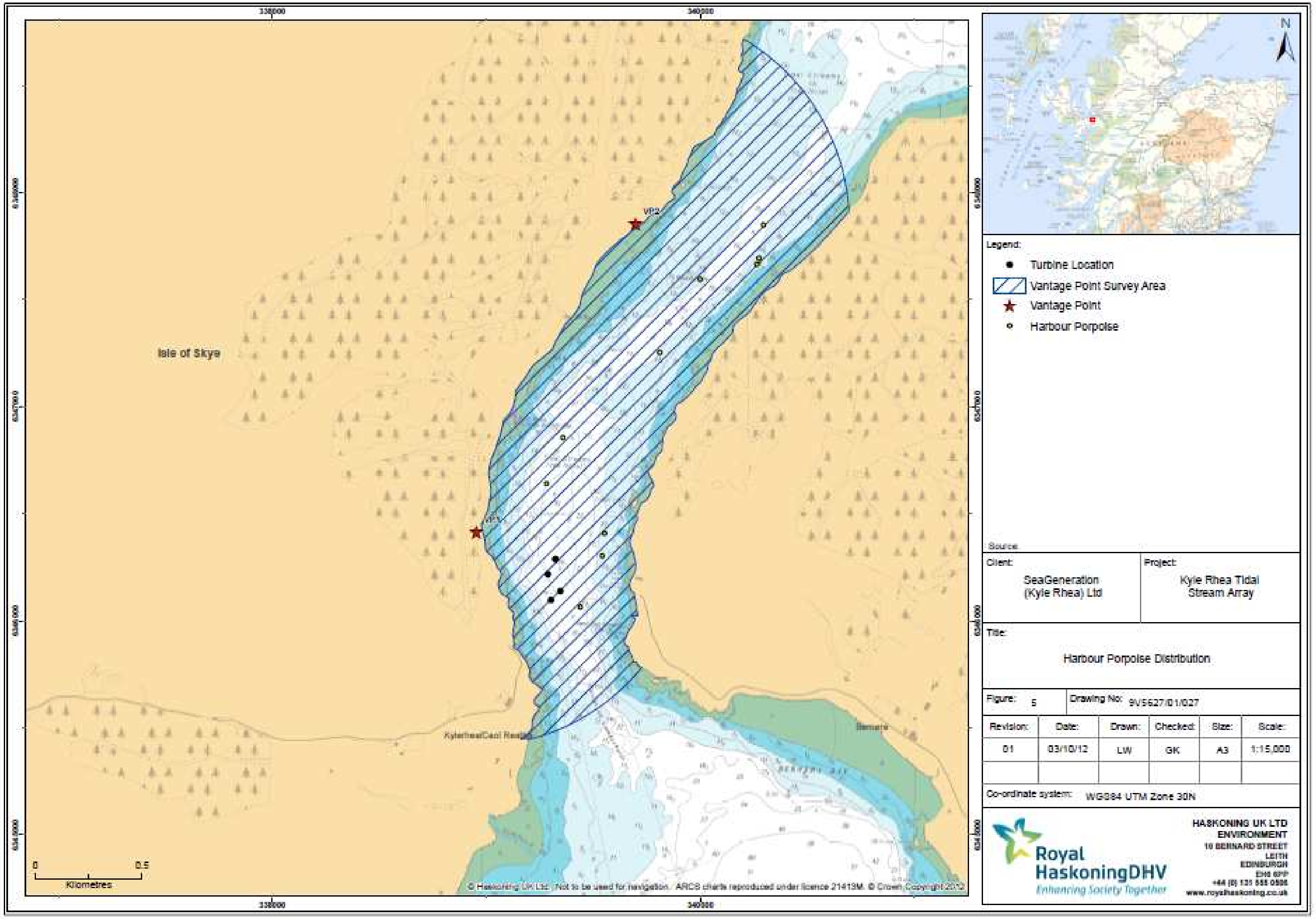
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N
Legend:
Turbine Location
Vantage Point Survey Area
Vantage Point
Harbour Porpoise
Source:
Client:
SeaGeneration (Kyle Rhea) Ltd
Project:
Kyle Rhea Tidal Stream Array
Title:
Harbour Porpoise Distribution
Figure: 5
Drawing No: 9V5627/01/027
Revision: 01
Date: 03/10/12
Drawn: LW
Checked: GK
Size: A3
Scale: 1:15,000
Co-ordinate system: WGS84 UTM Zone 30N
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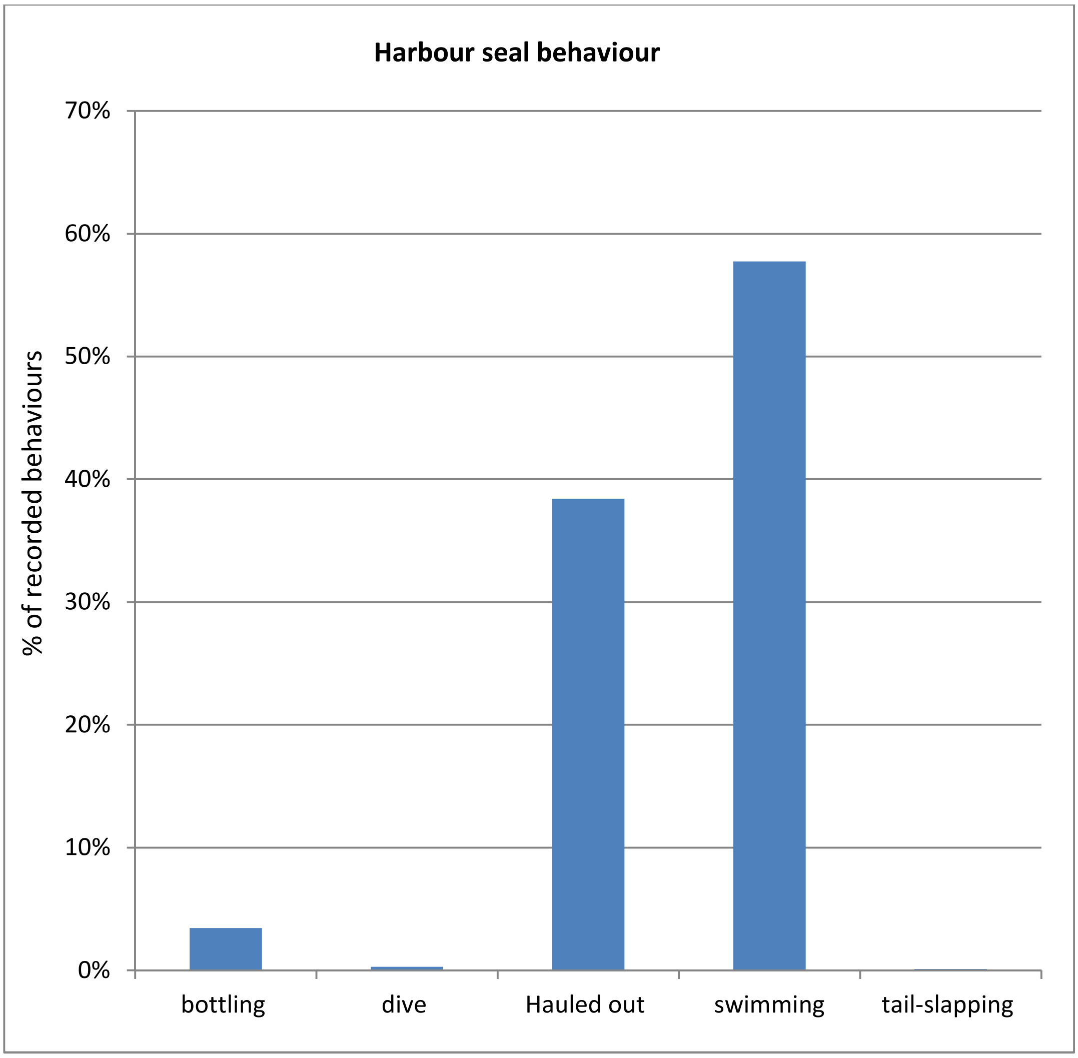
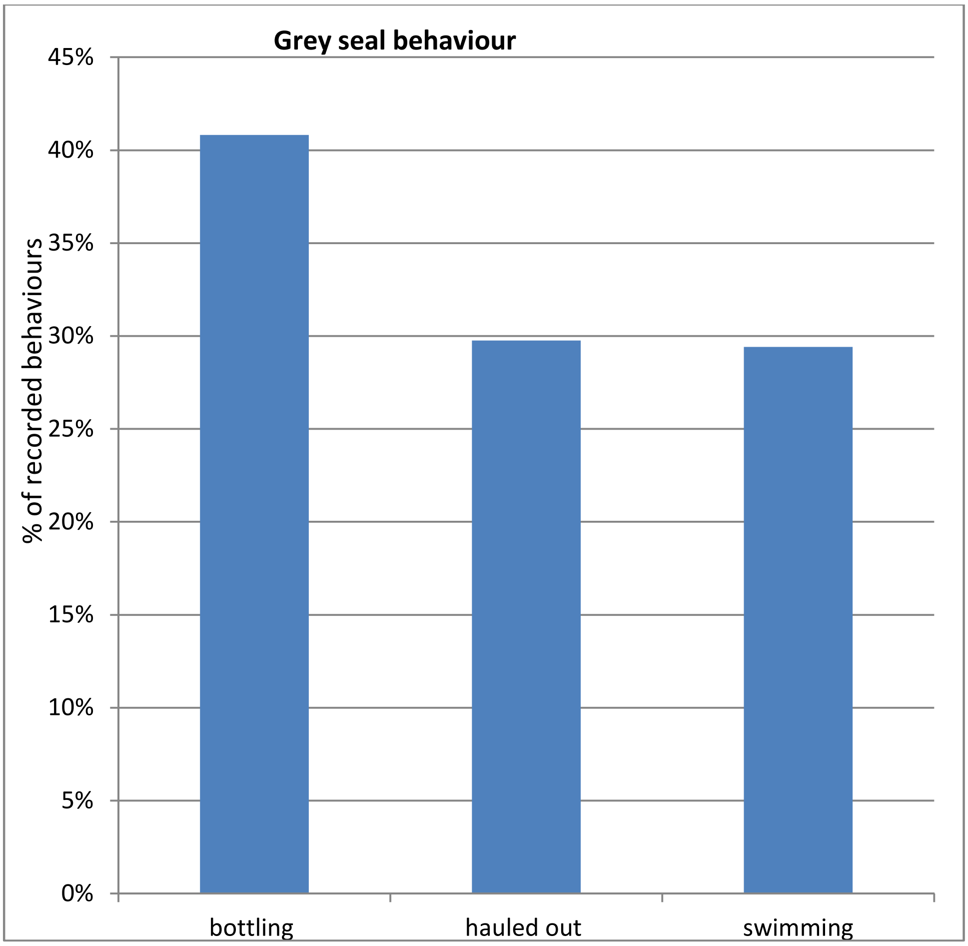
3.3 Behaviour

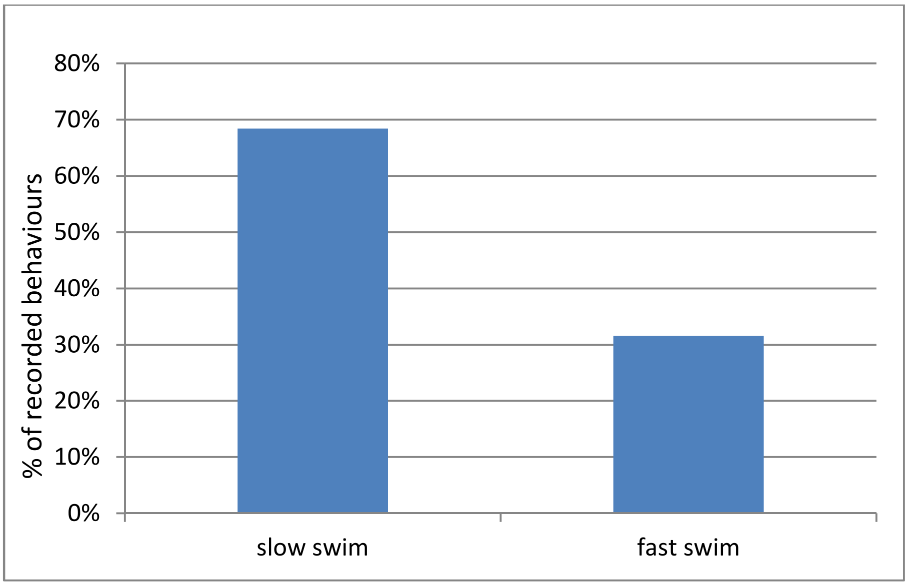
Plots 4 to 6 provide a breakdown of the recorded behaviours when the animals were first seen, for harbour seal, grey seal, and harbour porpoise. No behavioural information is available for incidental sightings.



Plot 4: Harbour seal first seen recorded behaviour



Plot 5: Grey seal first seen recorded behaviour



Plot 6: Harbour porpoise behaviour

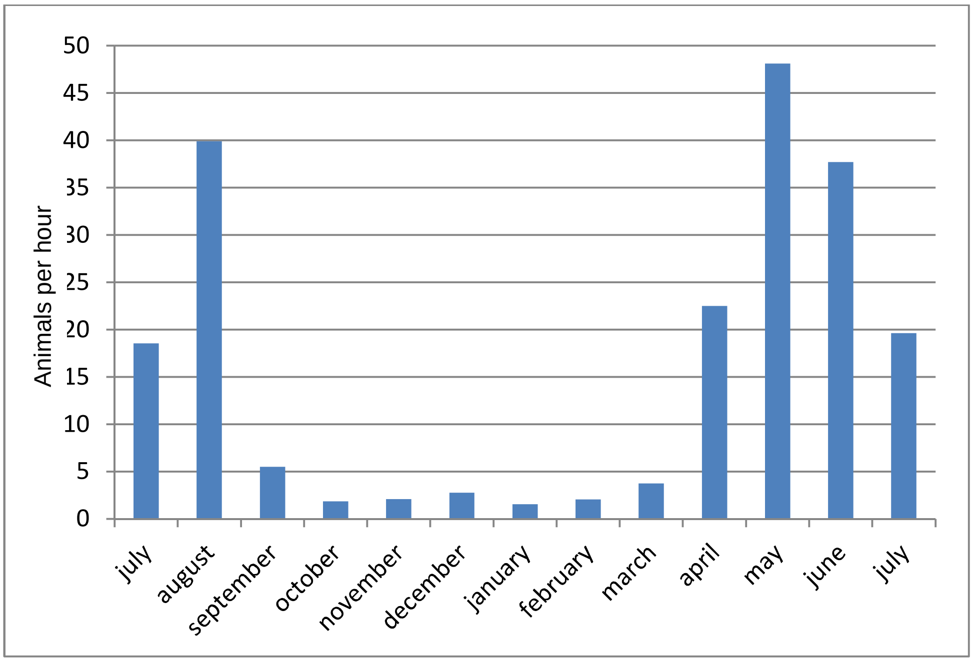
Most harbour seals were recorded swimming or hauled out. Other recorded behaviours include bottling (resting with the head held vertically above the surface), diving, and tail slapping. (Plot 4)

Three predominant grey seal behaviours were recorded; bottling, swimming or hauled out. (Plot 5)

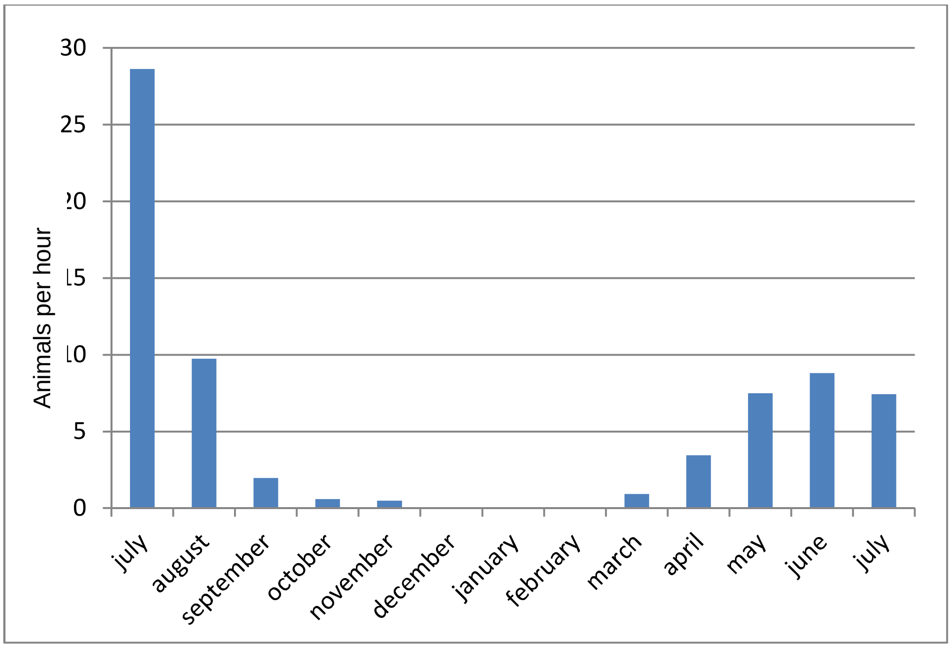
Harbour porpoise were recorded either fast swimming or slow swimming (Plot 6).

3.4 Seasonal trends

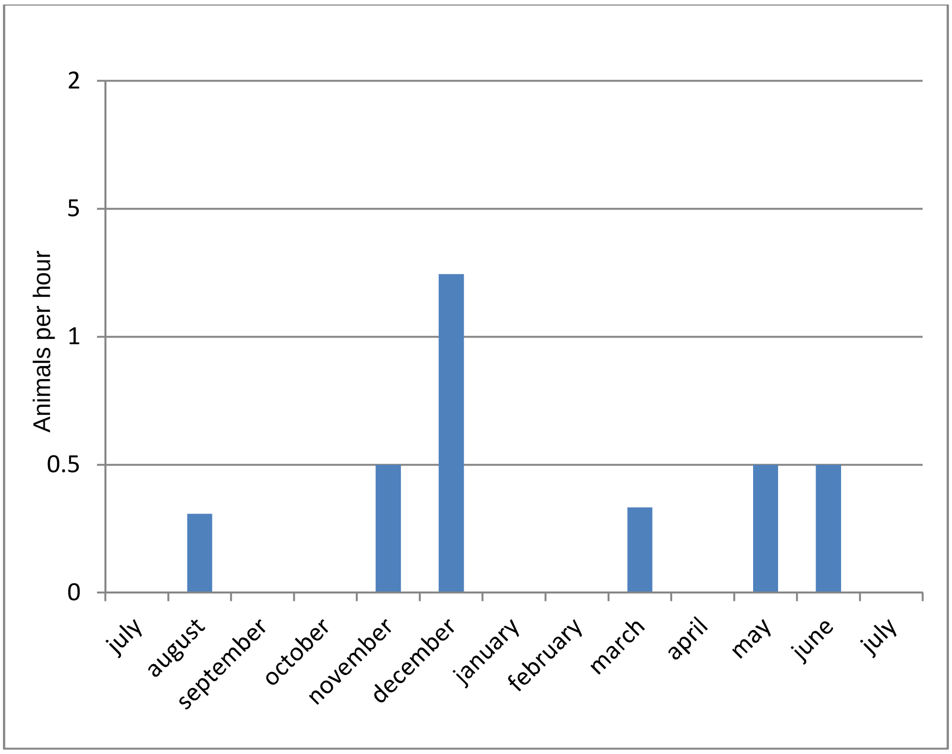
Plots 7 to 9 show the number of harbour seals, grey seals and harbour porpoise recorded per hour of effort each month.



Plot 7: Harbour seal numbers per hour effort



Plot 8: Grey seal numbers per hour effort



Plot 9: Harbour porpoise numbers per hour effort

Harbour seal numbers were relatively low from September 2011 to March 2012 at around five or less animals per hour effort (Plot 7) compared with summer months ranging from around 18 (July 2011) to 46 (May 2012) animals per hour of effort. Further detailed analysis of seasonal harbour seal numbers is provided in DMP (2012).

As with harbour seal, grey seal numbers were lowest in winter months. September to November 2011 and March to April 2012 had low numbers of animals (less than four per hour effort). December to February had no grey seal sightings (Plot 8). A high number (28.6 per hour effort) of grey seals was recorded in July 2011 compared with other summer months, August 2011 and May to July 2012 which all had less than 10 animals per hour effort.

Harbour porpoise were recorded infrequently throughout the year (Plot 9).

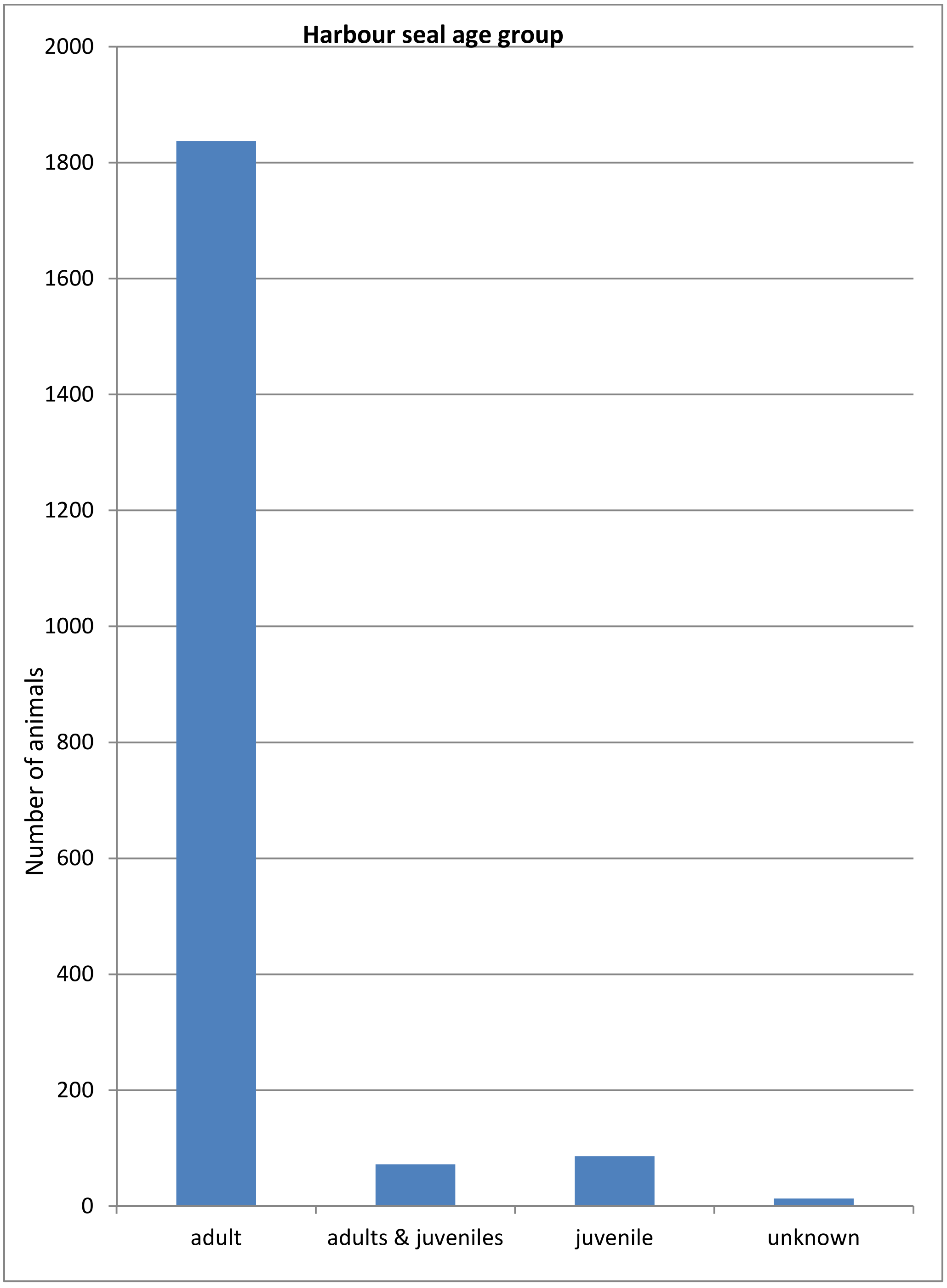
Incidental bottlenose dolphin and common dolphin sightings were recorded in May and June, respectively. Indeterminate dolphins were recorded in June and July 2012.

A minke whale was recorded by the ferry operators in June 2012.

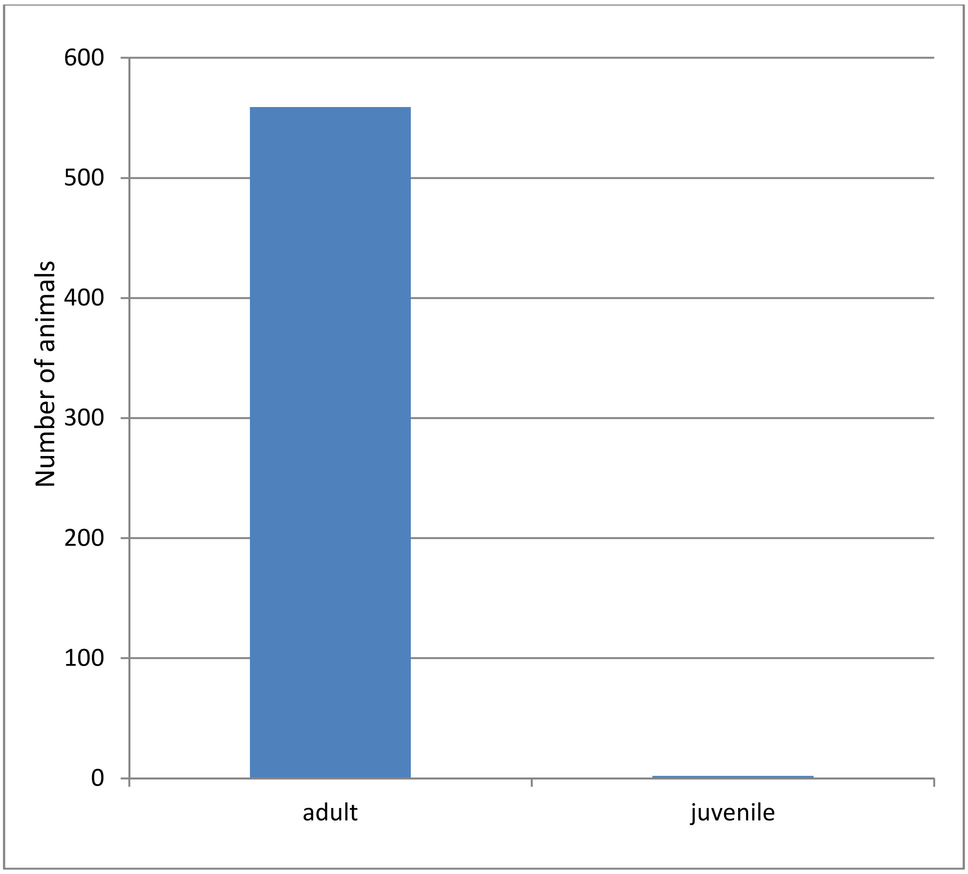
Incidental basking sharks were recorded in May, June and July 2012.

3.5 Age demographic

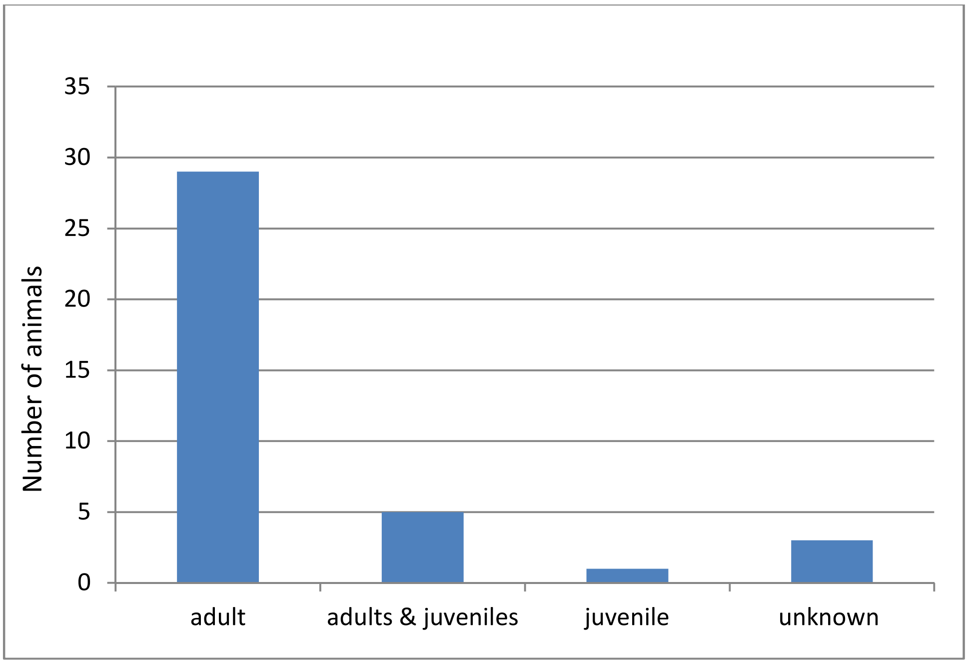
Plots 10 to 12 provide a breakdown of the recorded age groups, including adults and juveniles (< 1 year old) for harbour seals, grey seals and harbour porpoise recorded during marine mammal watches. Where adults are observed closely associated with juveniles animals these pairings were recorded as mixed groups (i.e. adults and juveniles)



Plot 10: Harbour seal recorded age groups



Plot 11: Grey seal recorded age groups



Plot 12: Harbour porpoise recorded age groups

Over 90% of the harbour seals recorded were adults (Plot 10). Juvenile animals were recorded in low numbers throughout the year.

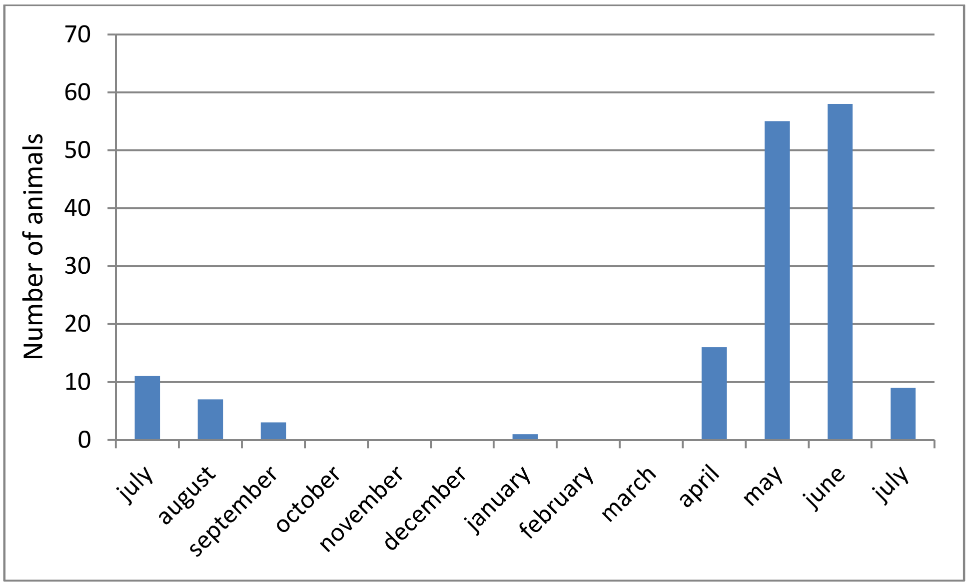
Over 99% of grey seals recorded were adults, with only 2 juveniles recorded (Plot 11). The juveniles were recorded in August and will therefore have been born the previous year.

Over 75% of adult harbour porpoise recorded were adults, however determining accurate ages in a pod is difficult, therefore some were recorded as a mix of adults and juveniles or as unknown age groups (Plot 12).

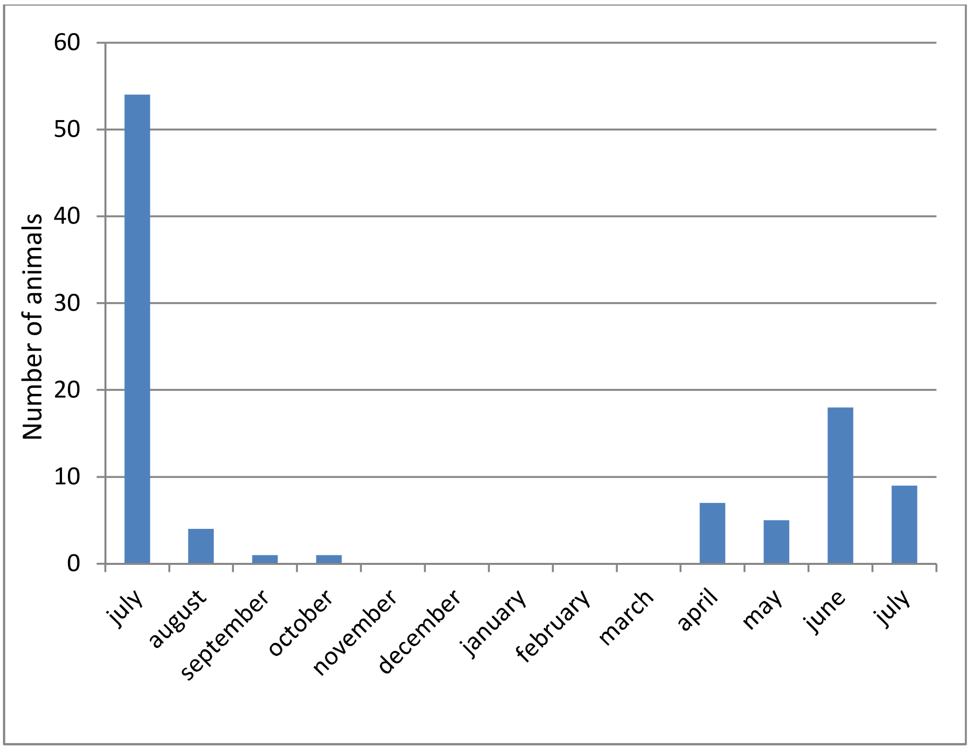
One of the basking sharks recorded was a juvenile, approximately 4m in length.

3.6 Haul out counts

Plots 13 and 14 provide the maximum number of seals hauled out per month during a period of 2 hours either side of low water.



Plot 13: Maximum number of harbour seals hauled out.



Plot 14: Maximum number of grey seals hauled out.

Harbour seals were recorded at haul out sites from April to September, with peaks in May and June. Maximum group sizes were around 70 animals (Plot 13).

Harbour seal juveniles were recorded on 5 days during July to October 2011. Up to 4 juveniles were recorded at one time.

Grey seals were recorded from April to October, with peaks around June and July. Over 60 grey seals were recorded hauled out in July 2011 and 40 in June 2012 (Plot 14). 4 grey seal pups were recorded on only 1 day (6th July 2011) during the 13 month survey.

In summer months when numbers hauled out (grey seal and harbour seal) were greatest there was a high amount of variation in the haul out numbers recorded (Plots 13 and 14).

4 DISCUSSION

4.1 Distribution

Harbour and grey seals are clearly concentrated around haul out sites to the north west of the proposed array location but are also using open water in much of the Kyle.

Harbour porpoise were recorded throughout the centre of the channel.

4.2 Behaviour

The predominant seal behaviour recorded for both seal species was hauled out and swimming. High numbers of grey seal were also recorded bottling. One record of tail slapping was recorded in July for harbour seals. This may reflect a courtship behaviour as this is within the breeding season (see Section 4.4 below). Harbour porpoise were recorded swimming, reflecting that they were most likely using Kyle Rhea as a transit route from the Sound of Sleat to Loch Alsh.

Anecdotal evidence from the surveyor suggests that shortly after low water both grey and harbour seals were regularly observed to feed on mackerel shoals around the ferry crossing area and further north. During the summer this is a daily occurrence.

4.3 Seasonal trends

Harbour seals pup in June and July, and moult from late July to September depending on their age and sex (Duck, 2010). Harbour seals use Kyle Rhea during these seasons and around 10% of the harbour seals recorded were juveniles (pups) or immature (pre-sexual maturity) animals. There is therefore potential that the site is used by harbour seal for breeding, however juvenile harbour seals were only recorded on 5 days during the haul out counts. This inconsistency in the presence of juveniles suggests harbour seals are not breeding at Kyle Rhea.

The low grey seal numbers throughout winter, from September 2011 to March 2012 suggests that this species is elsewhere during its breeding season around September and October and its moulting season January to March (Duck, 2010). Less than 1% of the grey seals recorded were juveniles.

Harbour porpoise records were too sporadic to determine any seasonal trend, with occasional pods recorded in winter and summer months.

Basking sharks were recorded during summer months as is expected on the west coast of Scotland (SNH, undated.

5 SUMMARY

The following key findings were observed following interrogation of data collected during 1 year of vantage point surveys at Kyle Rhea:

- Grey seal appear to leave Kyle Rhea during breeding season;
- Harbour seal are present at the site during the breeding season however the number of sightings of juvenile seals (<1 year) was relatively low;
- Most seals are recorded resting or hauled out close to the shore although they also use the whole of the Kyle, including the proposed array site;
- <0.5% of the recorded harbour seal behaviour was diving; no grey seals were recorded diving / feeding;
- Small numbers of harbour porpoise were recorded, most likely transiting through Kyle Rhea; and
- Only 3 basking sharks were recorded.

6 REFERENCES

Duck C. (2010). Charting Progress 2, Healthy and Biologically Diverse Seas. Feeder Report: Section 3.5: Seals. Published by DEFRA on behalf of UKMMAS. P506-539. In UKMMAS (2010) Charting Progress 2 Healthy and Biological Diverse Seas. (EDs. Frost, M & Hawkridge, J.)

Macleod, K., Lacey, C., Quick, N., Hastie, G. and Wilson J. (2011). *Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 2. Cetaceans and Basking Sharks*. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

Sparling, C., Grellier, K., Philpott, E., Macleod, K., and Wilson, J. (2011). *Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 3. Seals*. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

SNH (undated). Basking shark hotspots in west Scotland. Available at: http://www.snh.org.uk/pdfs/publications/marine/baskingsharkhotspotsflyer.pdf

Thompson P.M., McConnell B.J., Tollit D.J., Mackay A., Hunter C., Racey P.A. (1996) Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, NE Scotland. Journal of Applied Ecology 33 1572-1584.

Kyle Rhea Tidal Stream Array

Appendix 12.3

APPENDIX 12.3

STATISTICAL ANALYSES OF MARINE MAMMAL DATA FOR THE KYLE RHEA MCT TURBINE SITE: 1ST YEAR DATA JULY 2011 TO JULY 2012

PREPARED FOR ROYAL HASKONING
19 DECEMBER 2012

CONTENTS

1 EXECUTIVE SUMMARY

- Data covering the first year of visual surveys at the Kyle Rhea turbine array site were analysed to establish:
  - Statistical models for marine mammal densities.
  - Relationships between available covariates and animal densities.
  - The power to detect changes in animal densities of various sizes.

- There were sufficient sightings of harbour and grey seals to model density surfaces as per the SOW, however harbour porpoise were observed too infrequently to develop density models.

- The modelling methods employed accounted for nonlinearities in the data, potentially complex spatial distributions of the animals and any autocorrelation present in data of this kind.

- There were significant spatio-temporal patterns in the seal distribution (for both species) and significant links to tidal phases and heights. In particular there is a marked seasonal component to the numbers of swimming seals – April through August being substantially higher for harbour seals.

- The near-shore body of water between the visual observer points is an of high seal activity. There are also indications of decreasing ability to detect seals visually with distance within the observer zones.

- Power analyses were conducted for the harbour and grey seals, investigating the probability of detecting general declines in the numbers of locally swimming seals.

- The power analyses considered the current state and continuing similar data collection for 3 to 6 months. Underlying general declines of swimming seals of 10%, 20% & 50% were considered.

- Power analyses suggest there is a good chance (in excess of 65%) of detecting decreases of 20% or more in the local swimming harbour seal population, but this value falls to approximately 40% for the grey seals.

- Decreases of 50% are found to be certainly detected under the current data collection regime in the near term for both species.

- Decreases in the swimming seal population of only 10% in either species would markedly less like to be detected, < 25% chance in the near term.

2 DATA MANIPULATION AND EXPLORATION

The analyses presented here are based upon the data provided on the 26th of August 2012 in an Excel spreadsheet "*KR1 Y1 VP MarineMammals, 2012_08_25-1.xlsx*". Multiple sheets of data were contained therein; however analysis drew principally on the effort & environmental data contained in the "Sessions" sheet, and animal sightings & environmental data contained in the "VP Data" sheet.

2.1 EXTRACTION AND CLEANING OF DATA

The data extracted from the xlsx file as csv for import into R version 2.14.2 64-bit for windows (R Core Development Team, 2012).[1]

Two observer positions were utilised in the survey, the locations of which were inferable from the data as being:

- VP1 at 78715, 21709 (Easting, Northing)
- VP2 at 79480, 23140 (Easting, Northing)

A variety of data-cleaning and preparation steps were conducted. The more substantive of these were:

- The data contained extensive bird recordings and various other terrestrial & marine animals. The data were reduced to only harbour seals (Common Seals CS in the datasheets), grey seals and harbour porpoise.
- Two haulout sites are also indicated which are not included in the analysis.
- There were a variety of hidden data in Excel and data filters, which were removed prior to data importing.
- Similarly, missing values and cells containing errors were coded prior to importing.
- Visual observations were truncated to contain only observations within 1100m of the visual observation point. This was both in line with the nominal visual observer boundaries indicated in the interim report, and corresponded empirically to a marked decline in the numbers of detections. This excluded some 58 observations from 2088 non-missing values, an attrition of approximately 2.7%.

The effort data consisted of 575 unique 15 minute marine mammal observation scans, of which 404 contained non-zero observations (over a range of species). After filtering, the observation data comprised 1049 observations of grey seals (individuals or groups) and 9 observations of harbour porpoise (individuals or groups).

The survey region, observer points and nominal extents of visual coverage are given in Figure 1[2].

[1] Development Core Team (2012). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

[2] D. Jackson (2012) Kyle Rhea Marine Turbine Array Bird, Marine Mammal and Basking Shark Surveys Interim Progress Report March 2012

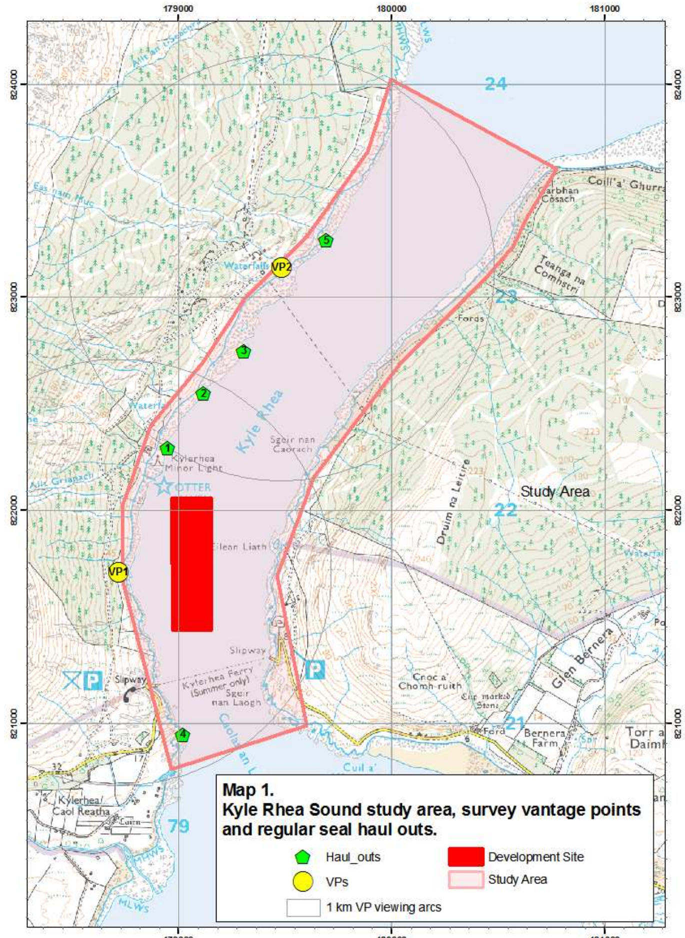
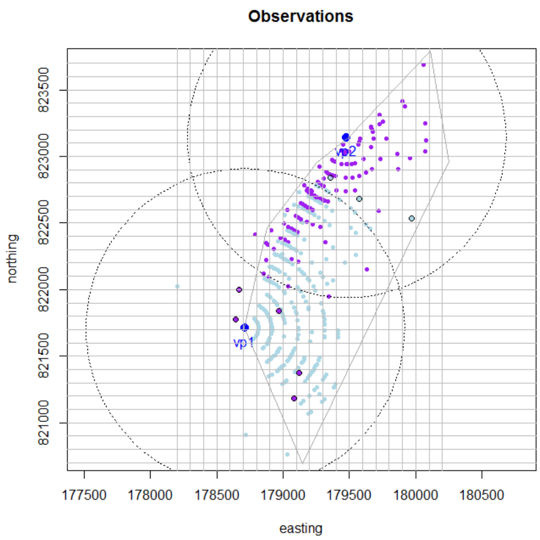


Figure 1: Survey region and visual observer points for the Kyle Rhea study region (D. Jackson, 2012)

Subsequent to these data manipulations, the data were filtered to remove any further data outside the survey region and/or the visual observer limits. The region was divided into a 100m grid, to which individual observations were assigned. The extent of the observer's scans and their timings were used to infer where animals were not observed i.e. spatio-temporal zero counts were added to the data. The grid and observations are indicated in Figure 2.



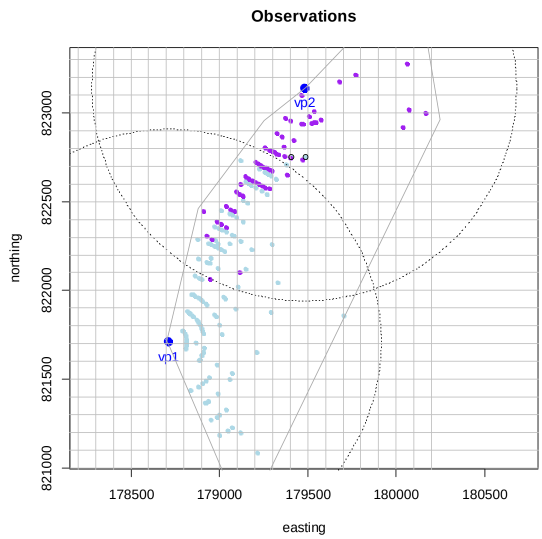


Figure 2: Observations of harbour (left) and grey seals (right) superimposed on the survey region, extent of visual observer scans and analysis grid. The dashed circles indicate the effective extent of visual scans. Observations associated with visual position 1 are given in blue, those in purple correspond to visual position 2. Excluded observations are ringed for emphasis.

3 EXPLORATORY DATA ANALYSIS

This section contains exploratory data results for harbour seals and grey seals. In each case the spatial distribution of the animals and the relationships between the raw counts and the (environmental) covariates are shown.

3.1 HARBOUR SEALS (*PHOCA VITULINA*)

The following gives an informal exploration of the harbour seal data. The majority of the animals were observed near the land; less animals were seen in cells distant from the two vantage points (Figure 3).

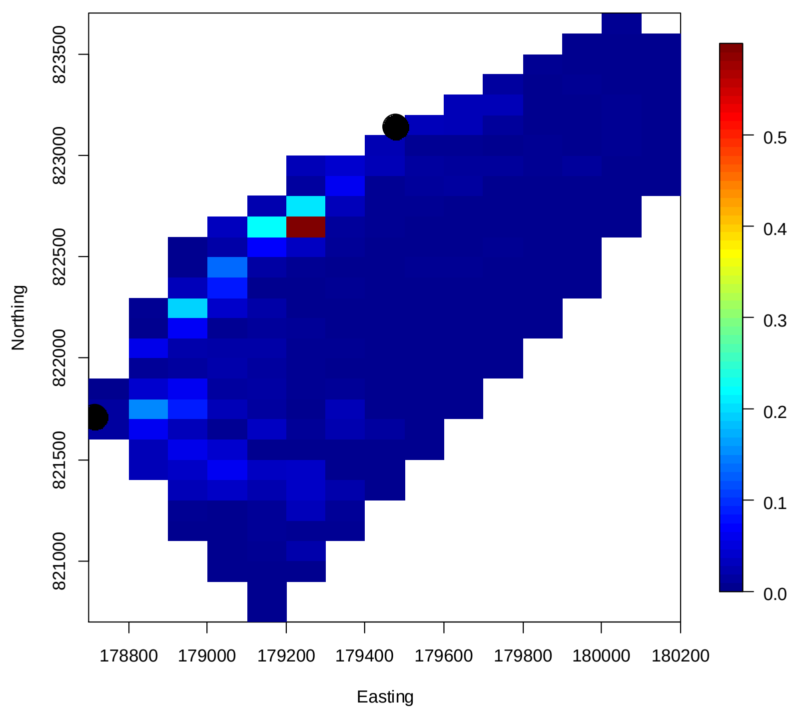


Figure 3: Average numbers of animals observed within the survey area, for each grid cell, pooled across time from both vantage points. The black circles represent the location of the vantage points.

There are indications of patterns in the numbers of animals observed with respect to month, time of day and tidal cycle (Figure 4 & Figure 5). The tide codes are as follows:

1: 0 to 2 hours after high tide
2: 2 to 4 hours after high tide
3: 2 to 0 hours before low water
4: 0 to 2 hours after low water
5: 2 to 4 hours after low water

6: 2 to 0 hours before high water

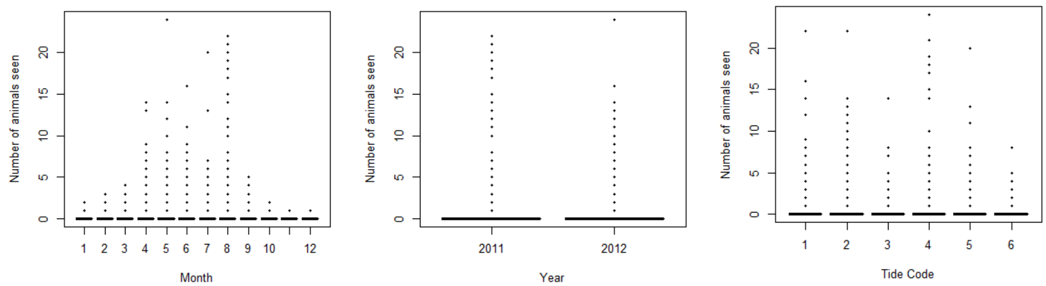


Figure 4: Boxplots representing the number of animals seen across the range for each categorical covariate.

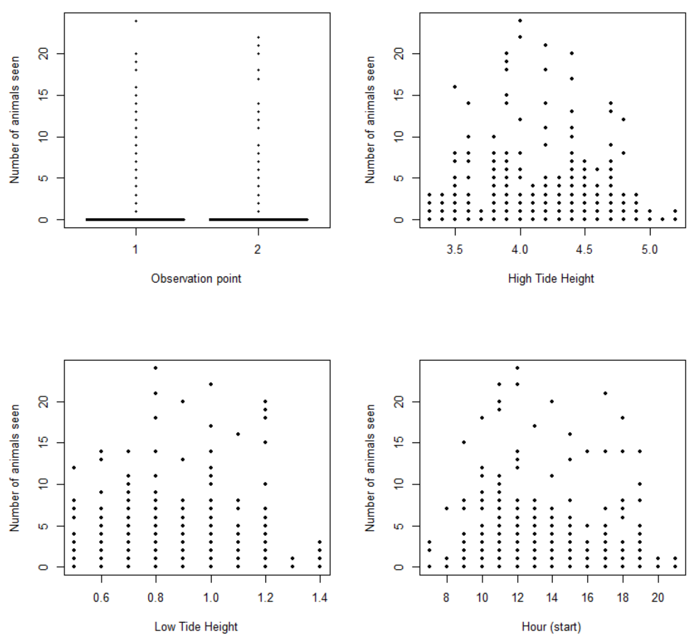


Figure 5: Boxplot and scatterplots representing the number of animals seen across the range for each covariate.

3.2 GREY SEALS (*HALICHOERUS GRYPUS*)

The following provides an exploration of the grey seal data. As for harbour seals, the majority of the animals were observed near the land; less animals were seen in cells distant from the two vantage points (Figure 6). Notably, the average number of grey seals is considerably lower than the average numbers of harbour seals seen across the surface.

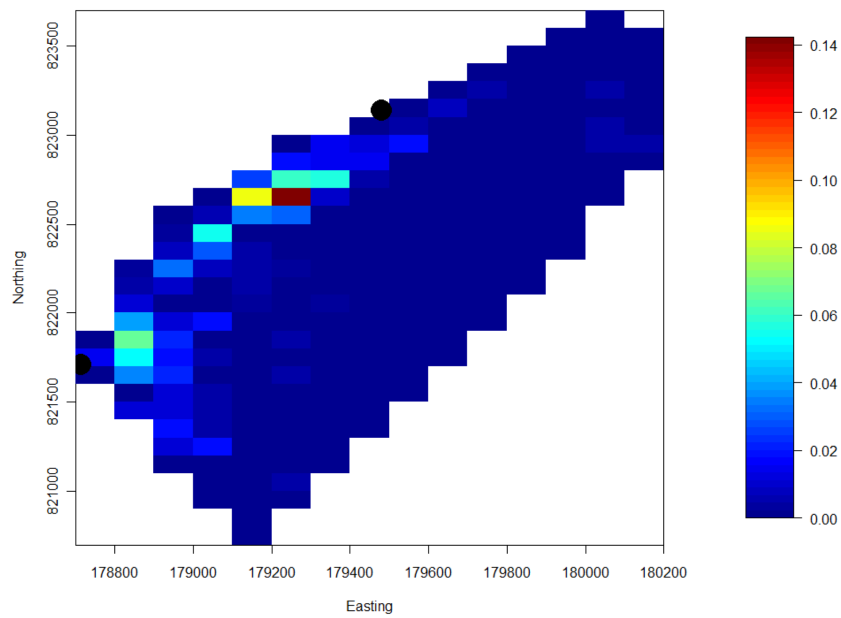


Figure 6: Average numbers of animals observed within the survey area, for each grid cell, pooled across time from both vantage points. The black circles represent the location of the vantage points.

There are similar patterns in the numbers of animals observed with respect to month, time of day and tidal cycle (Figure 7 & Figure 8) as observed for harbour seals (Figure 4 & Figure 5).

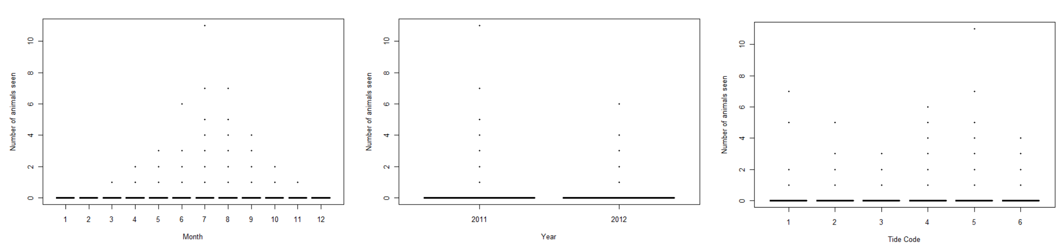


Figure 7: Boxplots representing the number of animals seen across the range for each categorical covariate.

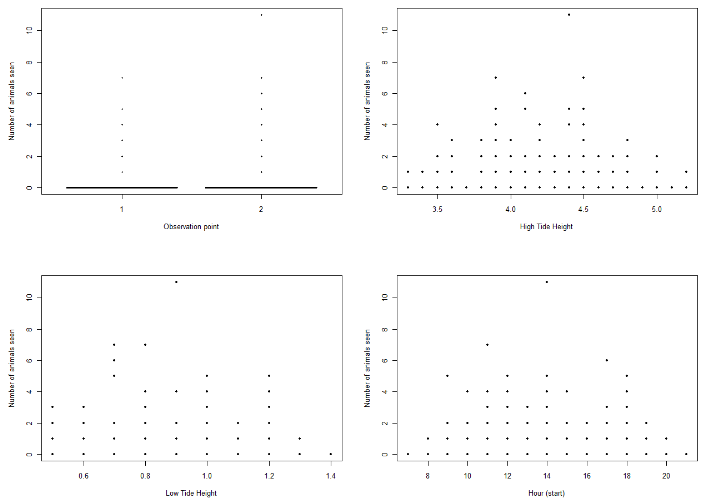


Figure 8: Boxplot and scatterplots representing the number of animals seen across the range for each covariate.

4 MODELLING METHODS

The following gives a brief outline of the statistical underpinnings of the analyses. Sections 4.3 to 4.6 presuppose familiar statistical modelling, in particular Generalized Linear Models (GLMs).

4.1 INPUT DATA

The counts provided by Royal Haskoning are considered to be relative abundances in the models here, since no account of the imperfect detection from the vantage points (likely to exist in the raw counts) has been accounted for in this analysis. For this reason, the number of animals that were present on the water is likely to have been underestimated by the raw data modelled as inputs here.

In the case that observations are recorded simultaneously from both vantage points in the future (at this stage, observations from each vantage point were taken at different times), and sufficient spatial overlap was found to be present in the observed counts, some calibration would be possible to scale the raw counts into estimates of abundance.

4.2 MODEL COVARIATES

The following candidate variables for both species were considered for selection:

- Easting and Northing: spatial co-ordinates of each grid cell centre (e.g. Figure 3)
- Observation Point: a classification value representing one of 2 vantage points (see also e.g. Figure 3)
- Calendar month: A categorical covariate valued from 1 to 12 (e.g. Figure 4)
- Calendar year: 2011 & 2012 (e.g. Figure 4)
- Tide Code: an ordinal categorical value from 1—6 (e.g. Figure 4)
- High Tide Height: a continuous covariate ranging from 3.3m to 5.5m (e.g. Figure 5)
- Low Tide Height 0.5m to 1.4m (e.g. Figure 5)
- Hour of day[3]: 0700 to 2100 hours (e.g. Figure 5)

To help ensure model stability in the face of potentially highly correlated explanatory variables, collinearity across the covariates was identified using variance inflation factors (VIFS[4]). Values greater than 5 were deemed to signal collinearity and of any collinear pairs identified, the covariate with the best explanatory power was retained and the other omitted.

[3] at start of 15 minute period

[4] 1992. Fox, J. and Monette, G. Generalized collinearity diagnostics. JASA, 87, 178–183

4.3 MODELLING FRAMEWORK: GENERALIZED ESTIMATING EQUATIONS (GEES)

The data are collected from two vantage points and the observed counts (seen from these points) are linked in space and time. Additionally, due to environmental/prey conditions (which may be unknown to us) the abundance of the marine mammals at any particular location is likely to be more similar for points close together in time compared with points distant in time. Models fitted to the relative abundance data attempt to explain marine mammal abundance at any particular location but the information (covariate data) that describes why animals are found in high/low numbers at particular locations is often missing from the model and this leaves pattern in the noise component of the model (model residuals), which is likely to be similar for points close together in time.

This (positive) correlation in model residuals for consecutive points violates a critical assumption for standard statistical models (such as GLMs/GAMs) which require an independent set of errors. Further, ignoring this violation can invalidate all model-based estimates of precision (e.g. standard errors, confidence intervals and *p*-values) resulting in overly complicated models, with high variance, which suggest that unrelated environmental covariates are statistically significant.

For this reason, an alternative modelling framework which incorporates this autocorrelation (Generalized Estimating Equations; GEEs)[5] was used to obtain realistic model-based estimates of precision in this analysis. GEEs are designed to explicitly estimate and incorporate residual autocorrelation within model residuals. To ensure this extra complexity was required, a runs-test[6] was employed to test for statistically significant levels of spatio-temporal autocorrelation in model residuals. The runs test compares the number of uninterrupted sequences (i.e. runs) of positive or negative residuals with the number of runs expected under independence, and fewer (longer) runs signifies positive autocorrelation. Statistically significant and positive autocorrelation results in a negative runs test statistic and a small *p*-value ($p<0.05$).

In the case that the autocorrelation was statistically significant, information about the survey design (e.g. grid code) and empirical autocorrelation function (acf) plots[7] were used to define the panel (or blocking) structure. In a GEE setting, correlation is permitted within panels but independence between panels is assumed.

Autocorrelation function plots (Figure 9) illustrate the empirical autocorrelation for a variety of intervals (or lags) between measurements. For example, points which are co-incident in time are assumed to have identical residuals (correlation=1) while in this example (Figure 9), points 1 unit apart are estimated to have a correlation of about 0.17. This correlation decays effectively to independence 16 units apart, as the empirical correlation falls within the confidence limits for zero correlation at this stage.

[5] 2002. Hardin, J and Hilbe, J. Generalized Estimating Equations. Chapman and Hall, CRC Press.

[6] 1982. Mendenhall, W. Statistics for Management and Economics, 4th Ed., 801-807, Duxbury Press, Boston

[7] 2002. Venables, W. N. and Ripley, B. D. Modern Applied Statistics with S. Fourth Edition. Springer-Verlag.

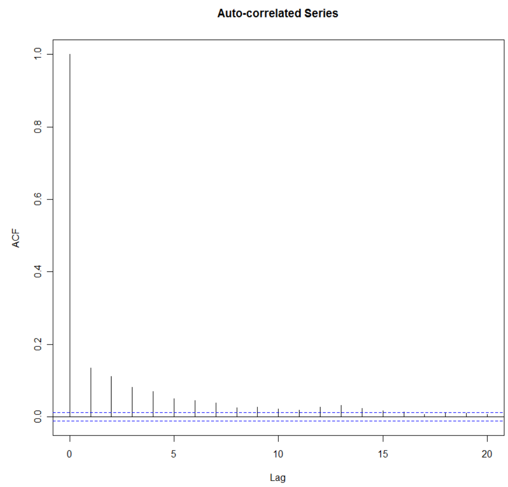


Figure 9: Illustrative empirical autocorrelation plot.

The magnitude of the correlation within blocks, in part, dictates the size of model standard errors and the nature of this correlation can either be estimated from the data (and robust, empirical, standard errors calculated) or it can be assumed to follow a particular model chosen by the user. For GEEs, QICr[8] values can be used to discriminate between competing correlation structures, however rather than choose from a very limited range of unlikely correlation structures currently available in statistical software (e.g. AR(1), compound symmetry) , the correlation (within blocks) was estimated from Pearson residuals observed as part of the modelling process in this case.

[8] 2002. Hardin, J and Hilbe, J. Generalized Estimating Equations. Chapman and Hall, CRC Press.

4.4 MODEL SELECTION

Model selection is an important part of the modelling process. A model with too many covariates (or with too many associated parameters) results in an overly complex model with a good fit to the data (low bias) but with high uncertainty regarding model parameters. A low bias/high uncertainty model means that while the predictions to the grid are very close to the observed data, the uncertainty about predictions to this grid, are unnecessarily large. These large associated geo-referenced confidence intervals then make it very difficult to make any general statements based on a model.

The converse situation is a model with high bias but low uncertainty; this describes a model with too few covariates/parameters which is too simplistic and has a poor fit to the data, but has low uncertainty about model parameters and therefore very precise geo-referenced confidence intervals in the associated predictions. These model types are the two extremes of the bias-variance trade off and for this reason a compromise (via the model selection process) is sought between models which are overly complex and models which are too simplistic for the process under study.

Model selection for GEE models can be carried out using AIC analogues for GEEs (e.g. QIC-U) , or BIC analogues (using the quasi-likelihood score) however there is some debate over the correct value for *N* to use in these cases due to the extent of non-independence likely to exist in data of this kind. For this reason, cross-validation (which these scores are designed to emulate) was used to govern the model selection process (details about the cross-validation process can be found in section 4.6).

4.5 SMOOTHING DETAILS

The model terms for the environmental covariates (e.g. the relationship between common seal abundance and time of the day) involved one dimensional smooth functions. The specification of these largely consists of deciding how flexible the function needs to be overall and where in the covariate range this flexibility should be targeted. The spatially adaptive local smoothing algorithm (SALSA[9]) was employed to select the location of the model flexibility for covariate relationships. Quadratic *B*-splines[10] were used to undertake the smoothing for each environmental covariate with quadratic bases (as per Walker *et al*, 2011).

Model specification for the two dimensional smooth function (i.e. the spatial surface) also requires choosing how flexible the surface should be and where on the surface this flexibility should be located. SALSA (implemented in two dimensions) was also used to target the flexibility of the spatially adaptive surface and *K*-fold cross-validation (CV; section 4.6) was used to determine the overall flexibility for the spatial surface (e.g. the degrees of freedom). Cross validation was also used to select the complexity of the environmental covariates. Due to the very low numbers of animals observed between 5 and 15 knots were trialled for the spatial surface; these produce relatively smooth surfaces however, more complicated models were not able to be supported by the data.

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[9] 2011. Walker, C., MacKenzie, M. L., Donovan, C. R.,& O'Sullivan, M. SALSA – A Spatially Adaptive Local Smoothing Algorithm.. Journal of Statistical Computation and Simulation. 81, 2.

[10] 1992., Hastie, T. J. Generalized additive models. Chapter 7 of Statistical Models in Seds J. M. Chambers and T. J. Hastie, Wadsworth & Brooks/Cole

The modelling process used here is recently developed and has been recently used to model the Joint Cetacean Protocol (JCP) which spans over a million km^2 in and around UK waters; http://jncc.defra.gov.uk/page-5657). A comparison with older off-the-shelf methods is also supplied with this report (section 4.6).

4.6 MODEL VALIDATION AND COMPARISON

The model presented in this report was validated using a 5-fold cross validation (CV) scheme. This process involved omitting 20% of the panels specified in the data (the validation set), and refitting the chosen model to the training set (the remaining 80% of the panels). Predictions based on each training set were then compared to the unseen data (the validation set) and the sum of the squared differences between these predictions and the unseen data were then calculated. This validation process was performed 5 times to ensure all data points were omitted at some stage during the process.

The spatially adaptive results presented here were also compared with the more traditional Generalized Additive Models (GAMs). While GAMs ignore the auto-correlation in the model residuals and employ a global smoothing parameter (the flexibility across the whole surface is restricted to be the same) for the spatial surface and each covariate, these provide a comparison for the models presented here. 5-fold cross validation was used as the basis of comparison since these are valid forms of comparison for both types of models fitted.

4.7 POWER ANALYSIS

As a part of this work, the power of the survey and data to detect real change in seal numbers was quantified under a range of scenarios (i.e. detecting the power to detect an overall decline of 10%-50%) in animal numbers. This simulation-based power analysis approach is designed to quantify the power of detecting an 'impact' while addressing the following important features of the survey data:

1) Non-linear model relationships
2) Correlated and/or over dispersed observations
3) Complex spatial distributions of the animals

The power analysis simulation-based process works as follows:

A model for the species distribution (including any environmental covariates) is constructed and this model, that has been developed on historical data, is assumed to hold true for the future monitoring periods, but with a general reduction in relative animal abundance (e.g. attributable to the impact). Simulation data is then generated from this process with noise and autocorrelation properties consistent with the historical recordings. The current modelling process is then applied to the multiple sets of simulation data but additionally estimating an impact effect.

Various sizes of decline in relative numbers are simulated, and detection of a statistically significant impact effect is sought from the models at two time periods of additional monitoring. Sampling at the current rate (or a reduced rate) can also be assumed for this process, should this be desired.

The inherent noise and auto-correlation in the system may mean small impact effects might be difficult to detect over small time-periods, but these effects will become more detectable with more data. Large effects should be detectible sooner. The simulation process allows quantification of the probability of detecting an effect for various effect sizes and periods of additional monitoring.

5 COMMON SEAL RESULTS

Collinearity was considered amongst the candidate covariates and not found to be prohibitively high; the maximum VIF was 2.95. All of the covariates were found to be statistically significant at the 1% level, including the spatial surface term in the model. These relationships are illustrated in Figure 11 and Figure 14 to Figure 17.

Covariate	P-value
s(Easting, Northing, df=12)	<0.0001
s(High Tide Height, df=8)	<0.0001
s(Low Tide Height, df=6)	<0.0001
s(Hour of day, df=6)	<0.0001
Month*	<0.0001
Year*	<0.0001
Tide Code*	<0.0001
Observation Point*	<0.0001

Table 1: Candidate covariates for model selection, where s(x) represents a one dimensional smooth function for x and s(Easting, Northing) represents a two dimensional smooth function for the spatial co-ordinates. The degrees of freedom shown for the smooths were chosen using SALSA.

The covariates listed as s(x) in Table 1 indicate they were trialled using quadratic *B*-splines with the number and location of knots chosen using SALSA[9] and governed by 5-fold cross validation. The covariates labelled with a '*', were fitted as factor variables in the model to permit maximum flexibility for these discrete covariates.

In all cases, potentially overdispersed[11] Poisson errors (with a log link) were assumed and the GEE framework allowed for any autocorrelation observed within gridcode-days. This autocorrelation was identified as being statistically significant[12] and was estimated using the Pearson residuals within each panel (gridcode-day).

[11] The dispersion parameter was estimated to be 2.43

[12] (the runs test returned a test statistic of -184.7996, and a *p*-value=0.0000)

5.1 FITTED DENSITIES OVER TIME

The average density (across the fitted surface, pooled across time) was estimated to be 0.0244 (95% CI: 0.0219, 0.0273) per 100m x 100m grid cell, and monthly estimates for the survey period (for the same grid cells) are shown in Figure 10 and are also supplied as csv file with this report.

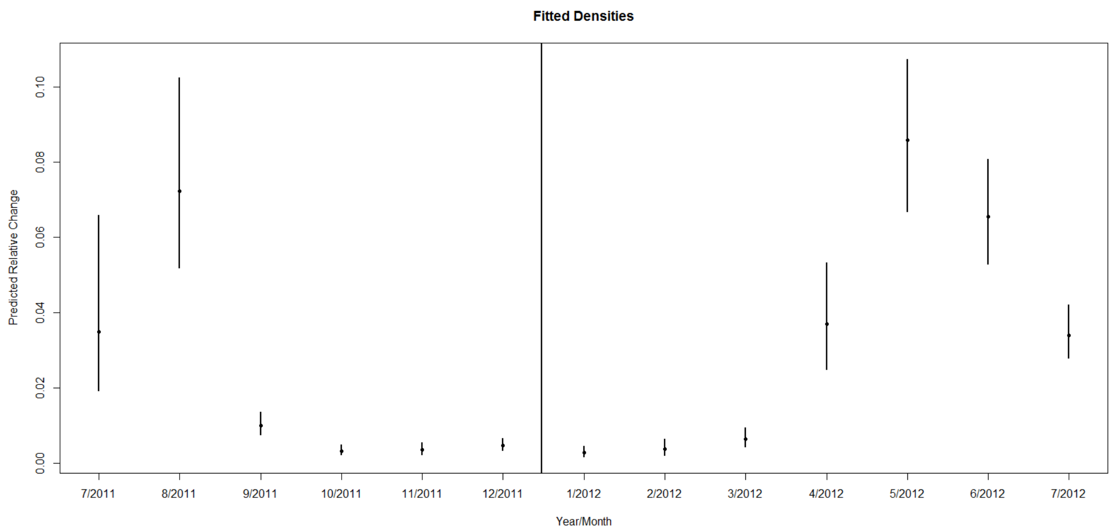

Figure 10: Fitted densities (with upper and lower 95% confidence limits) for the calendar months and years surveyed.

The fitted (relative) densities for common seals given the environmental characteristics observed on the last survey day) are shown in Figure 11 (and these estimates are also supplied with this report) and the model outputs are in close agreement with the input data (Figure 12). Naturally, the point estimates shown in Figure 11 should also be viewed whilst considering the 95% upper and lower confidence limits (Figure 13).

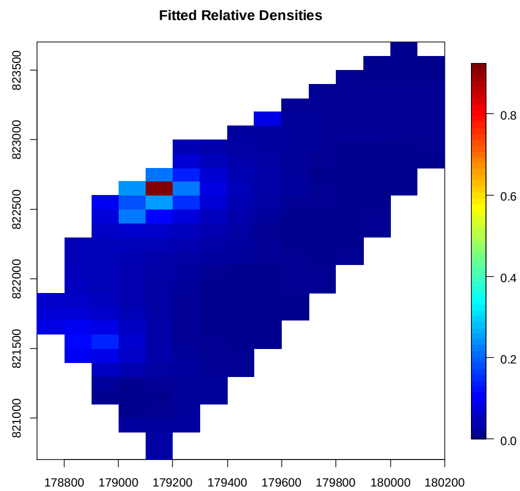

Figure 11: Fitted densities for the prediction grid based on chosen values for the environmental covariates in July 2012.

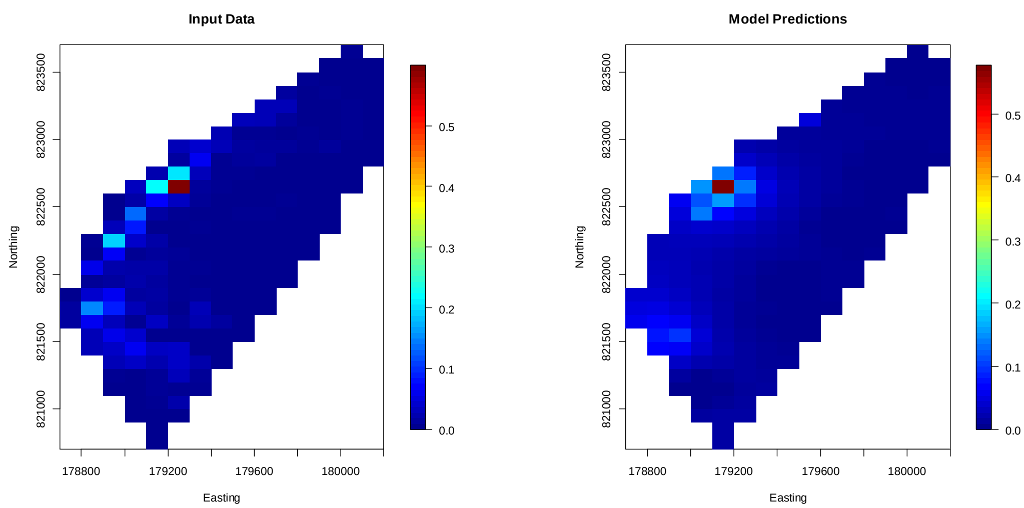

Figure 12: The raw data (input counts) and the fitted densities for the prediction grid averaged over the survey period.

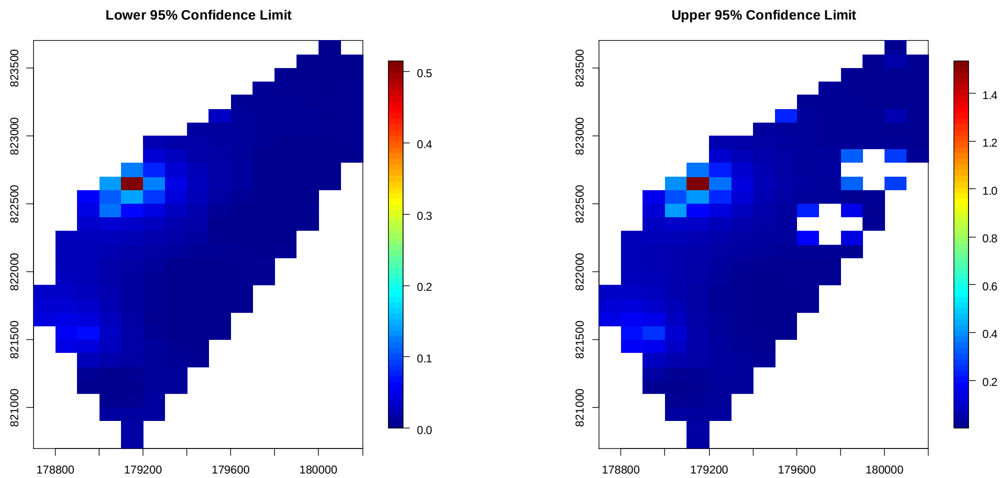

Figure 13: Upper and lower 95% confidence limits for the fitted densities based on chosen values for the environmental covariates in July 2012. Note: the values in the white cells are not shown due to unreasonably high upper values in these locations. This is due to the lack of non-zero values in these cells given their distance from the vantage points. This was not due to an overly complex model; this behaviour was also exhibited with even the simplest models tried.

5.2 ENVIRONMENTAL COVARIATES

Harbour seal numbers appear to increase in the warmer months and fall during winter (Figure 14) and are slightly lower in 2012 compared with 2011 (but not significantly so; see also Figure 14). Seal numbers also appear to cycle with tide codes (Figure 15) and appear to be lower at vantage point 2 (all other things being equal; Figure 16). Seal numbers are also predicted to be higher when daylight levels are good (most likely due to detectability issues) and low tide height is low (Figure 17) however, there is a great deal of uncertainty associated with these relationships.

Weather code was also found to have a statistically significant relationship with the numbers of sighted harbour seals. The variable is not expected a priori to have any biological link to harbour seal sightings and is most likely an artefact through relationships with other covariates. Given its lack of interpretability and small practical contribution to the prediction, it has been excluded.

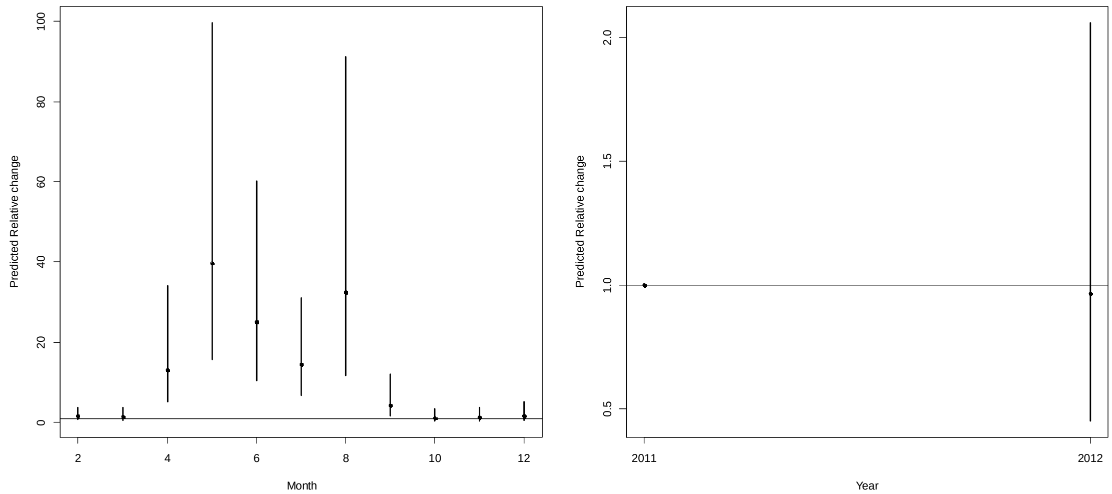

Figure 14: Exponentiated coefficients for Month (reference level: January) and Year (reference level 2011).

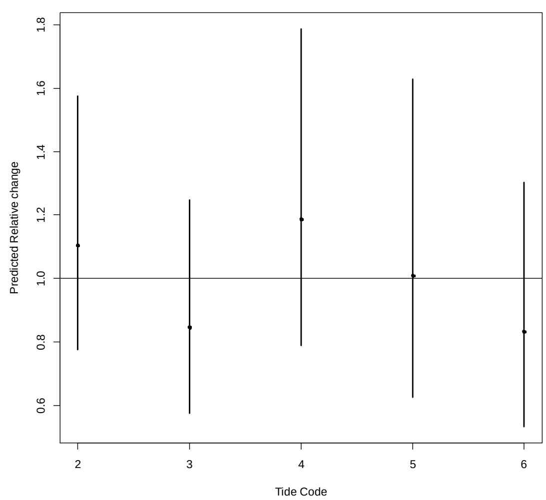

Figure 15: Exponentiated coefficients for Tide code (reference level: 1).

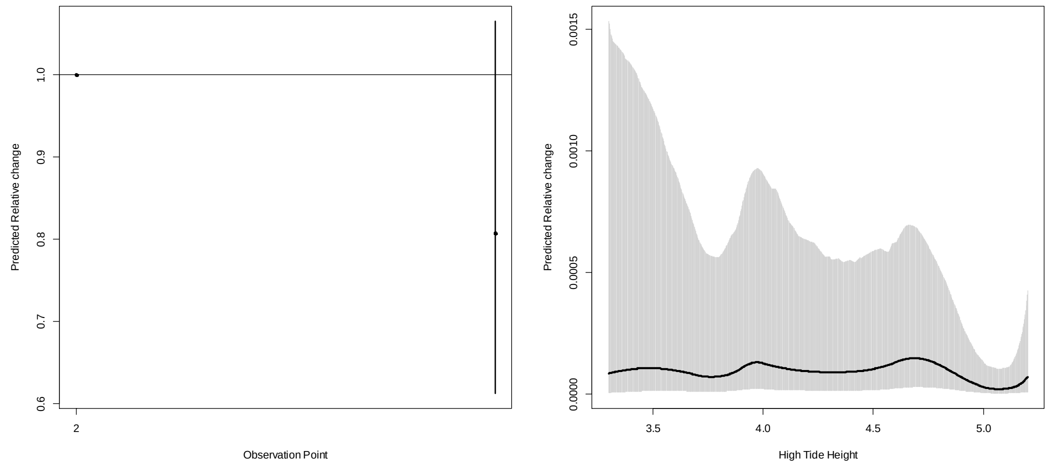

Figure 16: (left) Exponentiated coefficient for the difference between average numbers at vantage point 2 compared with vantage point 1 (all other things in the model being equal). (right) Exponentiated fitted curve (with GEE-based 95% confidence intervals) for the partial relationship between High Tide height and animal numbers.

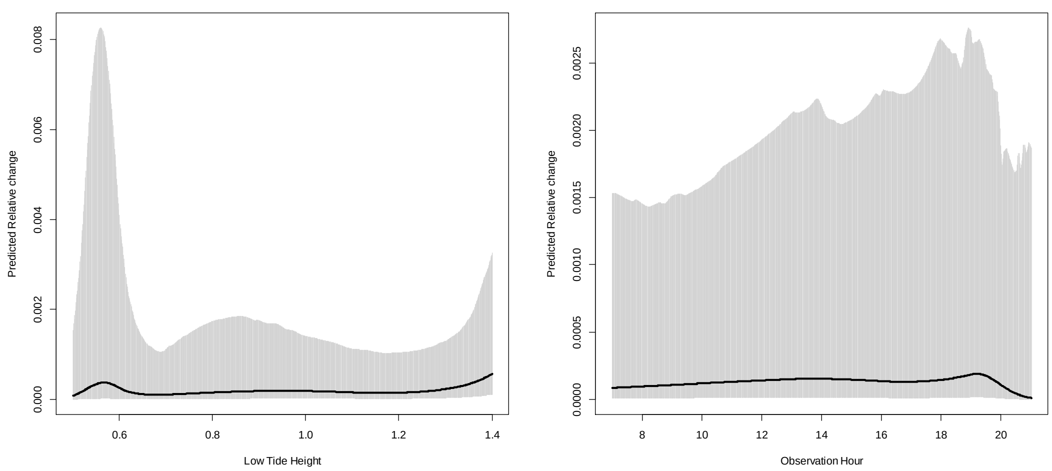

Figure 17: (left) Exponentiated fitted curve (with GEE-based 95% confidence intervals) for the partial relationship between Low Tide height and animal numbers. (right) Exponentiated fitted curve (with GEE-based 95% confidence intervals) for the partial relationship between Hour and animal numbers.

5.3 MODEL VALIDATION AND COMPARISON

5-fold cross validation was employed using both the selected model and the equivalent GAM – which uses a global smoothing parameter (as per the methods description) and the spatially adaptive modelling results presented here resulted in a CV score which was 9.4% better than the equivalent GAM[13].

5.4 POWER ANALYSIS RESULTS

Simulated decline	3 additional Survey months	6 additional Survey months
0%	9.6% (7.3%, 12.5%)	7.8% (5.8%, 10.5%)
10%	24.6% (21.0%, 28.6%)	26.4% (22.7%, 30.4%)
20%	66.4% (62.1%, 70.4%)	68.4% (64.2%, 72.3%)
50%	100%	100%

Table 2: Power analysis results for simulated declines of 0-50% with 3 and 6 additional survey months. Agresti-Coull 95% confidence intervals[14] for the estimated power are also shown.

There is low power to detect change for small declines (10% in relative abundance) but this increases as the percentage decline increases and marginally if the observation time is extended for 6 months (Table 2). Note the 95% confidence intervals between the estimates for power at 3 and 6 months overlap and is therefore statistically indistinct between the two survey scenarios. The results suggest that large declines in animal numbers (e.g. 50%) would be certain to be detected, based on the data collected to date.

[13] The spatially adaptive smooth produced a CV score of 0.147 compared with a MGCV GAM based score of 0.162.

[14] A. Agresti and B.A. Coull (1998), Approximate is better than "exact" for interval estimation of binomial proportions, American Statistician, 52:119-126.

6 GREY SEAL RESULTS

Collinearity was considered amongst the candidate covariates and not found to be prohibitively high; the maximum VIF was 2.407. Seven of the nine covariates were found to be statistically significant at the 5% level, including the spatial surface term in the model. Calendar month could not be fitted in the model due to universally zero counts in some survey months.

The fitted relationships are illustrated in Figure 11 and Figure 14 to Figure 17. For predictive purposes, the term(Low Tide Height) was dropped from the model and the model refitted; all remaining terms were significant at the 5% level in the revised model.

Covariate	*p*-value
s(Easting, Northing, df=12)	<0.0001
s(High Tide Height, df=8)	<0.0001
s(Low Tide Height, df=6)	0.3539
s(Hour of day, df=6)	<0.0001
Year*	<0.0001
Tide Code*	0.02502
Observation Point*	0.02635

Table 3: Candidate covariates for model selection, where s(x) represents a one dimensional smooth function for x and s(Easting, Northing) represents a two dimensional smooth function for the spatial co-ordinates. The degrees of freedom shown for the smooths were chosen using SALSA governed by cross validation.

The covariates listed as s(x) in Table 1 indicate they were trialled using quadratic *B*-splines with the number and location of knots chosen using SALSA[9] and governed by 5-fold cross validation. The covariates labelled with a '*', were fitted as factor variables in the model to permit maximum flexibility for these discrete covariates.

In all cases, potentially under/overdispersed[15] Poisson errors (with a log link) were assumed and the GEE framework allowed for any autocorrelation observed within gridcode-days. This autocorrelation was identified as being statistically significant[16] and was estimated using the Pearson residuals within each panel (gridcode-day).

[15] The dispersion parameter was estimated to be less than one (0.7314)

[16] (the runs test returned a test statistic of -209.2417 and a p-value=0.0000)

6.1 FITTED DENSITIES OVER TIME

The average density (across the fitted surface, pooled across time) was estimated to be 0.00603495 (95% CI: 0.005327419, 0.006858725) per 100m x 100m grid cell, and yearly estimates for the survey period (for the same grid cells) are shown in Figure 18 and are also supplied as a csv file with this report.

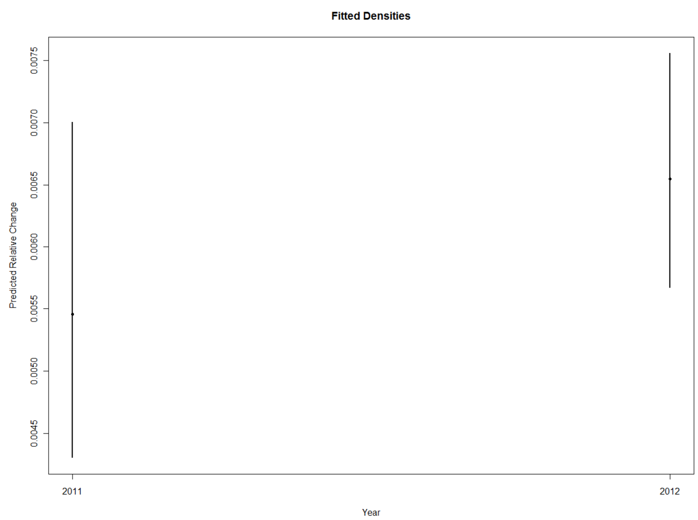

Figure 18: Fitted densities (with upper and lower 95% confidence limits) for the calendar years surveyed.

The fitted (relative) densities for grey seals given the environmental characteristics observed on the last survey day) are shown in Figure 19 (and these estimates are also supplied with this report) and the model outputs are in close agreement with the input data (Figure 20). As for the harbour seal results, the point estimates shown in Figure 11 should also be viewed whilst considering the 95% upper and lower confidence limits (Figure 21).

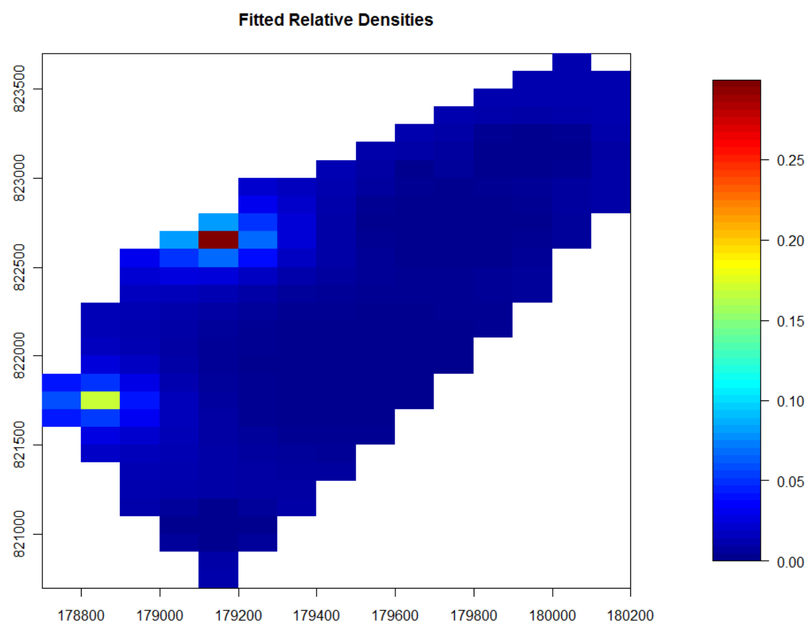

Figure 19: Fitted densities for the prediction grid based on chosen values for the environmental covariates in July 2012.

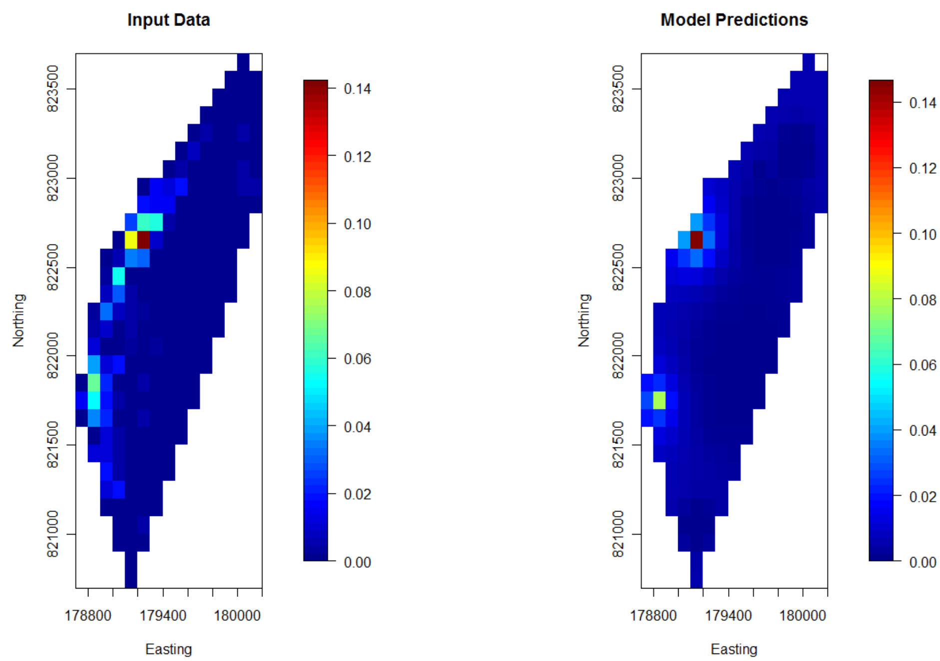

Figure 20: The raw data (input counts) and the fitted densities for the prediction grid averaged over the survey period.

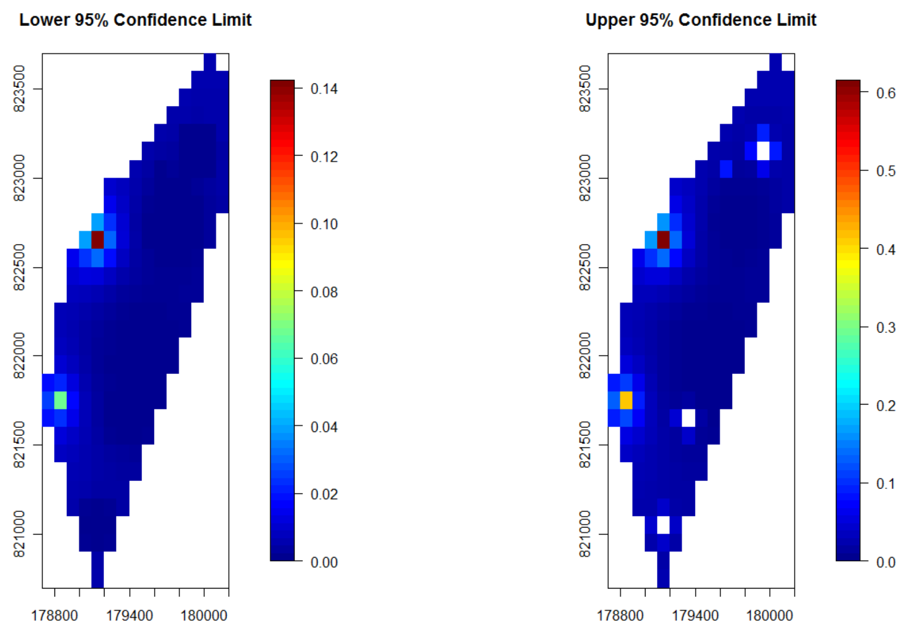

Figure 21: Upper and lower 95% confidence limits for the fitted densities based on chosen values for the environmental covariates in July 2012. Note: the values in the white cells are not shown due to unreasonably high upper values in these locations. This is due to the lack of non-zero values in these cells given their distance from the vantage points. This was not due to an overly complex model; this behaviour was also exhibited with even the simplest models tried.

6.2 ENVIRONMENTAL COVARIATES

Grey seal numbers appear to have fallen slightly in 2012 (but not significantly so; Figure 22) and average numbers appear to decrease as Tide code increases (Figure 22). Average numbers appear to be higher at vantage point 2 (all other things being equal; Figure 23) and appear to be higher at moderate tide heights. While there is a great deal of uncertainty associated with these relationships, there does seem to be higher average numbers in the early afternoon and before nightfall (Figure 24).

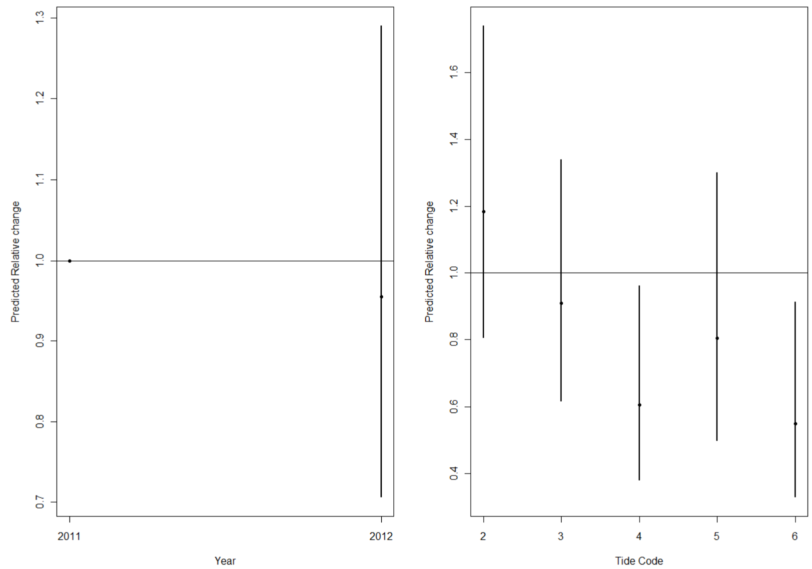

Figure 22: Exponentiated coefficients for Year (reference level 2011) and Tide Code (reference level 1).

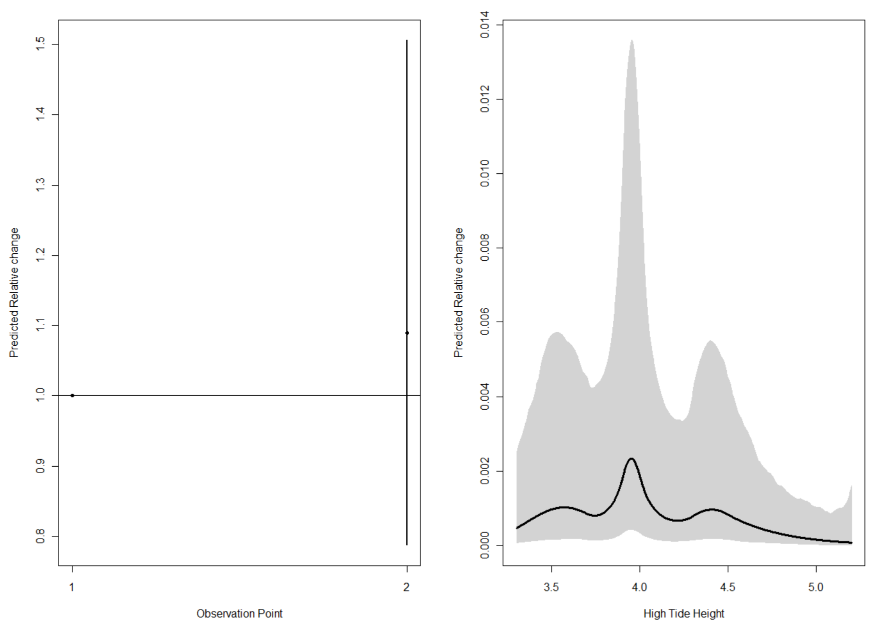

Figure 23: (left) Exponentiated coefficient for the difference between average numbers at vantage point 2 compared with vantage point 1 (all other things in the model being equal). (right) Exponentiated fitted curve (with GEE-based 95% confidence intervals) for the partial relationship between High Tide height and animal numbers.

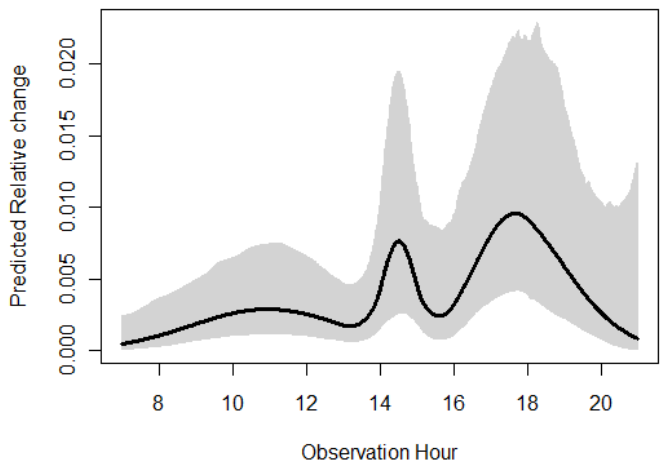

Figure 24: Exponentiated fitted curve (with GEE-based 95% confidence intervals) for the partial relationship between observation hour and animal numbers

6.3 MODEL VALIDATION AND COMPARISON

5-fold cross validation was employed using both the selected model and the equivalent GAM – which uses a global smoothing parameter (as per the methods description) and the spatially adaptive modelling results presented here resulted in a CV score which was 7.4% better than the equivalent GAM[17].

6.4 POWER ANALYSIS RESULTS

Simulated decline	3 additional Survey months	6 additional Survey months
0%	5.4% (3.7%, 7.8%)	6.2% (4.4%,8.7%)
10%	15.8% (12.9%, 19.3%)	13.6% (10.9%, 16.9%)
20%	42.6% (38.3%, 47.0%)	39.6% (35.4%, 44.0%)
50%	99.4%(98.2%, 99.9%)	99.8% (98.8%,100.0%)

Table 4: Power analysis results for simulated declines of 0-50% with 3 and 6 additional survey months. Agresti-Coull 95% confidence intervals[18] for the estimated power are also shown.

There is low power to detect change for small declines (10% in relative abundance) but the power increases as the percentage decline increases. There is no significant difference between the power results obtained at additional observation times of 3 or 6 months (Table 2) and the power is still low (<50%) for even reasonable declines (e.g. 20%). The results suggest that large declines in animal numbers (e.g. 50%) would be almost certain to be detected, based on the data collected to date.

[17] The spatially adaptive smooth produced a CV score of 0.01303406 compared with a MGCV GAM based score of 0.01407516.

[18] A. Agresti and B.A. Coull (1998), Approximate is better than "exact" for interval estimation of binomial proportions, American Statistician, 52:119-126.

7 DISCUSSION

Statistical analysis was conducted on the first year of visual observer data for the Kyle Rhea tidal turbine site. Models of seal density for both species with respect to space and collected covariates were developed, along with subsequent power analyses.

Harbour and grey seals were available in sufficient numbers to develop useful spatial models. However, the scarcity of harbour porpoise sightings to date suggests useful models of porpoise distribution will not be possible in the medium term. Similarly, power analyses cannot be conducted for harbour porpoise – but it is clear that the power to detect changes in the underlying process of such rare events will be very low.

Spatial models at 100mx100m resolution were able to be fitted to the harbour and grey seal data, which demonstrated both clear areas of high activity and a general near-shore tendency. The precision for the spatial density estimates of harbour and grey seals was reasonably good, as evidenced by the generally close agreement of the upper and lower confidence surfaces. Obvious temporal and spatial autocorrelation was accounted for in the fitting process, so inferences about the density model are expected to be good, as opposed to the naïve approaches frequently employed for this type of data.

The figures presented here are necessarily relative densities and we are not in a position to generate absolute numbers on the basis of these data. In particular, perception bias i.e. the probability of detecting animals on the surface from the observation points, which clearly decreases with distance, is difficult to determine from these data. If the visual observation points were to be simultaneously occupied for some period of time (with some design considerations) then detection functions for the positions & observers could be developed. Further adjustments for availability bias (i.e. an inability to detect animals underwater) could then be made to arrive at absolute numbers. Nonetheless, changes can still be detected on the basis of relative numbers.

The power to detect changes in the numbers of observable seals on the water was investigated by simulation. The scenarios considered were general decreases over the study area of varying sizes. There were fewer grey seals than harbour seals, and thus the power to detect change was lower for this species (compared with harbour seals) even despite the lower variability in the input data. Large decreases (e.g. a halving of numbers) are certainly detectable in a short period of time. More modest declines of 20% have a good chance of being detected in the short term. Decreases of 10% or less do not have good odds of being detected under this monitoring regime, in the short term. The power investigations here do not consider a spatial redistribution over the survey area, but only scenarios of lower numbers within the survey area, for example a partial relocation of the local seal population.

Kyle Rhea Tidal Stream Array

Appendix 12.4

Report to Royal Haskoning on the marine mammal species and basking sharks occurring in the Kylerhea study region.

By

Hebridean Whale and Dolphin Trust

Contents

Summary

Background

The productive waters off the west coast of Scotland support a wide variety of marine species, both of warm and cold oceans. Twenty-four species of cetacean have been recorded in these waters and for seal species (grey and common) and basking sharks these waters are too important. The area has one of the highest densities of harbour porpoise in Europe (SCANS-II, 2008; Evans and Wang, 2008), it is home to one of the UK's three resident populations of bottlenose dolphins and a resident population of killer whales.

This report identifies areas of importance for cetacean, seal and basking shark species in the Kylerhea study region and discusses their significance both within a local context, and within the context of the west coast of Scotland as a whole. The Kylerhea study region has been defined in this report as 57°28 - 56°56'N, 5°19 - 6°6'W. Visual and acoustic line-transect data collected from HWDT's survey vessel *Silurian* between 2003 and 2011 have been analysed for this report.

Main Findings

- Visual and acoustic data indicated relatively high sighting densities of harbour porpoise throughout the Kylerhea study region. The highest densities were found in the Sound of Sleat and the Inner Sound.

- Sighting densities of seal species within the Kylerhea study region were also relatively high with the highest sighting densities occurring closest to land although concentrations dispersed across the study region between July and September.

- The highest sighting densities of odontocete species in the Kylerhea study region were found in the Sound of Raasay. Sightings of these species were also found in the Sound of Sleat and in Loch Carron.

- Sightings of balaenoptera species occurred between July and September with most of the sightings occurring in the southern area of the Kylerhea study region. The highest sighting density however, was found in the northern area of the study region.

- There was only one sighting of basking shark in the study region resulting in a low sighting density.

Conclusions

- The Kylerhea study region contains important habitat for harbour porpoise. The Sound of Sleat was identified as an area of particular importance and has been previously identified as a key area for harbour porpoise on the west coast of Scotland (Embling et al. 2010 and Booth 2010). The passage of Kylerhea likely acts as an important corridor between the Sound of Sleat and the neighbouring high density area of the Inner Sound.

- The relatively high sighting densities of common seal and the presence of grey seal in the study region are consistent with the seal count data collected within the region (SMRU 2001) suggesting that the Kylerhea study region is an important area for UK seal species. The study region has previously been identified as hosting a high density of the Scottish population of common seals.

- Although sightings of odontocete species were low within the Kylerhea study region, it is probable that the Sound of Sleat, Kylerhea passage and the Sound of Raasay serve as important "corridors" between core habitats for the wide ranging Inner Hebridean bottlenose dolphin community.

Introduction

The Hebridean Whale and Dolphin Trust (HWDT) is dedicated to enhancing the knowledge and understanding of Scotland's whales, dolphins and porpoises (cetaceans) and the Hebridean marine environment through education, research, training and working within local communities as a basis for the lasting conservation of local species and habitats. Specifically, HWDT conducts long-term monitoring of cetacean abundance, distribution and habitat use, engages a wide range of people in marine environmental education through hands-on, outdoor learning experiences and provides local communities with volunteering and training opportunities to promote sustainable management of marine resources.

The aim of HWDT's monitoring work is to provide those who manage Scotland's marine wildlife and habitats with the information necessary to construct effective management strategies. The primary emphasis of this monitoring is the study of the distribution and relative density patterns of marine species (specifically marine mammals and basking sharks) and how these may change over time.

Since 2003, monitoring surveys have been conducted from HWDT's research vessel *Silurian*¸ an 18m motor-sailor vessel, specifically adapted for marine research. Survey coverage spans the entire west coast of Scotland from the Mull of Kintyre in the south, to Cape Wrath in the north and to St Kilda in the west (Figure 1).

Other monitoring activities include maintaining a Community Sightings and Strandings Programme for the west coast of Scotland, maintaining local tour operator's datasets and maintaining photo-identification catalogues for local populations of minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcinus orca*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), Risso's dolphin (*Grampus griseus*), common dolphin (*Delphinus delphis*) and basking shark (*Cetorhinus maximus*).

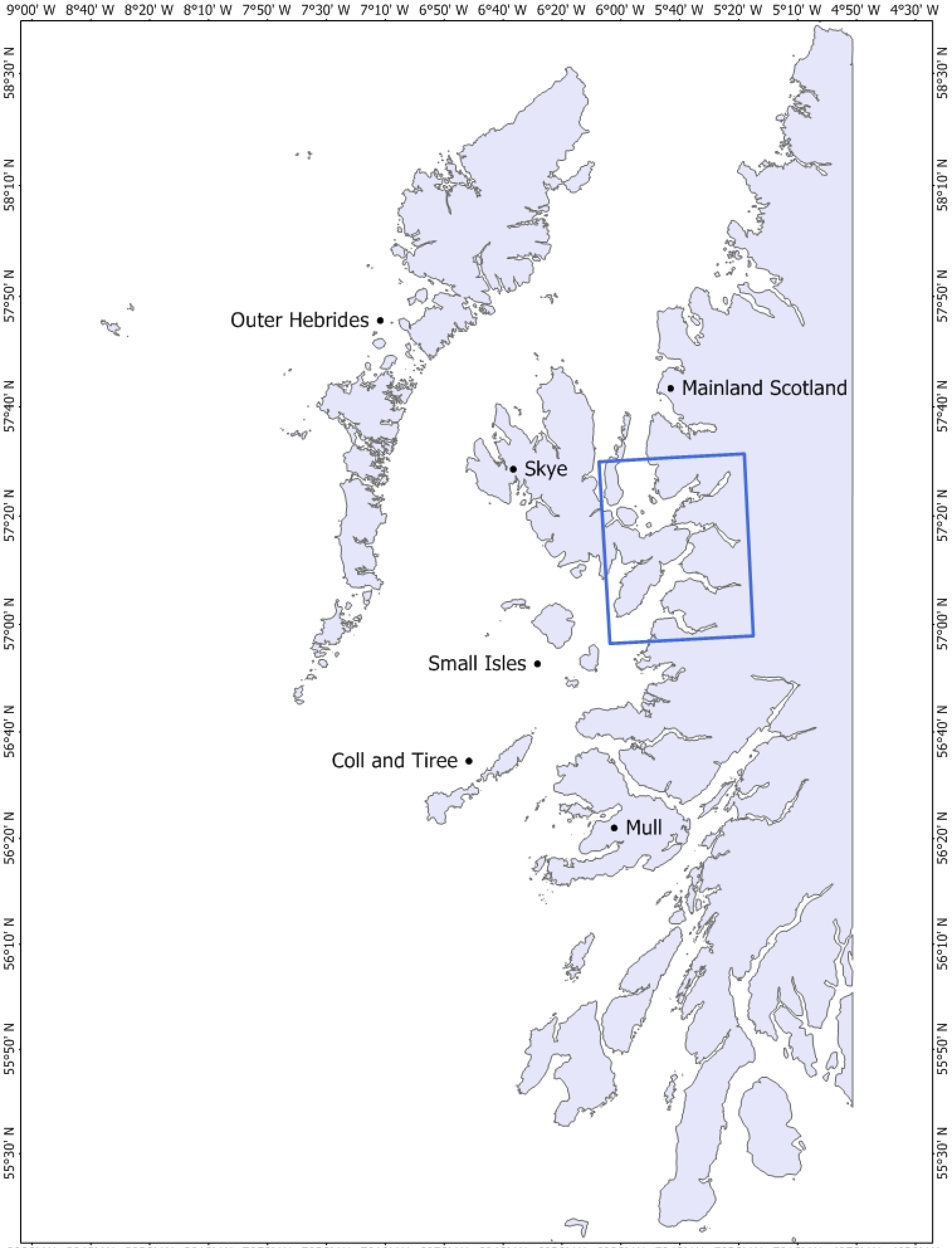

Figure 1: Map of west coast Scotland and survey area (blue box) for HWDT visual and acoustic surveys

Projection: Mercator
Latitude (Centre): 56°58'44" N
Longitude (Centre): 6°44'05" W

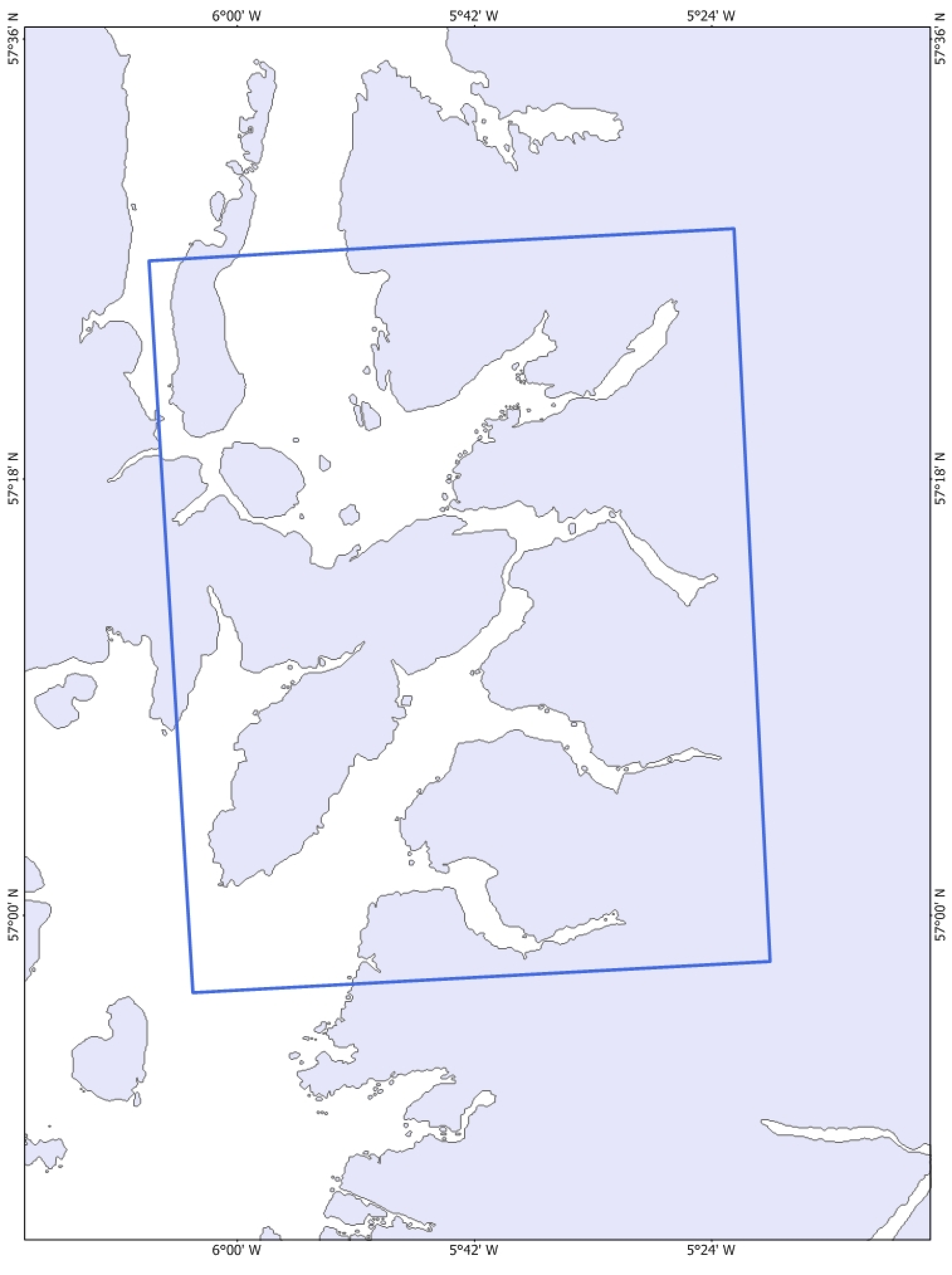

Figure 2: Study region for the Kylerhea analysis (blue box).

Projection: Mercator
Lat (Centre): 57°11'39" N
Lon (Centre): 5°41'47" W

Species review

The waters off western Scotland provide an oceanographically diverse environment that is able to support a high species diversity of marine megafauna (Booth 2010). Twenty-four species of cetacean have been recorded in west Scottish waters. The region comprises complex coastlines, complex submarine topography and a range of physical processes influence the coastal marine environment (Booth 2010). The North Atlantic Drift; relatively warm, saline water coming in from the Atlantic, Arctic waters; relatively cold south moving water, and Irish Sea coastal currents; cold, relatively fresh water moving north from the Irish Sea combine (an effect of the Gulf Stream) to provide an environment in which species typical of both warm and cold oceans can occur (Ellet, 1979).

The most commonly sighted marine species in the study area are the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin, common dolphin, minke whale, Risso's dolphin, white-beaked dolphin, killer whale, grey seal (*Halichoerus grypus*), common seal (*Phoca vitulina*) and basking shark (Shrimpton and Parsons 2000).

Harbour porpoise

The harbour porpoise is the most commonly recorded cetacean species off the west coast of Scotland and the shelf waters around the Hebrides hold one of the highest densities of harbour porpoises in Europe (SCANS-II; Evans and Wang 2008). Although year-round data are sparse from this area, harbour porpoise have been recorded in every month of the year (Reid et al. 2003). Due to their small size, small group sizes and shy surface nature harbour porpoise have lower detection rates than other cetacean species during visual surveys. Harbour porpoise may also change surfacing patterns in higher sea states; eliciting a behavioural response that too reduces detectability (Palka 1996 from Embling). Acoustic surveys offer an alternative method for the detection of harbour porpoise whereby irrespective of size, surface behaviour and environmental conditions, data can be collected. Harbour porpoise have been recorded, visually and acoustically, throughout the HWDT survey area, particularly in coastal areas (Figures 3 and 4). Previous research using data collected by HWDT have identified the following regions as areas of importance (high density) to harbour porpoise: the Sound of Jura, the Firth of Lorne, between Mull and the Treshnish Islands, the Small Isles (Rum, Eigg and Muck) and the Sound of Sleat (between Skye and the mainland).

Bottlenose dolphin

Bottlenose dolphins using the Scottish west coast appear to belong to two discrete parapatric communities, one of which appears to be confined to the waters around the Sound of Barra whereas the other ranges much more widely throughout the Inner Hebrides and mainland coasts (Thompson et al. 2011). 18 individuals from the Barra group have been catalogued and 35 from the Inner Hebridean group. There is no evidence to suggest mixing between these two groups. In addition to the apparent segregation of these two groups, there appears to be a degree of latitudinal partitioning amongst dolphins using the Inner Hebrides. Some animals have been recorded travelling further north and the majority appear to range further south. However, these animals have not occurred exclusively in separate schools, and all Inner Hebridean dolphins have been seen together at some point with the greatest degree of mixing occurring around the Sound of Mull. Due to the low number of individuals in each of these communities and the wide-ranging behaviour of the Inner Hebridean group, sighting rates and acoustic detections of this species are low during *Silurian* surveys.

Sightings of bottlenose dolphin onboard *Silurian* appear to be most frequent in the Sound of Barra and around the islands of Mull and Tiree. (Figure 5, red points). The vast majority of sightings are within close proximity to the coast.

Other odontocete species

Other species of odontocete occurring off the west coast of Scotland include common dolphin, Risso's dolphin, white-beaked dolphin, killer whale and Atlantic white-sided dolphin (*Lagenorhynchus acutus*). Of these, the most frequently sighted species are the common and white-beaked dolphin. Common dolphin sightings are widespread throughout the west coast of Scotland (Figure 5, yellow points) and most sightings of these species occur between May and September; common dolphins being seasonal visitors to the west coast of Scotland. White-beaked dolphins are typically found in open waters (Figure 5, purple points). HWDT research has identified three areas of importance (high-use habitats) for white-beaked dolphins; these are the South west of the Outer Hebrides, west of the Isle of Lewis and the northern Minch (Harries et al. 2012).

Balaenoptera species

The minke whale is the most commonly occurring whale species on the west coast of Scotland and is the most abundant within the European Union; an estimated 60% of Europe's minke whales are found in UK waters (UKBAP, 2008 ref below). Minke whale sightings are

frequent and widespread from May to October in west Scottish waters. Outside these months sightings are fewer and little is known about their winter distribution. The minke whale shows seasonal site fidelity to summer feeding grounds (Anderwald, 2012) and HWDT photo-identification studies have shown that many individuals are seasonally resident in the Hebrides, with some returning year after year to the same feeding grounds (Gill et al. 2000). The highest density of minke whale sightings on the west coast of Scotland occur in the Inner Hebrides, between Coll and the Small Isles, including the north and west coast of Mull, the south east coast of the Outer Hebrides and west of the Isle of Skye (Figure 6, green points). Over recent years, there have been fewer minke whale sightings in core survey areas (the Argyll areas). HWDT research has suggested a change in the availability of the small schooling fish on which they feed as a potential cause for these changes.
Other baleen species recorded occasionally in the waters off the west coast of Scotland are the humpback whale (*Megaptera novaeangliae*) and the fin whale (*Balaenoptera physalus*) although sightings of these species are rare (Figure 6, pink points).

Basking shark

Basking sharks are widely distributed in coastal waters on the continental shelves of temperate zones in both the northern and southern hemispheres. Research has shown some broad site fidelity to productive continental-shelf habitats like the North-east Atlantic (Southall et al. 2006). In west Scottish waters, basking sharks are frequently encountered between May and October. Two areas where significant numbers of sharks can be seen at the surface, on a regular basis (high-use habitat), have been identified; the islands of Hyskeir and Canna in the Sea of the Hebrides, and the island of Coll in the Inner Hebrides (Speedie et al. 2009). Other areas of high sighting rates include the waters off the west coast of Mull, around the Treshnish Isles and the south east coast of the Outer Hebrides (Figure 7).

Seals

There are two species of seal in the UK; the grey (*Halichoerus grypus*) and the common or harbour seal (*Phoca vitulina*). Population studies estimate that just under half of the world's grey seals live in the waters around the UK and 90% of the UK population of grey seals breed in Scotland (SMRU report 2001) The breeding colonies for grey seals in the Hebrides are amongst the largest in the UK. Grey seals spend most of the year at sea, and may range widely in search of prey.

85% of the UK population of common seals breed in Scotland. The distribution of this species is more coastal than that of the grey seal and this species can often be seen in estuaries, river mouths and even in more upstream waters. The common seal population is undergoing an unprecedented decline in some areas of Scotland of which the reasons are unknown. The Outer Hebrides population of common seals have decreased by 35% in recent years.

Areas of importance to grey seal include the colonies on the Treshnish Isles and the Monach Islands. Important sites for common seals include the Island of Lismore, the skerries and coastline of south east Islay, and the northwest coast of Skye (Figure 8).

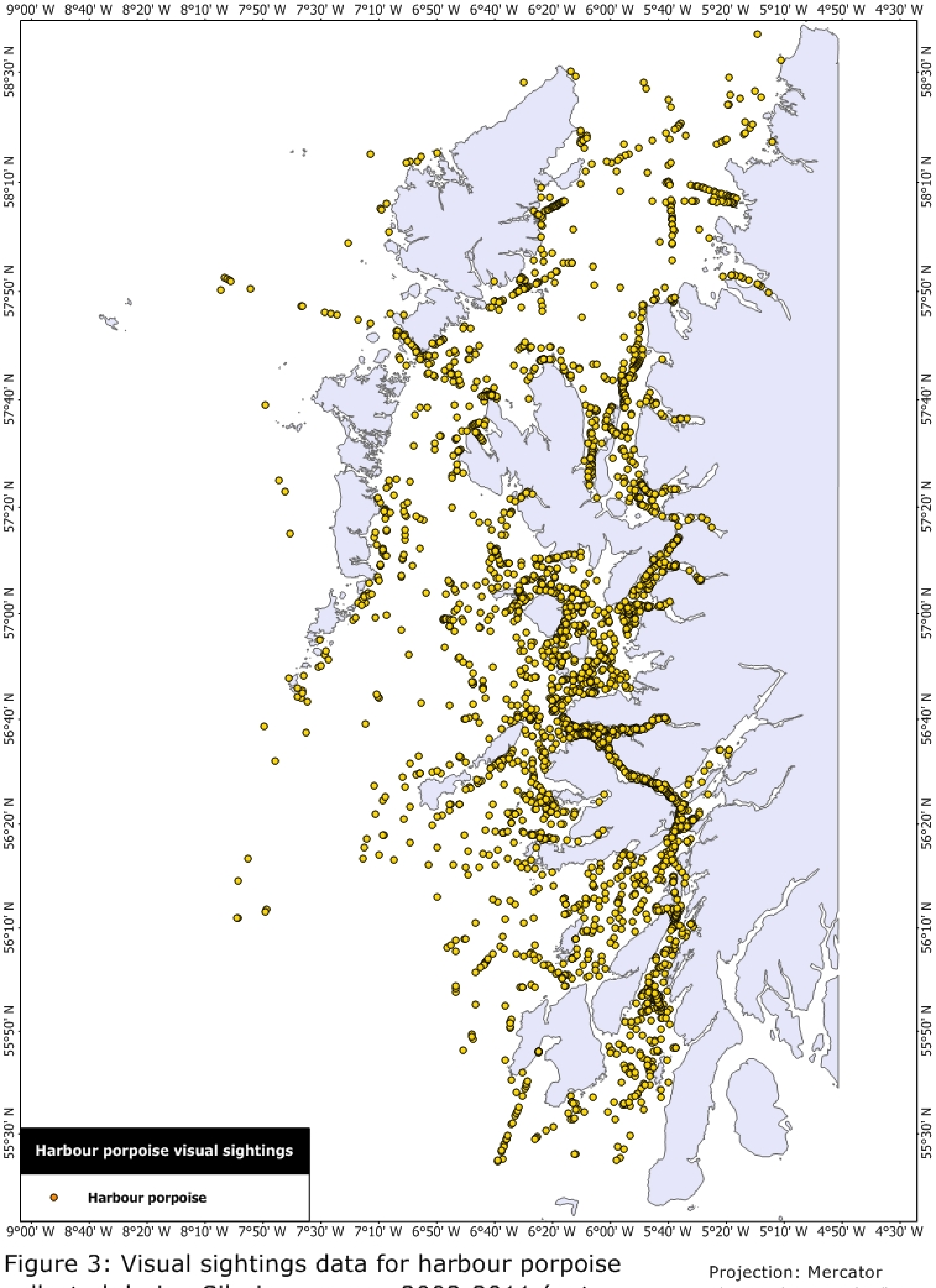

Figure 3: Visual sightings data for harbour porpoise collected during Silurian surveys 2003-2011 (not corrected for effort)

Projection: Mercator
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Lon (Centre): 6°44'05" W

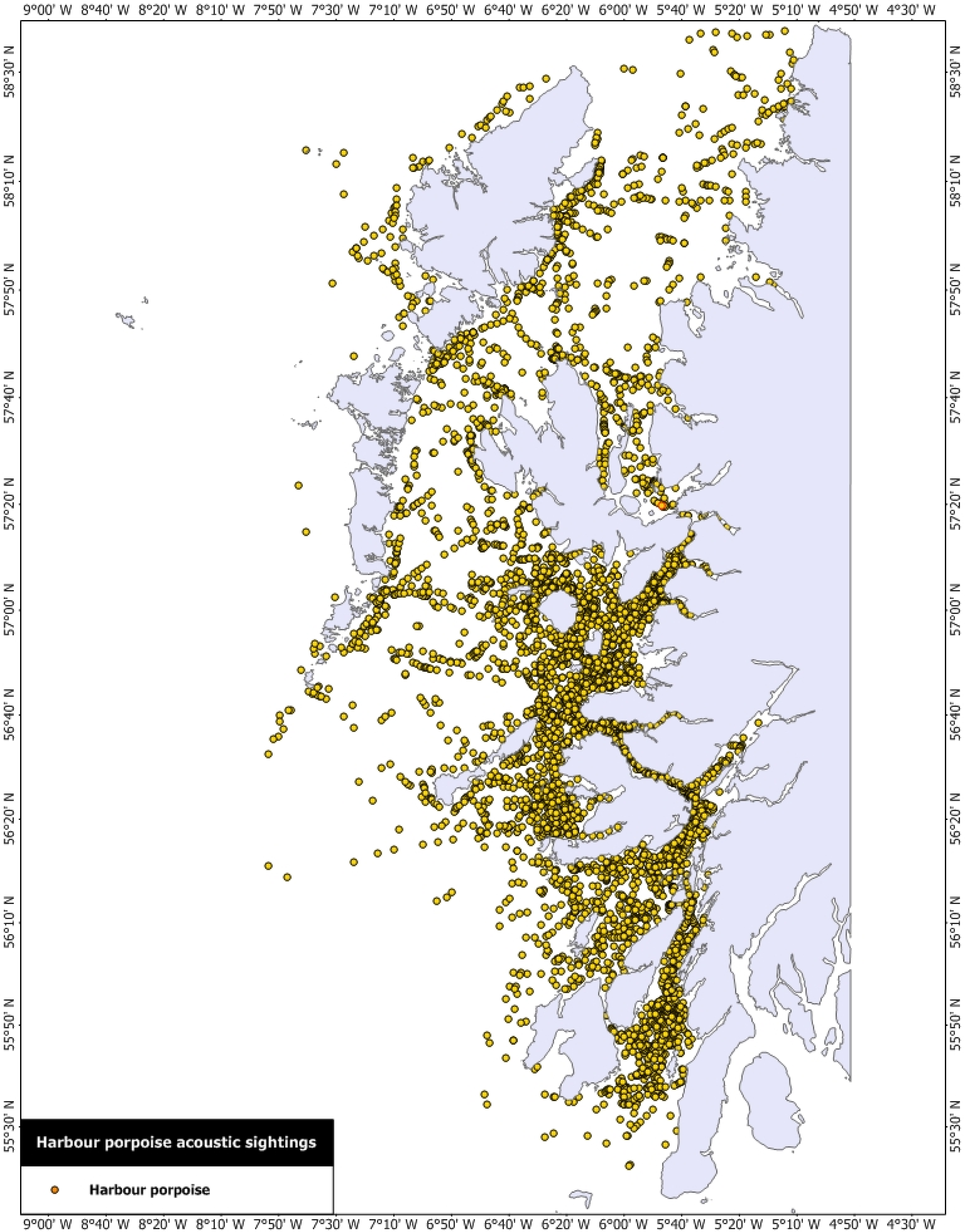

Figure 4: Acoustic detections data for harbour porpoise collected during Silurian surveys 2004-2011 (not corrected for effort)

Projection: Mercator
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Lon (Centre): 6°44'05" W

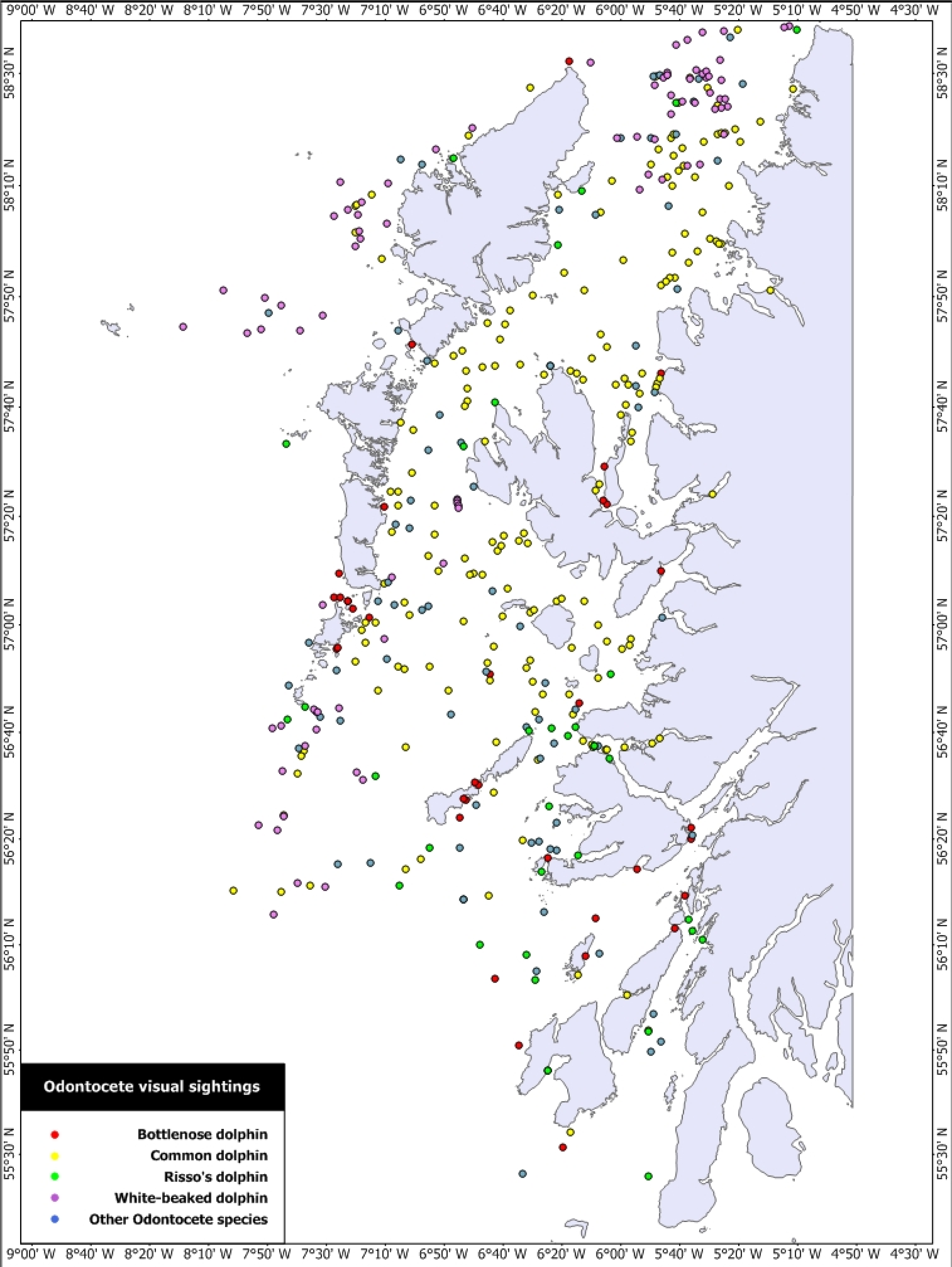

Figure 5: Visual sightings data for all odontocete species collected during Silurian surveys 2003-2011 (not corrected for effort)

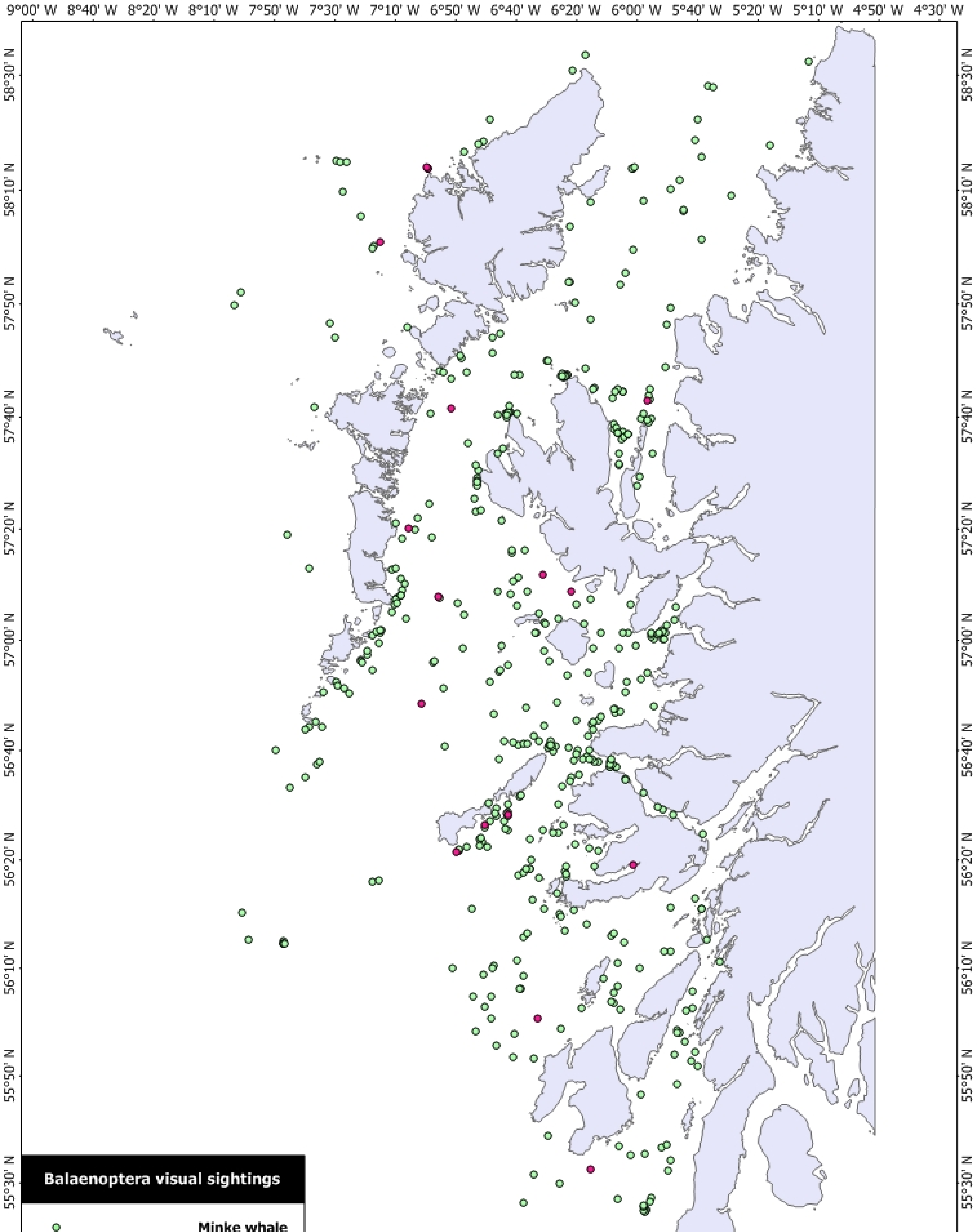

Figure 6: Visual sightings data for all balaenoptera species collected during Silurian surveys 2003-2011 (not corrected for effort)

Projection: Mercator
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Lon (Centre): 6°44'05" W

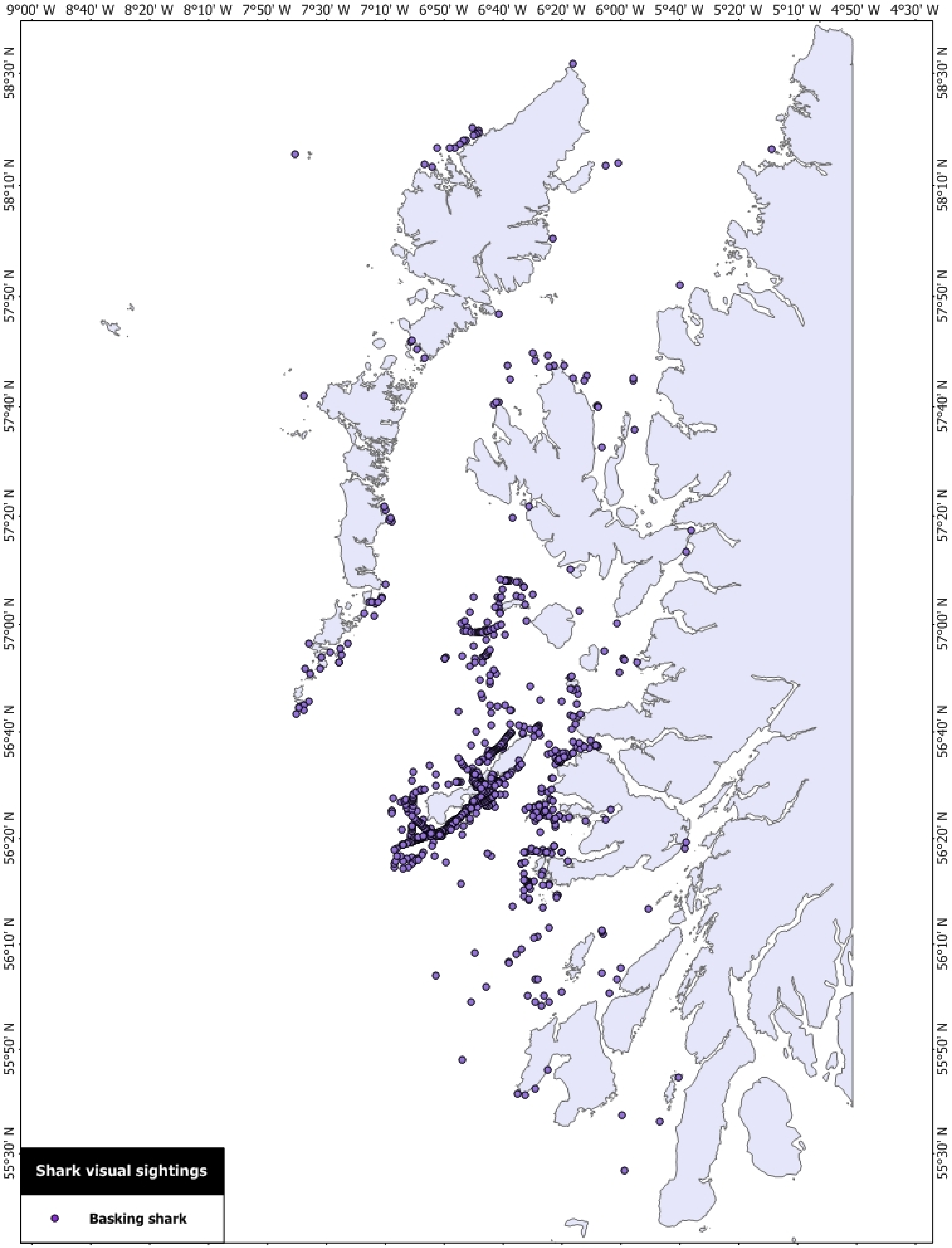

Figure 7: Visual sightings data for all shark species collected during Silurian surveys 2003-2011 (not corrected for effort)

Projection: Mercator
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Lon (Centre): 6°44'05" W

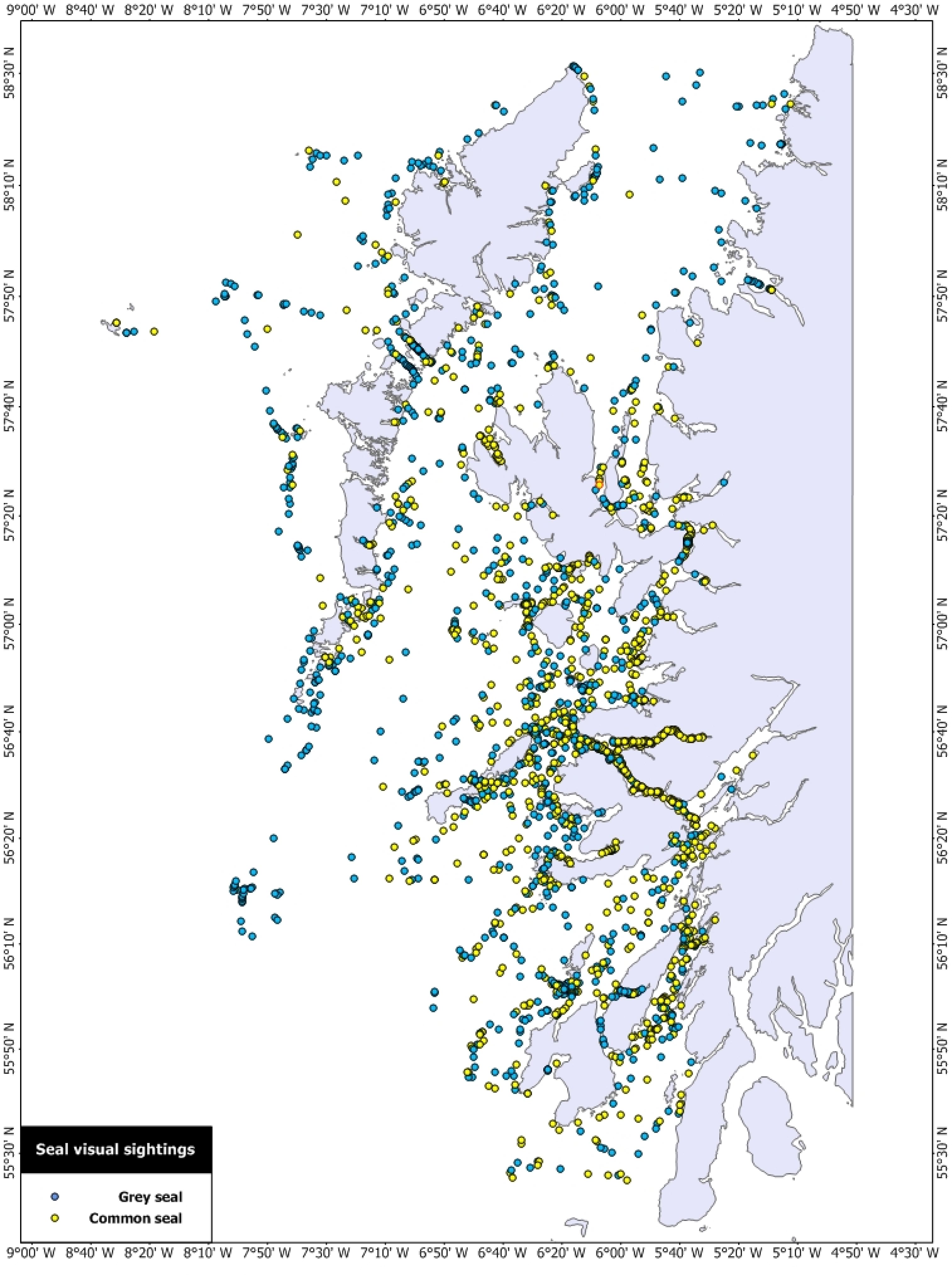

Figure 8: Visual sightings data for all seal species collected during Silurian surveys 2003-2011 (not corrected for effort)

Projection: Mercator
Lat (Centre): 56°58'44" N
Lon (Centre): 6°44'05" W

Methods

Visual and acoustic surveys were conducted from the HWDT research vessel *Silurian* on the west coast of Scotland (55° 10' – 58° 40' N, 5° 0' – 8° 35' W; Figure 1), between April and October (inclusive) during daylight hours. Visual surveys were carried out from 2003 to 2011 (Figure 9) and towed-array acoustic surveys were conducted simultaneously during the 2004 to 2011 seasons (Figure 10). In the 2003 and 2004 seasons, surveys were focused on the waters around the islands of Mull, Islay and Jura (55°10' – 57° 0' N, 5° 30' – 6° 50' W) and they gradually extended further north and west during 2005-2011. Every month at least one 10-day survey was designed and conducted to provide near even coverage of the core area investigated in 2003-2004 and every season, from 2007 onwards, two 10-day surveys were conducted from Kyle of Lochalsh to allow access to the more northern and western parts of the survey area. The constraints of the weather and finding suitable anchorages at night were considered when designing and executing these surveys.

Sightings of dolphin, whale, porpoise, seal species and basking shark were recorded during systematic line transect surveys. Towed hydrophones and an acoustic monitoring system were used to detect small cetaceans acoustically, with the most useful data being collected for harbour porpoise.

This analysis focused on a core region around Kylerhea (57°28 - 56°56’N, 5°19 - 6°6’W; Figure 2). Visual and acoustic survey tracks completed in this region can be seen in Figures 11 and 12, respectively.

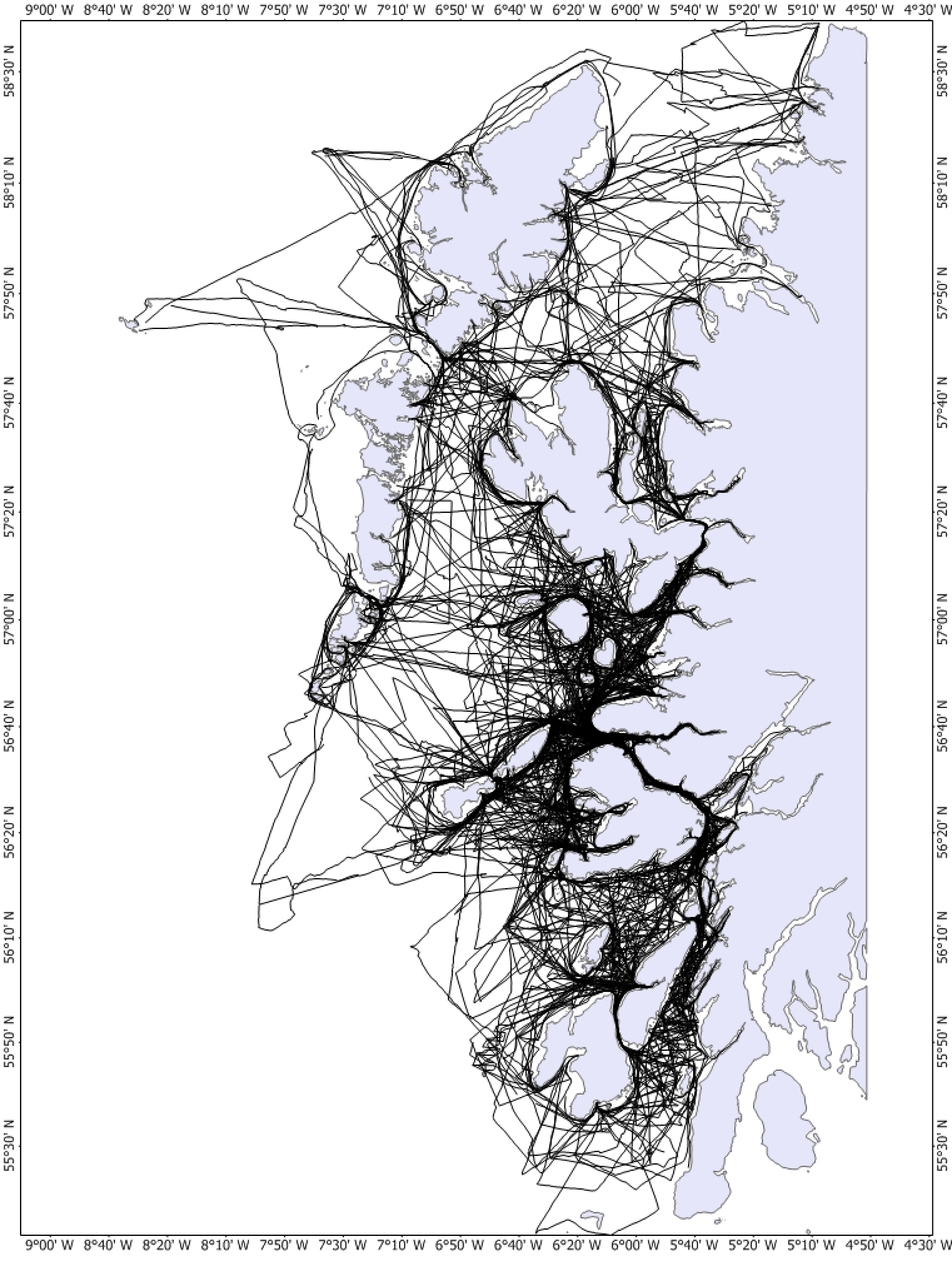

Figure 9: Map of HWDT visual survey tracks in the study area between 2003 and 2011.

Projection: Mercator
Latitude (Centre): 56°58'37" N
Longitude (Centre): 6°49'01" W

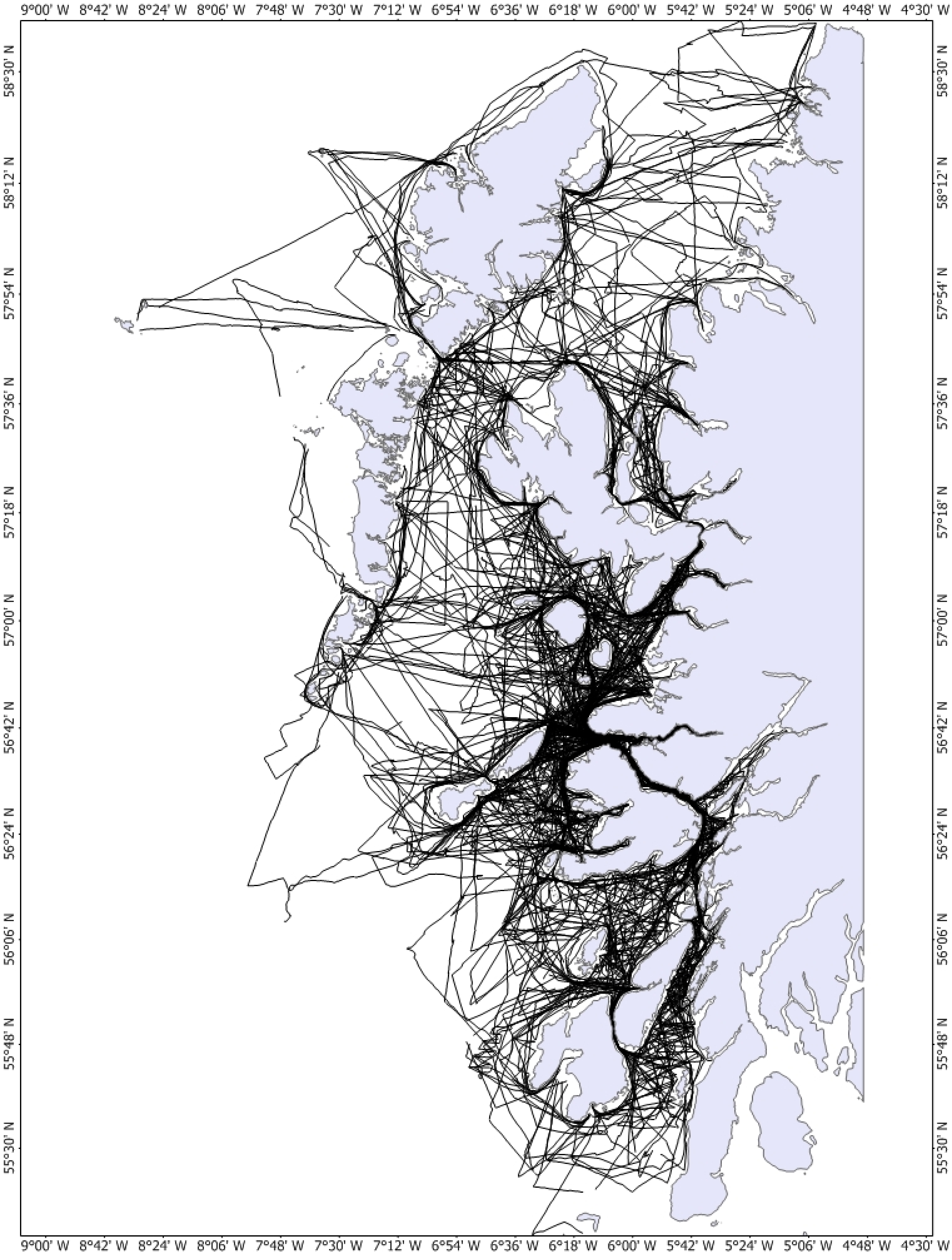

Figure 10: Map of HWDT acoustic survey tracks in the study area between 2004 and 2011.

Projection: Mercator
Latitude (Centre): 56°58'45" N
Longitude (Centre): 6°47'51" W

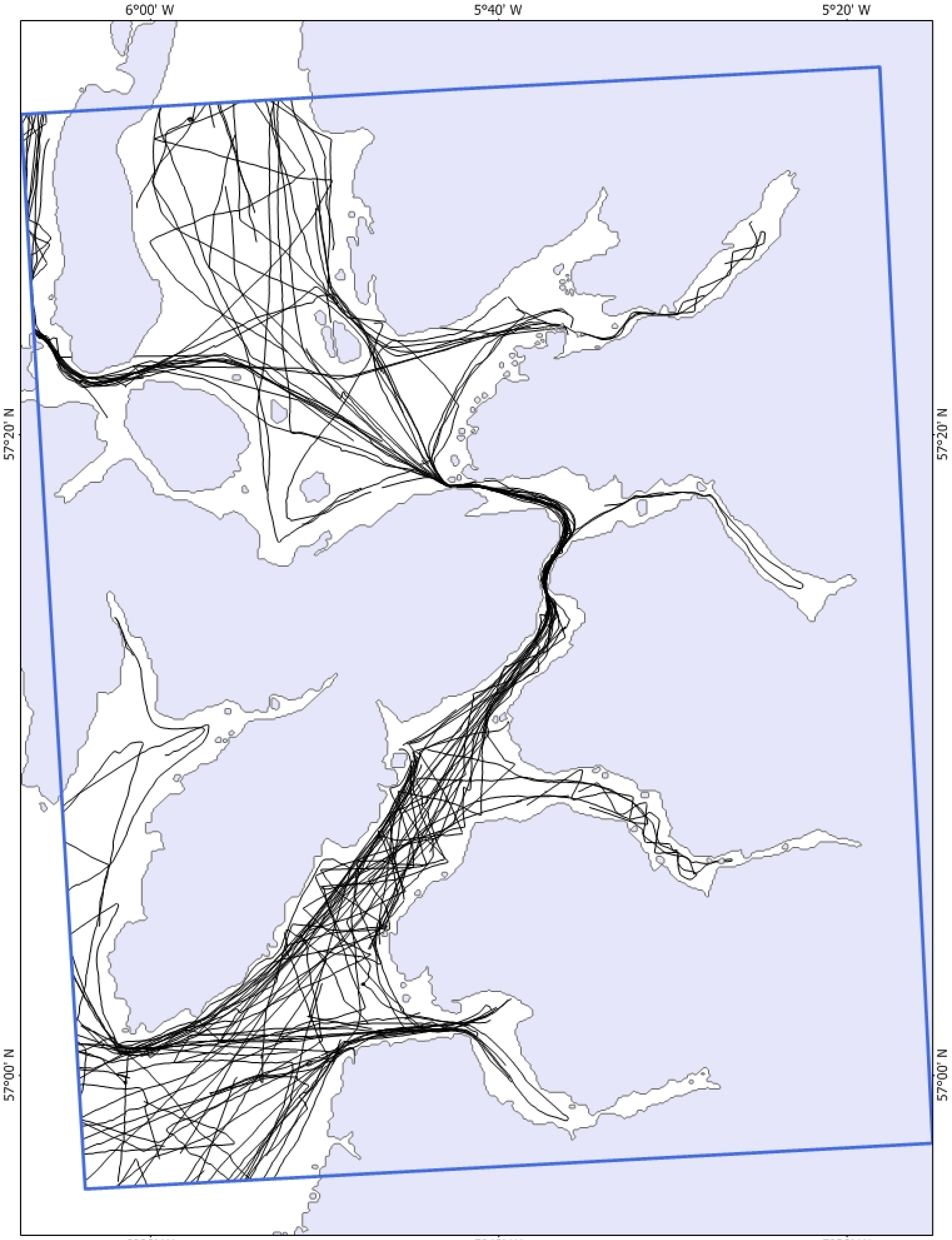

Figure 11: Visual survey tracks within the Kylerea area boundary (blue box) between 2003 and 2011.

Projection: Mercator
Lat (Centre): 57°12'35" N
Lon (Centre): 5°43'09" W

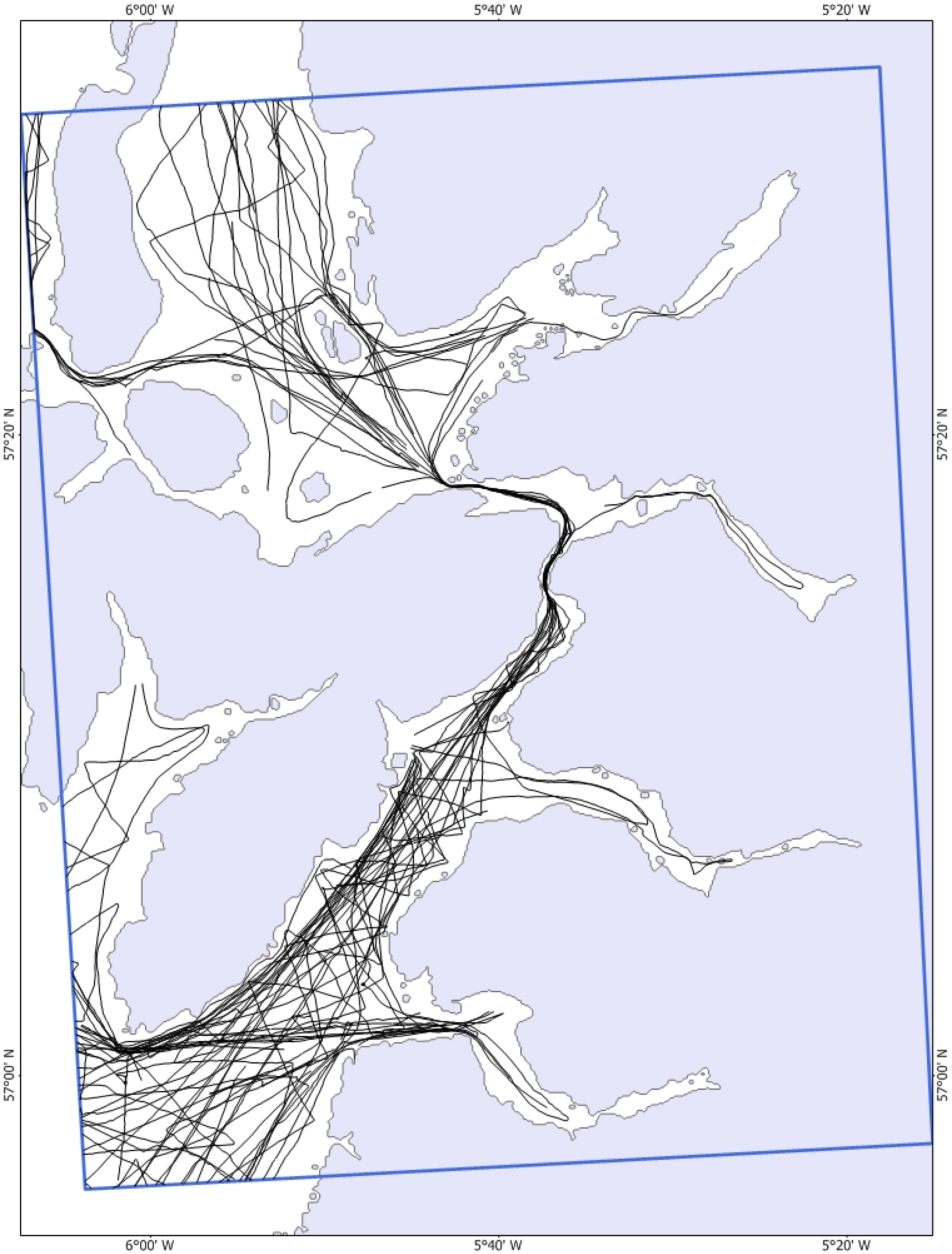

Figure 12: Acoustic survey tracks within the Kylerea area boundary (blue box) between 2004 and 2011.

Visual surveys

Visual observations were carried out from the front deck (2m above sea level) by teams of trained volunteers. Two observers were positioned on the front deck searching the water from -5° to 90° of the transect line on either side of the vessel by eye and with 7 x 50 binoculars (Marine Opticron and Plastimo). Visual observers were rotated every 30 minutes to avoid fatigue. Visual data were collected in sea conditions of Beaufort sea state ≤ 5. Surveys were carried out at an average speed of 6 knots, under motor when winds were low, and under sail when winds were sufficiently high enough. The majority of survey time was spent under motor. GPS location was recorded every ten seconds along with depth, wind speed and direction and boat speed from the vessel's NMEA compatible instruments. Environmental conditions (sea state, swell, visibility, sun glare, and weather conditions) were recorded every 15 minutes or whenever they changed. Survey effort and engine status, whether it was on or off, were recorded whenever they changed. "On Effort" status was defined as when visual observers were in place on the mast. When any cetaceans, seals or basking sharks were sighted, the species was identified and the following information was recorded: time of first sighting, distance, bearing (using an angle board), heading of the group/individual, group size and behaviour. These data, as well as the NMEA data (as listed above), environmental, survey effort and engine status data, were recorded directly into a computer running the International Fund for Animal Welfare (IFAW) software *Logger 2000/2010*, and stored in a Microsoft Access database in real-time. Occasionally, deviations were made from the track line in order to take photo-identification pictures, during which time the effort was recorded as 'With Whales'. Once the sighting was over, the vessel returned to its survey lines and the visual observers returned to their positions and the effort status was changed back to 'On Effort'. Detections (visual or acoustic) made during "With Whales" survey effort status were not included in the final analysis.

Acoustic surveys

Passive acoustic monitoring were carried out simultaneously with the visual surveys during systematic line transect surveys from 2004-2011. A towed hydrophone array was deployed in all sea conditions during daylight hours in waters >10 metres depth. The hydrophone array consisted of two high frequency elements and was towed 100m behind the boat by Kevlar-strengthened towing cable. The signal from the hydrophone array was fed into a computer running acoustic detection software. Porpoise Detector (2004-2005), Rainbow Click (2006-

2010) and PAMGUARD (2011) classify transient sounds detected on the hydrophone array; automatically detecting harbour porpoise click events. Events were checked by an operator and the number of vocalizing animals in each event was calculated. A table was created in the MS Access database linked with the GPS data collected in *Logger 2000/2010* where the number of animals in each porpoise detection was logged. Each detection was linked to a GPS fix for the mid-time of the detection by a custom macro (Gillespie, pers. comm.)
Effort and detections data collected from 2003-2011 were analysed using Manifold (Version 8.0). These data were broken down by grid cells. For this analysis a grid cell of 0.05 degree^2 was used as it provided approximately equal effort across the study region. All dolphin, whale and seal species were grouped together and treated as a single category in this analysis. Basking sharks, visual sightings of harbour porpoises and acoustic detections of harbour porpoise were treated separately. In each grid cell, detections per unit effort (per nautical mile completed trackline) maps were produced for each of these species groups (with two maps produced for harbour porpoise; one map for visual data and one for acoustic data). Additionally, detections per unit effort maps were produced for each of the species groups for each year of survey effort and for each month of survey effort.

Results

Harbour porpoise were the most common species sighted in the study region, followed by the seal species. In terms of DPUE values harbour porpoise had the highest values followed by seals, odontocetes, balaneopteridae species and lastly, basking shark.

Harbour porpoise visual and acoustic detections were spatially widespread throughout the study region and both visual and acoustic detections occurred in every year and month. Concentration values were highly variable across years, months and detection mode; that is visual or acoustic detections of harbour porpoise. The highest visual and acoustic DPUE values ranged between 0.53 harbour porpoise detections per nautical mile (Figure 14.2.2) and 8.67 harbour porpoise detections per nautical mile (Figure 13.1.8), although typically in both every month and year the highest visual and acoustic DPUE values were greater than 1. Spatially, the highest concentrations occurred in the southern area of the study region in the Sound of Sleat (Figures 13 and 14), followed by the Inner Sound and generally, lower concentrations were observed in the grid cells furthest from land.

Sightings of seals were also spatially and temporally widespread throughout the study region; occurring across the study region and in every year and month of the study period. The highest concentration of seals occurred in 2007, 2011 (3.33 seal detections per nautical mile (Figure 18.1.4) and 5.65 seal detections per nautical mile (Figure 18.1.8), respectively) and in October (7.16 seal detections per nautical mile (Figure 18.2.7). Monthly concentrations ranged widely (between 0.64 to 7.16 seal detections per nautical mile). Yearly concentrations ranged between 1.06 seal detections per nautical mile and 5.65 seal detections per nautical mile. Figures 18.1.1 – 18.2.7. Spatial concentrations of seals were highest closer to land (Figure 18) and were most dispersed across the study region during July, August and October (Figure 18.2.4 – 18.2.7).

There were relatively few sightings of odontocetes throughout the region, although in the three of the four years there were sightings of odontocete species, the sightings occurred in the Sound of Raasay (Figures 15, 15.1.1-15.1.3).

Sightings of balaenoptera species occurred in the latter half of a season within the months of July, August and September (Figures 16.2.4-16.2.6). Most of the sightings occurred in the southern area of the study region although the highest DPUE value (0.91) was found in the northern area of the study region in 2004 (Figure 16.1.1).

There was only one sighting of basking shark within the study period and within the study region (Figure 17).

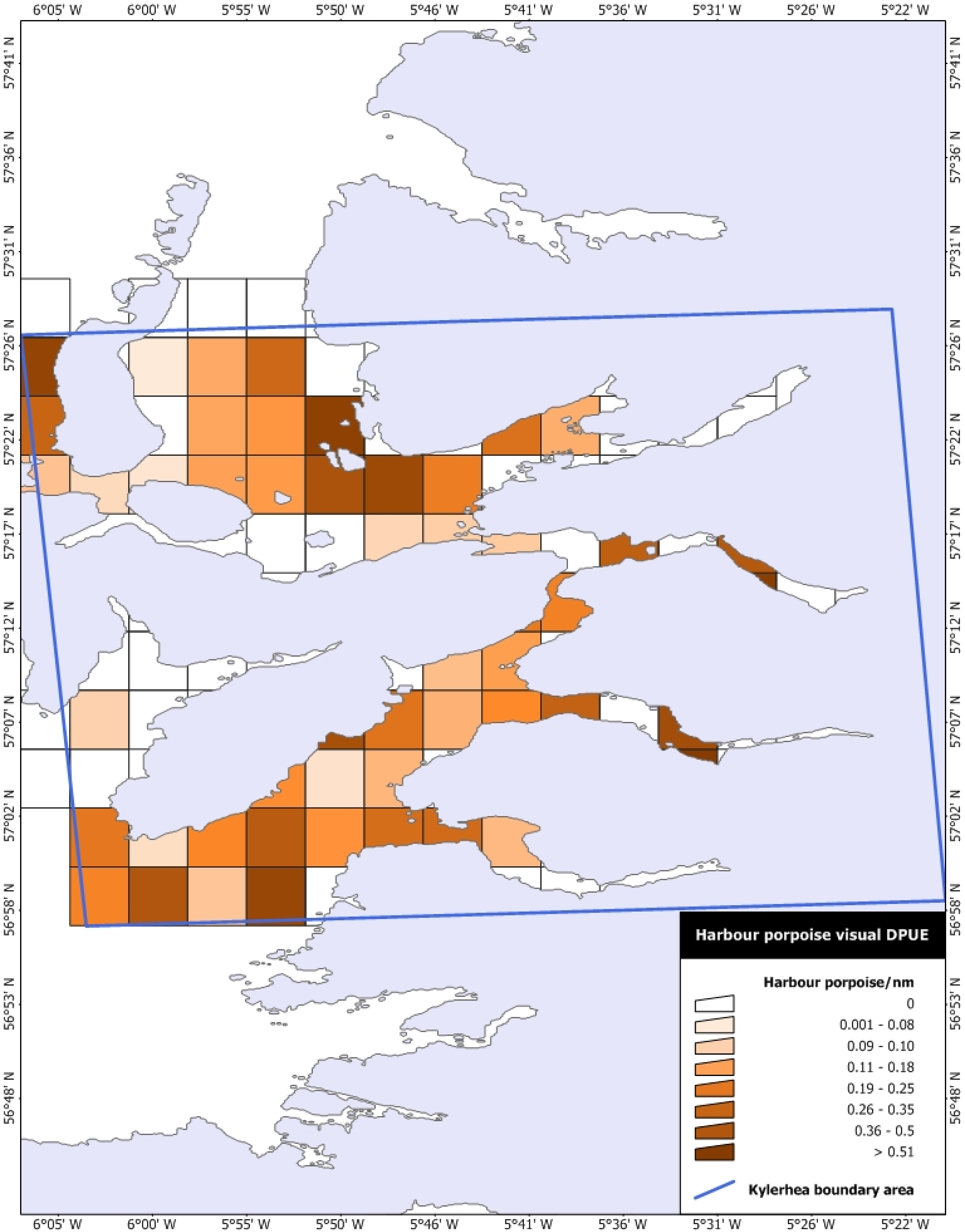

Figure 13: Detections per unit effort of harbour porpoise in the Kylerhea region between 2003 and 2011 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

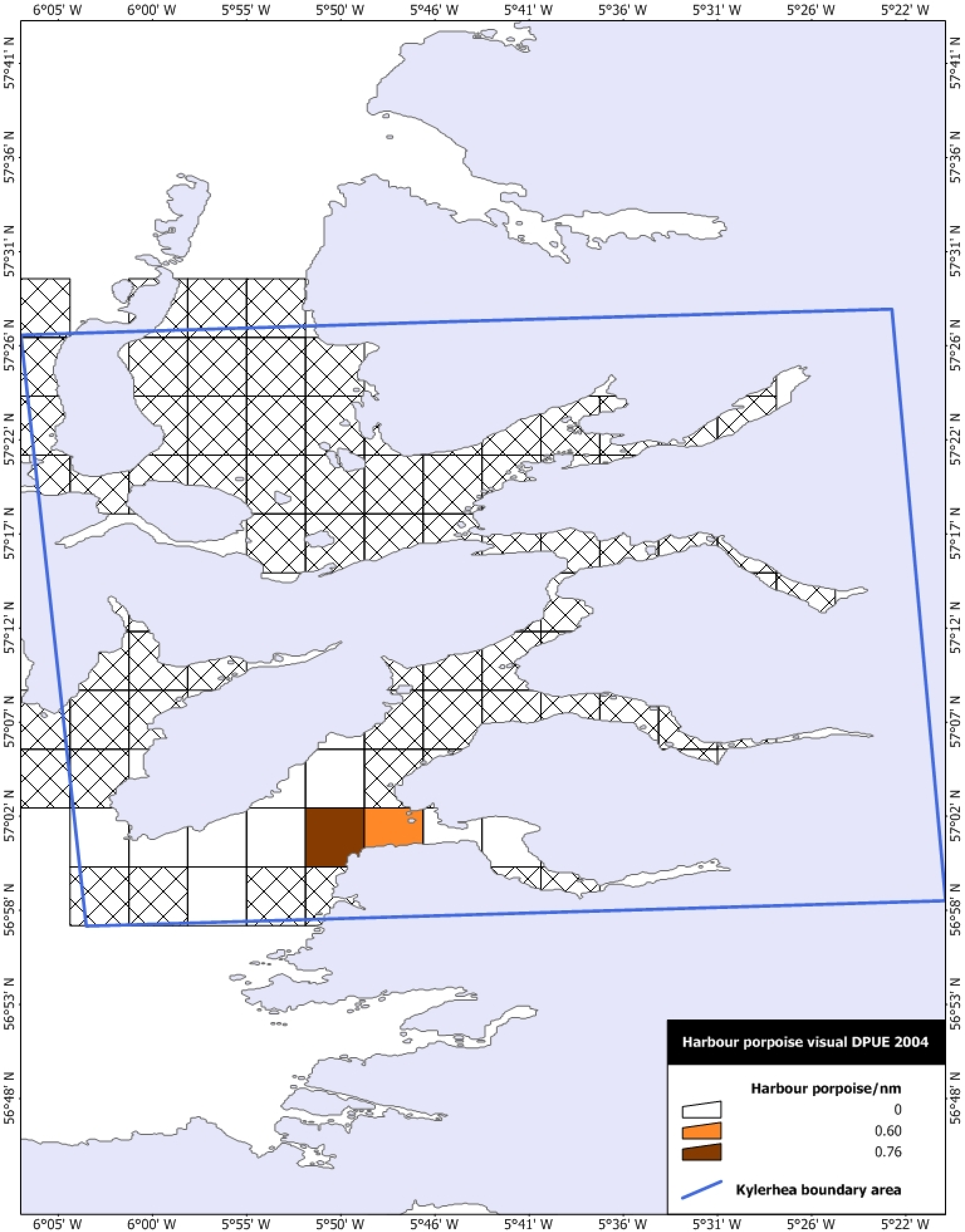

Figure 13.1.1: Detections per unit effort of harbour porpoises in the Kylerhea region during 2004 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

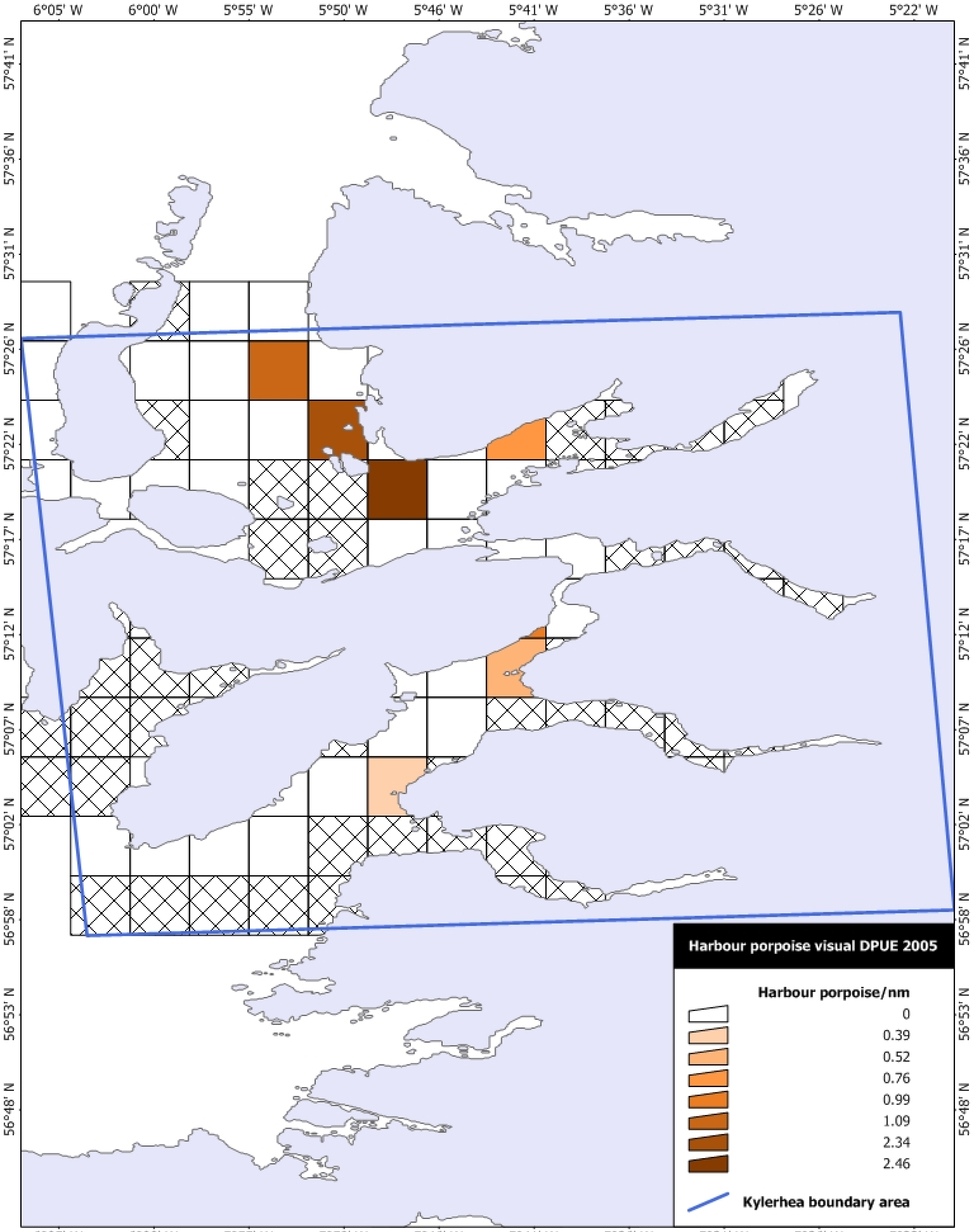

Figure 13.1.2: Detections per unit effort of harbour porpoises in the Kylerhea region during 2005 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

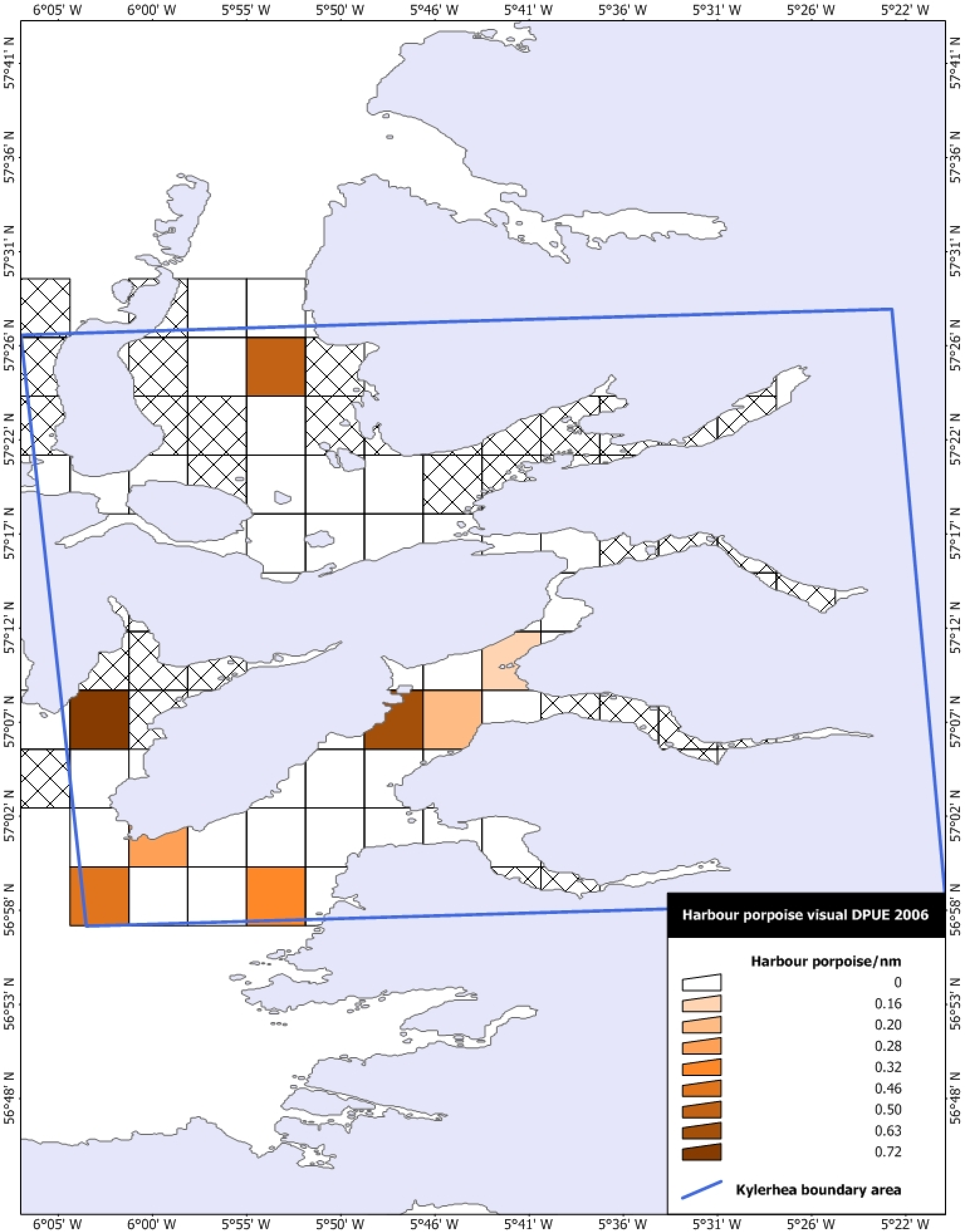

Figure 13.1.3: Detections per unit effort of harbour porpoises in the Kylerhea region during 2006 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

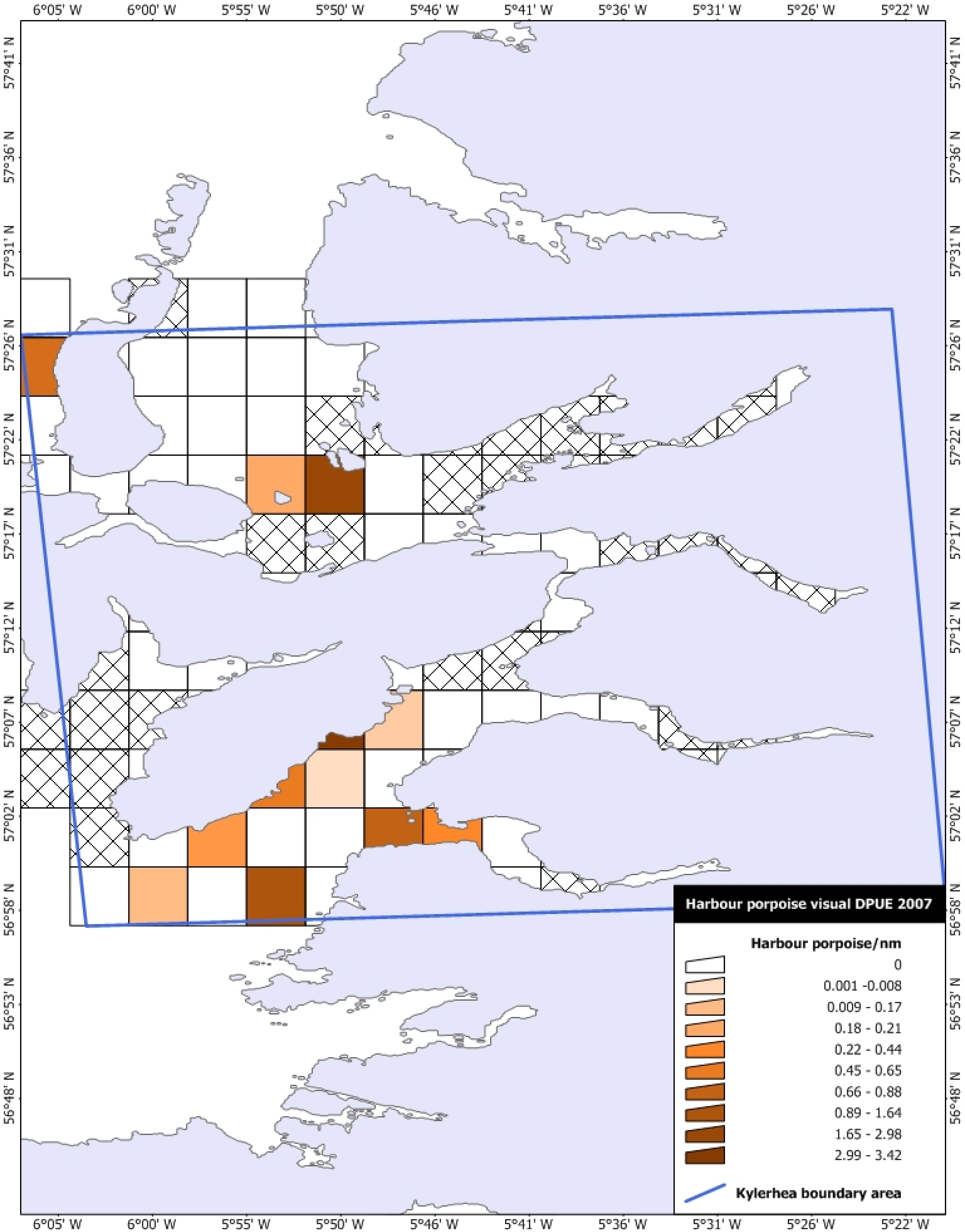

Figure 13.1.4: Detections per unit effort of harbour porpoises in the Kylerhea region during 2007 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

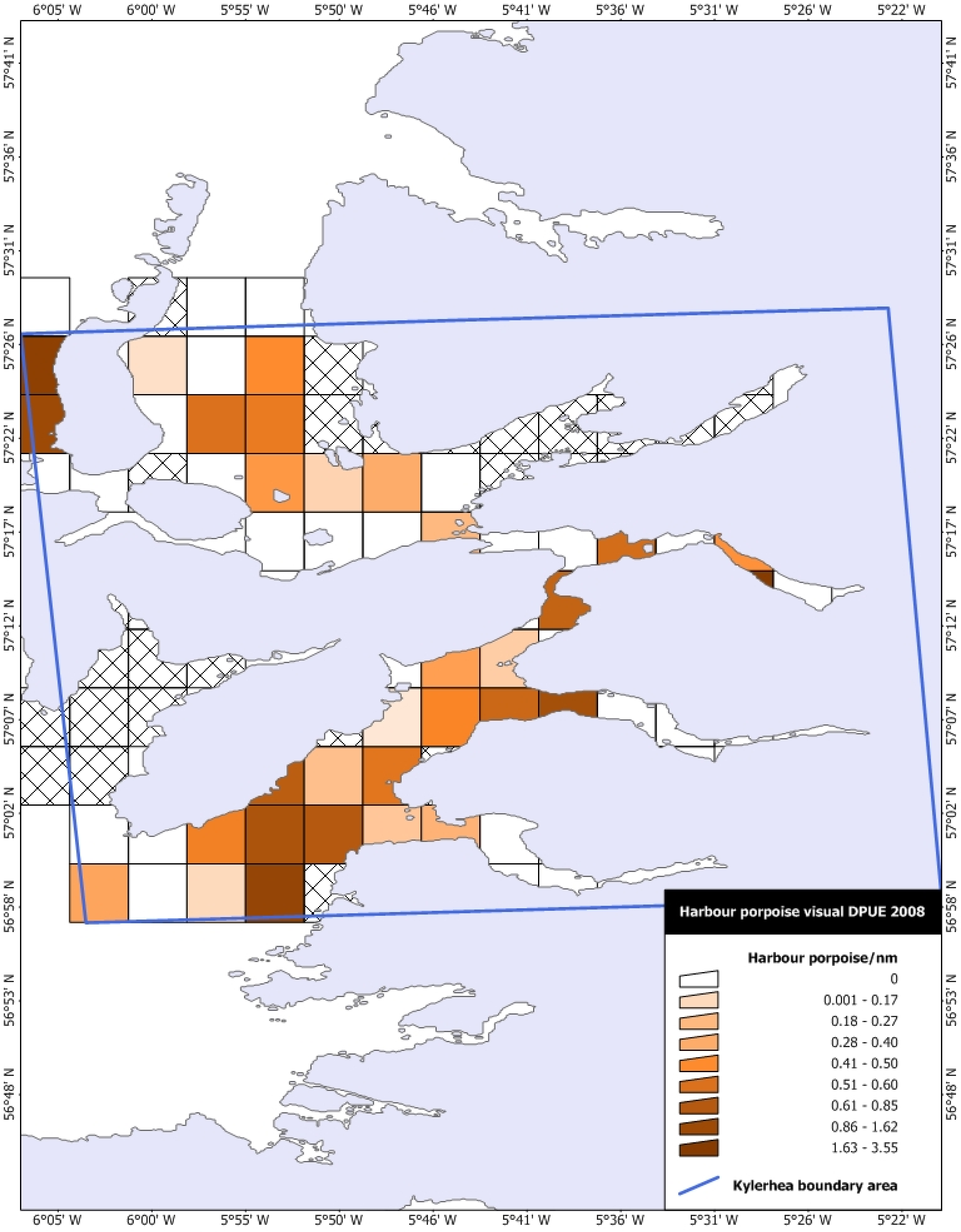

Figure 13.1.5: Detections per unit effort of harbour porpoises in the Kylerhea region during 2008 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

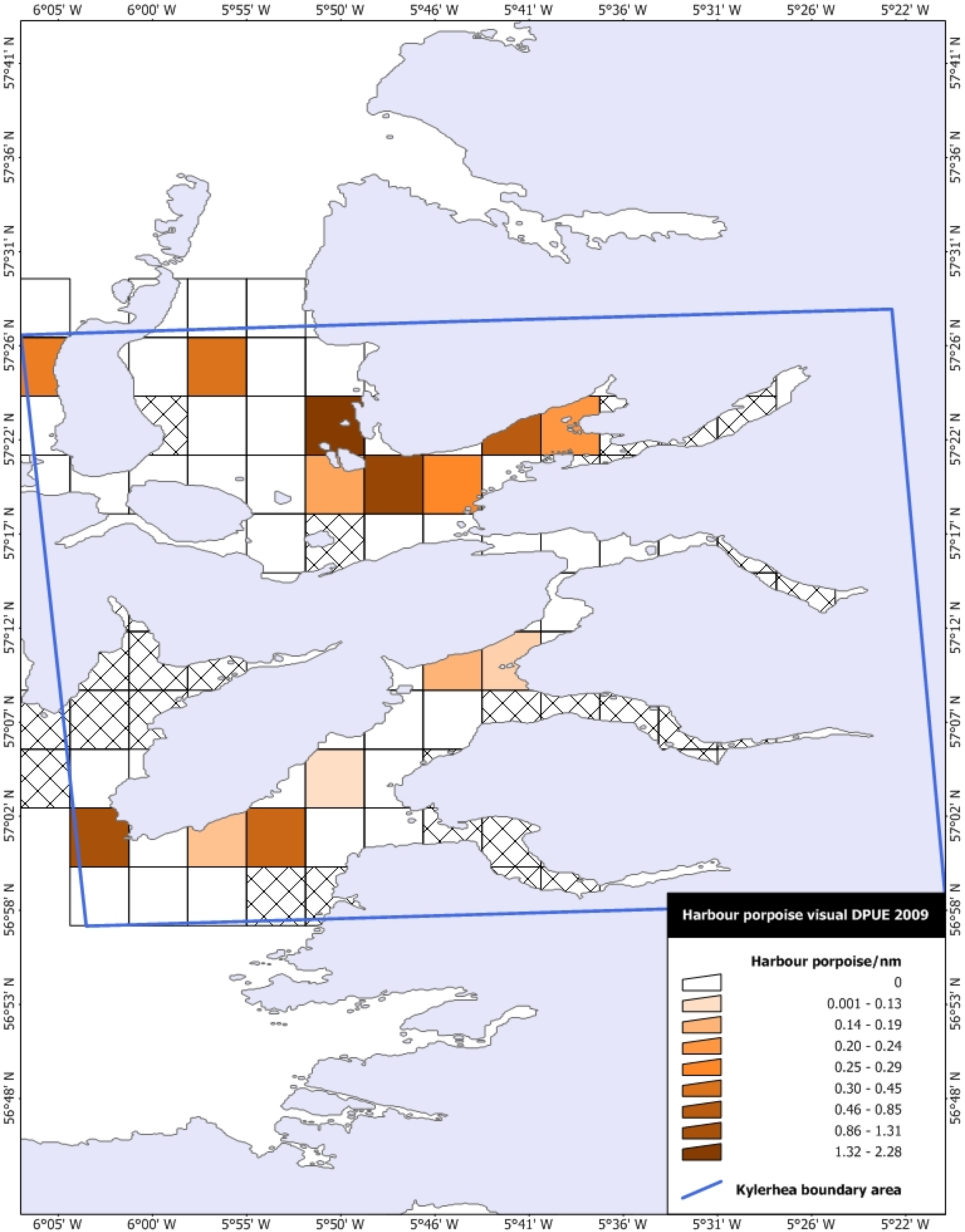

Figure 13.1.6: Detectionss per unit effort of harbour porpoises in the Kylerhea region during 2009 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

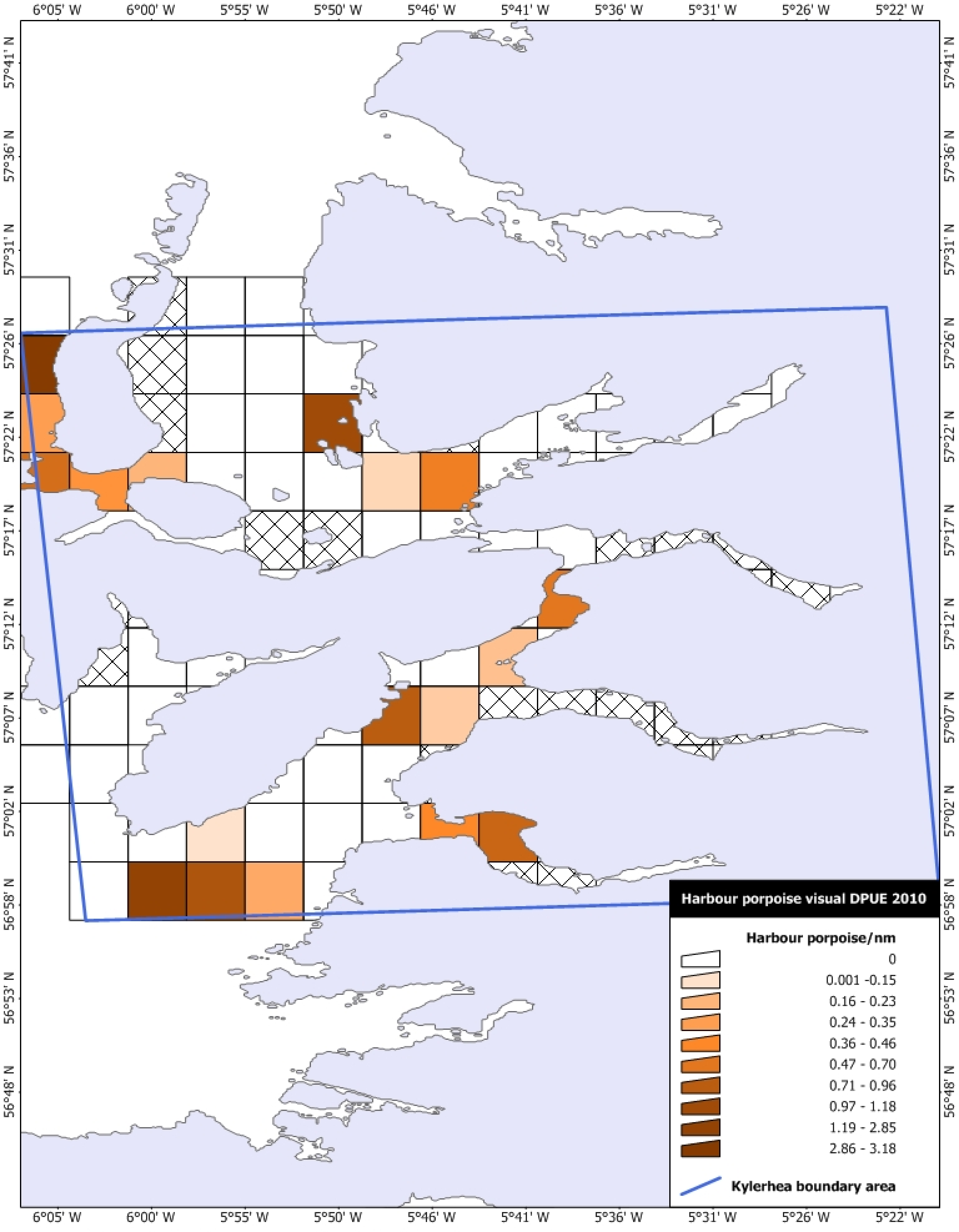

Figure 13.1.7: Detections per unit effort of harbour porpoises in the Kylerhea region during 2010 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

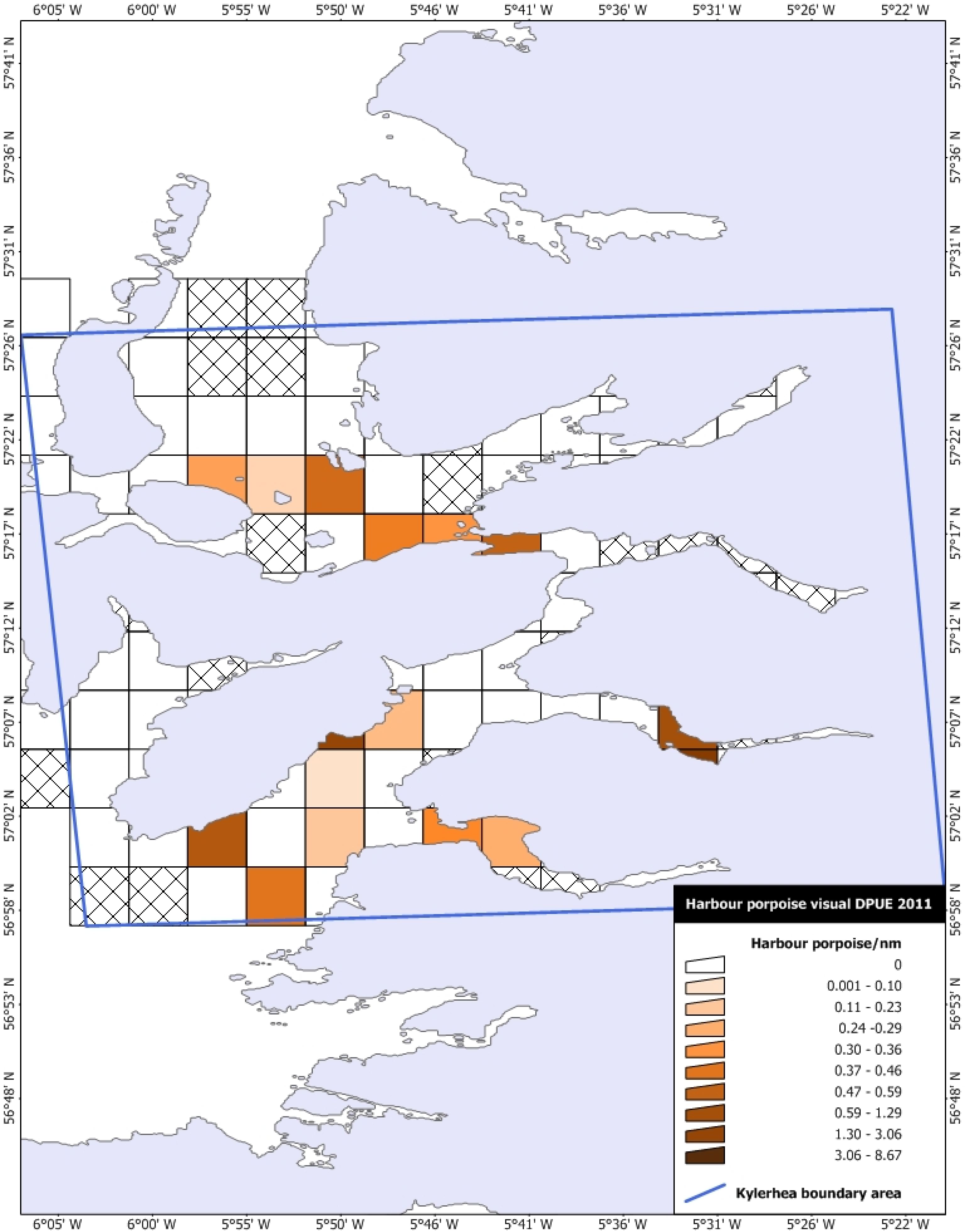

Figure 13.1.8: Detections per unit effort of harbour porpoises in the Kylerhea region during 2011 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

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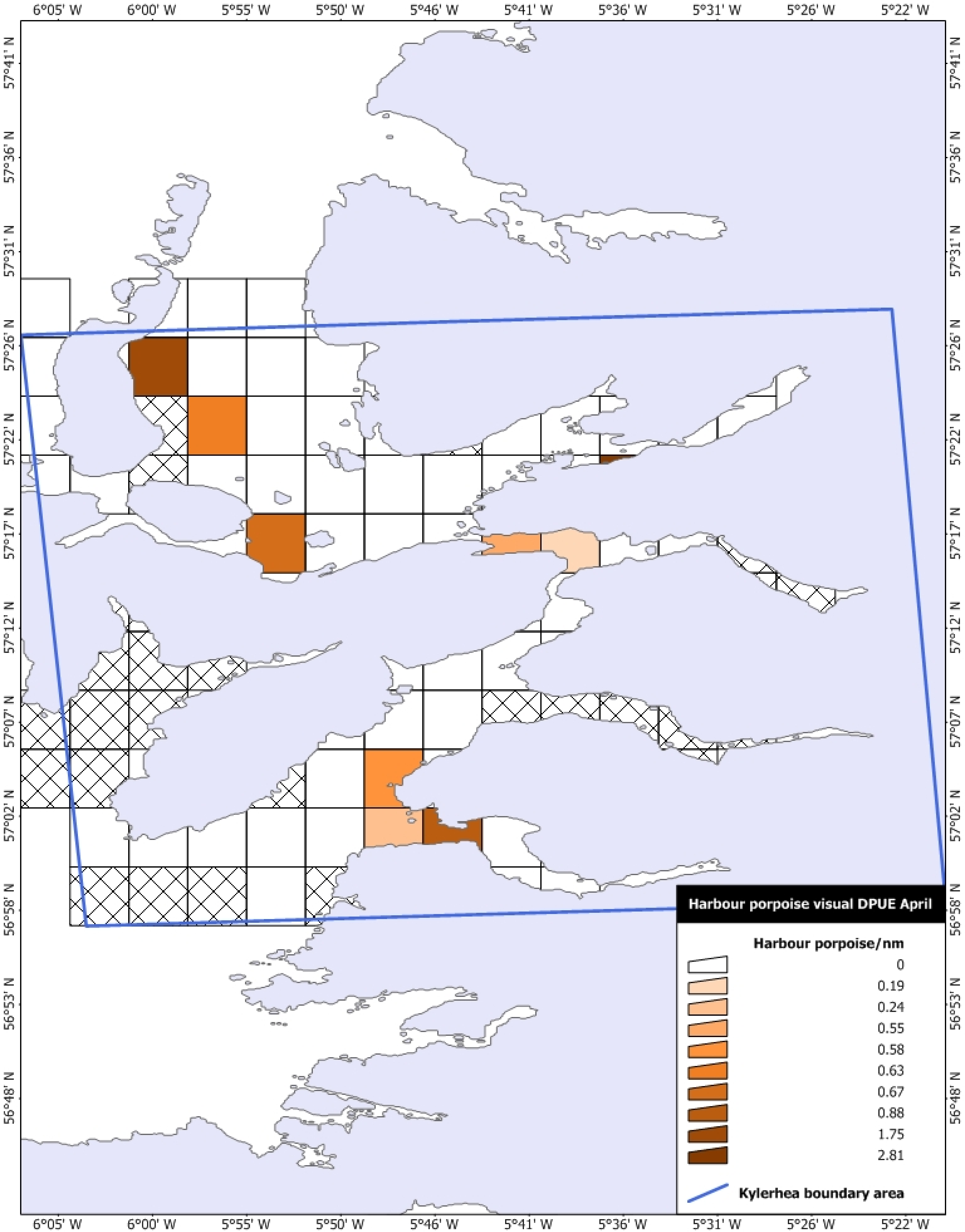

Figure 13.2.1: Detections per unit effort of harbour porpoises in the Kylerhea region during April (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

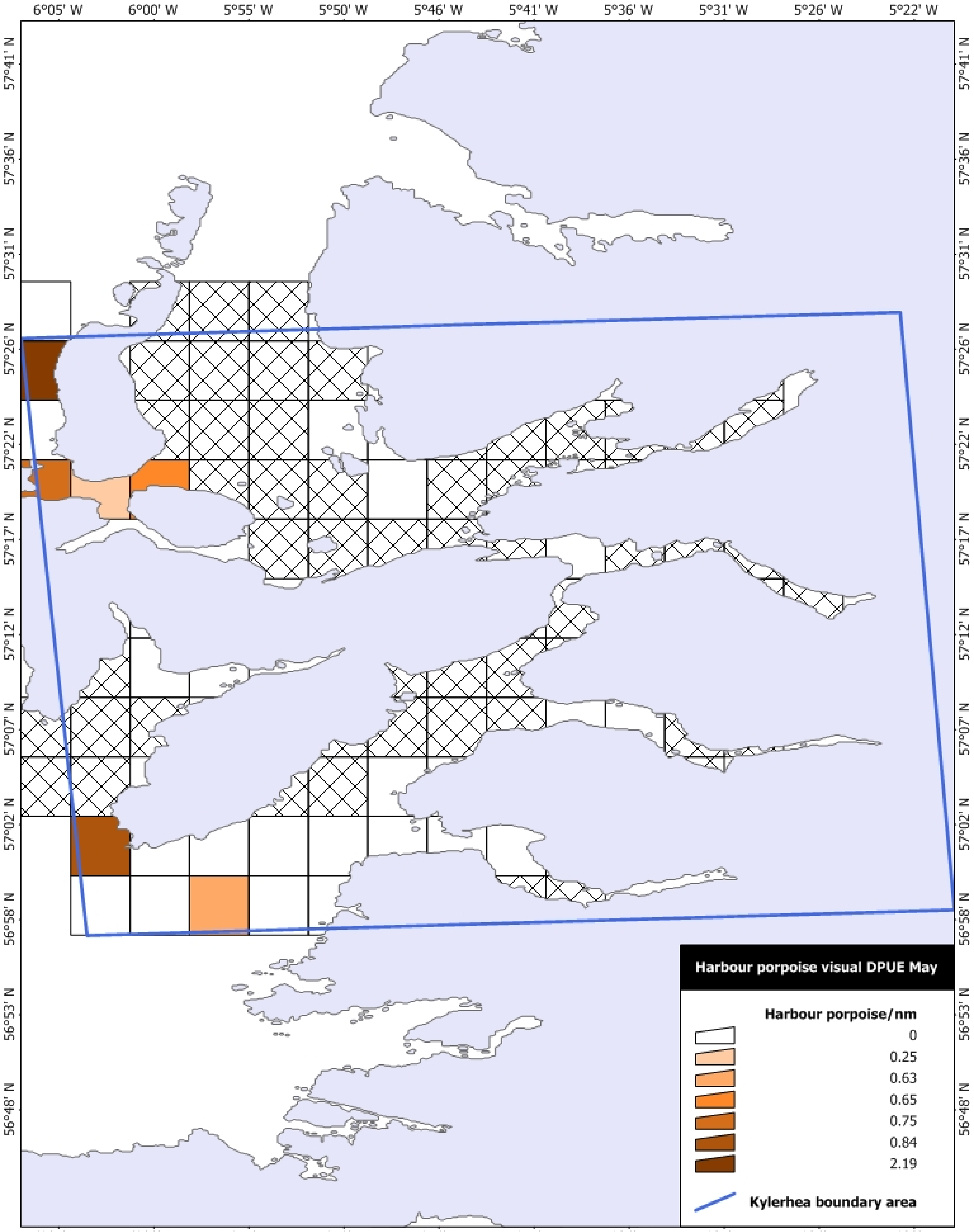

Figure 13.2.2: Detections per unit effort of harbour porpoises in the Kylerhea region during May (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

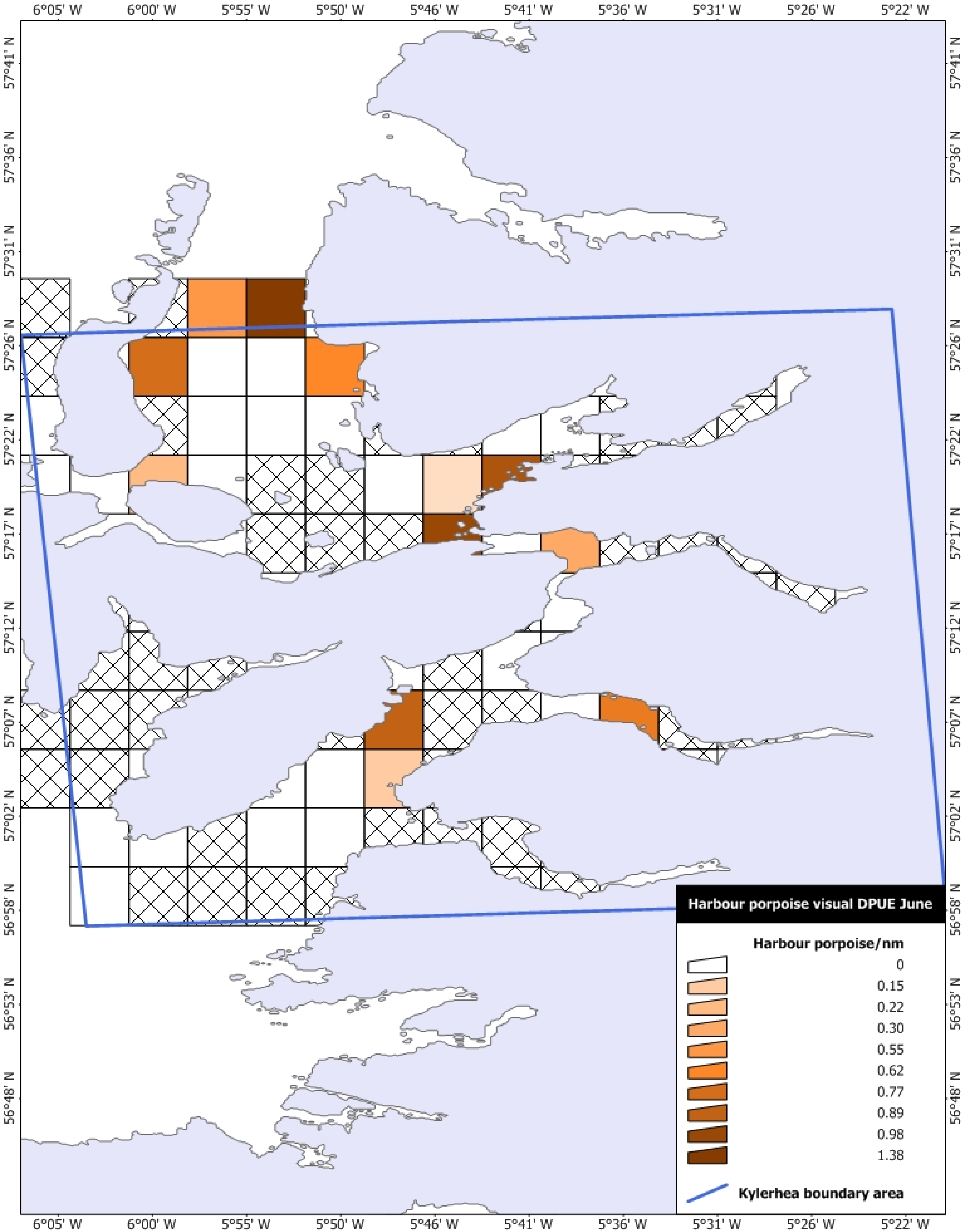

Figure 13.2.3: Detections per unit effort of harbour porpoises in the Kylerhea region during June (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

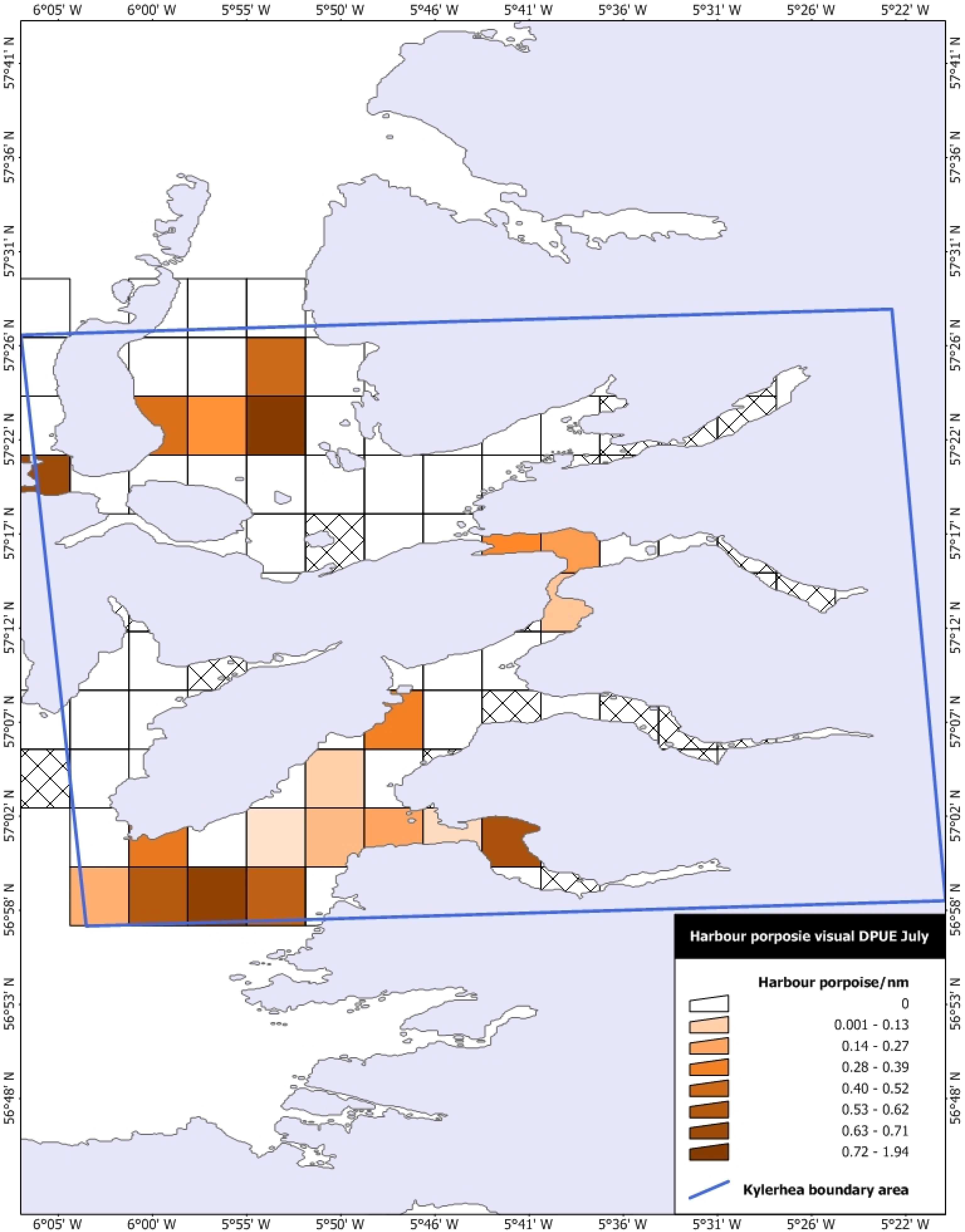

Figure 13.2.4: Detections per unit effort of harbour porpoises in the Kylerhea region during July (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

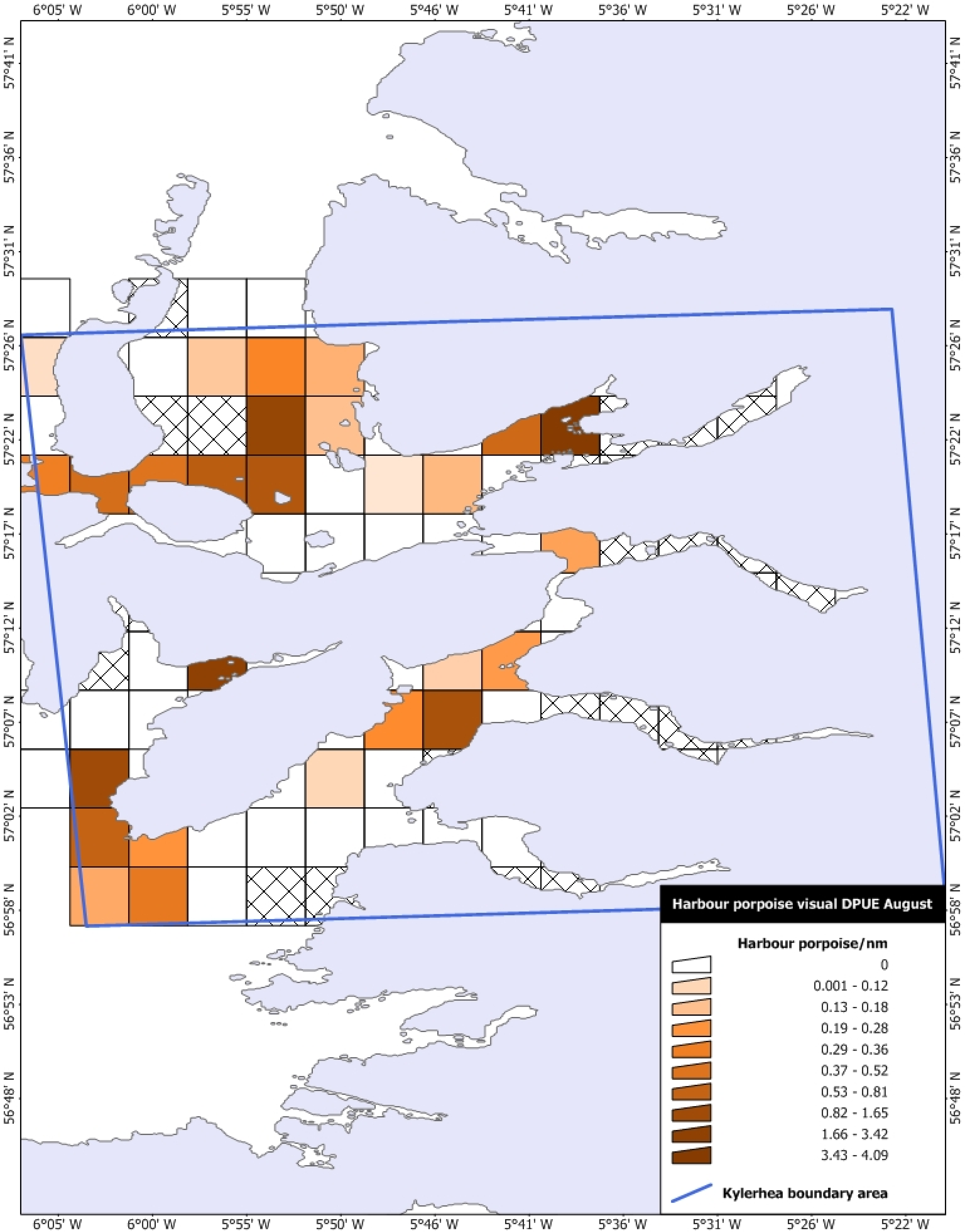

Figure 13.2.5: Detections per unit effort of harbour porpoises in the Kylerhea region during August (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

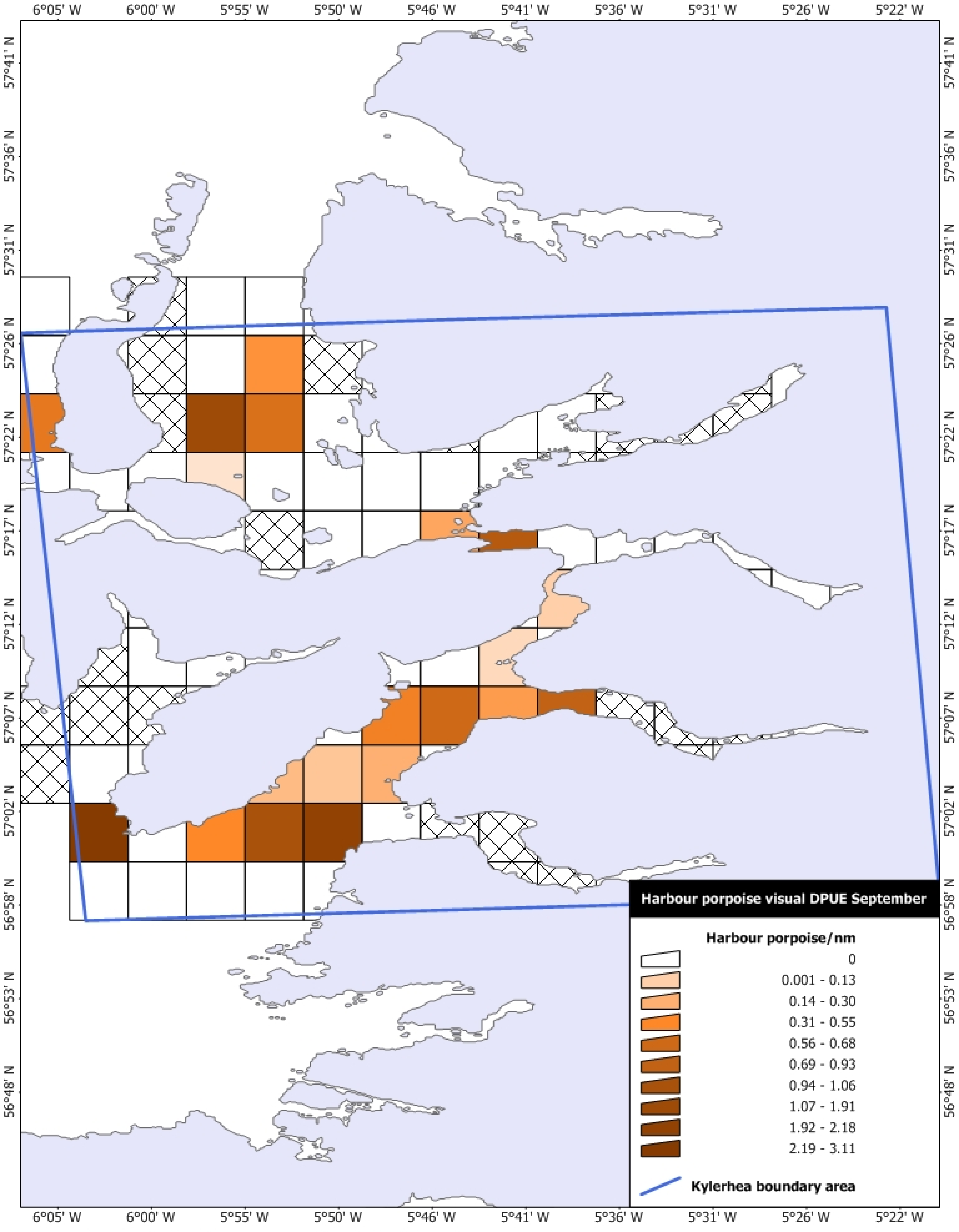

Figure 13.2.6: Detections per unit effort of harbour porpoises in the Kylerhea region during September (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

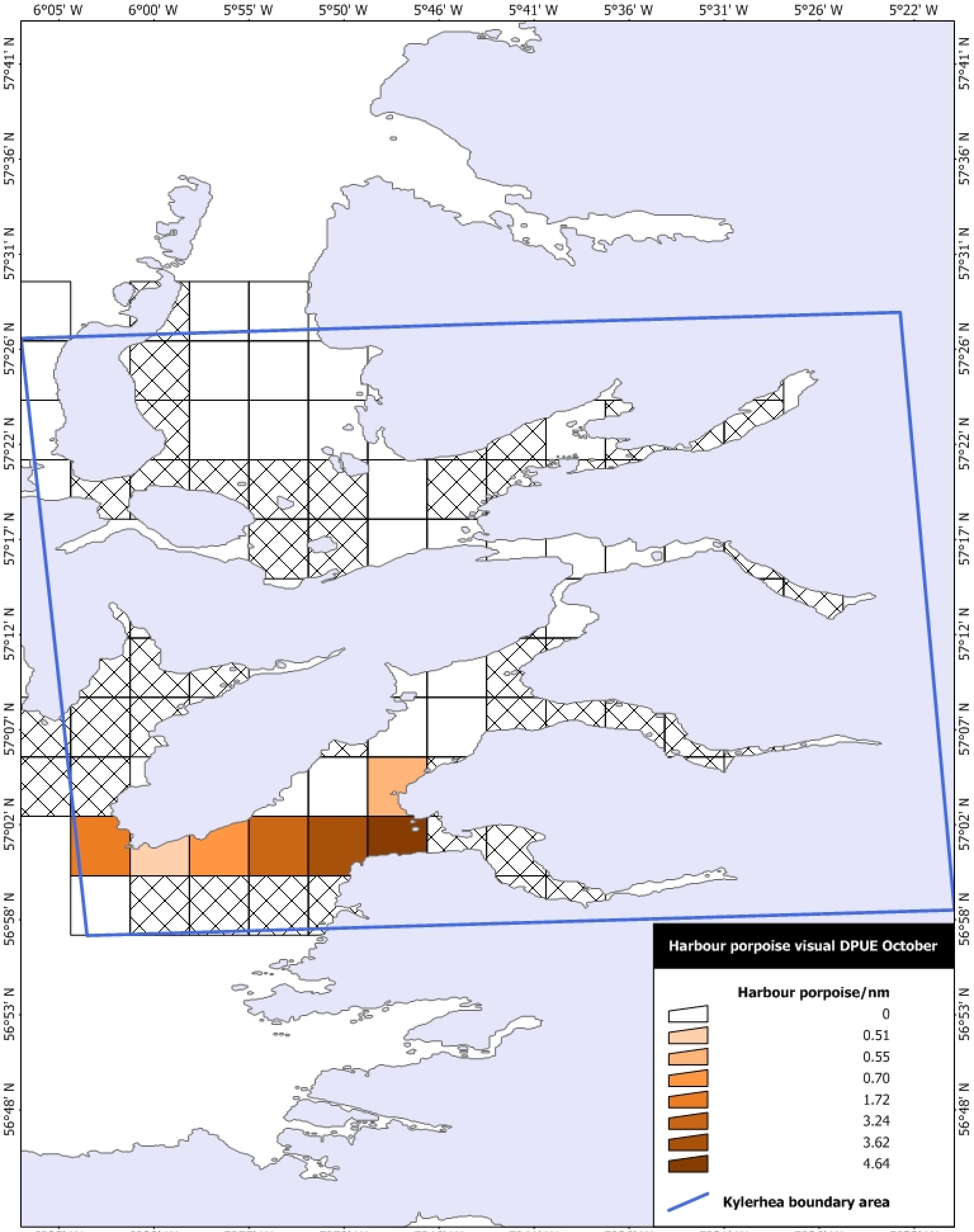

Figure 13.2.7: Detections per unit effort of harbour porpoises in the Kylerhea region during October (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

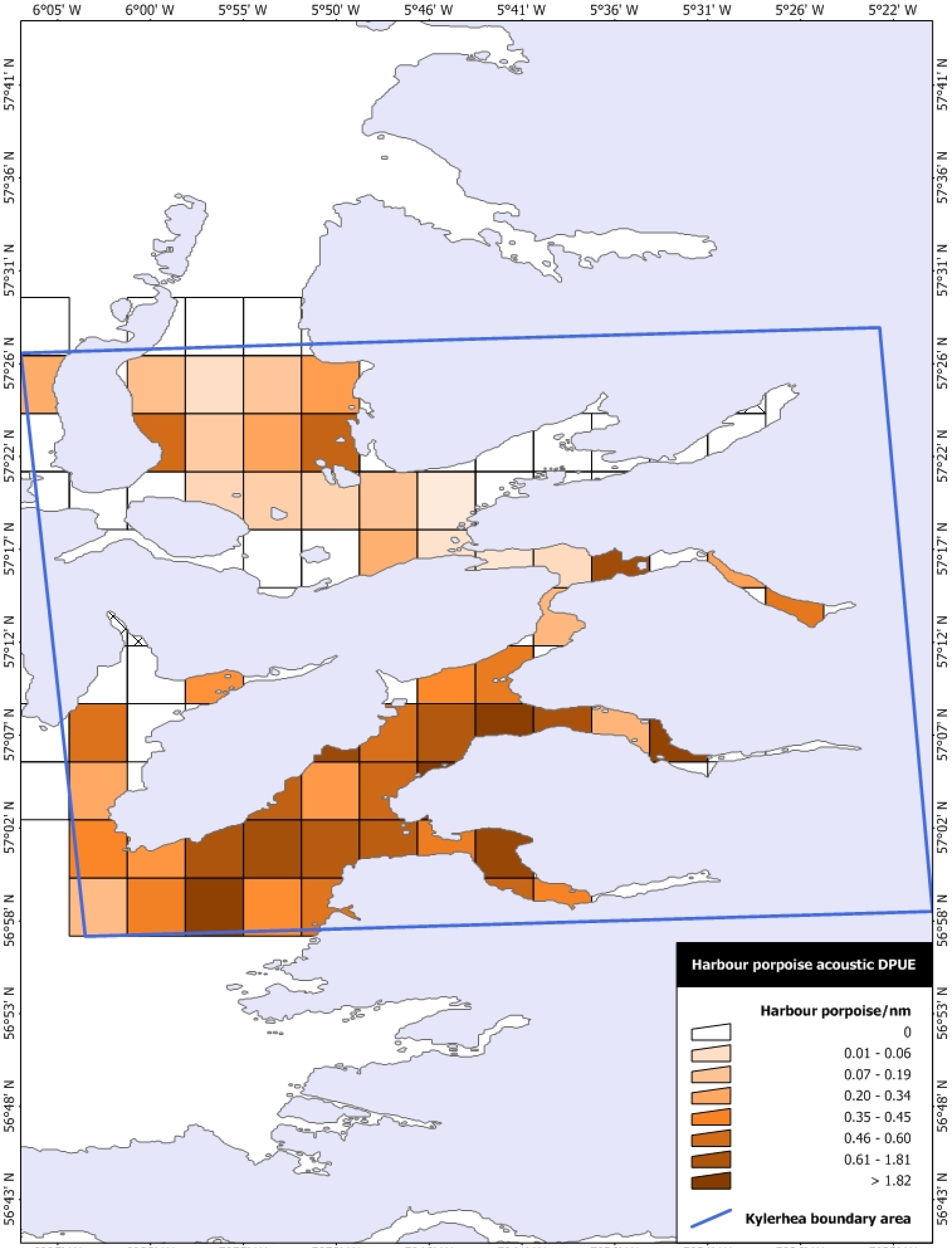

Figure 14: Detections per unit effort of harbour porpoise in the Kylerhea region between 2004 and 2011 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

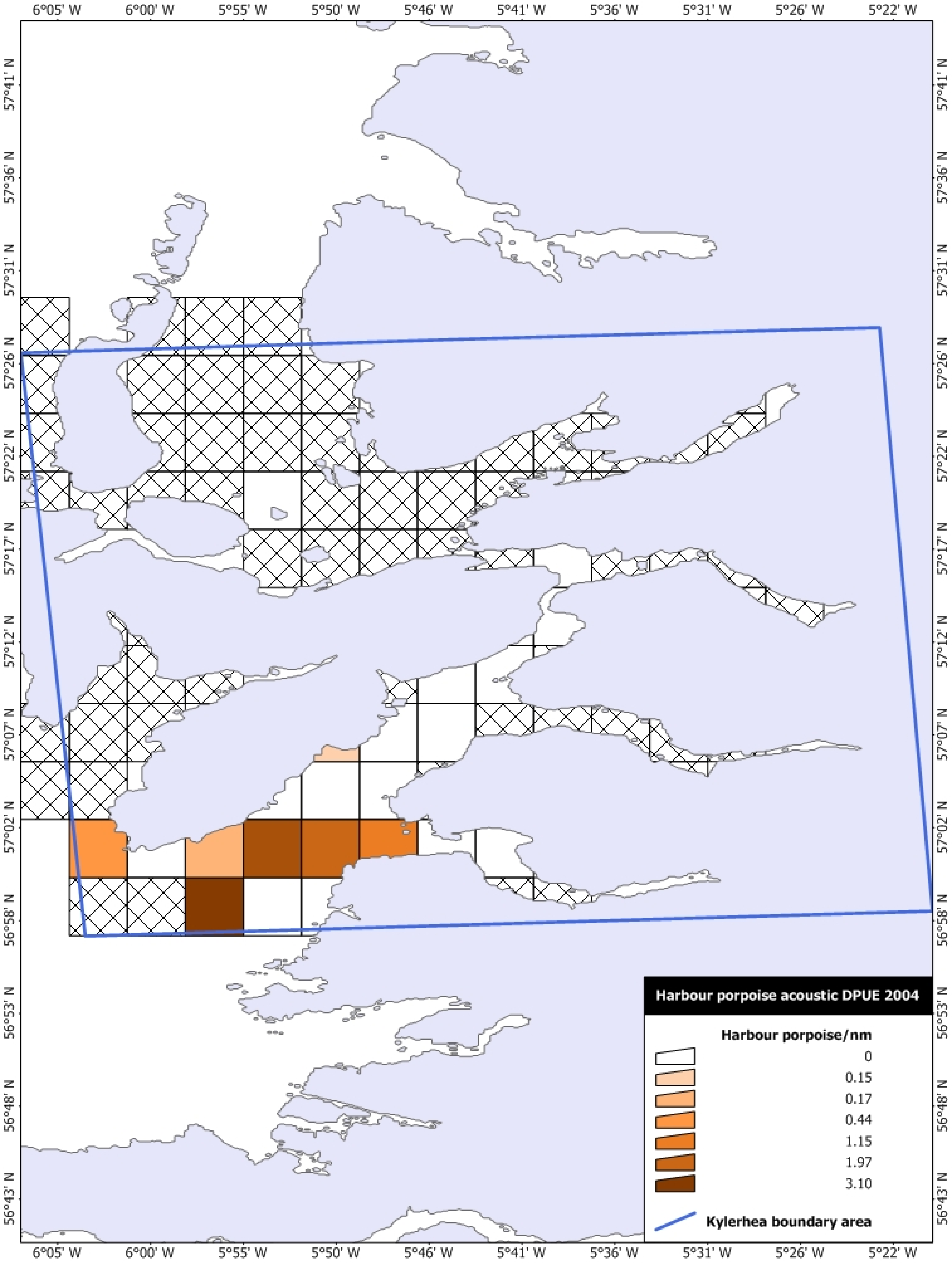

Figure 14.1.1: Detections per unit effort of harbour porpoise in the Kylerhea region during 2004 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

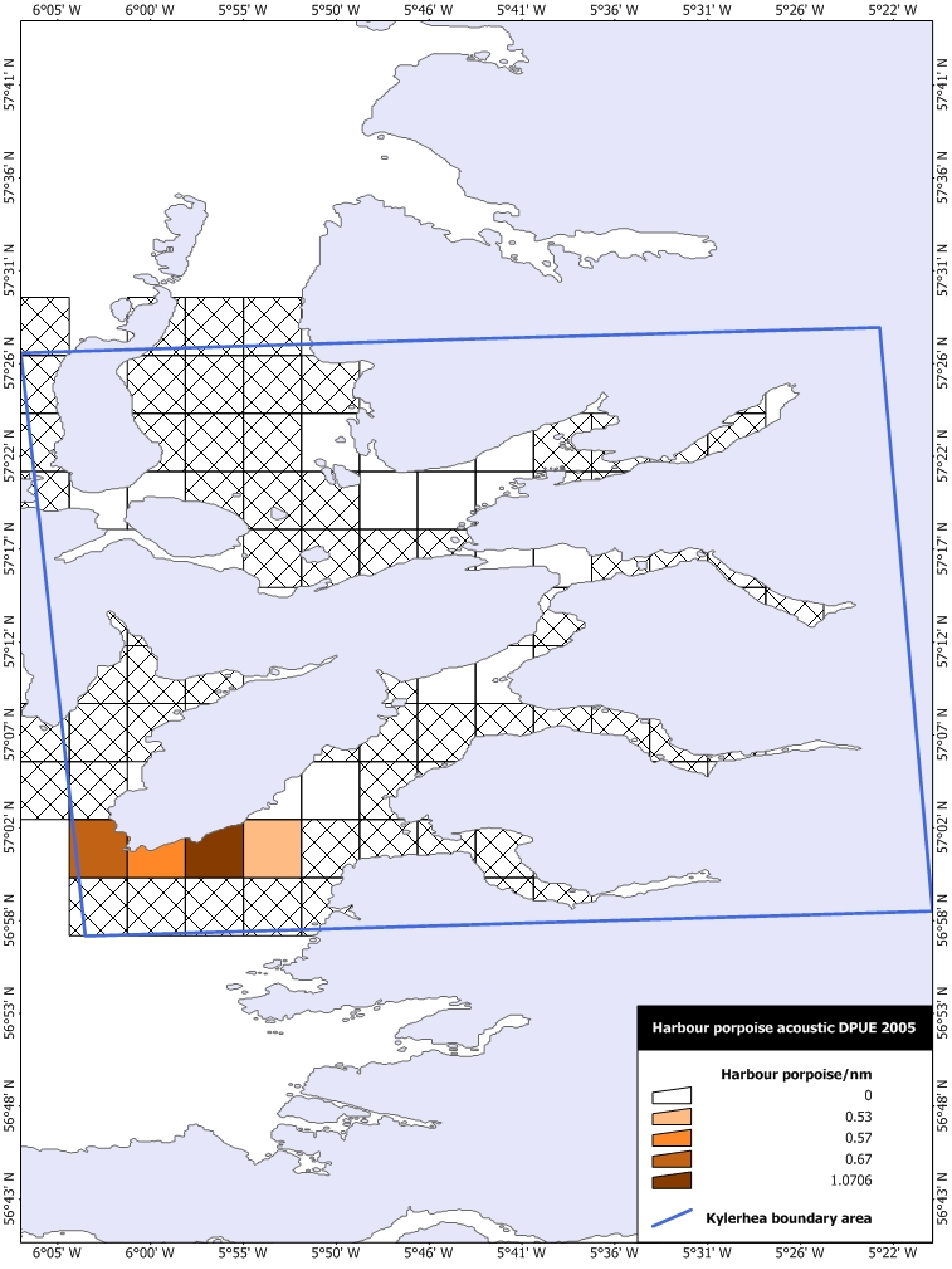

Figure 14.1.2: Detections per unit effort of harbour porpoise in the Kylerhea region during 2005 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

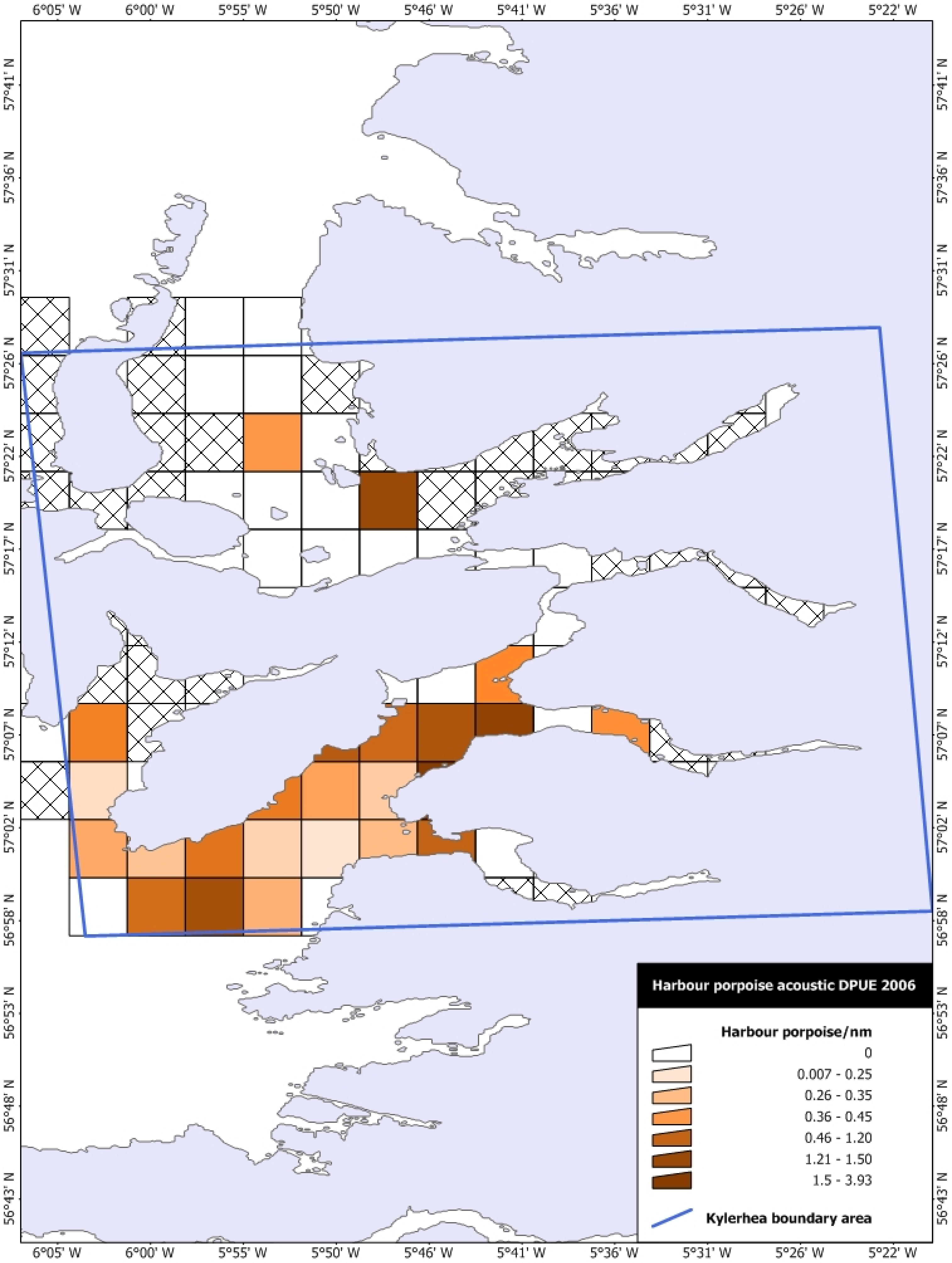

Figure 14.1.3: Detections per unit effort of harbour porpoise in the Kylerhea region during 2006 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

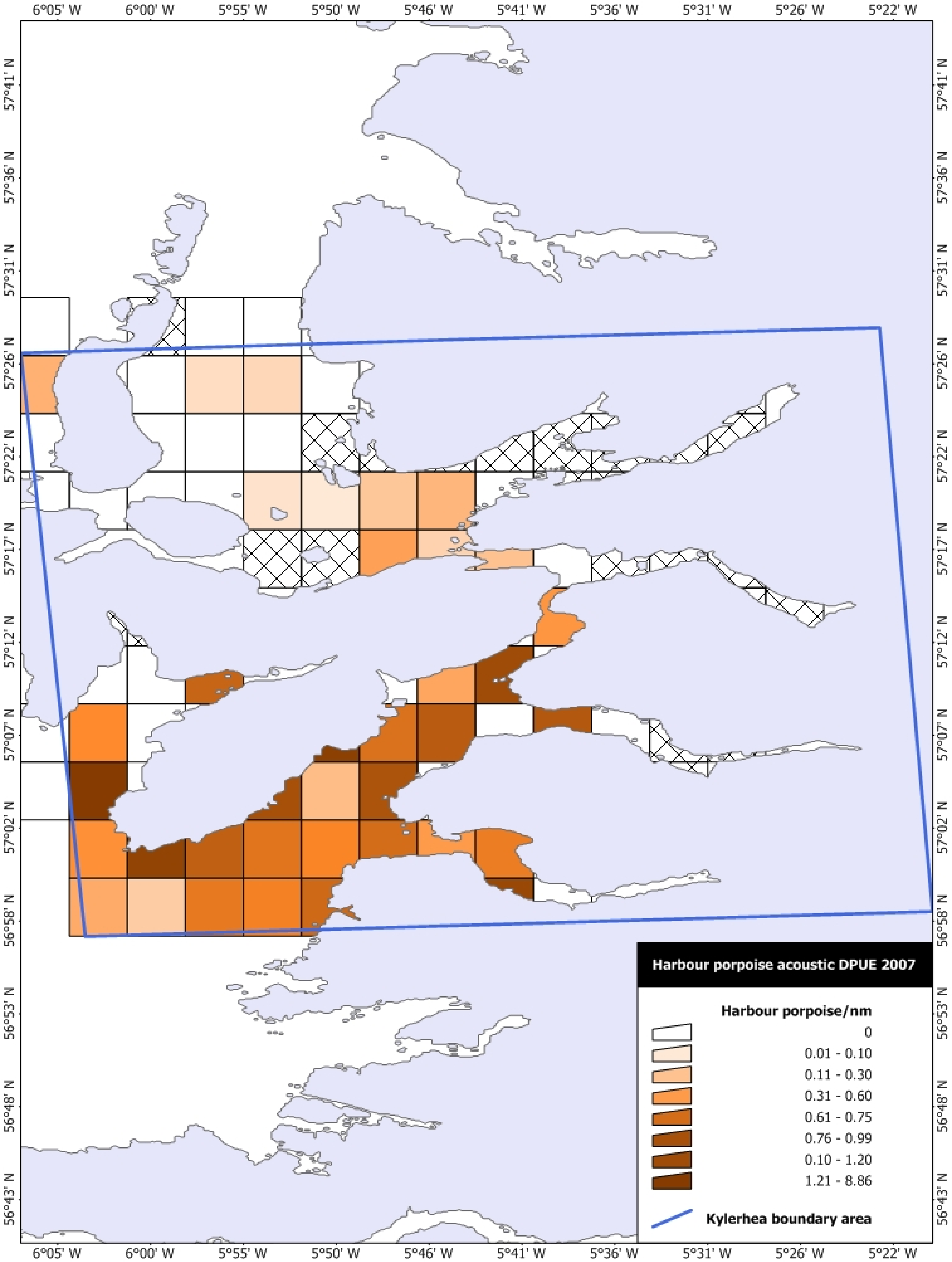

Figure 14.1.4: Detections per unit effort of harbour porpoise in the Kylerhea region during 2007 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

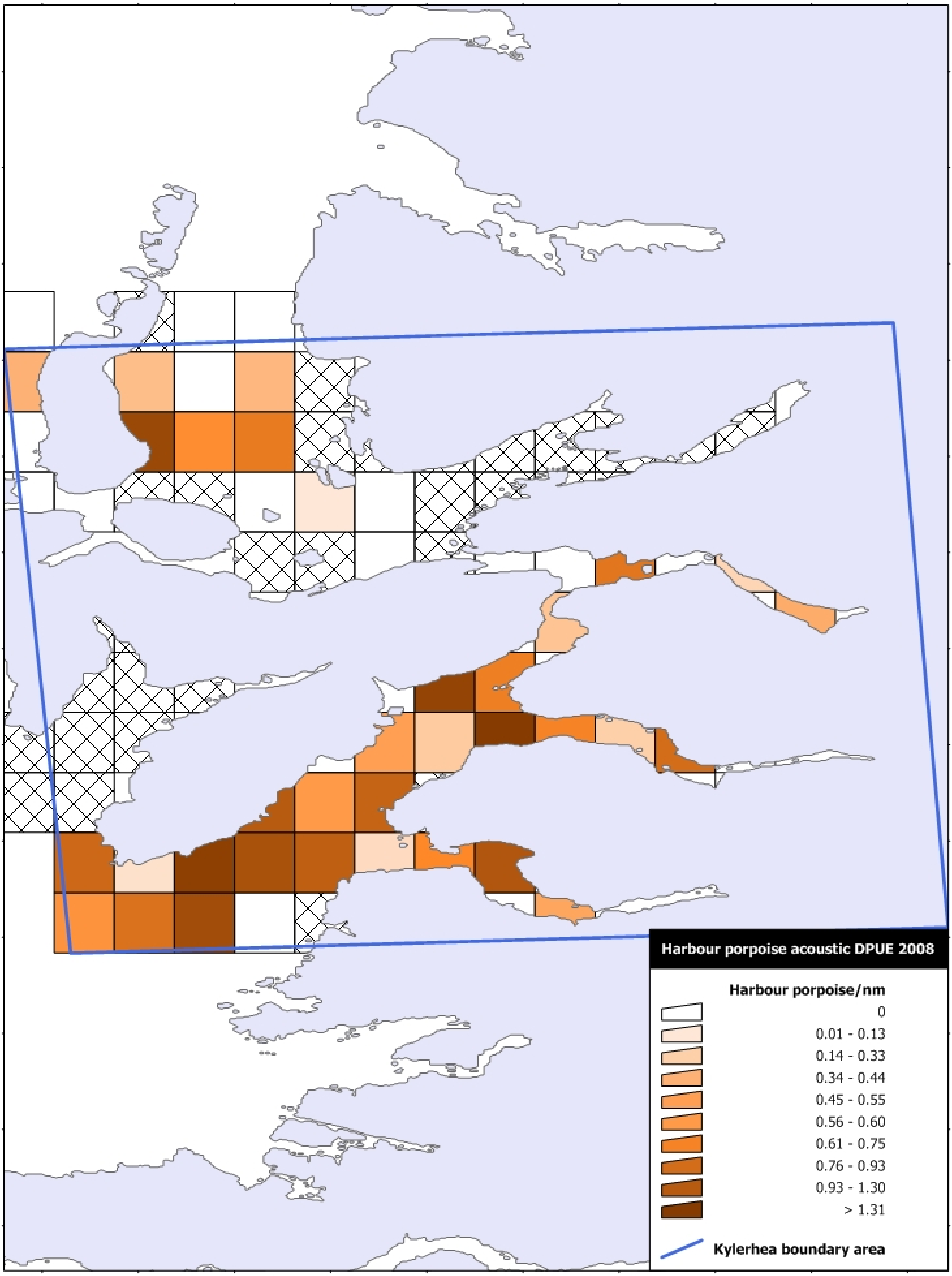

Figure 14.1.5: Detections per unit effort of harbour porpoise in the Kylerhea region during 2008 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

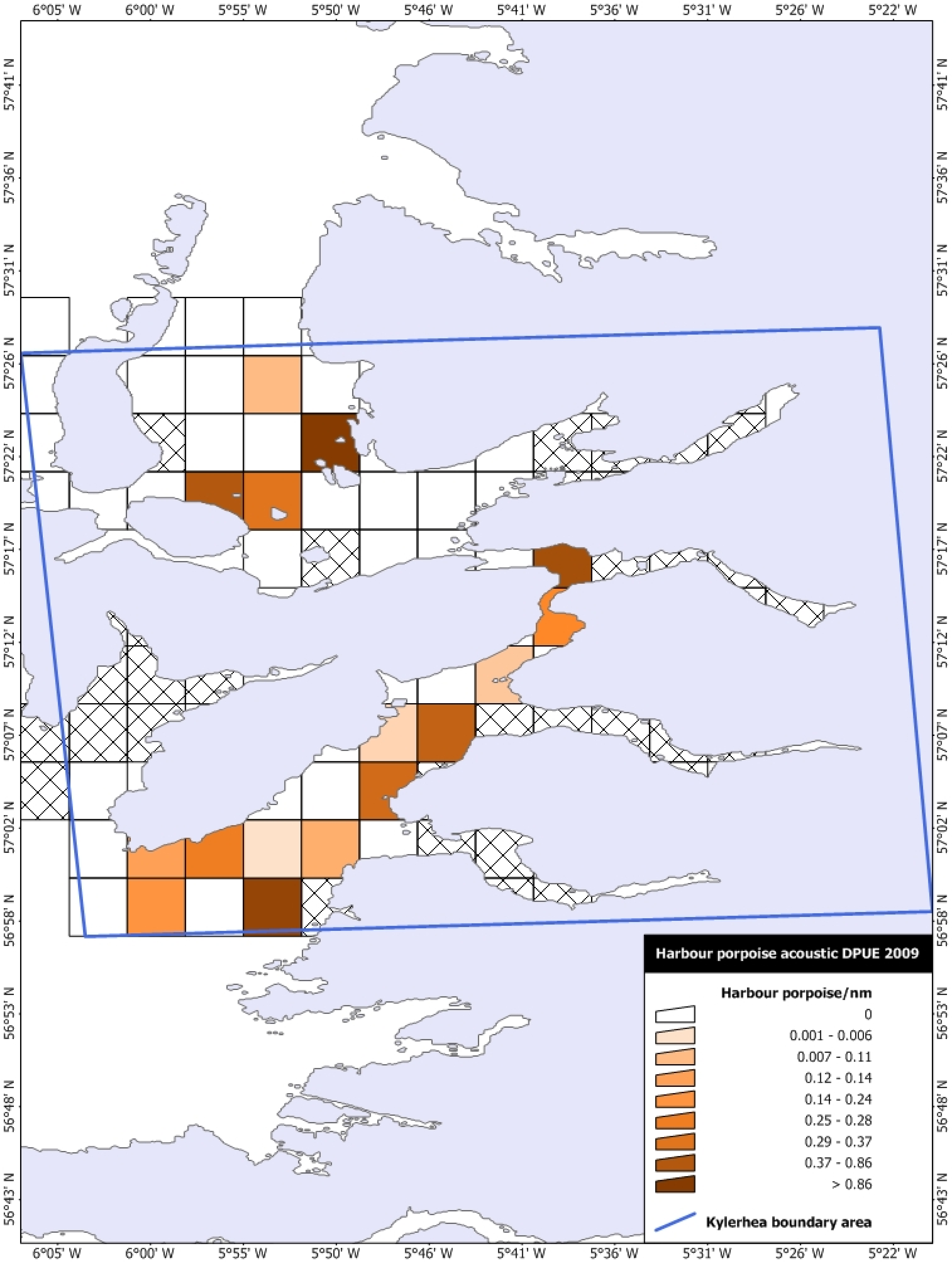

Figure 14.1.6: Detections per unit effort of harbour porpoise in the Kylerhea region during 2009 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

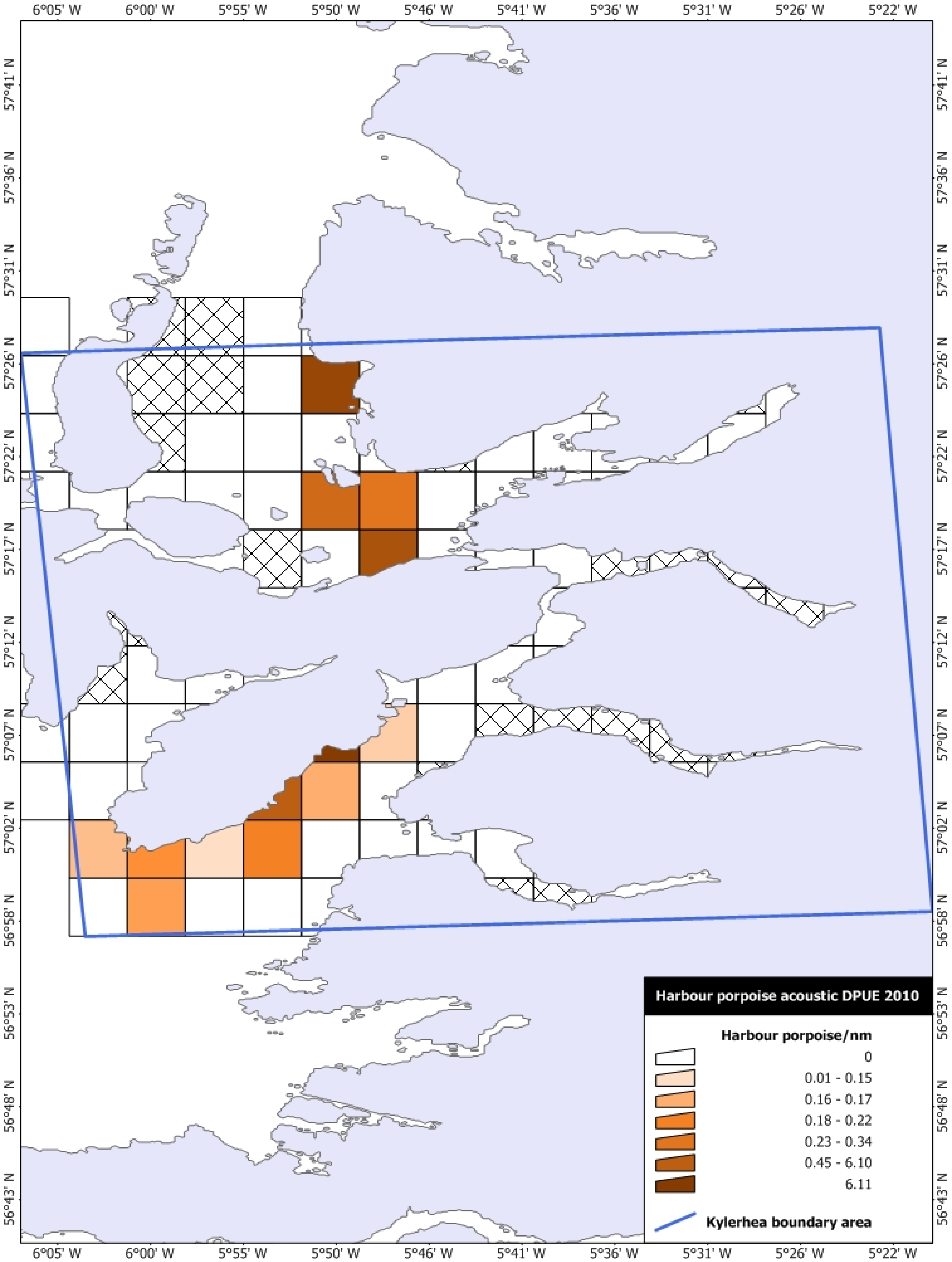

Figure 14.1.7: Detections per unit effort of harbour porpoise in the Kylerhea region during 2010 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

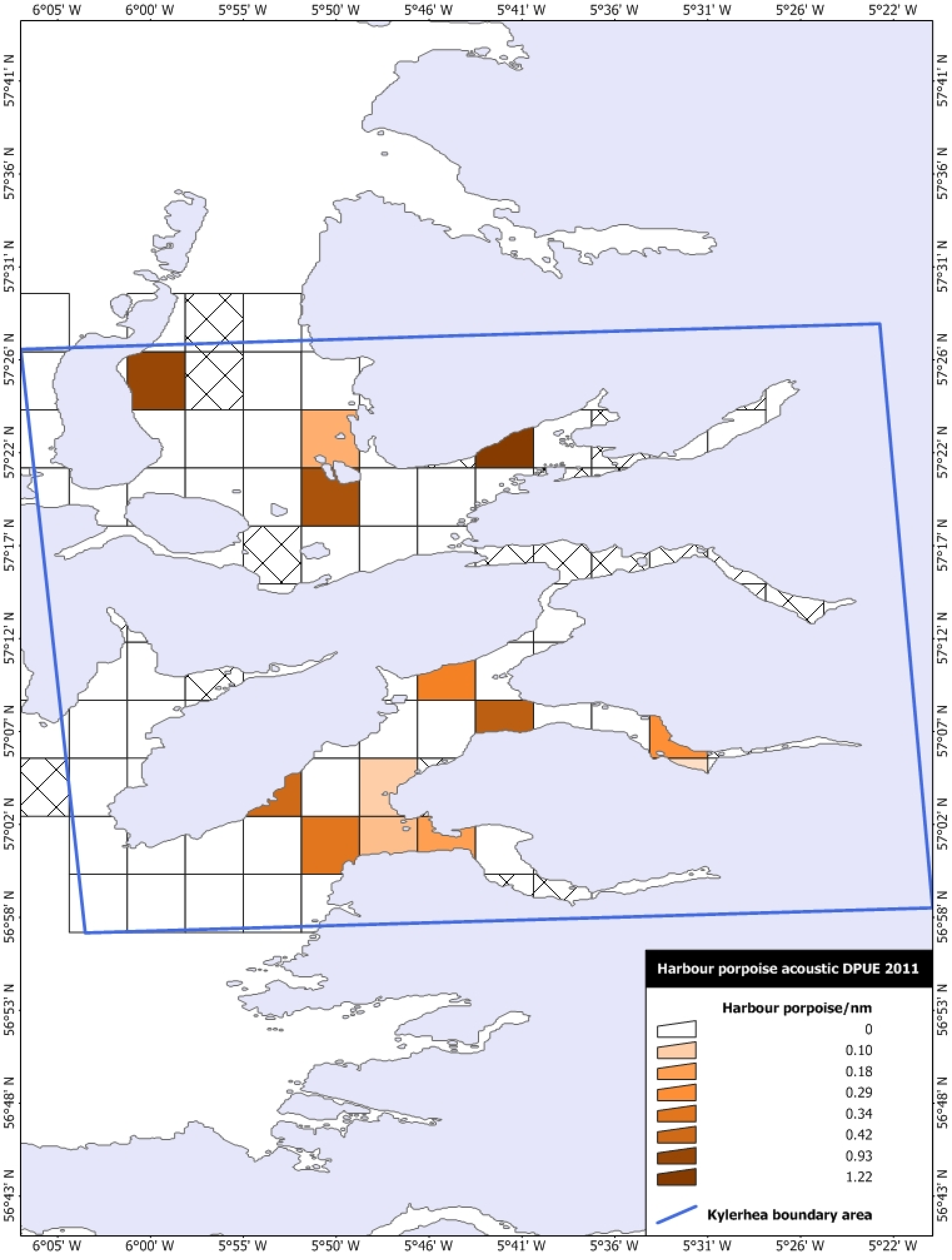

Figure 14.1.8: Detections per unit effort of harbour porpoise in the Kylerhea region during 2011 (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

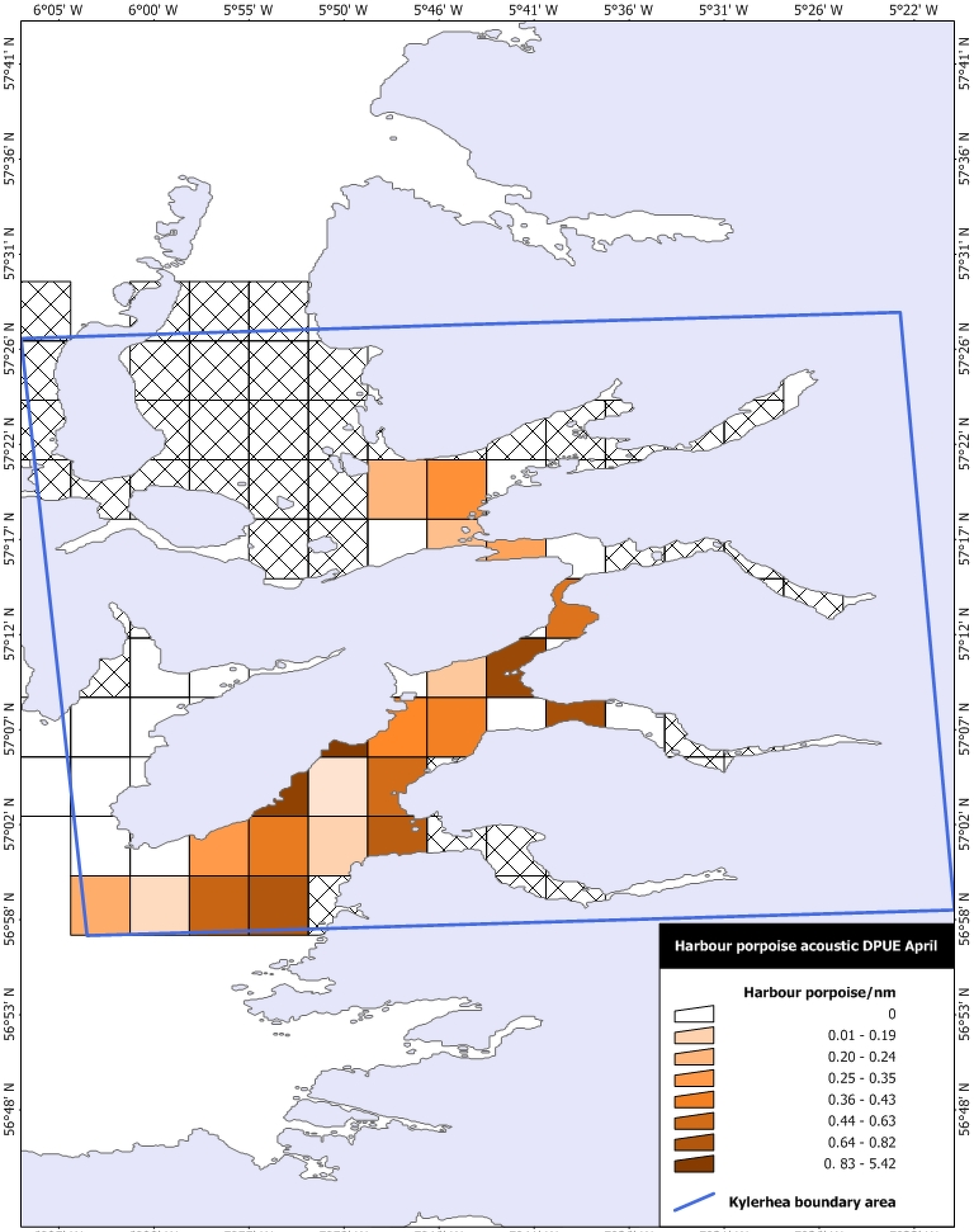

Figure 14.2.1: Detections per unit effort of harbour porpoise in the Kylerhea region during April (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

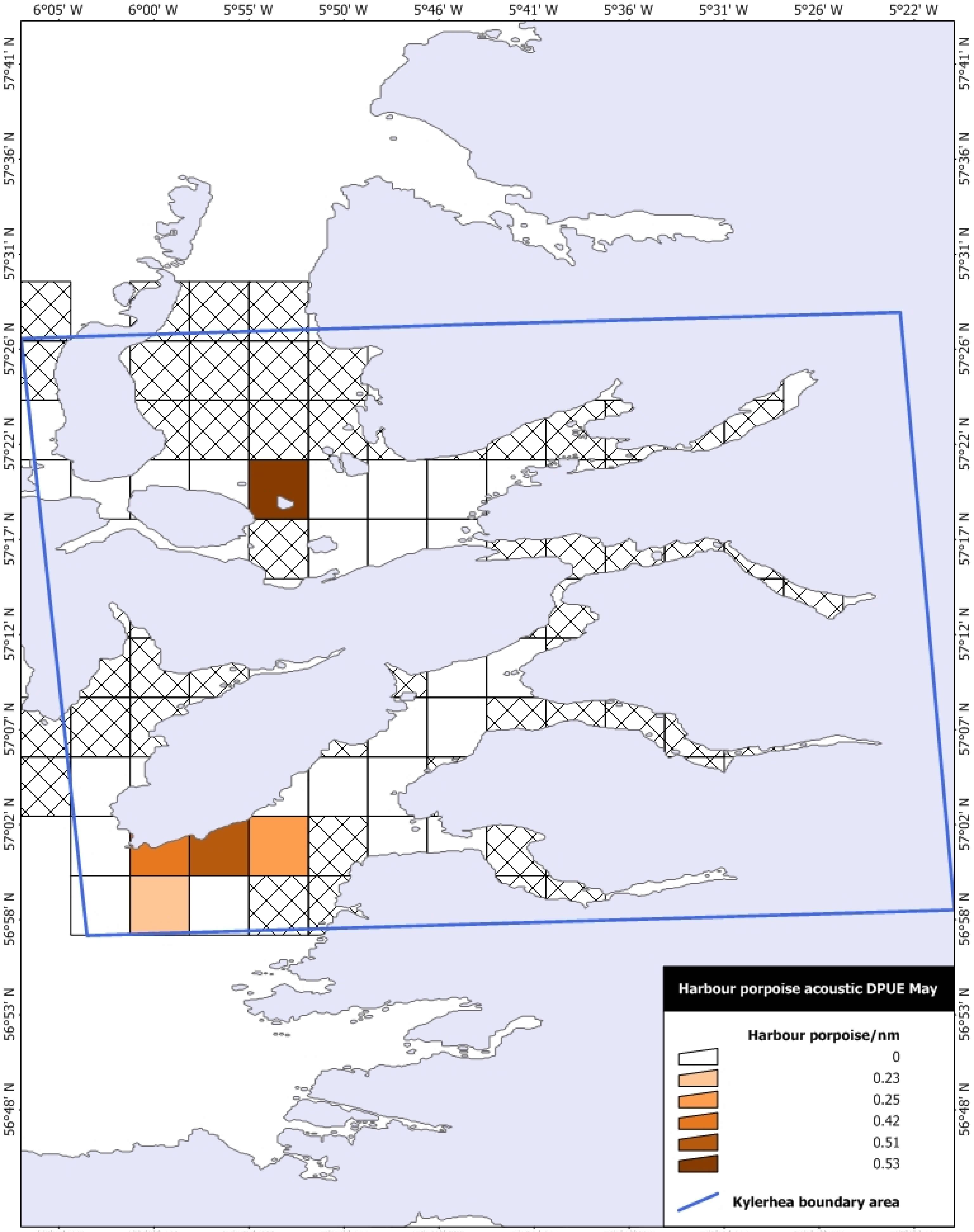

Figure 14.2.2: Detections per unit effort of harbour porpoise in the Kylerhea region during May (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

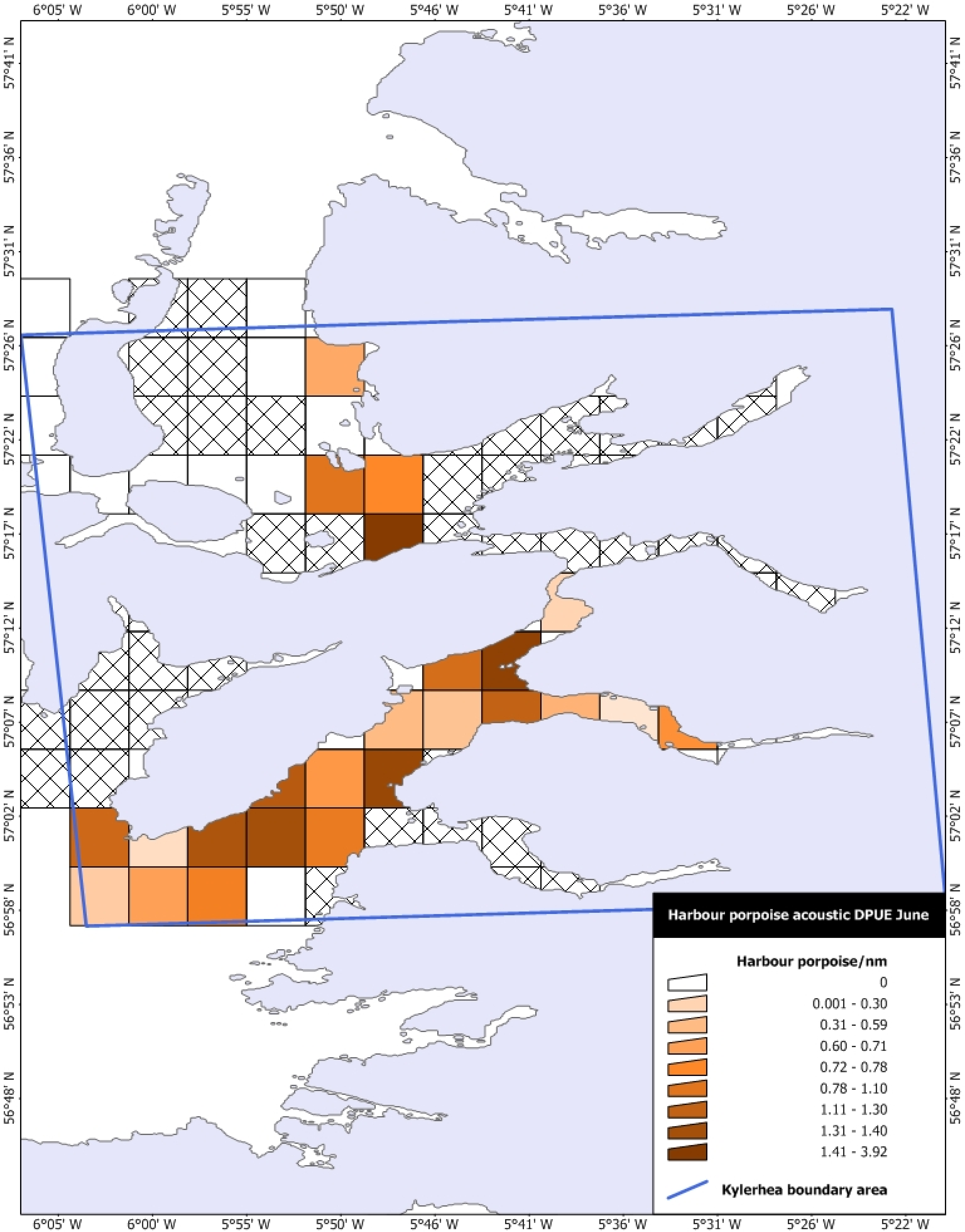

Figure 14.2.3: Detections per unit effort of harbour porpoise in the Kylerhea region during June (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

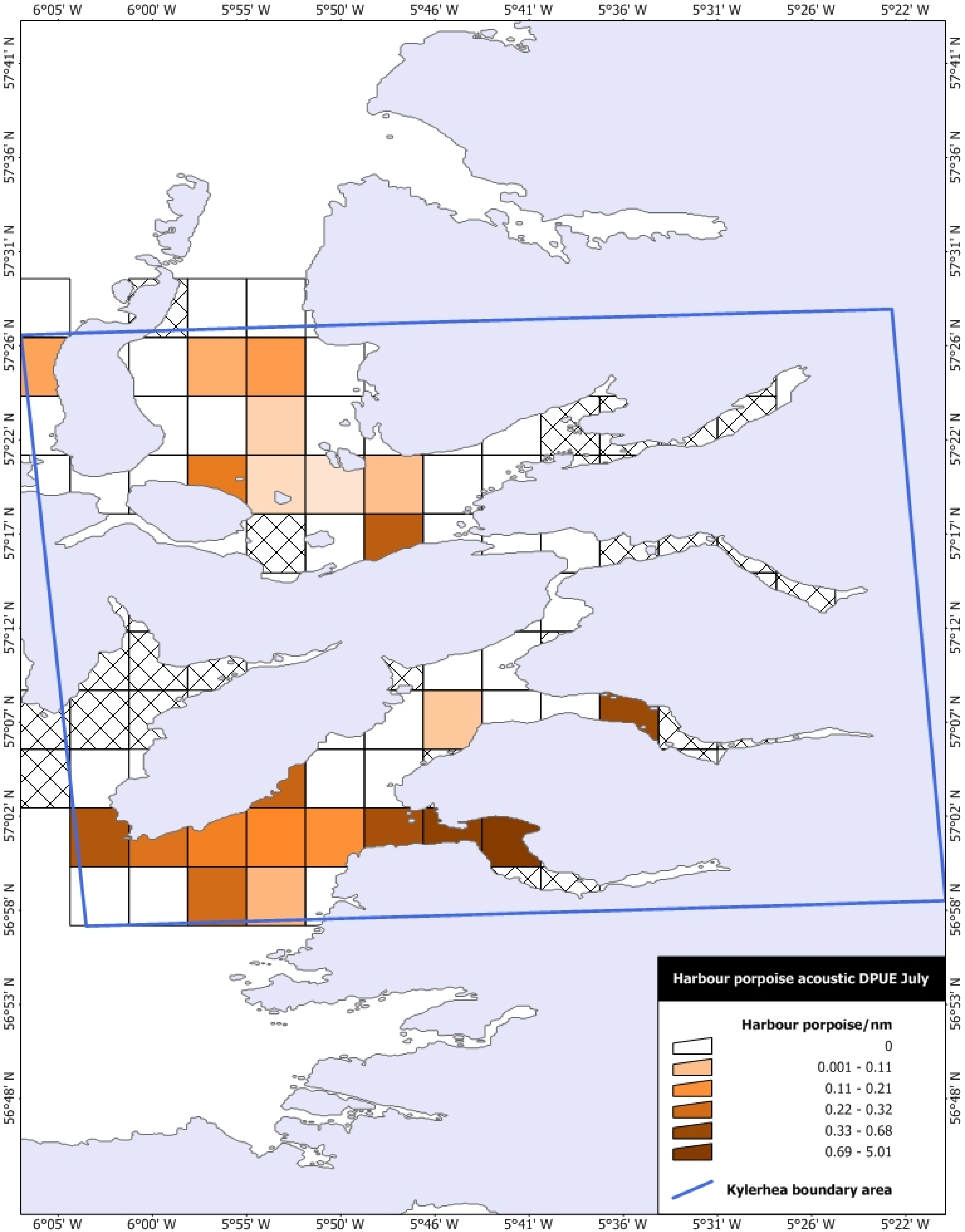

Figure 14.2.4: Detections per unit effort of harbour porpoise in the Kylerhea region during July (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

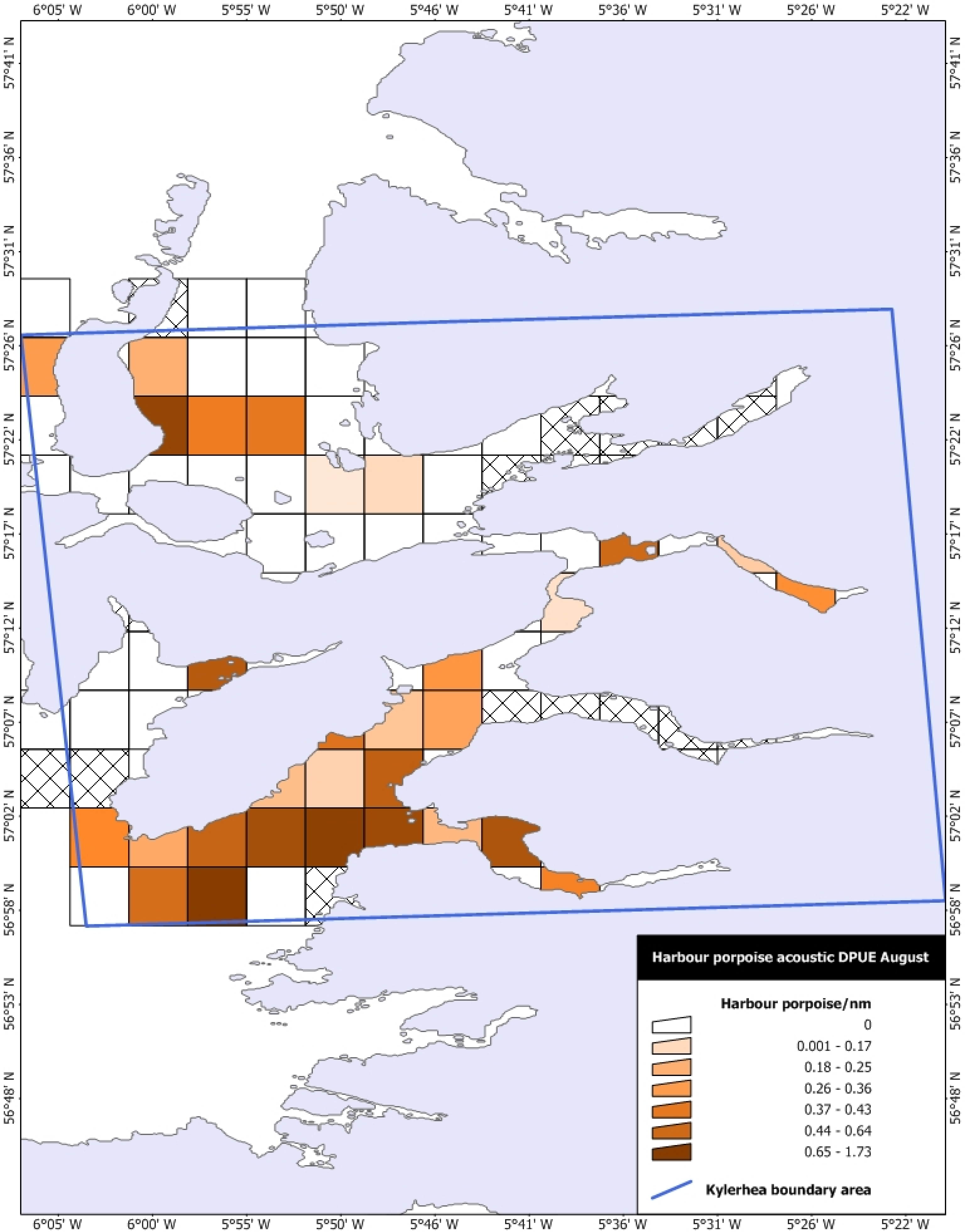

Figure 14.2.5: Detections per unit effort of harbour porpoise in the Kylerhea region during August (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

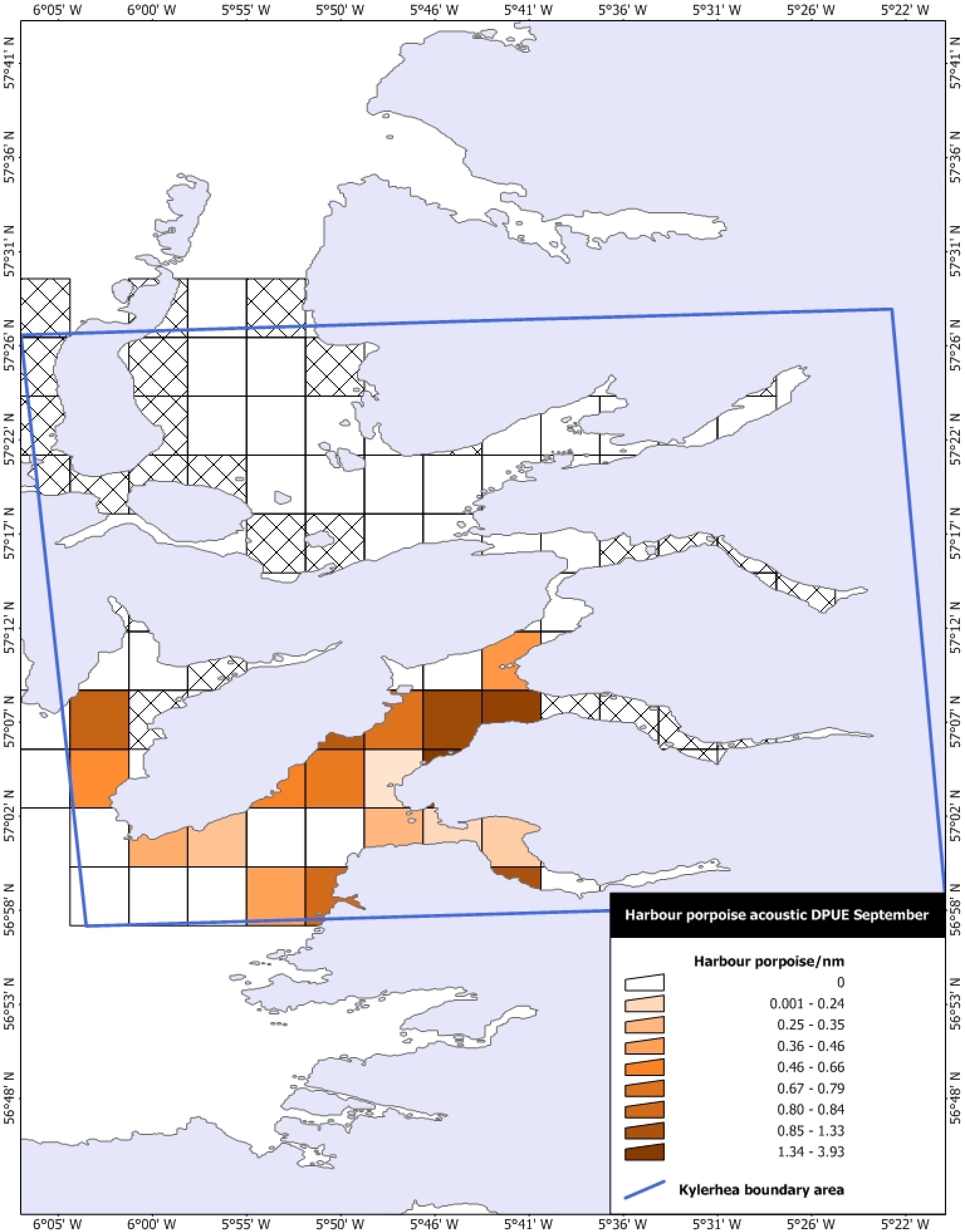

Figure 14.2.6: Detections per unit effort of harbour porpoise in the Kylerhea region during September (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

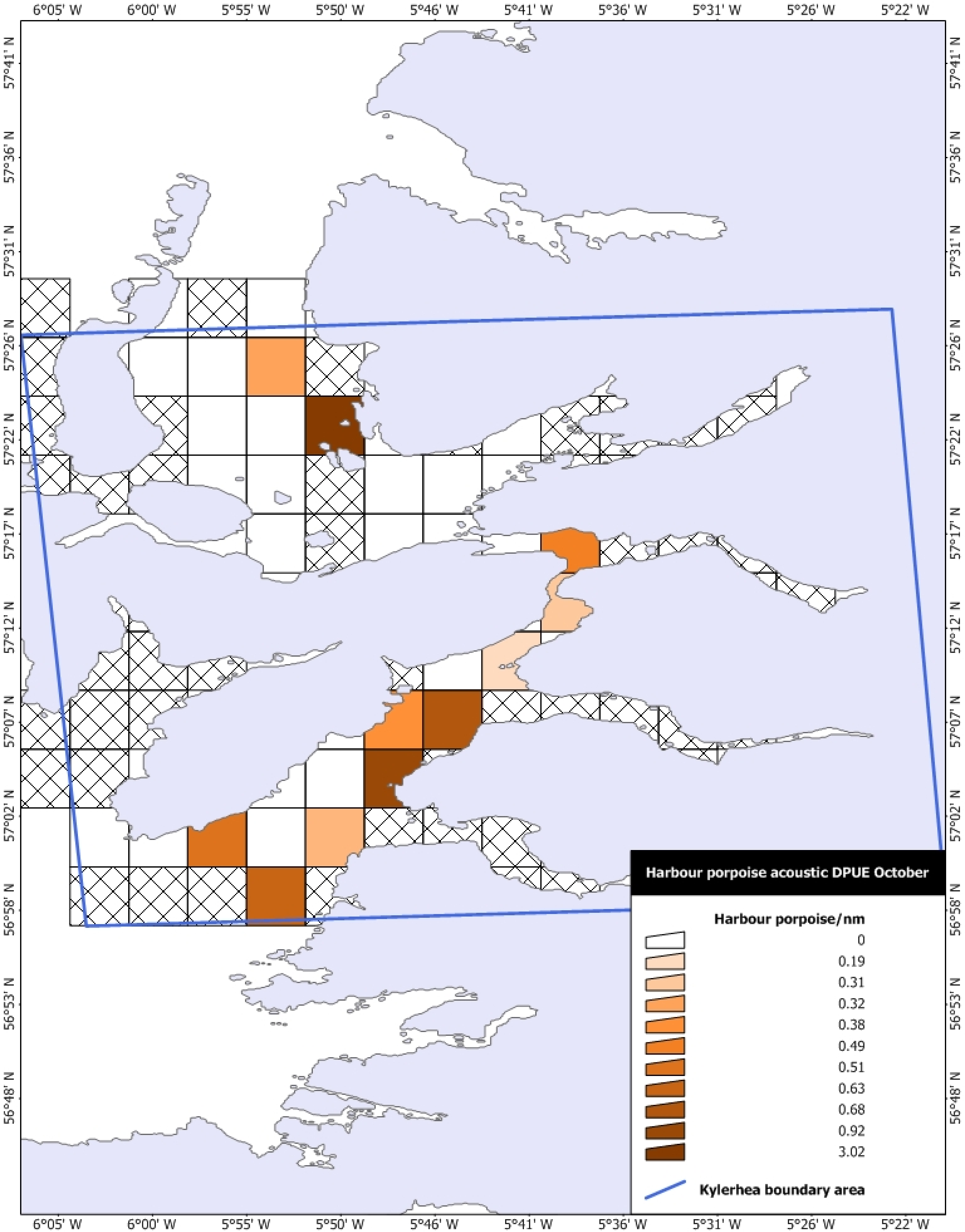

Figure 14.2.7: Detections per unit effort of harbour porpoise in the Kylerhea region during October (shown in shades of orange). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

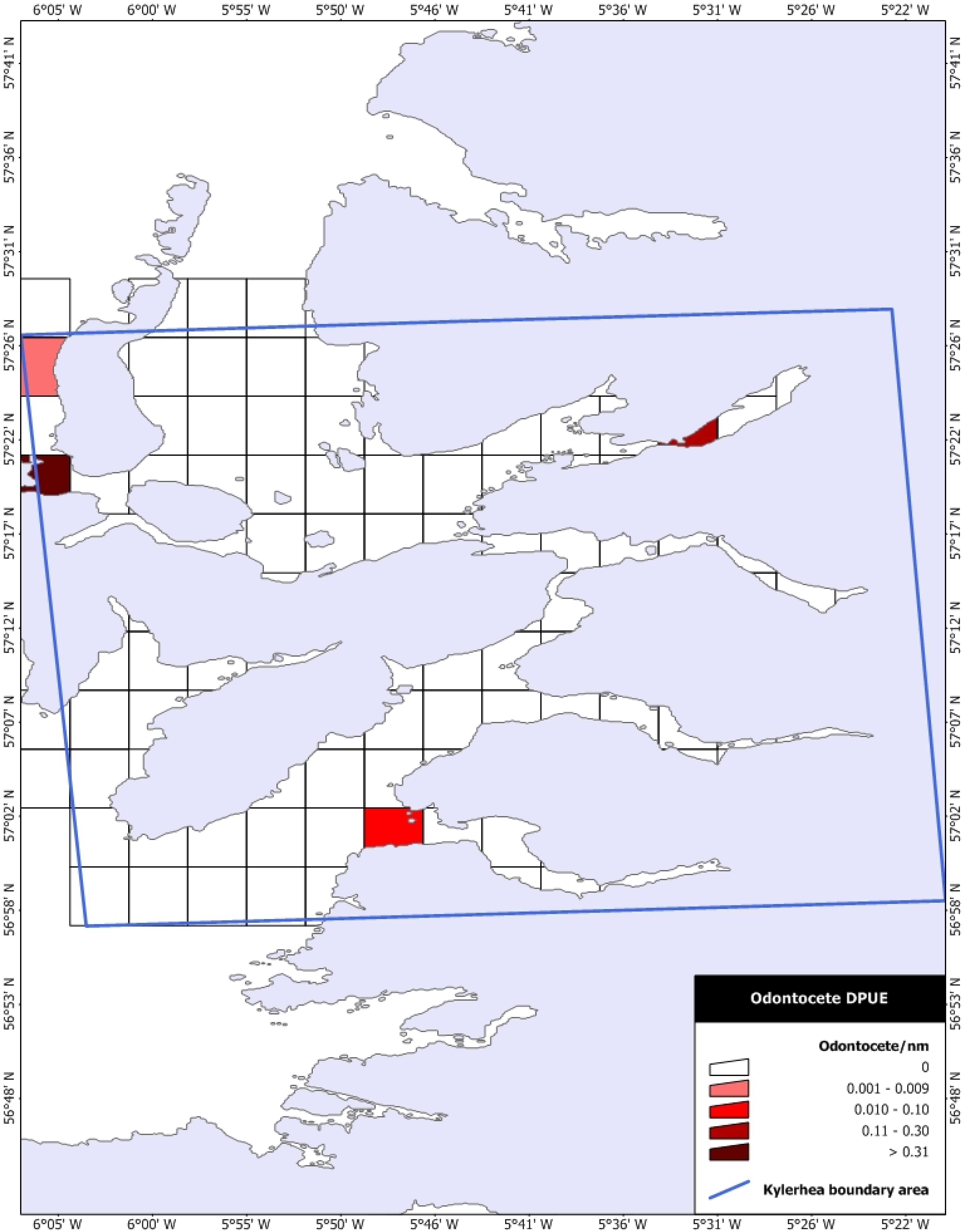

Figure 15: Detections per unit effort of odontocete species in the Kylerhea region between 2003 and 2011 (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

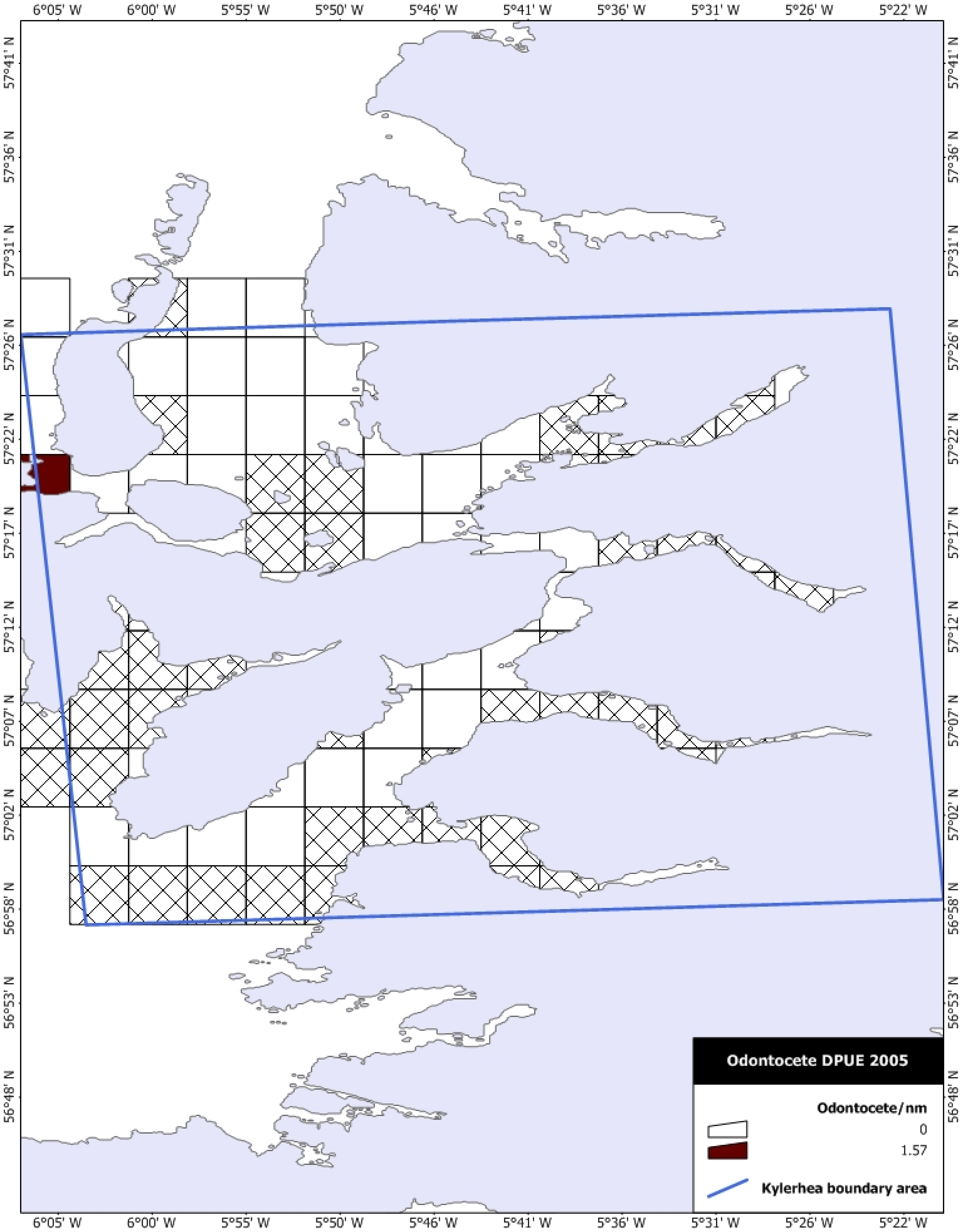

Figure 15.1.1: Detections per unit effort of odontocete species in the Kylerhea region during 2005 (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

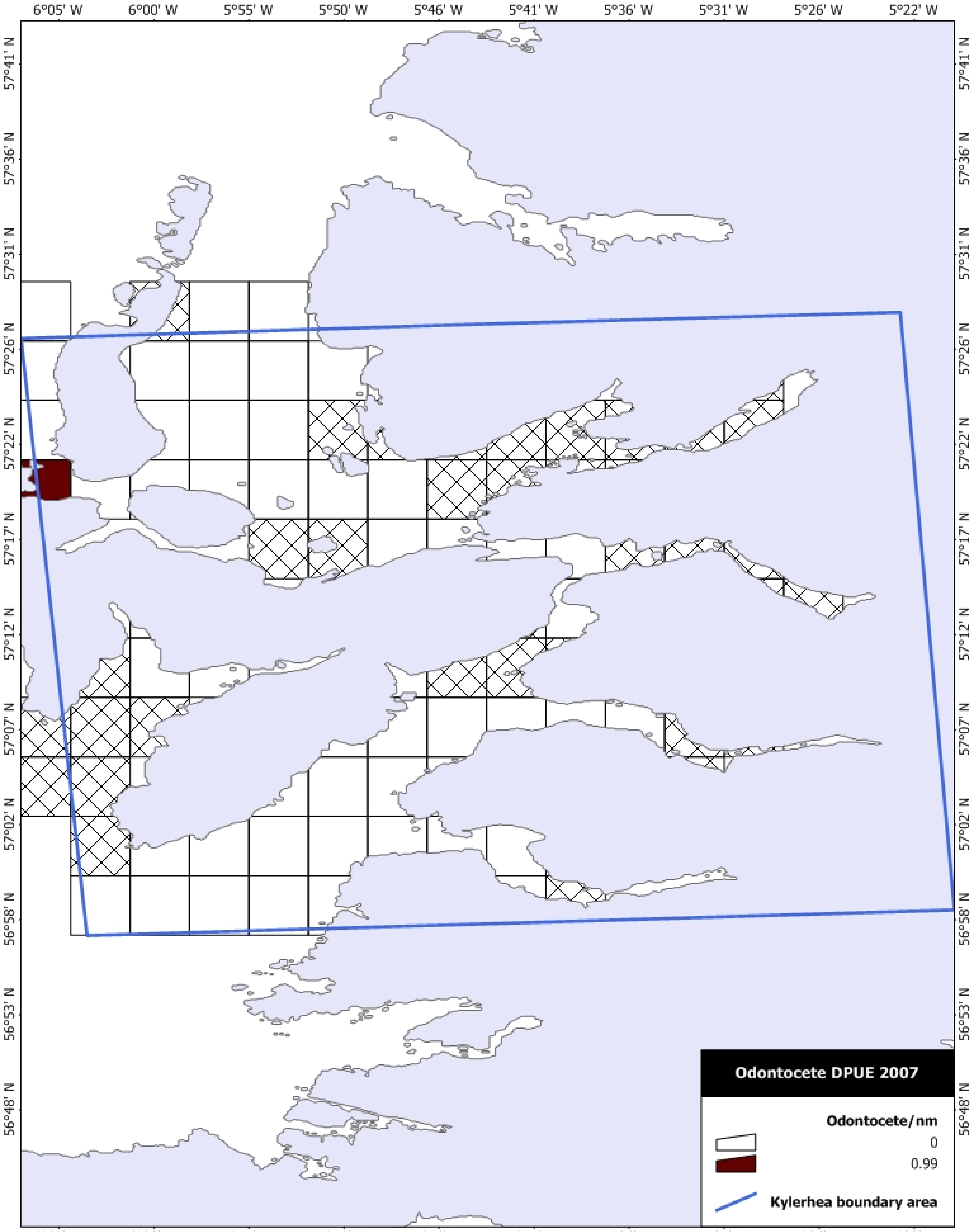

Figure 15.1.2: Detections per unit effort of odontocete species in the Kylerhea region during 2007 (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

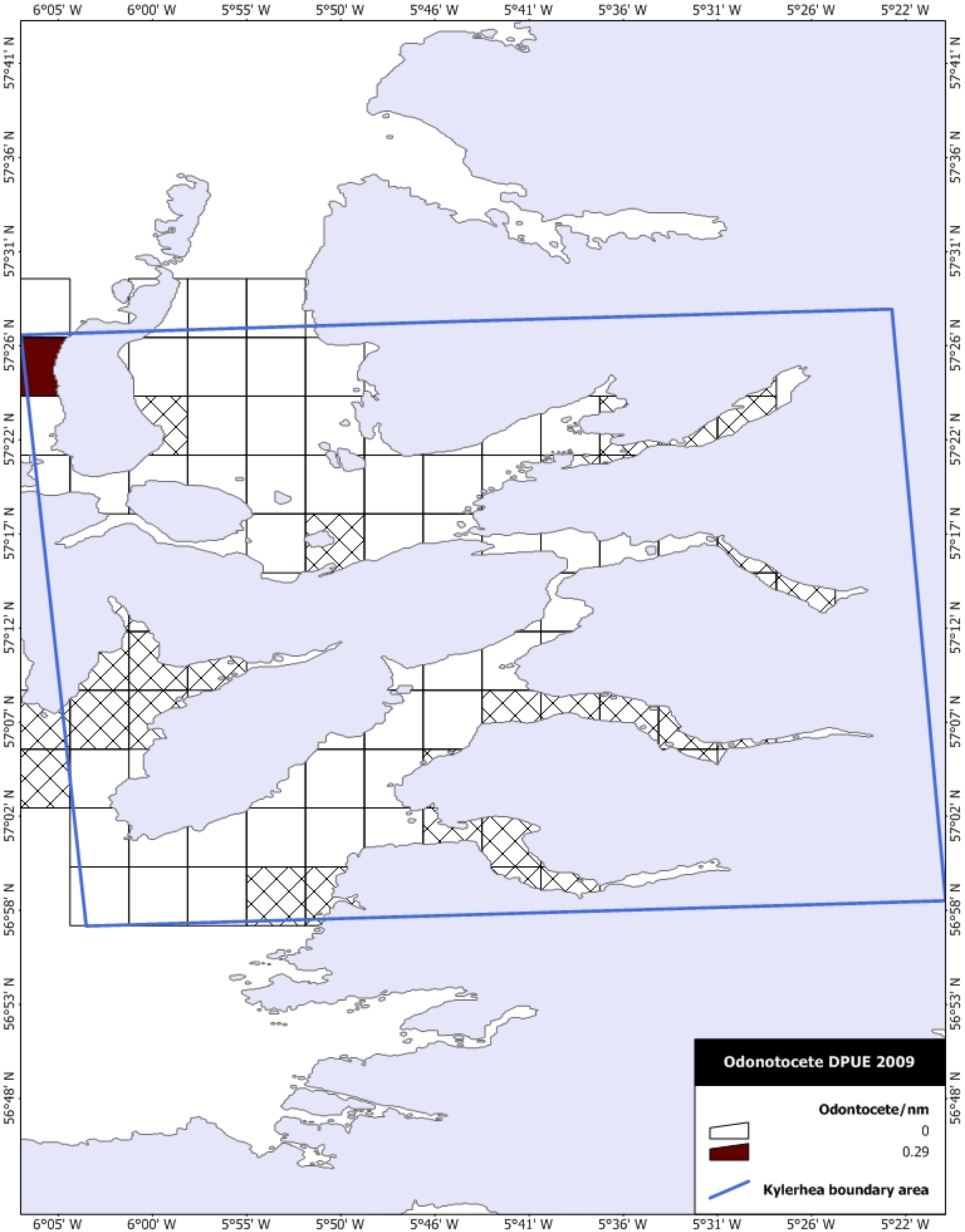

Figure 15.1.3: Detections per unit effort of odontocete species in the Kylerhea region during 2009 (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

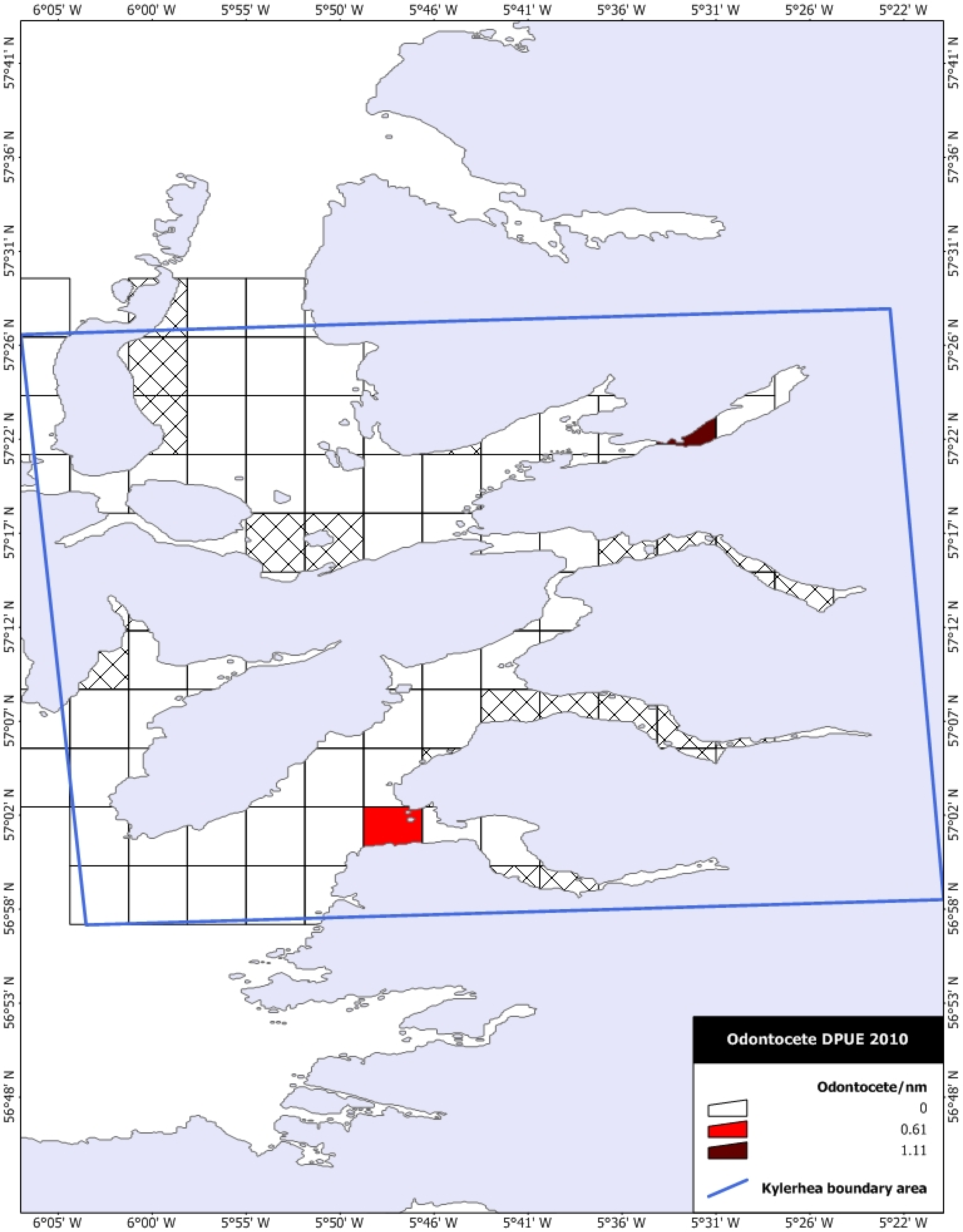

Figure 15.1.4: Detections per unit effort of odontocete species in the Kylerhea region during 2010 (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

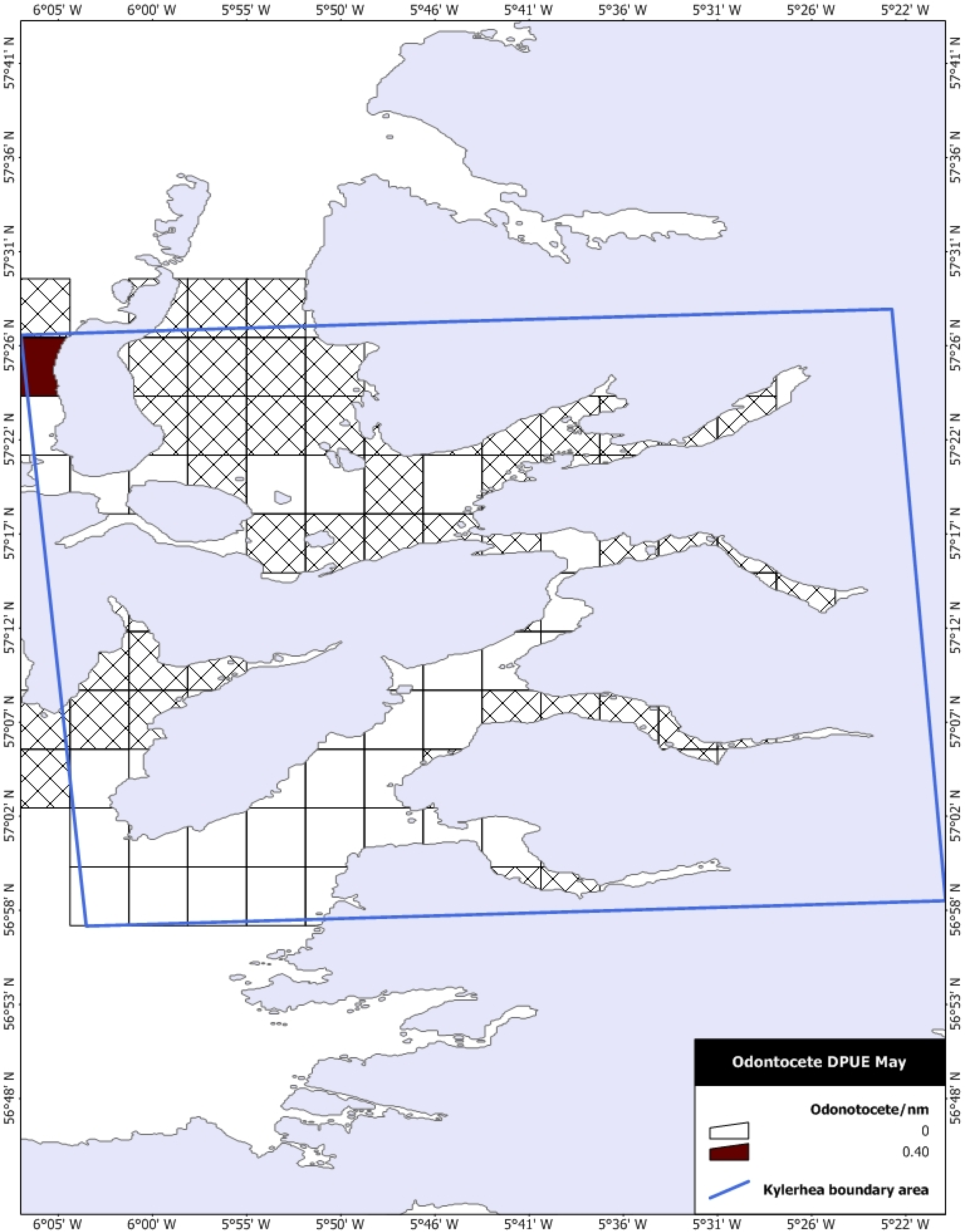

Figure 15.2.1: Detections per unit effort of odontocete species in the Kylerhea region during May (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

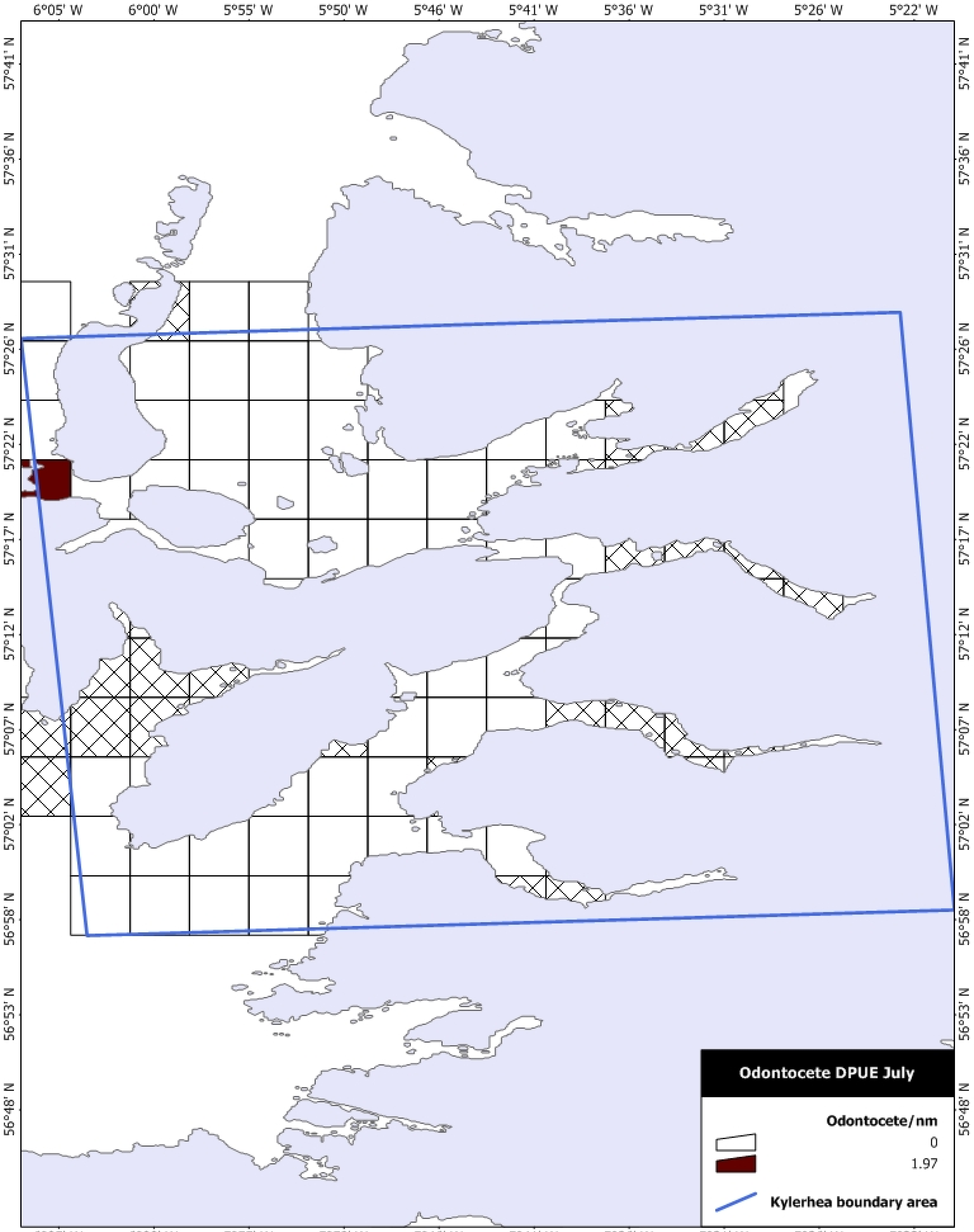

Figure 15.2.2: Detections per unit effort of odontocete species in the Kylerhea region during July (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

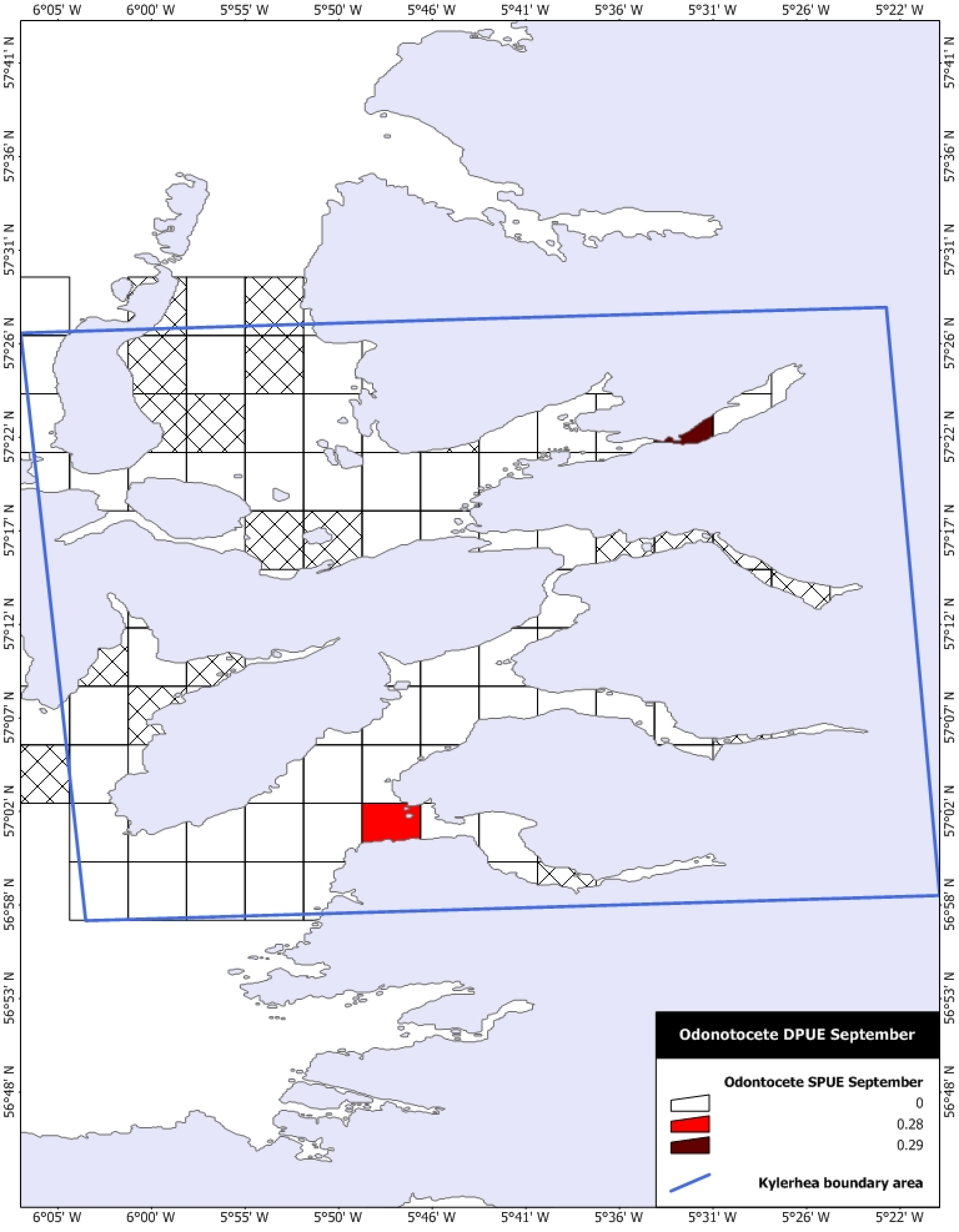

Figure 15.2.3: Detections per unit effort of odontocete species in the Kylerhea region during September (shown in shades of red). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

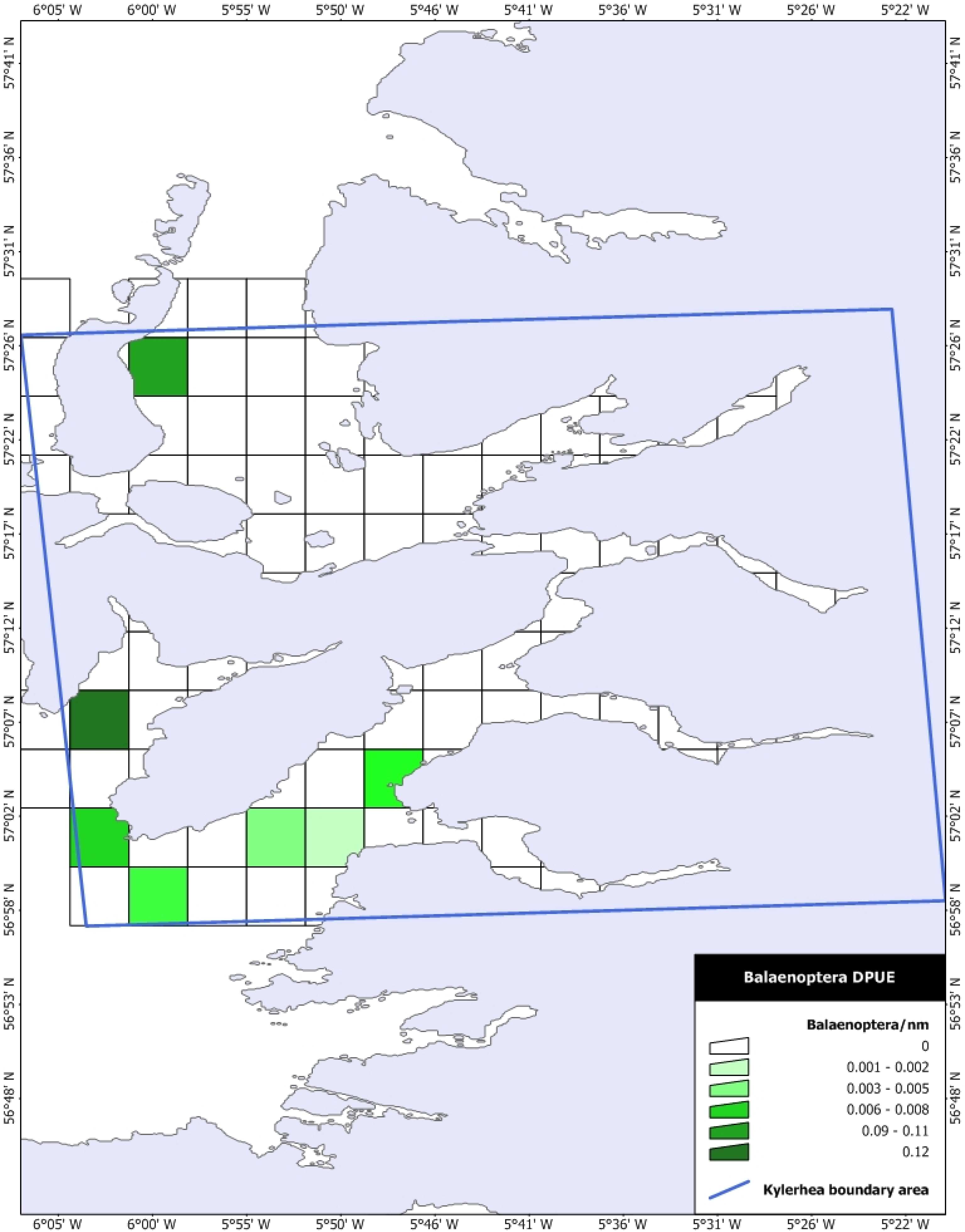

Figure 16: Detections per unit effort of balaenoptera species in the Kylerhea region between 2003 and 2011 (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

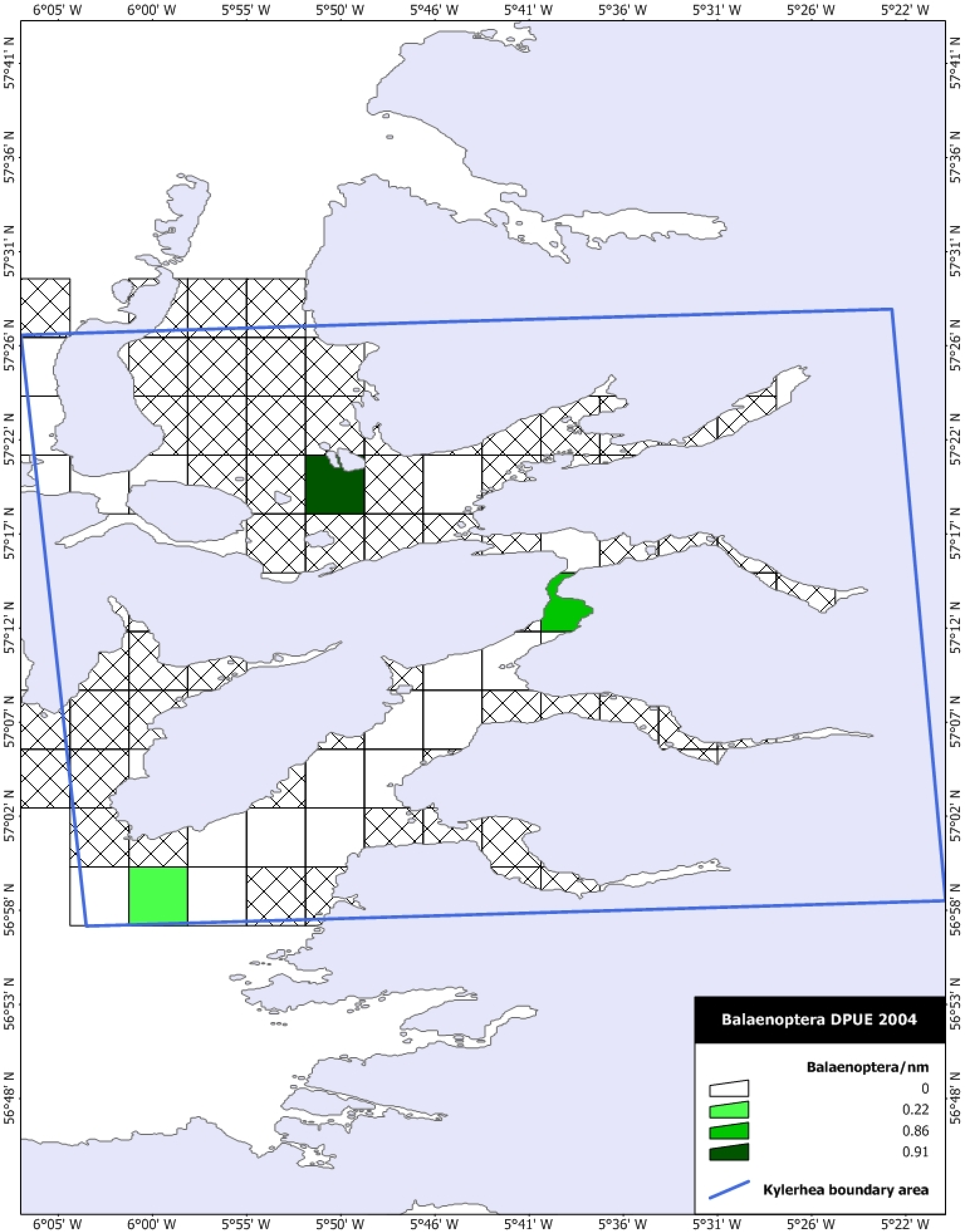

Figure 16.1.1: Detections per unit effort of balaenoptera species in the Kylerhea region during 2004 (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

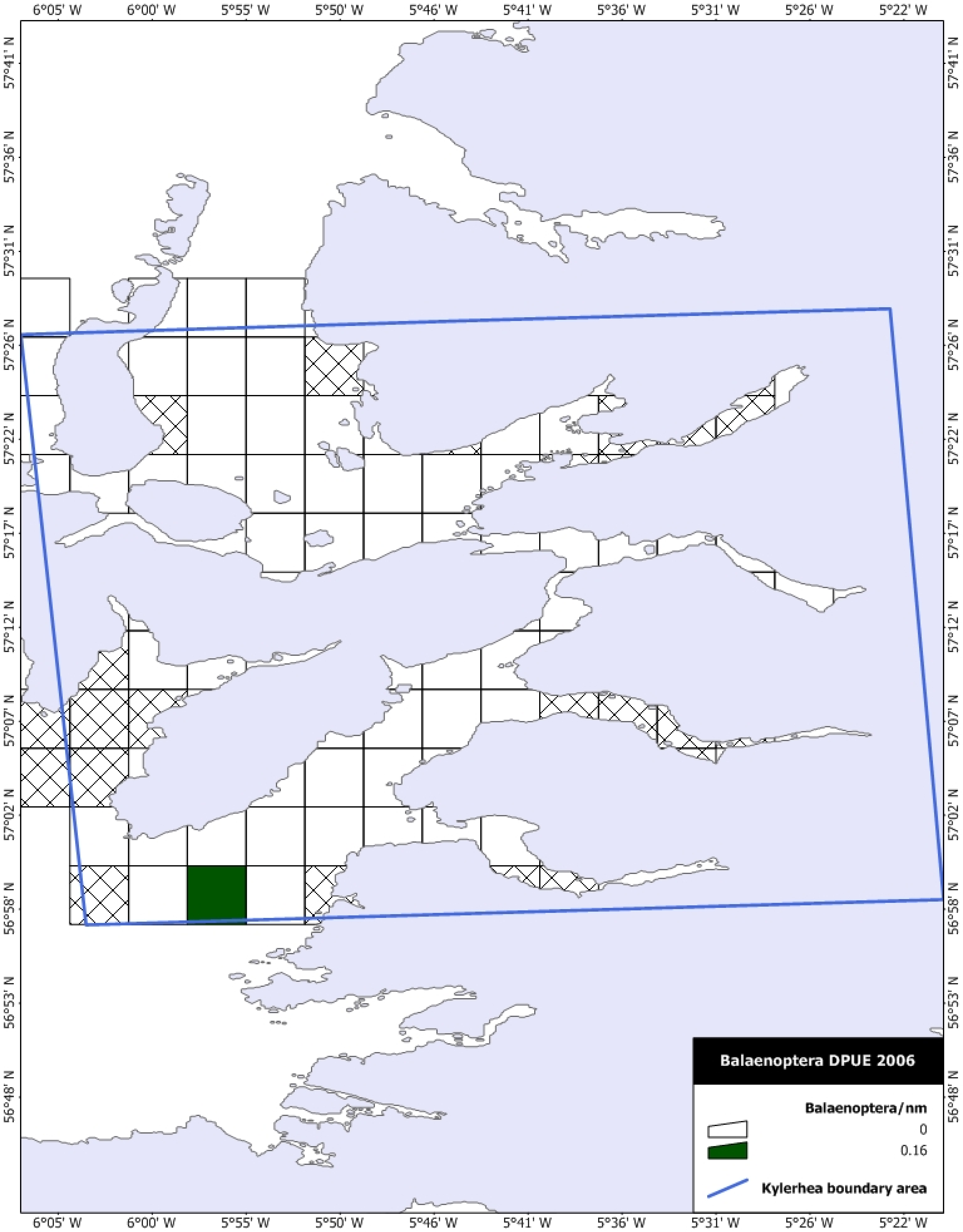

Figure 16.1.2: Detections per unit effort of balaenoptera species in the Kylerhea region during 2006 (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

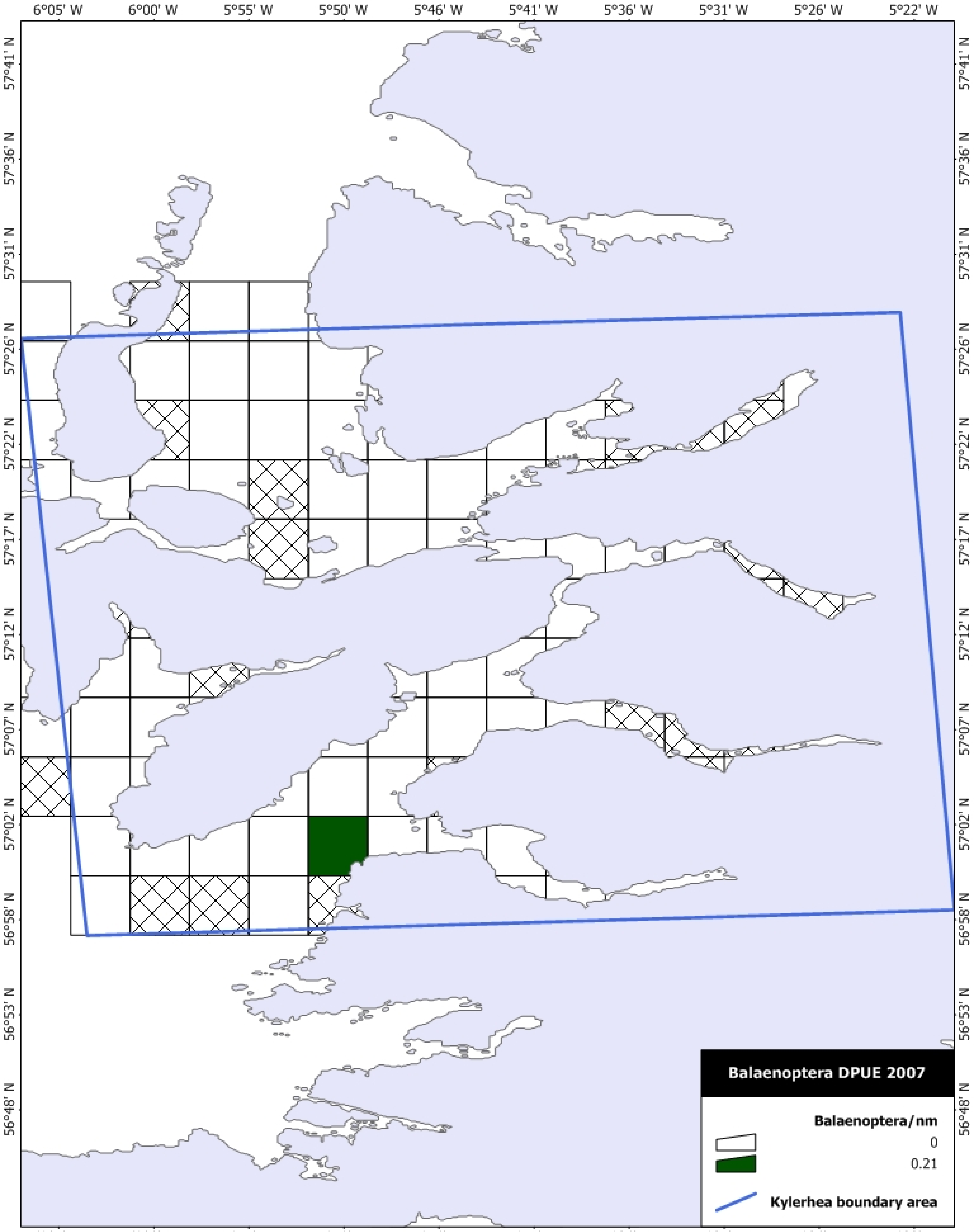

Figure 16.1.3: Detections per unit effort of balaenoptera species in the Kylerhea region during 2007 (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

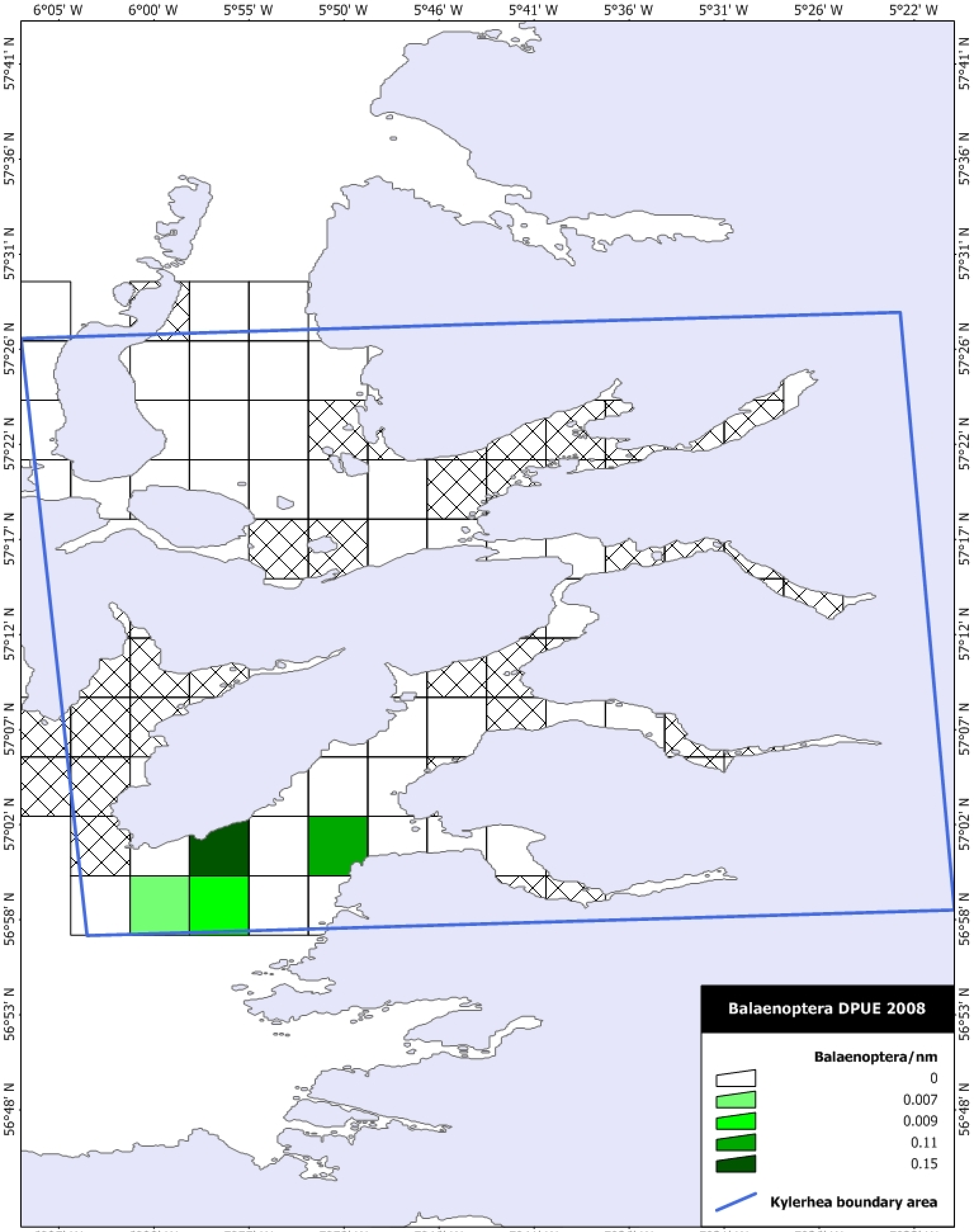

Figure 16.1.4: Detections per unit effort of balaenoptera species in the Kylerhea region during 2008 (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

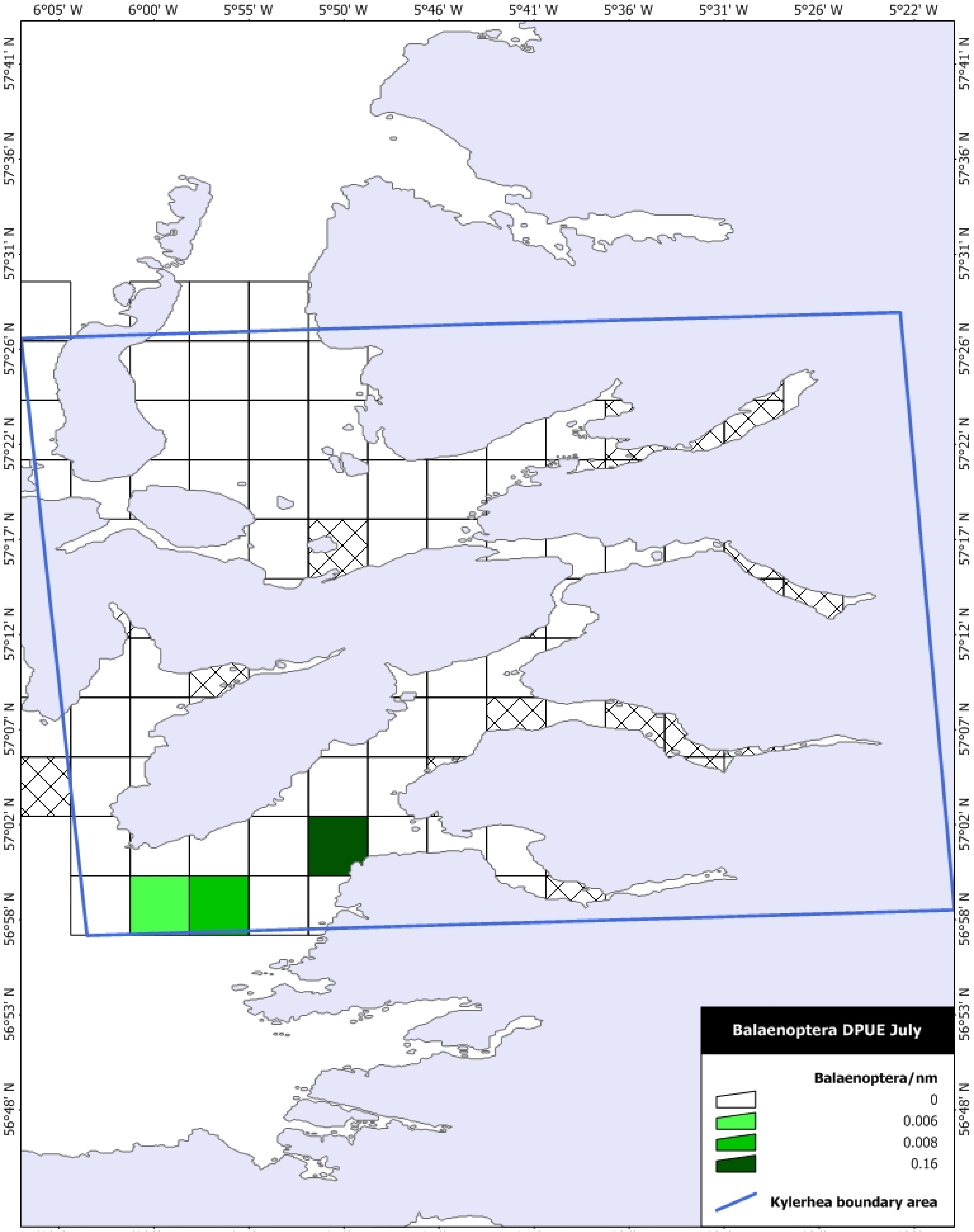

Figure 16.2.1: Detections per unit effort of balaenoptera species in the Kylerhea region during July (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

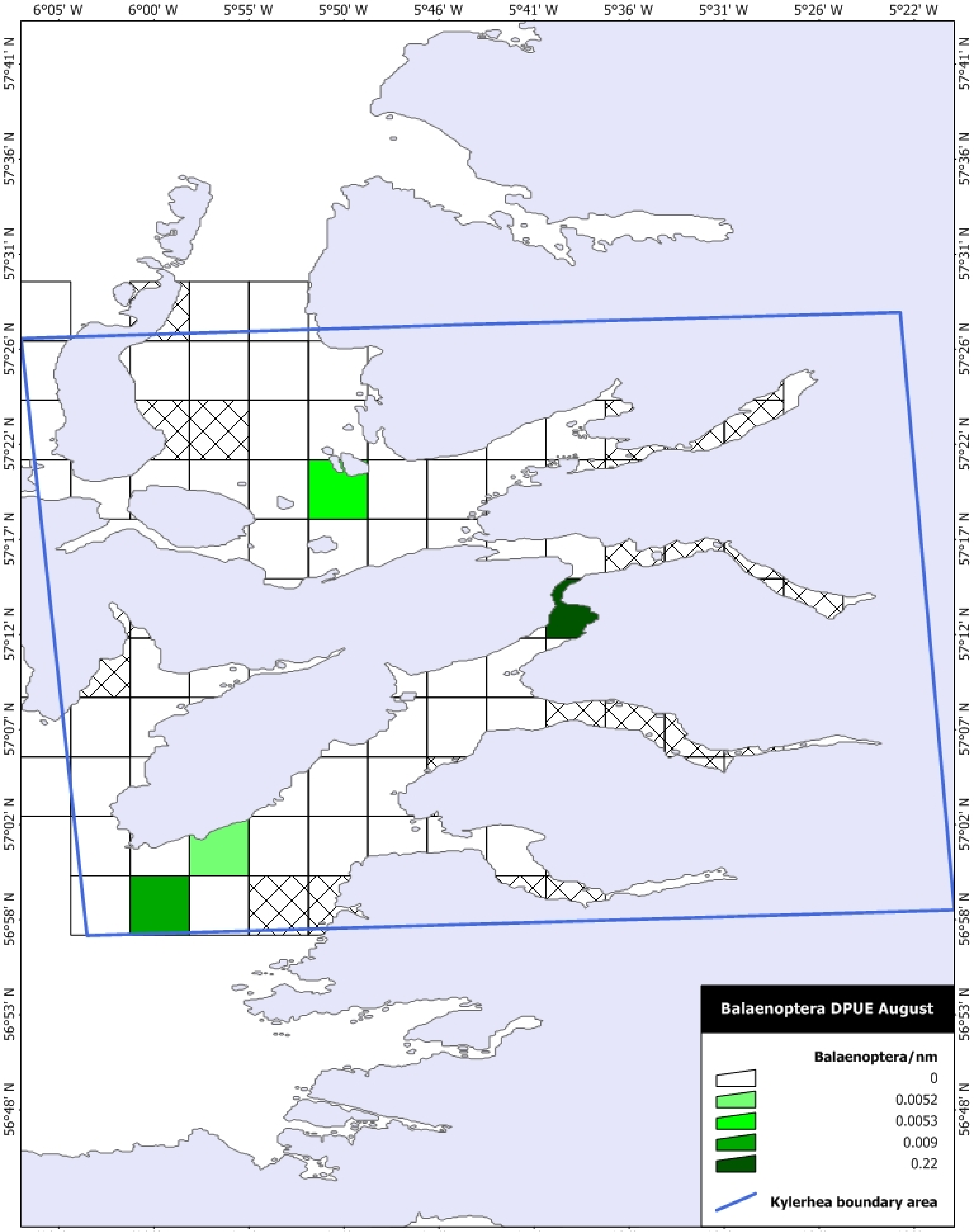

Figure 16.2.2: Detections per unit effort of balaenoptera species in the Kylerhea region during August (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

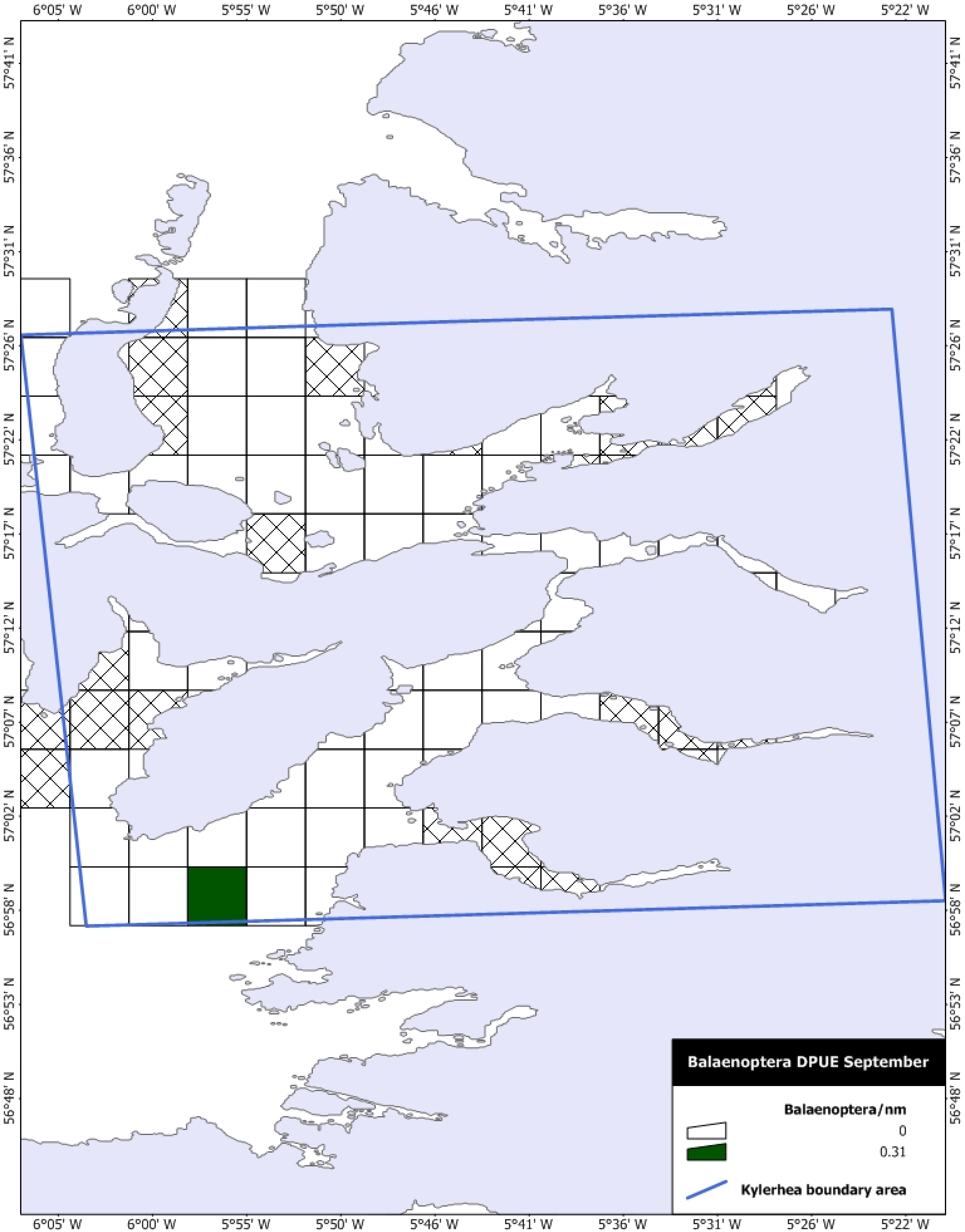

Figure 16.2.3: Detections per unit effort of balaenoptera species in the Kylerhea region during September (shown in shades of green). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

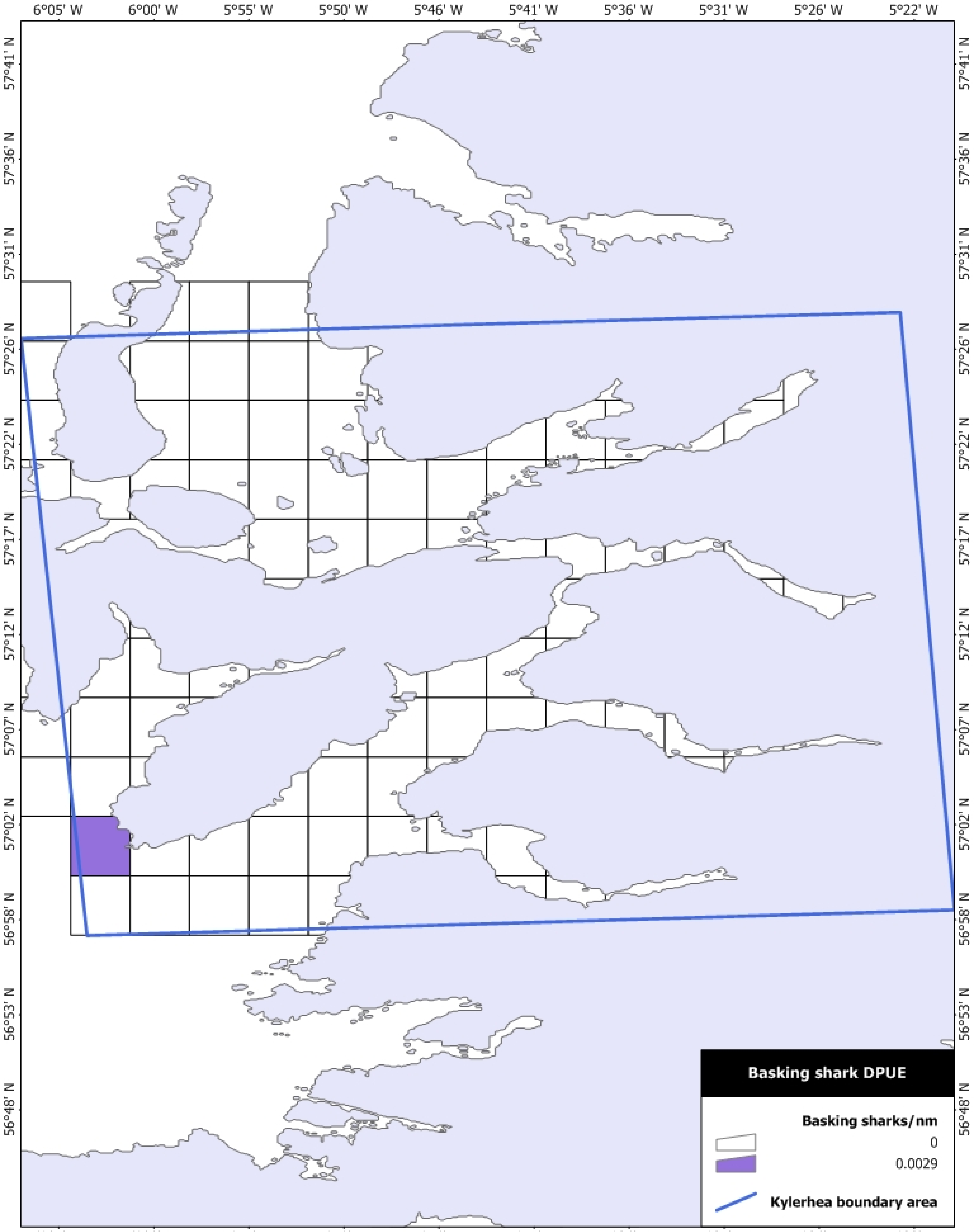

Figure 17: Detections per unit effort of basking shark in the Kylerhea region between 2003 and 2011 (shown in shades of purple). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

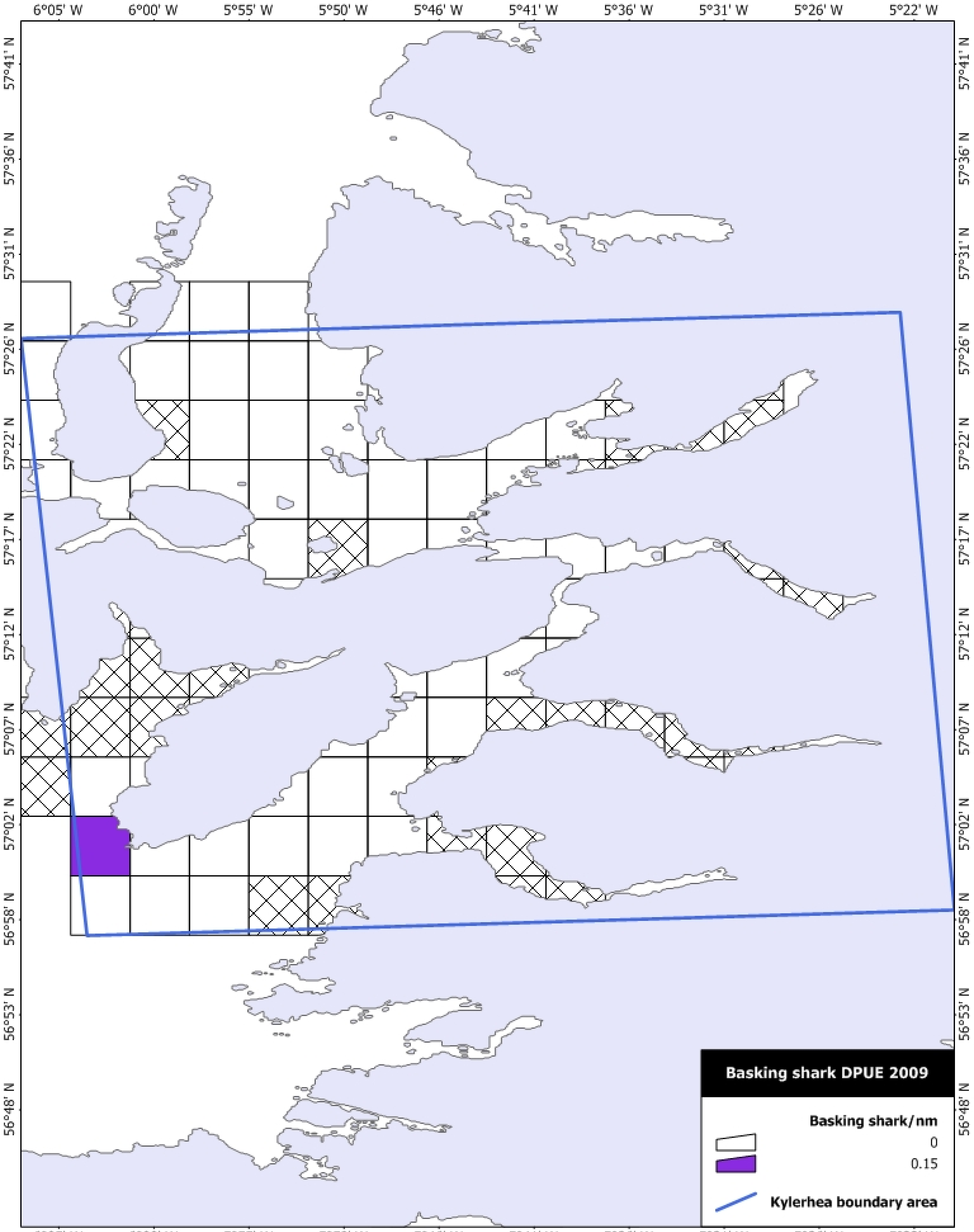

Figure 17.1.1: Detections per unit effort of basking shark in the Kylerhea region during 2009 (shown in shades of purple). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

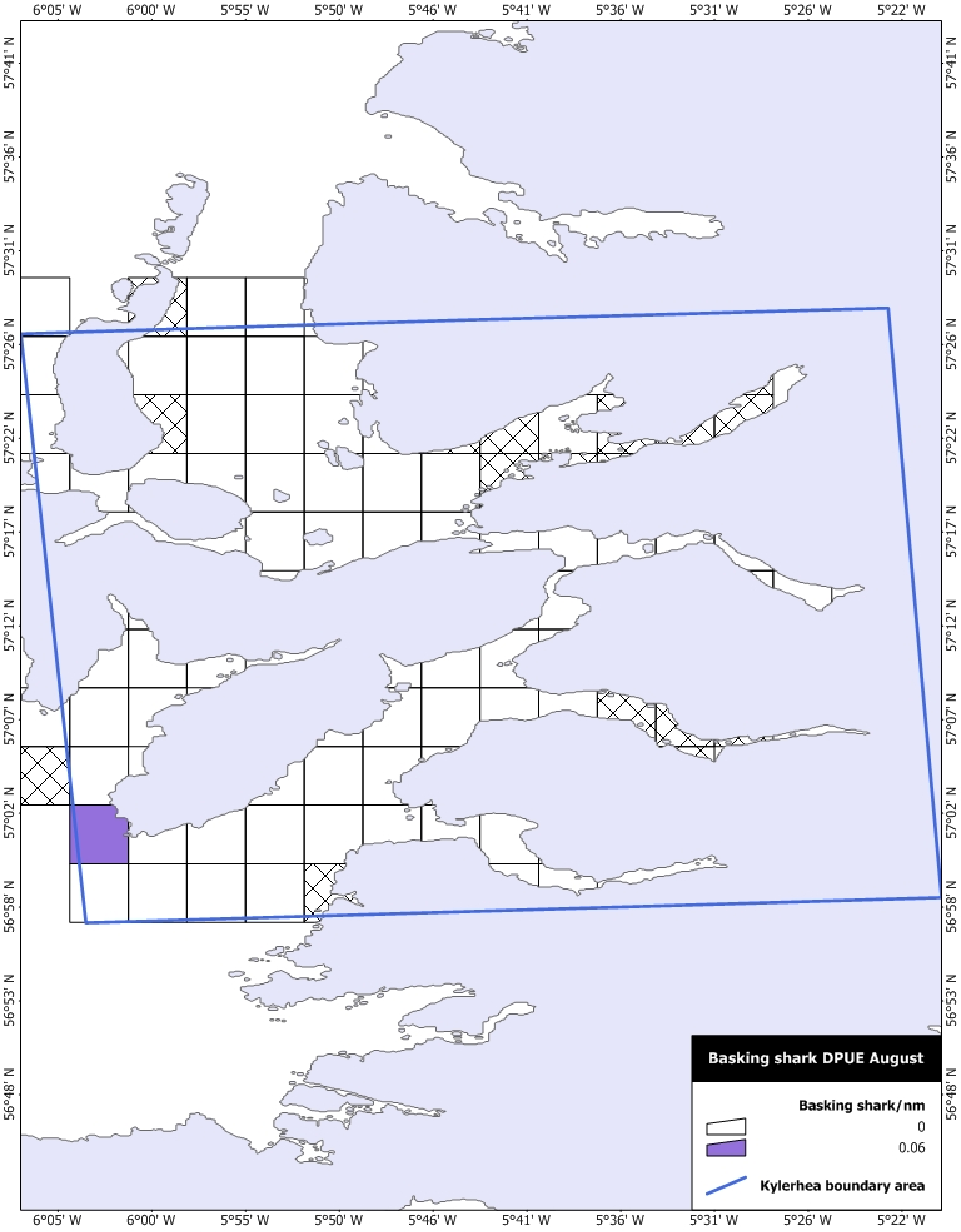

Figure 17.2.1: Detections per unit effort of basking shark in the Kylerhea region during August (shown in shades of purple). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

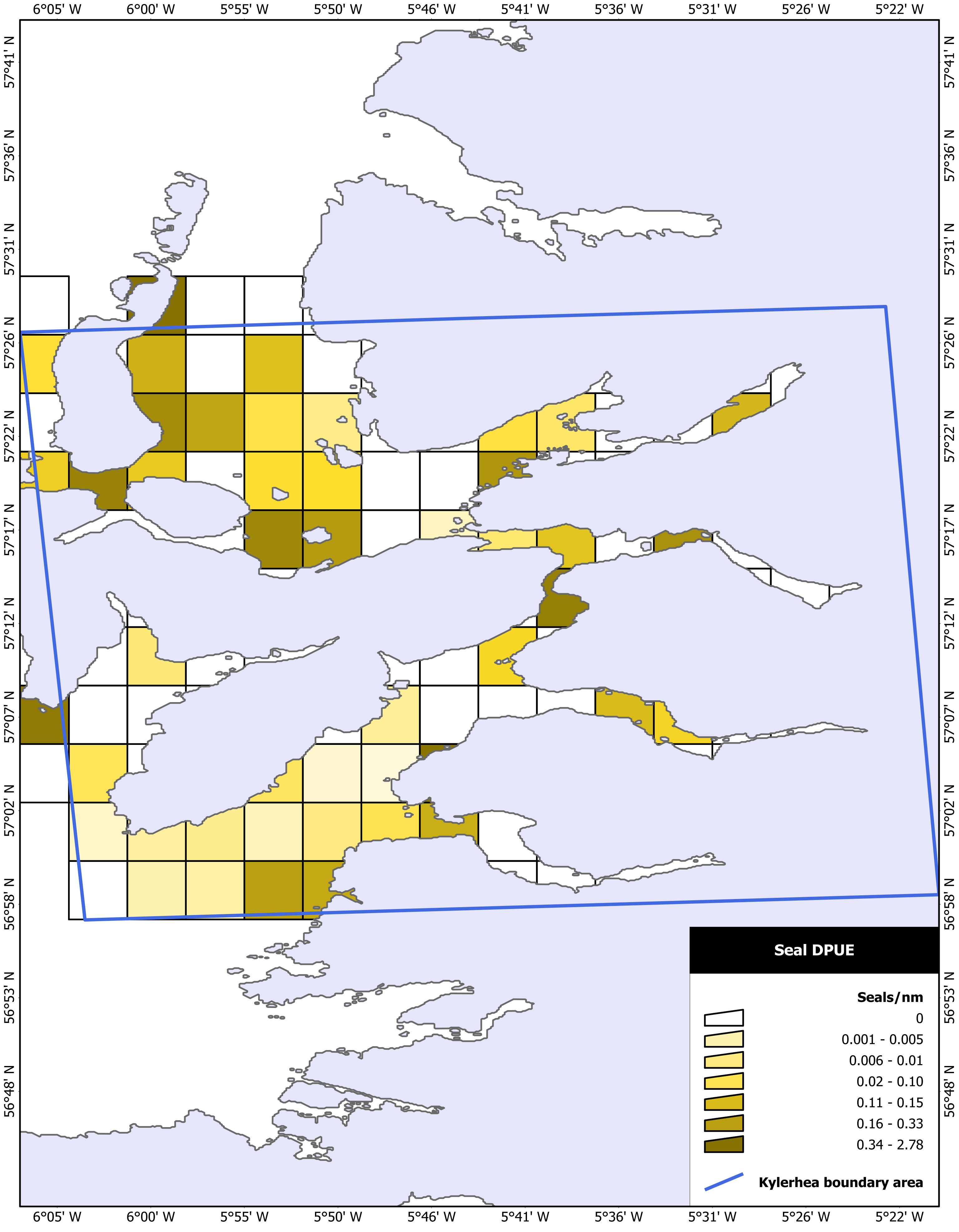

Figure 18: Detections per unit effort of seals in the Kylerhea region between 2003 and 2011 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

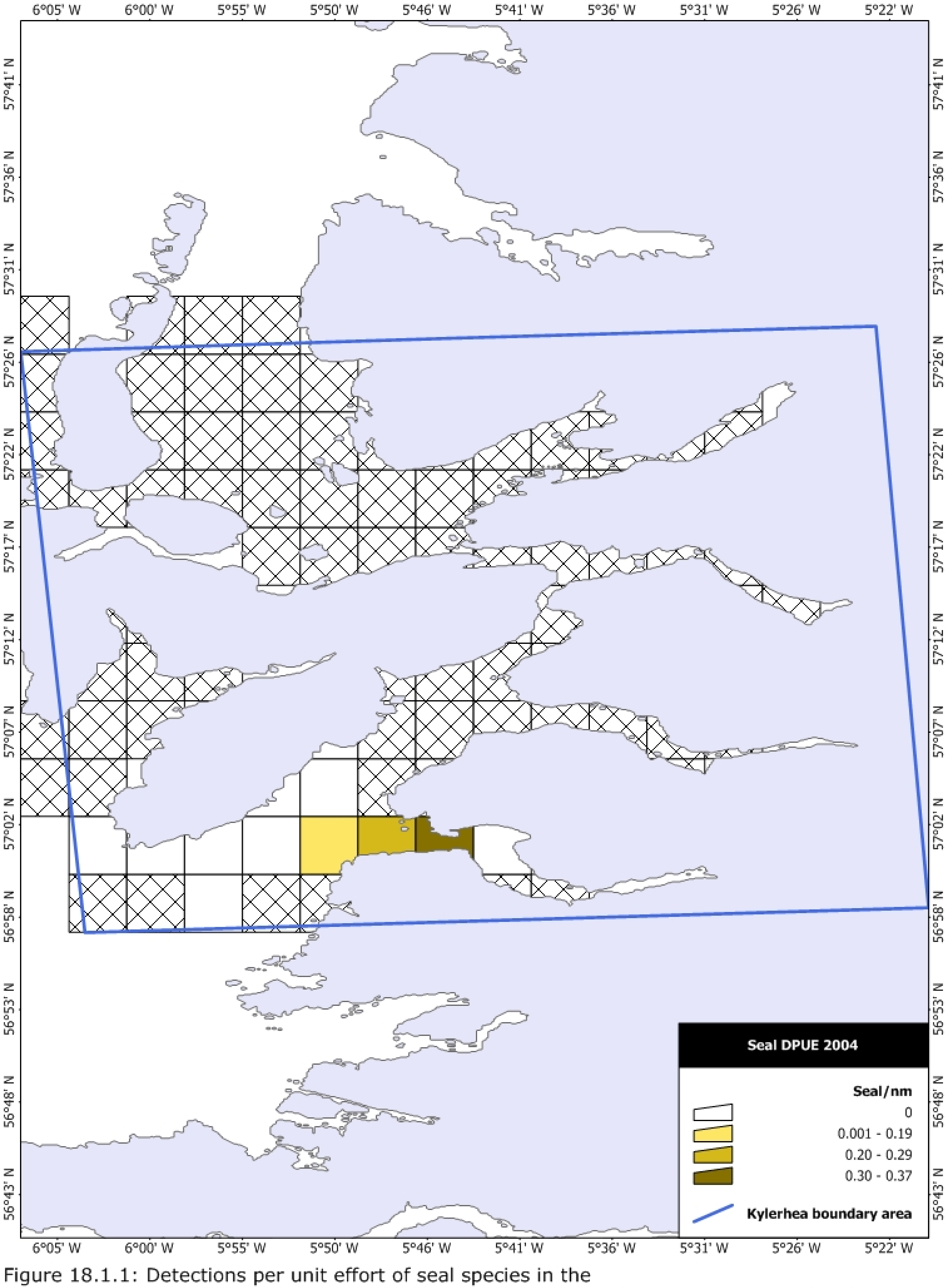

Figure 18.1.1: Detections per unit effort of seal species in the Kylerhearegion during 2004 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

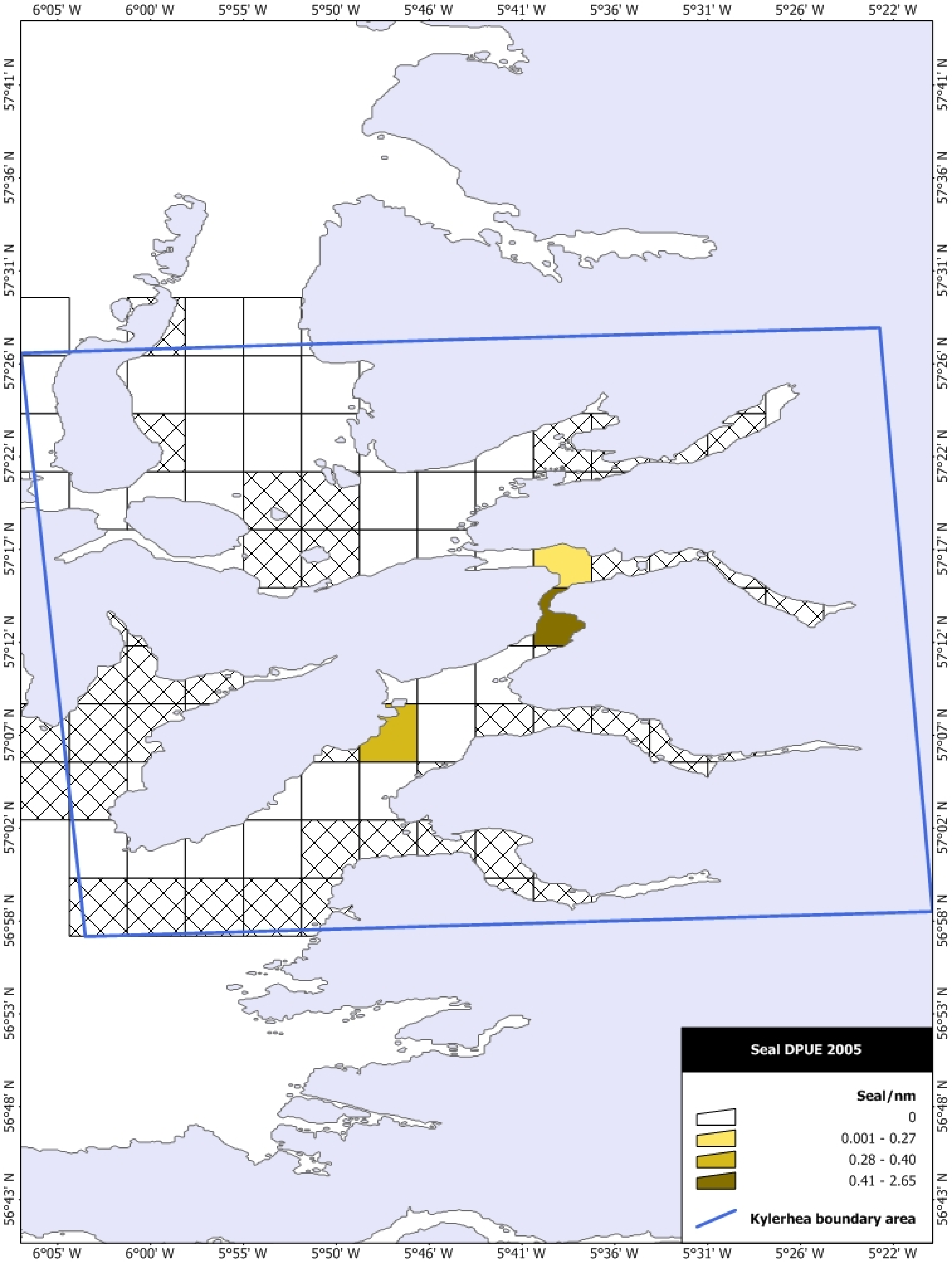

Figure 18.1.2: Detections per unit effort of seal species in the Kylerhea region during 2005 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

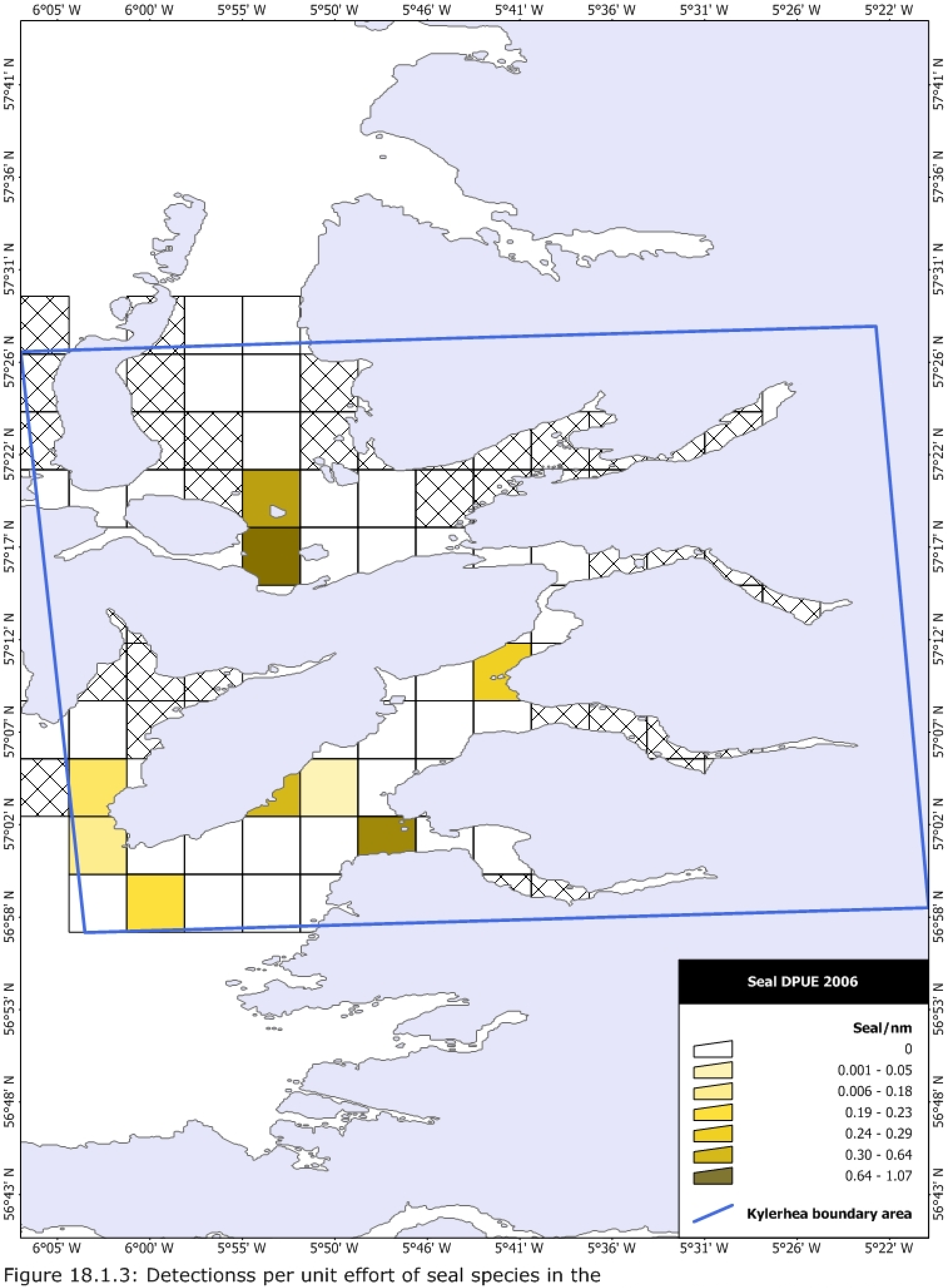

Figure 18.1.3: Detectionss per unit effort of seal species in the Kylerhea region during 2006 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

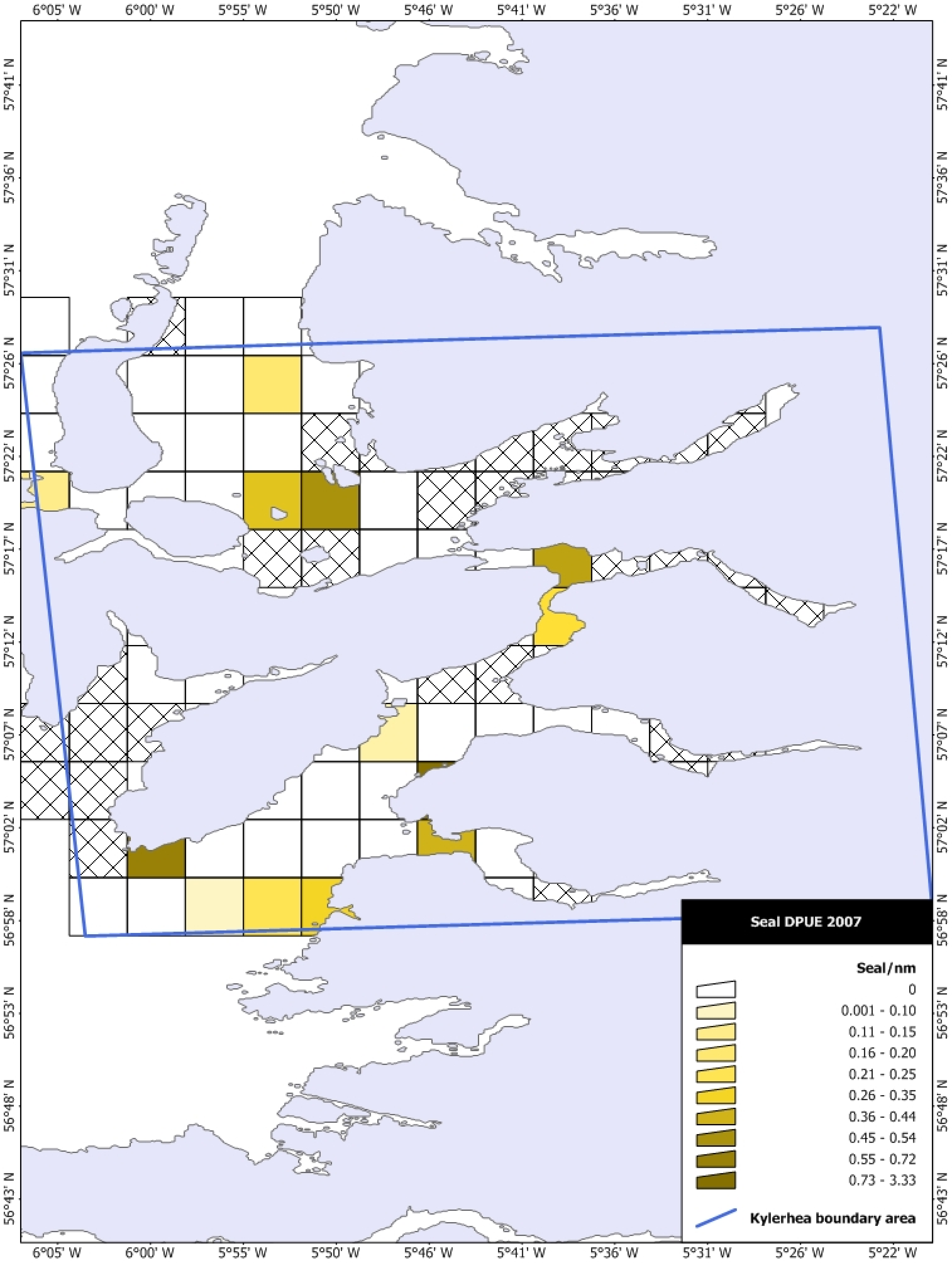

Figure 18.1.4: Detections per unit effort of seal species in the Kylerhea region during 2007 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

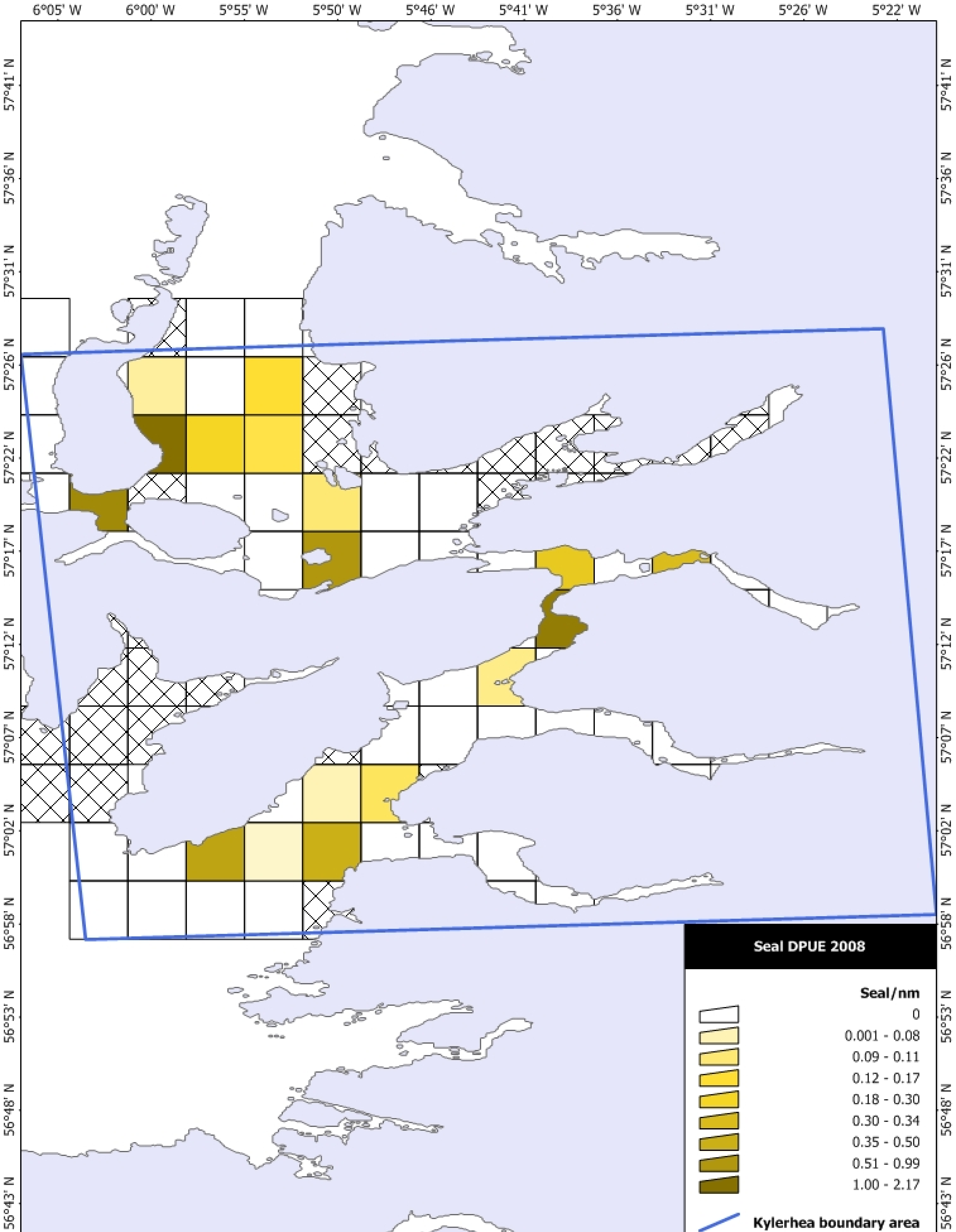

Figure 18.1.5: Detections per unit effort of seal species in the Kylerhea region during 2008 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

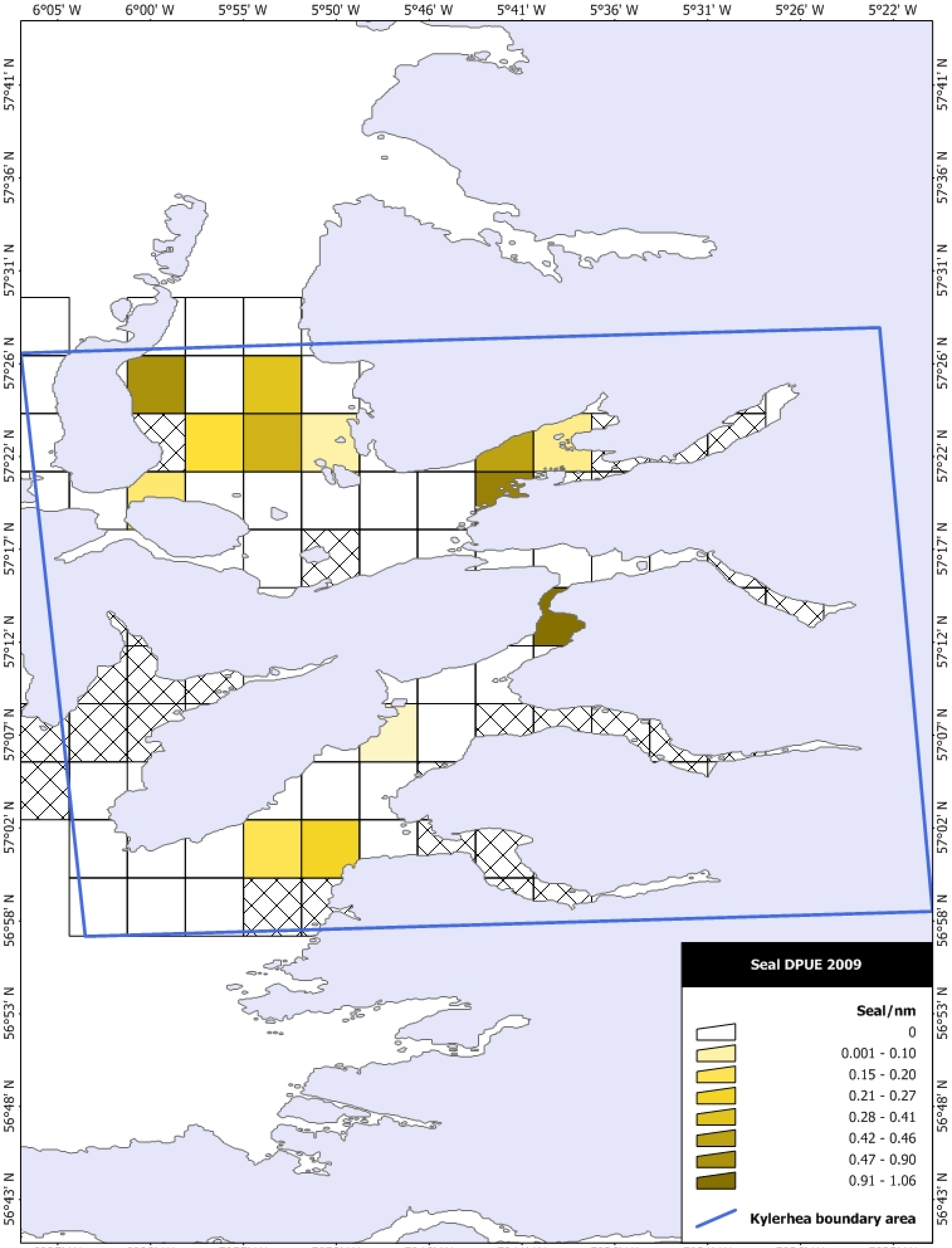

Figure 18.1.6: Detections per unit effort of seal species in the Kylerhea region during 2009 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

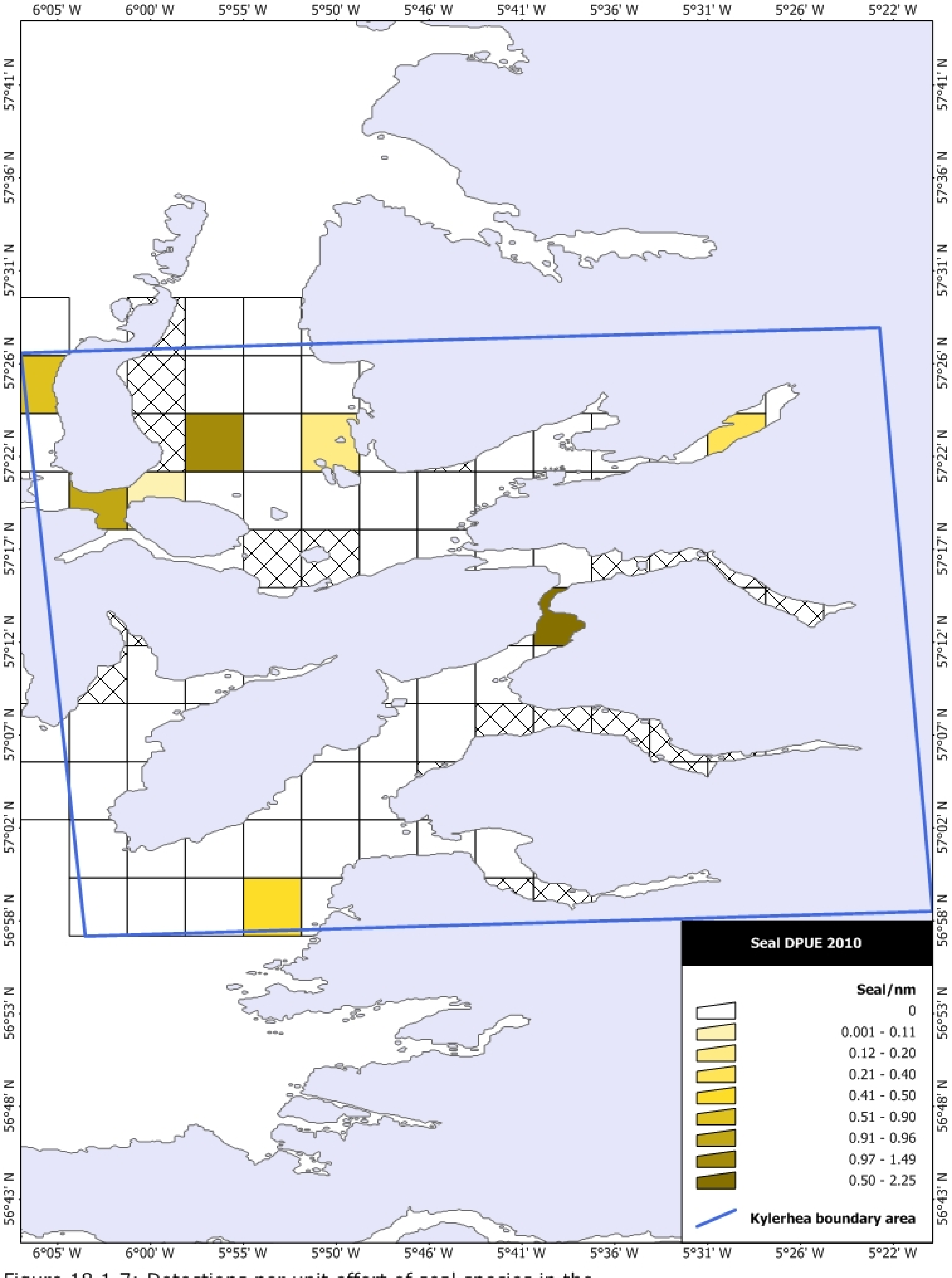

Figure 18.1.7: Detections per unit effort of seal species in the Kylerhea region during 2010 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

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Lon (Centre): 5°43'09" W

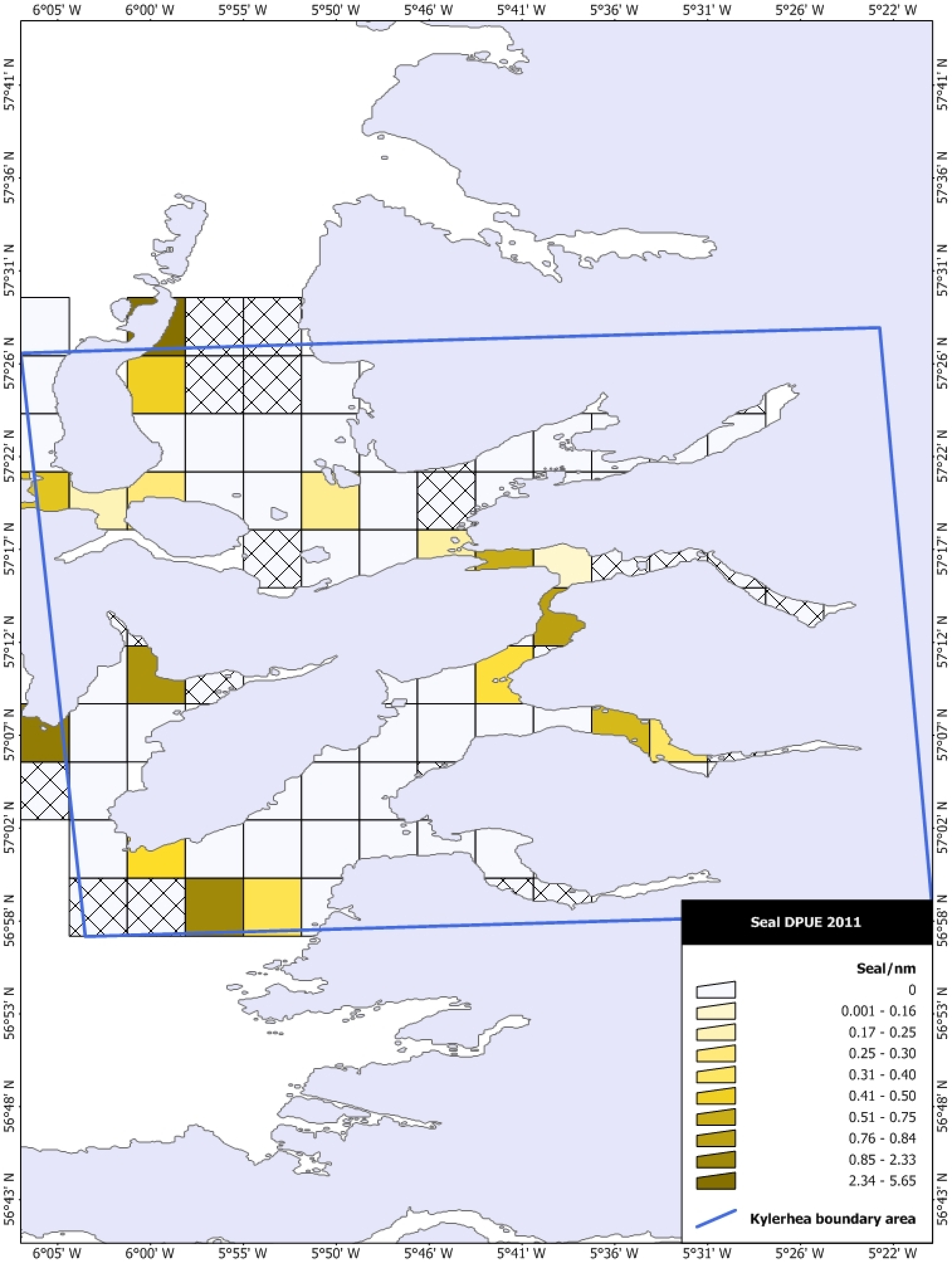

Figure 18.1.8: Detections per unit effort of seal species in the Kylerhea region during 2011 (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

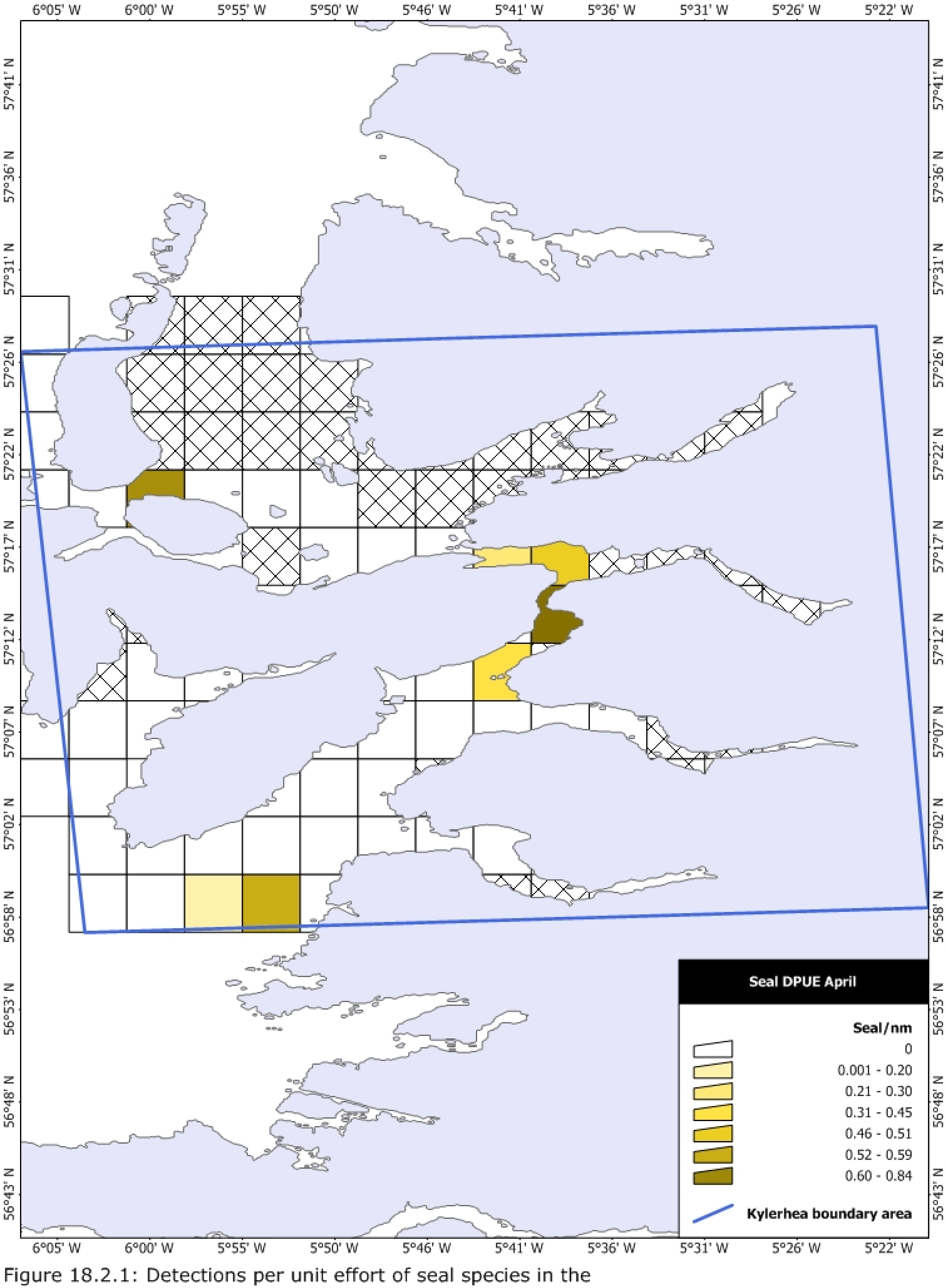

Figure 18.2.1: Detections per unit effort of seal species in the Kylerhea region during April (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

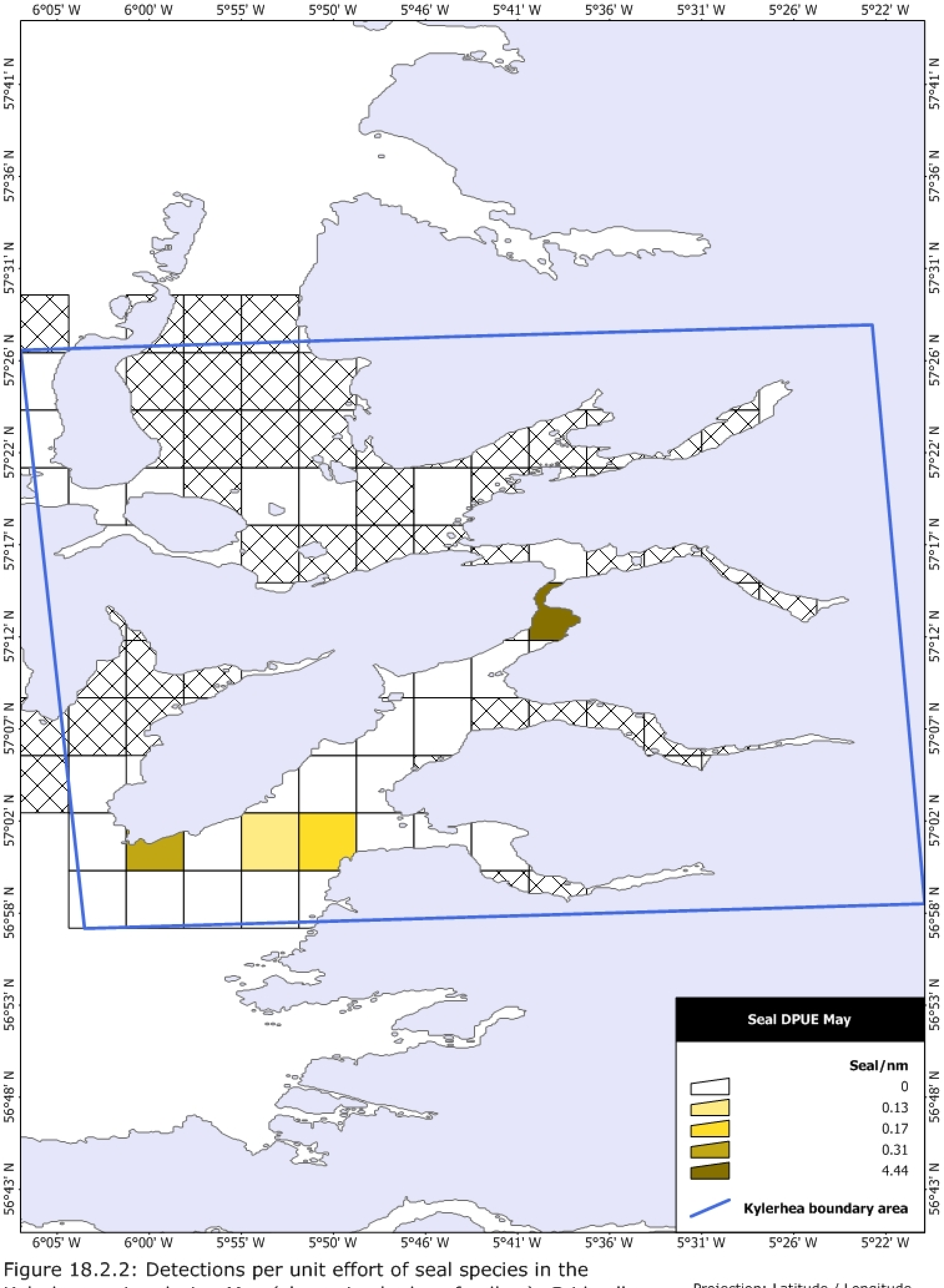

Figure 18.2.2: Detections per unit effort of seal species in the Kylerhea region during May (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

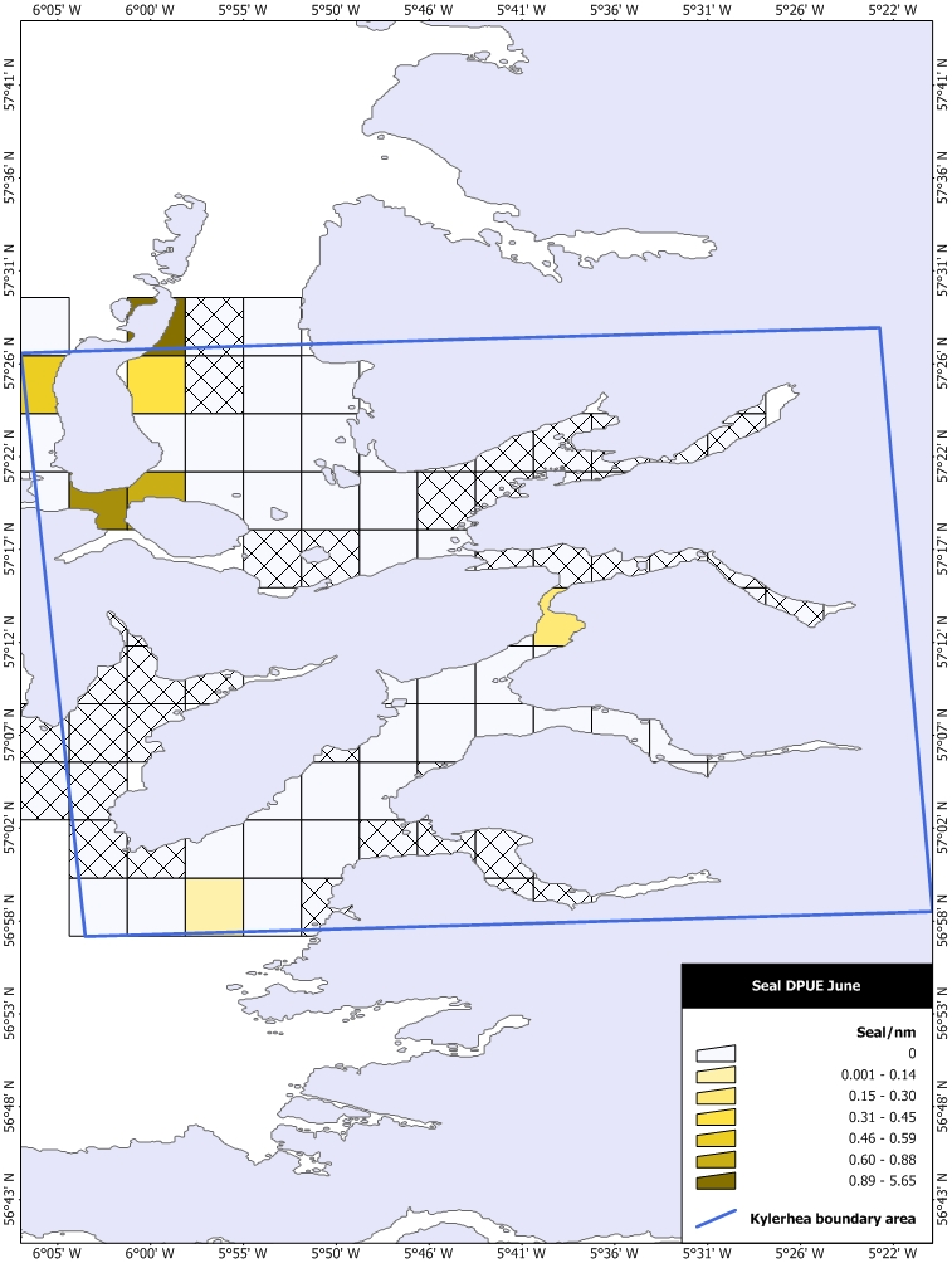

Figure 18.2.3: Detections per unit effort of seal species in the Kylerhea region during June (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

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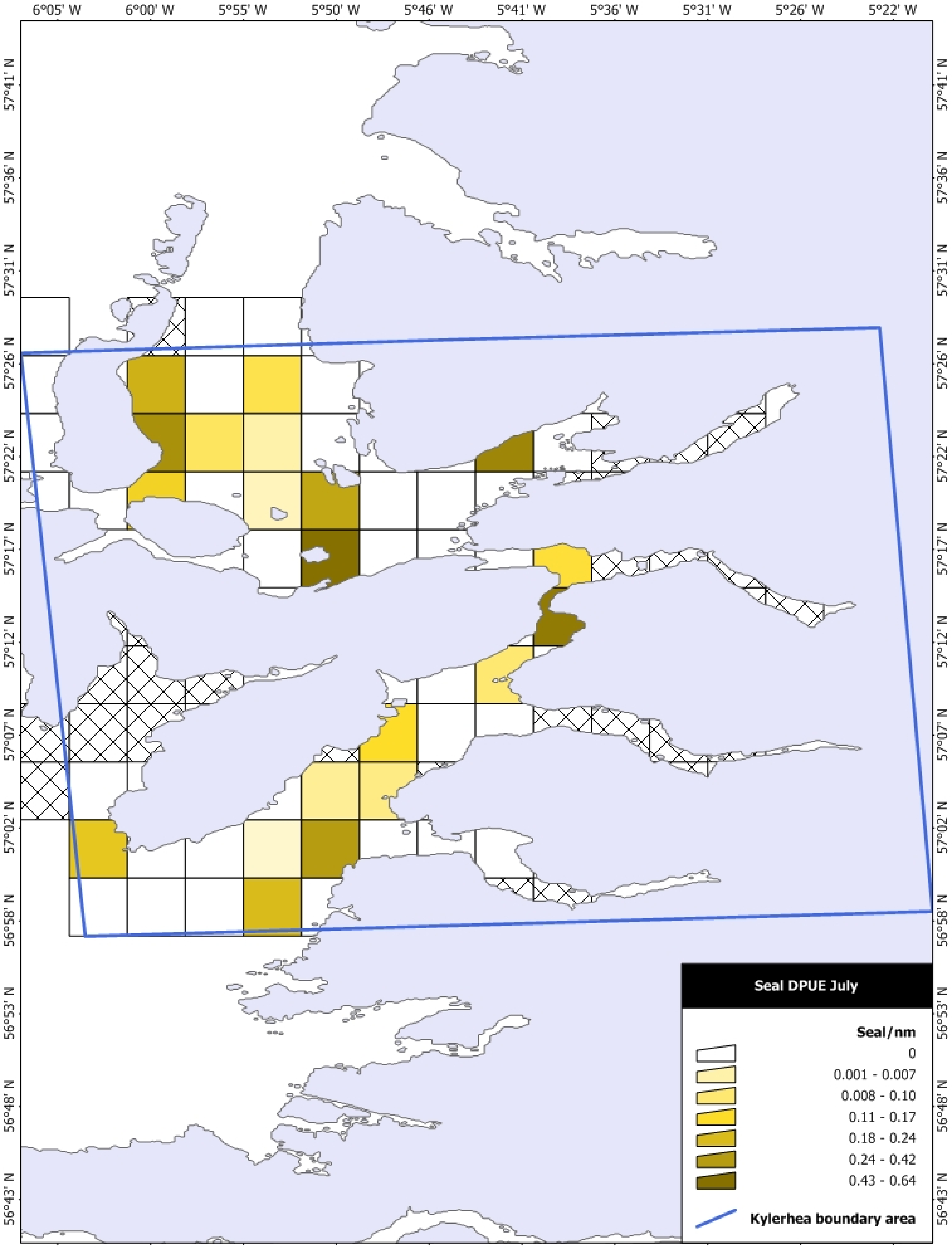

Figure 18.2.4: Detections per unit effort of seal species in the Kylerhea region during July (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

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Lon (Centre): 5°43'09" W

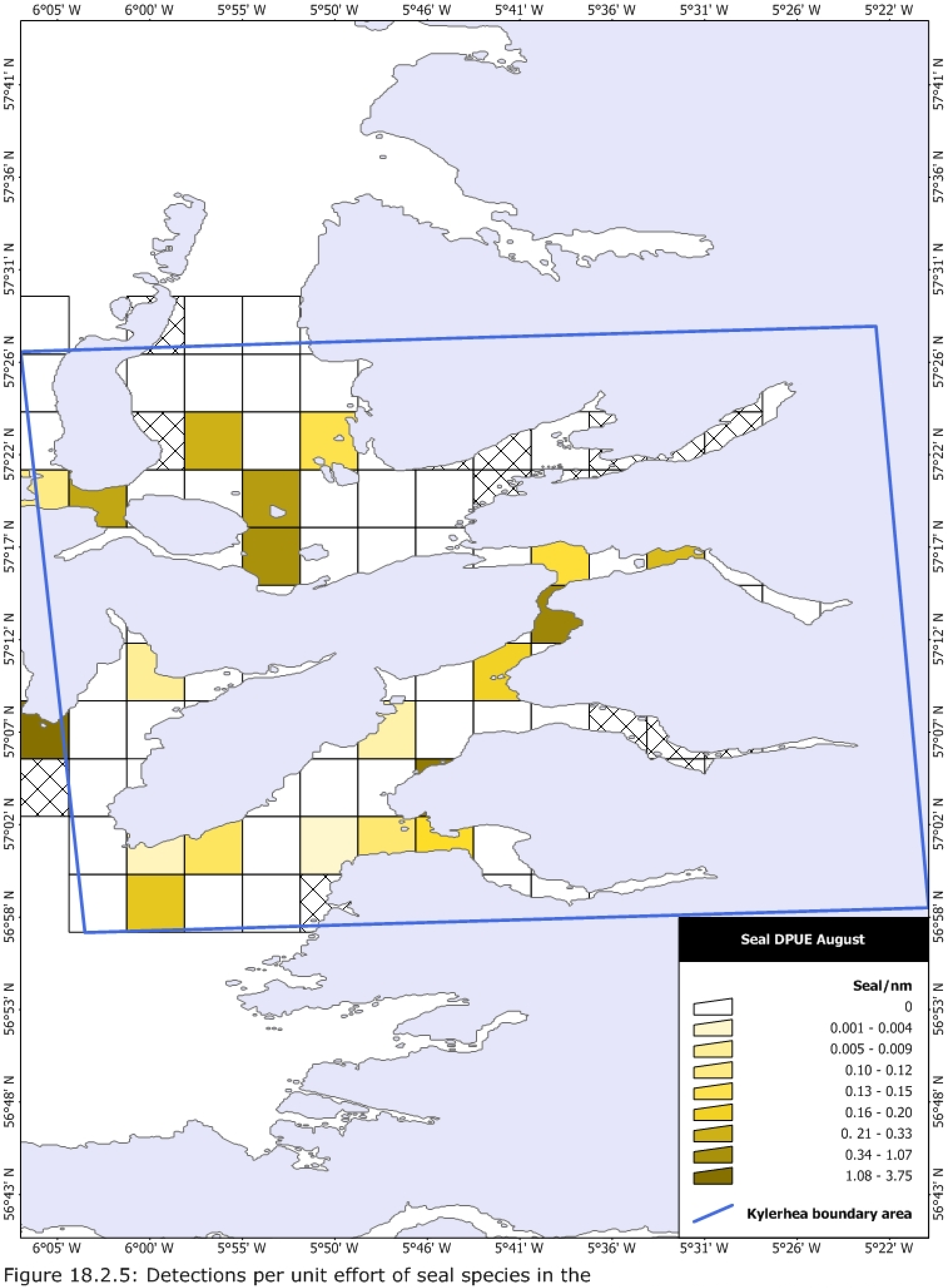

Figure 18.2.5: Detections per unit effort of seal species in the Kylerhea region during August (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
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Lon (Centre): 5°43'09" W

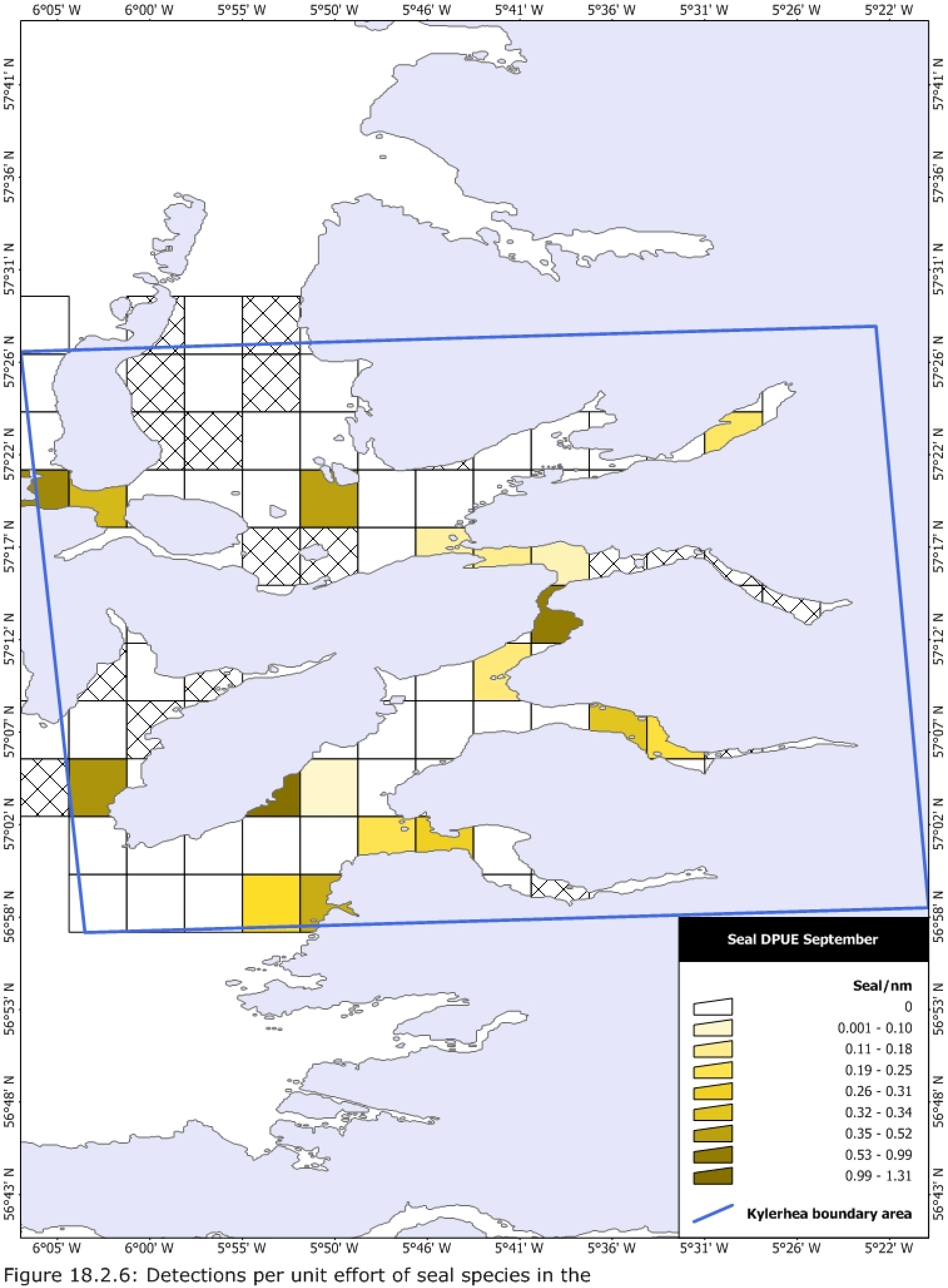

Figure 18.2.6: Detections per unit effort of seal species in the Kylerhea region during September (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

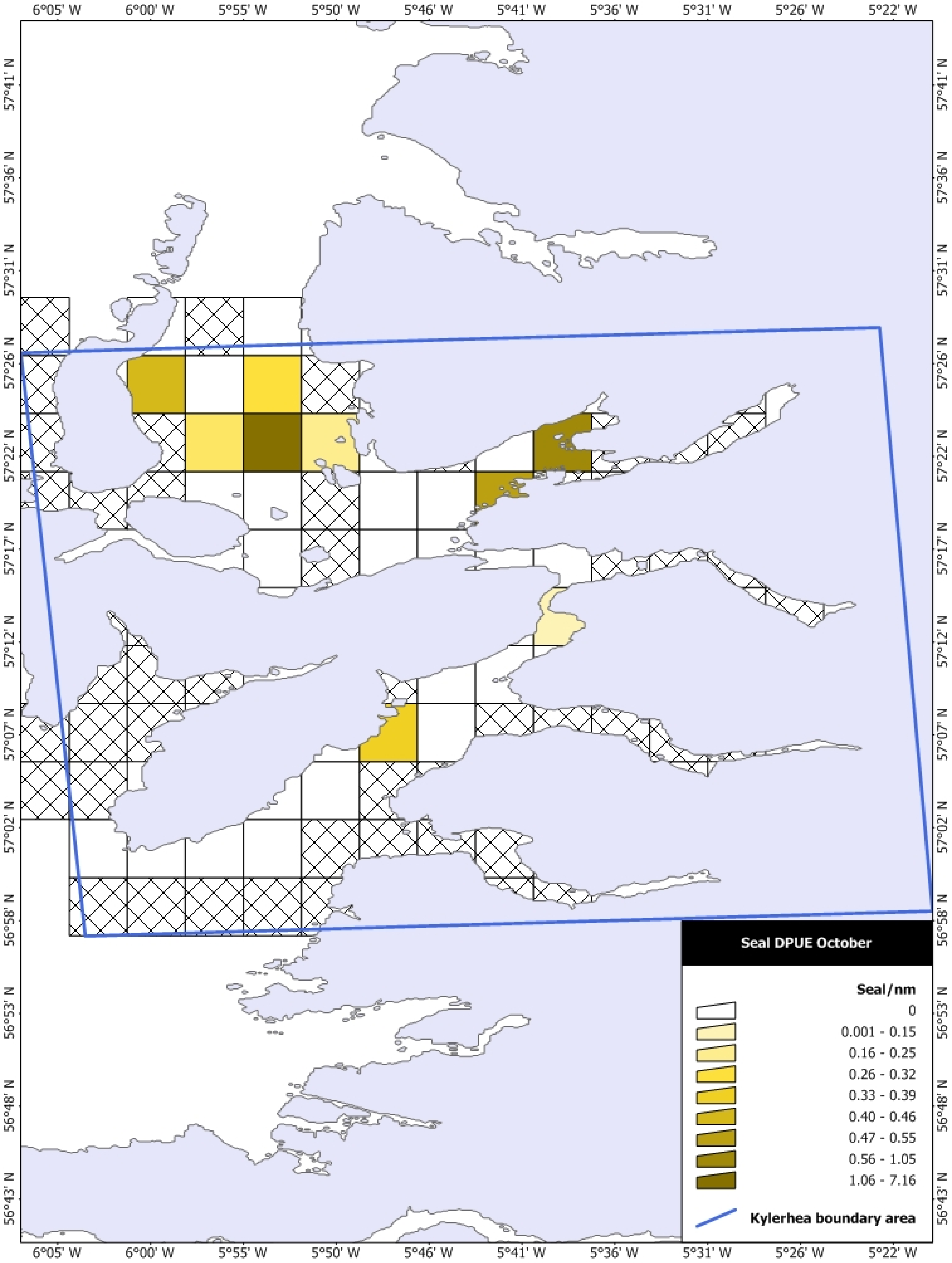

Figure 18.2.7: Detections per unit effort of seal species in the Kylerhea region during October (shown in shades of yellow). Grid cells not surveyed within the boundary area (blue box) have been cross-hatched.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

Conclusions

The goal of this analysis was to identify areas of importance for cetacean, seal and basking shark species in the Kylerhea study region and to discuss their significance both within a local context, and within the context of the west coast of Scotland as a whole. The combined results of this analysis indicate that the Kylerhea study region contains important habitat for harbour porpoises and seals. The region also appears to be relatively important for balaenoptera species and odontocete species but less important for basking sharks.

The highest concentrations of harbour porpoise within the study region were found in the Sound of Sleat. Whilst, acoustic detections were higher than that of the visual detections in this particular area, differences between DPUE values are likely attributable to environmental conditions which heavily influence the visual detection rate of harbour porpoise. The Sound of Sleat has been identified as an area of high importance to harbour porpoise by Embling et al. (2010) and by Booth (2010) who investigated harbour porpoise densities across the HWDT survey area. In November 2011, a submission for an SAC in the Inner Hebrides and west Scottish waters highlighted the Sound of Sleat as a region of high harbour porpoise relative density in a European context (Embling et al. 2010). Harbour porpoise are highly mobile and are thought to move widely across the Hebrides using corridors to travel between foraging locations and high-use areas. The narrow passage at Kylerhea is likely to be an important corridor between core habitats in the Sound of Sleat and the Inner Sound which followed the Sound of Sleat in terms of high DPUE values.

Two common seal haul out sites exist within the study region, one on the Island of Pabbay and the other on the north tip of the Island of Rona. The high sighting densities of seals observed during HWDT surveys is consistent with the count data collected at these haul out sites (SMRU, 2001) that suggest that the Kylerhea study region has a high density of the Scottish population of common seals. Grey seals are not as prevalent within the study region as common seals however HWDT sightings data shows that grey seals have been found in the area in all study months and years (Figure 8).

Due to the relatively low number of sightings of the Hebridean bottlenose dolphin group, broad-scale surveys provide limited power for detecting these animals. However, given the highly wide-ranging nature of the Inner Hebridean bottlenose dolphins, it is likely that channels such as the Sound of Sleat, the narrow Kylerhea passage and the Sound of Raasay serve as important routes to foraging grounds. HWDT public sightings data of bottlenose dolphins indicate a high presence of this species in the study region with sightings highest around Mallaig, Kyle of Lochalsh and in the south of the Sound of Raasay (Figure 19). These data are a valuable source of information that can be used alongside data collected onboard *Silurian* to suggest that the narrow passage of Kylerhea is likely used by bottlenose dolphins to access core habitats. The other odontocete species to be recorded in the study region is the common dolphin. Sightings of this species have been recorded in the Sound of Raasay and in the north of the Inner Sound (Figure 5, yellow points). Additionally, for the past four years, two common dolphins have been consistently reported as residing in Loch Carron (HWDT, unpublished data).

The study region appears to be less important for balaenoptera species than other parts of the west coast of Scotland; however the data suggests a presence of whales in the study region during July, August and September. The Small Isles have been suggested as an area of importance to minke whale. The majority of the sightings of minke whale within the study region appear in the southern area of the Sound of Sleat, in close proximity to this area of importance.

In conclusion, the species most likely to interact with tidal turbine installations in the Kylerhea region are likely to be the harbour porpoise, common and grey seal and bottlenose dolphin. The most likely risks to these species include collision, temporary or permanent habitat displacement (caused by noise or by increased human activity) and barrier effects. The Kylerhea passage is a restricted high tidal energy site; a habitat that coastal marine mammals are known to target, either in transit or to forage (Carter et al. 2008). This work indicates that the region holds important habitat for harbour porpoises and seals and it seems that the Kylerhea passage may too serve as a corridor between core habitats for transiting bottlenose dolphins. Whilst injury from collision may be limited to the site itself, habitat displacement could extend to much greater distances. Barrier effects pose a significant risk in restricted passages and could close important corridors for seals; between offshore foraging habitats and haul-out, breeding or moulting sites and between core foraging habitats for harbour porpoise and bottlenose dolphin. It is also worth noting that whilst the impact of tidal turbine devices on baleen whales are little known, species such as the minke whale may be susceptible to disturbance from low frequency noise (Nowacek et al. 2007). An area of high importance to minke whale is situated close to the array site and thus the impact of noise disturbance may need further consideration.

It is recommended therefore, that more information is needed on the movement patterns of these highly mobile species (for example how and why they use these high tidal energy sites) before the full impact on local populations can be assessed.

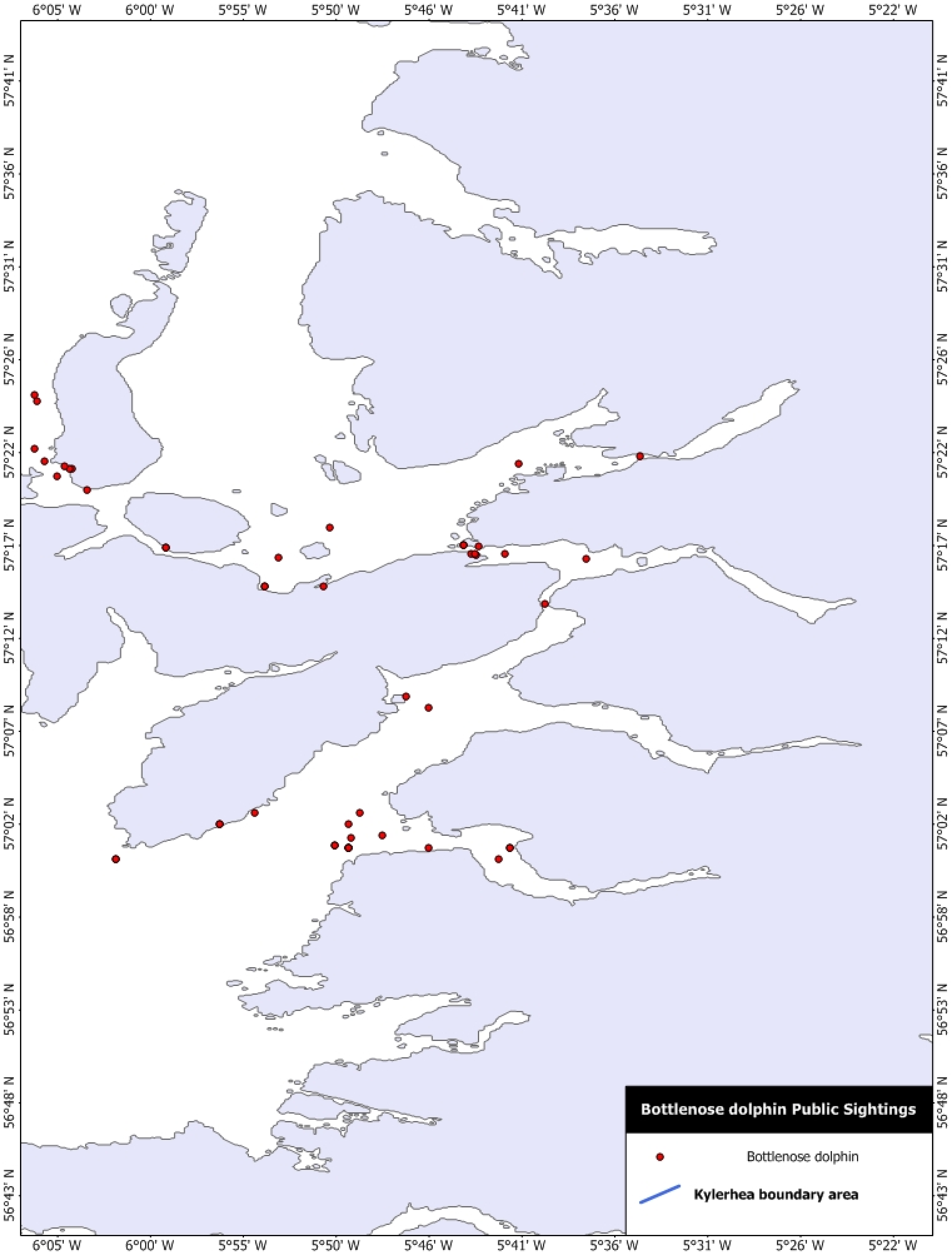

Figure 19: Public sightings data for bottlenose dolphins in the Kylerhea region between 2003 and 2011.

Projection: Latitude / Longitude
Lat (Centre): 57°12'32" N
Lon (Centre): 5°43'09" W

Acknowledgements

The development of the Logger program was funded by the International Fund for Animal Welfare with financial assistance from the European Commission through the Eurogroup for Animal Welfare. The funding for the fieldwork was kindly provided by Scottish Natural Heritage (SNH), Heritage Lottery Fund (HLF), WWF and the Earthwatch Institute. Additional thanks go to all of the many HWDT and Earthwatch volunteers who participated in surveys and helped with data collection.

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Kyle Rhea Tidal Stream Array

Appendix 12.5

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Measurement of Baseline Underwater Noise prior to Construction of Kyle Rhea Tidal Array

A. G. Collett, S. Cheesman

13 November 2012

Subacoustech Report No. E366R0207

Approved by Technical Director: Dr J R Nedwell

This report is a controlled document. The Report Documentation Page lists the version number, record of changes, referencing information, abstract and other documentation details.

Executive Summary

This report has been prepared by Subacoustech Environmental Ltd for Marine Current Turbines (MCT). It describes a number of background underwater noise measurements undertaken in preparation for the construction of a tidal turbine array to be situated close to the mouth of the Kyle Rhea between the Isle of Skye and the Scottish mainland. Measurements were taken along transects north, south and east of the proposed tidal array location during different tidal states.

The time history and power spectral density (PSD) of the data has been analysed. Higher levels of high frequency broadband noise, between 20 kHz and 150 kHz, were found in a significant number of recordings most notably when the tide was flowing. The source of the increased levels of high frequency broadband noise is thought to have been approximately 100 to 200 m north of the proposed tidal array location, where the high frequency noise was measured to be greatest. A number of recordings evidenced multiple ‘snaps’ in the time history which could be due to marine biological activity.

The data were also analysed to provide an indication of the unweighted RMS levels as well as the perceived levels of underwater noise for each species in terms of the dB_{ht}(*species*) metric. This analysis provides estimates of the unweighted sound levels and the sound levels that each underwater species analysed are likely to hear.

Based on this analysis, both the unweighted and dB_{ht} sound levels are shown to be higher when the tide was in flow compared to the sound levels recorded at slack water. For example, the mean RMS level when the tide was flowing out on 24th July was 120.1 dB and at low tide the mean unweighted RMS level was 111.7 dB. High dB_{ht} levels are shown to have occurred for marine mammals, most notably a maximum for the harbour porpoise of 95.5 dB_{ht} (*Phocoena phocoena*). These high dB_{ht} levels are as a result of the presence of high frequency noise, which was greatest during tidal flow.

List of Contents

1 Introduction

This report has been prepared by Subacoustech Environmental Ltd for Marine Current Turbines Ltd. It describes a series of baseline underwater noise measurements undertaken at the proposed Kyle Rhea Tidal Array site. The measurements were taken in order to determine the background noise levels prior to installation of a tidal turbine array. The data has been analysed to obtain noise levels in terms of unweighted levels and dB_{ht}(*Species*) metric in order to determine existing levels of noise perceived by various species of animals in the water.

The proposed tidal turbine is situated in Kyle Rhea, a narrow strait between the Isle of Skye and the west coast of mainland Scotland. The tidal array is to consist of four turbine installations as illustrated by figure 1-1. Measurements were taken along transects from the proposed turbine positions at various ranges.

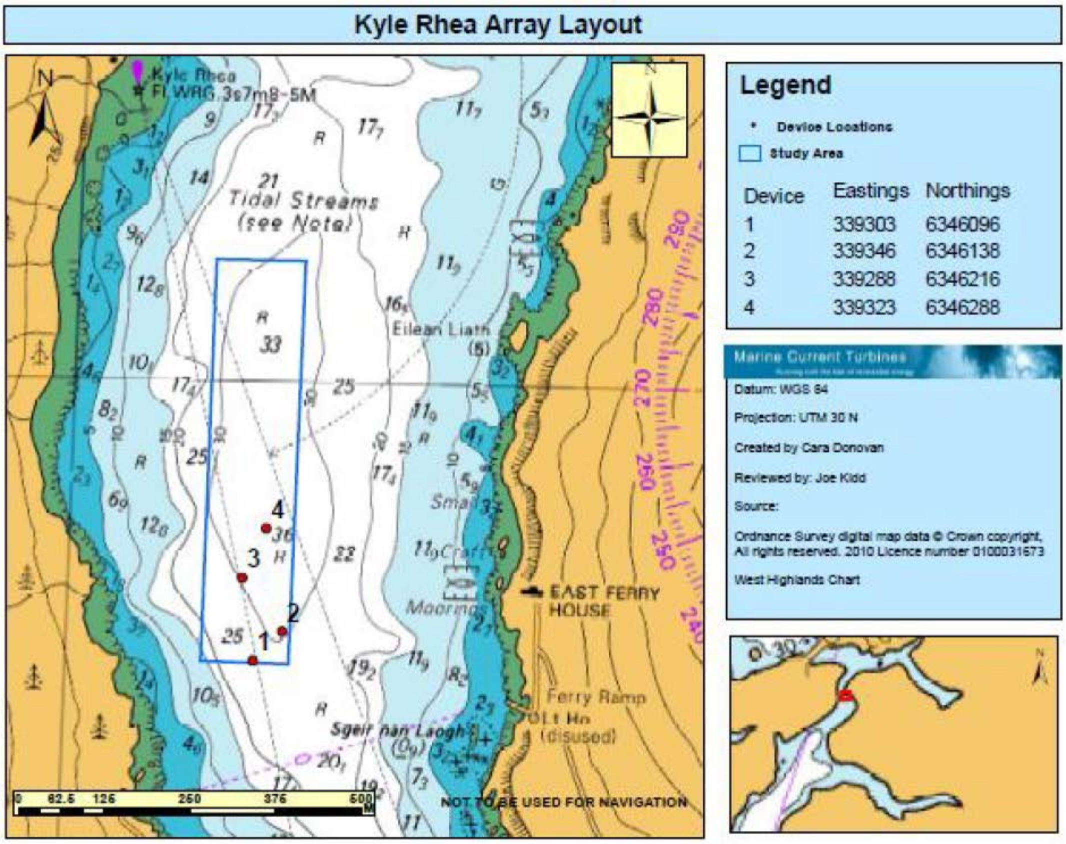

Figure 1-1 Location of the array and likely layout

2 Assessment of underwater noise.

2.1 Introduction

Sound travels much faster in water (approximately 1500 m/s) than in air (340 m/s). Since water is a relatively incompressible, dense medium the pressures associated with underwater sound tend to be much higher than in air. Background levels of about 130 dB re. 1 µPa for coastal waters (Nedwell *et al.*, 2003) and rivers are not uncommon. This level equates to about 100 dB re 20 µPa, in the units that would be used in air. Such levels in air would be considered to be hazardous; however, marine animals have evolved to live in this environment and are thus insensitive to these sound levels compared with terrestrial mammals.

2.2 Units of measure

Sound measurements underwater are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. A logarithmic scale is used because rather than equal increments of sound having an equal increase in effect, typically a constant ratio is required for this to be the case, that is, each *doubling* of sound level will cause a roughly equal increase in "loudness".

Any quantity expressed in this scale is termed a "level". If the unit is sound pressure, expressed on the dB scale, it will be termed a "Sound Pressure Level". The fundamental definition of the dB scale is given by

$$Level = 10 \times \log_{10}\left(\frac{Q}{Q_{ref}}\right) \qquad \textbf{eqn. 2-1}$$

where Q is the quantity being expressed on the scale, and Q_{ref} is the reference quantity. The dB scale represents a ratio and, for instance, 6 dB really means "twice as much as…" It is therefore used with a reference unit, which expresses the base from which the ratio is expressed. The reference quantity is conventionally smaller than the smallest value to be expressed on the scale, so that any level quoted is positive. For instance, for sound in air a reference quantity of 20 µPa is usually used, since this is the threshold of human hearing.

A refinement is that the scale when used with sound pressure is applied to the pressure squared, rather than the pressure. If this were not the case, if the acoustic power level of a source rose by say 10 dB the Sound Pressure Level would rise by 20 dB. So that variations in the units agree, the sound pressure must be specified in units of Root Mean Square pressure (see section 3.3 below). This is equivalent to expressing the sound as

$$Sound\ Pressure\ Level = 20 \times \log_{10}\left(\frac{P_{RMS}}{P_{ref}}\right) \qquad \textbf{eqn. 2-2}$$

For underwater sound, typically a unit of one microPascal (µPa) is used as the reference unit; a Pascal is equal to the pressure exerted by one Newton over one square metre. One microPascal equals one-millionth of this.

2.3 Measurements

Sound may be expressed in several ways, which include:

Root-Mean-Square (RMS) Level. For continuous sound and vibration, or signals that vary in level, the RMS is used as an "average" value when calculating the level. The time over which the mean is calculated has to be quoted. For instance, in the case of a pile strike lasting say a tenth of a second, the mean taken over a tenth of a second will be ten times higher than the mean taken over one second.

RMS levels are normally appropriate for characterising noise and vibration of a continuous nature such as drilling, boring and background sea and river noise levels.

Peak Level. The peak level is calculated using the maximum level of the acoustic pressure, usually for positive pressures. It is often used for blast measurements where there is a clear positive peak following the detonation of explosives.

Peak to peak level. The peak to peak level is usually calculated using the maximum variation of the pressure from positive to negative within the wave. Where the wave is symmetrically distributed in positive and negative pressure, the peak to peak level will be twice the peak level, and hence 6 dB higher. Peak levels and peak to peak levels are used to characterise sound transients from impulsive sources such as gunfire, impact piling and blast.

Source Level. Where there is a single and well-defined source of noise, underwater sound pressure measurements may be expressed as dB re 1 µ Pa @ 1 m, which represents the *apparent* level at a distance of one metre from the source. In fact, since the measurements are usually made at some distance from the source, and extrapolated back to the source, the true level at one metre may be very different from the Source Level. The Source Level may itself be quoted in any of the measures above, for instance, a piling source may be expressed as having a "peak to peak Source Level of 200 dB re 1 µPa @ 1 metre".

Impulse. The term "impulse" is used to describe a wide range of underwater sound events. The term has been mainly used to describe the pressure pulses caused by the detonation of high explosives underwater, but the term is often used to characterise any event of limited duration (transient). As a measure, the impulse is defined as the integral of pressure over time and is given by

$$I = \int_0^\infty P(t)\,\delta t \qquad \textbf{\textit{eqn. 2-3}}$$

where I is the impulse in Pascal-seconds (Pa.s), P(t) is the acoustic pressure in Pascal of the sound wave at time t, and t is time.

Impulse may be thought of as the average pressure of the wave multiplied by its duration. The importance of impulse is that in many cases a wave acting for a given time will have the same effect as one of twice the pressure acting for half the time. The impulse of both these waves would be the same. For impulsive sources, the impulse is often the parameter of the noise and vibration that is used as the measure of its strength in respect of environmental effects such as lethality and physical injury.

2.4 Sound propagation

Sound propagation is frequently described by the equation

$$L_r = SL - TL \qquad \textbf{eqn. 2-4}$$

where *L(r)* is the Sound Pressure Level at distance *r* from a source (m),

SL is the (notional) source level at 1 m from the source, and

TL is the transmission loss.

The Transmission Loss is frequently described by the equation

$$TL = N\log_{10}(r) + \alpha r \qquad \textbf{eqn. 2-5}$$

where *r* is the distance from the source (m),

N is a factor for attenuation due to geometric spreading, and

α is a factor for the absorption of sound in water and boundaries ($dB.km^{-1}$).

Using this form of sound transmission loss, the sound level with range *L(r)* can be described by the expression

$$L_r = SL - N\log_{10}(r) - \alpha r \qquad \textbf{eqn. 2-6}.$$

2.5 The dB_{ht} (*Species*)

Measurement of sound using electronic recording equipment provides an overall linear level of that sound. The level that is obtained depends upon the recording bandwidth and sensitivity of the equipment used. This, however, does not provide an indication of the impact that the sound will have upon a particular fish or marine mammal species. This is of fundamental importance when considering the behavioural impact of underwater sound, as this is associated with the perceived loudness of the sound by the species. Therefore, the same underwater sound will affect marine species in a different manner depending upon the hearing sensitivity of that species.

The measurements of noise herein are in the main presented as dB_{ht} levels; this scale incorporates the concept of “loudness” for a species. The metric incorporates hearing ability by referencing the sound to the species’ hearing threshold, and hence evaluates the level of sound a species can *perceive.* Experimental evidence indicates that the scale provides an objective rating of the effects of underwater noise on marine animals (Nedwell *et al*., 1998; Nedwell *et al*., 2005).

Since any given sound will be perceived differently by different species (since they have differing hearing abilities) the species name must be appended when specifying a level. For instance, the same sound might have a level of 70 dB_{ht}(*Gadus morhua*) for a cod and 110 dB_{ht}(*Phoca vitulina*) for a seal.

The perceived noise levels of sources measured in dB_{ht}(*Species*) are usually much lower than the unweighted (linear) levels, both because the sound will contain frequency components that the species cannot detect, and also because most marine species have high thresholds of perception to (are relatively insensitive to) sound (Nedwell *et al*., 2004).

If the level of sound is sufficiently high on the dB_{ht}(*Species*) scale it is likely that an avoidance reaction will occur. The response from a species will be probabilistic in nature (e.g. at 75 dB_{ht}(*Species*) one individual from a species may react, whereas another individual may not), and may also vary depending upon the type of signal. For unusual, man-made noise a response may occur with a level as low as 30 dB_{ht}(*Species*). A level of 0 dB_{ht}(*Species*) represents a sound that is at the hearing threshold for that species and is therefore at a level at which sound will start to be ‘heard’. At this, and lower perceived sound levels, no response occurs as the receptor cannot hear the sound.

Currently, on the basis of a large body of measurements of fish avoidance of noise (Nedwell *et al.,* (2005)) it is proposed that levels of 90 dB_{ht} (*Species*) and above will cause significant avoidance reaction by most individuals, with nearly 100% avoidance at 100 dB_{ht} (*Species*).

The species upon which the dB_{ht} analysis has been conducted in this study have been selected based upon regional significance and also crucially, upon the availability of a good quality audiogram. Figure 2-1 and Figure 2-2 present the cited audiogram data for the species of fish and marine mammal considered in this study. These data have been used to develop the Finite Impulse Response (FIR) filters that are used to assess the perceived level of underwater sound by marine species.

In certain cases, when insuffient data is available on the hearing of target species it is necessary to use surrogate audiograms. For example the only high quality audiogram obtained from a white beaked dolphin (Nachtigall *et* al, 2007) does not cover the full frequency range needed to calculate a dB_{ht} level. However, over the frequency values available in Nachtigall *et* al, 2007, the White beaked dolphin seems to have very similar hear capabilities to the Bottlenose dolphin. The Bottlenose dolphin may therefore also be thought of as a surrogate for the White beaked dolphin..

The filter for the harbour seal is made up of a combination of the audiograms obtained by Mohl (1968) and Kastak and Schusterman (1978), Therefore, in a similar fashion to the White beaked dolphin and Bottlenose dolphin, the Harbor seal may also be used as a surrogate for the Grey seal.

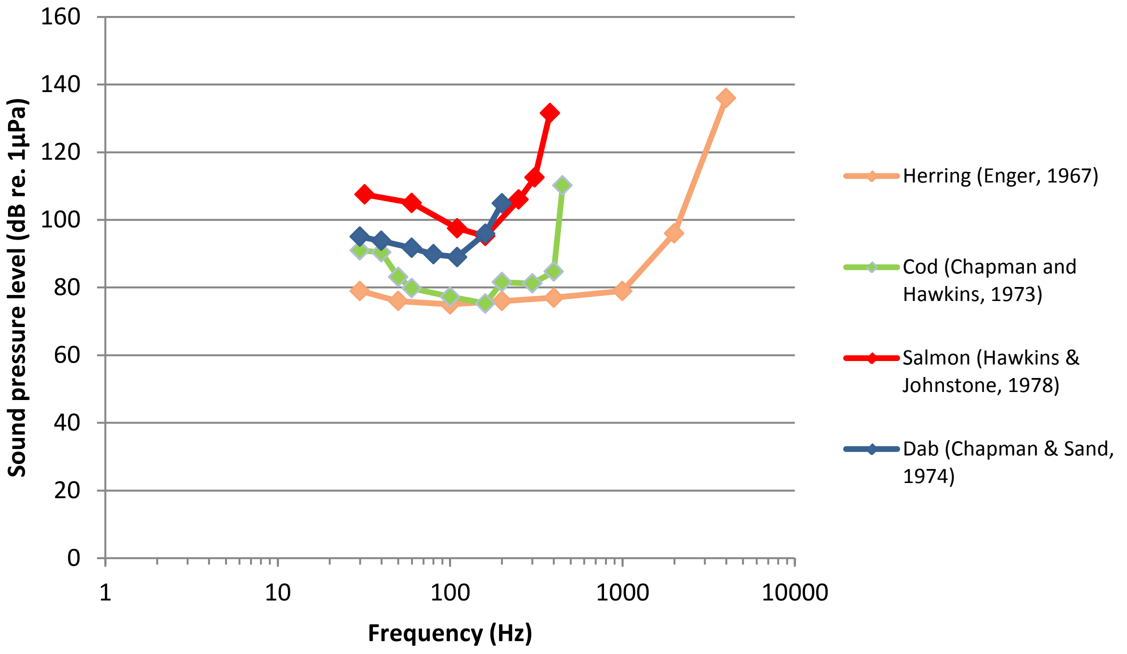

Figure 2-1 Hearing threshold for species of fish.

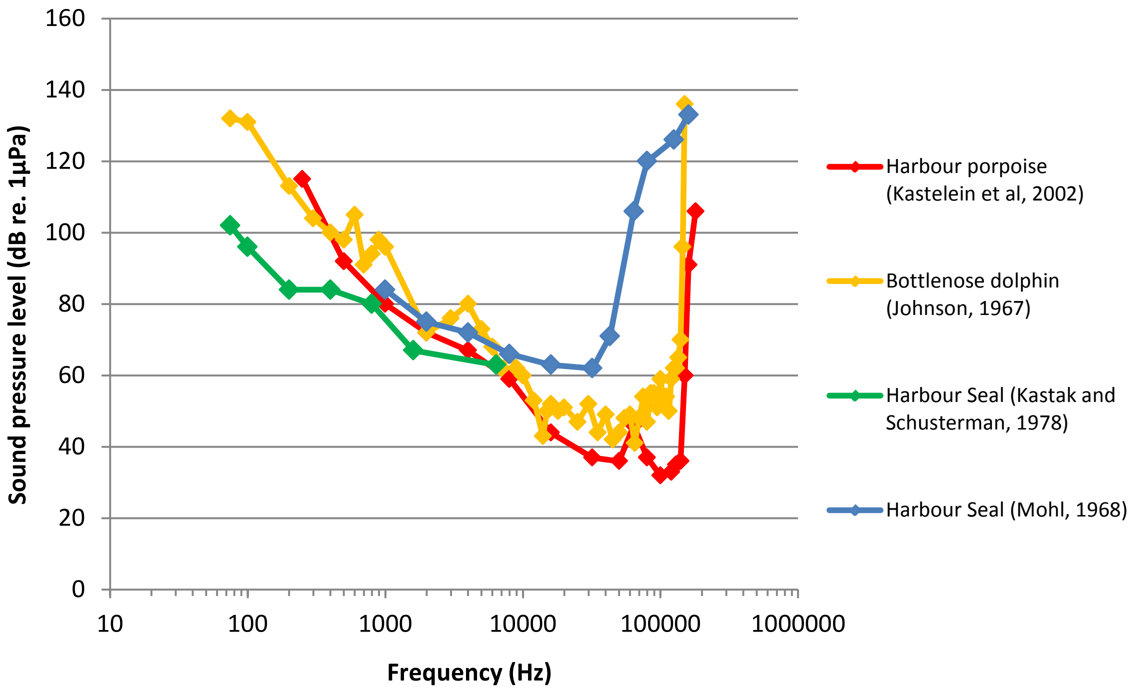

Figure 2-2 Hearing threshold for species of marine mammal.

3 Methodology

3.1 Introduction and Prevailing Conditions

The underwater noise survey at the proposed Kyle Rhea tidal turbine array was undertaken on the 24th July 2012 between 1030 and 1900 and on the 25th July 2012 between 0830 and 1330. Conditions on the 24th July were mostly overcast and dry. Wind speed was recorded to be between 3.6 and 6.4 m/s throughout the day from a S or SW direction. In the final measurement of the day there was some moderate rain. On the 25th July it was again overcast and dry with the wind speed varying between 0.6 and 3.75 m/s from a S to SW direction. The sea state was calm throughout the survey period with no significant surface waves or swell. Underwater sound measurements at the Kyle Rhea were taken in water depths that varied from 5 to 47 m.

3.2 Instrumentation

Underwater sound was measured with a Brüel & Kjær Type 8106 hydrophone (S/N 2575949), connected to a Subacoustech power supply and amplification (S/N 68SP0201). The signal from the amplifier was fed via a connector box to a National Instruments A-to-D converter card (a Type 6062E DAQCard, S/N 60DAQ0201) inserted in a PC card slot in a notebook computer.

The sensitivity of the hydrophone was traceable to Danish Primary Laboratory of Acoustics (DPLA) and National Institute of Standards and Technology, USA (NIST) international calibration standards. Calibration certification for the equipment is provided at Appendix A.

The boat's position was recorded on the computer system by sending the output from a Garmin eTrex handheld GPS receiver to a USB port on the computer, which was logged with the acoustic data.

3.3 Measurement specification

Underwater sound measurements were taken at a sample rate of 350,000 samples.sec^{-1}, these wideband frequency recordings allowing post-processed acoustic analysis over the frequency range from 1 Hz to 175 kHz (covering the full audiometric frequency range of fish, human divers and marine mammal species).

3.4 Measurement procedure

Underwater sound recordings were undertaken using a low noise hydrophone deployed from the side of the survey vessel, the *Spirit of Adventure*. The hydrophone was attached to an anti-heave buoy, which was allowed to float freely from the vessel. The vessel's engines and other equipment which might have caused interference with the measurements were turned off and the boat was allowed to drift while measurements were taken. At intervals, data was acquired on the computer, together with details of the boat's position and other relevant information. Measurements were taken in transects north and south of the proposed turbine positions as well as across the narrow strait east of the turbine locations.

Tables 3-1 and 3-2 show summaries of the ranges, time and tidal state of each transect undertaken. Figures 3-1 and 3-2 show the positions at which measurements were taken along a north and south transect on 25th July.

24th July 2012	Ranges of measurements	Time	Approx. Tidal state during measurement
1st –Transect South from KR1	679 to 2030m	11:17	High Tide
2nd –Transect North from KR4	20 to 1560m	12:30	High Tide to Low Tide
3rd –Transect East from KR4	55 to 486m	13:27	High Tide to Low Tide
4th –Transect North from KR4	69 to 2180m	14:41	High Tide to Low Tide (Full tidal flow)
5th –Transect South from KR1	157 to 1400m	15:30	High Tide to Low Tide
6th –Transect East from KR1	118 to 414m	17:32	Low Tide
7th –Transect North from KR4	90 to 2150m	17:55	Low Tide

Table 3-1 Summary of the approximate ranges that measurements were taken on each transect or drift path on 24th July 2012

25th July 2012	Ranges of measurements	Time	Approx. Tidal state during measurement
1st –Transect South from KR1	60 to 1190m	09:25	Low Tide to High Tide
2nd –Transect East from KR1	819 to 1240m	09:44	Low Tide to High Tide
3rd –Transect North from KR4	40 to 1820m	10:06	Low Tide to High Tide
4th –Transect South from KR1	10 to 699m	10:44	High Tide (at Gleneg 11:07)
5th –Transect East from KR1	61 to 345m	11:01	High Tide
6th –Transect South from KR1	107 to 1370m	11:43	High Tide
7th –Transect North from KR4	60 to 1990m	12:35	High Tide

Table 3-2 Summary of the approximate ranges that measurements were taken on each transect or drift path on 25th July 2012

Figure 3-1 Locations at which measurements were taken along a north transect on 25th July (Black dots represent the proposed turbine locations, red dots represent measurement locations)

Figure 3-2 Locations at which measurements were taken along a south transect on 25th July (Black dots represent the proposed turbine locations, red dots represent measurement locations)

4 Results

4.1 Analysis

Both the time history and power spectral density (PSD) data used in the analysis have been inspected to ensure the quality of the data used in the analysis and assessment. The recorded underwater noise time history data were analysed to obtain PSDs for the data acquired.

It should be noted that during the 1st transect undertaken on 24th July, extraneous noise was seen to be picked up by the survey equipment. Subsequently, components of the survey equipment that appeared to be picking up the extraneous noise were changed and the problem was resolved. All the data that was recorded in the 1st transect has been disregarded. Also during a small number of recordings, the hydrophone cage ended up coming into contact with the seabed creating clanging noises. This happened where measurements were started in one location and the drift took the boat and equipment into shallower water depth resulting in the hydrophone cage being dragged along the bottom. Whenever this occurred the hydrophone was quickly lifted up and redeployed. The measurements containing noises from the hydrophone cage contacting the seabed were not included in the analysis.

Figure 4-1 presents a 30 second underwater noise time history recorded at 470 m south of the proposed tidal turbine positions at 12:12pm on 25th July. This figure indicates that there are two prominent sources of noise present. The first is typical of underwater broadband background noise, with a level of around 100 dB re. 1µPa RMS, and is the dominant source recorded during the survey. The second is a varying number of high frequency snaps. The snaps in this recording reached levels of up to 144 dB re. 1µPa peak to peak. Similar kinds of snapping has been measured by Subacoustech on several occasions, in the Irish Sea, the Thames estuary and in lakes across the UK and Ireland. Some snaps have been recorded at levels in excess of 180 dB re. 1 µPa peak to peak. It should be noted that this is likely to be significantly lower than its source level as the distance to the source of the snap was unable to be determined. Similarly, the recorded level of snaps in the Kyle Rhea will be considerably lower than the actual source level. Although the source of the snapping is still unconfirmed, it is thought that they emanate from various biological sources. For instance, from snapping shrimp which congregate in small groups in sheltered locations. Although there is little evidence of these creatures outside the south of the British Isles there is growing evidence that they are moving into new areas along with changing climates. Acoustically, measurements conducted by Au and Banks (1997), indicate the source level from these shrimp may reach up to 189 dB re. 1 µPa peak to peak. In this particular recording the snaps do not appear to contribute significantly to the overall RMS level.

Figure 4-2 shows plots of PSD levels taken during each tidal state at approximately 150 m north of the proposed tidal turbine positions. It can be seen that when recordings were undertaken whilst the tide was flowing there is a significant presence of high frequency broadband noise particularly between 20 kHz and 150 kHz. Although this noise is in the same frequency range as the snapping, the increase is not accompanied by an increase in the number of snaps. This increase in high frequency noise with water flow has also been observed by Subacoustech at other sites. Therefore it is thought that the high frequency noise is related to the flow of water resulting in higher levels when the tide is flowing at its fastest. The noise could also be partially caused by some interaction of the flowing water over the seabed but this is unable to be deduced from the data.

Further to the observation of the presence of the high frequency broadband noise, it was found to be greatest in one location. Figure 4-3 shows a number of PSD level plots each taken from measurements along a transect where the R referred to in the figure is the distance south of the proposed tidal turbine array and a negative number corresponds to a distance north of the turbine positions. Figure 4-3 shows that the level of the high frequency noise is greatest at 130 m north of the proposed tidal turbine positions and decays increasingly the further south from that location. From all the analysed data it was found that the highest level of the high frequency noise between 20 kHz and 150 kHz seen in the PSD levels, was from measurements taken at 100 to 200 m north of the proposed tidal array location.

Figures 4-4 and 4-5 show a time history plot and PSD plot, respectively, for a recording taken approximately 200 m away from the Kyle Rhea ferry, Glenachulish. The average RMS level was measured to be 120 dB re. 1µPa RMS for the duration of this recording. The operation of the ferry and the frequent passing of boats and ships can be considered as part of the existing baseline noise in Kyle Rhea and has been taken into account in the data presented.

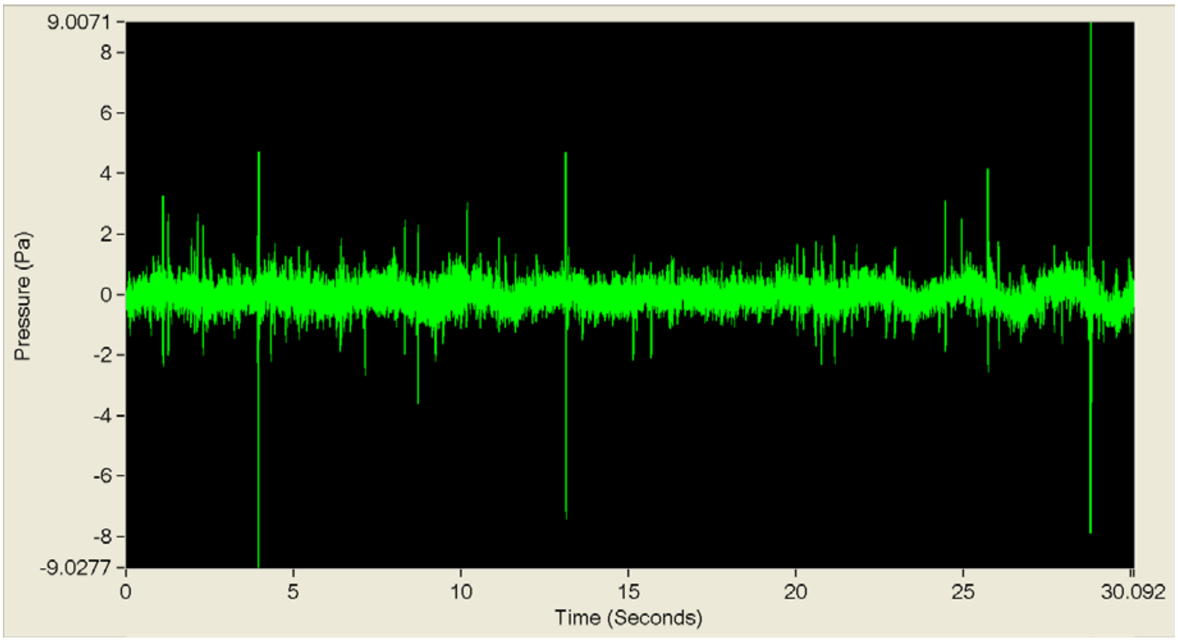

Figure 4-1 30 second time history of sound pressure measurements taken 470 m south of the proposed turbine positions at 12:12pm on 25th July

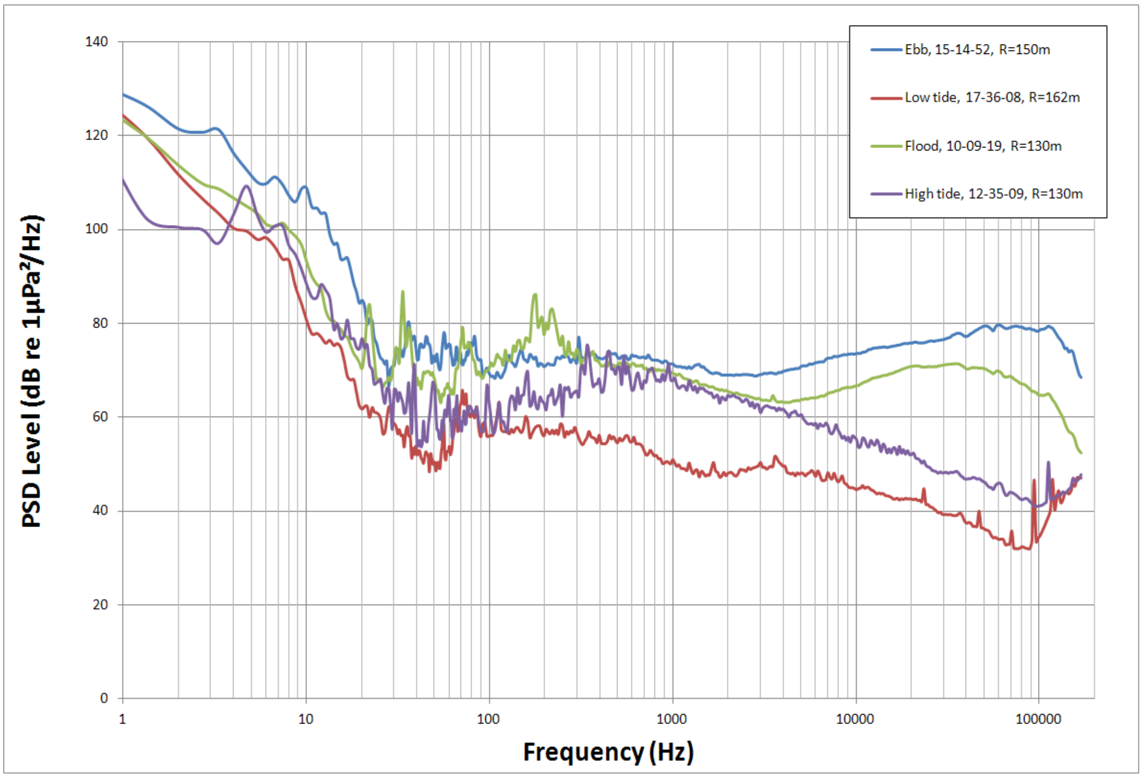

Figure 4-2 PSD plots of data captured at different tidal states where R is the distance in metres north of the proposed tidal turbine array

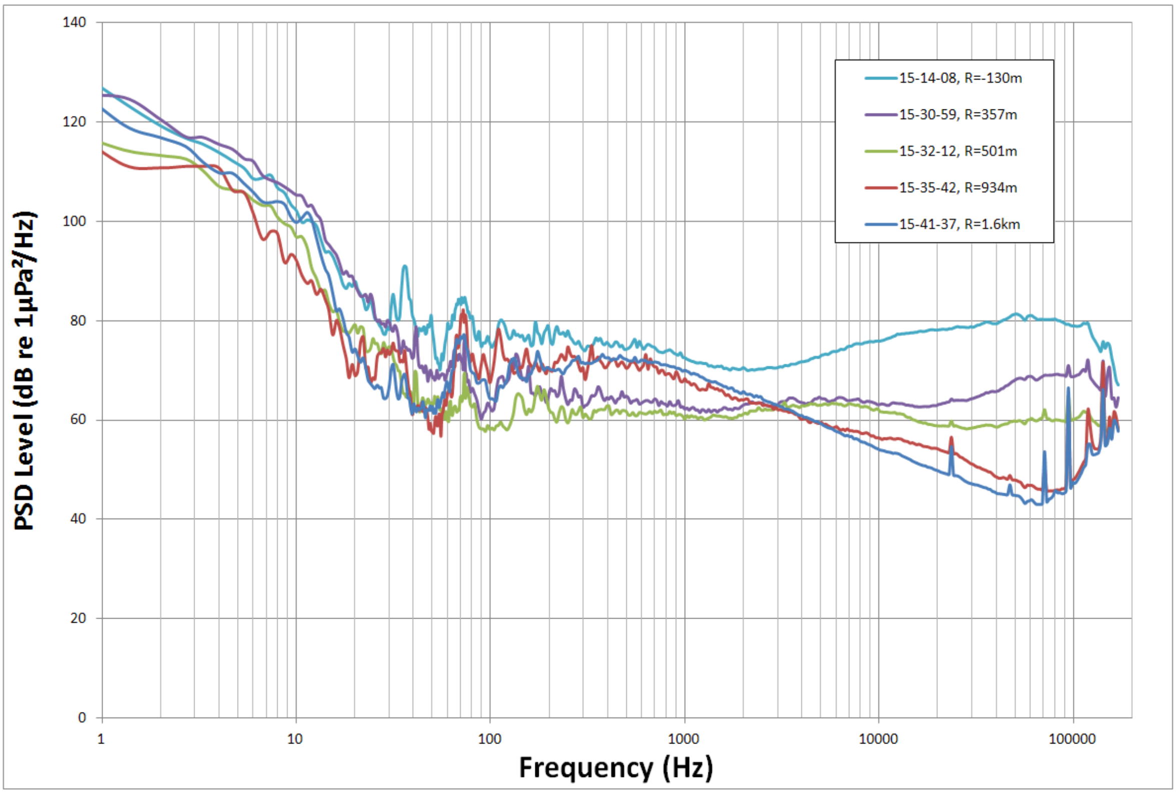

Figure 4-3 PSD plots presented illustrating the variation in the PSD level across the frequency range at different points along the Kyle Rhea where R is the distance south of the proposed location of the tidal array

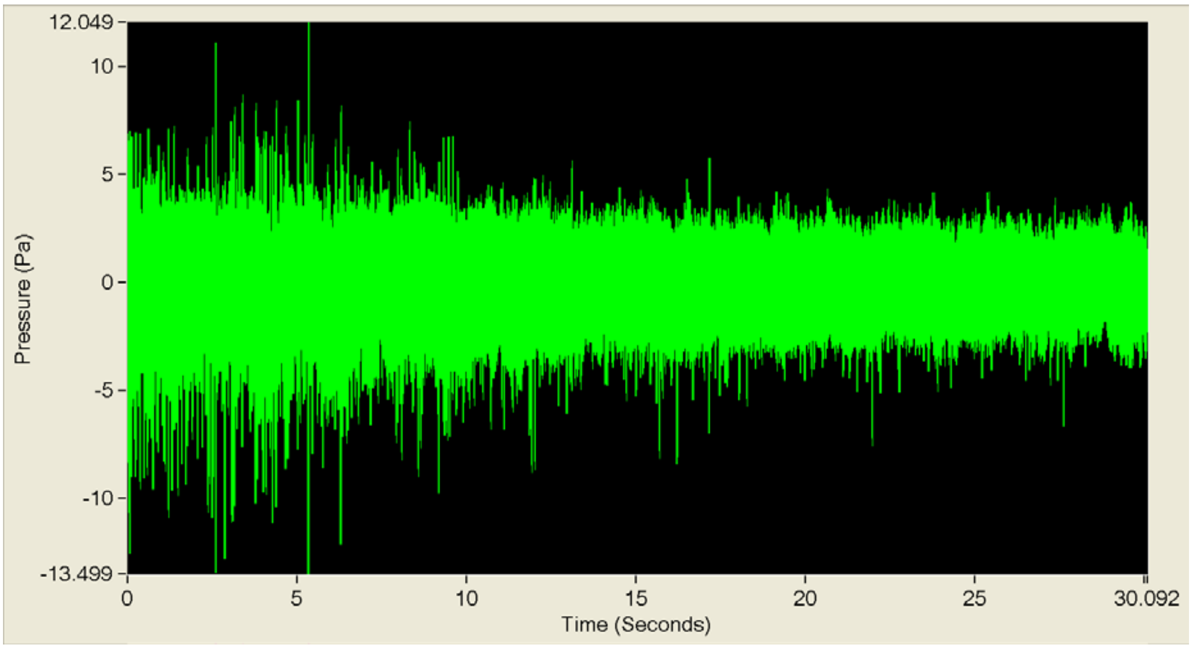

Figure 4-4 30 second time history of sound pressure measurements taken 200 m away from the Glenachulish ferry at 11:03am on 25th July

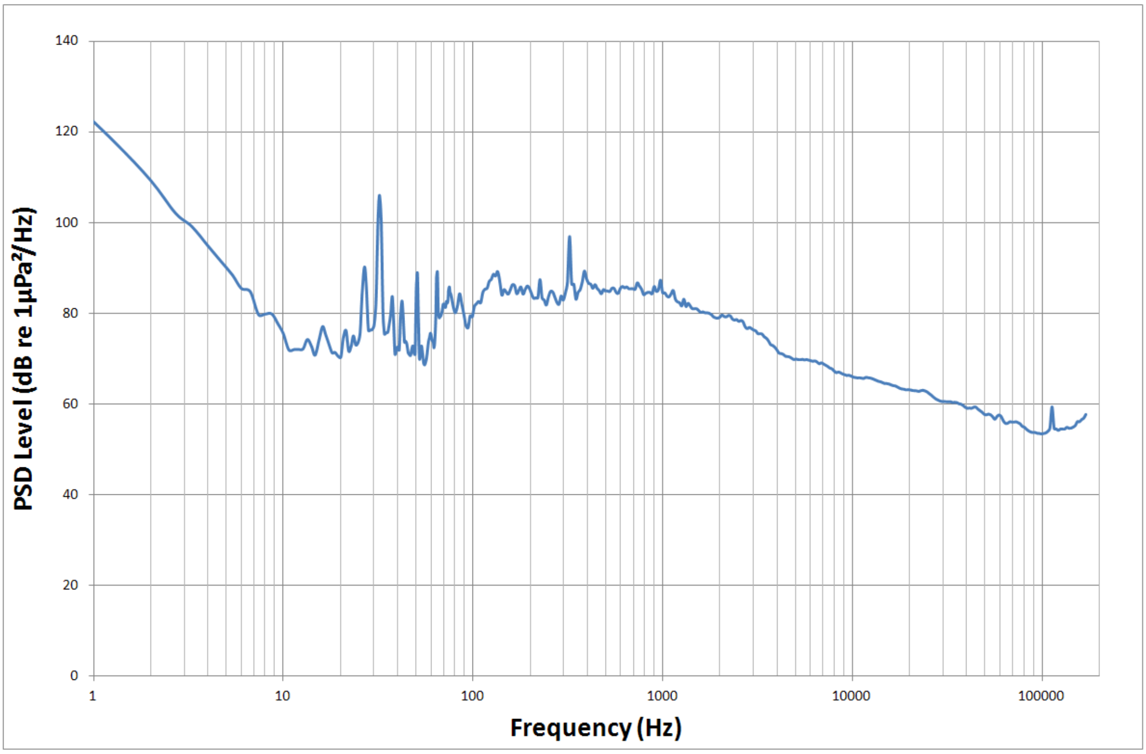

Figure 4-5 PSD plot of the time history recording shown in figure 4-4

4.2 Unweighted levels

Table 4-1 shows the maximum, minimum and mean unweighted RMS levels over each tidal state for each measurement day. The unweighted levels for each tidal state take into account all the measurements taken at various positions approximately during that tidal state. The values in table 4-1 show that at slack water the unweighted RMS levels are less than the previous tidal state. For example, on the 24th July during Ebb, when the tide was going out, the mean level was 120.1 dB compared with mean level of 111.7 dB at low tide, similarly, the mean level for flood on 25th July was 114.7 dB and at high tide the mean level was 112.1 dB.

Tables 4-2 to 4-4 present maximum, minimum and mean unweighted RMS levels over each tidal state as table 4-1. However, each table corresponds to a certain transect i.e. table 4-2 summarises the unweighted RMS levels from measurements taken along the north transect at different tidal states. The general trend observed from the unweighted RMS levels presented below indicates that RMS levels at slack water are almost without exception less than the RMS levels during the previous tidal state. The only instance this does not occur can be seen in table 4-3 on 25th July. The mean unweighted RMS level is shown to be greater during high tide, 111.8 dB, than when the tide is coming in during flood 110.3 dB. The reason for this can be pinpointed due to the presence of a ferry in the recording increasing the mean unweighted RMS value. It should be noted that the maximum and minimum unweighted RMS levels during high tide are both less than that during flood.

	Unweighted RMS Levels (dB re 1µPa)		
Tidal state	Max	Min	Mean
Ebb (24/7/12)	135.0	104.1	120.1
Low tide (24/07/12)	129.2	99.7	111.7
Flood (25/7/12)	130.3	101.4	114.7
High tide (25/7/12)	128.0	95.9	112.1

Table 4-1 Summary of the unweighted levels at approximate tidal states

	North	Unweighted RMS Levels (dB re 1µPa)		
Tidal state	Time	Max	Min	Mean
Ebb (24/7/12)	12:30	133.2	111.1	120.2
	14:41	134.2	104.1	119.9
Low tide (24/07/12)	17:55	129.2	100.8	114.7
Flood (25/7/12)	10:06	129.6	106.9	116.1
High tide (25/7/12)	12:35	122.6	99.0	111.6

Table 4-2 Unweighted RMS levels measured in the north transect at different tidal states

	East	Unweighted RMS Levels (dB re 1µPa)		
Tidal state	Time	Max	Min	Mean
Ebb (24/7/12)	13:27	133.8	116.4	123.5
Low tide (24/07/12)	17:32	123.4	99.7	108.3
Flood (25/7/12)	09:44	129.0	101.4	110.3
High tide (25/7/12)	11:01	126.9	96.1	111.8

Table 4-3 Unweighted RMS levels measured across Kyle Rhea towards the east of the proposed turbine positions at different tidal states

	South	Unweighted RMS Levels (dB re 1µPa)		
Tidal state	Time	Max	Min	Mean
Ebb (24/7/12)	15:30	135.0	105.9	116.3
Flood (25/7/12)	09:25	130.3	110.2	121.5
High tide (25/7/12)	10:44	117.4	101.5	110.0
	11:43	128.0	95.9	112.6

Table 4-4 Unweighted RMS levels measured in the south transect at different tidal states

4.3 Species perceived sound level (dB_{ht})

All the data have been analysed to obtain noise levels in terms of the dB_{ht}(*Species*) metric. This method of presenting data indicates the likely perception by an animal of the underwater sound, and thereby provides a measure that can be used to assess the potential for the underwater sound to cause a behavioural effect.

Tables 4-5 to 4-8 presents maximum, minimum and mean dB_{ht} levels for the selected species of fish and marine mammal, described in section 2.5, at each of the measurement locations. It can be seen that the dB_{ht} levels for fish, compared to those for marine mammals are significantly lower. This is to be expected given the audiogram data presented in Figure 2-1 and Figure 2-2, which indicate that marine mammals have a much lower threshold of hearing than fish. In addition, the range of hearing in marine mammals is significantly wider and they are most sensitive to higher frequencies.

From the PSD levels presented previously it was seen that there was an increase in the high frequencies between 20 kHz and 150 kHz which was greater when the tide was in flow. This is illustrated in the comparison of the marine mammal dB_{ht} levels in the tables below. Tables 4-5 and 4-7, showing dB_{ht} levels when the tide is in flow, generally present higher dB_{ht} levels than presented in tables 4-6 and 4-8 which show dB_{ht} levels during slack water. The highest dB_{ht} levels are seen to be for the bottlenose dolphin and harbour porpoise.

Based on the criteria of Nedwell *et al* (2007b), perceived levels of noise above 90 dB_{ht} are likely to cause a behavioural avoidance response. Table 4-5 shows that the maximum dB_{ht} levels of the harbour porpoise exceeds 90 dB_{ht}(*Phocoena phocoena*) on more than one occasion, 95.5 dB_{ht}(*Phocoena phocoena*) in the 3rd transect and 92.6 dB_{ht}(*Phocoena phocoena*) in the 4th transect. These high dB_{ht} levels are inextricably linked to the presence of high frequency noise found to be a maximum approximately 150 m north of the proposed location of the tidal array. This also explains why the harbour seal dB_{ht} levels are not as high as the rest of the marine mammals because their hearing sensitivity drops off considerably before 50 kHz.

		High tide to low tide (Ebb)						
24/07/12	RMS dB_{ht} Levels	Cod	Dab	Herring	Salmon	Bottlenose Dolphin	Harbour Porpoise	Harbour Seal
2nd Transect - North	Max	36.3	16.3	41	14.9	75.6	84.0	55.2
	Min	13.6	-5.1	21.4	-8.1	50.8	59.6	35.4
	Mean	22.8	3.4	29.2	1.4	64.7	73.1	46.9
3rd Transect - East	Max	37.8	16.6	41.3	17.4	86.8	95.5	59.9
	Min	4.9	-13.3	12.7	-17.2	44.4	52.8	37.1
	Mean	20.8	1.5	27.6	-0.6	72.7	81.2	50.7
4th Transect - North	Max	49.2	31.6	56.5	26.1	84.0	92.6	59.8
	Min	8.2	-8.9	17.7	-14.4	48.0	56.6	31.1
	Mean	21.2	2.5	28.7	0.0	65.3	73.8	45.5
5th Transect - South	Max	29.4	7.4	39.1	10.4	71.4	80.2	46.7
	Min	5.7	-12.5	14.6	-15.7	47.2	56.9	31.9
	Mean	15.5	-4.2	22.9	-5.8	56.5	66.0	38.0

Table 4-5 Maximum, minimum and mean dB_{ht} RMS levels for several species of fish and marine mammals recorded across the transects during tidal state between high and low tide

		Low Tide						
24/07/12	RMS dB_{ht} Levels	Cod	Dab	Herring	Salmon	Bottlenose Dolphin	Harbour Porpoise	Harbour Seal
6th Transect - East	Max	24.4	3.7	28.9	20.5	49.4	64.2	37.0
	Min	-2	-18.9	6.4	-26.0	38.8	47.2	18.0
	Mean	10.6	-7.6	18.5	-10.8	46.0	55.3	29.4
7th Transect - North	Max	24.9	4.4	29.5	19.8	79.8	88.1	58.2
	Min	-3	-20.8	5.2	-25.9	53.6	62.1	29.9
	Mean	11.4	-7.5	18.8	-8.9	66.0	74.5	42.2

Table 4-6 Maximum, minimum and mean dB_{ht} RMS levels for several species of fish and marine mammals recorded across the transects during low tide

		Low tide to high tide (Flood)						
25/07/12	RMS dB_{ht} Levels	Cod	Dab	Herring	Salmon	Bottlenose Dolphin	Harbour Porpoise	Harbour Seal
1st Transect - South	Max	42.6	19.2	48.7	22.3	84.9	93.6	59.5
	Min	13.9	-4.1	23.0	-8.6	50.7	59.0	33.9
	Mean	28.3	5.8	35.0	5.5	67.1	75.4	47.2
2nd Transect - East	Max	50.7	35.0	53.2	29.9	55.8	64.1	40.3
	Min	1.1	-15.8	8.6	-20.2	47.9	55.5	32.4
	Mean	18.5	0.7	24.3	-2.5	51.0	59.1	35.7
3rd Transect - North	Max	39.2	20.1	43.5	19.0	78.5	87.1	53.2
	Min	4.9	-15.9	19.5	-20.7	42.6	50.1	33.3
	Mean	16.5	-2.6	27.0	-7.0	60.0	68.0	44.3

Table 4-7 Maximum, minimum and mean dB_{ht} RMS levels for several species of fish and marine mammals recorded across the transects during tidal state between low and high tide

		High Tide						
25/07/12	RMS dB_{ht} Levels	Cod	Dab	Herring	Salmon	Bottlenose Dolphin	Harbour Porpoise	Harbour Seal
4th Transect - South	Max	34.2	19.9	37.7	13.2	60.4	68.8	39.8
	Min	8.9	-7.8	20.2	-13.5	40.9	49.0	29.5
	Mean	20.9	4.1	28.1	-1.2	50.7	58.8	36.1
5th Transect - East	Max	45.5	29.1	49.5	25.2	72.2	80.3	56.8
	Min	0.4	-16.1	8.8	-21.5	38.8	47.2	23.2
	Mean	23.5	5.1	30.0	1.4	54.6	62.9	38.0
6th Transect - South	Max	41.0	22.5	48.5	19.2	66.7	74.3	59.9
	Min	0.6	-14.7	9.3	-21.6	37.7	46.0	25.3
	Mean	21.7	-0.3	31.0	-2.0	50.9	58.7	40.3
7th Transect - North	Max	42.9	26.5	46.1	22.5	64.1	72.4	47.7
	Min	4.2	-17.5	13.8	-22.6	41.6	49.8	27.2
	Mean	21.8	1.4	29.0	-1.7	50.3	58.3	36.7

Table 4-8 Maximum, minimum and mean dB_{ht} RMS levels for several species of fish and marine mammals recorded across the transects during high tide

5 Conclusions

A series of underwater noise measurements has been undertaken by Subacoustech Environmental Ltd to survey the baseline noise prior to construction of the Kyle Rhea tidal array which is to be located between the Isle of Skye and the Scottish mainland. Measurements were taken along transects north, south and east of the proposed tidal array location during different tidal states over two days.

1. The time history and PSDs of the captured data were analysed and a considerable amount of the measurements were found to evidence high levels of high frequency broadband noise between 20 kHz and 150 kHz. The high frequency broadband noise was seen to be significantly greater when the tide was flowing and has been shown to be a maximum approximately 100 to 200 m north of the proposed tidal array location. In a number of measurements ‘snaps’ have been observed. The source of these ‘snaps’ could be due to marine biota.

2. The data were also analysed to provide an indication of the sound levels in terms of unweighted RMS levels as well as the perceived levels of underwater noise for each species using the dB_{ht}(*species*) metric. This analysis provides estimates of the variation of the unweighted sound levels and the sound levels that each underwater species analysed are likely to hear.

3. Based on this analysis, both the unweighted and dB_{ht} sound levels are shown to be higher when the tide was in flow compared to the sound levels recorded at slack water. For example, the mean unweighted RMS level when the tide was flowing out on 24th July was 120.7 dB compared to the unweighted RMS level at low tide of 111.7 dB. High dB_{ht} levels are shown to have occurred for marine mammals, in for a harbour porpoise the maximum level recorded was 95.5 dB_{ht}(*Phocoena phocoena*). These high dB_{ht} levels are as a result of the presence of high frequency noise, greatest during tidal flow, which may be linked to the source of the ‘snaps’.

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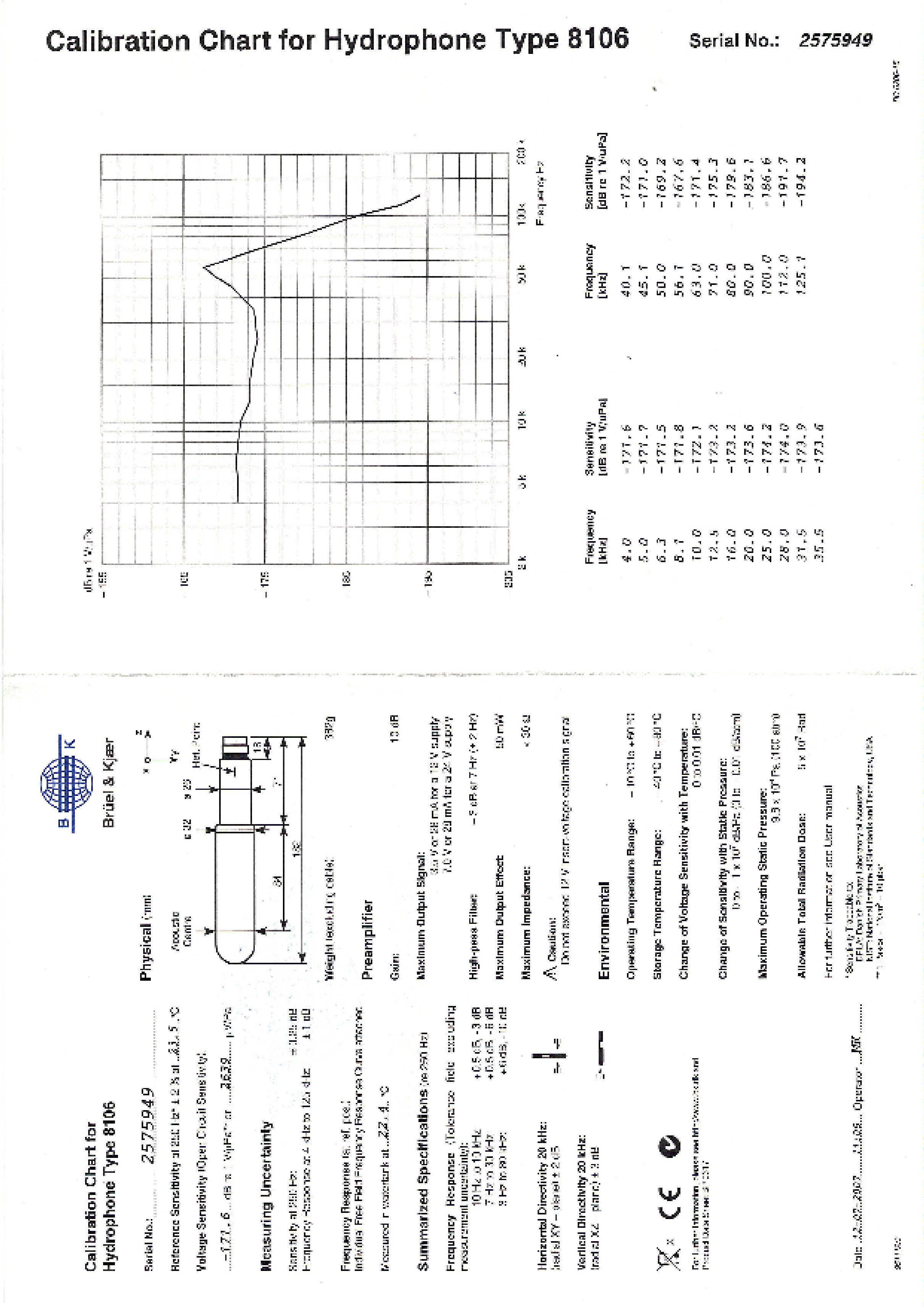
A Calibration charts



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Kyle Rhea Tidal Stream Array

Appendix 12.6

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Assessment of underwater noise from construction and operation of the Kyle Rhea Tidal Array

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20 November 2012

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Approved by Technical Director: Dr J R Nedwell

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List of Contents

1 Introduction

1.1 Project and Site description

SeaGeneration (Kyle Rhea) Ltd are looking to install a small array of SeaGen tidal turbines in Kyle Rhea, in north west Scotland.

A single device, using the same technology, was installed, and successfully operated in Strangford Lough, Northern Ireland. The devices proposed for the array at Kyle Rhea will be slightly larger in terms of rotor dimensions, in order to increase the output power to 2 Megawatts (MW).

Each SeaGen tidal turbine is likely to be mounted on a quadropile, which will be installed using a percussive drilling technique.

A map of the Kyle Rhea Array site with the proposed locations of the devices is presented in Figure 1-1.

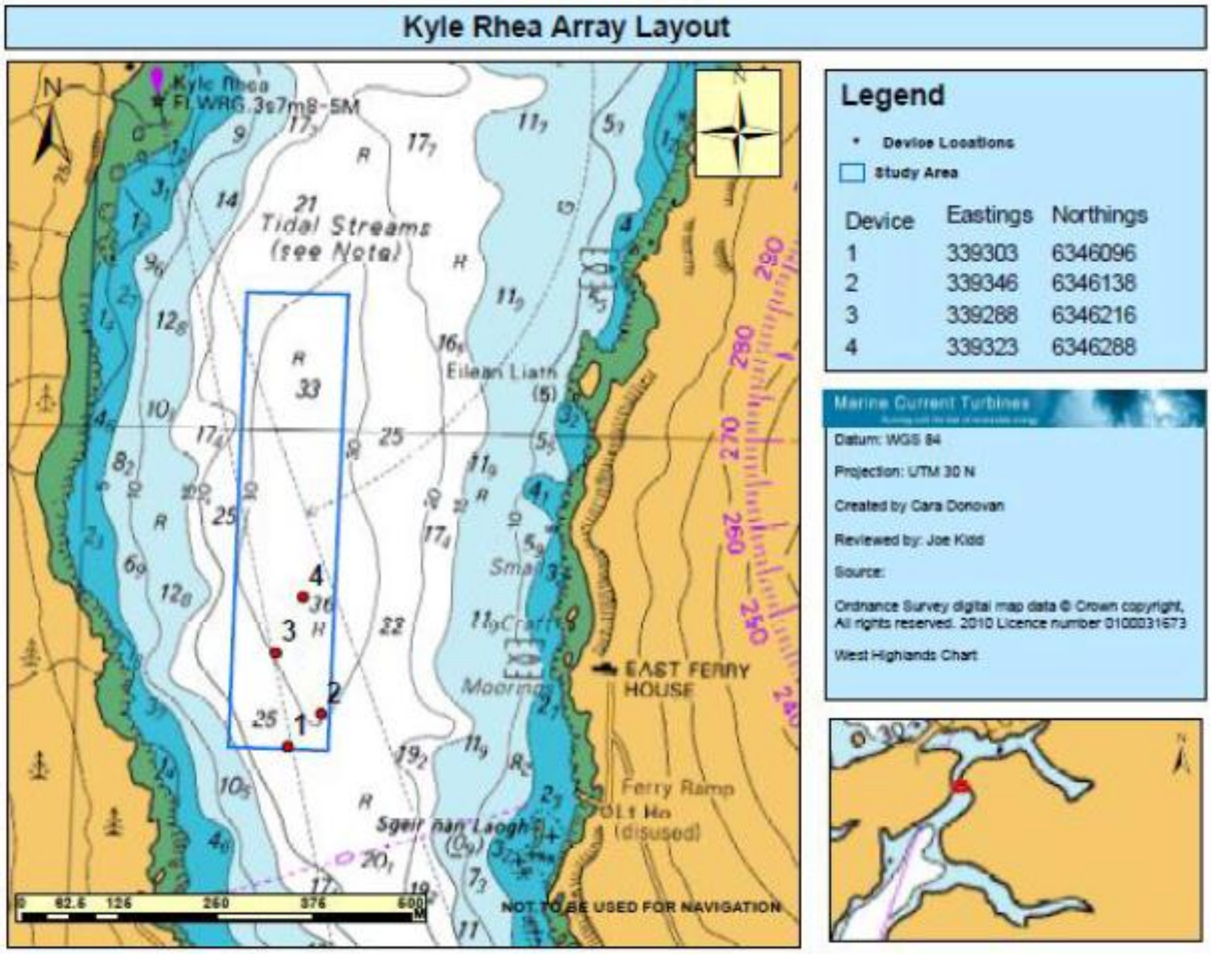

Figure 1-1 Location and likely layout of the Kyle Rhea Tidal Array

1.2 Percussive drilling operations

It is anticipated that the foundations of the SeaGen energy devices will need to be installed using a percussive drilling technique. It is expected that underwater noise will be generated primarily by interactions of the drill teeth with the substrate material along with the impact action of the hammer, causing vibrations that are transmitted through the drill string and surrounding structures. The primary route for noise to be transmitted into the surrounding body of water is through any of these structures that are directly in contact with the water.

1.3 Project objectives and structure of report

This report has been compiled by Subacoustech Environmental Limited to estimate the likely levels of underwater noise from the construction and operation of the Kyle Rhea Tidal Array, Subacoustech Environmental has completed the following project objectives:

- A brief summary of the project and proposed activities (Section 1);
- A brief overview of background information on the units for measuring and assessing underwater noise and vibration from construction activities in coastal regions (Section 2);
- A review of the sensitivity of fish and marine mammals to underwater sound and established criteria for estimating the impact. The review presents peer reviewed audiogram data for the key species of fish and marine mammal where data is available (Section 3);
- A review of the available information on the levels of underwater noise from percussive drilling operations (Section 4);
- Estimation of the likely levels of underwater noise from the specific drilling operations envisaged to be used at the Kyle Rhea site based on similar drilling operations at a site in UK coastal waters (Section 4);
- Impact zone analysis for the key marine species based on various assessment metrics (Section 4);
- Assessment of the likely noise from vessels associated with the Kyle Rhea Tidal Array (Section 5)
- Review of the likely levels of underwater noise from the Kyle Rhea Tidal Array while it is operational (Section 6); and
- Summary and Conclusions (Section 7).

This report, therefore, estimates the potential levels of underwater noise that are likely to be generated during drilling operations at the Kyle Rhea site as well as the operational Tidal Array and interprets these data in respect of their likely effects.

2 Measurement of underwater noise

2.1 Introduction

Sound travels much faster in water (approximately 1,500 m/s) than in air (340 m/s). Since water is a relatively incompressible, dense medium, the pressures associated with underwater sound tend to be much higher than in air. As an example, background levels of sea noise of approximately 130 dB re 1 µPa for UK coastal waters are not uncommon (Nedwell *et al,* 2003a and 2007a). This level equates to about 100 dB re 20 µPa in the units that would be used to describe a sound level in air. Such levels in air would be considered to be hazardous. However, marine mammals and fish have evolved to live in this environment and are thus relatively insensitive to sound pressure compared with terrestrial mammals. The most sensitive thresholds are often not below 100 dB re 1 µPa and typically not below 70 dB re 1 µPa (44 dB re 20 µPa using the reference unit that would be used in air).

For this reason it is generally of little use and potentially misleading to directly compare levels of underwater noise from sound sources underwater to those in air. Table 2-1 presents a summary of the typical levels of noise for various sound sources in air and in water. From these data it is clearly evident that the typical levels of underwater noise are far higher than those found in air. This should be borne in mind when considering quoted levels of underwater noise.

Typical noise levels in air		**Typical noise levels in water**	
Sound Source	**Typical noise level (dB re 20 µPa)**	**Sound Source**	**Typical noise level (dB re. 1 µPa)**
Quiet Office	~40 dB	Background noise	100 – 130 dB RMS
Conversation	~60 dB	Fishing trawler	168 dB RMS @ 1 m range
Pneumatic road drill	~100 dB	Impact piling	243 – 257 dB peak to peak @1 m
Jet aircraft taking off 25 m away	~140 dB	Underwater explosive blast	285 dB peak pressure @ 1 m

Table 2-1 Summary of typical levels of noise from various sources in air and in water

2.2 Units of measurement

Measurements of underwater sound are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. A logarithmic scale is used because rather than equal increments of sound having an equal increase in effect, typically a constant ratio is required for this to be the case, that is, each *doubling* of sound level will cause a roughly equal increase in “loudness”.

Any quantity expressed in this scale is termed a “level”. If the unit is sound pressure, as is the case with underwater noise, it will be termed a “Sound Pressure Level”. A refinement is that the scale such as when used with sound pressure, is that the pressure squared is applied rather than the pressure. If this were not the case, if the acoustic power level of a source rose by 10 dB the Sound Pressure Level would rise by 20 dB.

As the dB scale represents a ratio (that is, the result of dividing one quantity by another base quantity), it is used with a reference unit which expresses the base from which the ratio is expressed. For underwater sound, typically a unit of one microPascal (µPa) is used as the reference unit; a Pascal is equal to the pressure exerted by one Newton over one square metre. One microPascal equals one millionth of this. It is important to state the reference unit when describing the level of a sound in decibels as the use of a different reference pressure for a given measured sound pressure will result in a different value. For underwater noise, therefore, a noise level would be expressed as “120 dB re 1 µPa”.

2.3 Quantities of measurement

A sound level may be expressed in many different ways depending upon the particular type of noise that is being measured, and the parameters of the noise that allow it to be evaluated in terms of a biological effect. For example, measurement of underwater noise following the detonation of explosives indicates a clear peak in positive (high) pressure and only a much smaller peak in negative (low) pressure. As the resulting impact on any surrounding objects is likely to be related to the positive peak, it is usually appropriate to quote the peak level of the sound.

For impact piling, however, where the pressure wave is roughly equal in positive and negative peaks, the resulting impact is likely to be related to both the positive and negative pressure peaks. It is therefore more appropriate to quote the level in terms of “peak to peak” levels which is the maximum variation between the positive and negative pressures in the sound wave.

When noise and vibration is of a continuous nature such as that associated with drilling, boring, continuous wave sonar, or background sea and river noise levels it is more appropriate to characterise the noise level over a longer period of time. The variation in sound pressure is therefore measured over a specific time period to determine the Root Mean Square (RMS) level of sound that is varying with time. This is the Sound Pressure Level (SPL) which can be considered to be a measure of the average unweighted level of the sound over the measurement period.

Where a particular noise source is expressed in terms of SPL it is necessary to quote the time period over which the RMS level is calculated. For instance, in the case of a transient noise source such as a pile strike lasting say a tenth of a second this is critically important as the mean taken over a tenth of a second will be ten times higher than the mean taken over one second. Generally the time period is chosen to be of a sufficient duration to incorporate the typical variations in level of the particular noise source being recorded to provide an accurate indication of the average levels.

2.4 Source Level and Transmission Loss

As sound propagates through water it reduces in level as a result of losses relating to energy dissipation (absorption) and also due to the sound energy simply spreading over a wider area (geometric spreading). Typically, a source of underwater noise is quantified in terms of a Source Level, which is the level of sound energy released by the source, usually described as the level of underwater noise at a range of 1 m from the source. In order to characterise the rate at which energy is lost a value for the transmission loss is often given. The level at a particular point in the water space is therefore the Source Level minus the Transmission Loss.

Over short distances, absorption effects have little influence on the Transmission Loss and can often be ignored. The Source Level itself may be quoted in any physical quantity, for instance, a piling source may be expressed as having a “peak to peak Source Level of 200 dB re 1 µPa @ 1m”.

This simple but convenient formulation ignores the practical difficulty of estimating the Source Level. Since the measurements are usually made at some distance from the source and extrapolated back to the source, the true level at one metre may actually be very different from the Source Level used in these equations.

It is often not realised that, since the value of Source Level quoted for a particular source is obtained by extrapolation, the value will depend on the model that is used to perform the extrapolation. Figure 2-1 illustrates this point. The diagram illustrates a set of measurements made of the noise from piling. In the simplest case, in order to draw conclusions about the data, it may be fitted to a straight-line model; this is shown in the figure by the green line. Such a model effectively assumes that the noise level attenuates only as a result of geometric spreading. This however will generally over-estimate the level for low and high ranges, since it ignores the effects of absorption of the noise. An improved model, including absorption, is represented by the red line and gives a better fit to the data, and indeed this simple form is usually adequate for modelling sound propagation from a source in deep water of roughly constant depth. However, in the case of shallow coastal waters, where the proposed project is situated, the depth may rapidly fluctuate between shallow water of a few metres and deep water of tens of metres or more. In these circumstances, the Transmission Loss becomes a more complex function of depth that depends heavily on the local bathymetry and hence should ideally be calculated using a more sophisticated model, such as *INSPIRE*. Where these effects are included, as illustrated by the blue line, yet another value of Source Level may result; typically lower levels of noise may be predicted near to the noise source.

The variation in estimates of Source Level for the same data set, when analysed in different ways, indicates how Source Level will in general be a function of the model that is used to express the noise levels.

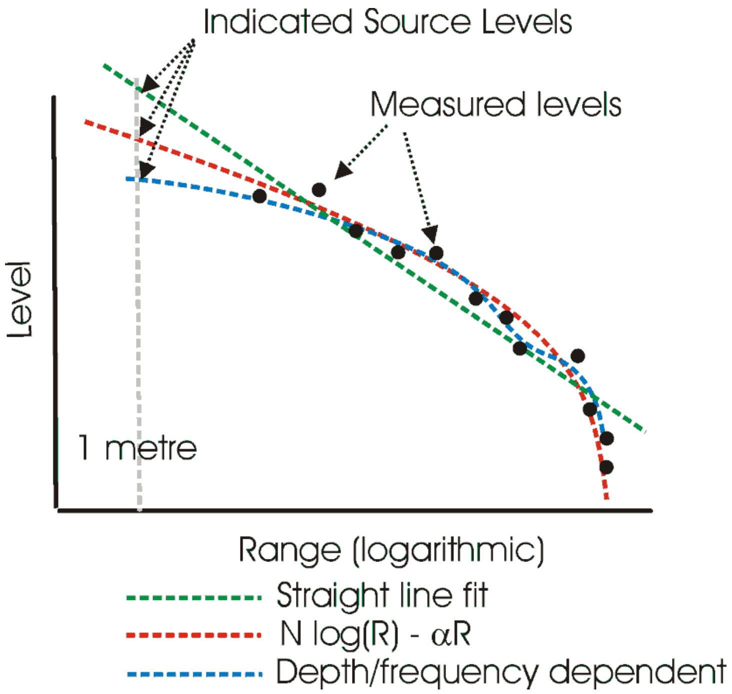

Figure 2-1 Differences in Source Level estimation based on various models

Where actual measured underwater noise data from a particular activity is not available, ideally the most sophisticated model will be used in all cases. These tend to require a very advanced level of knowledge of how a particular sound behaves in the underwater environment and/or a large amount of information on the conditions at the particular site such as temperature, salinity, etc and of the substrate conditions. Where actual measured data from a similar activity is available the introduction of the numerous variables used in sophisticated models is not required.

The approach that has been used in this study has therefore been to use existing high quality measurements of underwater noise from a similar drilling operation to that proposed at Kyle Rhea. These data have been used to estimate the Source Levels and Transmission Losses associated with the drilling operation. The data have then been directly scaled up for the more powerful device based on the manufacturers specifications of the two drilling devices. While some uncertainties do still remain when using this approach, it is felt that it offers the best estimate of potential levels of underwater noise possible based on the currently available information.

3 Impact of underwater sound on marine species

3.1 Introduction

Over the past 20 years it has become increasingly evident that noise from human activities in and around underwater environments may have an impact on the marine species in the area. The extent to which intense underwater sound might cause an adverse environmental impact in a particular species is dependent upon the incident sound level, frequency content, duration and/or repetition rate of the sound wave (see, for example Hastings and Popper, 2005). As a result, scientific interest in the hearing abilities of aquatic animal species has increased. These studies are generally based on evidence from high level sources of underwater noise such as blast or impact piling, as these sources are likely to have the greatest environmental impact and therefore the clearest observable effects. In the absence of direct evidence from other sources these reviews have been used to inform assessments of lower level underwater noise sources such as drilling.

The impacts of underwater sound can be broadly summarised into three categories:

- Physical injury and fatality
- Auditory damage (either permanent or temporary)
- Behavioural avoidance

The levels of underwater noise associated with these impacts are briefly reviewed below and various criteria against which to assess the likelihood of these occurring presented.

3.2 Impacts and their associated sound levels

3.2.1 Physical injury and fatality

The data currently available relating to the levels of underwater noise likely to cause physical injury or fatality are primarily based on studies of blast injury at close range to explosives with an additional small amount of information on fish kill as a result of impact piling. All the data concentrates on impulsive underwater noise sources as other sources of noise are rarely of a sufficient level to cause these effects.

Parvin *et al* (2007) presents a comprehensive review of information on lethal and physical impacts of underwater noise and proposes the following criteria to assess the likelihood of these effects occurring;

- Lethal effect may occur where peak to peak levels exceed 240dB re 1µPa; and
- Physical injury may occur where peak to peak levels exceed 220dB re 1µPa.

It might be noted however that for smaller fish sizes of mass 0.01 g, an interim “no injury” criteria has been proposed for fish exposed to impact piling noise of 208 dB re 1µPa peak level (equivalent to 214 dB re 1 µPa peak to peak level) or a Sound Exposure Level of 187 dB re 1 $\mu Pa^2 s$. In view of the very small fish size that this limit addresses, and the fact that it is extrapolated from limited data, it has not been used in this study.

3.2.2 Auditory Damage

Parvin *et al*., (2007) also suggests that for continuous sound, direct injury to gas-containing structures or auditory mechanisms may occur at lower incident sound levels depending on duration and frequency content of the noise. Several studies have been carried out relating to the onset of auditory damage in terms of Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) (see, for example Nedwell *et al*., (2007b) and Southall *et al*., (2007) for a review of these studies). Nedwell *et al*., (2007b) suggests the use of species specific weighting metrics (the dB_{ht}) similar to the approach used to assess human response to noise. (see

Appendix C for further explanation of the dB_{ht} approach). The study suggests the perceived level by a particular species of 130 dB_{ht}(*Species*) will cause instantaneous hearing damage from a single event. As the assessment using this metric will require the noise to be filtered for a specific marine species to determine if it is above 130 dB_{ht}, this approach takes into the account the varying hearing abilities of marine species.

Based on the current description of foundation installation operations envisaged at the Kyle Rhea site it is not envisaged that the underwater noise will be of sufficient level to cause auditory damage.

3.2.3 <u>Behavioural response</u>

At levels lower than those that cause auditory injury, noise may nevertheless have important behavioural effects on a species, of which the most significant is avoidance of the insonified area (the region within which noise from the source is above ambient underwater noise levels). The significance of the effect requires an understanding of its consequences; for instance, avoidance may be significant if it causes a migratory species to be delayed or diverted. However, in other cases, the movement of species from one area to another may be of no consequence.

Various metrics have been proposed to assess the possibility of auditory damage and behavioural avoidance response occurring to marine species. On the basis of a large body of measurements of fish avoidance of noise (Maes *et al,* 2004), and from re-analysis of marine mammal behavioural response to underwater sound the following assessment criteria was published by the Department of Business, Enterprise and Regulatory Reform (BERR) (Nedwell *et al,* 2007b) to assess the potential impact of the underwater noise on marine species:

Level in dB_{ht}(species)	Effect
0 – 50	Low likelihood of disturbance
75 and above	Avoidance reaction by 50 – 85% of individuals but habituation or context may limit effect
90 and above	Strong avoidance reaction by virtually all individuals
Above 130	Possibility of traumatic hearing damage from single event

Table 3-1 Assessment criteria used in this study to assess the potential impact of underwater noise on marine species

3.2.4 <u>Overview of hearing in fish and marine mammals</u>

Behavioural impacts in fish following their exposure to underwater sound relate to the way in which they hear and how they may subsequently respond to the sound. Variation in the anatomy and physiology of the ears and associated structures in fish is extensive, indicating that different species detect sound in different ways (Popper and Fay, 1993). Furthermore, published data also indicates that there is a considerable variation in the hearing abilities of fish sensitive to sound, both in terms of the minimum levels of sound perceptible and the frequency range over which they can hear (e.g. Hawkins, 1981; Lovell *et al*, 2005; Popper *et al,* 2004; Hastings and Popper, 2005; Thomsen *et al,* 2006; Madsen *et al,* 2006). Any assessment of potential impacts on a particular species must therefore take this into account. The dB_{ht}, which is a probabilistic model, takes this into account by estimating the proportion of a population that will react, rather than trying to estimate whether an individual will.

This variation appears to be linked to particular physiological adaptations in the distance of the swim bladder to the inner ear. The herring for example has an extension of the swim bladder that terminates within the inner ear (Blaxter *et al*, 1981; Popper *et al,* 2004). By comparison, the swim bladder in salmon is not in close proximity to the ear anatomy and, as such, this species has poorer hearing. Species such as dab and plaice do not have a swim bladder and thus tend to have a lower hearing ability than many other species of fish.

Sensitivity to underwater noise in marine mammals is considerably more developed than in fish due to the use of sound in these species for hunting, echolocation and communication. Although there is also considerable variation in the hearing abilities of marine mammals, the data suggest that, in general, they are able to perceive both a wider range of frequencies and also to lower levels than fish.

Table 3-2 presents a generalised summary of the hearing abilities of fish and marine mammals. As mentioned, there is a considerable variation even within these groups, however, this does provide an indication of the typical frequencies and levels that species are able to perceive.

Species group	Typical frequency range	Lowest threshold level	Frequency of peak sensitivity	Example species
Fish – hearing specialists	30 Hz – 4 kHz	75 dB re. 1 µPa	30 Hz – 1 kHz	herring (*Clupea harengus*), sprat (*Sprattus sprattus*)
Fish – hearing generalists	30 Hz – 400 Hz	95 – 118 dB re. 1µPa	100 – 200 Hz	Dab (*Limanda limanda*), cod (*Gadus morhua*)
Cetaceans	100 Hz – 170 kHz	40 dB re. 1 µPa	20 – 150 kHz	Harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncates*)
Pinnipeds	100 Hz – 128 kHz	60 dB re. 1 µPa	10 – 40 kHz	Common (harbour) seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*)

Table 3-2 Summary of typical hearing sensitivity data for species of fish and marine mammals

3.2.5 Selection of species

The species upon which the dB_{ht} analysis has been conducted in this study have been selected to give a spread of different species' hearing abilities and also crucially upon the availability of a good quality peer-reviewed audiogram shown in Figures 3-1 to 3-3. These species may also indicate the possible impacts that may occur to similar species.

The species of fish considered in this study are:

- Cod (*Gadus morhua*), have an anterior part of the swimbladder that, although not connected to the inner ear, is in close proximity, and hence, cod have have a relatively high sensitivity to underwater sound. The audiogram data used in this study is from Chapman and Hawkins (1973).
- Dab (*Limanda* limanda), a flatfish species with generalist hearing capability, but that based on current peer reviewed audiogram data (Chapman and Sand, 1974) is the most sensitive flatfish to underwater sound. Also a surrogate for sole and lemon sole;
- Herring (*Clupea harengus)*, a fish hearing specialist that, based on current peer reviewed audiogram data (Enger, 1967) is the most sensitive marine fish to underwater sound. Also as a surrogate for sprat;

- Salmon (*Salmo salar*), (Hawkins and Johnstone, 1978) a species with lower hearing sensitivity than herring and therefore they may be classed as hearing generalists; and

The species of marine mammal considered in this study are

- Harbour seal (*Phoca vitulina*), a pinniped that based on current peer reviewed audiogram data (Mohl, 1968, Kastak and Shustermann, 1998) is the most sensitive seal species to underwater sound and may be representative of other seal species and marine mammals that are sensitive to mid-frequency underwater sound. In this study this is also being used as a surrogate for grey seal
- Harbour porpoise (*Phocoena phocoena*), a marine mammal (toothed whale) that based on current peer reviewed audiogram data (Kastelein, 2002) is the most sensitive marine mammal to high frequency underwater sound;
- Bottlenose dolphin (*Tursiops truncatus*), (Johnson, 1967) a marine mammal (toothed whale) with good high frequency hearing sensitivity. Also as a surrogate for white-beaked dolphin; for which only partial audiogram data is available.

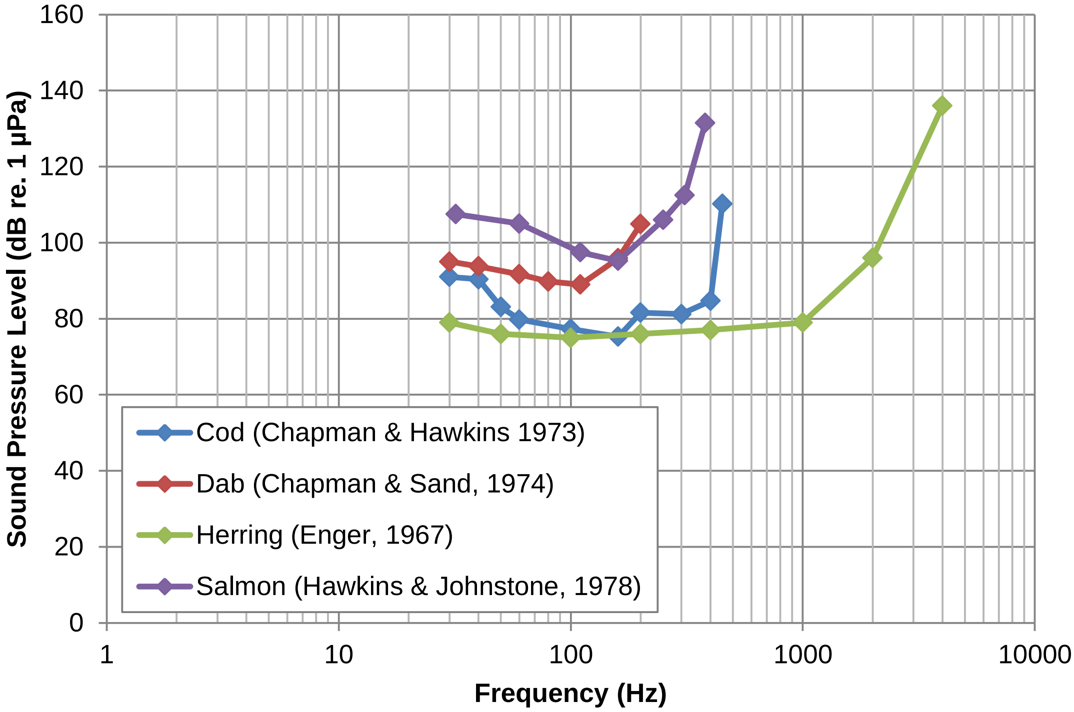

Figure 3-1 Comparison of hearing thresholds for species of fish

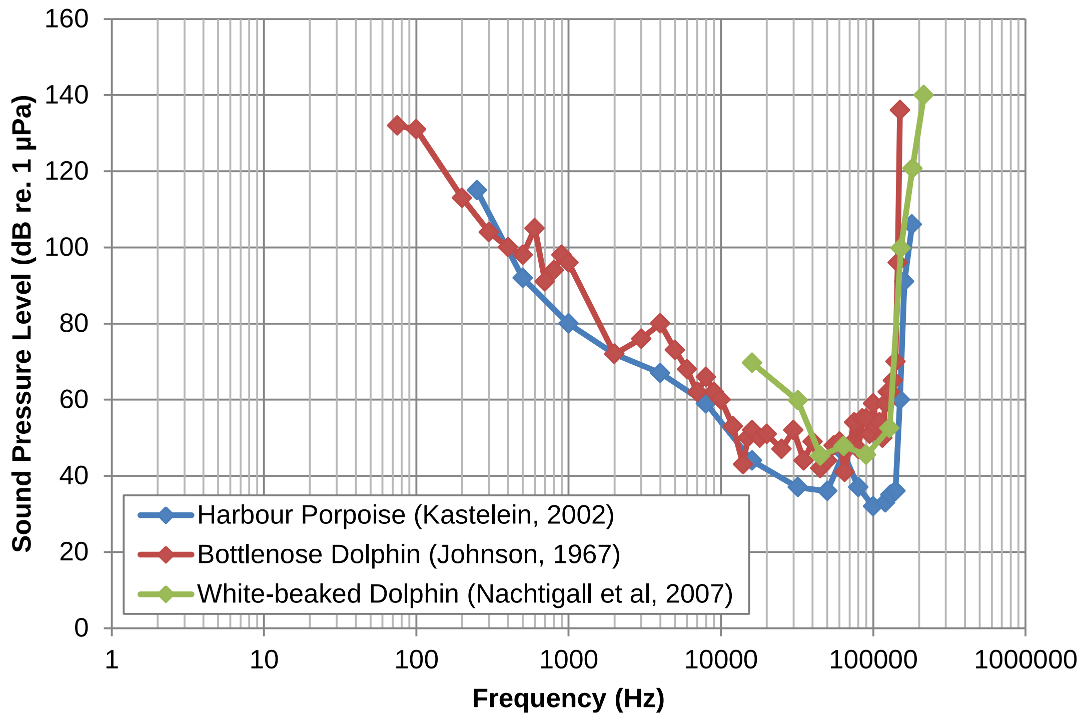

Figure 3-2 Comparison of hearing thresholds for species of marine mammal

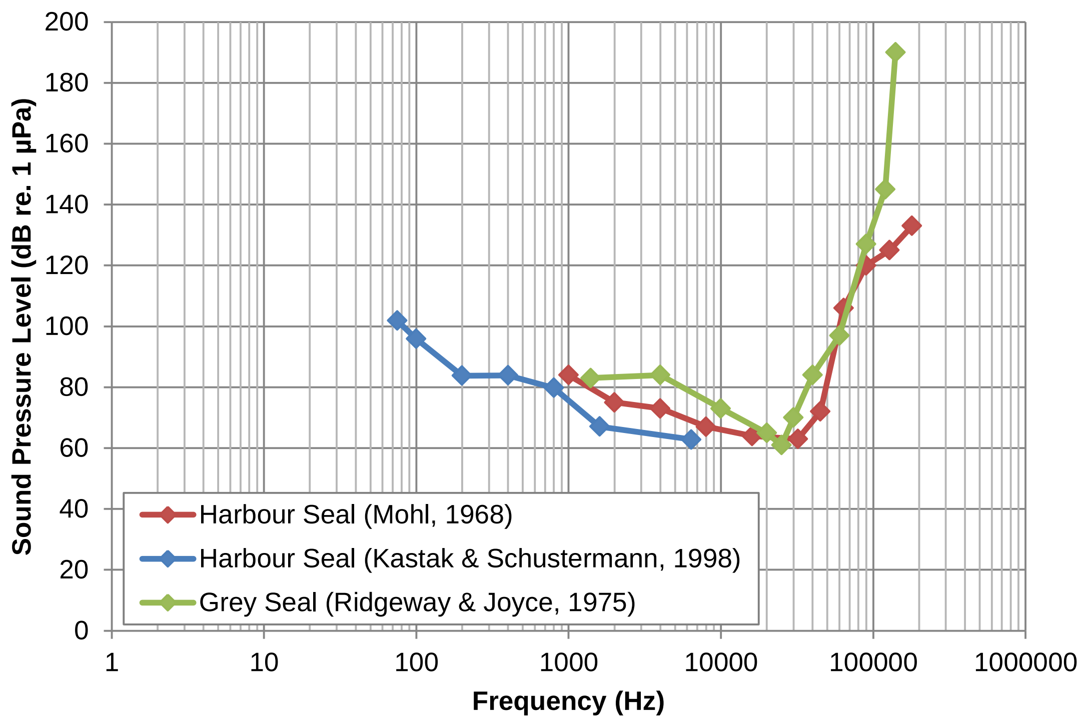

Figure 3-3 Comparison of auditory threshold levels of harbour seal

4 Assessment of noise levels as a function of range from drilling operations

4.1 Review of current information relating to drilling operations

4.1.1 Introduction

A search has been carried out for information relating to the levels of underwater noise that may be produced during percussive drilling operations in coastal waters. As was expected, however, very little high quality information is available in the public domain. The assessment of the levels of underwater noise from drilling operations at Kyle Rhea has therefore been based on a set of high quality recordings undertaken by Subacoustech Environmental during similar drilling operations. These have been reviewed and the assessment process explained in the following sections.

4.1.2 Drilling operations at the Fall of Warness, Orkney

Underwater noise measurements were gathered during foundation drilling operations to install a prototype tidal turbine at the European Marine Energy Centre (EMEC) tidal test facility in Orkney, Scotland.

The EMEC tidal test site is located in the Fall of Warness, to the west of the island of Eday in Orkney, Scotland. The facility provides an opportunity for developers of new tidal turbine technology to test and demonstrate their products on a purpose built, grid connected site before release into the commercial market.

Measurements of underwater noise during a successful drilling operation to secure one of the piles to the sea bed were carried out on the 02 July 2009 between about 21:30 and 00:00.

Figure 4-1 presents a typical time history of underwater noise measured at a range of 34 m from drilling operations. The noise is characterised by very rapid high level transient peaks likely to be associated with the unique hammer action of the drilling rig being used. Figure 4-2 presents a windowed section of the same recording of 0.5s duration which shows more clearly the individual strikes of the drill. It can be seen that the strikes occur approximately 15 times per second. The data indicates that during this recording the RMS underwater pressure levels varied between approximately 26 – 38 Pa or one second RMS Sound Pressure Levels of about 148 – 151 dB re. 1 µPa.

In comparison, Figure 4-3 presents a typical time pressure history measured at a range of 520 m from the drilling operations. The drilling noise is still clearly well above background sea noise levels during this recording. At this range the recorded levels of noise ranged from RMS pressure levels of between 2.2 and 2.8 Pa or between 127 and 129 dB re. 1 µPa.

The raw data have also been analysed in terms of the hearing abilities of the key species of fish marine mammal identified earlier using the dB_{ht}(*Species*) metric. This analysis has been used to predict ranges out to which adverse impacts may occur including traumatic hearing damage and behavioural avoidance response. These results are summarised in Figure 4-4, showing the dB_{ht} level for each of the key species against the range from the noise source.

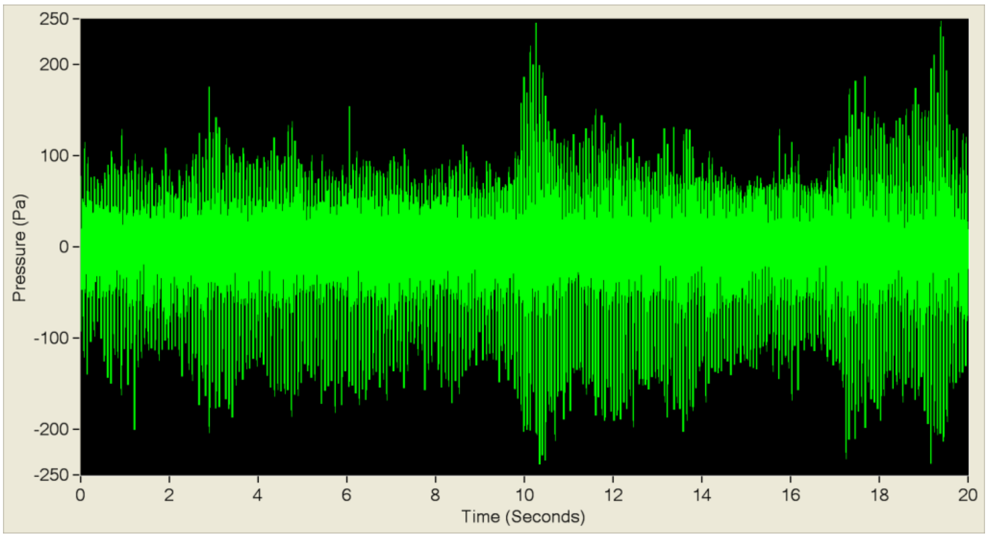

Figure 4-1 An underwater noise time history at a range of 34 m from percussive drilling operations, Fall of Warness

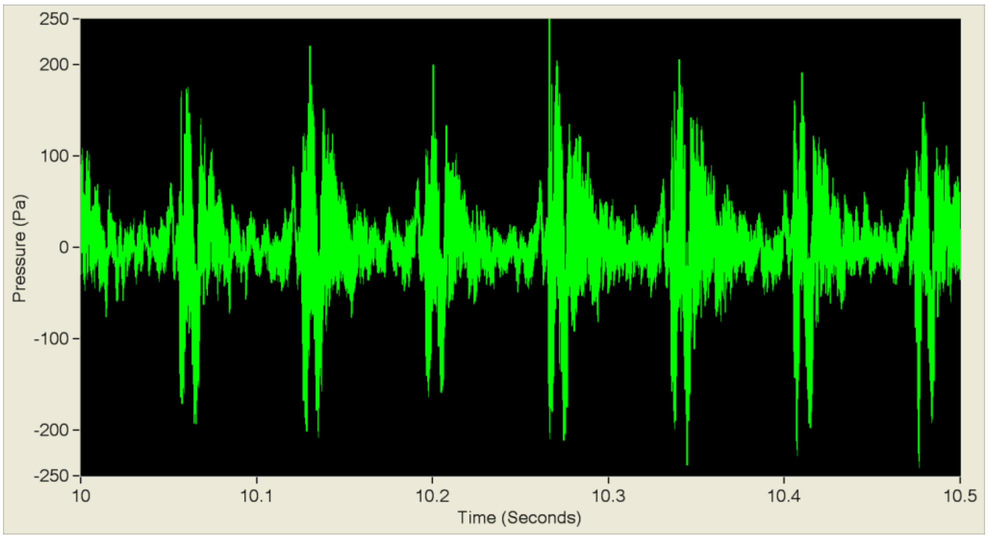

Figure 4-2 A section of the underwater noise time history of 0.5 s duration measured at a range of 34 m from percussive drilling operations, Fall of Warness

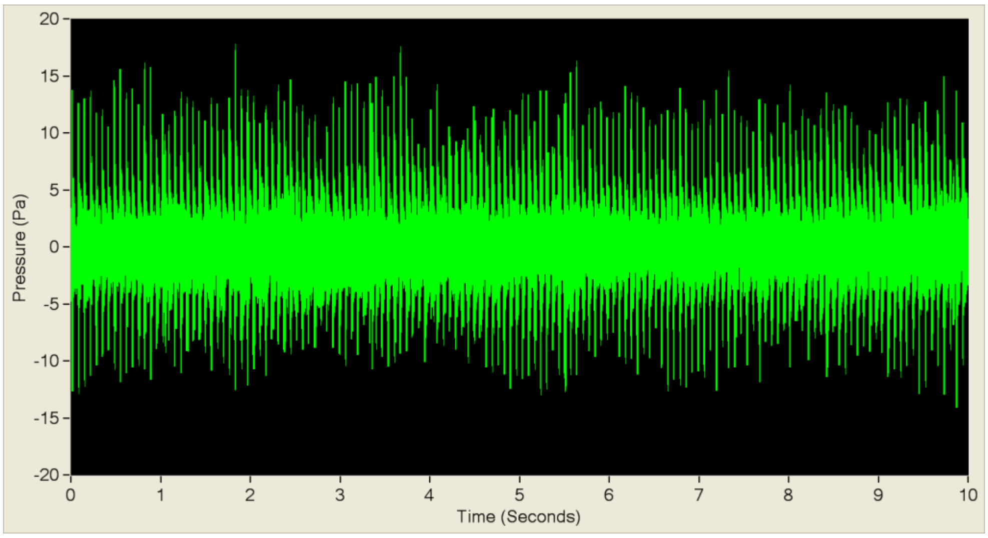

Figure 4-3 An underwater noise time history at a range of 520 m from percussive drilling operations, Fall of Warness

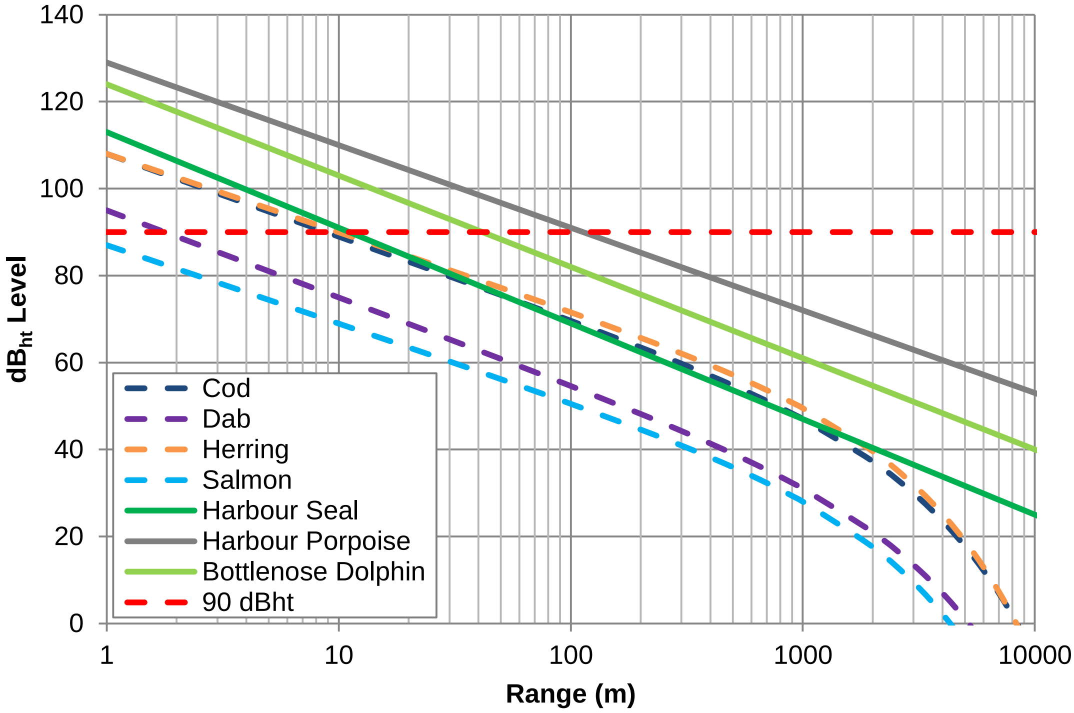

Figure 4-4 Summary of dB$_{ht}$ levels as a function of range from measurements during percussive drilling operations, Fall of Warness. The data presented is for selected species of fish and marine mammal

4.2 Comparison of drilling devices

The data obtained at the Fall of Warness was taken during installation of foundations using a very similar drilling technique to that proposed for Kyle Rhea; a percussive drilling technique, whereas measurements from the installation of a similar tidal turbine, such as Strangford Lough in Northern Ireland (Nedwell and Brooker, 2008) used a rotary drilling technique and are therefore not directly comparable.

The principal difference between the Kyle Rhea and Fall of Warness projects, however, is the size of the drill, both in terms of its physical size and its drilling power. Of particular note when comparing the two drilling rigs are the differences in operating parameters; whereas the maximum torque that can be applied to the drill proposed for Kyle Rhea is up to 110 kNm, the corresponding value for the drill used in Orkney is 51.5 kNm. The proposed drilled sockets at Kyle Rhea are planned to be 2300 mm in diameter, whereas the the socket drilled at the Fall of Warness was only 889 mm in diameter. The speeds of revolutions of the two drills are quite similar, with the average speed of the Kyle Rhea drill being 15 rpm and the drill used at the Fall of Warness being only slightly less at 12 rpm. The estimated implications of these differences in terms of the levels of underwater noise generated during drilling operations with the two devices is explained in the following sections.

4.3 Estimated impact ranges for drilling operations using the proposed drilling rig at the Kyle Rhea site.

4.3.1 Assessment process

Generally the most accurate way to assess the likely levels of underwater noise from a particular source is to obtain actual measurements from that device working in similar conditions. Obviously, however, this is not always feasible. Therefore, in order to estimate the likely levels of underwater noise that may be produced, the levels of noise from the measurements at the Fall of Warness, outlined earlier, have been reviewed and a suitable scaling factor has been calculated which can be applied to estimate the increase in noise generated by the larger drill at Kyle Rhea.

The approach that has been used in this case has been to look at the relative power applied to each drill as it is known that power typically shows a close correlation to the noise levels produced. It is understood that these drills use hydraulic power packs of varying power ratings depending on the application. As these are decided during the review of the particular requirements of the project this information may not provide an accurate and comparable estimate of input power levels to each drill. It was therefore decided that a calculation of the maximum possible power applied should be made based on the maximum workable limits outlined in the technical specifications provided by the manufacturer.

The power applied to the drill can be calculated from the torque and the revolution speed by the equation:

$$Power\ (W) = torque\ (N.m) \times 2\pi \times rotational\ speed\ (rps) \qquad \text{eqn. 4.1}$$

Note that the rotational speed in the above equation is converted into revolutions per second (rps), not rpm, and the power in watts results.

Using the manufacturers data presented in the preceding section, the power of each drill can be calculated. From the supplied data for the Kyle Rhea drill the normal operating power is therefore:

$$W = 40{,}000 \times 2\pi \times \left(\frac{15}{60}\right) = 62{,}832W = 62.832kW$$

Performing the same calculation from the data for the Kyle Rhea drill rig at maximum power, for when a blockage or hard substrate is present, gives:

$$W = 11{,}0000 \times 2\pi \times \left(\frac{15}{60}\right) = 172{,}788W = 172.788kW$$

The power of the drill used at the Fall of Warness site in Orkney was stated to be 51.5 kW.

In order to then use these values to calculate the increase in acoustic output from a device the ratio between the power of the two devices is estimated:

$$Power\ ratio = 10\log_{10}\left(\frac{P_2}{P_1}\right) \qquad \text{eqn. 4.2}$$

This process essentially assumes that the energy conversion efficiency, in terms of the acoustic energy radiated *versus* the shaft power applied, is the same for the two drills. Taking the power of the Kyle Rhea drill as P_2 and the power of the Fall of Warness drill as P_1 gives us the estimated increase in noise levels at normal operating power:

$$Scaling\ factor\ (dB) = 10\log_{10}\left(\frac{62.832}{51.5}\right) = +0.86\ dB$$

And at full operating power:

$$Scaling\ factor\ (dB) = 10\log_{10}\left(\frac{172.788}{51.5}\right) = +5.26\ dB$$

In other words, the level of underwater noise generated from the larger Kyle Rhea drill may be expected to be 0.86 dB higher at normal operating power and 5.26 dB higher at maximum operating power than the drill used at the Fall of Warness.

4.3.2 Predicted impact ranges – unweighted RMS levels

Using the calculations above, the levels of underwater noise likely to be generated during drilling operations at Kyle Rhea have been estimated. Table 4-1 presents a summary of the predicted Source Level (notional level of noise at 1 m from the source) in terms of unweighted RMS levels for drilling using the percussive drill rig, along with the estimated impact ranges in 10 dB increments. From these results it can be seen that, using the criteria from section 3.2.1, the levels of underwater noise from the drilling activity at Kyle Rhea will not be of a sufficiently high level to cause lethal or physical injury to marine species.

	Unweighted RMS Sound Pressure Level (Normal Operating Power)	Unweighted RMS Sound Pressure Level (Maximum Operating Power)
Source Level	179 dB re. 1 µPa @ 1m	183 dB re. 1 µPa @ 1m
170 dB re. 1 µPa	3 m	6 m
160 dB re. 1 µPa	13 m	23 m
150 dB re. 1 µPa	49 m	88 m
140 dB re. 1 µPa	180 m	310 m
130 dB re. 1 µPa	610 m	980 m
120 dB re. 1 µPa	1700 m	2400 m
110 dB re. 1 µPa	3500 m	4500 m

Table 4-1 Summary of estimated unweighted RMS impact ranges and Source Level of percussive drilling operations at Kyle Rhea

Figure 4-4 graphically shows the predicted unweighted RMS levels displayed in Table 4-1 radiating from drilling operations at the northernmost likely location where the SeaGen devices are to be installed at Kyle Rhea.

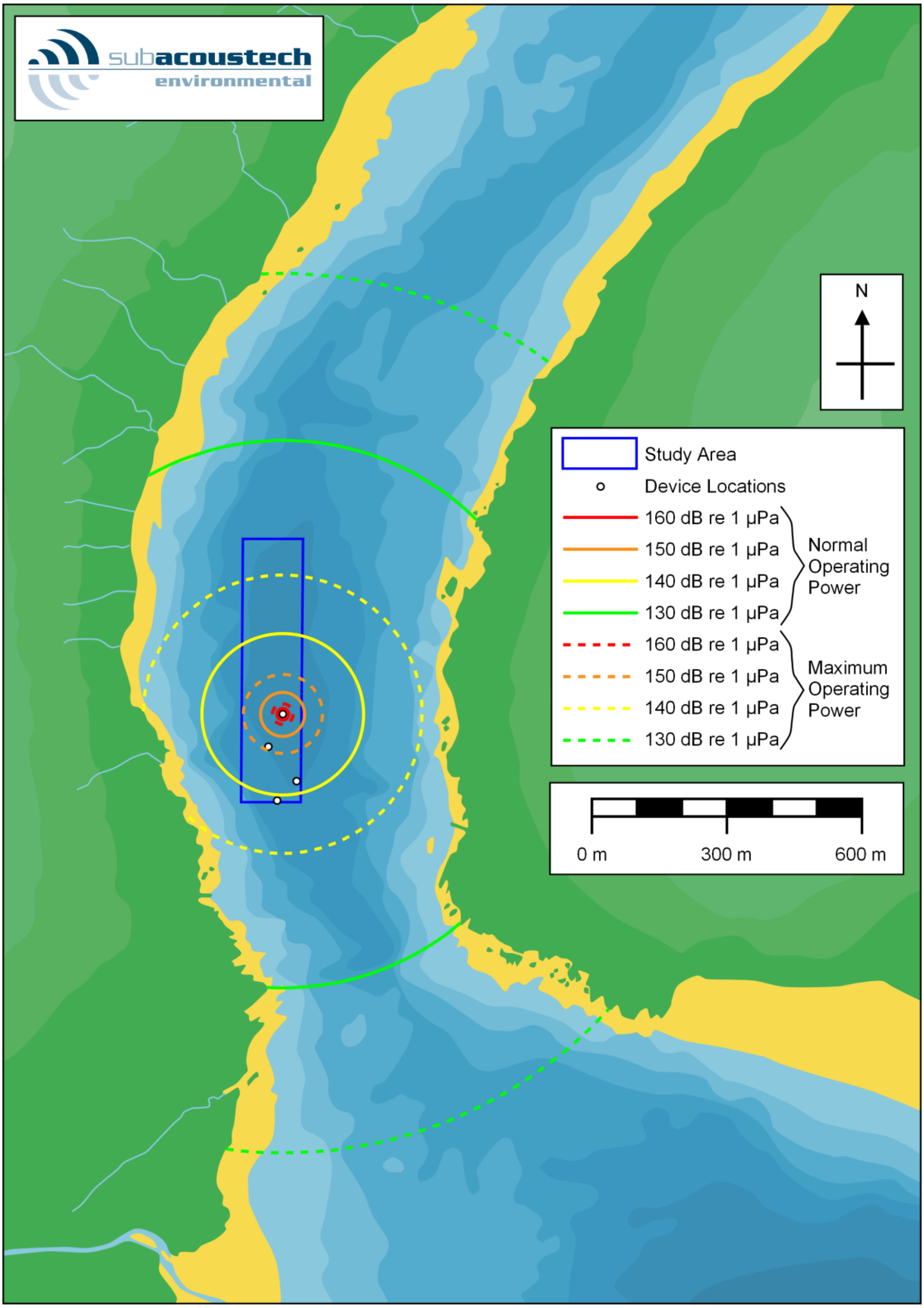

Figure 4-5 Contour plots showing the estimated extent of underwater noise propagation in terms of unweighted RMS Sound Pressure Levels for percussion drilling operations at both normal and maximum operating powers at the Kyle Rhea site

4.3.3 Predicted impact ranges – RMS dB_{ht} levels

Tables 4-2 and 4-3 summarise the predicted ranges out to specific dB_{ht} levels for species of fish and marine mammals. Based on the criteria proposed in Nedwell *et al* (2007) a perceived level of noise of 90 dB_{ht} or above is highly likely to cause a strong behavioural avoidance response in marine species, levels in excess of 130 dB_{ht} for a single event are likely to cause traumatic injury. Perceived noise levels of 75 dB_{ht} and above are likely to cause a significant behavioural avoidance response in the majority of marine species, although habituation may limit this effect.

It can be seen that, with the exception of harbour porpoise (*Phocoena phocoena*), perceived underwater noise levels in excess of 130 dB_{ht} are not expected for any species. For the harbour porpoise this is only considered likely at extremely close range (1-2 m from the source). Therefore the likelihood of traumatic auditory injury is considered to very low.

Underwater noise is only expected to exceed the 90 dB_{ht} perceived level for the fish species out to a maximum of 19 m during maximum operational drilling power. The largest impact ranges for the fish species considered are estimated to be for herring, which are predicted to hear levels of 75 dB_{ht}(*Clupea harengus*) at distances of 120 m when the maximum operating power is being used. While an avoidance response may, therefore, be expected in herring or sprat out to about 120 m, the estimated perceived levels of noise are of low enough levels at this range that habituation to the noise or if the animals have a strong motivation to enter the insonified area (such as to spawn) may limit this effect. The fish estimated to be affected over the smallest region around the drilling operations, at maximum power, with a predicted source level at 1 m of 92 dB_{ht}(*Salmo trutta*) is the salmon.

Due to the high level of high frequency flow noise in the data collected at the Fall of Warness, Orkney, on which this assessment is based, it has not been possible to predict an absorption loss and therefore it has only been possible to estimate impact ranges for marine mammal species based solely on Transmission Loss. This means that the impact ranges presented for marine mammals can be considered a conservative overestimate, as any absorption factors would cause the noise to attenuate at a faster rate. The estimated impact ranges for these species are also presented in Tables 4-4 and 4-5. The data indicate that cetaceans sensitive to high frequency noise, such as the harbour porpoise may exhibit a strong avoidance reaction during maximum operating drill power in an area out to a maximum of about 210 m as the perceived levels of underwater noise are estimated to be above 90 dB_{ht} at this range. Dolphin species may avoid an area out to about 74 m according this analysis. While an avoidance response might initially be expected out to these ranges, habituation or a strong motivation to enter the insonified area may limit the effect at this range.

Impact ranges for the harbour seal, which is sensitive to sound in a lower frequency range than the harbour porpoise and dolphin species, are predicted to be 90 dB_{ht}(*Phoca vitulina*) out to 19 m and levels of 75 dB_{ht}(*Phoca vitulina*) out to ranges of 73 m while the drill is operating at maximum power.

A summary of all the predicted perceived noise levels vs. range is shown in Figures 4-6 and 4-7.

	Cod	Dab	Herring	Salmon
Source Level	109 dB_{ht} @ 1m	96 dB_{ht} @ 1m	109 dB_{ht} @ 1m	88 dB_{ht} @ 1m
90 dB_{ht} RMS	10 m	2 m	11 m	< 1 m
75 dB_{ht} RMS	59 m	11 m	73 m	5 m

Table 4-2 Summary of source level at 1 m and dB_{ht} ranges for the selected species of fish for normal operating power

	Cod	Dab	Herring	Salmon
Source Level	113 dB_{ht} @ 1m	100 dB_{ht} @ 1m	113 dB_{ht} @ 1m	92 dB_{ht} @ 1m
90 dB_{ht} RMS	17 m	3 m	19 m	1.3 m
75 dB_{ht} RMS	98 m	18 m	120 m	9 m

Table 4-3 Summary of source level at 1 m and dB_{ht} ranges for the selected species of fish for maximum operating power

	Harbour Seal	Harbour Porpoise	Bottlenose Dolphin
Source Level	114 dB_{ht} @ 1m	130 dB_{ht} @ 1m	125 dB_{ht} @ 1m
90 dB_{ht} RMS	12 m	130 m	46 m
75 dB_{ht} RMS	58 m	770 m	240 m

Table 4-4 Summary of source level at 1 m and dB_{ht} ranges for the selected species of marine mammals for normal operating power

	Harbour Seal	Harbour Porpoise	Bottlenose Dolphin
Source Level	118 dB_{ht} @ 1m	134 dB_{ht} @ 1m	129 dB_{ht} @ 1m
90 dB_{ht} RMS	19 m	210 m	74 m
75 dB_{ht} RMS	93 m	1300 m	380 m

Table 4-5 Summary of source level at 1 m and dB_{ht} ranges for the selected species of marine mammals for maximum operating power

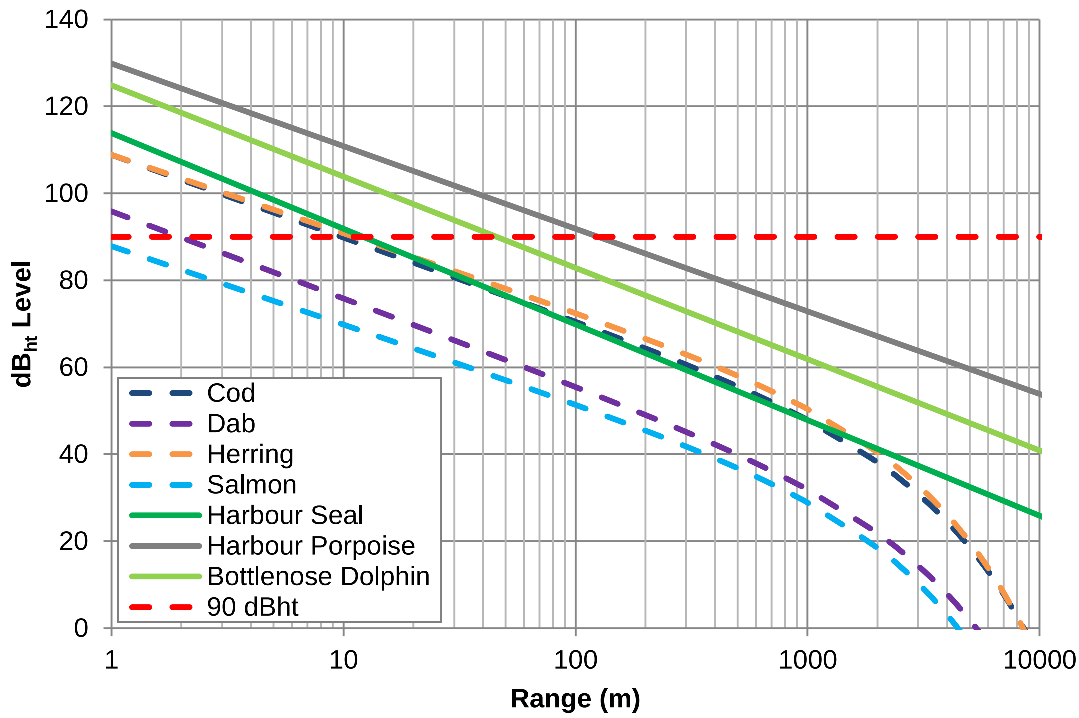

Figure 4-6 Summary of predicted dB_{ht} levels as a function of range for percussive drilling operations at normal operating power for the Kyle Rhea site for various marine species

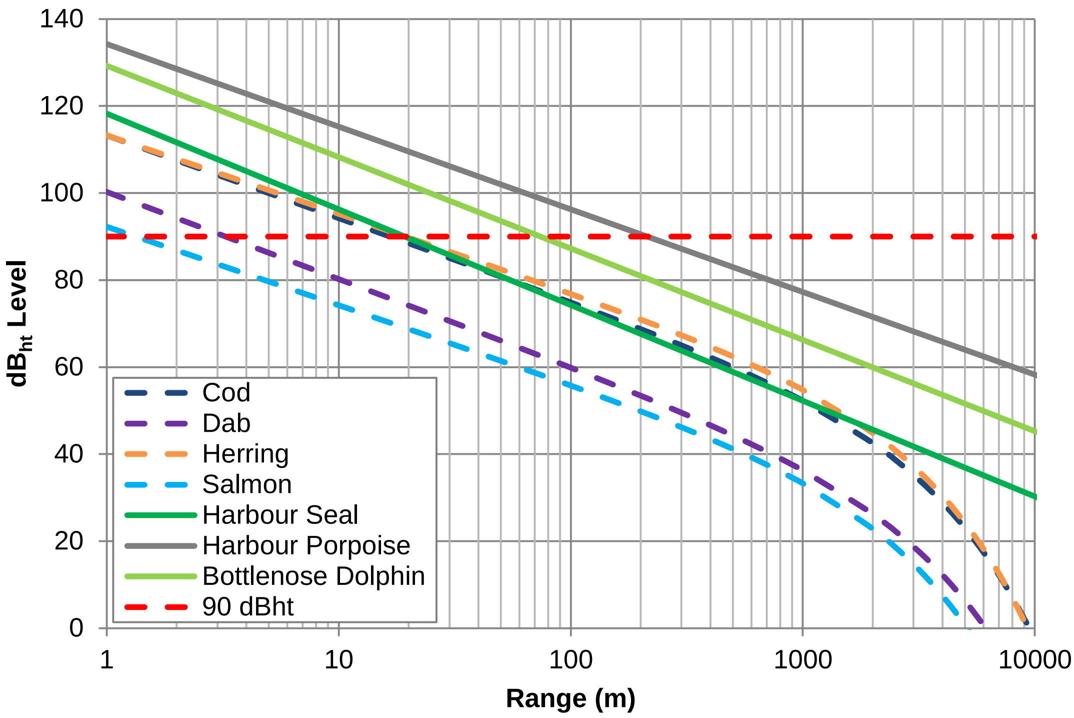

Figure 4-7 Summary of predicted dB_{ht} levels as a function of range for percussive drilling operations at maximum operating power for the Kyle Rhea site for various marine species

4.4 Comparison to measured background noise data

Subacoustech Environmental undertook a series of underwater noise measurements at the Kyle Rhea site in July 2012 (Subacoustech report reference E366R0207). This data showed high levels of high frequency broadband noise between 20 kHz and 150 kHz. The high frequency broadband noise was seen to be significantly greater when the tide was in flow compared to the levels measured at slack water.

Mean unweighted RMS sound levels when the tide was in full flow were measured to be 121 dB re 1µPa, compared with mean levels of 112 dB re 1µPa at low tide. Analysis of the measurements in terms of the dB_{ht}(*Species*) metric showed measured levels for harbour porpoise to be as high as 95.5 dB_{ht}(*Phocoena phocoena*). These high background noise levels are primarily as a result of the presence of high frequency noise, which was greatest during tidal flow.

Comparing these background levels to those predicted levels during percussive drilling operations shows that mean unweighted construction noise levels should reach ambient background noise levels at a range of approximately 300 m at full flow and 3 km at slack water.

5 Assessment of the impacts of underwater noise from vessels associated with the Kyle Rhea tidal array

5.1 Introduction

The noise from shipping is one of the dominant underwater noise sources in the sea in the lower frequency range. Individual vessels may generate very different sound levels and can have very different frequency characteristics depending upon factors such as the propulsion system, and whether there is propeller cavitation or singing.

Vessel noise during any construction operation is a factor that needs to be considered when assessing the impact of underwater noise on marine species. There are likely to be three types of vessels on site during the installation of the tidal array at Kyle Rhea; these are:

- Jack-up barge

Jack-up barges are generally used in large construction operations, including offshore wind farm construction. The primary noise sources related to these vessels generally appear to be generators and machinery on board.

- Tugs

Tugs are high powered vessel frequently used for manoeuvring of larger vessels and as guard boats. During offshore construction operations of this type they are often located in close proximity to the jack up barge on standby in case they are required. They are also likely to return to port on a regular basis.

- Multi-cat vessels

Multicat vessels are likely to be used as crew transfer vessels and in supporting roles. These generally travel between the installation site and port on a regular basis.

5.2 Summary of vessel noise data

5.2.1 *Review of published data*

Figure 5-1 presents some of the shipping noise data from Cybulski (1977), Malme *et al.* (1989) and Richardson and Malme (1993), which are reproduced in Richardson *et al.* (1995). The data are presented as estimated Third Octave Levels (TOLs) of source level noise, based on the extrapolation of shipping noise data measured at various far field distances. These data only present the underwater noise spectrum at low frequency, but highlight that there is considerable underwater noise energy at frequencies from 10 Hz to 1000 Hz, coinciding with the peak frequencies at which fish are able to perceive underwater noise. (It should be noted here that other ship systems such as echosounders and fish finders produce very high frequency noise that is above the frequency band shown in this data).

These measurements of underwater noise refer to ships that are fully underway in open waters. The vessels that will be present during installation of the Kyle Rhea tidal array will most likely be travelling at slower speeds or stationary and in relatively shallow water depths (the deepest point in Kyle Rhea is less than 40 m deep), and hence the underwater noise levels are likely to be lower than the levels published in the literature.

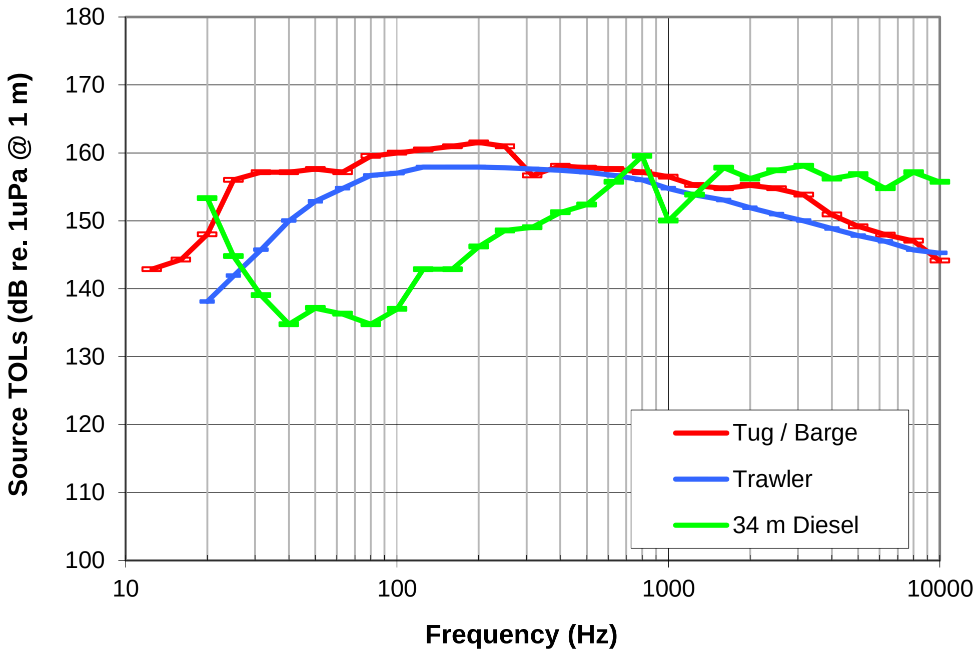

Figure 5-1 Estimated Third Octave Levels (TOLs) of underwater noise at source (at 1 m) for typical examples of shipping (Data from Richardson et al. (1995), based on data from Cybulski (1977), Malme et al. (1989) and Richardson and Malme (1993))

5.2.2 Analysis of unpublished measured data

Subacoustech Environmental has taken measurements in close proximity to jack-up barges with tugs and other vessels operating in the surrounding area, similar to those envisaged for the Kyle Rhea installation. The measurements are generally carried out during breaks in marine construction operations such as impact piling on an opportunity basis. Measurements were taken at ranges between 90 m and 140 m from a jack-up barge with tugs varying in distances between 100 m and 500 m from the measurement positions aboard the survey vessel.

The measured data from near the jack-up barge has been analysed for the selected marine species and the data is presented in Table 5-1 below. The data indicate that species of marine mammal perceive higher levels of vessel noise than fish. The typical frequency content of the measured underwater noise in these conditions is shown in Figure 5-3. The data indicate high levels of underwater noise in the frequency range between about 100 Hz and 1 kHz characterised by several high level narrowband peaks indicative of tonal noise sources. These are typical of engine noise and rotating machinery and may also be linked to propeller noise.

The highest perceived noise levels were measured for harbour porpoise, with perceived noise levels ranging between 76 dB_{ht}(*Phocoena phocoena*) at a range of 90 m from the jack-up barge to 72 dB_{ht}(*Phocoena phocoena*) at 140 m distance.

The highest perceived noise for a species of fish was for herring, which could perceive noise levels of up to 57 dB_{ht}(*Clupea harengus*) at a range of 90 m from the jack-up barge. The lowest perceived sound level was calculated to be for the trout, for which levels between 7 and 15 dB_{ht}(*Salmo trutta*) were measured.

These data indicate that an avoidance response may occur in marine mammal species out to a few hundred metres from vessels of this type as the perceived level was about 75 dB_{ht}. However, habituation to vessel noise is likely to be a factor at these perceived noise levels. The Kyle Rhea location itself has a very fast flow, and subsequently background noise levels can be very high. This high level of background noise, along with similar characteristics to the noise likely to be generated by vessels associated with the Kyle Rhea installation may allow the animals to become habituated to these types of underwater noise.

Possibly of greater significance to the impact on marine mammal species from vessel activity is the use of high powered echosounders on the vessels. These devices emit high levels of high frequency noise, often in the frequency band of highest sensitivity for many marine mammal species. This noise source so far seems to have been given little attention in terms of environmental impact and very little data therefore exist on the actual noise levels generated. Unfortunately, due to the lack of measured and reported data on these noise sources it has not been possible to carry out an in-depth assessment as part of this study.

Avoidance of the vessel noise by fish species is unlikely beyond a few metres based on the dB_{ht} data with perceived levels only marginally exceeding 50 dB_{ht} at 90 m from the vessel. A higher probability of disturbance is likely at ranges from the various vessels closer than those quoted above. This suggests that behavioural avoidance to vessel noise for fish species is likely to be limited to within a few metres of vessel activity.

The dB_{ht} data for the marine mammal species indicates that these animals may avoid the vessel activity out to greater ranges with a significant avoidance response out to 100 – 200 m from the vessels. At these ranges, however, the levels of noise may be of a sufficiently low level for the animals to become habituated to the noise. A higher likelihood of avoidance would be expected closer to the vessels as the levels of underwater noise would be higher; however, it is unlikely that marine species would suffer physical or auditory injury from vessel activity.

It should be noted that no results for cod have been presented as this species were not included in the analysis of the data, when these measurements were taken, however it can be assumed that the dB_{ht} levels for cod will fall between those for herring and dab.

	RMS Sound Level		
	Maximum	**Minimum**	**Mean**
Unweighted	135 dB re. 1 µPa	129 dB re. 1 µPa	133 dB re. 1 µPa
Dab	38 dB_{ht}	26 dB_{ht}	33 dB_{ht}
Herring	57 dB_{ht}	50 dB_{ht}	55 dB_{ht}
Salmon	32 dB_{ht}	21 dB_{ht}	28 dB_{ht}
Bottlenose Dolphin	69 dB_{ht}	64 dB_{ht}	67 dB_{ht}
Harbour Porpoise	76 dB_{ht}	72 dB_{ht}	75 dB_{ht}
Harbour Seal	59 dB_{ht}	56 dB_{ht}	57 dB_{ht}

Table 5-1 Summary of measured noise levels between 90 and 140 m away from a jack-up barge with operating tugs and survey vessels in the vicinity

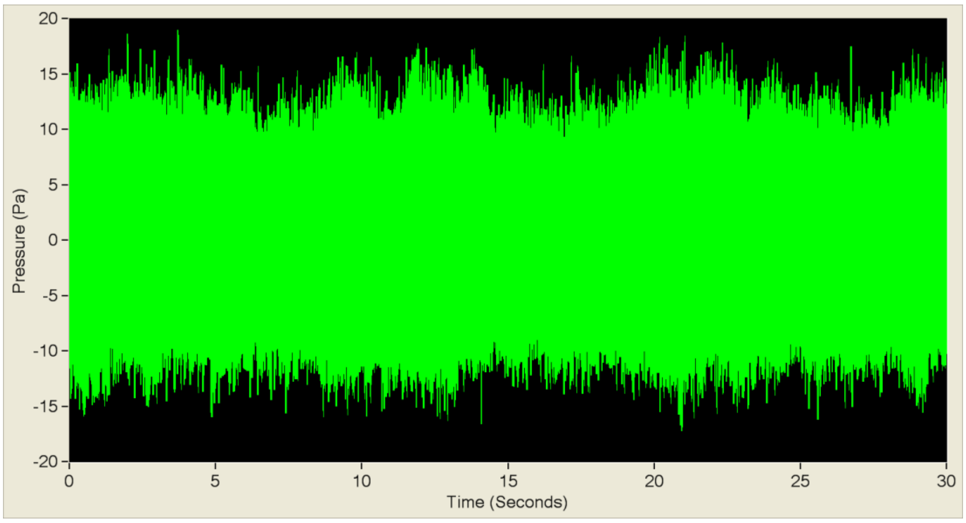

Figure 5-2 A typical time history showing vessel noise taken approximately 90 m from a jack-up barge with tugs operating in the vicinity

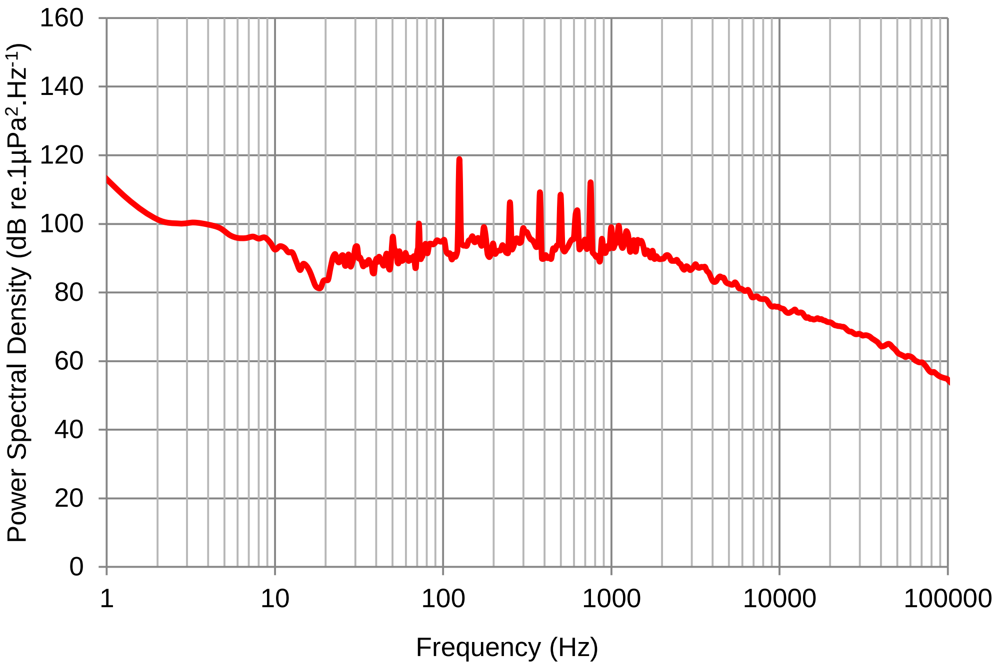

Figure 5-3 A typical spectral range plot showing the frequency spread of the vessel noise shown in Figure 5-2

6 Assessment of the impacts of underwater noise from the operational tidal array

6.1 Introduction

In order to predict the likely level of noise the operational tidal array at Kyle Rhea is likely to have, previous measurements of operational SeaGen turbines have been used. Two sets of data, one taken by Subacoustech off the coast of Lynmouth, Devon (Parvin *et al*, 2005) and one in Strangford Lough, Northern Ireland by Kongsberg Maritime Ltd. (Needham, 2010) have been considered while calculating this prediction. In each case a smaller turbine than the 2.0 MW turbines proposed for Kyle Rhea were measured; a tidal turbine with a power output of 350 kW in Lynmouth and 1.2 MW in Strangford Lough.

6.2 Predicting the noise level from a 2.0 MW tidal turbine

At present there is not data available on operational noise of a 2.0 MW tidal current turbine. For the purposes of this study the Source Level of the tidal turbine has been estimated by scaling up the measurements from Lynmouth and Strangford Lough. This approach assumes that the radiation efficiency does not vary with turbine size, which is a valid assumption as the Lynmouth data indicate, the noise from the turbine is dominated by machinery noise (Parvin *et al,* 2005).

Least sum of square fits have been used to estimate Source Levels for both the Lynmouth and Strangford Lough data, indicating an increase of 5.3 dB to the Source Level from the increase in size and power of the turbine.

Using a power ratio equation, (eqn 4.2, Section 4.3), an increase of Source Level can be calculated. Using this equation to estimate the difference in Source Level between the operational turbines at Lynmouth (350 kW) and Strangford Lough (1.2 MW) gives the following result, which shows a very strong correlation to the measured data.

$$Scaling\ factor\ (dB) = 10\log_{10}\left(\frac{1200}{350}\right) = +\ 5.35\ dB$$

If this equation is used to predict the Source Level for a 2.0 MW turbine, which is proposed for Kyle Rhea, the following results are given:

$$Scaling\ factor\ (dB) = 10\log_{10}\left(\frac{2000}{350}\right) = +\ 7.57\ dB$$

$$Scaling\ factor\ (dB) = 10\log_{10}\left(\frac{2000}{1200}\right) = +\ 2.22\ dB$$

This means that the level of underwater noise generated from the larger Kyle Rhea turbine may be expected to be 7.57 dB higher than the operational turbine at Lynmouth, or 2.22 dB higher than the levels measured at Strangford Lough.

Figure 6-1 shows the measured unweighted levels against range for the data from Lynmouth and Strangford Lough along with their respective least sum of square fits, and the predicted noise levels from the proposed Kyle Rhea turbine.

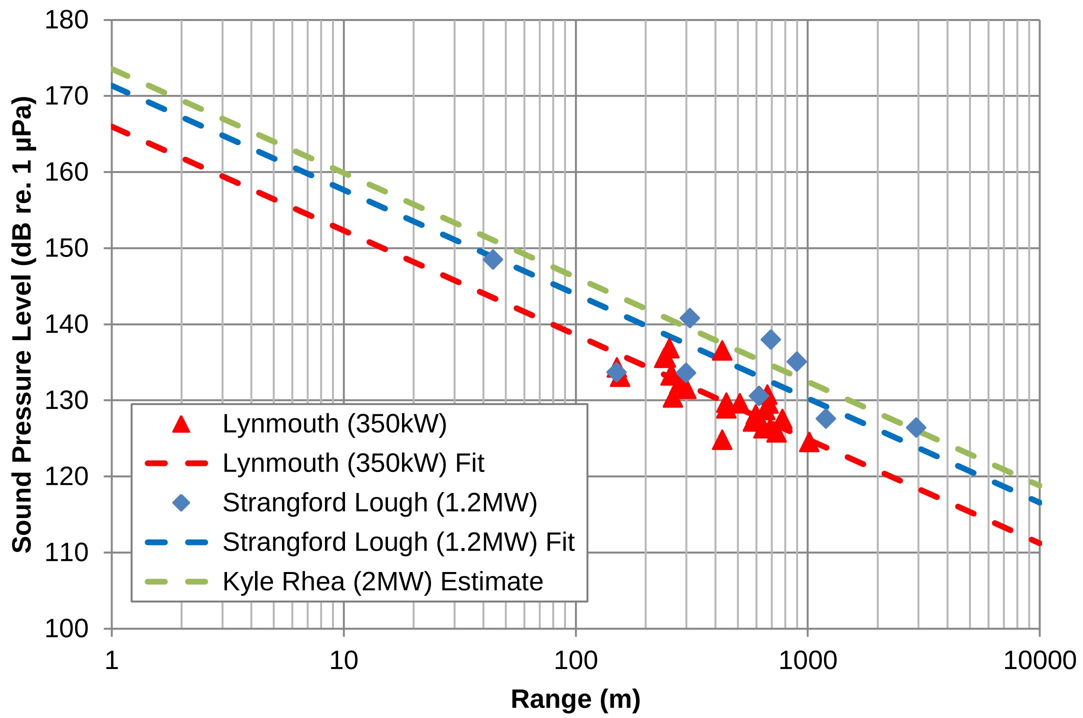

Figure 6-1 Summary of measured unweighted levels from operational SeaGen turbines with a prediction of noise levels from the Kyle Rhea site

6.3 Predicted dB_{ht} impact ranges

Using the approach outlined above, 90 and 75 dB_{ht} levels have been estimated for key species of fish and marine mammal from the proposed operational tidal turbine at Kyle Rhea. It should be noted that no results for bottlenose dolphin have been presented as these species were not included in the Parvin *et al* (2005) and Needham (2010) reports.

Tables 6-1 and 6-2 summarise the predicted ranges out to specific dB_{ht} levels for species of fish and marine mammals for a 2.0 MW tidal turbine.

	Cod	Dab	Herring	Salmon
Source Level	87 dB_{ht} @ 1m	61 dB_{ht} @ 1m	91 dB_{ht} @ 1m	54 dB_{ht} @ 1m
90 dB_{ht} RMS	< 1 m	< 1 m	1.3 m	< 1 m
75 dB_{ht} RMS	2 m	< 1 m	16 m	< 1 m

Table 6-1 Summary of source level at 1 m and dB_{ht} ranges for the selected species of fish for an operational 2.0 MW tidal turbine

	Harbour Porpoise	Harbour Seal
Source Level	117 dB_{ht} @ 1m	103 dB_{ht} @ 1m
90 dB_{ht} RMS	90 m	8 m
75 dB_{ht} RMS	1.1 km	100 m

Table 6-2 Summary of source level at 1 m and dB_{ht} ranges for the selected species of marine mammal for an operational 2.0 MW tidal turbine

These results estimate that the underwater noise will be low for species of fish, with a maximum 75 dBht range of 16 m predicted for a mild behavioural avoidance for herring. Larger ranges are estimated for marine mammals with a maximum predicted 90 dBht strong avoidance range out to 90 m for harbour porpoise.

The proposed turbine locations for the tidal array, illustrated in Figure 1-1, show that the minimum distance between adjacent turbines are 60 m apart. For all species of fish the data indicate that will be no cumulative effects between adjacent turbines as the largest impact range predicted is 75 dB_{ht} out to 16 m for herring.

For species of marine mammal, where the impact ranges are predicted to be larger, there are likely to be some cumulative effects between the turbines. For harbour porpoise the majority of the array site will be insonified by levels in excess of 90 dB_{ht} out to 90 m from the turbines, resulting in a strong avoidance reaction, this is illustrated below in Figure 6-2, however it should be noted that in fast flowing waters such as Kyle Rhea, it is not uncommon for background flow noise in excess of 90 dB_{ht} for harbour porpoises. In fact, during the background noise survey undertaken by Subacoustech Environmental in July 2012, levels of up to 95.5 dB_{ht}(*Phocoena phocoena*) were measured.

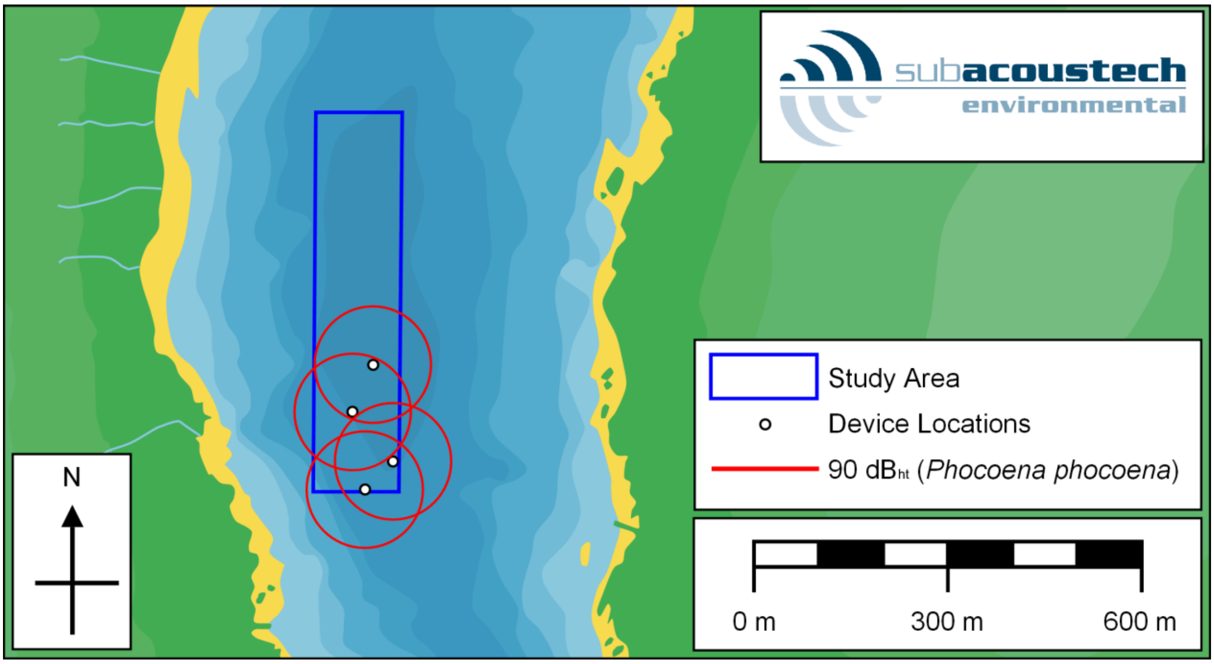

Figure 6-2 Sketch map showing the extents of the Kyle Rhea site that will be insonified while the tidal array is operational

6.4 Comparison to measured background noise data

There is currently insufficient measured data at ranges in excess of 1 km to make accurate predictions about the levels at greater distances using the same approach as Section 4.4. However, during high tide, levels of up to 95.5 dB_{ht}(*Phocoena phocoena*) were measured in Kyle Rhea, in this case a harbour porpoise would be unlikely to hear the operational turbine over the background noise level at ranges greater than 11 m.

7 Summary and Conclusions

An assessment of the levels of underwater noise associated with the installation and operation of tidal turbine array at the Kyle Rhea site has been carried out in order to determine the potential impact on marine species. Estimates have been made of potential impact zones around the array based on previously recorded data of similar operations.

1. The levels of underwater noise that are likely to be generated from percussive drilling operations at the Kyle Rhea site have been estimated based on underwater noise measurements of a similar drilling operation in the Fall of Warness, Orkney. In order to provide these estimates a scaling factor has been derived;
2. The data suggest that the levels of underwater noise from the drilling at Kyle Rhea are likely to be 0.86 dB higher at normal operating power and 5.26 dB higher at maximum operating power than those measured at the Fall of Warness.
3. On the basis of this information it is thought that the levels of underwater noise from the drilling activity at Kyle Rhea will not be of a sufficiently high level to cause lethal or physical injury to marine species.
4. An assessment was also made using the dB_{ht}(*Species*) metric. It is estimated that the underwater noise is only expected to exceed the 90 dB_{ht} perceived level for the fish species out to a maximum of 19 m during maximum operational drilling power of foundations for the SeaGen devices.
5. A mild behavioural avoidance response might be expected in fish species out to slightly larger ranges of the drilling operation (up to 120 m for herring) but that this may be limited by habituation to the noise or if the fish have a strong motivation to enter the insonified area.
6. It is estimated that a strong avoidance response is likely to occur in harbour porpoise within an area around the drilling operation at maximum power out to approximately 210 m, with dolphin species likely to avoid a smaller region.
7. Measurements of underwater noise in close proximity to vessels similar to those envisaged to be used at Kyle Rhea have been reviewed. The primary measurements used were undertaken between 90 and 140 m from a jack up barge and between 100 and 500 m from nearby tugboats.
8. At these ranges, sensitive marine mammal species such as harbour porpoise may exhibit a behavioural avoidance response. The data indicate that dolphin species and fish are unlikely to avoid the underwater noise from these vessels at these ranges.
9. The operation noise of the proposed tidal turbines have been estimated using measured data from smaller SeaGen turbines installed in Lynmouth and Strangford Lough. The data suggest that the operational turbines at Kyle Rhea could be as much as 7.57 dB higher than the Lynmouth turbine and 2.22 dB higher than the one in Strangford Lough.
10. It is estimated that the underwater noise will be low for species of fish, with a maximum range of 16 m predicted for a mild behavioural avoidance (75 dB_{ht}) for herring. Larger ranges are estimated for marine mammals with a predicted strong avoidance (90dB_{ht}) range out to 90 m from the operational turbine for harbour porpoise.
11. For all species of fish the data indicate that will be no cumulative effects between adjacent turbines. For species of marine mammal, where the impact ranges are predicted to be larger, there are likely to be some cumulative effects between the turbines. For harbour porpoise the majority of the Kyle Rhea site will be insonified by levels in excess of 90 dB_{ht}, resulting in a strong avoidance reaction, however in fast flowing waters such as Kyle Rhea, it is not uncommon for background flow noise in excess of 90 dB_{ht} for harbour porpoises.

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A Underwater Sound Measurements

Units of measure

The fundamental unit of sound pressure is the Newton per square metre, or Pascal. However, in quantifying underwater acoustic phenomena it is convenient to express the sound pressure (either peak, or Root Mean Square (RMS)) as a Sound Pressure Level (SPL) through the use of a logarithmic scale.

There are three reasons for this:

- there is a very wide range of sound pressures measured underwater, from around 0.0000001 Pascal in quiet sea to say 10000000 Pascal for an explosive blast. The use of a logarithmic scale compresses the range so that it can be easily described (in this example, from 0 dB to 260 dB re. 1 μPa (referenced to a sound level of 1 μPa)).
- many of the mechanisms affecting sound underwater cause loss of sound at a constant rate when it is expressed on the dB scale.
- the effects of noise tend to increase in proportion to the SPL rather than the linear level. For instance, a given increase in effect will occur each time the sound is doubled, rather than each time it increases by a given unit of pressure.

The Sound Pressure Level, or SPL, is defined as

$$SPL = 20\log\left(\frac{P}{P_{ref}}\right)$$

eqn. A.1.

where P is the sound pressure to be expressed on the scale and Pref is the reference pressure, which for underwater applications is 1 μPa.

Peak level

The peak level of the noise is the maximum variation in the acoustic pressure from the ambient level within the measurement period. Peak pressures are often quoted for underwater blast measurements where there is a clear positive peak following detonation.

Peak-to-peak level

The peak-to-peak level is calculated using the maximum variation of the pressure from positive to negative within the wave. Where the wave is symmetrically distributed in positive and negative pressure, the peak-to-peak level will be twice the peak level, and hence 6 dB higher.

Root-Mean-Square (RMS) level

For both continuous sound, or sound that varies in level, the RMS is used as an “average” value when calculating the level. The time period over which the averaging is conducted has to be quoted as this will influence the average level. For instance, in the case of a pile strike lasting say a tenth of a second, the mean taken over a tenth of a second will be ten times higher than the mean taken over one second.

Source Level

Where there is a single, well-defined source of noise, underwater sound pressure measurements may be expressed as dB re 1 μPa @ 1m, which represents the apparent level at a distance of one metre from the source. In fact, since the measurements are usually made at some distance from the source, and extrapolated back to the source, the true level at one metre may be very different from the Source Level. The Source Level may itself be quoted in any of the measures above, for instance, a piling source may be expressed as having a “peak-to-peak Source Level of 200 dB re 1 µPa @ 1 metre”.

Sound Exposure Level

The degree by which a noise source affects marine animals may depend on the duration the sound is present above background levels. Sound Exposure Level (SEL) takes into account both the SPL of the sound source and the duration the sound is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)dt$$

eqn. A.2

Where p is the acoustic pressure in pascals, T is the duration of the sound in seconds and t is time.

Equation A-2 gives units of pascal squared seconds (Pa^2-s).

The SE can be expressed as a deciBel level by using a reference pressure (P_{ref}) and a reference time (T_{ref}) on a logarithmic scale giving Sound Exposure Level (SEL):

$$SEL = 10\log_{10}\left(\frac{\int_0^T p^2(t)dt}{P_{ref}^2 T_{ref}}\right)$$

eqn. A.3

P_{ref} and T_{ref} are typically 1 µPa and 1 second respectively for underwater noise.

Equation A-3 can also be expressed by:

$$SEL = SPL + 10\log_{10}(T)$$

eqn. A.4

Where T is the duration of the noise in seconds.

Using the reference pressures above Equation A.4 shows that for a sound of 1 second duration the Sound Exposure Level is equal to the Sound Pressure Level as $10\log_{10}(1) = 0$. For a sound of 10 seconds duration the SEL will be 10 dB higher than the SPL, for a sound of 100 seconds duration the SEL will be 20 dB higher than the SPL and so on.

Frequency content

To interpret an underwater sound signal for the manner in which it will be heard by an underwater animal, the sound signal in a time history format must be converted into its frequency components. This is because the response of marine species to underwater sound is frequency dependent (see the audiogram for salmon in Figure 2-1). This transformation of the sound is achieved by performing a Power Spectral Density (PSD) analysis of the signal. ‘The PSD’s (frequency spectra) presented in this report may therefore be regarded as dividing up the total power of the sound into its frequency components, and are presented in deciBels referenced to 1 µPa.

The dB$_{ht}$ (Species)

Measurement of sound using electronic recording equipment provides an overall linear level of that sound. The level that is obtained depends upon the recording bandwidth and sensitivity of the equipment used. This, however, does not provide an indication of the impact that the sound will have upon a particular fish or marine mammal species. This is of fundamental importance when considering the behavioural impact of underwater sound, as this is associated with the perceived loudness of the sound by the species. Therefore, the same underwater sound will affect marine species in a different manner depending upon the hearing sensitivity of that species.

The measurements of noise in this study have therefore also been presented in the form of a dB$_{ht}$ level for the species. This scale incorporates the concept of “loudness” for a species. The metric incorporates hearing ability by referencing the sound to the species’ hearing threshold, and hence evaluates the level of sound a species can perceive. In Figure C-1, the same noise spectrum is perceived at a different loudness level depending upon the particular fish or marine mammal receptor. The aspect of the noise that can be heard is represented by the ‘hatched’ region in each case. The receptors also hear different parts (components) of the noise spectrum. In the case shown, Fish 1 has the poorest hearing (highest threshold) and only hears the noise over a limited low frequency range. Fish 2 has very much better hearing and hears the main dominant components of the noise. Although having the lowest threshold to the sound, the marine mammal only hears the very high components of the noise and so it may be perceived as relatively quiet.

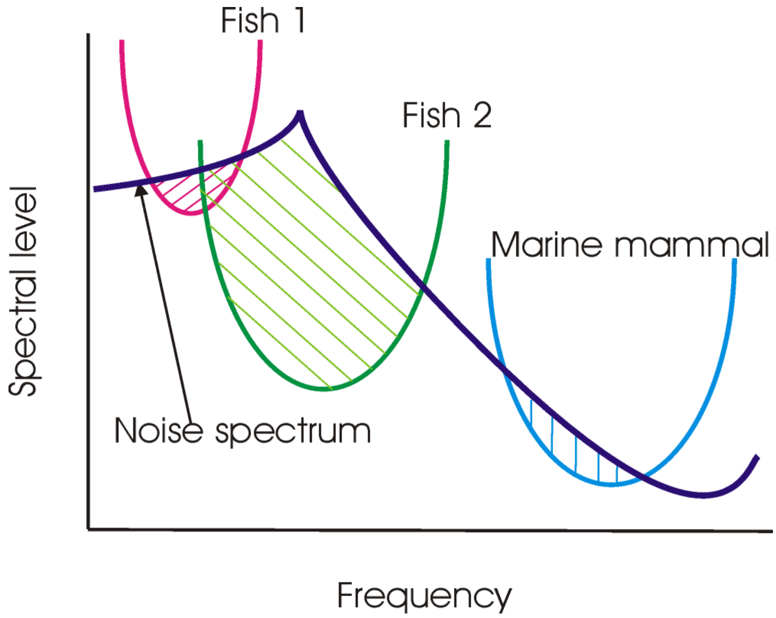

Figure A-1. Illustration of perceived sound level (dB$_{ht}$) for representative fish and marine mammal species.

Since any given sound will be perceived differently by different species (since they have differing hearing abilities) the species name must be appended when specifying a level. For instance, the same sound might have a level of 70 dB$_{ht}$ (*Gaddus morhua*) for a cod and 40 dB$_{ht}$ (*Salmo salar*) for a salmon.

The perceived noise levels of sources measured in dB$_{ht}$ (species) are usually much lower than the un-weighted (linear) levels, both because the sound will contain frequency components that the species cannot detect, and also because most aquatic and marine species have high thresholds of perception to (are relatively insensitive to) sound.

Background levels

Of critical importance in assessing the impact of noise and vibration from an activity is a measure of the ambient noise environment. The pre-existing noise and vibration levels in fast flowing rivers, busy estuaries and coastal waters will be high compared to the levels that are associated with airborne perception by terrestrial animals. As an example, ambient underwater noise in coastal waters measured as a broadband level from 1 Hz to 100 kHz, typically varies from 100 to 130 dB re. 1 µPa.

Attenuation of sound

To normalise underwater sound and vibration measurements to a common reference point, levels are normally quoted as Source Levels. As the sound propagates out from the source the level will reduce both as a result of geometric spreading and absorption in the propagation medium. These effects when combined provide a model for the Transmission Loss (TL) of the noise and vibration with range. This means that the received level at range is substantially lower than the Source Level in the immediate vicinity of the activity.

The sound level at range from an activity can be described by the expression;

$$L(r) = SL - TL \qquad \text{eqn. A.6}$$

where L(r) is the Sound Pressure Level at distance r from a source (m), SL is the (notional) source level at 1 m from the source, and TL is the transmission loss.

The Transmission Loss is frequently described by the equation

$$TL = N \log(r) + \alpha r \qquad \text{eqn. A.7}$$

where r is the distance from the source (m), N is a factor for attenuation due to geometric spreading, and α is a factor for the absorption of sound in water and boundaries ($dB.m^{-1}$).

Using this form of sound transmission loss, the sound level with range L(r) can be described by the expression

$$L(r) = SL - N \log(r) - \alpha r \qquad \text{eqn. A.8}$$

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Kyle Rhea Tidal Stream Array

Appendix 12.7

Kyle Rhea Tidal Stream Array

Appendix 12.7: Background to Marine Scotland Science collision model

Drafted by	Beth Mackey	
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Approved by	Frank Fortune	
Date/initials approval	…12/12/12………	…FF……………….

12.1 Introduction

This Appendix provides a background to the Marine Scotland Science (MSS) (Davies and Thompson, 2010) collision risk model used in the marine mammal impact assessment for the Kyle Rhea Tidal Stream Array Environmental Impact Assessment. This appendix includes the high-level concepts behind the model and the data and assumptions used to feed in to the model.

12.2 Model

The model, developed at MSS to estimate the number of potential collisions, is based around the concept that the diving behaviour of marine mammals (and some seabirds) is very strongly structured and of simple pattern.

Seals tend to spend some time at the surface, and some time on the seabed foraging, with rapid transits in both directions between the surface and the seabed. The dives may by U-shaped or V-shaped, but the pattern of behaviour is broadly consistent between animals. The key parameter of the exposure of a seal to the rotors is therefore the frequency of diving, which is directly related to the frequency (and number) of transits of the depth zone where the rotors are located. A diagrammatic representation of the factors associated with the potential for animals to encounter the rotors is shown in Figure 1. The risk radius, presented by the rotor to animals swimming in the water, is the radius of the rotor (Chapter 5, Figure 5.3) plus the length of the target animal. It should be noted that the hydrodynamics around the rotors will not draw animals into the device.

The velocity of an animal diving from the surface is parameterised as the vector sum of its vertical swimming speed and the current velocity. If there were no avoidance behaviour, animals diving within a cylindrical projection of the area of risk, defined by the radius of the rotors will encounter the area swept by the rotors. The area of the elliptical section through the cylindrical projection at its intersection with the sea surface is combined with the surface density of seals obtained from site characterisation monitoring, to provide an estimate of the number of animals diving within the area of risk. The same number of animals will also be at risk when returning to the sea surface from the seabed. The risk is not dependent on the depth of water.

12.3 Data and assumptions

The model is informed by project specific vantage point survey data as presented in **Appendix 12.3** (statistical analysis of the vantage point data) and technical parameters relating the project. Table 1 presents the input parameters for harbour and grey seal. The densities used in the assessment for harbour and grey seal are based on the data collected during the vantage point surveys (**Appendix 12.3).** These data represent minimum estimates of relative density, as a proportion of animals, will potentially be below the surface at any one time, and therefore will not be counted. To provide a more realistic estimate of density for the collision risk model, densities of 0.04 per 100m^2 have been estimated for grey seal (based on them spending an average of 86% of their time submerged (Thompson *et al.,* 1991) and 0.09 per 100m^2 for harbour seal (based on them spending an average of 73% of their time submerged (Lesage *et al.,* 1999).

The swimming speeds of seals (typically around 1.8 ms^{-1}) and the dive rates are informed by SMRU (pers.comm. to MSS, 2010) suggesting grey seals make approximately six dives per hour, while harbour seals make around 12. Thompson *et al*., (1991) support this, with an average dive time of just over 5 minutes and an average surface interval of approximately 50 seconds in tagged grey seal. Published data for harbour seal dive durations in the UK are not available, but data presented in Lesage *et al*., (1999) suggest that harbour seal could make up to 24 dives per hour, although their analysis excluded dives with extended post dive surface intervals.

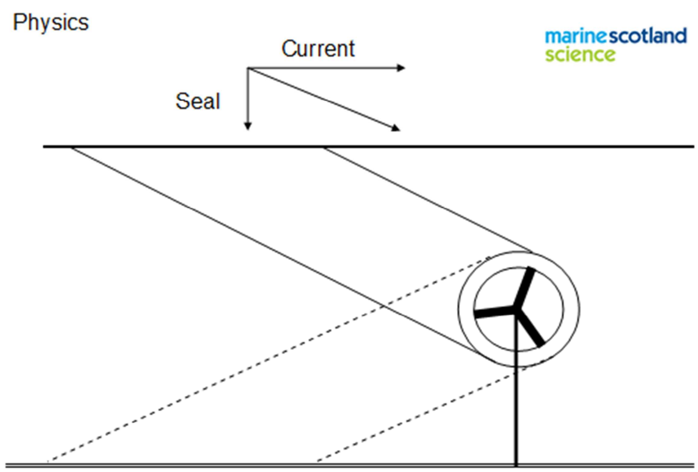

Figure 1 : Relationship between rotor size, seal dive and current speed and projection of the rotor face on the sea surface and seabed.

Table 1 : Input parameters to collision risk and encounter model

Input Parameters	Harbour seal	Grey seal	Harbour porpoise	Notes
No. Blades	3	3	3	A worst case of three rotors per turbine is assumed.
Max Chord	1.56m	1.56m	1.56m	
Pitch (degrees)	7.88	7.88	7.88	
Animal length (m)	1.8	2.2	1.3	
'wingspan' (m)	0.4	0.8	0.4	
Calculated animal speed	2.915 m/sec	2.915 m/sec	2.64 m/sec	Based on an ascent and decent rate of 1.5m/s for seals, and ascent rate of 0.9 and decent rate of 0.8m/s in harbour porpoise.
Rotor diameter	20m	20m	20m	
Rotation period	5.26 sec	5.26 sec	5.26 sec	
Dive profile model				
Tidal current speed	2.5 m/sec	2.5 m/sec	2.5 m/sec	This is based on approximately 60% of the current speed at Kyle Rhea being >1<2.5m/s.
Number of turbines	8	8	8	Assumption of four devices and two turbines on each device
Area of survey	$0.01km^2$	$0.01km^2$	1 km"	This is based on the unit of area (100mx100m for seals) that densities are generated over (see **Appendix 12.3**) and the densities per km^2 provided by the JCP for harbour porpoise
Percent of time spent foraging	100	100	100	
Average number of animals recorded	0.09 seals per $100m^2$	0.04 seals per $100m^2$	0.45 porpoise	For seals this is based on the densities presented in

Input Parameters	Harbour seal	Grey seal	Harbour porpoise	Notes
per observation period			per km^2	Appendix 12.3, and adjusted to reflect availability of animals at the surface. See text for explanation.
Average foraging time per day	24hrs	24hrs	24hrs	
Percentage of time rotors are moving (availability)	90	90	90	

Key parameters for harbour porpoise were informed by published data presented in:

- Otani *et al*., (1998); mean time at surface of 32% and 68% diving.
- Otani *et al.,* (2000); descent and ascent rates of 0.8m per second and 0.9 m per second respectively. Mean dive duration of 26.2 seconds, and mean surface time of 3.9 seconds, giving approximately 120 dives per hour.
- Westgate *et al*., (1995); decent rates of 1.1-2.3m per second and ascent rates of 0.9 - 2.1 m per second. Mean dive duration of between 44 and 103 seconds, suggesting a dive rate of approximately 60 per hour.
- Lockyer *et al.,* (2001); mean length of approximately 130cms.

12.4 References

Davies and Thompson, 2010)

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Westgate, A. J., A J. Head, P. Berggren, H. N. Koopman, D.E. Gaskin. 1995. Diving behaviour of harbour porpoises, *Phocoena phocoena*. Canadian Journal of Fisheries and Aquatic Sciences, 52(5): 1064-1073.

Kyle Rhea Tidal Stream Array

Appendix 13.1

ENVISION MAPPING

Kyle Rhea Benthic Video Survey

July 2012

Prepared for

Sea Generation (Kyle Rhea) Ltd.
and Royal Haskoning Ltd.

Prepared by

Envision Mapping Ltd.

Authors

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PREPARED FOR	Sea Generation (Kyle Rhea) Ltd. and Royal Haskoning Ltd.
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NOTES

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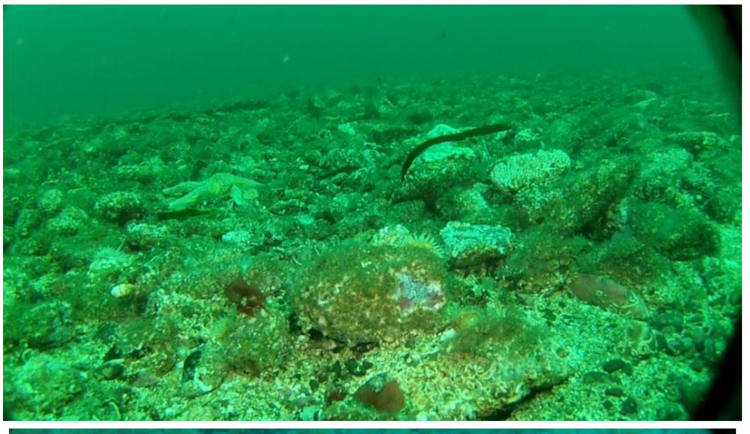


1. Introduction

1.1. Marine Current Turbines

Marine Current Turbines (MCT) is a tidal technology developer based in Bristol. MCT is the world leader in marine current and tidal stream energy having installed the first commercial scale tidal turbine, SeaGen, in Strangford Lough in 2008.

1.2. SeaGen technology

The technology which is proposed for the Kyle Rhea tidal array is based upon the SeaGen device, installed and successfully operated in Strangford Lough. There will be a slight increase in rotor dimensions to increase the power to 2MW.

The SeaGen turbine consists of twin rotors mounted on a cross beam, extending either side of a tubular tower, which itself protrudes approximately 10m above the water surface (during Mean Sea Level). Subsurface, each SeaGen turbine is likely to be mounted on a quadropile drilled and pinned into the seabed providing a minimal direct seabed footprint of approximately 3.1m2.

The combined generation capacity of the array at Kyle Rhea will be up to 8MW, comprising of four of SeaGen tidal turbine devices. Onshore infrastructure is likely to include construction of a substation on the shore adjacent to the array (this could be either side of Kyle Rhea), and directional drilling between the substation and the array.

1.3. Environmental Impact Assessment

MCT has received a scoping opinion from Marine Scotland and is currently in the process of carrying out Environmental Impact Assessment (EIA) works.

The purpose of this present survey was to provide detailed seabed habitat and species information for the Kyle Rhea Tidal Array project, allowing characterisation of the seabed as part of the Kyle Rhea Tidal Array EIA to support the applications for statutory consents. The characterisation will support an assessment of potential impacts of the proposed development on the seabed environment.

1.4. Envision Mapping Ltd.

Envision Mapping Ltd. was contracted by MCT, with its work to be managed by MCT's EIA coordinator, Royal Haskoning Ltd. to ensure efficient feed in to the EIA.

Envision Mapping Ltd. is a consultancy with specialist expertise in marine environmental mapping, management and data services. The company has been at the forefront of developing techniques and standards for seabed survey and mapping and has a wide experience of baseline surveys for Environmental Assessment and habitat mapping for marine management objectives in the UK, Europe and internationally.

The final report is to be summarised in the Environmental Statement by Royal Haskoning and is to be included in full as a technical Appendix.

1.5. Survey Objectives

The specific objectives of the study were to carry out a video survey to characterise the seabed within the study area (Figure 1) in terms of:

- Distribution and abundance of marine habitats and communities;
- Identify habitats or species of conservation importance; and
- Determine the substrate type at all locations sampled.

2. Survey Site

The broad site boundary is shown in Figure 1, and encompasses the majority of Kyle Rhea, an area of approximately 2km^2. Kyle Rhea, a narrow strait between the Isle of Skye and mainland Scotland with high current velocities in a wave sheltered environment. Maximum depths within the strait are around 35m.

Kylerhea is a village to the south west of the Kyle Rhea, with Glenelg on the opposite shore. The site is accessible from both the mainland, via the Old Military Road to Glenelg off the A87 south of Loch Duich, and from the Isle of Skye, via a minor road from the A87 at Ashaig to the settlement of Kylerhea. Immediately south of the proposed site, a small ferry crosses the Kyle between Glenelg and Kylerhea during the summer.

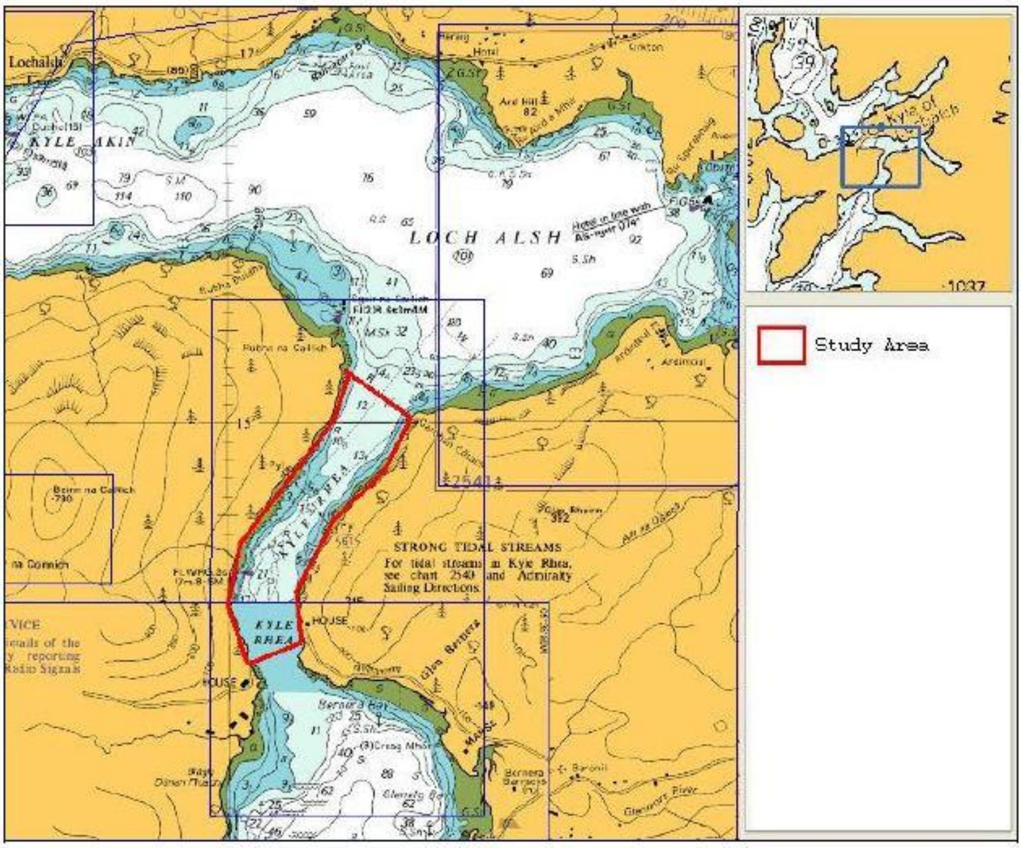


Figure 1.
Kyle Rhea study area

3. Survey Plan

As required by the contractor, the design of the survey strategy for the Kyle Rhea video survey was prepared by Envision and was agreed by Scottish Natural heritage (SNH) and Marine Scotland prior to the survey being carried out.

This section of the report describes the process of data exploration and analysis of the geophysical data collected by Osiris and other available data to produce the suggested video sampling plan.

3.1. Approach used to design a sampling strategy

A sampling strategy should be designed to fully represent the range of habitats that might be expected in a location in order to provide a comprehensive baseline description of an area. The general approach (as described in the MESH guidelines) is to segment the area into habitat types based on the geophysical data available, informed, where possible, by available habitat information on the distribution of biota. This provides a framework for sampling and the locations selected for ground-truthing are then arranged to sample each potential habitat class a minimum number of times with the locations spread geographically throughout the survey area.

In this study the focus for information is centred around the proposed installation sites but the sampling design also provides a broader context of Kyle Rhea and the entrance to the Sound of Sleat. The survey should provide a baseline for future studies to determine if there are any impacts on the environment in relation to distance from the installation sites. Designing the sampling programme based on an interpretation of the geographical data ensures that the sampling strategy is cost effective and is demonstrably representative of the area of interest.

(Note that the habitat classes used here are those given in the MNCR database but they have been updated to correspond with the descriptions in the Marine Habitat Classification for Britain & Ireland (v04.05) (http://jncc.defra.gov.uk/page-1584)).

3.2. Analysis of the data provided

3.2.1. Geophysical data

The main geophysical datasets are the bathymetry and sidescan sonar mosaicked image provided by Osiris. The data have been interpreted into broad sediment categories by Osiris (sand & gravel with mega-ripples, sand & gravel with cobbles and rare/occasional boulders, sand & gravel with numerous/frequent small boulders, and rock).

Envision has taken the bathymetry data and derived a secondary layer of large scale habitat roughness which equates to the various degrees of ruggedness of the terrain (i.e. very rugged, moderately rugged, rock, sand waves, rough sediment and sand). The high resolution data were of a very high standard and allowed a derived roughness map to be prepared with confidence.

The bathymetry was re-classed into depth zones: 0-5m, 5-10m, 10-20m, 20-50m and the roughness into the classes: very rugged, rugged, moderately rough, smooth. The original physical data (bathymetry and roughness) and the transformed (re-classed) data are shown in Figure 2.

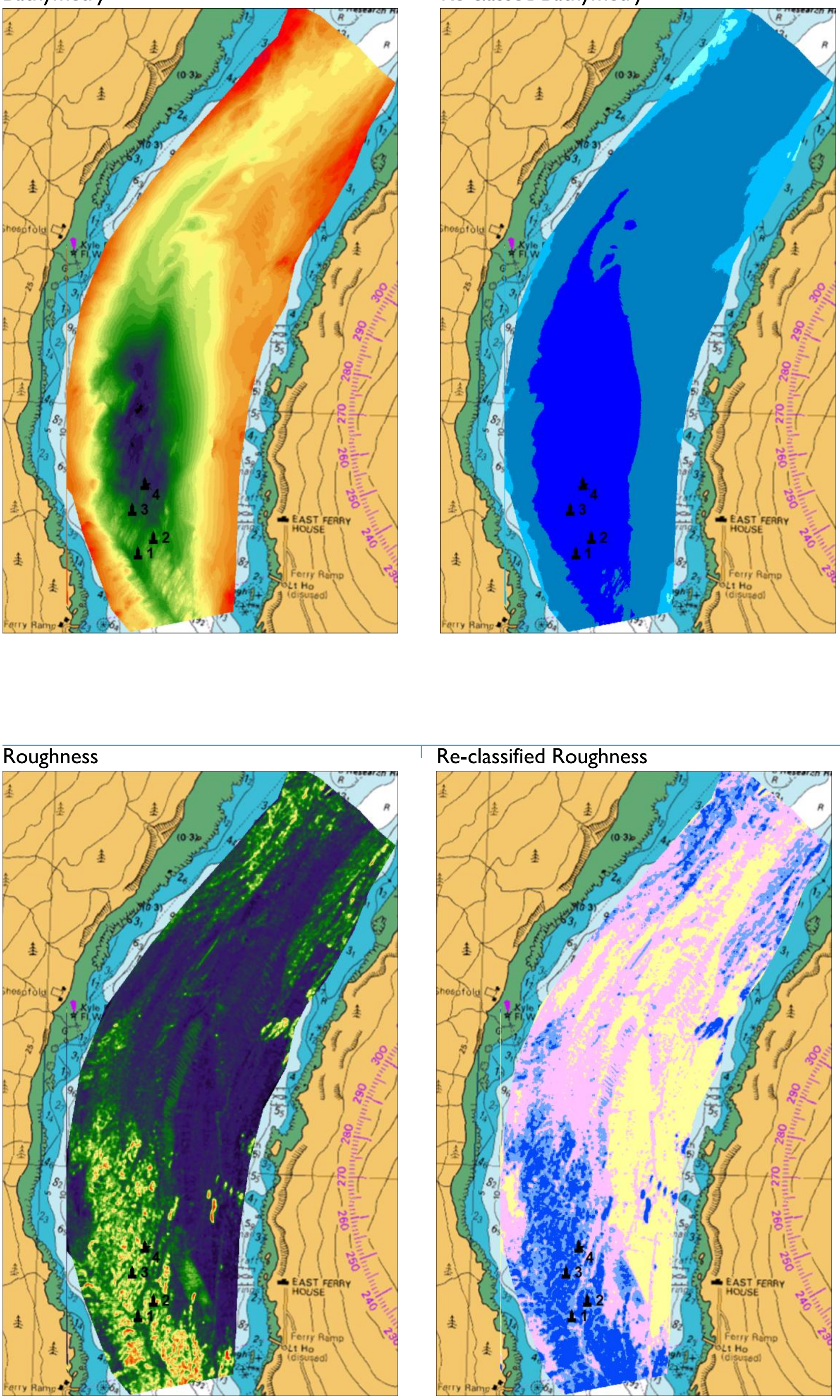


Figure 2.
The high resolution bathymetry and its roughness derivative re-classed in order to segment the area into habitat categories

3.2.2. Ground-truth data

There are few sources of sample data from Kyle Rhea itself. The most extensive dataset is the MNCR Database (with records assigned to biotope classes according to the Marine Habitat Classification for Britain & Ireland [v04.05]); other samples include a few Marine Scotland drop down video stations. However, only 17 records in total are within Kyle Rhea and, of these, only 7 are deep enough to be within the area of the geophysical survey. Thus, there are insufficient data to classify the geophysical data.

An alternative approach was therefore adopted in which all the MNCR records within the sheltered area of Loch Alsh and approaches (Figure 3) were assigned to broad sediment categories and depth zones in a matrix. The depth zones were those used for re-classification of the Kyle of Rhea bathymetry and the sediment categories were chosen to reflect the probable sediments that corresponded to the roughness classes: very rugged = rugged bedrock; rugged = bedrock and boulders; moderately rough = mixed gravel; sand and boulder and smooth = sand.

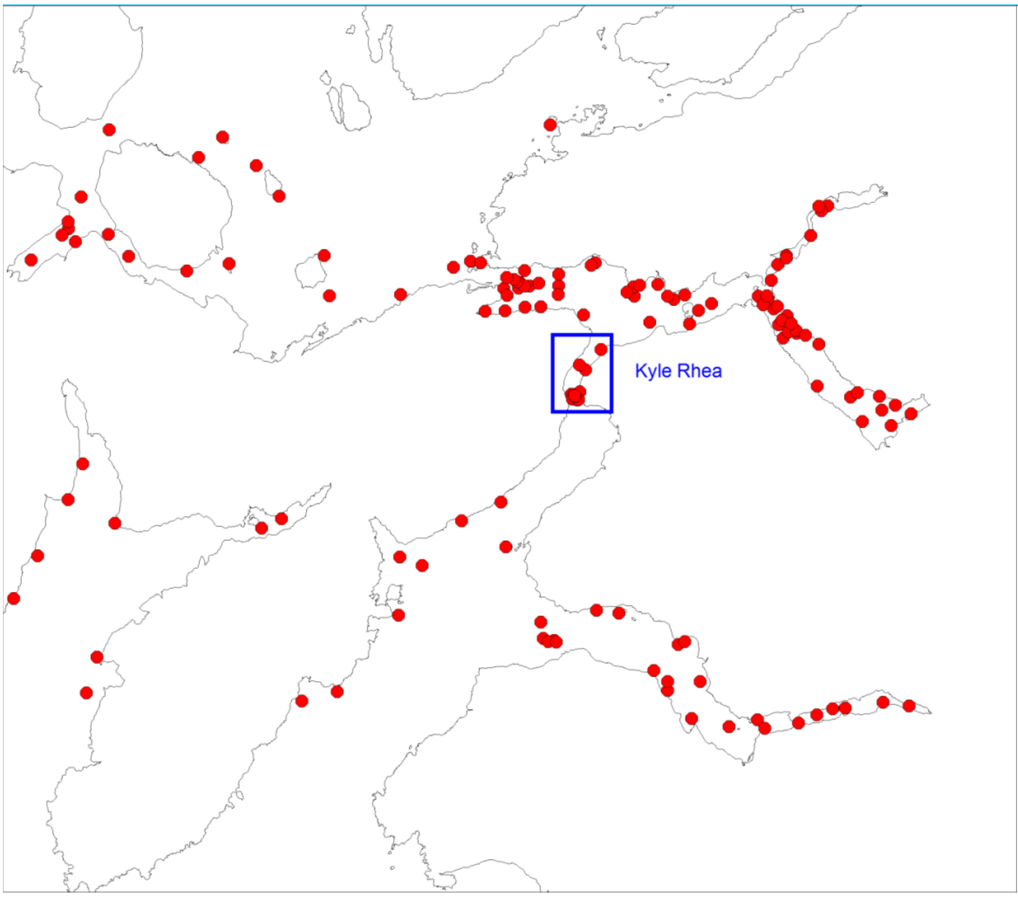


Figure 3.
The location of the biotope data from the MNCR database used for the construction of the biotope matrix

The resulting depth/sediment matrix derived from the MNCR database is presented in Table 1.

Although the available data within the depth zones were very limited, even taking the whole of Loch Alsh into account, there was still a wide range of possible biotopes that may have occurred in each of the habitat classes derived from segmentation, especially when the more detailed levels in the biotope classification (Level 4 & 5) were considered.

Table 1. Depth zone/roughness matrix and possible biological communities present

		Depth zones (m)			
Roughness category	**Range of possible sediments**	**0-5**	**5-10**	**10-20**	**20-50**
Smooth	**Mud**	Lsac	KSwSS	KSwSS	Afil/VirOph
	Sand	Zmar	KSwSS/sand	KSwSS/sand	Afil/VirOph
Moderately rough	**Gravel**	Mrl	Mrl/gravel	Mrl/gravel	Gravel?
	Cobble/mixed	Lhyp/Lsac	KSwSS	Lsac.pk/BrAs/ FaAlCr	Ftrf/Lsac.pk/ Mod
Rugged	**Bedrock/boulder**	Lhyp/Lsac	Lhyp/Lsac	Lsac	Ftrf/Lsac.pk?
Very rugged	**Bedrock mixed**	Lhyp/Lsac/Vert	Lhyp/Lsac/Vert	Lsac/BrAs/ FaAlCr	BrAs/FaAlCr/ Lsac.pk

3.2.3. Analysis of the combined data

The re-classed bathymetry and roughness data were cross-tabulated to derive a map that had potentially 16 different habitat classes. The output from cross-tabulation of the re-classed depth and roughness images was compared with the interpreted side-scan data (Osiris) and the side-scan mosaic. There were few areas of conflict, although some of the sand/gravel mega-ripples were quite rough. A few of the "rough" polygons were re-coded accordingly. But this was applied sparingly and the general concordance between the side-scan interpretation and the analysis was good.

The final stage in the analysis of the geophysical data was to assign the most frequently found biotope class or classes from the depth/sediment biotope matrix derived from the MNCR database (Table 1) to the outputs from the geophysical segmentation process and this is presented in map form in Figure 4. The uncertainty in the interpretation, due to the small amount of ground truth data within Kyle Rhea, must be borne in mind. This map, which segments the survey area, was produced for the purposes of devising a representative sampling strategy and the biotopes presented are for guidance only.

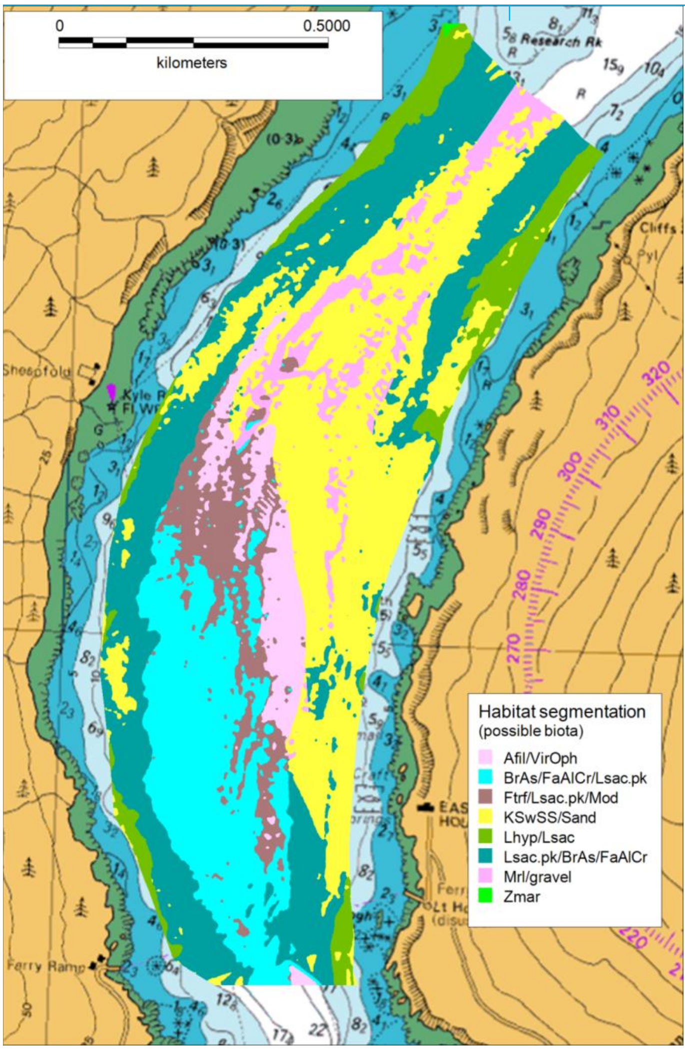


Figure 4.
Segmented habitat map labelled according to the biota assigned to the habitat categories (see Table 1).

3.3. Selection of sites for video sampling

The likely distribution of biotopes presented in Figure 4 covers the whole of Kyle Rhea (including some extension beyond the area covered by the geophysical data) but with a focus on the potential installation sites for the devices. The sample stations were selected to represent all the main habitat types throughout the area.

It was thought possible that maerl (currently listed under Annex Vb of the EU Habitats Directive) may be present. In addition, the eelgrass, *Zostera marina,* could potentially have been found in the shallow sediment. Eelgrass is a Habitat Action Plan species and a component of a number of priority habitats in the EC Habitats Directive. It was recognised that neither Maerl nor Eelgrass had been recorded in Kyle Rhea, but it was felt that the sampling should be vigilant for these habitats.

The proposed sample sites were arranged in transects across the narrows to follow the main environmental gradients. The sample locations were positioned to be within the main habitat categories and were representative of the range of habitats expected to occur. The focus of the sampling was designed to be in the area where the devices are to be installed with additional samples to be taken north and south (in line with the tidal flow) of the proposed installation sites. Note also that some samples were located south of the surveyed area for completeness especially considering the nearness of the devices to the southern entrance to Kyle Rhea.

The proposed sample sites (50 in all) are displayed overlain on the segmented map (Figure 5), together with the proposed position of the devices. The proposed sample positions are given in Appendix 1. (In the event there was opportunity to take more samples [see section 5.1]).

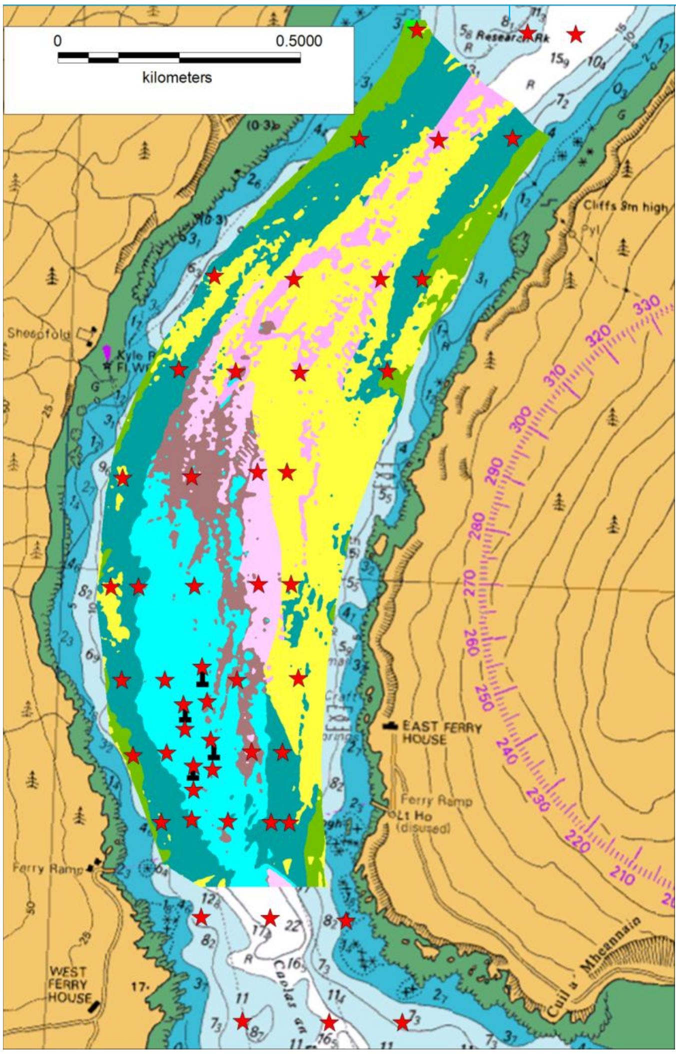


Figure 5.
The proposed video sample positions (red stars) superimposed on the segmented map. The proposed positions of the devices are shown as black "towers".

Additional planning, including the details of the vessel and equipment to be used, the foul weather/downtime procedure, logistics in relations to slack water, travel pans and risk assessment, were all submitted to the EIA Co-ordinator prior to the start of the field survey.

4. Methodology

4.1. Survey Operations

The field survey was carried out by the survey team (Bob and Judy Foster-Smith from Envision Mapping Ltd. and David Tarrant, as Client Representative, for the EIA Co-ordinator, Royal Haskoning Ltd.) during 12th-17th June 2012 with time both before and after for mobilising and demobilising equipment (Table 2).

Table 2. Survey Operations

Date	Operation
11th June	• Check and mobilise equipment
12th June	• Travelled to Kyle of Lochalsh (7 Hours) • Discussed survey plans with crew on site and checked vessel's electricity supply
13th June	• Mobilised video equipment onto vessel • Began video survey • Reviewed video captured to ensure good quality
14th June	• Continued video survey • Reviewed video captured to ensure good quality
15th June	• Completed Field survey • Demobilised video equipment
16th June	• Travelled back to Envision base (7 hours)
18th June	• Demobilised (office) and checked equipment

The timing of the video work was confined to the periods coinciding with slack water. Slack water in Kyle Rhea is limited, being approximately 20 minutes before HW or LW, and lasting roughly 20-30 minutes only, even at neap tides. The times during which the video work was carried out around slack water are given in Table 3.

Table 3. The timing of the video work around slack water

Date	Tide	Slack Water	Times of Video
13th June	LW 0913 HW 1600	0850-0920 1540-1610	0750-1100 1430-1715
14th June	LW 1020 HW 1657	1000-1030 1635-1705	0900-1200 1500-1825
15th June	LW 1118 HW 1743	1100-1130 1725-1755	1000-1335 -

4.2. The Vessel

The vessel used for the survey was 'Spirit of Adventure' (Figure 6) owned by Seaprobe Atlantis Ltd. (www.seaprobeatlantis.com). This was 11.5 metres in length with a cruising speed of 16-20 knots. The boat was conveniently berthed at Kyle of Lochalsh about 20 minutes steaming time from the survey area.

Figure 6.
The survey vessel - 'Spirit of Adventure'

4.3. Drop down video

4.3.1. Camera system

Envision designs, builds and operates a range of camera systems as dictated by the local environmental conditions within the proposed survey areas. They include those designed for deployment in extreme tidal conditions where Envision has carried out video surveys, such as in the narrows of Strangford Lough.

The system built specifically for the Kyle Rhea survey is shown in Figure 7. Its robust structure was designed to enable it to maintain position in strong current as well as to glide easily over a variety of substrates without snagging.

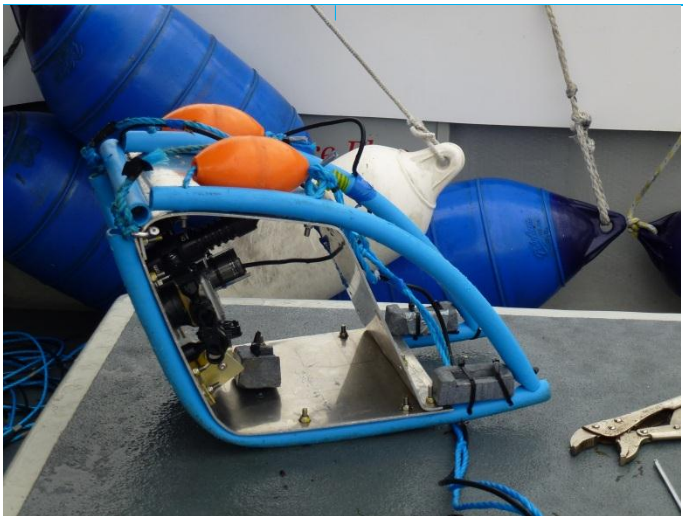


Figure 7.
The camera system designed by Envision for use in the strong tidal current conditions in Kyle Rhea

The system was tethered to, and partly powered from, the surface via an umbilical connected to a surface unit. This unit enabled the operators to view a live image whilst the camera was deployed and allowed for footage to be recorded onto MiniDV tape at the surface. Recordings were also made within a second camera on the seabed.

4.3.2. Video sampling

At each sampling station the camera system was lowered to the seafloor and allowed to drift or be towed behind the vessel for between 1 and 5 minutes. The position of each drop was located using a dedicated dGPS and plotting system, whilst depth was recorded using the vessel's sounder.

Each video drop was numbered and recorded, for subsequent analysis, using a Sony DV tape recorder, and the position and time at the start and end of each deployment were logged. The positions were recorded using a differentially corrected GPS (dGPS) system (with a published accuracy of ≤ 1m). Depths were also noted for each sample.

The video clips captured were reviewed during non-boat time to ensure that the recordings were of sufficiently good quality for analysis. This allowed opportunity during the survey to repeat any samples for which the video was deemed unsuitable.

4.4. Video analysis

The video clips that had been recorded on the digital tapes were transferred to an external hard drive (a) as a form of back-up and (b) for analysis using video processing software.

During analysis, each video clip was observed several times: firstly to get an overview of the sample site; secondly to obtain substrate data; thirdly to obtain species data and fourthly, to take frame grabs to illustrate particular features. Initially, a brief written description of each of the 70 sample sites was given. Substrate and species data obtained from the video clips were then entered into an Excel™ spreadsheet based on a 'Data Entry Spreadsheet' produced by the JNCC for biotope analysis. Once this process was completed, it was then possible to allocate biotopes to each of the sample (video drop) sites. This was done using the 'Marine Habitat Classification v. 04.05' (Connor et al., 2004). Frame grabs were obtained from the video to illustrate the different biotopes present. Where biota could not be identified to species (e.g. because they would need to be collected and closely examined to be certain, such as for the sponges, or where only a glimpse of them was available on the video) then they were assigned a higher taxonomic category within which they are definitely contained. It was not possible to be certain about the precise identity of some of the encrusting fauna (e.g. barnacles [Cirripedes], and keel worms [Serpulids - genus *Pomatoceros*]) because of their small size and, in many cases, much of the foliose red algae could not be distinguished because of the density with which they grew.

4.5. Mapping

Envision processed the geophysical datasets as part of the analysis required for planning the sampling campaign (see Section 3.2.1). The main geophysical datasets are the bathymetry (XYZ gridded point data) and sidescan sonar mosaicked image provided by Osiris. Envision have taken the bathymetry data and derived a secondary layer of large scale habitat roughness which equates to the various degrees of ruggedness of the terrain. The resulting image resembled the sidescan mosaic and was used instead of the sidescan image since it had fewer artefacts. The bathymetry and roughness raster images were transformed so that they were exactly the same size and resolution and were geographically coincident.

The sample data were classed into (a) physical seabed habitat and (b) biotope classes (the main outputs from the video analysis). The samples within the area covered by the geophysical data were used as ground truth data. A small buffer zone was created around each sample point and used to extract data from the two geophysical images. These data were associated with the habitat and biotope classes and used to create statistical signatures (separately) for habitats and biotopes. These two signature sets were then used to interpret the complete coverage to estimate the distribution of habitats and biotopes.

The resulting images were converted to vector polygon format and exported into ArcGIS. The habitat and biotope class attributes associated with the polygons were then displayed as points superimposed on the maps (see Results section 5.4 below).

Samples were also taken outside the area covered by the geophysical data, particularly to the south at the entrance of Kyle Rhea from the Sound of Sleat. Very approximate habitat and biotope boundaries were drawn by eye around the sample points using the depth contours from the hydrographic chart as collateral information. These extensions to the south of the interpreted area are provided for completeness, but can be regarded as only very approximate.

5. Results

5.1. Field Survey

Sea conditions during the survey were good with no significant swell. The weather was dry during the first 2 days, with very light winds. On the third day there was light rain and a NNE force 3 wind.

In all, 70 video samples were taken (Table 4). These included the 50 stations originally proposed (Section 3.3 and Appendix 1) and, in addition, an extra 14 stations which were added during the survey as time allowed. The other 6 samples were 'repeats', being second samples from each of 6 of the original stations; these were taken because the first samples were felt to have been inadequate. (In the event, these first video samples *had* been adequate and so all 6 were analysed as well as the repeat samples).

Table 4. Numbers of video samples taken during the survey

Date	Number of stations sampled	Number of repeat samples
13th June	33	-
14th June	27	3
15th June	10	3
TOTAL	**70**	**6**

Sampling began at the south end of the survey area, concentrating on the more central stations, where the tidal current was strongest, during the slackest water, and then progressed to the marginal stations as the current increased. This pattern was repeated working towards the northern part of the area. Once it was apparent that the original stations could be sampled in good time within the allocated survey period, the EIA Co-ordinator requested that more stations be sampled to ensure that a maximum number of stations could be sampled.

The additional stations (51-64) were located south of the original survey area and also around the sites of the proposed Turbines. The positions of all of the video sample stations (including repeated samples) are given in the Survey Log (Appendix 2). Every attempt was made to sample as close to the proposed sampling positions as possible, although the speed of the drift (over 3 knots at times) meant that this was not always as close as planned.

Sampling on the second survey day was delayed for an hour or so due to problems with the equipment. Seawater leaked into the camera cable and also, in a separate incident, one of the camera lenses was damaged during video operations. A replacement system was set up on board by Envision.

The depth of the stations ranged between 4.3m and 35.0m.

5.2. Preliminary Observations

At the request of Royal Haskoning Ltd. a preliminary map of the habitats and communities present was produced before the full analysis took place. The rough initial analysis of the video footage showed there to be 7 different Biotope/Life form categories present in the survey area. These included Coarse Sand, Faunal Crust, Faunal Turf, Floral and Faunal Turf, Kelp Forest, Kelp Park and Maerl (Figure 8). As was expected, the proposed turbine sites coincided with the presence of a robust faunal turf community characteristic of high tidal current. Maerl was found in varying densities at 3 sites at the southernmost boundary of the (extended) survey area. Both kelp forest and kelp park tended to be found in shallower water towards the landward margins of the site, where the current was least. A patch of coarse sand was recorded to occur to the east of the proposed turbine positions, although this was much less extensive than was predicted by the geophysical analysis. North of the sand an area of cobble and pebble covered with faunal crust was characteristic. A mixed floral and faunal turf seemed to occur predominantly to the north and south, presumably in areas of considerable, but not extreme, current.

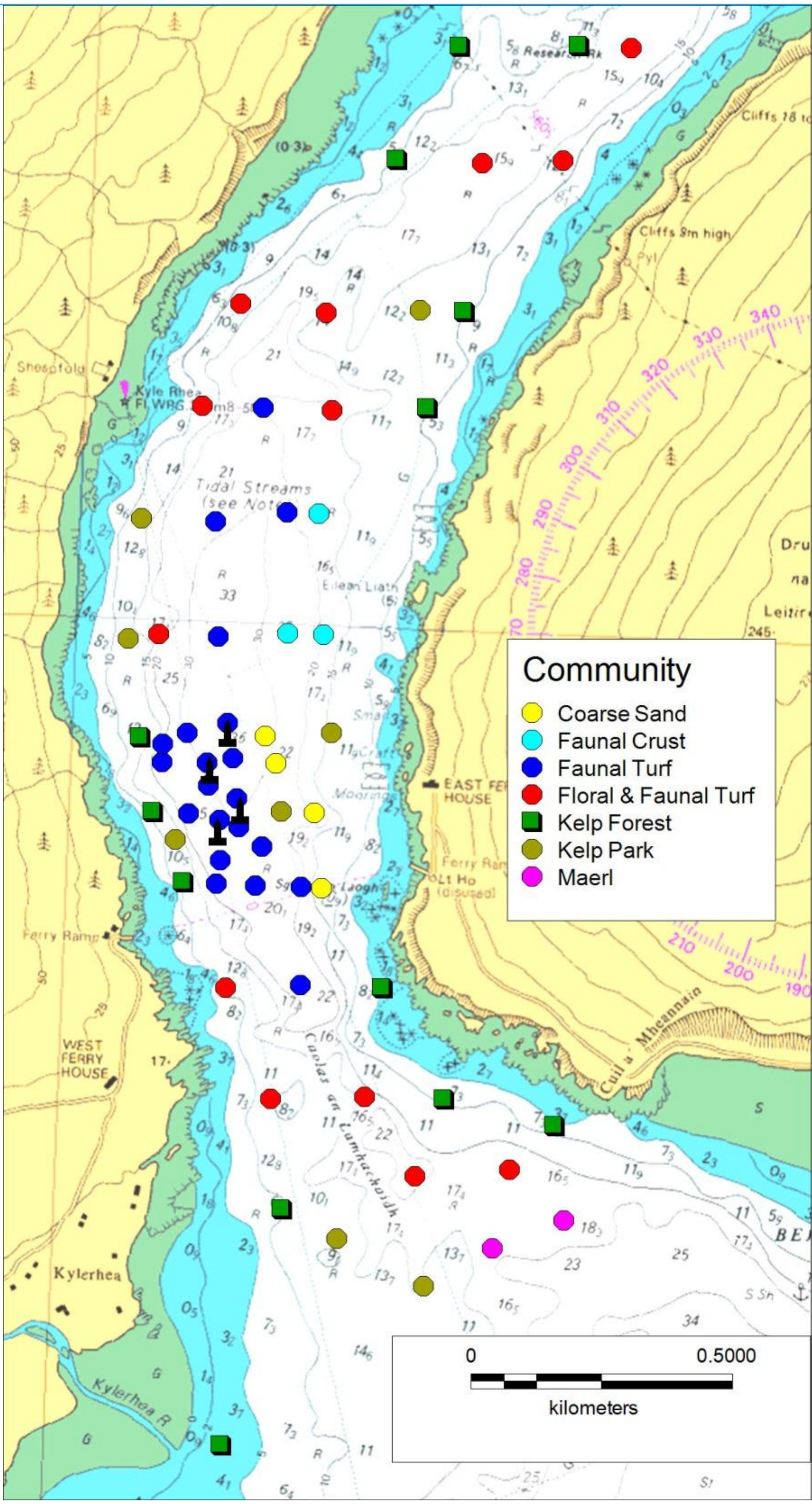


Figure 8.
Preliminary assignment of biotope/life form to the sampling station positions

5.3. Taxonomic observations

82 taxa were recorded from the video clips (Appendix 3). The dominant species found in the circalittoral areas in the centre of the main channel (the hydroid, *Tubularia indivisa,* the anthozoan, *Alcyonium digitata*, and anemones *Sagartia elegans, Corynactis viridis* and *Metridium senile*) are characteristic of accelerated tidal stream environments and would be expected in the tidal current regime and in the depths that occur in Kyle Rhea. These species formed almost 100% coverage of the substrate at several stations. Similarly, the dominant species found in shallower water towards the edges of the channel, where the tidal flow still tended to be strong (but much less so than in the channel centre), *Laminaria hyperborea*, hydroids (such as *Nemertesia* and *Sertularia),* and foliose red algae, occurred as expected. (It is usual to find a tide-swept turf of hydroids and red algae in the lower infralittoral and well-developed kelp forest dominated by *Laminaria hyperborea* in the upper infralittoral, above circalittoral areas of *Alcyonium* and *Tubularia).* Other obvious and widespread species, such as the echinoderms, *Echinus esculentus* and *Asterias rubens* and the swimming crab, *Necora puber*, were present throughout the depth range, while the sponge *Pachymatisma johnstoni* was frequently observed in the circalittoral areas. Again, this species is characteristic of areas of high tidal current.

Some of the species recorded on the video are of particular note as they are of conservation importance as follows:

- Maerl (Stations [Takes] 52, 53, 55). There are two common species of maerl in Scotland: *Phymatolithon calcareum* is widespread, and *Lithothamnion glaciale* is more northern in its range, although it is not easy to tell them apart. The importance of Maerl is discussed in the context of Maerl beds below.

- Spurdog (or Spiny dogfish) *Squalus acanthias* (Station [Take] 52). Spurdog populations have seen drastic declines in the north-east Atlantic and the species is on the OSPAR list of threatened and/or declining species (http://www.ospar.org/content/content.asp?menu=00730302240000_000000_000000 @24/7/12). It is also included in the 'Recommended list of Priority Marine Features in Scottish Territorial Waters' (http://www.snh.gov.uk/docs/B1064114.pdf @ 24/7/12).

- Common seal *Phoca vitulina* (Station [Take] 63). The Common seal is included in the 'Recommended list of Priority Marine Features in Scottish Territorial Waters' (http://www.snh.gov.uk/docs/B1064114.pdf @ 24/7/12); it is classified as a Priority Species in the UK Biodiversity Action Plan for Scotland. (http://jncc.defra.gov.uk/page-5167 @ 24 /7/12) and is also protected under the Habitats Directive (Schedule 3) (http://www.snh.gov.uk/protecting-scotlands-nature/protected-species/legal-framework/habitats-directive/euro/ @ 26/7/12) as well as the Marine (Scotland) Act 2010.

- Sandeel *Ammodytes* (Station [Take] 62). The two *Ammodytes* species are difficult to distinguish underwater and so it is not clear which species was recorded in Kyle Rhea. Nonethelesss, both *A. marinus* and *A. tobianus* are included in the 'Recommended list of Priority Marine Features in Scottish Territorial Waters' (http://www.snh.gov.uk/docs/B1064114.pdf @ 24/7/12). In addition, *Ammodytes marinus* classified as a Priority Species in the UK Biodiversity Action Plan for Scotland (http://jncc.defra.gov.uk/page-5167 @ 24 /7/12).

There was no evidence of the presence of species listed in Schedule 5 of the Wildlife and Countryside Act 1981 (as amended in Scotland through the Nature Conservation (Scotland) Act 2004).

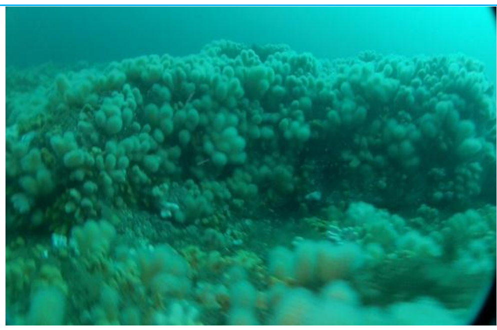
5.4. Seabed Substrate (Habitat) and Biotope observations

Eleven different categories of seabed substrate were recorded for the whole survey site (i.e. including the extended area) (Figure 9.).The deeper areas, in the central channel, tend to be bedrock; surrounding these is a mix of sediment categories, from boulders through to coarse sand. It is likely that the rugged bedrock and boulder areas equate to 'Reef' as included in the Habitats Directive Annex1 list of habitat types (http://jncc.defra.gov.uk/page-1523 @ 26/7/12) and so these may require further investigation and assessment.

A wide range of topographical reef forms meet the EU definition of this habitat type. Rocky reefs are extremely variable, both in structure and in the communities they support. (see e.g. Irving, 2009 and the JNCC website (http://jncc.defra.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H1170 [@ 31/07/12]). These range from vertical rock walls to horizontal ledges, sloping or flat bed rock, broken rock, boulder fields, and aggregations of cobbles. Reefs are characterised by particular communities which vary according to local conditions. In strong tidal streams there are communities of barnacles, the soft coral *Alcyonium digitatum*, massive sponges and hydroids.

It is on the basis of these descriptions that that parts of the seabed in Kyle Rhea are thought likely to be classified as 'reef' (see e.g. Figure 9).

(a) Station 66



(b) Station 27

Figure 9.
Examples of possible Annex I 'reef' habitat.

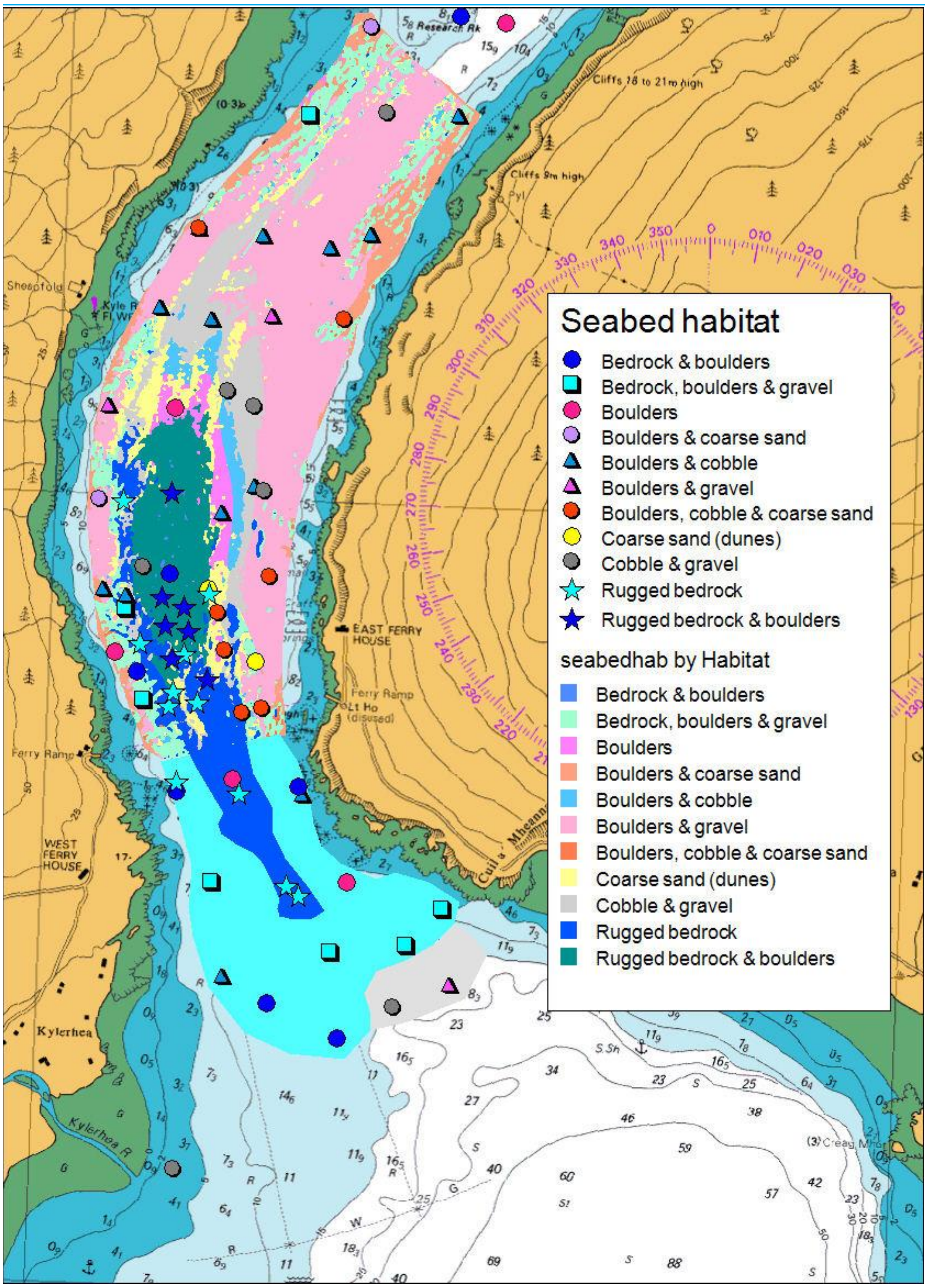


Figure 10.
The extent and distribution of seabed substrate (habitat). (The coded seabed habitats represent the habitat type at the different sample stations; 'seabedhab by Habitat' represents the extent of the various habitats with derived boundaries).

Thirteen different biotope categories were allocated (Table 5; Appendix 4; Figure 10). The distribution of the biotopes appears to reflect the pattern of the natural contours of the site. Those based on the presence of kelp occur towards the edges of the channel in the shallower water; those with large densities of foliose red algae occupy the next 'shelf' down; below this the encrusted (with Corallinaceae and *Pomatoceros*) cobble and gravel and, finally, the *Alcyonium*/*Tubularia* biotopes tending to be on bedrock forming the deeper 'basin' of the channel. The dominant biotope was '*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock', occurring in 25 of the 70 samples.

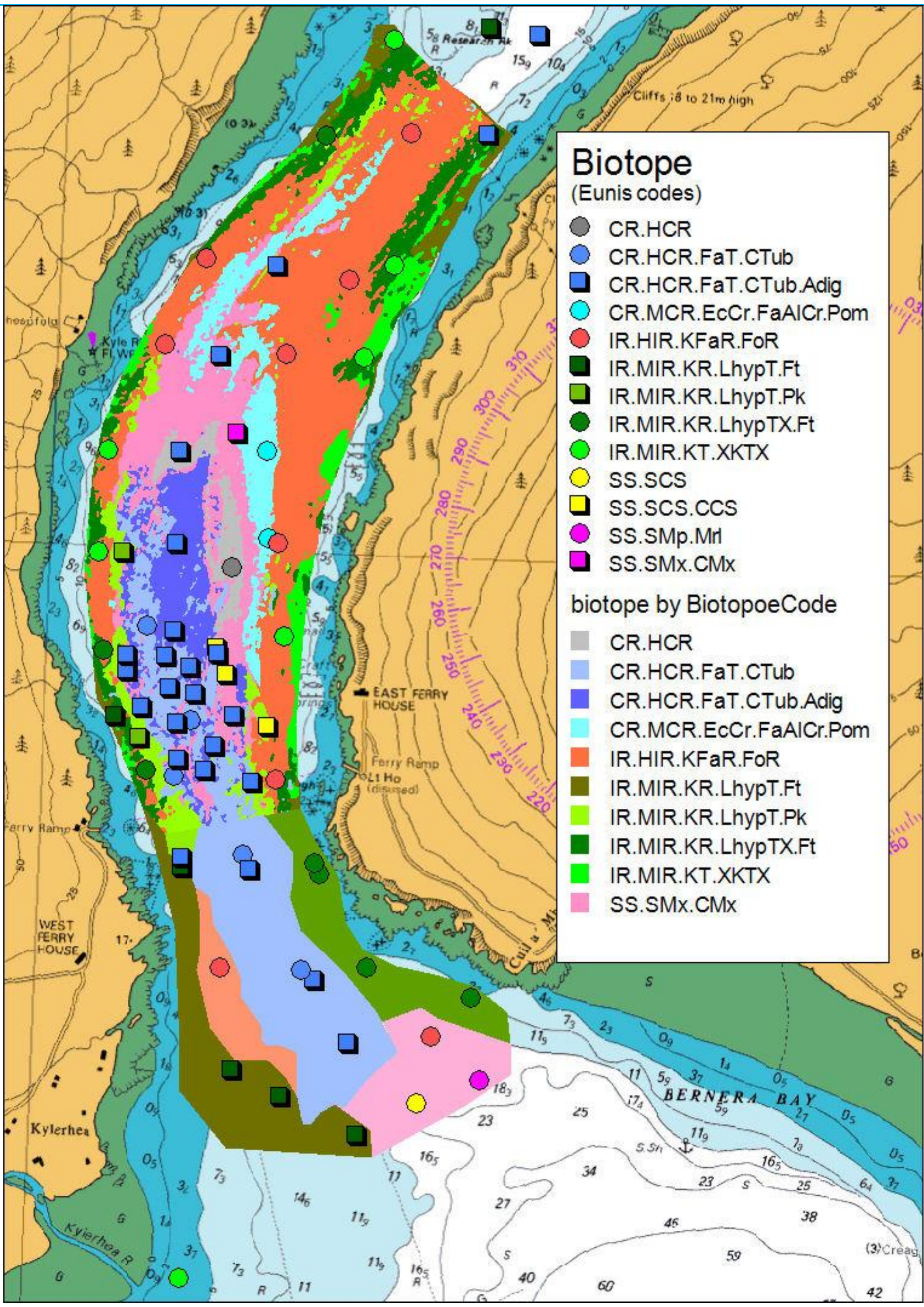
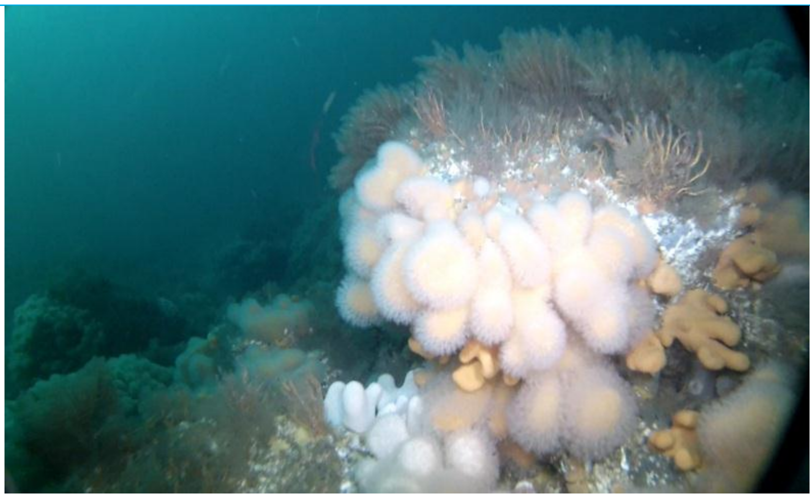
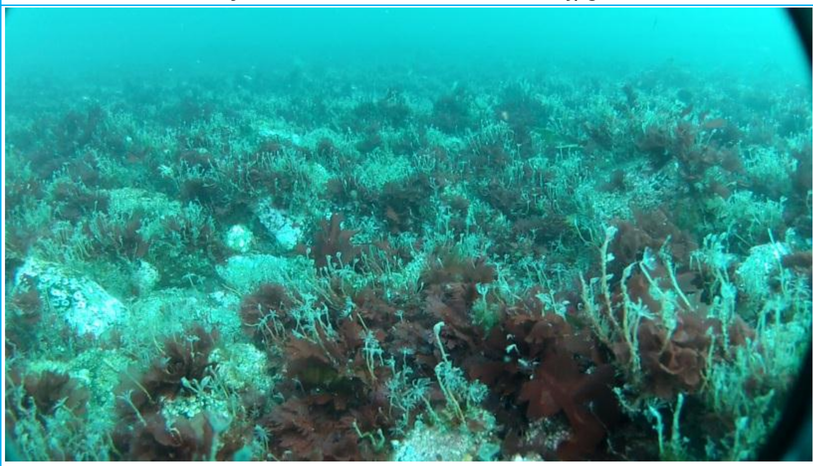


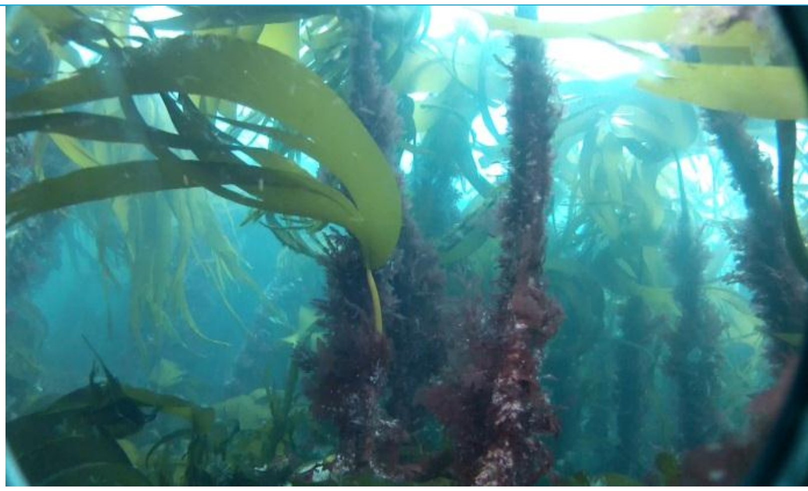
Figure 11.
The extent and distribution of biotopes

Table 5. Biotopes allocated for the survey area

Biotope Code and Description	Number of Video Stations[1]	Video image
CR.HCR High energy circalittoral rock	1	 *B – Take 4-2.jpg*
CR.HCR.FaT.CTub *Tubularia indivisa* on tide-swept circalittoral rock	5	 *J Take 37R GOPRO1164a - Tubularia.jpg*

[1] *This includes two biotope assignments at one of the stations where the biotope changed within the video clip.*

CR.HCR.FaT.CTub.Adig *Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock	25	 *J Take 3 GOPRO1163c - scene.jpg*
CR.MCR.EcCr.FaAlCr.Pom Faunal and algal crusts with *Pomatoceros triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock	2	 *J Take 5R GOPRO1178a - scene.jpg*
IR.HIR.KFaR.FoR Foliose red seaweeds on exposed lower infralittoral rock	10	 *B Take 14 – 6 .jpg*

IR.MIR.KR.LhypT.Ft *Laminaria hyperborea* forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock	6	 *Take 38R GOPR 1182 - Kelp forest.jpg*
IR.MIR.KR.LhypT.Pk *Laminaria hyperborea* park with hydroids, bryozoans and sponges on tide-swept lower infralittoral rock	2	 *J Take 61 GOPRO1180e - scene.jpg*
IR.MIR.KR.LhypTX.Ft *Laminaria hyperborea* forest and foliose red seaweeds on tide-swept, upper infralittoral mixed substrata	7	 *B Take 31.3.jpg*

IR.MIR.KT.XKTX Mixed kelp and red seaweeds on infralittoral boulders, cobbles and gravel in tidal rapids	7	 *B Take 48 – 2.jpg*
SS.SCS Sublittoral coarse sediment (unstable cobbles and pebbles, gravels and coarse sands)	1	 *J Take 56 GOPRO1172a - scene.jpg*
SS.SCS.CCS Circalittoral coarse sediment	3	 *J Take 62 GOPR 1181a - Gravel.jpg*

SS.SMp.Mrl Maerl beds	I	 *J Take 55 GOPRO1171a Maerl.jpg*
SS.SMx.CMx Circalittoral mixed sediment	I	 *J Take 8 Bullet Video Tape 2 Part B - Dragonet.jpg*

Of particular note are two biotopes: Maerl beds (SS.SMp.Mrl - Station [Take] 55) and *Laminaria hyperborea* on tide-swept infralittoral mixed substrata (IR.MIR.KR.LhypTX - Stations [Takes] 18, 21, 31, 38, 41, 54 and 68) as they are included in the 'Recommended list of Priority Marine Features in Scottish Territorial Waters' (http://www.snh.gov.uk/docs/B1064114.pdf @ 24/7/12).

Maerl beds, found at Station [Take] 55, are also a UK BAP Priority habitat (http://jncc.defra.gov.uk/page-5706). Maerl beds typically develop where there is some tidal flow, such as in the narrows and rapids of sea lochs, or the straits and sounds between islands. They are an important habitat for a wide variety of marine animals and plants which live amongst or are attached to its branches, or burrow in the coarse gravel of dead maerl beneath the top living layer. Current and potential threats to Maerl beds include:

- *Obstruction to water flow* - building of barrages, causeways and bridges are potential blockages to water flow, particularly in sea lochs and between islands causing fine sediment particles to accumulate between the maerl fragments and smother the bed.

Tide-swept channels are also listed under UK BAP Priority habitats (http://jncc.defra.gov.uk/page-5706), where the habitat action plan uses the term 'tidal rapids' to cover a broad range of high energy environments including deep tidal streams and tide-swept habitats.

The following biotopes, recorded within the survey area, are associated with tide-swept conditions.

CR.HCR.FaT.CTub
IR.MIR.KR.LhypTX.Ft
CR.HCR.FaT.CTub.Adig
IR.MIR.KR.LhypT.Pk
IR.MIR.KT.XKTX
IR.MIR.KR.LhypT.Ft
SS.SMp.Mrl

Current and potential threats to tide-swept channels listed on the UK BAP documentation include:

- *Obstruction to the water flow*
- *Tidal power generation*

6. Conclusion

The video survey was carried out in good working conditions and included 14 samples in addition to those originally planned. The survey conclusions are given below in the context of the aims of the project, i.e. to characterise the seabed in terms of

- The distribution and abundance of marine habitats and communities;
- the habitats or species of conservation importance; and
- the substrate type at all locations sampled.

6.1. Distribution and abundance of marine habitats and communities

Analysis of the video data has resulted in a map representing the distribution and abundance of the marine habitats and communities (together forming biotopes) present in Kyle Rhea. This shows that the key biotopes in the immediate vicinity of the proposed turbines are: CR.HCR.FaT.CTub.ADig - *Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock and CR.HCR.FaT.CTub - *Tubularia indivisa* on tide-swept circalittoral rock.

6.2. Habitats and species of conservation importance

The conservation importance of the particular species and habitats recorded at the site has been assessed. Four species have been identified as being of some conservation importance, namely Maerl, Spurdog, Common seal and Sandeel. Maerl is of particular importance when it is in sufficient abundance to form Maerl beds, as it did at one station (within the extended survey area, to the south of the original survey area). Although Spurdog and Common seal are not benthic creatures, and therefore not strictly relevant to this project, it is nonetheless important to highlight presence of these protected species in Kyle Rhea. Sandeels, on the other hand, spend much of their life cycle buried in seabed sediment of a particular grade (coarse sand) and can be regarded as benthic; the areas of coarse sand identified during the survey may be of significance to this species.

6.3. The substrate type at all locations sampled

The substrate type at each of the video sampling stations has been identified and mapped. There are some notable differences between the interpretation of the sidescan data undertaken by Osiris, where there were few data available for validation, and the analysis of the geophysical data supported by the video data. The most significant is the extensive central area interpreted from the sidescan as sand and gravel with occasional small boulders which would appear, from the video evidence, to be characterised by boulders and cobble. The video evidence also suggests that the shallow western margin of Kyle Rhea close to the rocky shore is composed predominantly of boulders and these give way to bedrock in deeper water slightly further from the shoreline. Although bedrock outcrops at many different locations on the western side of Kyle Rhea and the entrance to the Sound of Sleat, rugged bedrock is confined to the deeper areas in the south western sector of Kyle Rhea.

7. References

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northern, K.O. and Reker, J.B. (2004) The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough ISBN 1 861 07561 8 (internet version). jncc.defra.gov.uk/MarineHabitatClassification

Irving, R. 2009. The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008. *JNCC Report* No. 432

8. Appendices

8.1. Appendix 1. Positions of the proposed sample stations

Sample	Longitude	Latitude	eastUTM30N	northUTM30N
1	-5.6652	57.2330	339135	6346475
2	-5.6642	57.2331	339192	6346475
3	-5.6623	57.2331	339306	6346477
4	-5.6602	57.2332	339437	6346480
5	-5.6590	57.2332	339505	6346480
6	-5.6649	57.2351	339159	6346698
7	-5.6626	57.2351	339301	6346702
8	-5.6603	57.2353	339436	6346710
9	-5.6593	57.2353	339496	6346710
10	-5.6631	57.2371	339275	6346922
11	-5.6612	57.2371	339391	6346916
12	-5.6590	57.2371	339522	6346915
13	-5.6561	57.2372	339702	6346918
14	-5.6621	57.2389	339347	6347114
15	-5.6594	57.2388	339510	6347107
16	-5.6564	57.2389	339688	6347107
17	-5.6550	57.2389	339773	6347107
18	-5.6573	57.2415	339645	6347394
19	-5.6546	57.2415	339808	6347392
20	-5.6521	57.2416	339960	6347396
21	-5.6631	57.2288	339238	6345992
22	-5.6621	57.2288	339301	6345997
23	-5.6609	57.2288	339375	6345994
24	-5.6594	57.2288	339463	6345992
25	-5.6588	57.2288	339502	6345990
26	-5.6642	57.2300	339180	6346129
27	-5.6631	57.2300	339249	6346135
28	-5.6615	57.2298	339343	6346100
29	-5.6602	57.2301	339424	6346137
30	-5.6591	57.2301	339488	6346135
31	-5.6647	57.2313	339157	6346284
32	-5.6632	57.2314	339245	6346284
33	-5.6620	57.2316	339322	6346310
34	-5.6607	57.2314	339394	6346284
35	-5.6587	57.2315	339520	6346287
36	-5.6617	57.2270	339320	6345797
37	-5.6593	57.2271	339462	6345795
38	-5.6567	57.2271	339617	6345790
39	-5.6601	57.2251	339405	6345584
40	-5.6572	57.2252	339583	6345580
41	-5.6547	57.2252	339733	6345580
42	-5.6625	57.2309	339284	6346234
43	-5.6625	57.2305	339286	6346183

44	-5.6621	57.2298	339304	6346107
45	-5.6621	57.2294	339304	6346058
46	-5.6616	57.2303	339340	6346161
47	-5.6617	57.2310	339332	6346240
48	-5.6555	57.2435	339763	6347619
49	-5.6517	57.2436	339991	6347613
50	-5.6501	57.2436	340090	6347610

8.2. Appendix 2. Survey Log

Date	Sample Number	Station (Take) Number	Time	Latitude	Longitude	Depth	Substrate	Conspicuous species	Reason for repeating sample
13/06/2012	1	41	08:37:00	57 13.518	5 39.295	9.1	Bedrock	*Laminaria, Delesseria, Dynamena , Echinus esculentus*, Hydroids	
13/06/2012	2	40	08:44:00	57 13.514	5 39.436	15.3	Bedrock	*Delesseria, Henricia, Tubularia, Sagartia,* Brittlestars, Hydroids	Current too fast
13/06/2012	3	39	08:49:00	57 13.513	5 39.612	11.5	Bedrock	*Delesseria, Tubularia, Sagartia, Sertularia* Red/Brown algae	
13/06/2012	4	38	08:54:00	57 13.624	5 39.407	6.6	Boulder/Cobble	*Laminaria,* Ascidians?, *Echinus esculentus,* Hydroids, Red/Brown algae	Clip too short
13/06/2012	5	37	08:59:00	57 13.644	5 39.573	25.3	Bedrock	*Tubularia, Asterias? Sertularia, Necora puber, Hydroids*	Clip too short
13/06/2012	6	36	09:05:00	57 13.624	5 39.702	9.3	Bedrock	*Laminaria, Delesseria, Echinus,* Hydroids Red/Brown algae	Clip too short
13/06/2012	7	21	09:10:00	57 13.742	5 39.788	11.5	Bedrock	*Alcyonium Laminaria Echinus, Henricia, Calliostoma, Tubularia,* Ascidians?	
13/06/2012	8	22	09:15:00	57 13.732	5 39.729	18.5	Bedrock	*Alcyonium*	
13/06/2012	9	23	09:23:00	57 13.739	5 39.661	21.1	Bedrcok	*Alcyonium,Tubularia, Sertularia, Echinus*	
13/06/2012	10	26	09:29:00	57 13.800	5 39.860	8.5	Cobble/Coarse sand	*Laminaria, Abietinaria,* Red/Brown algae, Hydroids, *Echinus, Delesseria*	
13/06/2012	11	31	09:36:00	57 13.876	5 39.890	10.9	Cobble/Coarse sand	*Laminaria, Abietinaria,* Red/Brown algae, Hydroids, *Echinus,* Starfish	
13/06/2012	12	1	09:43:00	57 13.990	5 39.909	12.5	Cobble/Pebble Coarse sand	*Sparse Laminaria,* Red/Brown algae, *Sertularia, Echinus*	
13/06/2012	13	2	09:48:00	57 13.990	5 39.854	16.5	Rugged bedrock	*Alcyonium, Tubularia, Nemertesia ramosa, Echinus, Crossaster,* Red/Brown algae	
13/06/2012	14	6	09:54:00	57 14.111	5 39.896	13.5	Cobble	Sparse *Laminaria,* Red/Brown algae, *Sertularia, Echinus, Tubularia, Dynamena*	
13/06/2012	15	30 (= 25)	10:04:00	57 13.734	5 39.509	13.5	Cobble/Coarse sand	*Asterias, Echinus, Necora puber*	

13/06/2012	16	24	10:11:00	57 13.730	5 39.557	17	Bedrock/Coarse sand	*Alcyonium, Tubularia, Sagartia, Echinus*	
13/06/2012	17	50	10:24:00	57 14.624	5 38.985	16.6	Bedrock	*Alcyonium, Tubularia*, Red/Brown algae	
13/06/2012	18	48	10:33:00	57 14.606	5 39.315	6.9	Cobble	*Laminaria*, Red/Brown algae, *Dynamena, Alaria?* Hydroids	
13/06/2012	19	45	15:39:00	57 13.753	5 39.720	27	Bedrock?	*Alcyonium, Tubularia*, Fish	
13/06/2012	20	44	15:46:00	57 13.795	5 39.724	28.1	Cobble	*Alcyonium, Tubularia* Seafan? *Sagartia, Echinus*	
13/06/2012	21	28	15:52:00	57 13.801	5 39.696	26.7	Boulders	*Tubularia, Sagartia, Echinus*	
13/06/2012	22	27	15:58:00	57 13.812	5 39.801	23	Bedrock	*Alcyonium, Tubularia, Sagartia, Sertularia*	
13/06/2012	23	46	16:04:00	57 13.830	5 39.688	30	Cobble	*Alcyonium, Tubularia*, Sponge?	
13/06/2012	24	43	16:10:00	57 13.835	5 39.744	28.2	Bedrock	*Alcyonium, Tubularia, Sagartia, Sertularia, Pachymatisma?*	
13/06/2012	25	30	16:16:00	57 13.792	5 39.529	15.6	Coarse sand/Pebble	*Laminaria*	
13/06/2012	26	29	16:29:00	57 13.808	5 39.603	24.9	Cobble/Coarse sand	*Alcyonium*, Encrusting Red algae	
13/06/2012	27	35	16:31:00	57 13.900	5 39.503	14.9	Bedrock/Boulder/Gravel/Coarse sand	Sparse *Laminaria*, Red/Brown algae, *Abietinaria, Desmarestia, Echinus*	
13/06/2012	28	5	16:34:00	57 14.017	5 39.545	19.9	Cobble/Pebble/Coarse sand	Encrusting Red algae, *Pomatoceros, Asterias*	Clip too short
13/06/2012	29	4	16:39:00	57 13.978	5 39.620	26.9	Cobble/Pebble/Coarse sand	Encrusting Red algae, *Pomatoceros, Asterias*	
13/06/2012	30	9	16:47:00	57 14.117	5 39.555	20.5	Cobble/Pebble/Coarse sand	*Alcyonium, Sagartia, Pomatoceros*, Barnacles? Encrusting Red algae	
13/06/2012	31	10	16:56:00	57 14.241	5 39.782	17	Boulder/Cobble	*Alcyonium, Tubularia, Asterias, Echinus, Cancer?*, Sponge? Red/Brown algae	
13/06/2012	32	14	17:02:00	57 14.342	5 39.701	12.9	Cobble	*Tubularia*, Red/Brown algae, *Asterias, Dilsea?*	Clip too short
13/06/2012	33	18	17:09:00	57 14.491	5 39.452	9.1	Bedrock/Cobble	*Laminaria, Delesseria, Dilsea?, Tubularia, Sagartia, Alcyonium*	
14/06/2012	34	42	09:59:00	57 13.871	5 39.755	28	Bedrock	*Tubularia, Sagartia, Alcyonium*	
14/06/2012	35	32	10:08:00	57 13.906	5 39.799	27.2	Bedrock	*Alcyonium, Sertularia, Echinus, Nemertesia ramosa, Asterias*	
14/06/2012	36	47	10:27:00	57 14.114	5 39.740	26.4	Bedrock	*Alcyonium, Tubularia, Sertularia*	Deleted
14/06/2012	37	8	10:34:00	57 14.135	5 39.618	20.8	Cobble/Pebble/Gravel	*Pomatoceros, Sertularia, Alcyonidium*	
14/06/2012	38	11	10:39:00	57 134.224	5 39.661	20.4	Bedrock/ Cobble	*Alcyonium, Tubularia, Sertularia, Sagartia, Henricia*	

14/06/2012	39	15	10:45:00	57 14.335	5 39.547	15.2	Bedrock/Sand	*Alcyonium, Echinus, Tubularia*, various other hydroids	
14/06/2012	40	14 (Repeat) = 16	11:05:00	57 14.348	5 39.712	11.4	Boulder/Cobble	Sparse *Laminaria,Tubularia, Delesseria, Alcyonium*, Encrusting Red algae, Fine Red/Brown algae, Ascidians	
14/06/2012	41	13	11:19:00	57 14.230	5 39.353	7.1	Boulder/Sand	Laminaria, Red/Brown algae, *Chorda filum, Saccharina latissima, Alaria, Desmarestia, Echinus*	
14/06/2012	42	12	11:25:00	57 14.230	5 39.520	15.5	Cobble/Pebble	Sparse *Laminaria*, Encrusting Red algae, Fine Red/Brown algae, *Alcyonium, Echinus*	
14/06/2012	43	17	11:32:00	57 14.340	5 39.296	10	Bedrock?/Cobble	*Laminaria*, Fine Red/Brown algae, Green algae, *Delesseria, Echinus*	
14/06/2012	44	16 (Repeat) = 70	11:37:00	57 14.324	5 39.391	13.4	Cobble	*Laminaria*, Fine Red/Brown algae, Green algae, *Delesseria, Echinus, Alcyonium, Necora*	
14/06/2012	45	20	11:44:00	57 14.495	5 39.102	11.6	Cobble	Fine Red/Brown algae, Alcyonium, *Tubularia, Echinus, Crossaster* (3 knots)	
14/06/2012	46	47	16:26:00	57 13.857	5 39.702	31.7	Bedrock/Boulder	*Alcyonium, Tubularia, Sertularia, Sagartia*	
14/06/2012	47	33	16:32:00	57 13.902	5 39.738	34	Bedrock/Boulder	*Alcyonium, Tubularia, Sertularia, Sagartia*,Sponge, Fish	
14/06/2012	48	34	16:41:00	57 13.886	5 39.645	28.1	Gravel/Coarse sand drifting onto Bedrock	*Alcyonium, Tubularia, Sertularia, Sagartia* (on bedrock only)	
14/06/2012	49	3	16:48:00	57 14.003	5 39.739	35	Bedrock	*Alcyonium, Tubularia, Sertularia, Sagartia, Echinus, Asterias*, Ascidians	
14/06/2012	50	37 (Repeat) = 66	16:57:00	57 13.627	5 39.557	24.3 (-15.0)	Rugged Bedrock	*Alcyonium, Tubularia, Sagartia*, Sponge; (*Tubularia*, Fine Red/Brown algae at shallow depths)	
14/06/2012	51	40 (Repeat) = 67	17:04:00	57 13.501	5 39.408	16.7	Rugged Bedrock	*Alcyonium, Tubularia, Necora*, Fine Red/Brown algae	
14/06/2012	52	51	17:10:00	57 13.391	5 39.577	10	Pebble	*Laminaria*, Red/Brown algae, *Alcyonium, Sertularia, Echinus*, Sponge, Ascidians	
14/06/2012	53	52	17:17:00	57 13.431	5 39.329	20.4	Pebble	*Alcyonium*, Encrusting Red algae, *Asterias, Echinus, Tubularia*, Hydroids, Spurdog?	
14/06/2012	54	53	17:22:00	57 13.442	5 39.151	17.8	Boulder/Cobble	Encrusting Red algae, Red/Brown algae, Green algae, *Tubularia, Alcyonium, Echinus*	
14/06/2012	55	54	17:27:00	57 13.489	5 39.069	10	Cobble?/Sand	Red/Brown algae, Green algae, *Laminaria*	

14/06/2012	56	55	17:33:00	57 13.391	5 39.045	20.2	Cobble/Pebble/Maerl	Encrusting Red algae, Squat lobster	
14/06/2012	57	56	17:39:00	57 13.359	5 39.177	19.3	Pebble/Maerl	Red/Brown algae, *Tubularia, Nemertesia, Asterias*, Squat lobster	
14/06/2012	58	58	17:44:00	57 13.317	5 39.304	14.5	Bedrock/Boulder	Laminaria, Red/Brown algae, *Echinus, Asterias, Alcyonium*, Ascidians	
14/06/2012	59	57	17:51:00	57 13.363	5 39.472	13.1	Rugged Bedrock/Gravel	*Laminaria, Alcyonium, Tubularia, Echinus*	
14/06/2012	60	59	17:56:00	57 13.143	5 39.675	4.3	Pebble/Gravel	*Saccharina latissima, Chorda filum, Desmarestia*, Brittlestar	
15/06/2012	61	49	10:46:00	57 14.622	5 39.107	10	Bedrock/Boulder	*Laminaria, Tubularia*, Red/Brown algae, *Echinus*	
15/06/2012	62	19	10:53:00	57 14.497	5 39.271	16.5	Cobble/Pebble	*Alcyonium, Pomatoceros*, Red/Brown algae, *Tubularia, Sertularia, Sagartia, Asterias, Urticina*, Ascidians	
15/06/2012	63	5 (Repeat) = 69	11:02:00	57 14.009	5 39.524	16.6	Cobble/Pebble	*Alcyonium, Pomatoceros*, Sponge	
15/06/2012	64	60	11:10:00	57 13.853	5 39.837	21.6	Rugged Bedrock	*Alcyonium, Nemertesia, Abietinaria, Marthasterias, Brittlestar, Facelina*, Ascidians	
15/06/2012	65	61	11:16:00	57 13.773	5 39.806	14.5	Bedrock	*Alcyonium, Tubularia, Sertularia, Pomatoceros, Laminaria* (*Alcyonium*/Kelp boundary)	
15/06/2012	66	62	11:22:00	57 13.856	5 39.622	23.9	Coarse sand/Boulder	*Tubularia*, Barnacles	
15/06/2012	67	38 (Repeat) = 68	11:31:00	57 13.636	5 39.417	6.3	Boulder	*Laminaria*,Hydroids, Red/Brown algae, Sponge, *Alcyonium, Pomatoceros, Echinus*	
15/06/2012	68	36 (Repeat) = 65	11:35:00	57 13.637	5 39.704	12.3	Rugged Bedrock	*Alcyonium, Delesseria*	
15/06/2012	69	63	11:31:12	57 13.769	5 39.642	22.1	Bedrock/Boulders	*Tubularia, Sertularia, Alcyonium*, Seal	
15/06/2012	70	64	11:55:00	57 13.872	5 39.837	20.9	Rugged bedrock	*Alcyonium, Nemertesia, Tubularia, Echinus*	

8.3. Appendix 3. List of Taxa recorded

Abietinaria abietina
Alaria esculenta
Alcyonidium gelatinosum
Alcyonium digitatum
Alcyonium digitatum
Ammodytes
Aplidium
Asterias rubens
Brongniatella byssoides
Calliblepharis ciliata
Callionymus lyra
Calliostoma zizyphinum
Callophyllis laciniata
Cancer pagurus
Carcinus maenas
Caryophyllia
Chaetopterus variopedatus
Chorda filum
Cirripedia
Clavelina lepadiformis
Corallina officinalis
Corallinaceae
Corallinaceae (Maerl)
Corynactis viridis
Crossaster papposus
Cryptopleura ramosa
Delessaria sanguinea
Desmarestia aculeata
Dictyota dichotoma
Dilsea carnosa
Diphasia
Drachiella spectabilis
Echinus esculentus
Electra pilosa
Filamentous Brown Algae
Filamentous Green Algae
Filograna
Gibbula cineraria
Halecium
Halichondria
Henricia oculata
Henricia sanguinolenta
Heterosiphonia plumosa
Janolus cristatus
Laminaria hyperborea
Lithopyllum
Lytocarpia myriophyllum
Marthasterias glacialis
Membranipora membranacea
Metridium senile
Munida rugosa

Necora puber
Nemertesia antennina
Nemertesia ramosa
Nitophyllum punctata
Obelia geniculata
Odonthalia dentata
Ophiothrix fragilis
Pachymatisma johnstonia
Pagurus bernhardus
Phoca vitulina
Pholis gunnellus
Phycodrys rubens
Phyllophora
Plocamium cartilagineum
Plumaria plumosa
Pomatoceros triqueter
Porifera
Ptilota gunneri
Ptilota plumosa
Rhodomela confervoides
Rhodymenia
Sabella pavonina
Saccharina latissima
Sagartia elegans
Sertularia
Short faunal turf
Squalus acanthias
Tubularia indivisa
Tubularia larynx
Ulva lactuca
Urticina felina

Kyle Rhea Tidal Stream Array

Appendix 14.1

ROYAL HASKONING

APPENDIX 14.1 Species landings by weight form the RSA

The table below contains a complete list of all recorded species landed from the Regional Study Area between 2006 and 2011. Live weight of landings by species and year is also displayed. The Table is arranged by total landings throughout all years in descending order.

		Landings (tonnes) In Years 2006-2011						
Common name	**Scientific Name**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total landings (tonnes) 2005-2011 inclusive**
Nephrops (Norway Lobster)	*Nephrops norvegicus*	422.51	464.40	400.73	316.96	307.01	299.20	**2210.80**
Scallops	*Pecten maximus*	105.20	103.69	755.59	81.46	81.10	74.85	**1201.89**
Crabs (C.P.Mixed Sexes)	*Cancer pagurus*	173.32	172.26	44.59	60.29	53.56	61.57	**565.59**
Razor Clam	*Ensis ensis*			6.73	50.13	35.28	53.05	**145.19**
Crabs - Velvet (Swim)	*Necora puber*	36.84	26.85	12.31	17.25	23.98	9.43	**126.66**
Sprats	*Sprattus sprattus*						103.94	**103.94**
Mackerel	*Scomber scombrus*						19.73	**19.73**
Lobsters	*Homarus gammarus*	1.23	2.65	1.46	2.66	2.27	0.66	**10.92**
Skates and Rays	*Raja spp*	0.19	1.87	0.92	0.86	0.51	0.49	**4.84**
Witch	*Glyptocephalus cynoglossus*	0.11	0.01	0.02	0.34	0.98	2.93	**4.39**
Haddock	*Melanogrammus aeglefinus*	0.14	0.17	0.14	0.06	0.14	2.83	**3.49**
Monks or Anglers	*Lophiidae*	0.27	0.20	0.19	0.36	0.58	1.31	**2.90**
Queen Scallops	*Aequipecten opercularis*		2.38					**2.38**
Other or mixed Demersal	*Osteichthyes*		0.27	0.85	0.39	0.61	0.10	**2.20**
Spurdog	*Squalus acanthias*	1.72	0.03	0.38		0.03		**2.15**
Hake	*Merluccius merluccius*	0.02	0.08	0.10	0.20	0.65	0.57	**1.61**
Megrim	*Lepidorhombus boscii*		0.06	0.25	0.05		0.76	**1.12**
Green Crab	*Carcinus maenas*	0.15	0.32	0.08	0.03	0.30	0.23	**1.11**
Cod	*Gadus morhua*	0.10	0.25	0.06	0.05	0.23	0.39	**1.09**
Ling	*Molva molva*	0.32					0.58	**0.90**
Cuckoo Ray	*Leucoraja naevus*					0.01	0.52	**0.53**

Common name	Scientific Name	Landings (tonnes) In Years 2006-2011 2006	2007	2008	2009	2010	2011	Total landings (tonnes) 2005-2011 inclusive
	(previously Raja)							
Plaice	*Pleuronectes platessa*	0.00	0.01	0.03	0.01	0.16	0.29	**0.51**
Thornback Ray	*Raja clavata*					0.04	0.42	**0.45**
Squid	*Loligo spp*			0.02		0.14	0.29	**0.45**
Spotted Ray	*Raja montagui*					0.02	0.36	**0.38**
Common Prawns	*Palaemon serratus*				0.27	0.08		**0.35**
Whiting	*Micromesistius poutassou*	0.13					0.18	**0.31**
Shrimps - Other	*Crangon crangon*			0.03	0.17			**0.20**
Saithe	*Pollachius virens*				0.14			**0.14**
Pollack	*Pollachius pollachius*			0.14				**0.14**
Lemon Sole	*Microstomus kitt*	0.04	0.03			0.00	0.03	**0.10**
Periwinkles	*Littorina spp*				0.09			**0.09**
Other Flatfish	*Pleuronectiformes*		0.06			0.02		**0.08**
Brill	*Scophthalmus rhombus*			0.01			0.02	**0.03**
Blonde Ray	*Raja brachyura*					0.03		**0.03**
Turbot	*Psetta maxima*					0.00	0.02	**0.02**
Crawfish	*Palinurus spp*	0.00		0.00	0.01	0.00		**0.02**
Sole	*Solea solea*						0.01	**0.01**
John Dory	*Zeus faber*					0.01		**0.01**
Mixed Squid and Octopi	*Loliginidae, Ommastrephidae*					0.01		**0.01**
Whelks	*Buccinum undatum*	0.01						**0.01**
Risso S Smoothhead	*Alepocephalus rostratus*						0.01	**0.01**
Halibut	*Reinhardtius hippoglossoides*						0.01	**0.01**
Blue Ling	*Molva dypterygia*		0.01					**0.01**

		Landings (tonnes) In Years 2006-2011						
Common name	Scientific Name	2006	2007	2008	2009	2010	2011	Total landings (tonnes) 2005-2011 inclusive
Gurnard and Latchet	*Triglidae*					0.003		**0.00**
Unid DS Squal Sharks & Dogfish	*Squalidae*					0.001		**0.00**
Grand Total		**742.30**	**775.56**	**1224.60**	**531.78**	**508.09**	**634.78**	**4417.11**

Kyle Rhea Tidal Stream Array

Appendix 14.2

APPENDIX 14.2 Fish and shellfish species present within the wider region

The following table contains a list of species known to occur throughout the wider region (West Coast of Scotland) on the basis of fisheries landings data and the findings of the Marine Renewables SEA (Faber Maunsell, 2007).

Shellfish	Fish	Fish	Elasmobranches and Anadromous fish
Crustaceans	Cod *Gadus morhua*	Sea bream *Spondyliosoma cantharus*	Elasmobranches
Lobster *Homarus gammarus*	Ling *Molva molva*	Bass *Dicentrarchus labrax*	Spurdog (Squalus acanthias)
Nephrops *Nephrops norvegicus*	Whiting *Merlangius merlangus*	Hake *Merluccius merluccius*	Lesser spotted dogfish (Scyliorhinus canicula)
Squat lobster *Galathea squamifera*	Mackerel *Scomber scombrus*	Gurnards *Triglidae spp*	Basking shark (Cetorhinus maximus)
Crawfish *Palinurus elephas*	Sandeels *Ammodytes spp.*	Dab *Limanda limanda*	Porbeagle (Lamna nasus)
Edible crab *Cancer pagurus* *	Sprat *Sprattus sprattus*	Turbot *Psetta maxima*	Tope(Galeorhinus galeus)
Green crab *Carcinus maenas*	Pollack *Pollachius pollachius*	Dover sole *Solea solea*	Thornback Ray (Raja clavata)
Velvet crab *Necora puber*	Plaice *Pleuronectes platessa*	Lemon sole *Microstomus kitt*	Common skate (Dipturus batis)
Spider crab *Maja verrucosa*	Saithe *Pollachius virens*	Megrim *Lepidorhombus whiffiagonis*	Anadromous Fish
Brown shrimp *Crangon crangon*	Haddock *Melanogrammus aeglefinus*	Conger eel *Conger conger*	Salmon (Salmo salar)
Molluscs	Norway pout *Trisopterus esmarkii*	Herring Clupea harengus	Sea trout (Salmo trutta)
King scallop *Pecten maximus*	Flounder *Platichthys flesus*	Atlantic halibut *Hippoglossus hippoglossus*	sea lamprey Petromyzon marinus
Queen scallop *Aequipecten opercularis*	Monkfish (angler) *Lophius piscatorius*	Red gurnard *Aspitrigla cuculus*	river lamprey Lampetra fluviatilis
Razor clam *Ensis ensis*	Witch *Glyptocephalus cynoglossus*	Brill *Scophthalmus rhombus*	allis shad Alosa fallax
Horse mussel *Modiolus modiolus*	Striped red mullet *Mullus surmuletus*	Long rough dab *Hippoglossoides*	

Shellfish	Fish	Fish	Elasmobranches and Anadromous fish
		platessoides	
Mussel *Mytilus edulis*¤	John dory *Zeus faber*		
Cockle *Cerastoderma edule*			
Native oyster *Ostrea edulis*			
Squid *Loligo spp.*			
Whelk *Buccinum undatum*			
Common periwinkle *Littorina littorea*			
Spiny Lobster Palinurus elephas			

* Identified as potentially present during the benthic survey

Kyle Rhea Tidal Stream Array

Appendix 15.1

APPENDIX 15.1 Kyle Rhea - Marine Current Turbines - Commercial Fisheries Questionaire

Questionaire widely distributed to all local fishermen's associations, SFO, NNWFA & WoSFPO, copies available for collection and submission at Mallaig and Kyle harbour office.
Summer 2012
5 completed repsonses.

		Response 1		Response 2		Response 3		Response 4		Response 5
Length	17m		16.7m		16.09		10.4		18m	
Vessel Age	32 yr		4 yr		40 yr		60 yr		52 yrs	
Power (kW)	250		355		270		120 BHP		197.7	
Registered tonnage (GT)	70		105		66		52 (?)		47	
Draught (m)	2m		3.7		2.32		1.9		9' - 10' (3m?)	
Home port	Mallaig		Mallaig		Mallaig		Kyleakin		Mallaig	
Gear	Twin Rig Trawl		Twin rig trawl		Twin Rig Trawl		Creel		Dredge	
For static gear only	**Number of fleets**	n/a	**Number of fleets**	n/a	**Number of fleets**	n/a	**Number of fleets**	14	**Number of fleets**	n/a
	Creels per fleet	n/a	**Creels per fleet**	n/a	**Creels per fleet**	n/a	**Creels per fleet**	50	**Creels per fleet**	n/a
Membership / representation	**Producer Organisation**	Y	**Producer Organisation**	Y	**Producer Organisation**	Y	**Producer Organisation**	N	**Producer Organisation**	Y
	Please state which?	WSFPO	**Please state which?**	WSFPO	**Please state which?**	West Coast PO	**Please state which?**		**Please state which?**	SFO
	Fishermen's Association	Y	**Fishermen's Association**	Y	**Fishermen's Association**	Y	**Fishermen's Association**	N	**Fishermen's Association**	Y
	Please state which?	Mallaig & NW	**Please state which?**	Mallaig & NW	**Please state which?**	Mallaig & NW	**Please state which?**		**Please state which?**	Mallaig & NW
No. Crew (inc. skipper)	5		4		4		2		4	
Approx no. fishing days per year	200		180		200		230		185 days	
% fishing areas	15% in Sleat, hourn & Nevis		70-80% in other areas		no info provided		6.6% within Kyle Rhea Narrows, 13% North of narrows, 13% south of narrows, 6.6% elsewhere in Loch Duich, Loch Alsh or Inner sound, 53% Elsewhere in sound of sleat, loch hourn, loch nevis, 6.6% Beyond ICES rectange 43E4		tow 1 - 2 weeks per year to north of narrows and 1-2 weeks per year to south of narrows. This is typically in early April or late September. Around 4 weeks per year elsewhere in sound of sleat, loch hourn and and loch nevis.	
Target species	Prawn (nephrops)		Prawn (nephrops)		no info provided		Crab & Lobster in narrows, prawn elsewhere		scallops	

	Response 1	Response 2	Response 3	Response 4	Response 5
No. Kyle Rhea Transits p/a	Regular	10 times p/a to reach east coast	no info provided	Does not state, but around 2 thirds of time spent south of narrows - which would equate to over 150 days per year	30 each way.
Comments	no info provided	"So long as they don't encroach on fishing grounds, bring it on"	no info provided	"May affect tidal flow and navigation hazard. Other than that - good idea. Please inform me of developments	no info provided

Questionaire circulated to:
Local Non-affilated Fishermen's representative
Skye & LochalshFishermen's Asscoaition
Scallop Association
Mallaig & NW Fishermen's Association
West of Scotland Fish Producers Organiisation
NW IFG members
Small Isles & Mull IFG members
Mallaig Harbour
Kyle Harbour
Scottish Fishemen's Organisation
Scottish Fishermen's Federation

Kyle Rhea Tidal Stream Array

Appendix 15.2

Background to Commercial Fishing in the Kyle Rhea Area

Drafted by	T. D. Southall
Checked by	Gemma Keenan and Frank Fortune
Date/initials check	…12/12/12……… …FF……………….
Approved by	Frank Fortune
Date/initials approval	…12/12/12……… …FF……………….

APPENDIX 15.2 BACKGROUND TO COMMERCIAL FISHERING IN THE KYLE RHEA AREA

Introduction

This appendix has been prepared to support Chapter 15, Commercial Fisheries of the Kyle Rhea Tidal Stream Array (the Project) Environmental Statement. The Appendix provides information regarding: the key species targeted in the region, the main fishing methods used to target those species and a brief overview of fleet economics.

Key species featuring in the landings data.

A number of species were identified during the compilation of the commercial fisheries baseline as being important to the regional fisheries. These are termed 'Key species' and information about the ecology and biology of these species is provided below.

Nephrops

Nephrops is a key species fished within the wider region (i.e. 43E4), alongside lobster, scallops, clams (including razor clam) and crabs (velvet and brown).

Nephrops is a crustacean commonly found sublittorally (from 20 – 800m) on soft muddy sediments throughout the North East Atlantic. Nephrops has a planktonic larval phase, lasting six to eight weeks prior to post-larvae settlement on a mud substratum. Once settled they dig burrows, or enter existing burrows. Juveniles typically remain within burrows for anything up to a year. Adults emerge from burrows to feed on a varied diet of benthic fauna. Representatives of most invertebrate phyla have been found in their foregut, although small crustaceans and molluscs and to a lesser extent polychaetes and echinoderms tend to dominate the diet. Nephrops is also able to sustain itself as a suspension feeder when in burrows.

Although by burrowing, nephrops has some protection from predation, it is still preyed upon, not least when emerging from burrows to feed, by species of fish such as cod, dogfish and rays. The dynamic of this predator prey relationship is thought to impact on overall population dynamics.

Females become sexually mature at around three years (carapace length approximately 20-23 mm) and when ovigerous (eggbearing or 'berried') carry 1000 to 5000 eggs attached to the underside of the abdomen, for about eight or nine months.

There is no evidence of migratory behaviour and although capable of swimming, most movement is by crawling. However planktonic larval dispersal plays a key role in the species distribution pattern. Nephrops in different areas grow at different rates and mature at different sizes, perhaps related to density of animals and sediment type.

Scallops

King scallop (thereafter scallop) is a bivalve shellfish, with ribbed, fan-shaped shell. Scallops grow to about 150 mm in diameter and are considered to be of reasonable commercial size from about 100 mm upwards. Scallops are sedentary filter-feeding bivalves (although capable of swimming limited distances using jets of water) found just below the low water mark to depths of 180 metres or more, typically in shallow recesses of sand, gravel and mud, even where these occur in patches between rocks or stones.

Scallop is a hermaphrodite. The roe ripens during the winter months, with spawning occurring generally in late spring. Fertilisation takes place in mid-water and tiny free-swimming larvae develop from the fertilized eggs and after drifting in the currents, attach with sticky threads to seaweeds, hydroids and bryozoans. After a time the tiny scallops (around 10mm) leave the weed to lie in shallow depressions in the sea bed with their flat shell valve uppermost and just level with the surface. A second spawning takes place during generally late summer.

Scallops feed by filtering microscopic planktonic organisms from the sea water. Mature scallops are not subject to substantial predatory pressure but are preyed upon by some benthic fauna such as the common starfish *Asterias rubens* and edible or brown crab *Cancer pagurus*. Scallops are most subject to predation in juvenile life stages, where prey species would include flat fish.

Brown crab

Brown or edible crab *Cancer pagurus* is a crustacean widely distributed in Britain and Ireland, found on bedrock including under boulders, mixed coarse grounds, and offshore in muddy sand. Occurs on the lower shore, shallow sublittoral and offshore to about 100m.

Brown crab is not restricted by quota, although crab has a minimum EU landing size of 140 mm. In the study region crabs are typically caught by creel fisheries.

Lobster

Lobster *Homarus gammarus* is a widely distributed crustacean in British coastal water, found on rocky substrata, living in holes and excavated tunnels from the lower shore to about 60 m depth. Lobsters live for at least 20 and possibly to 50 years of age and recruit to the fishery probably between ages 4-8 years. Eggs are carried externally from September to April-May when hatching occurs. Lobster larvae swim freely for about 30-40 days, mainly close to the surface where they can be preyed upon by seabirds and fish before settling onto an appropriate seabed habitat. Juveniles or adult lobsters do not undertake any significant migrations and juveniles in the first 3-4 years of life maybe particularly sedentary.

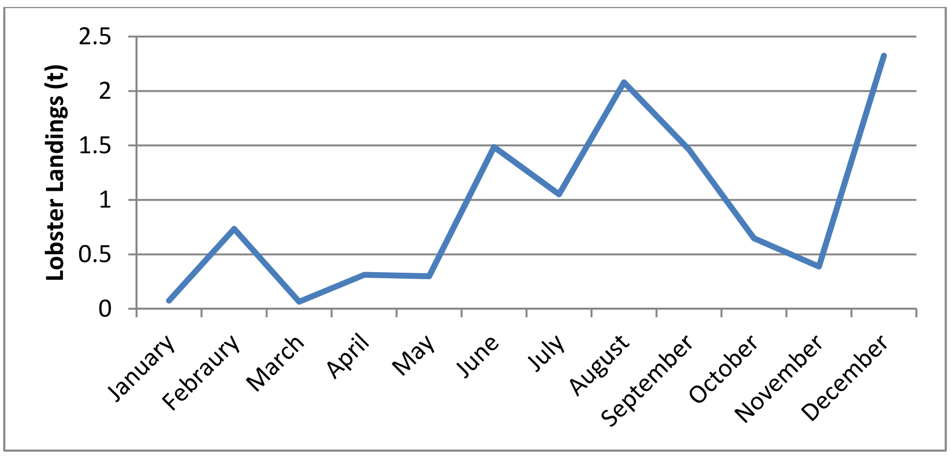


Figure 3: Seasonality patterns in the lobster fishery in 43E4

The seasonality pattern of the lobster fishery (**Figure 3**) shows the pre-Christmas importance of this fishery when market demand and price both increase.

Lobster are not restricted by quota although they have a minimum EU landing size of 87 mm. In the study region lobster are typically caught by creel fisheries. There are no additional management measures such as lobster v-notching byelaws in the wider region.

Other locally important species

Razor fish (or razor shell or razor clam) (*Ensis arcuatus*) is a burrowing bivalve mollusc with an elongated shell. Living in coarse sand, held down by a powerful muscular foot and protrude a siphon from burrows when covered to filter feed. Can be fished by mechanical or suction dredge. Often sold for bait.

Velvet crab (*Necora puber*) is a fast moving swimming crab found on stony and rock substrata intertidally and in shallow water, most abundant on moderately sheltered shores. Widely distributed in the UK and Ireland.

Velvet crab are not restricted by quota although they have a minimum EU landing size of 65 mm. In the study region velvet crabs are typically caught by creel fisheries and are exported live to Europe in vivier trucks.

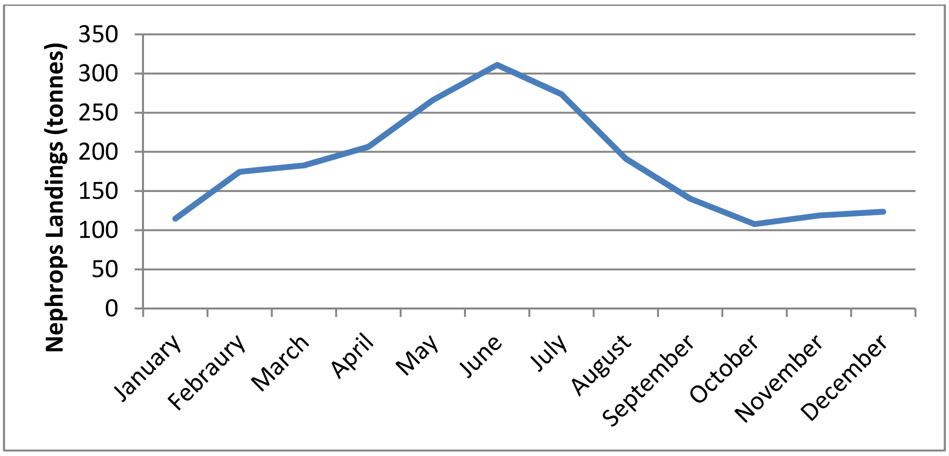


Figure 4 Seasonal patterns of Nephops landings from 43E4.

The nephrops fishery is restricted by quota and minimum landing size, and (for larger vessels) effort restriction. However, in practice much of the fishing in 43E4 by creel is only affected by the minimum landing size.

Figure 4 shows the seasonality in the fishery, with landings peaking in the summer months; a reflection of the fewer days lost to creel fishermen due to bad weather and perhaps more significantly the fact that the waters of the inner sound are open to mobile gears.

Main fishing activities within the region of the Project

The two most common fishing methods used in and around Kyle Rhea are creel fishing and scallop dredging. Information about these activities is provided below.

Creel fishing

Creel fishing or potting was identified as the only form of fishing that occurs within the vicinity of the Project site. Further detail on this practice is provided below.

Traditionally any fleets of pots set within Kyle Rhea would have been hauled by hand but today even the smallest commercially operating boats are equipped with hydraulic haulers. Some vessels are also fitted with a chute to guide the newly baited pots back over the boats stern when shooting the gear (this may also be employed to facilitate single handed fishing). Occasionally gear may be lost, particularly after prolonged periods of poor weather, or if gear becomes entangled with passing shipping or mobile fishing gears.

Small inshore potting vessels, which make short daily fishing trips, are typically less technologically equipped than their larger cousins in the demersal or, in particular, the pelagic fleet. Fish finding sonar is of little value for shellfish species targeted with static gear. Echo sounders and GPS have been common for many years but more recent advances allows data from the echo sounder to be used to build up a more comprehensive map of the seabed, which can be presented on the GPS chart plotter, thus providing the fishermen with a more detailed self-surveyed seabed chart. The position of fleets can readily be plotted on the electronic chart, meaning that fishermen can increasingly target particular seabed features, such as crevices, with static gear.

Scallop fishing

Scallops are caught using mobile gear-toothed spring-loaded dredges. The dredge consists of a triangular frame leading to a mouth opening 0.83m wide, a tooth bar with a distance of 65 mm between teeth, length of teeth of approximately 8-10 cm long, and a bag of steel rings (75 mm internal diameter) and netting back (75 mm stretched mesh). The tooth bar rakes through the sediment lifting out scallops and the spring-loaded tooth bar swings back, allowing the dredge to clear obstacles on the seabed. The compression in the springs changes and is set up in order to work in stony grounds and to reduce incidence of stones in the dredge. The dredges are held in series on two beams, which are fished on each side of the vessel.

Fleet economics

The following figures (both in the text and in **Table 1**) on fleet economics are taken from the 2009 Economic Survey of the UK Fishing Fleet conducted by Seafish. At the time of writing these are the most up to date fleet economic estimates for UK national fleet sectors. The economic performance of the UK fleet are estimated for some 35 different UK fleet sectors. Of these, summary figures for 5 fleet sectors most relevant to the vessels operating closest to Kyle Rhea are reproduced here. It should be noted however, that these summary estimates are largely based on vessel licensing numbers, landings records combined with operating costs based on surveys of skippers and vessel owners. Although for the nephrops trawl fleet, this is geographically restricted to the west of Scotland (WoS), for the pots and traps fishery the figures are based on UK averages, so may be less accurately reflective of the local situation.

This shows that the under 10m pot and trap fishery has the highest net profit as a percentage of income, of the 5 fleet sectors which fish closest to Kyle Rhea. This is also the sector that is most likely to be fishing closest to the development site or routinely transiting the narrows. This implies that the sector is relatively resilient.

Table 1: Summary of typical (fleet average) key costs and earnings of commercial fishing vessels operating in and around the wider region.

	West of Scotland nephrops		North Sea & West of Scotland	Pots & Traps	
	> 250kW	< 250kW	scallop dredge	10 -12m	<10m
Average no. Days at sea	187	163	160	179	113
Average Crew Size	4	3	4	5	2
Average Annual Landings (t)	119	59	153	194	19
Average Annual Landings (£)	£221,283	£120,229	£265,767	£248,017	£44,280
Total Income	£227,289	£129,568	£278,099	£290,058	£46,864
Total operating costs	£219,953	£99,134	£219,102	£222,009	£28,566
Operating Profit	£7,336	£30,435	£58,997	£68,049	£18,297
Net Profit	-11,727	18,664	40,893	54,901	12,946
Net profit as % of income	-5%	14%	15%	19%	28%

Kyle Rhea Tidal Stream Array

Appendix 16.1

Memo

To	Robert Main (Marine Scotland), Colin Wishart (Highland Council) and Chris Leakey (SNH)	Date	12 August 2012
From	Simon Myers	Project No	JE30605
Copy	Joseph Kidd (MCT), Cara Donovan (MCT), Gemma Keenan (Royal Haskoning)		
Subject	**Proposed Tidal Stream Turbines Array, Kyle Rhea, Scotland; Scope of Seascape, Landscape and Visual Assessment**		

1. Introduction

SKM Enviros (managed by Royal Haskoning) has been commissioned by Sea Generation Kyle Rhea Ltd. (Marine Current Turbines) to prepare the Seascape, Landscape and Visual Impact Assessment (SLVIA) for a proposed array of marine current turbines to be positioned within Kyle Rhea. Sea Generation Kyle Rhea Ltd. has undertaken a thorough evaluation of the resource potential against technical, commercial and environmental criteria. Based on these criteria, the proposed site has been identified as being appropriate for the proposed marine current turbine development.

This note has been prepared to highlight the key aspects of the scope of the assessment to be considered as part of the Seascape, Landscape and Visual Impact Assessment (SLVIA). These points are based on an analysis of the proposed development, its context and the feedback received from The Highland Council and Scottish Natural Heritage in relation to the original scoping exercise. The key elements outlined in the note are as follows:

- An outline of the proposed development;
- Overview of approach to the assessment including;
  - Documents and guidance that will be referred to in the preparation of the assessment;
  - Proposed study area;
- Assessment of potential seascape/landscape impacts, including:
  - Key designations;
- Assessment of potential visual impacts, including:
  - Proposed viewpoints;
  - Approach with regard to visualisations; and
- Summary.

The proposed development would comprise a maximum of four turbines, which would be located as shown in Figures 1a, 1b and 1c. The visible component of the proposed structures would typically comprise a tower on top of which would be a platform, railings, small crane etc. The attached draft installation drawing provides further detail in relation to each turbine (please note that this drawing is draft and the actual dimensions may vary slightly from those shown). The normal maximum exposed height of each turbine above sea level is expected to be 15.7m, although clearly this would vary with the tide. The form of the structure and maximum height would change during periods of maintenance, with the lift legs raising to

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approximately 36m and the cross beam and turbines coming above the water. However, such periods would only occur occasionally and be relatively short in duration. It is anticipated that the turbines will be yellow in colour and lit at night (in conformance with guidance from Trinity House and International Association of Marine Aids to Navigation and Lighthouse Authorities (IALI) (IALA Recommendation O-117 On The Marking of Offshore Wind Farms, Edition 2, December 2004) to ensure that they are conspicuous to marine traffic. A draft installation drawing has been included with this note to provide more detail in relation to the proposed turbines.

Indicative photomontages for the turbine array (prepared as part of initial work on the proposed development) have also been included to provide an indication of the location and scale of the proposed turbine array. Please note that they have been included for information only (and should not be distributed) and the proposals are likely to vary in terms of location, height and colour. In addition, the photomontages that will be prepared as part of the SLVIA will be presented to conform with relevant guidance (as set out in this note). However, it is considered that the photomontages that are included with this note provide useful information to help inform the scope of the assessment.

The grid connection would be on the western side of Kyle Rhea, with the offshore connection to the substation being directionally drilled from below the water to the electricity substation i.e. there would be no works or connection pit on the shoreline. It is anticipated that the substation would be positioned between the otter hide and the forestry commission car park to the south, and is currently proposed to be located at/near the current toilet block. The detail of the substation is still being considered, however it is currently envisaged that the maximum dimensions of this structure will be 6m by 3m by 3m (height).

The connection from the substation to the local electricity transmission network would be subject of a separate application in the future. It is anticipated that cabling would be buried, following the alignment of existing tracks/roads (within or alongside) to the nearest 11kv line and then the existing 11kV line would be re-strung with 33kV cable.

2. Overview of Approach

Following the Landscape Institute’s Guidelines, landscape (and seascape) impacts are defined as relating to changes in the fabric, character and quality of the landscape as a result of the proposed development. Visual impacts relate to changes in the available views of the landscape and are therefore impacts on people and their perceptions.

The SLVIA will examine the potential impacts of the proposed development on the seascape/landscape and visual amenity within the agreed study area. It will be based on relevant and accepted guidance, and will draw on information provided by statutory consultees, current landscape planning policies and other relevant documentation, a computer based visibility analysis and fieldwork observations.

The general approach to the SLVIA would include the following key tasks:

- Confirmation of scope and approach with representatives of The Highland Council and Scottish Natural Heritage;
- Desk study;
- Site Survey;

- Baseline visual assessment;
- Baseline landscape assessment;
- Mitigation and design optimisation options;
- Landscape and visual assessments including cumulative assessment; and
- Reporting.

The SLVIA methodology will be based in accordance with best practice and relevant guidance. It will also draw on published information and analysis available for the site and study area (e.g. landscape character assessments). The following provides an outline of the key document likely to be used in the preparation of the assessment:

- Skye and Lochalsh Landscape Assessment (SNH, 1996);
- Scottish Marine Renewables SEA, Environmental Report Section C SEA Assessment: Chapter C19: Seascape Assessment (Scottish Executive 2007);
- An assessment of the sensitivity and capacity of the Scottish seascape in relation to windfarms (SNH, 2005);
- Landscape Character Assessment: Guidance for England and Scotland (The Countryside Agency and SNH, 2002);
- Guidelines for Landscape and Visual Assessment (Landscape Institute and Institute of Environmental Assessment 1995 and 2nd Edition 2002);
- Guidance on Landscape/Seascape Capacity for Aquaculture (SNH, 2008)
- Guide to Best Practice in Seascape Assessment (Countryside Council for Wales, Brady Shipman Martin and University College Dublin, 2001);
- Seascape and Visual Impact Assessment Guidance for Offshore Wind Farm Developers (DTI, 2005);
- Visual Assessment of Wind Farms Best Practice, (SNH 2002);
- Visualisation Standards for Wind Energy Developments (The Highland Council, January 2010); and
- Photography and photomontage in landscape and visual impact assessment, Landscape Institute Advice Note 01/11 (Landscape Institute, 2011).

A Zone of Theoretical Visibility (ZTV) has been prepared for the proposed array of turbines. In order to provide a comprehensive and detailed indication of the likely visibility this is presented at three scales in Figures 1a, 1b and 1c. Initial analysis of the ZTV identifies that potential visibility will initially be focussed within and defined by the landforms either side of Kyle Rhea. There would also be visibility associated with higher ground to the east and west, but the key publically accessible locations are likely to be on lower slopes. To the north and south the footprint of the ZTV splays outwards, as the channel widens. Much of this part of the ZTV comprises open water prior to reaching the shoreline. The position of the proposed array of turbines within the channel results in greater potential visibility to the south than the north. Long distance views would be possible from certain elevated locations to the south and north, but these would be at distances over 3km or 6km respectively.

To calculate the zone of theoretical visibility (ZTV) a digital terrain model is required to represent the level of the ground in the area of interest. Ordnance Survey Profile data has been obtained for a rectangular area approximately 10km in each direction from the proposed

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turbine array. OS profile data comprises of a 10m grid of spot heights and has a stated vertical accuracy of +/- 2.5m. The DTM was generated by using the spot heights to create a Triangular Irregular Network (TIN) which was then converted to a raster DTM. The ZTV was produced from the turbine locations and the DTM layer using the Viewshed tool in available in ESRI's ArcGIS.

Turbine locations were provided in the Universal Trans Mercator 30N map projection which uses the WGS 1984 datum. As the Ordnance survey base maps and Profile data use the British National Grid as their map projection which is based on the OSGB 1936 datum, it was necessary to transform the turbine locations into British National Grid. This transformation was undertaken using the OSGB 1936 to WGS1984 Petroleum transformation.

The specifications for the ZTV analysis were that the maximum level of the turbine should be 13.05m above Ordnance Datum (AOD) and that the observer height should be 1.75m. The digital terrain model (DTM) used in this analysis records that the level of the level of the surface is -1 m AOD in the turbine locations. Therefore, the height of the turbine has been set as 14.05m in order to return a level of 13.05m AOD. Please note that the draft drawing included showing the turbine details requires minor adjustments and does not quite correspond to the detail described in this paragraph.

Given the focus of potential visibility and the scale of the proposed structures it is proposed to concentrate the assessment on a study area extending to 5km from proposed array. However, it is recognised that sensitive landscape and visual receptors lie beyond this 5km area. Therefore, to demonstrate the potential impacts in relation to such locations, it is proposed to include viewpoints beyond the 5km area to the north and south.

3. Assessment of Potential Seascape/Landscape Impacts

The assessment of potential seascape and landscape impacts would be focussed within the 5km study area. A character assessment will establish the baseline landscape conditions, and examine the sensitivity of the context of the array location and surrounding study area to change associated with the proposed development.

The seascape/landscape assessment will use the existing landscape character assessments to establish the existing baseline landscape character of the study area and identify distinct landscape character types. The location, use, seascape/landscape elements, scale, nature of views and seascape/landscape quality of distinct seascape/landscape character areas will be described. Their sensitivity to change in relation to the proposed development will then be evaluated. The assessment will then describe the resulting change on the character unit receptor and indicate the nature of the impact and its significance.

Landscape Planning Considerations /Landscape Designations

The SLVIA will take into consideration the potential impacts of the Proposal on relevant national and local landscape designations. Analysis of national and local designations has identified that the site for the proposed development does not lie within and national or local landscape designation. The key landscape designations that lie closest to the proposed development are Knoydart, Kintail and The Cuillin Hills National Scenic Areas (NSA). The closest of these is Knoydart the boundary of which lies approximately 6.5km to the south. The closest parts of Kintail and The Cuillin Hills lie approximately 7km to the east and 16km to the west respectively. Analysis of the terrain and ZTV suggests that the proposed array would only be visible from the Knoydart NSA. There will be no, or extremely limited visibility from Kintail and The Cullin Hills, and the separation distance will also severely limit any potential impacts. Therefore the assessment would only consider potential impacts on the Knoydart NSA.

Analysis of the Proposals Map for the Highland Wide Local Development Plan (adopted 5th April 2012) identifies that the majority of land to either side of Kyle Rhea is defined as being of local/regional importance. However, Kyle Rhea itself is of international importance. The wider landscape varies, with land to the west of Kyle Rhea (on the Isle of Skye) being of international importance, particularly the elevated ground. The land to the east of Kyle Rhea is typically of local/regional importance, with some of the elevated land being designated as wider countryside. There are areas of national importance to the east and south of Kyle Rhea, with larger areas coinciding with the NSA. The key policy of the Highland Wide Development Plan is Policy 57. This covers the protection of Natural, Built and Cultural Heritage that are identified as being or local/regional, national or international importance from changes associated with development proposals, with the level of protection afforded by the policy increasing with the defined importance.

It is also noted that the Vision and Spatial Strategy for the West Highlands and Islands (Figure 2 within the Highland Wide Local Development Plan) suggests that Kyle Rhea forms a "renewable resource". There appears to be no other reference to this renewable energy resource within the Development Plan, with the exception of general comments in relation to the opportunities that renewable energy offers for economic diversification. The same diagram also identifies a "national/strategic footpath/cycleway" along the northern side of Loch Hourn, eastern side of the Sound of Sleat and crossing Kyle Rhea at the ferry crossing. However, no sources making reference to this long distance route can be found, therefore it is unclear if this is an aspiration rather than an established route.

The Inventory Gardens and Designed Landscapes has been consulted. This has identified that there are no gardens or designed landscapes (included in the inventory) within the proposed 5km study area. Two gardens and designed landscapes have been identified in the wider area; Balmacara Estate (Lochalsh Woodland Garden) and Kyle House, located approximately 5.8km to the north and 6.7km to the north west respectively. Analysis of the ZTV identifies that the proposed array of turbines would not be visible from either of these Gardens and Designed Landscapes. The very limited visibility of the proposed development and the separation distance between the array and these historic landscapes means the likely impact will be limited. It is proposed to include them in the assessment to provide context, but it is not anticipated that they will be assessed in detail.

4. Assessment of Potential Visual Impacts

The visual assessment will be based on:

- The analysis of the ZTV for the proposed development; and
- Views from agreed viewpoints representing sensitive receptors within the surrounding area at a range of distances and directions from the proposed development.

The assessment will involve desk study, field observations and the preparation of computer generated wireframes/photomontages for the viewpoint assessment. It is also proposed to photograph certain viewpoints at night to record the baseline condition in order to evaluate the potential impact associated with lighting.

The viewpoint assessment will be carried out to determine the effect of the proposed development on specific receptors and viewpoints in the study area. In addition it is proposed to include a viewpoint at greater distances to demonstrate potential visual impacts within the wider area. Six potential viewpoints have been identified for inclusion in the assessment following the production of the ZTV, analysis of Ordnance Survey maps and initial fieldwork. These represent a range of views at different distances and directions, as well as reflecting different receptors. The viewpoint are shown on the figures showing the ZTV and the Table 1 outlines that proposed location, comments (including reasons for inclusion) and the type of visualisation expected to be prepared.

Table 1: Proposed Viewpoints

No.	Location	Approx. Distance	Comments	Visualisation
1	Kyle Rhea ferry crossing, west side	290m	Representative of people crossing Kyle Rhea, also in close proximity to a residential receptor.	Photomontage
2	Kyle Rhea ferry crossing, east side	330m	Representative of people crossing Kyle Rhea, also in close proximity to a residential receptor. Night time photography also proposed.	Photomontage
3	Otter hide	610m	Representative of people visiting the otter hide.	Wireframe
4	Glenelg	2.9km	Representative of views from the village. Night time photography also proposed.	Wireframe
5	Road between Glenelg and Arnisdale	4.2km	Representative of views seen by road users. Also a relatively elevated location, close to the edge of the Knoydart NSA.	Wireframe
6	A87 at Reraig	6km	Key route to/from the Isle of Skye. Also a marked viewpoint on Ordnance Survey Maps. Night time photography also proposed.	Wireframe

It is important to note that the viewpoints locations identified are indicative at this stage and will be micro-sited on the ground. We do not propose to include any offshore viewpoints in the assessment as the land based views will provide a good indication of the potential impacts.

The sensitivity of each viewpoint and the magnitude of predicted change arising from the proposed development will be assessed. An assessment of significance of residual visual impact will then be undertaken.

The existing and predicted view of the proposed development will be described and illustrated using photographs with either matching wireframe views, or photomontage visualisations. A camera equivalent to a 35mm camera with a 50mm lens will be the chosen format for shooting the viewpoint panoramas, which is generally endorsed by the relevant as the most suitable focal length for assessment and photomontage production. Best endeavours will be made to ensure the condition are ideal for viewpoint photography.

The changing tidal conditions present challenges for the production of visualisations. The tower associated with each turbine is fixed, therefore a different proportion of the turbine would be seen depending on the prevailing tide. As it will not be practical to time good weather, sun position and low tide (to maximise the proportion of the turbine visible) it is suggested that the photomontages present as realistic scenario as possible. Wireframe will be presented based on the correct height of the structures above the terrain model.

Assessment of visual impacts at viewpoints will be determined based on the combination of visual receptor sensitivity and magnitude of change caused by the proposed development. The significance of the visual impacts at the chosen viewpoint will then be presented in the assessment.

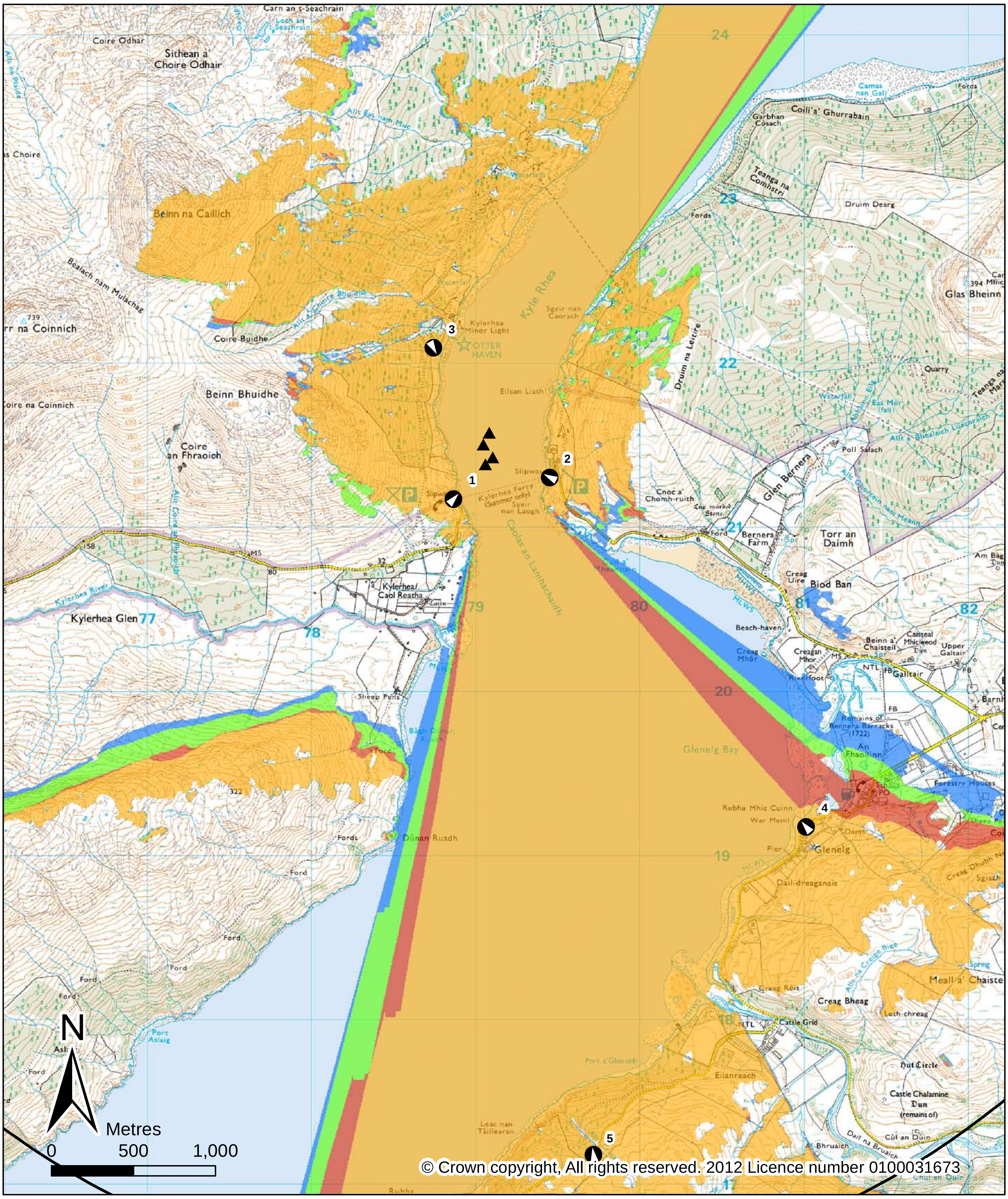
5. Cumulative Assessment

An initial review of the proposed development in relation to its context has not identified any similar developments that are likely to result in cumulative impacts in conjunction with the proposed development. Other tidal projects with an Agreement for Licence with the Crown Estate would be considered in the assessment.

6. Summary

The SLVIA will establish the seascape, landscape and visual baseline conditions using a combination of desk based studies and field studies. The sensitivity to change of receptors identified within the proposed study area and magnitude of the change to the baseline conditions, as a result of the proposed development, will be predicted and the significance of these changes assessed. The SLVIA will therefore summarise the seascape, landscape and visual changes identified in the detailed assessment, and judgement exercised on the acceptability of the proposed tidal stream turbines.

We welcome your comments on the scope of the SLVIA.



KEY

- Viewpoints
- Turbine Locations
- 5 km buffer
- 1 Turbine visible
- 2 Turbines visible
- 3 Turbines visible
- 4 Turbines visible

Notes: ZTV is based on a maximum turbine level of 13.05m aOD and an observer height of 1.75m. The digital terrain model (DTM) used in this analysis records that the level of the level of the surface is -1 m aOD. Therefore the height of the turbine has been set as 14.05m in order to return a level of 13.05m aOD. The turbines would be a consistent height.

The positions of the turbines have been converted from UTM 30N to British National Grid using the OSGB 1936 to WGS1984 Petroleum transformation.

The ZTV has been prepared using a DTM produced from Ordnance Survey Profile data.

Kyle Rhea SLVIA

Scale: 1:25,000@A3

Project no.: JE30605

Client: Marine Current Turbines

Content: CD

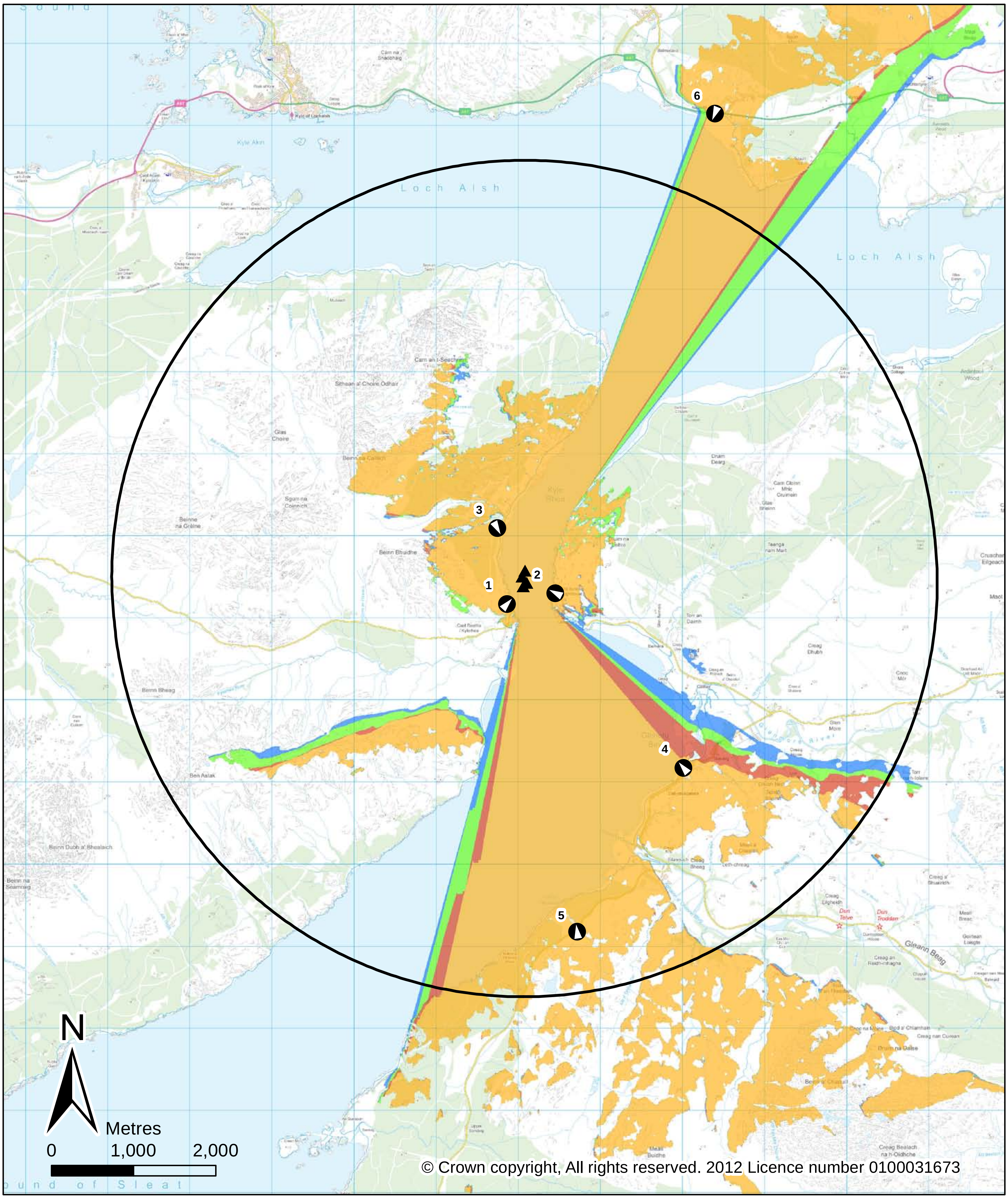
Drawn: CD

FIGURE 1a
Zone of theoretical visibility

Checked: SM

Date: 07/08/12

SINCLAIR KNIGHT MERZ SKM ENVIROS



KEY

◓	Viewpoints	Blue	1 Turbine visible
▲	Turbine Locations	Green	2 Turbines visible
☐	5 km buffer	Red	3 Turbines visible
		Orange	4 Turbines visible

Notes: ZTV is based on a maximum turbine level of 13.05m aOD and an observer height of 1.75m. The digital terrain model (DTM) used in this analysis records that the level of the level of the surface is -1 m aOD. Therefore the height of the turbine has been set as 14.05m in order to return a level of 13.05m aOD. The turbines would be a consistent height.

The positions of the turbines have been converted from UTM 30N to British National Grid using the OSGB 1936 to WGS1984 Petroleum transformation.

The ZTV has been prepared using a DTM produced from Ordnance Survey Profile data.

Kyle Rhea SLVIA

Scale: 1:50,000@A3

Project no.: JE30605

Client: Marine Current Turbines

FIGURE 1b
Zone of theoretical visibility

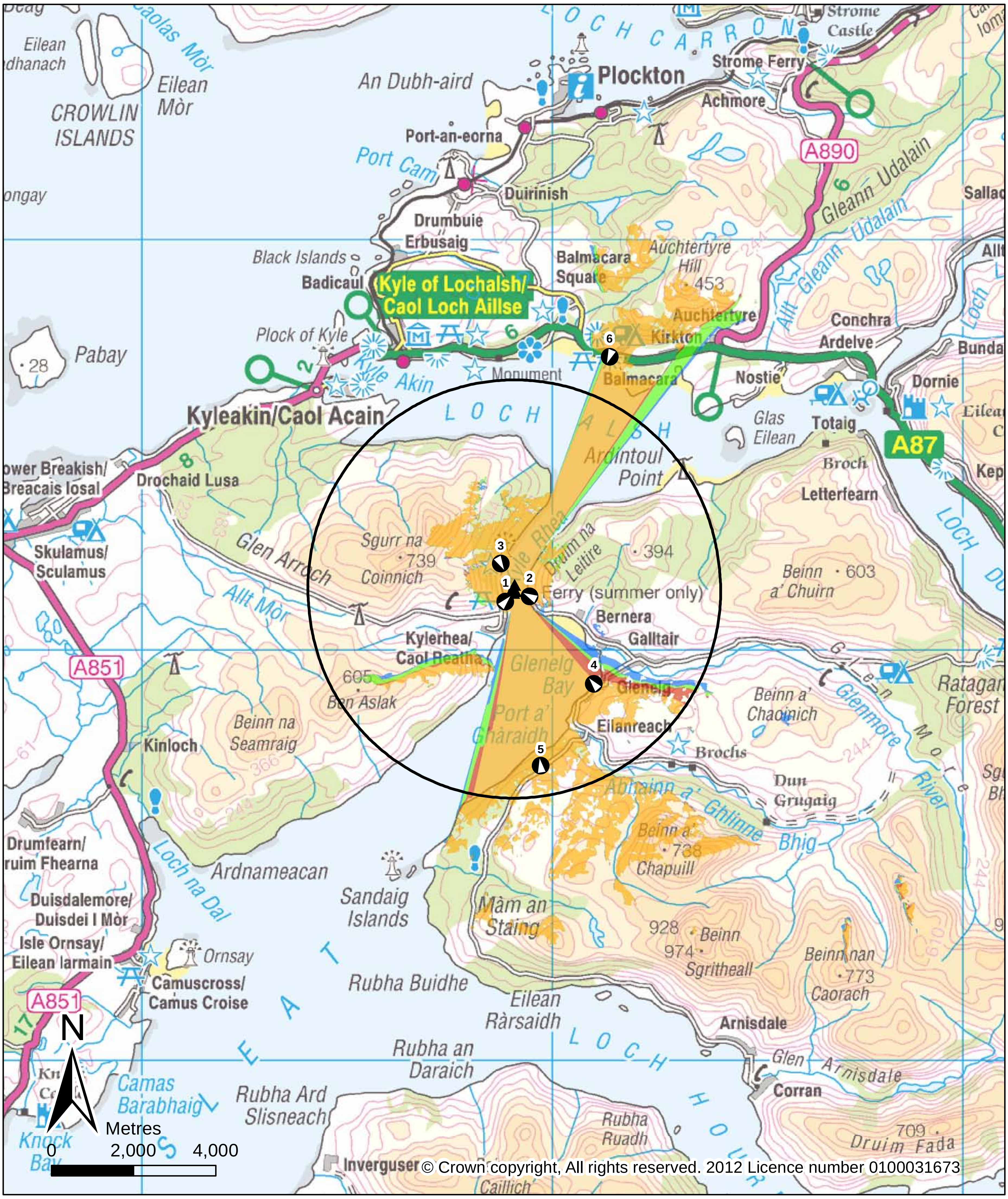
Content: CD

Drawn: CD

Checked: SM

Date: 07/08/12

SINCLAIR KNIGHT MERZ SKM ENVIROS



KEY

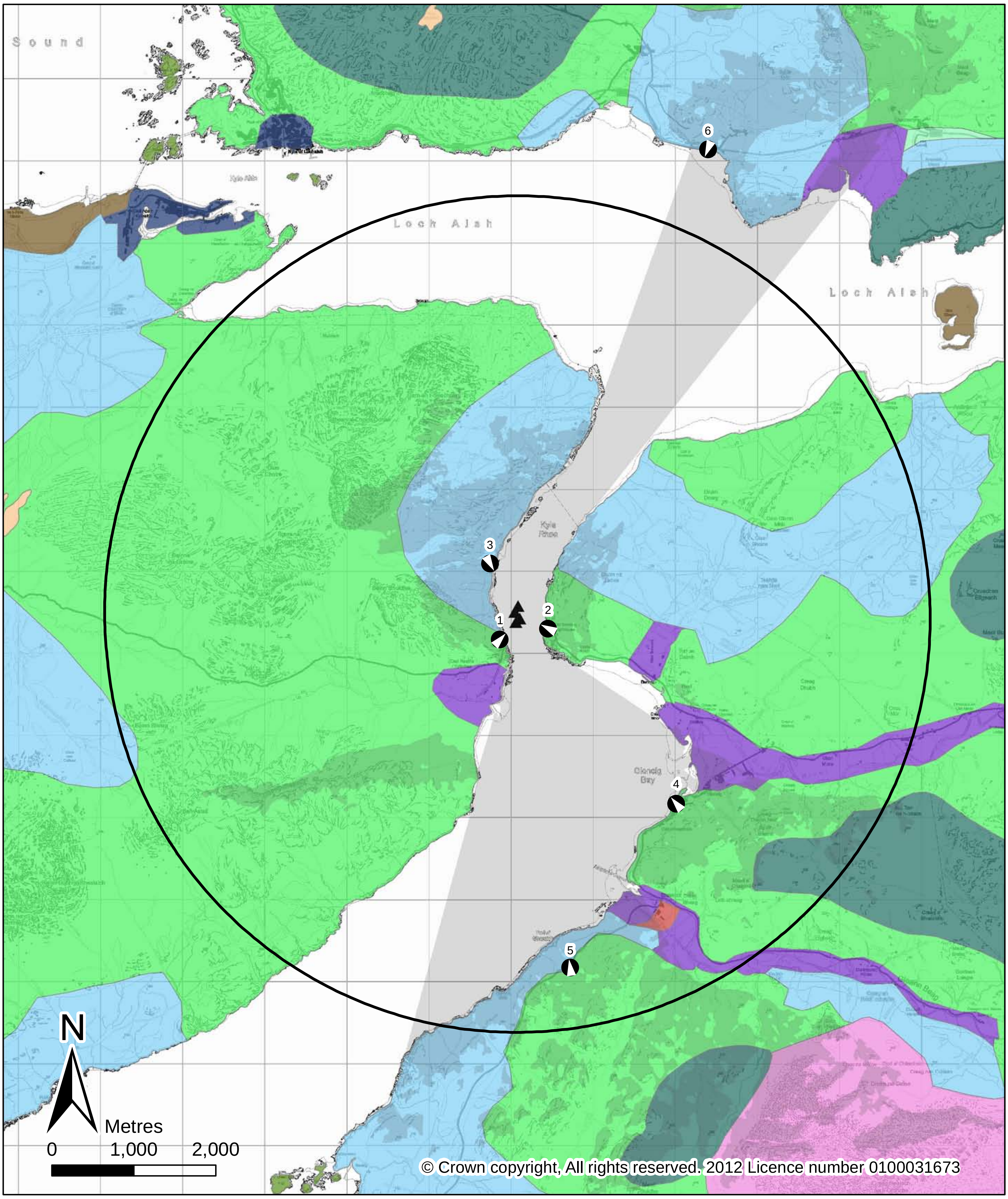
- Viewpoints
- Turbine Locations
- 5 km buffer
- 1 Turbine visible
- 2 Turbines visible
- 3 Turbines visible
- 4 Turbines visible

Notes: ZTV is based on a maximum turbine level of 13.05m aOD and an observer height of 1.75m. The digital terrain model (DTM) used in this analysis records that the level of the level of the surface is -1 m aOD. Therefore the height of the turbine has been set as 14.05m in order to return a level of 13.05m aOD. The turbines would be a consistent height.

The positions of the turbines have been converted from UTM 30N to British National Grid using the OSGB 1936 to WGS1984 Petroleum transformation.

The ZTV has been prepared using a DTM produced from Ordnance Survey Profile data.

Kyle Rhea SLVIA	Scale: 1:100,000@A3	Project no.: JE30605	Client: Marine Current Turbines
FIGURE 1c **Zone of theoretical visibility**	Content: CD	Drawn: CD	SKM ENVIROS
	Checked: SM	Date: 07/08/12	



KEY

5 km buffer	
Viewpoints	
Not visible	
Visible	
Turbine Locations	

LEVEL 1 Landscape description

- Coastal Island
- Coastal Strath
- Farming with Settlement
- Forest Slopes and Moorland Mosaic
- Harbour Settlement
- Inland Loch
- Interlocking Sweeping Peaks
- Linear Crofting
- Rocky Moorland Plateau
- Rugged Massif
- Smooth Moorlands

Kyle Rhea SLVIA

Scale: 1:50,000@A3

Project no.: JE30605

Client: Marine Current Turbines

Content: CD

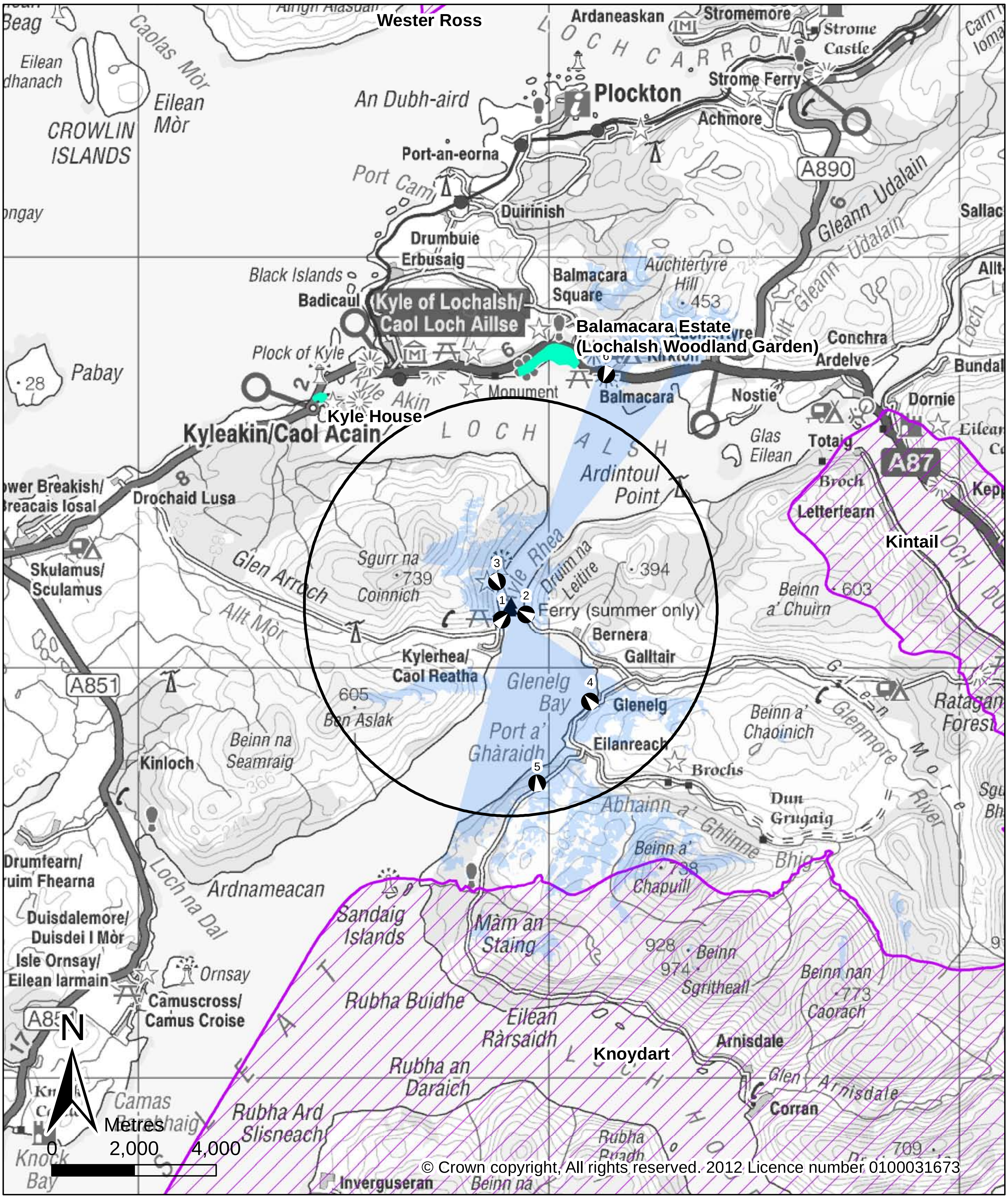
Drawn: CD

FIGURE 2a
Landscape character areas

Checked: SM

Date: 07/08/12

SINCLAIR KNIGHT MERZ SKM ENVIROS



KEY

- 5 km buffer
- Viewpoints
- Not visible
- Visible
- Turbine Locations
- Gardens and Designed Landscapes
- National Scenic Areas

Kyle Rhea SLVIA

Scale: 1:100,000@A3

Project no.: JE30605

Client: Marine Current Turbines

Content: CD

Drawn: CD

FIGURE 2b
Designated Sites

Checked: SM

Date: 07/08/12

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Kyle Rhea SLVIA

Indicative Photomontage – Kyle Rhea ferry crossing, west side

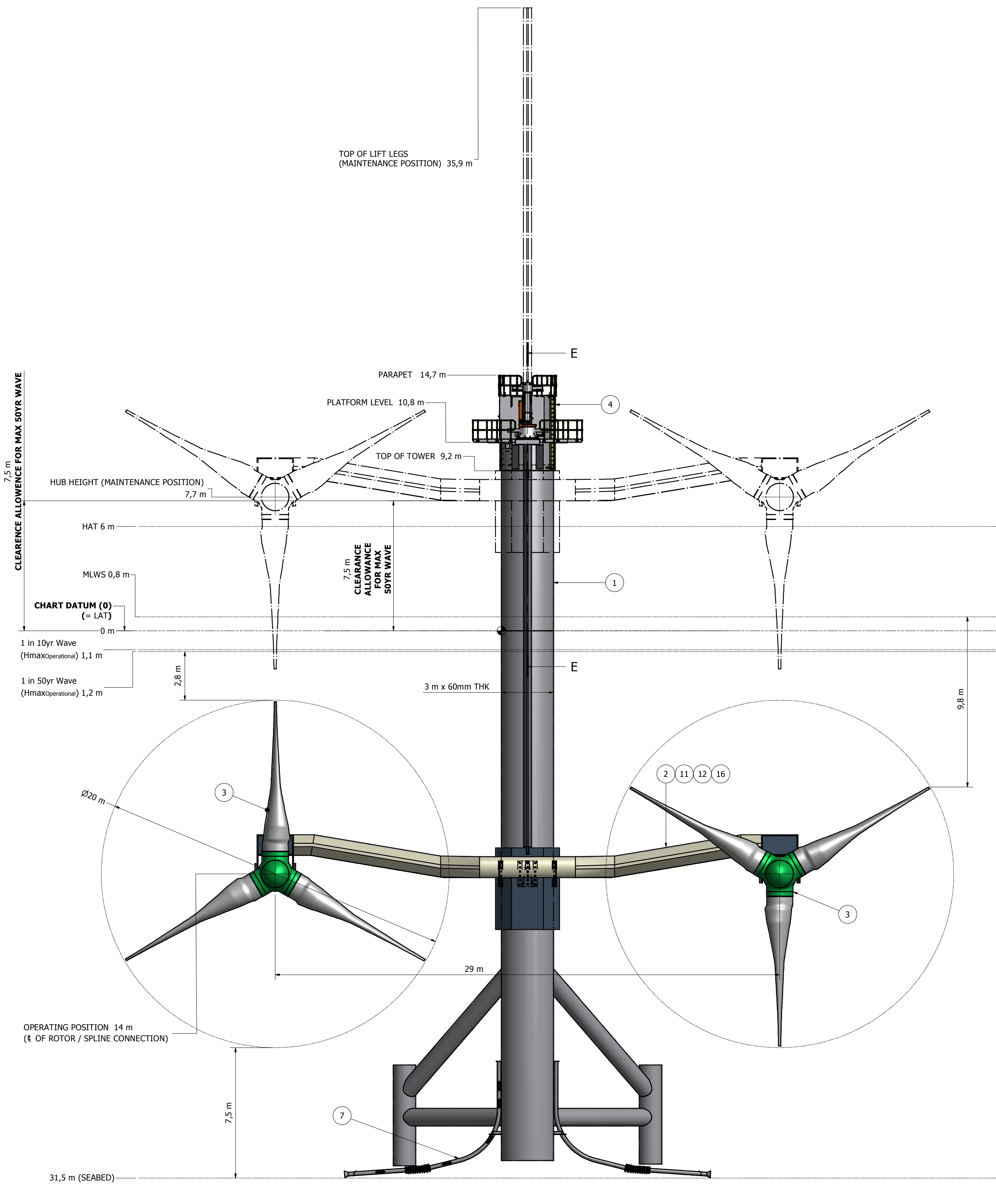
Notes: the photomontages are only included to provide an the proposed locations and scale of the proposed array. The colour, precise location, height and layout of the turbines is likely to vary from that shown here.

It is not presented to a specific viewing distance.

The photomontages that will be included with the assessment will conform with the relevant guidance, as set out in the note on the proposed assessment scope.

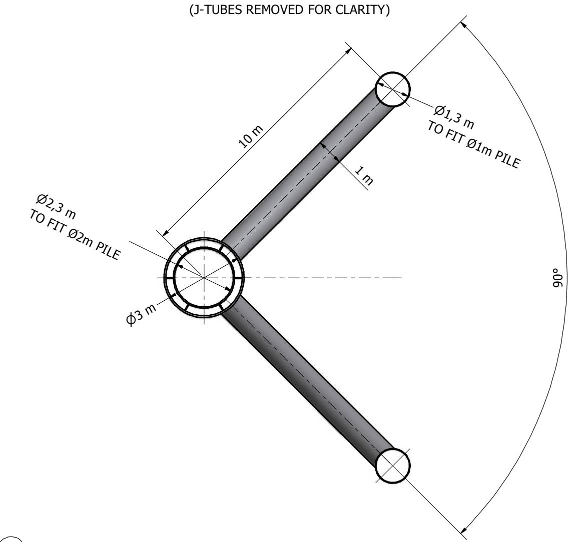
Kyle Rhea SLVIA
Indicative Photomontage – Kyle Rhea ferry crossing, east side

Notes: the photomontages are only included to provide an the proposed locations and scale of the proposed array. The colour, precise location, height and layout of the turbines is likely to vary from that shown here.
It is not presented to a specific viewing distance.
The photomontages that will be included with the assessment will conform with the relevant guidance, as set out in the note on the proposed assessment scope.

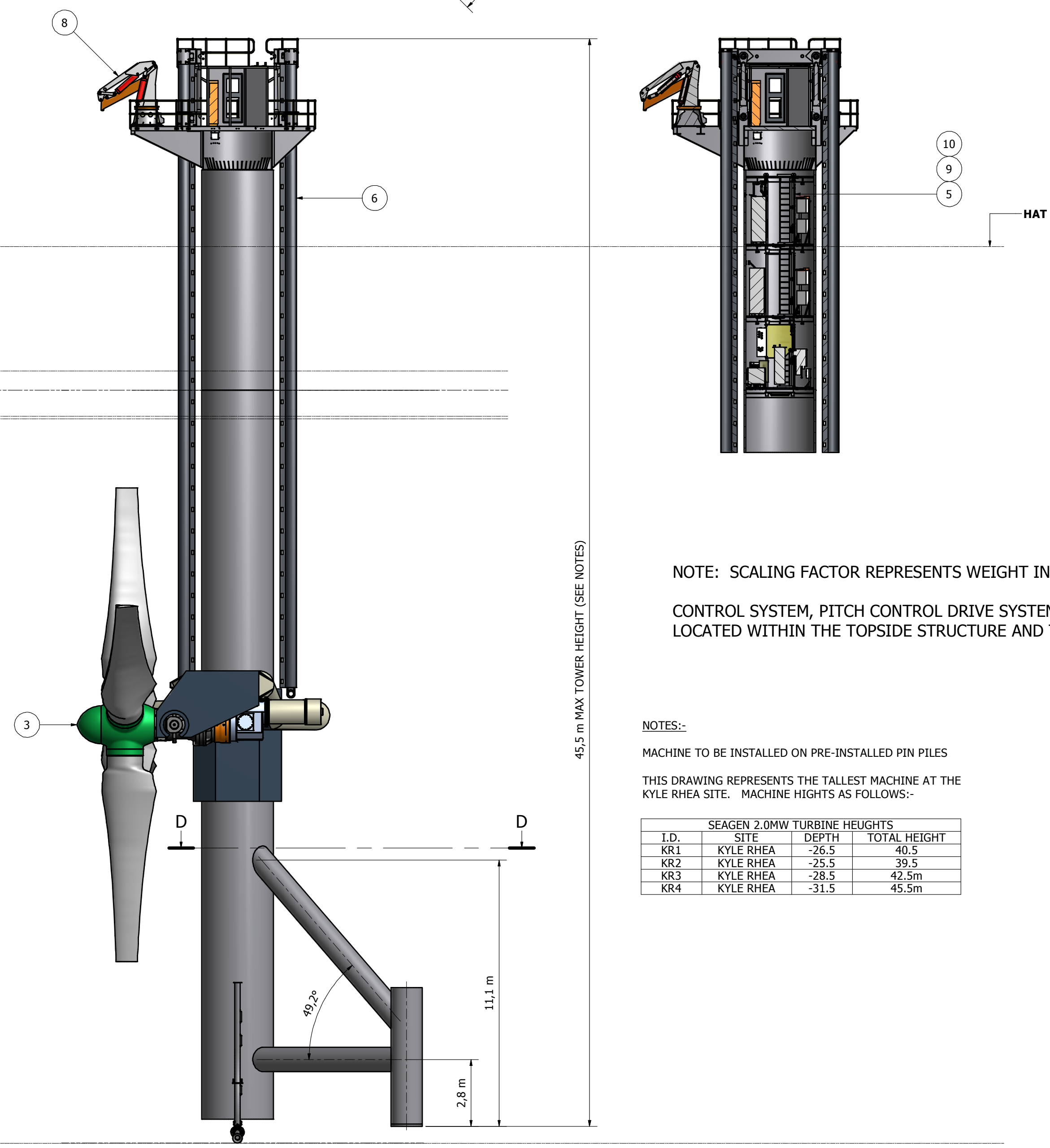


VIEW1 (1 : 100)

D-D (1 : 100)
FOUNDATION SPREAD
(J-TUBES REMOVED FOR CLARITY)



E-E (1 : 100)



PARTS LIST						
ITEM	QTY	PART NUMBER	DESCRIPTION	SCALING FACTOR	EST. MASS	NOTES
1	1	N/A	TOWER ASSEMBLY	1.51	250 te	3M DIA X 60mm THICK WITH TRIPOD FOUNDATION. MAX HEIGHT TAKEN.
2	1	N/A	CROSSBEAM GA	2.33	220 te	SIMPLIFIED FROM SEAGEN 1.2MW. FAIRINGS MADE FROM STEEL FABRICATIONS, GEOMTRY SIMPLIFIED.
3	2	N/A	1MW POWERTRAIN	1.76	60 te (ea)	3 BLADED
4	1	N/A	TOPSIDE STRUCTURE	N/A	35 te	SIMPLIFIED FOR 2.0MW, NO COMPOSITES
5	1	N/A	MACHINERY INSERTS	N/A	18 te	AS SEAGEN 1.2MW (THOUGH EQUIPMENT WITHIN FOR 2.0MW). POSIBILITY OF USING 4 INSERTS AND SIMPLIFIED TOPSIDE STRUCTURE TO BE EXPLORED
6	2	N/A	LIFT LEGS	1.51	25 te (ea)	LENGTH IS GOVERNED BY TOWER HEIGHT. SIMPLIFICATION TO BE EXPLORED (REMOVE RACK)
7	2	N/A	J-TUBE	N/A	5 te (ea)	AS SEAGEN 1.2MW IN 2 POSITIONS
8	1	N/A	CRANE	N/A		TO SUIT LARGEST LIFT - PROBABLY REMOVAL OF BLADES
9	1	N/A	33KV CABLES	N/A		
10	1	N/A	GENERATOR POWER CABLES	N/A		QTY COULD GO UP TO 4 CABLES, AS OPPOSED TO 3 (COMPARED TO 1.2MW)
11	1	N/A	GENERATOR SUBSEA POWER CABLES	N/A		QTY COULD GO UP TO 4 CABLES, AS OPPOSED TO 3 (COMPARED TO 1.2MW)
12	1	N/A	SUBSEA CONTROL CABLES	N/A		AS SEAGEN 1.2MW - LENGTHS CHANGE TO SUIT TOWER HEIGHT
13	1	N/A	FIRE DETECTION SYSTEM	N/A		AS SEAGEN 1.2MW
14	1	N/A	CORROSION PROTECTION SYSTEM	N/A		AS SEAGEN 1.2MW
15	1	N/A	TURBINE PNEUMATICS	N/A		AS SEAGEN 1.2MW - SCOPE FOR SIMPLIFICATION
16	1	N/A	BRAKE HOSES	N/A		AS SEAGEN 1.2MW

NOTE: SCALING FACTOR REPRESENTS WEIGHT INCREASE FROM 1.2MW TO 2.0MW

CONTROL SYSTEM, PITCH CONTROL DRIVE SYSTEM, POWER ELECTRONICS ARE LOCATED WITHIN THE TOPSIDE STRUCTURE AND THE MACHINERY INSERT LEVELS

NOTES:-

MACHINE TO BE INSTALLED ON PRE-INSTALLED PIN PILES

THIS DRAWING REPRESENTS THE TALLEST MACHINE AT THE KYLE RHEA SITE. MACHINE HIGHTS AS FOLLOWS:-

SEAGEN 2.0MW TURBINE HEUGHTS			
I.D.	SITE	DEPTH	TOTAL HEIGHT
KR1	KYLE RHEA	-26.5	40.5
KR2	KYLE RHEA	-25.5	39.5
KR3	KYLE RHEA	-28.5	42.5m
KR4	KYLE RHEA	-31.5	45.5m

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Email: Info@marineturbines.com
Website: www.marineturbines.com

DWG TITLE: SEAGEN 2.0 MW KYLE RHEA - PRELIMINERY GA	
DWG NO.: DR-SGS2-GA-000-0954	ISSUE NO.: DRAFT
SHEET NO. 1 OF 1 / SCALE @ A0 :- 1:100	A0
MATERIAL:-	MASS:- ~ 750 te
DRAWN BY N. SARGENT	DATE 22/03/2012
CHECKED BY	DATE
AUTHORISED BY	DATE

FILE: C:\VaultWorkSpace\Designs\SeaGen II\General Arrangement (GA)\DRAWING\SeaGen 2.0MW - KYLE RHEA - GA.dwg

Kyle Rhea Tidal Stream Array

Appendix 17.1

Navigation Risk Assessment

Kyle Rhea Tidal Stream Array

Prepared by:	Anatec Ltd.
On behalf of:	Sea Generation (Kyle Rhea) Ltd
Date:	18.12.2012
Revision No.:	00
Ref.:	A2748-KR-NRA-1

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1. Introduction

1.1 Background

Anatec have been commissioned by SeaGeneration (Kyle Rhea) Ltd, a company set up by Marine Current Turbines (MCT), to perform a Navigation Risk Assessment (NRA) of a planned tidal turbine array site within Kyle Rhea, located between the Isle of Skye and the mainland of western Scotland.

The project would involve the construction of an array of four 2MW SeaGen tidal devices within Kyle Rhea.

1.2 Objectives

The main aims of this study were as follows:

- Identify the key navigational features of the area including sea room, tidal streams, water depth, navigational aids, port / harbour locations and metocean characteristics.

- Analyse vessel activity data for Kyle Rhea to characterise all the different vessel types using the area, taking into account seasonal and tidal variations.

- Review historical maritime incidents that have occurred in the area in recent years and the Search and Rescue resources in the vicinity which may be called upon in the event of a maritime incident.

- Assess the impact on navigation and maritime risk associated with the project (including the different phases of installation, operation and maintenance, and decommissioning). This stage included a Hazard Review Workshop involving a cross-section of maritime stakeholders.

- Quantitatively assess the collision risks associated with the project. This included an assessment of the risk of vessel collision with both the surface and subsea elements of the SeaGen devices. The modelling takes into account the vessel activity information (including draught profile), metocean data (water depths, wave heights and tidal levels) and project parameters (location coordinates, dimensions above and below water and orientation).

- Assess the potential cumulative and in-combination impacts of nearby projects on marine traffic.

- Review the available measures to mitigate the navigational risks associated with the Project.

1.3 Data Sources and Methodology

The main data sources used in the study are as follows:

- Radar and Automatic Information System (AIS) Vessel Tracking Data
- Government Fishing Surveillance Data (sightings and satellite)
- RYA UK Coastal Atlas Data
- Admiralty Charts 2540 – Loch Alsh and Approaches and 2540_2 – Kyle Rhea
- Admiralty Sailing Directions NP66 West Coast of Scotland
- RNLI Launches Data
- MAIB Incident Data

The above data sources were supplemented by extensive consultation with national and local stakeholders representing the different types of vessel activity occurring within Kyle Rhea.

The assessment methodology principally followed the Department of Energy and Climate Change (DECC) Risk Assessment Methodology (Ref. i) and the Maritime and Coastguard Agency's (MCA) Marine Guidance Notice 371 (MGN 371) (Ref. ii). An overview of the general methodology applied in the assessment is presented in Figure 1.1.

(The DECC guidance, developed in association with the MCA and DfT, was originally developed for offshore wind farms but most of it is relevant to other offshore renewable energy installations.)

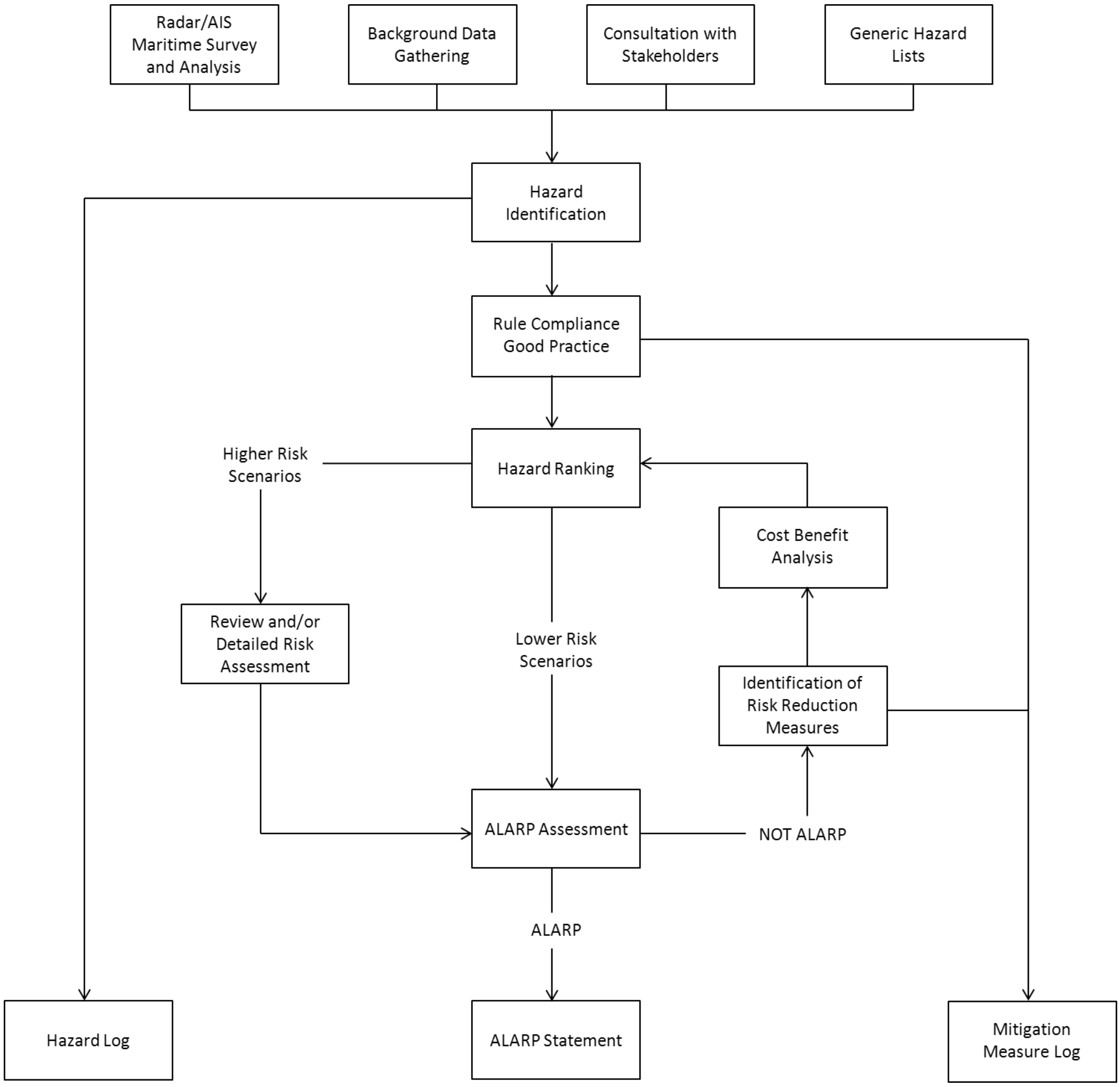


Figure 1.1 Overview of Methodology for Navigation Assessment

1.4 Abbreviations

The following abbreviations are used in this report:

AIS	-	Automatic Identification System
CA	-	Cruising Association
CCC	-	Clyde Cruising Club
ETV	-	Emergency Towing Vessel
DGPS	-	Differential Global Positioning System
GPS	-	Global Positioning System
HF	-	High Frequency
HW	-	High Water

ICES	-	International Council for the Exploration of the Seas
IOSFCIC	-	Isle of Skye Ferry Community Interest Company
LAT	-	Lowest Astronomical Tide
m	-	Metre
MAIB	-	Marine Accident Investigation Branch
MCA	-	Maritime and Coastguard Agency
MCT	-	Marine Current Turbines
MGN	-	Marine Guidance Note
MRCC	-	Maritime Rescue Coordination Centre
MRSC	-	Maritime Rescue Sub Centre
MSL	-	Mean Sea Level
MW	-	Megawatts
nm	-	Nautical Mile (1nm ≡ 1,852metres)
NRA	-	Navigation Risk Assessment
OREI	-	Offshore Renewable Energy Installation
PLN	-	Port Letter Number
RIB	-	Rigid Inflatable Boat
RNLI	-	Royal National Lifeboat Institution
RYA	-	Royal Yachting Association
SAR	-	Search and Rescue
TS	-	Training Ship
VHF	-	Very High Frequency
VTS	-	Vessel Traffic Services

2. Site Details

2.1 Location Overview

The proposed tidal device array is within Kyle Rhea, between the Isle of Skye and the mainland of western Scotland.

Figure 2.1 and Figure 2.2 present general and detailed chart overviews of the Study Area defined by the project. Figure 2.2 presents the planned device locations which are the main focus of this work.

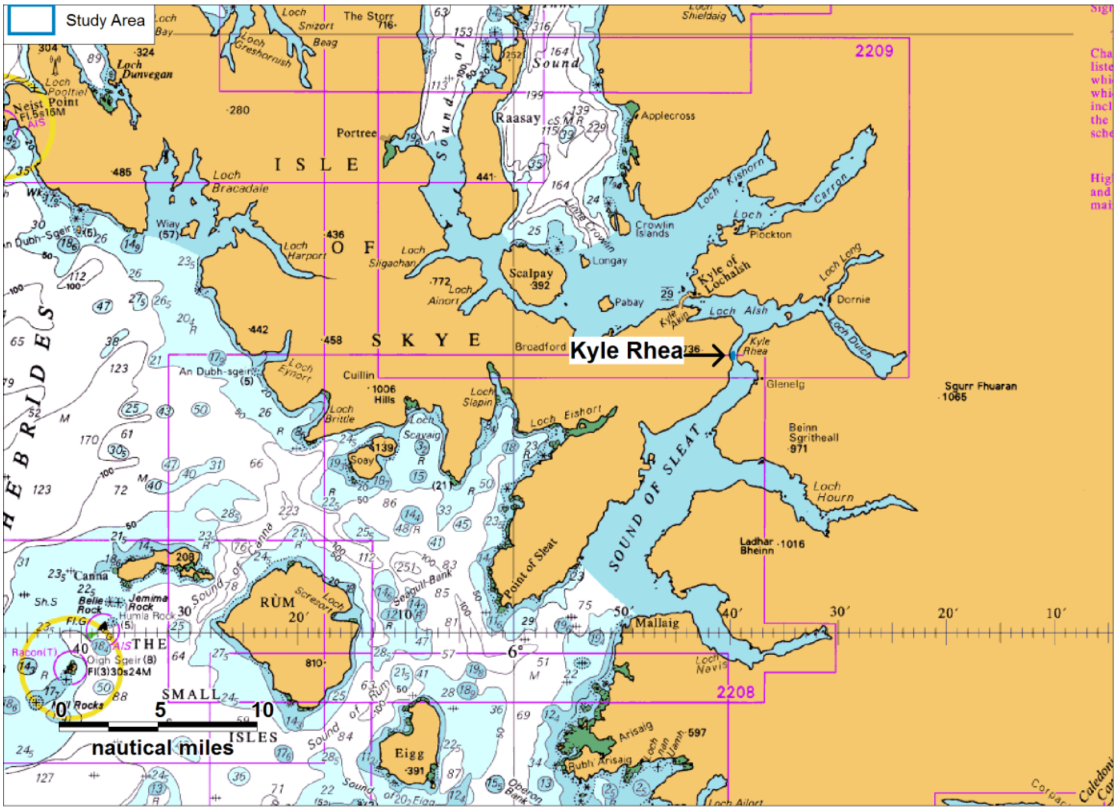


Figure 2.1 Overview of Kyle Rhea Site Location

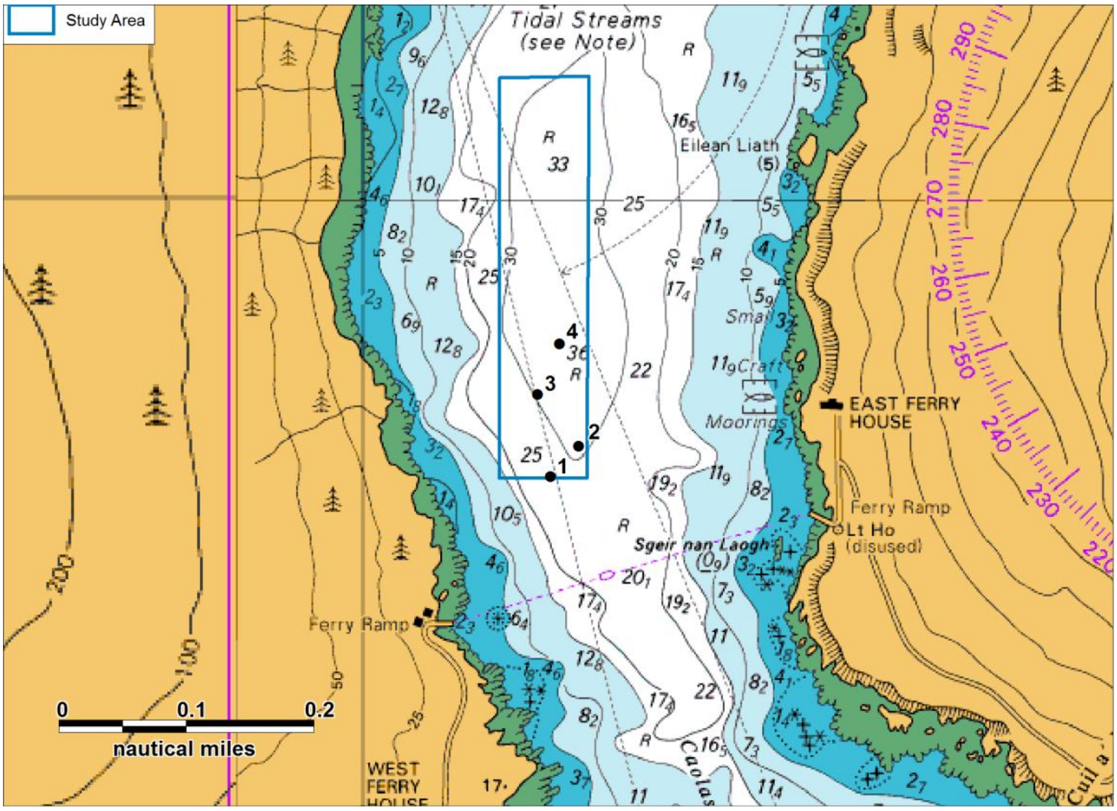


Figure 2.2 Detailed Chart of Kyle Rhea Indicative Farm Layout

The geographical coordinates and water depths of the proposed device locations are presented in Table 2.1. The minimum distance between the devices is 60m.

Table 2.1 Kyle Rhea Proposed Device Locations

Device Location	WGS84		Water Depth (m) below LAT
	Latitude	Longitude	
1	57° 13' 46.92"N	005° 39' 43.67"W	26.8
2	57° 13' 48.35"N	005°39' 41.22"W	25.8
3	57° 13' 50.80"N	005° 39' 44.82"W	28.8
4	57° 13' 53.17"N	005° 39' 42.89"W	31.8

The current minimum width of the channel at a device location is 550m between landfalls (440m between the charted 5m contours) at Device 1. This compares to 420m between landfalls (260m between 5m contours) at the narrowest point of the channel, to the south of the ferry track.

With the devices installed, the minimum width to the east of a device is at Device 2 (approximately 250m from maximum extent of device to 5m contour near shore).

2.2 Devices

The Project array will consist of four 2MW SeaGen tidal devices with a maximum design life of 25 years.

The technology proposed for the Kyle Rhea tidal array is based upon the SeaGen device installed and operated in Strangford Lough, with some alterations to the design. For example, it is proposed that the device installed at Kyle Rhea will have three rotor blades, whereas those operated at Strangford Lough have only two.

The device consists of axial flow rotors, of 20m in diameter, which drive a generator via a gearbox. The rotors turn at a maximum of 11 rpm with a tip speed of each rotor at a maximum of 12m/s. Twin rotors are mounted on a wing-like crossbeam, extending either side of a tubular tower, which itself protrudes approximately 17.7m above the water surface (at LAT). The crossbeam can be raised above the water surface on hydraulic rams to allow maintenance and repair as required.

Subsurface, each device is likely to be mounted on a quadropile drilled and pinned into the seabed. The worst case quadropod will have 2.2m rock sockets, 15.2m^2 per device. This will be a seabed footprint of 60.8m^2 for the array.

Onshore infrastructure is likely to include construction of a substation on the Skye shore adjacent to the array (either on Forestry Commission land or near Kylerhea village) and directional drilling between the substation and the array.

When the crossbeam is submerged under water, the device tip clearance below LAT will be 3.0m. When the crossbeam is raised out of the water, the distance from the underside of the crossbeam to LAT is approximately 8m.

The devices will be orientated so that they are facing approximately 150º from due north, i.e., into the direction of the tidal flow. The maximum span between device blade tips will be approximately 49m.

Figure 2.3 provides an elevation view of the devices with indicative dimensions and position in the water column.

Figure 2.4 present a plan view of the devices at the location (to scale) overlaid on a chart.

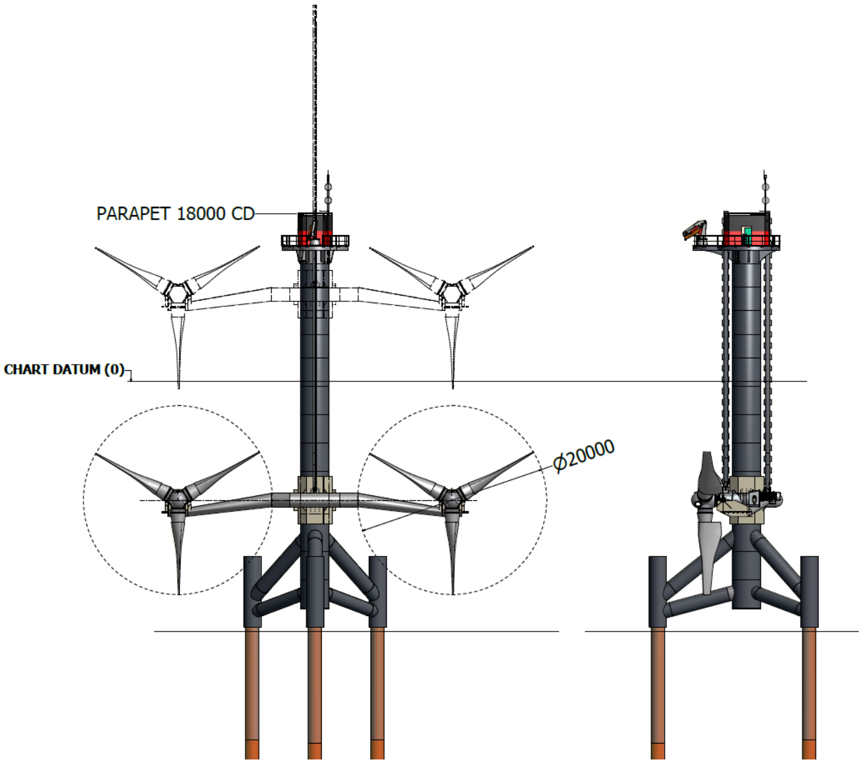


Figure 2.3 Schematic of Device Dimensions

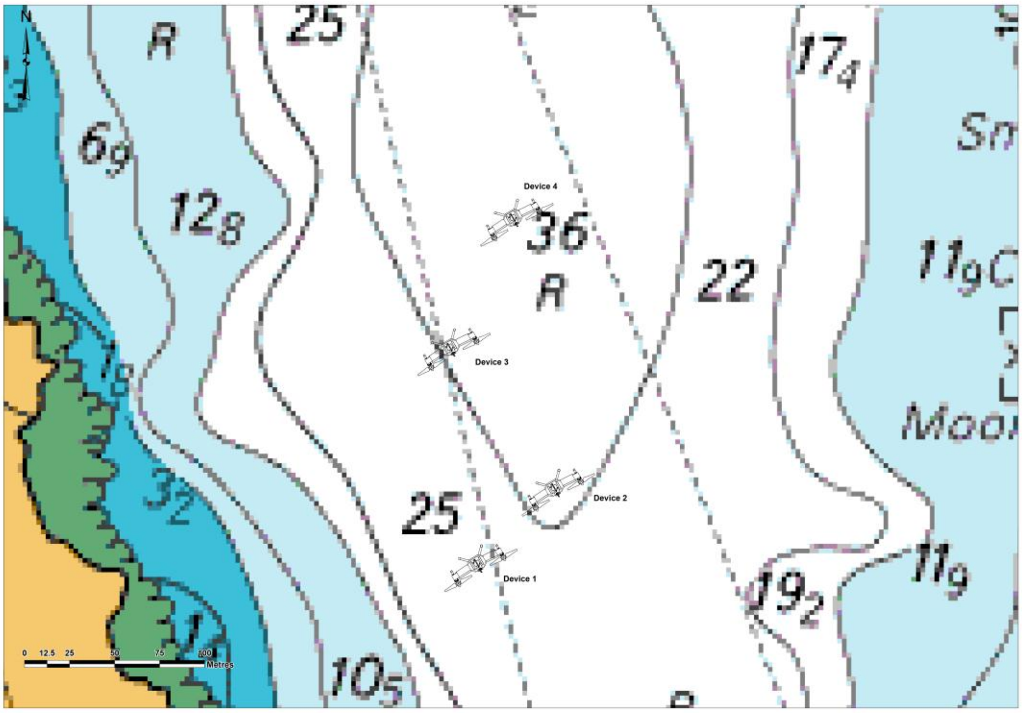


Figure 2.4 Plan View (to Scale) of Devices including Subsea Rotors

Key details are summarised in Table 2.2.

Table 2.2 Device Details

Device Component	**Specification**
Rated Power	2MW
Number of rotors	2
Number of blades per rotor	3
Rotor diameter	20m
Height of parapet above LAT	17.7m
Minimum clearance from blade tip to sea surface at LAT (crossbeam submerged)	3m
Maximum span between blade tips	49m

2.3 Support Vessels

It is anticipated that the majority of material and equipment for construction and installation will be transported by sea.

2.3.1 Site Investigation

Geotechnical investigation options to be used at the development are diver coring, seabed drilling, canyon seabed drilling and jackup coring.

For seabed coring, a construction barge vessel 30-40m long and 10-15m wide, with a crane on-board, would be used. This vessel would be an anchor barge and use anchor wires. Operations will be restricted by tide.

The canyon seabed drill would not use anchor wires and drilling would take 16 hours per hole.

Jackup coring would be unlikely due to the cost involved. The jackup would not need anchor wires once positioned.

2.3.2 Installation

Installation is expected to follow a similar method to that for the SeaGen device in Strangford Lough. Normally the marine installation phase is scheduled to take place during the summer and autumn months when suitable weather conditions are most likely to occur. (However, it was indicated at the Hazard Review Workshop that efforts would be made to avoid the Skye ferry operating period and peak recreational traffic in summer. Refer to Section 12.)

Vessels being considered for the installation of the devices include jack-up barges, moored barges or vessels using Dynamic Positioning (DP). It is most likely that the foundation and device components will be stored at a nearby port and transported to site by support barge. Ancillary barges, tugs, safety vessels and personnel transfer vessels may also be required.

In terms of navigation, a moored barge is considered to be the worst-case option as this would require a significant mooring spread. Should a moored barge be used for installation, a maximum of eight point anchor spread would be used with gravity as well as drag anchors.

The main installation vessel will move between the installation site and the supporting port for large components. There will be daily runs of additional support vessels for small materials, plant, equipment and personnel.

The foundations will be installed one year preceding the device installation. The most likely method for foundation installation uses a subsea drilling template and subsea drill. Installation of individual foundations could take up to 18 days per device, or an estimated total of three months for all four devices.

Foundations will require percussive drilling of rock sockets and the installation of four steel piles to pin the supporting tower to the seabed (see Figure 2.3). The foundations piles will protrude above the seabed by approximately 5-6m once installed.

This would involve the following approximate timeframe per pile, although weather delays may extend the programme:

- 24 hours of vessel set-up time;
- 12 hours to deploy the drill frame;
- 6 hours to deploy the drill;
- 30 hours of drilling;
- 24 hours to install and grout the pile; and
- 6 hours to remove the drill frame.

This timescale for percussive drilling of the pile sockets is based on experience of the installation of the SeaGen device at Strangford Lough. A maximum of 30 hours continuous drilling is likely. This will be interspersed with approximately 78 hours of non-drilling activities. Each device will have a quadropod foundation structure (i.e. four piles) and there will be four devices (i.e. 16 piles in total).

Device installation is expected to take 4 days per device, including collection of each unit from Kyle of Lochalsh and grouting onto the foundations.

All marine operations are estimated to run 24 hours per day and this is likely to be a requirement of the rock socket drilling operations, which cannot be stopped and restarted with ease.

Foundation installation is planned for 2014 and it is likely that the devices will be installed the following year in the summer months. It is expected to take approximately 3 months to install all 4 of the devices.

Installation works will be subject to weather conditions. Offshore installation operations are likely to continue 24/7 throughout to minimise the overall installation period.

Safety zones are not considered to be practicable. At Strangford Lough a pilot / escort vessel was employed to take vessels through the channel along a safe track, avoiding the mooring lines.

Vessel options for cable installation works could potentially include a combination of moored barge, jack-up vessel, multicat and small construction DP vessel. The export cable(s) will be installed using directional drilling. For the inter-array cables, a winch mounted on the SeaGen platform or mounted on a suitable vessel will be used to connect the cable to the devices. A cable laying vessel will then be used to take the cable to the next device in the array.

2.3.3 Maintenance

Minor maintenance will be carried out using small personnel craft (RIB) operated from a local harbour. Other maintenance and inspection will be carried out with the crossbeam of the device raised. It is intended that the servicing of the generators be carried out before the end of April and after September, to avoid possible conflicts with recreational vessels during the summer season. If necessary emergency or essential maintenance must be performed in summer months, this will be carried out, whenever possible, during daylight hours on weekdays to avoid weekends when recreational activities are at their height.

2.3.4 Port Facilities

Kyle of Lochalsh is the main local port which could be used during the Project.

2.3.5 Decommissioning

The duration and seasonal timing of the decommissioning period will be similar to construction. Structures will be dismantled and taken away by the crane vessel / barge for recycling. Crew boats and service vessels etc. will be required as during construction.

3. Metocean Data

3.1 Introduction

Metocean data for the Kyle Rhea area is presented in the subsections below. Further information is available from the Metocean Design Basis report (Ref. iii).

3.2 Wind Data

Wind observations have been obtained from Ardnamurchan Lighthouse (10 years of data from 1978-1988), where wind conditions have been determined to be comparable to those at Kyle Rhea. These data were supplemented with observations from Saasaig on the Isle of Skye (4 years of data from 1973-1976) to investigate how wind direction is modified by the local hills. From this, a 10 year wind dataset for Kyle Rhea has been synthesised by using the speeds observed at Ardnamurchan and adjusting their directional distribution to resemble that at Saasaig. The wind speeds represent 1 hourly means at a standard reference height of 10m.

The annual wind rose for Kyle Rhea, based on the above, is presented in Figure 3.1.

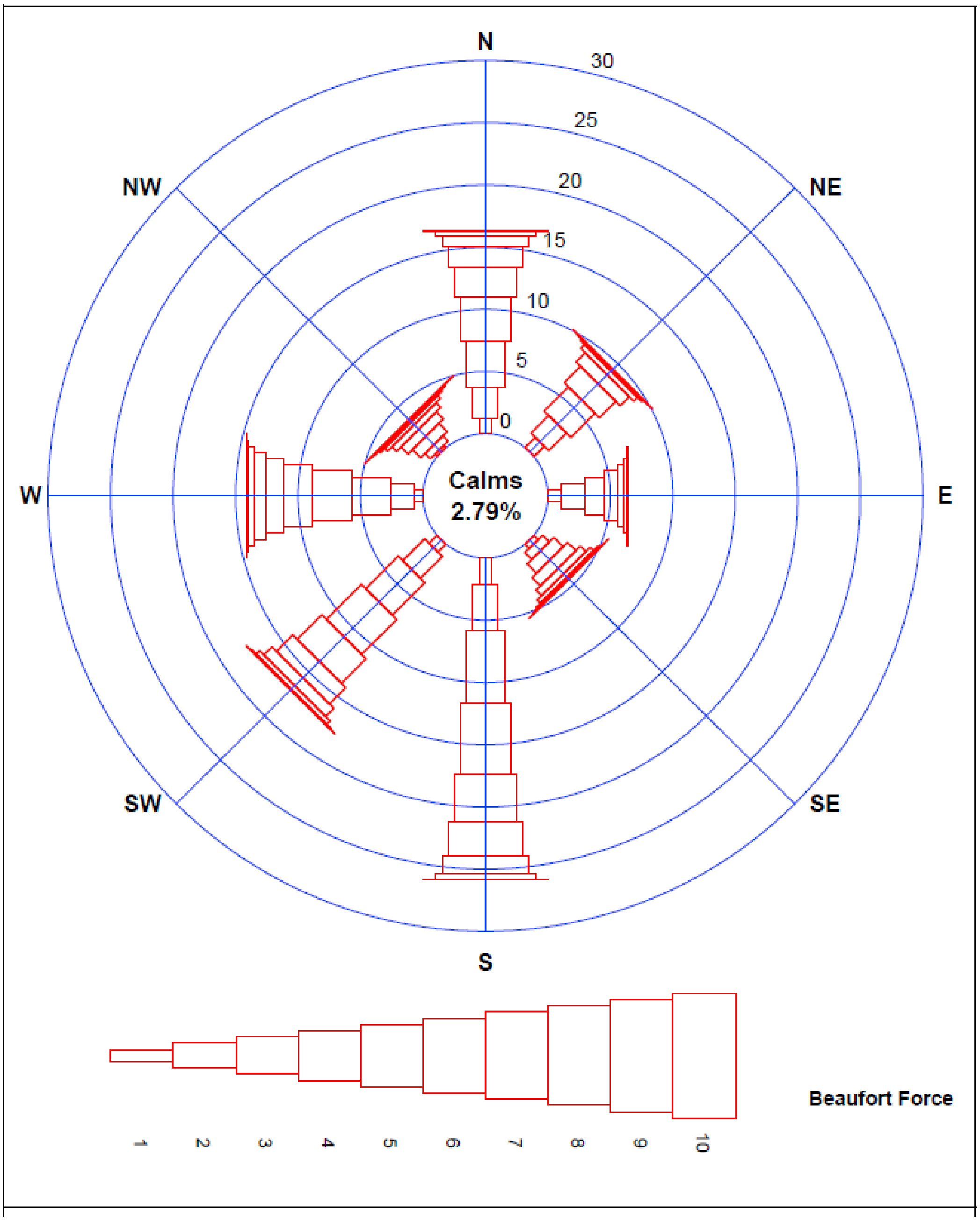


Figure 3.1 Annual Wind Rose for Kyle Rhea

The prevailing winds are from the south (25.9% of observations) and southwest (17% of observations). Beaufort Forces 3 and 4 were the most commonly observed wind speeds.

Seasonal wind force and direction probability distributions were calculated from the data and are presented in Figure 3.2 and Figure 3.3.

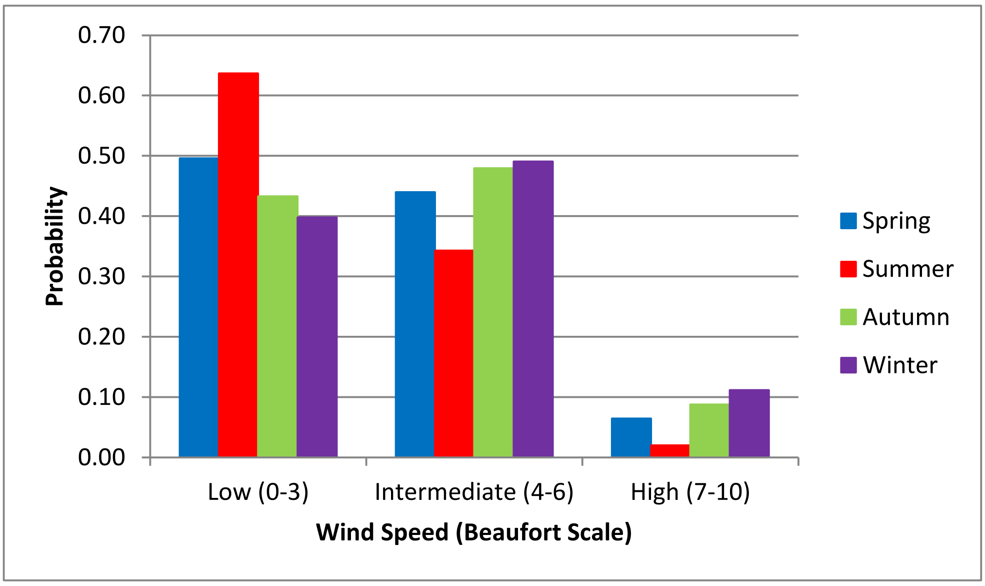


Figure 3.2 Seasonal Wind Force Data for Kyle Rhea

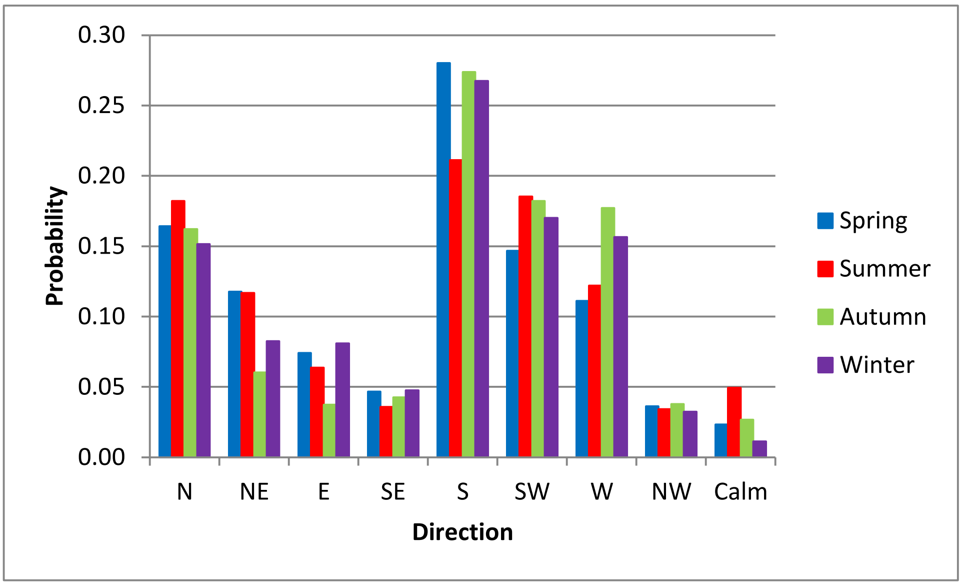


Figure 3.3 Seasonal Wind Direction Data for Kyle Rhea

As expected, wind speeds tended to be higher during autumn and winter. There was less seasonal variation in direction.

3.3 Wave Data

In the absence of measured or hindcast wave data in Kyle Rhea, wave heights were calculated from wind speed, fetch and duration. Further details of this can be found in the Metocean Design Basis report (Ref. iii). This concluded that within the Study Area, all waves are locally generated and ocean swell is negligible. Kyle Rhea is so enclosed that waves reach their fully developed state in less than an hour and will not grow further unless the wind strengthens. Annual and seasonal significant wave height probability distributions were calculated for the southern part of Kyle Rhea based on data extracted from the Metocean Design Basis report and are presented in Figure 3.4.

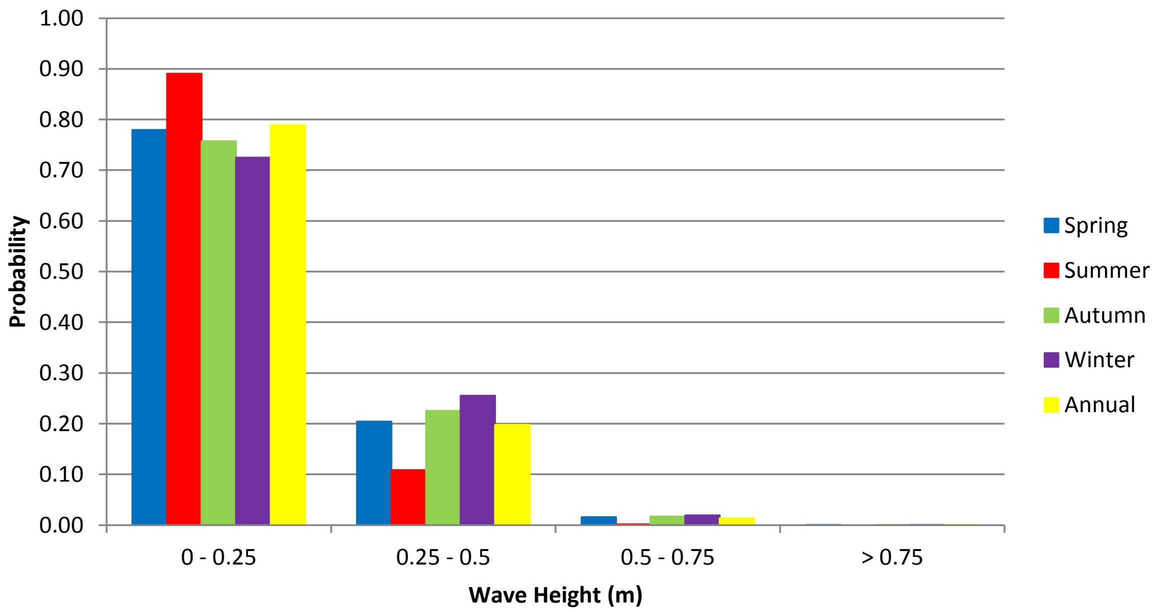


Figure 3.4 Significant Wave Height Data for Kyle Rhea

Significant wave heights vary seasonally with an increase in smaller waves in summer compared to other seasons.

On an annual basis, the probability of the significant wave height exceeding 0.5m is 1.3%. The annual probability of the significant wave height exceeding 0.75m is 0.03%. The 100-year extreme significant wave height was estimated to be 1.3m and the maximum wave height 2.5m in the southern part of Kyle Rhea.

The annual and seasonal wave direction probability distributions were calculated and are presented in Figure 3.5.

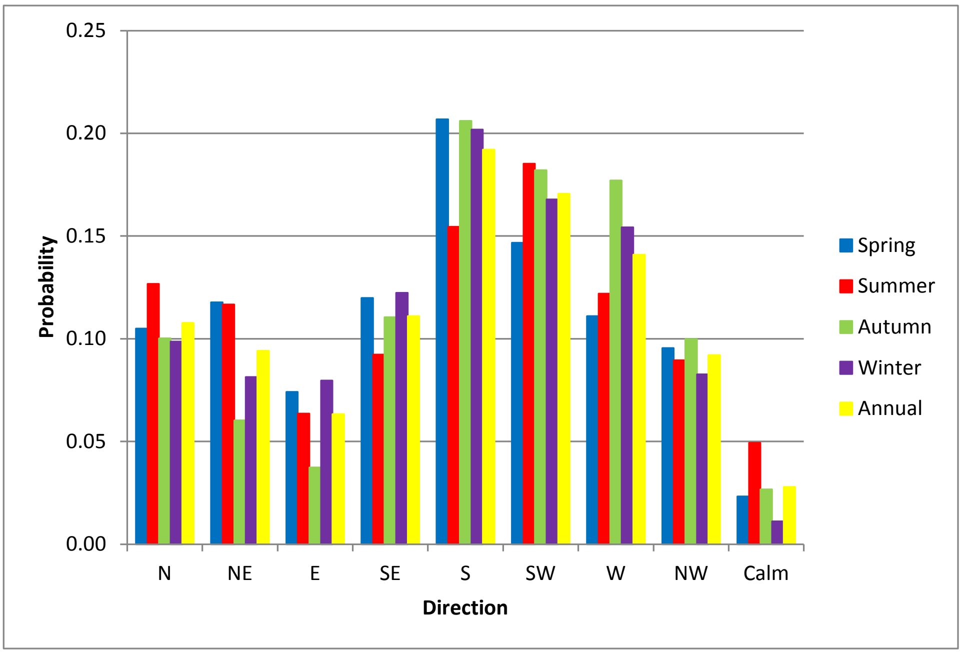


Figure 3.5 Annual and Seasonal Directional Wave Data

The wave direction varies but the dominant wave directions are south to south-west and north to northwest.

3.4 Tidal Levels

In the absence of long term tide gauge data in the Study Area, standard tidal heights have been interpolated from surrounding national tide gauge sites. Further details on the methodology can be found in the Metocean Design Basis report (Ref. iii).

Figure 3.6 presents the standard tidal elevations in Kyle Rhea between Highest Astronomical Tide (HAT) and Lowest Astronomical Tide (LAT).

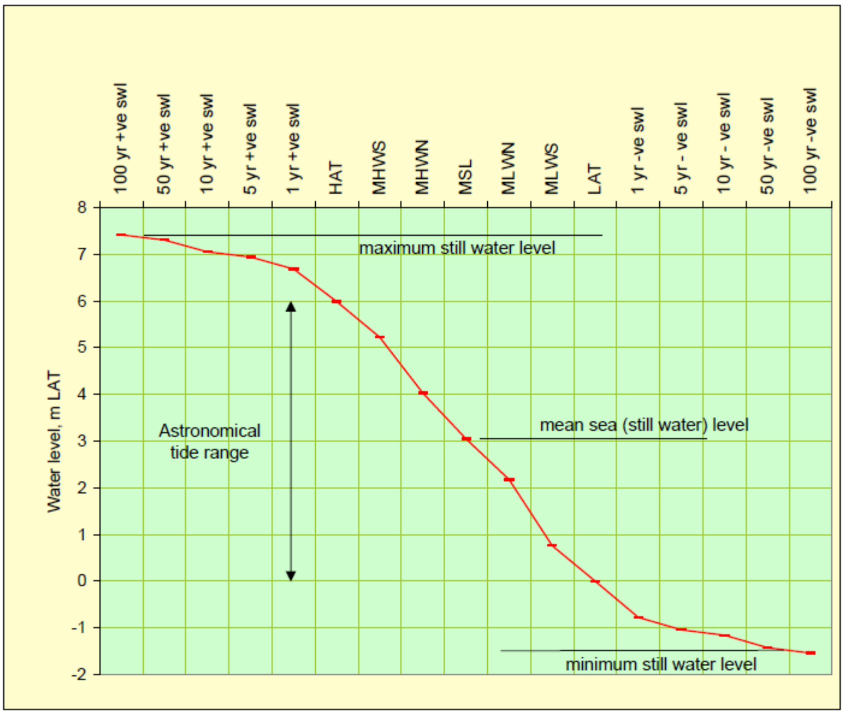


Figure 3.6 Standard Tidal Elevations between HAT and LAT for Kyle Rhea

Therefore, mean sea level is 3.0m above LAT. The mean spring range at the Study Area is 4.5m, and the mean neap range is 1.8m.

The annual probability distribution of tidal height above LAT has been calculated based on hindcast tidal data for the year 2001 (for a location which is very close to the most southerly and most energetic device location at Kyle Rhea (Ref. iv). The results are presented in Figure 3.7, with an exceedence curve presented in Figure 3.8.

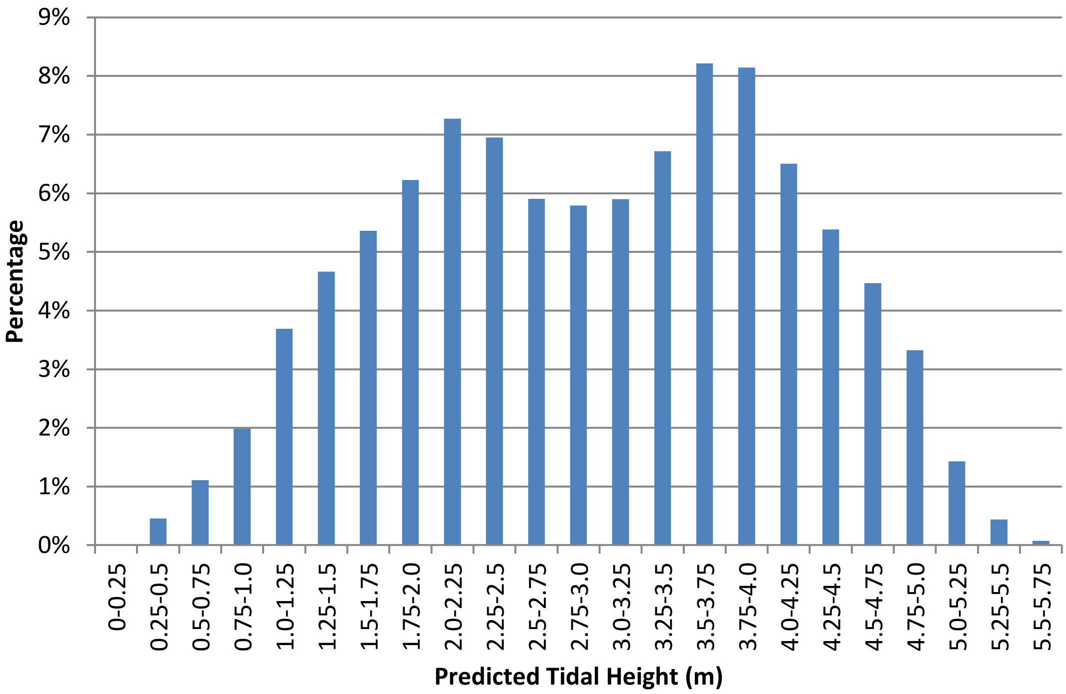


Figure 3.7 Distribution of Tidal Height above LAT (2001)

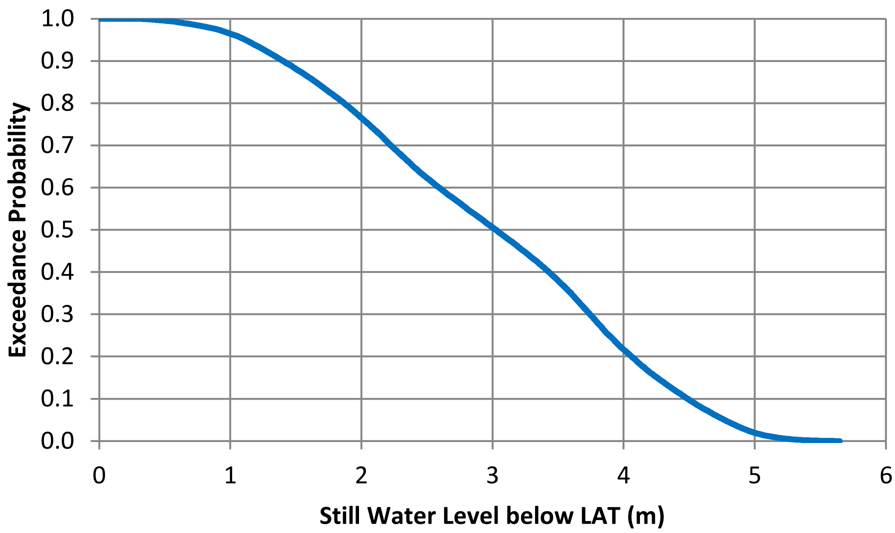


Figure 3.8 Water Level Exceedence Probability (2001)

The above graph illustrates that 96% of the time the tidal height is at least 1m above LAT and 77% of the time it is at least 2m above LAT.

Finally, extreme water levels were calculated by combining tide and surge elevations (Ref. iii). Table 3.1 presents extreme still water levels (tide and surge combined) with return periods of 1, 5, 10, 50 and 100 years.

Table 3.1 Kyle Rhea Extreme Still Water Levels

Condition	LAT (m)
100 yr +ve swell	7.4
50 yr +ve swell	7.3
10 yr +ve swell	7.0
5 yr +ve swell	6.9
1 yr +ve swell	6.7
HAT	6.0
MHWS	5.2
MHWN	4.0
MSL	3.0
MLWN	2.2
MLWS	0.8
LAT	0.0
1 yr -ve swell	-0.8
5 yr -ve swell	-1.0
10 yr -ve swell	-1.2
50 yr -ve swell	-1.4
100 yr -ve swell	-1.5

3.5 Visibility

The Pilot Book for West of Scotland (Ref.v) indicates the percentage frequency of fog (visibility below 1km) in the open sea areas off the west coast of Scotland is typically 1-2%.

The average number of days with fog recorded at coastal stations in the vicinity varies from 26 days per year at Skye to 2 days per year at Aultbea. It should be noted that this indicates the probability of fog occurring on a given day but not the duration of the fog.

Overall, it is considered conservative to assume a 3-5% probability of fog at Kyle Rhea.

4. Navigational Features

4.1 Overview

Kyle Rhea separates the east coast of the Isle of Skye from the mainland of Scotland. The Kyle connects the Sound of Sleat with Loch Alsh, 2nm north-northeast. It forms part of an inshore traffic route described in the Admiralty Sailing Directions (Pilot Book, Ref. v), along the west coast of Scotland, in which there is shelter and many anchorages, connecting the Mull of Kintyre at the north end of the North Channel to the North Minch.

The route is recommended only for small vessels, due to the limiting conditions that the Skye Bridge imposes at the west entrance to Kyle Akin in Kyle Akin (vertical clearance of 29m and navigable width of 80m). The Pilot Book also states that it is not advisable to proceed through Kyle Rhea at night without local knowledge.

The main aid to navigation within the stretch is Kyle Rhea Direction Light, a white tower 7m high. This light is a flashing red, white and green light, with a period of 3 seconds. The luminous range of the light is white 8nm, green 5nm, red between 8nm and 5nm. The three-colour directional sectored light is designed to keep vessels in the centre of the channel, indicated by the white ('safe') sector, as shown in Figure 4.1. (At present, three of the four proposed device locations are within the current white sector of this light, although the lighting is likely to be altered as part of the mitigation for the project.)

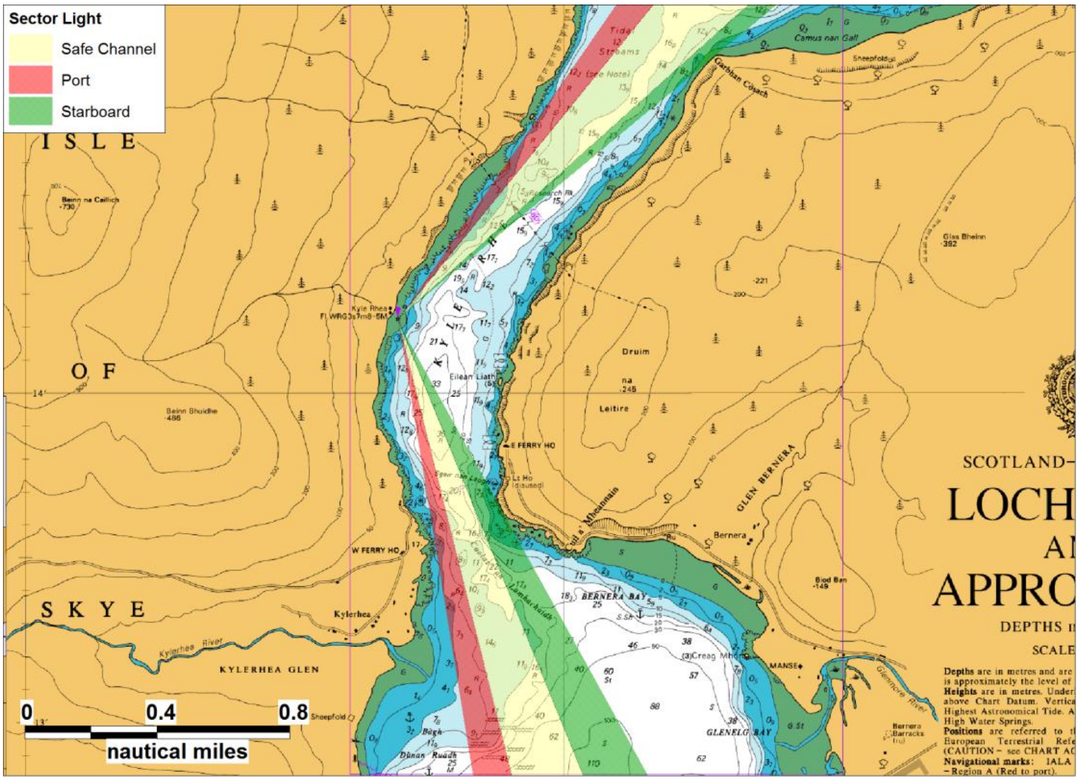


Figure 4.1 Kyle Rhea Sector Lighting

While waiting for a favourable tidal stream, mariners may obtain anchorage at the south end in Bàgh Dùnan Ruadh and, for small vessels, in Glenelg Bay and Bernera Bay. At the north end, anchorages suitable for coasters may be obtained off Rubha Buidhe and in Balmacara Bay.

There are charted marine farms in Kyle Rhea but consultation with Marine Scotland Compliance has confirmed that these are no longer present.

There are two cables spanning the north end of the Sound of Sleat, approximately 1,880m south of the Study Area. In Kyle Rhea itself, approximately 950m north of the Study Area, there is an overhead power cable with pylons, which a safe vertical clearance of 60m.

To the north, in Kyle Akin, are a number of submarine cable areas and submarine power cables.

4.2 Tidal Streams

This section outlines the information provided to mariners on Admiralty Charts and in the Pilot Book, which notes that the strong tidal streams may at times constitute a hazard to vessels on passage through the kyle. Tidal data available to mariners is presented in Section 3.4.

Tidal streams in Kyle Rhea are shown in diagrams on Admiralty Chart 2540-2 and are based on high water (HW) at Ullapool. These are presented in Figure 4.2 and Figure 4.3. The arrows show the mean direction of the tidal streams and their length and weight indicates, approximately, the rate of the stream. The figures show the mean neap and spring rates.
In Kyle Rhea the tidal streams set as presented in Table 4.1.

Table 4.1 Tidal Streams in Kyle Rhea

Interval from HW Ullapool	Remarks
+0545	N-going stream begins
-0015	S-going stream begins

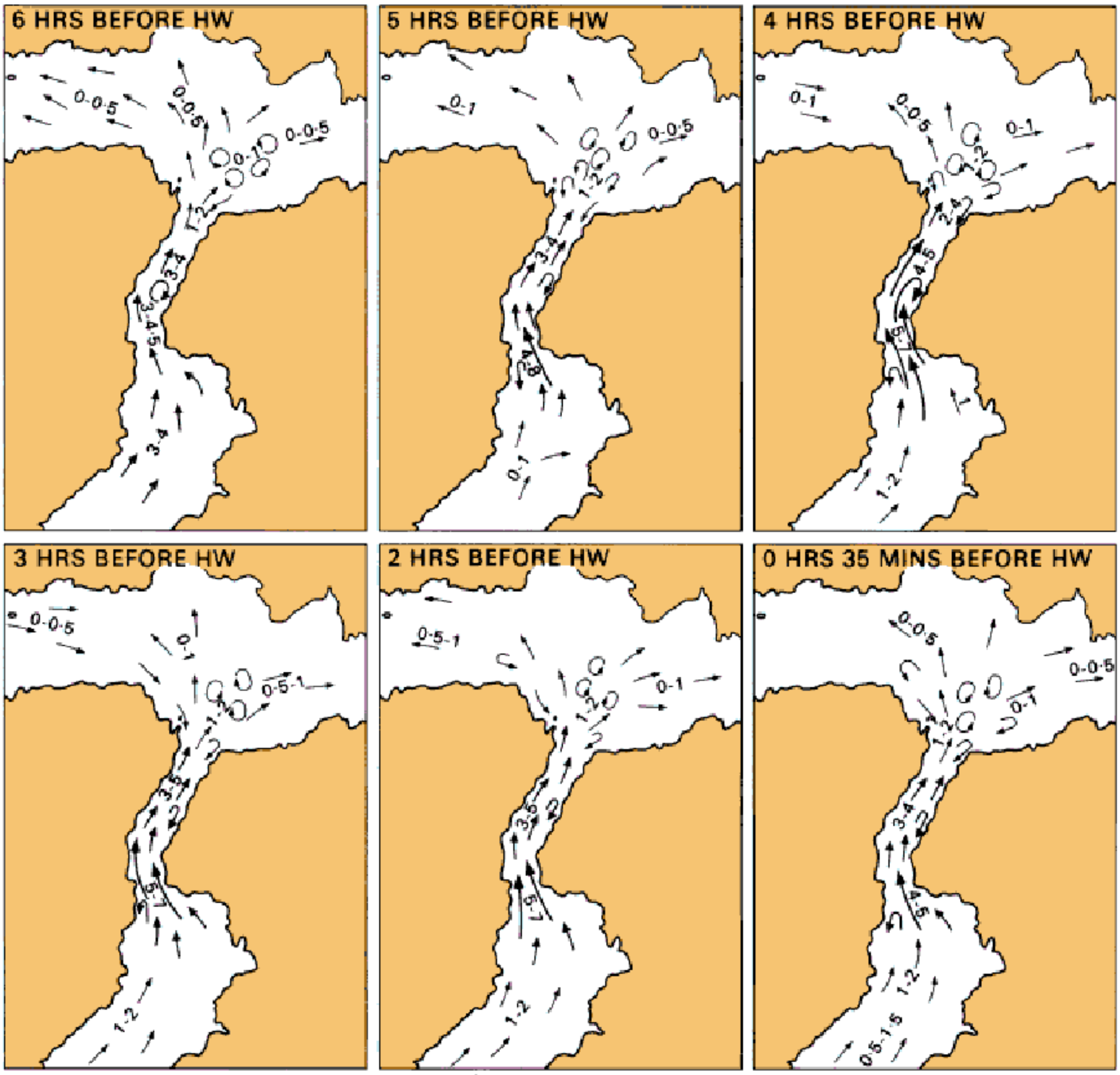


Figure 4.2 Tidal Stream Diagram before High Water

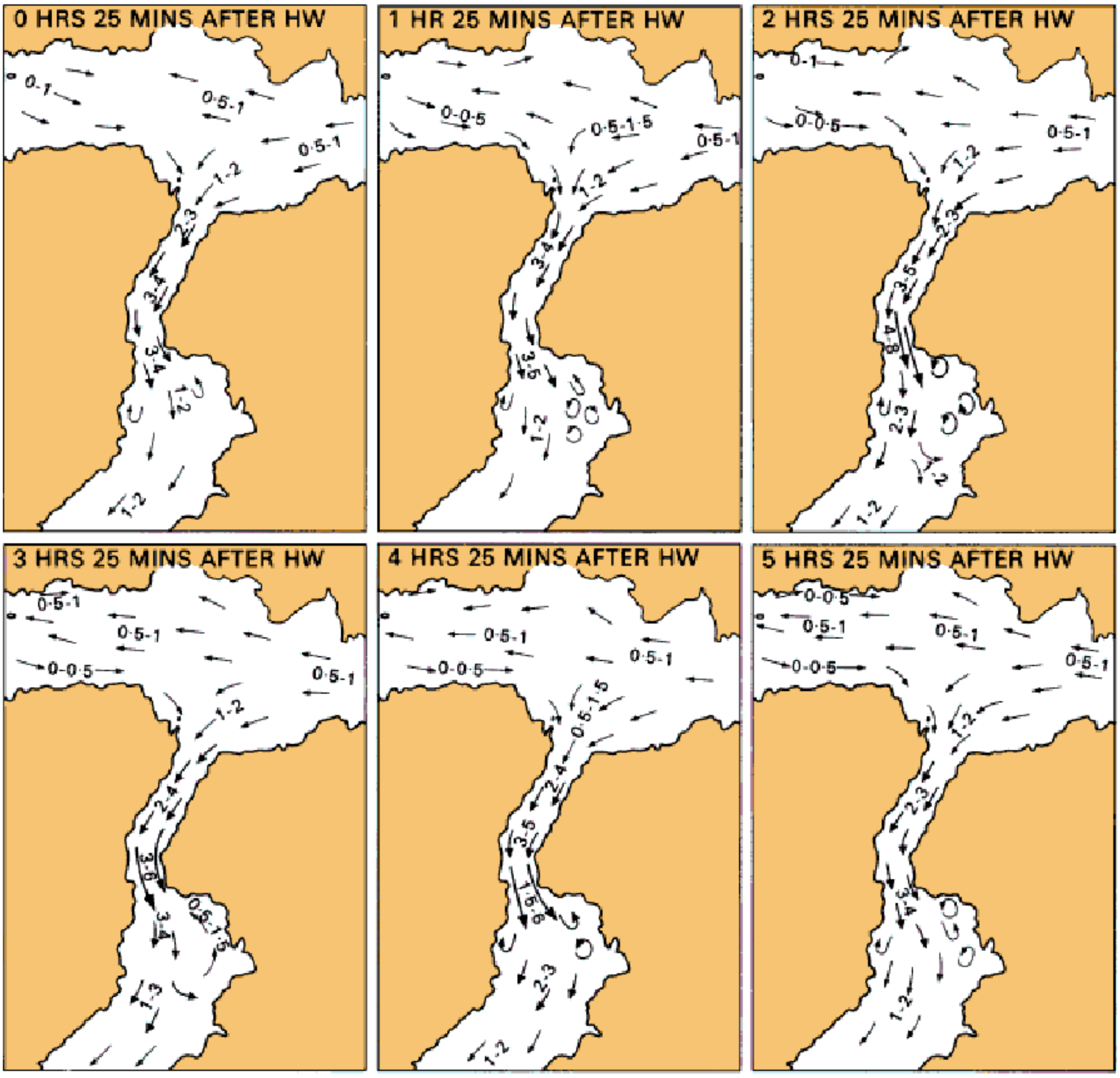


Figure 4.3 Tidal Stream Diagram after High Water

The Pilot Book states that the rates at mean spring tides are 6-7 knots on the north-going stream and 8 knots on the south-going stream. Strong and prolonged winds from the south and southwest increase both the duration and rate of the north-going stream and correspondingly reduce the south-going stream. Strong and continuous winds from the north have the reverse effect. The south-going stream is also increased, and the north-going stream reduced, when snow is melting in spring, and during and after periods of heavy rain.

When approaching from the Sound of Sleat an appreciable increase in the rate of the stream begins within about 0.3nm of the south entrance, inside the 30m depth contour. The rate then increases very quickly as Caolas an Lamhachaidh is approached.

Within Kyle Rhea, from 3 hours before high water until high water, the north-going stream sets over the low-water rocks along the west shore, at rates of 4.5 knots. At the north end of the Kyle it then discharges NNE into Loch Alsh as a narrow, rapid stream with eddies on both sides of it, quickly losing strength until, 0.5nm outside the 30m depth contour, it spreads weakly west towards Kyle Akin and east into the east part of Loch Alsh.

The south-going stream sets towards the north entrance of Kyle Rhea from both east and west and begins to increase its rate at about 0.6nm from the entrance. Within Kyle Rhea, near the south end, the south-going stream sets directly over Sgeir nan Laogh and the adjacent rocks which lie within 0.3nm of the east Ferry Pier. At the south end of the Kyle it discharges SSE into the Sound of Sleat as a narrow, rapid stream, with north-going eddies on both sides of it. This stream then loses strength quickly and, a mile or so from the south entrance, it is no stronger than the natural stream in the Sound of Sleat.

4.3 Eddies

Throughout the duration of the north-going stream, an eddy sets south close along the west shore of the channel, from Kyle Rhea Direction Light to the point, 6.75 cables south, which lies close northeast of West Ferry House. This eddy then continues from a position close south of the same point to a position 2 or 3 cables south of the entrance to the Kylerhea River. At the same time, an eddy sets south along the east shore of the channel, from a position 3 or 4 cables north of Eilean Liath.

During the whole of the south-going stream an eddy sets north along the west shore of the channel from the point lying northeast of West Ferry House to Kyle Rhea Direction Light, 6.75 cables north. At its north end, a short distance south of the light, this eddy extends 1.5 cables offshore. An eddy also sets north along the east shore of the channel from a position 3.5 cables south of Eilean Liath to a position 2.5 cables north of that islet. At its widest part, 1 cable south of Eilean Liath, this eddy extends 1 cable offshore.

4.4 Overfalls

When the south-going stream is opposed by fresh south and southwest winds, heavy overfalls, dangerous to boats, extend from 6 cables to 1 mile SSE of the south entrance to Kyle Rhea.

5. Stakeholder Consultation

5.1 Introduction

This section summarises the consultation which was carried out for the Project during preparation of the NRA.

This involved the following organisations representing the different users / stakeholders:

- Maritime and Coastguard Agency (MCA)
- Northern Lighthouse Board (NLB)
- Local Harbours (Kyle of Lochalsh and Mallaig)
- Vessel Operators (Ferguson Transport, Mallaig Marine, Marine Harvest, Isle of Skye Ferry and *Hebridean Princess*)
- Fishing Representatives (Lochalsh and Mallaig & NW Fishermen's Associations, Marine Scotland Compliance Fisheries Officer and Local Skipper)
- Ministry of Defence (MoD)
- Recreational Organisations (RYA Scotland, Cruising Association and Clyde Cruising Club) and Individual Sailors
- RNLI (Kyle of Lochalsh and Mallaig stations)

A summary of the consultation is presented below. In addition, a Hazard Review Workshop was carried out for the Project, involving a cross-section of the above stakeholders and others. This is detailed in Section 12 and Appendix A.

5.1 Maritime and Coastguard Agency

5.1.1 Navigation Safety Branch

A consultation meeting was held with the MCA in Southampton on 1 November 2012. The purpose of the meeting was to discuss potential navigational issues associated with the Project.

The MCA commented that the Project would undoubtedly reduce the width of the navigable channel, which may restrict vessels or affect their behaviour, such as timing of transits. There could also be an economic impact if vessels have to re-route west of Skye, e.g., cage towing vessels.

Mitigation measures identified by users at the workshop were encouraging but will need further consideration in terms of practicability and cost to implement, e.g., improved VHF coverage and traffic management. Further dialogue will be needed with the Coastguard.

In terms of traffic management, it was suggested that an advisory traffic scheme with clearly laid out guidance in Sailing Directions may be preferable to a mandatory scheme.

Further evaluation of specific issues during site investigations will be needed looking at the different options, e.g., moored barge, jackup or DP vessel.

It was noted that the maritime traffic survey data from 2010 will be out of date based on the MGN 371 requirements. MCA requested the data be refreshed when there is geotechnical work being carried out in 2013. It was noted that traffic would potentially be affected by activity on site but this would provide useful feedback on how vessels are able to cope with reduced sea room in the channel.

The MCA requested that the hydrographic data collected by Sea Generation Ltd be provided to them and UKHO to allow update of Admiralty Charts, which currently are very dated.

5.1.2 Stornoway Coastguard

Consultation was also held with the Rescue Co-ordination Centre (RCC) Manager at Stornoway Coastguard about the project and to obtain details on the Kyle of Lochalsh Vessel Reporting Scheme.

Concern was expressed that three of the devices are within the arcs of the leading light as approach is made from the south. It was also noted that Kyle Rhea suffers from poor or non-existent VHF/AIS coverage. The RCC Manager was unable to attend the Hazard Workshop. However, he reviewed the outcomes and commented that it was a comprehensive list of potential hazards and mitigation measures to reduce the risk. This includes measures for altering the sector lighting and improving VHF coverage.

In terms of traffic management, the existing voluntary system applies to the following vessels passing under the main span of the Skye Bridge.

- All passenger vessels
- All vessels bulk or packaged dangerous goods
- All other vessels of 300 GT and over
- Fishing vessels of 30m LOA and over
- Vessels restricted in their ability to manoeuvre

Vessels call Stornoway on VHF and provide details including vessel name, course, speed, port of departure / destination, draught, cargo, type, size and ETA at Skye Bridge. Suggested mitigation for the Kyle Rhea project also includes some form of traffic management. However, further discussion will be needed with the MCA nationally and locally to explore this.

5.2 Northern Lighthouse Board

NLB were also unable to attend the Hazard Review workshop but a consultation meeting was held in Edinburgh on 29 October 2012.

Concerns were raised about the Project, relating mainly to tides and tidal shear pushing vessels to the west, towards the proposed device locations. Back eddies either side of the main channel could affect vessels more following development due to re-routeing within Kyle Rhea.

It was stated that it was likely that there would be a significant increase in risk over the life of the development if effective mitigation was not introduced. NLB will wait for the full NRA to help them decide whether the predicted increase in risk is acceptable, taking into account mitigation. It was noted that modelling would be valuable, although it is recognised it has limitations, which need to be understood.

The benefit of AIS as an Aid to Navigation (AtoN) at Kyle Rhea would depend on the type of display on the vessel, as some have only a basic minimum keyboard display which is not optimally located on the vessel. Larger vessels have AIS integrated on radar but these should also see the turbines on radar. It was recommended to obtain feedback on the radar return of the device in Strangford Lough from vessels that transit the area.

It was noted that for installation and geotechnical work, the anchor wire profile would be key to the degree of risk, i.e., the profile of the mooring spread under water.

Initial advice on lighting and marking of the Project was given. The existing sector light would cause danger. Different options were discussed for altering this, e.g. shutting down the existing light and putting the sector light on Device 1, keeping the light for the north sector but installing a new light to the south, or a light ashore to mark mid-channel and where vessels are going to turn. It was noted that the current light is 7m high so could be affected by turbines. The light could be placed near the pylon, e.g. as a sector light to mark the heading north, or on one of the structures to provide a head and stern mark.

Lights on the southern and northern devices would likely be 5nm range, as per IALA. They could be sectored to present the impact onshore, mimicking existing lights. Other devices would have small yellow lights (1-2nm range with 360 coverage).

Lights could be located on the railings of the devices, lower down than at Strangford Lough, where feedback has indicated that small vessels may have difficulty observing them.

Floodlights were considered an appropriate means of ensuring the crossbeam is visible when raised for maintenance.

5.3 Vessel Operators

5.3.1 Ferguson Transport

Ferguson Transport were consulted directly about the project and one of their experienced Masters attended the Hazard Review Workshop.

Their vessels are approximately 30m in length and transit Kyle Rhea several times a week, making passage day and night. Operations include running fish farm feed vessels through the Kyle. Activity could potentially increase with company expansion.

Transits take place in all tides although greater consideration is given to this when vessels are loaded and/or towing. Transits do not usually vary with the seasons but adverse weather conditions could delay certain passages.

In terms of the effect of the project on safe navigation, it was commented that care would need to be exercised whilst passing the structures, particularly at night and with reduced visibility, meeting other vessels and whilst engaged in towing. If the current was strong, an extra degree of vigilance would be required.

5.3.2 Marine Harvest

Marine Harvest has fish farming operations along the west coast of Scotland (including Mallaig, Skye, Fort William and various lochs) and on the Western Isles. The main product is salmon, sold as whole fish.

Marine Harvest consulted with fish farm well-boat crews (vessels which contain vats of water in which to transport live fish prior to harvest). This included the Masters of the *Ronja Pioneer* and *Ronja Commander* which were recorded in the traffic survey regularly transiting Kyle Rhea.

Feedback indicated that the Masters did not have any major concerns provided the array is clearly marked and lit. It was noted that vessels when heading south with a strong tide can "drift a bit wide" but they can prevent this if/when there are structures in the way. As a matter of course, the vessels call on VHF before committing to the passage to let other vessels aware of their transit.

5.3.3 Mallaig Marine

Mallaig Marine operate the *Emma C* towing cages for Marine Harvest to support fish farms on the west coast of Scotland. Scottish Sea Farms and Scottish Salmon Company also use Kyle Rhea. In total, it is roughly estimated that there are approximately 40 cage towing operations per year.

Plastic cages are approximately 35m in diameter but larger steel cages are 50m wide. Barges are also towed, but these are only 6m wide.

In terms of navigation with the tidal array in place, no problems were anticipated when transiting through not towing cages or with smaller barges. The Master would tend to keep to the Glenelg side close to shore to avoid strong tides and would always pass east of the devices. When towing cages, there is less control and the tide can cause the cage to swing out from behind the vessel.

Passage is timed to have a favourable tide, e.g., by waiting at the top end of the narrows pushing against the last half hour of the tide, then when it is turning transit through. Slack water lasts approx. 20-30 minutes. The area to the south of the potential device locations, just north of the ferry landing, has the strongest tide.

It was commented that in the area where the devices are planned, it is possible to see other vessels coming so they could wait for them. VHF could also be used to broadcast intent to transit, but not all vessels do this or monitor VHF.

Mallaig Marine would want to be given priority when towing cages through Kyle Rhea to avoid encountering opposing vessels. Even then, there could still be an issue due to the lateral movement of the cages, caused by tides, and they would most likely re-route west of Skye. This would need a suitable weather window and take extra time.

5.3.4 Hebridean Princess

Consultation by telephone and email was carried out with the Master of the *Hebridean Princess*, a 72m long passenger cruise ship recorded in the traffic survey. He was unable to attend the Hazard Review Workshop but provided feedback on the outputs.

The Master has been through Kyle Rhea over one hundred times and stated that it is difficult to maintain a precise course when transiting during spring tide and at mid-tide when the current is running at its strongest.

The *Hebridean Princess* transits Kyle Rhea at all states of the tide, both with and against the stream. When transiting against the tide, progress is slow and there is perhaps a slightly higher risk of the ship taking a shear caused by the tidal eddies in the area. When transiting with the tide, the transit is faster (17 knots is frequently reached), and there is risk of the turn being wider than planned. The devices would be located near the apex of the turn, posing a risk if a vessel was to overshoot.

After receiving the device locations for consultation, he has marked them on the ship ECDIS and transited Kyle Rhea four times using a revised passage plan. The revised passage plan put the vessel approximately 0.06nm (110m) from charted hazardous rocks off the eastern shore and 0.06nm from the position of Device 2 (0.05nm / 90m with the crossbeam in the raised position). This is very close to hazards for a cruise ship, and the strong tides make it difficult to maintain a precise course. Marker buoys or perches on the eastern shore would be very helpful in marking the safe water.

A safety announcement is made on VHF Channel 16 prior to transiting, but not all vessels listen or respond, and he has encountered vessels coming in the opposite direction. A concern would be if another vessel, such as a yacht, is not complying with the ‘rules of the road’. Whilst this may not cause an actual collision, it could force a ship to take avoiding action and with the devices in place there is very little sea room to spare. For this reason, it was felt that mitigation should include an active VTS properly controlling traffic in a one way system.

5.3.5 Isle of Skye Ferry Community Interest Company (IOSFCIC)

A meeting was held onboard the ferry (*Glenachulish)* with the Master and a representative of IOSFCIC during three crossings between Glenelg and Kylerhea. (IOSFCIC also attended the Hazard Review Workshop.)

The ferry service operates from April to October, with the start date varying according to when Easter occurs each year. Sailings are on demand up to every 20 minutes between 10:00 and 18:00 hrs.

The ferry takes a more northerly course (towards device locations) during ebb tide (running southbound) but it was considered this was manageable.

The draught of the ferry is 1.3m which means the risk of interaction with the subsea rotors is minimal. The service is suspended in Force 8 or above. Despite the sheltered location, there can be some waves through the area in south-westerly conditions, and the sea gets choppier when the wind is opposing the tide.

The ferry was built in 1969 and has a single engine. It has suffered engine failure in recent years but was able to anchor to fix the problem. The ferry can anchor most of the way across except in the deepest water towards the centre of the channel.

The ferry Master checks north / south transiting vessels before setting off to make sure encounters are avoided. It is common to see vessels heading in the same direction, and two vessels crossing in opposite directions is observed roughly once a month.

Many vessels broadcast their intention to transit on VHF Channel 16 before entering the channel. This helps to inform other vessels with the same intention, meaning that they can wait or time their arrival south or north of the channel to avoid opposing traffic.

Overall, it was considered that the ferry would not be adversely affected by the devices provided they are clearly marked and lit. Work on the site, e.g., moored barges, could have more potential impact but this can be mitigated by carrying out this work off-season, i.e., before Easter or late autumn.

5.4 Local Harbours

5.4.1 Kyle Harbour

A meeting was held with the Kyle Harbour Master during the NRA, and the Deputy Harbour Master attended the Hazard Review Workshop.

It was emphasised that Kyle Rhea is a sheltered route and shorter than the alternative route west of Skye, so it is considered vital for transits off the west coast of Scotland. The tidal streams have a major influence on vessel heading and control through the narrows.

Two vessels transiting in opposite directions at the same time was considered the biggest navigation safety issue. The tide helps manage this to an extent, some vessels with local knowledge use the back eddies. It was thought that some local vessels may pass to the west of the turbines, but this would depend on the tide.

Ronja fish farm vessels are the main vessels that transit against the tide. Larger vessels may prefer this as it gives them more steerage. It is likely, however, that they do so because they sail to a timetable. Fish farm cages get towed through Kyle Rhea and these vessels have restricted manoeuvrability.

Some form of reporting system was seen as vital to control traffic by direction. Alternatively some kind of traffic lights system (adjusted for tidal times) to prevent vessels going in opposite directions.

5.4.2 Mallaig Harbour Trust

A meeting was held with Mallaig Harbour Authority during the NRA, including the Harbour Master, who also attended the Hazard Review Workshop.

Kyle Rhea was noted to be a busy seaway with limited sea room. The available sea room would be significantly reduced due to the surface elements of the Project which was of concern in terms of the likelihood of an increased rate of accidents.

It was indicated that when transiting Kyle Rhea mariners are committed as they cannot stop and turn back. Anchoring is not practicable due to strong tidal streams. Coasters and some yachts may be discouraged from using the area as they would not want to pass through the narrower channel. Cage towing vessels were also noted to have limited manoeuvrability when transiting Kyle Rhea.

It was noted that new fish farming facilities are being built in the area and boats are expected to get larger because of this (longer and deeper draught).

A new yacht facility opened in Mallaig in 2011, however, the harbour felt that this would not necessarily increase transits through Kyle Rhea, it may just mean yachts call at Mallaig en route rather than competing ports.

Key mitigation was summarised as follows:

- Pre-warn vessels so they can re-route if necessary
- Marking and lighting of site (including changing existing sector lights)
- Traffic management, e.g., holding pattern by Coastguard who know what is coming in each direction, although does not cover all vessels.
- Large vessels can wait off Ornsay to the south or in Loch Alsh to the north and / or slow down to time arrival and avoid a head-on encounter.

5.5 Fishing Representatives

5.5.1 Lochalsh Fishermen's Association

A member of Lochalsh Fishermen's Association attended the meeting held with Kyle Harbour (see notes above) and also attended the Hazard Review Workshop.

In terms of fishing vessel activity, there are about four day-running fishing vessels out of Kyle which transit Kyle Rhea, going south in the morning and returning north before dark. Typically 2m draught. Larger east coast vessels also use Kyle Rhea, typically 3-4m draught. Their activities are more variable year-to-year.

5.5.2 Mallaig and North-West Fishermen's Association

Dialogue was held by telephone and email but the main consultation with this Association was through a representative's attendance at the Hazard Review Workshop.

5.5.3 Mallaig Fisheries Officer

Mallaig Fisheries Officer from Marine Scotland Compliance was consulted about the Project at a meeting in Mallaig.

There are approximately 15 fishing vessels based in Mallaig. The fishing fleet can be divided into approximately four smaller vessels, up to 10-14m in length, and larger vessels of up to 22m. The larger vessels do not regularly transit Kyle Rhea as they generally work around the west coast islands and Sound of Sleat. They may pass through occasionally, approximately four to five times a year. The smaller vessels are likely to transit Kyle Rhea, as are smaller vessels based at Kyle of Lochalsh.

There is no significant fishing activity in Kyle Rhea. There is also no aquaculture, as recently confirmed by a RIB survey (despite a project being depicted on Admiralty Charts to the east of the site). There is a low level of leisure fishing in the area by smaller boats.

In terms of seasonality, movements can vary from year-to-year depending on fishing patterns. Mallaig has a spring fishery, with some vessels land in Kyle of Lochalsh and therefore transiting Kyle Rhea. There is also the nomadic Scottish fishing fleet, e.g., vessels based in Fraserburgh and Peterhead, primarily prawn trawlers, which could transit Kyle Rhea on occasion. In 2012 there was a very high level of this activity as the east coast fleet used up a large proportion of the allocated days for Scottish vessels. In future there are likely to be additional geographical controls to prevent this being repeated, which will reduce the number of transits.

The area is closed to trawling from October to April under the Inshore Fisheries Act. Although there is no fishing in the Kyle Rhea area all-year round, this closure may influence fishing transits by vessels from further afield. Overall, it was felt the survey data from February and June 2010 should be reasonably representative of fishing vessel movements.

Well-boats offload to Mallaig and their numbers could increase in future with new facilities being built.

Information in advance of operations at the site could be circulated to fishermen via Portree and Mallaig Fisheries Offices.

5.5.4 Skipper, Helen Bruce (BRD 90)

The skipper of this fishing vessel, the most regular transiting fishing vessel observed in the traffic survey, was consulted directly about the project as he is not a member of an Association.

He commented that the devices are located close to the strongest part of the tidal stream. His vessel going with the tide can be travelling at 13-14 knots, twice the normal speed of 7-8 knots, which makes it more difficult to control heading. He has recently fitted a more powerful engine to the vessel to allow transit against the tide, typically 3-4 knots.

He uses local knowledge when necessary to avoid the strongest tide by hugging both the Skye and mainland coasts. From this point of view, any form of traffic separation scheme would not be favoured as it would limit a skipper's ability to do this.

He is always wary when transiting Kyle Rhea in case of getting into difficult, e.g., fuel blockage. However, he felt that provided the array is well marked, and mariners are well informed, the navigational issues could be managed. Most concern would be people with less knowledge, such as a visitor chartering a yacht. A leaflet would be helpful summarising all the information about the project, tidal streams and who to contact for more information. An extension of the Coastguard Reporting system would also help.

5.6 Ministry of Defence

The MoD uses Kyle Rhea for training. Occasional vessels transit through to give university students navigational training in a narrow channel. The proposed turbines would be another constraint for them but they should not pose a problem given the vessels' sizes and specifications. Larger Royal Navy vessels would not tend to transit Kyle Rhea, except for the occasional frigate.

No Royal Navy submarines would pass through. Vessels associated with the British Underwater Test and Evaluation Centre (BUTEC) in the Inner Sound occasionally go into Kyle Akin but would not go as far south as Kyle Rhea. If a small submarine passed through from another country, it would do so on the surface.

It was stated that if a merchant vessel could navigate through Kyle Rhea with devices in place, then it should be safe for a small submarine (on the surface) or a Royal Navy frigate or destroyer to do the same.

5.7 Recreational Organisations and Vessel Operators

5.7.1 RYA Scotland

A meeting was held with RYA Scotland during the NRA and they provided additional feedback based on canvassing members knowledgeable about the area. A summary of the information provided is as follows:

- Proposed devices will restrict sea room, especially Device 2 which is relatively central.
- Tides make it difficult to control heading especially for recreational vessels with low power. A small minority are sail-only.
- Feedback from members who use Kyle Rhea has indicated the devices will be significant hazard to navigation.
- Not practicable for all vessels to re-route west of Skye.
- Planned new facilities could increase recreational traffic in future.
- Collision incident could lead to people in the water. Mitigation considered essential in the form of guard / emergency response vessel.
- Poor existing VHF coverage in Kyle Rhea. RYA has been lobbying the MCA to improve this.
- Several means available to pre-warn mariners, e.g., Notices to Mariners, charts and Sailing Directions. Should reach most people but there will always be a few exceptions.
- Timing of passages near slack water may sometimes be possible but not always. Depends on circumstances.
- Good anchorages / waiting areas are available for use both north and south of Kyle Rhea.
- Would like to see devices moved west to align with white sector of existing leading light.
- Would like to see "traffic light" system to manage traffic, equivalent to a Port VTS.
- Possibility that bow wave effect would push smaller vessels away from the tower, reducing collision likelihood. Needs to be simulated.

5.7.2 Clyde Cruising Club

The CCC commented by email that the establishment of the devices would cause an unnecessary hazard in a very well used passage. If the installation was to go ahead, the devices would be better sited towards the northwest so that the usable channel would be wider. Any obstruction of Kyle Rhea would be a cause of danger to any vessel that did not have its own power as the wind cannot be relied upon.

5.7.3 Cruising Association (CA)

The CA were consulted by email. Following canvassing of members in the local area they provided a detailed response, with the main points summarised below:

- Project will pose a serious hazard to the safe navigation of recreational traffic.

- Obstruction in a narrow channel essential to navigation but already complex for small craft due to strong tidal streams.
- Project will significantly reduce the sea room available in the channel.
- Increased hazard of vessel-to-vessel encounters / collisions.
- Forces small craft towards shore or to use difficult passage west of Skye.
- Mitigation can best be achieved by relocating devices westwards, west of the white ('safe') sector of the existing light.

5.7.4 Gordonstoun School

Gordonstoun School operate the sail training vessel *Ocean Spirit of Moray*, which was tracked a number of times during the traffic survey. They were initially consulted by the RYA Scotland and subsequently by Anatec and asked to review the Hazard Review Workshop outputs. Comments are summarised below:

- The proposed mitigations make an assumption about the diligence, professionalism and seamanship of users that may not be applicable to all owners of pleasure boats. May need a permanent guard ship on duty to monitor leisure users.

- The risks of a passage by inexperienced sailors in small vessels to the West of Skye in strong winds are well known, but when a strong south westerly wind is opposed by the ebbing tide, a passage through Kyle Rhea itself can also present significant difficulty to small vessels. Any additional hazard to navigation would further increase the difficulty of making this passage at times when it provides the only tenable alternative to a passage west of Skye.

- A small vessel making a passage from the Point of Sleat to destinations in the Inner Sound via the west of Skye could have 18–24 hours added to the passage time in fair weather in comparison to the Kyle Rhea route. If Kyle Rhea became difficult to navigate many yachts based south of Kyle Rhea would stop making regular visits to Kyle of Lochalsh and ports beyond.

- The difficulty of making a passage past the installation at night has not been adequately addressed. Currently the sector light provides clear indication that a vessel in in safe water and this is essential when the rate of tidal set cannot be gauged by other visual reference. The inclusion of the tidal scheme would require vessels to take a "dog leg" around the hazard which would take them out of the safe sector of the current light.

- A line of buoys marking the eastern extremity of the safe water would not necessarily provide the reference that is needed to judge the extent of tidal set to the west (particularly for the inexperienced visitor) and so a properly marked channel using red and green lateral marks would be required. The difficulties of maintaining the position of theses buoys in the tideway has already been identified and the buoys could pose a collision hazard to vessels.

- The assumptions that the local coastguard/lifeboat crews will always be on hand to deal with the additional hazards imposed by this scheme does not seem to take into account the impact that this would have on resources that are already stretched to maintain current levels of safety cover for other seafarers.

- Expressed concern about the devices being on the surface for maintenance both in terms of timing and sequence of operations, as this could impact safe navigation for larger vessels.

- Greatly concerned about the hazards associated with the project, even with the suggested mitigation. Concluded that the project would create an unacceptable hazard to shipping in a restricted area of water already needing careful navigation.

5.8 RNLI

5.8.1 Kyle of Lochalsh

Kyle of Lochalsh RNLI was consulted about the Project at a meeting at the station and provided more details on their response capability and historical incidents in the area.

The inshore lifeboat (ILB) at Kyle of Lochalsh can tow approximately 40-50ft vessel, depending on tides and conditions. The all-weather lifeboat (ALB) based at Mallaig is tasked for larger vessels.

The ILB would take approximately six minutes to reach the site, with the launch time ranging from 4-4.5 minutes to a maximum of 7.5 minutes.

VHF coverage for a lifeboat is virtually non-existent. Other vessels also have poor communications. RNLI have requested the Coastguard improve VHF coverage for the area. In the meantime, Kyle station has TETRA (Terrestrial Trunked Radio). A major reason for this investment was concern about incidents involving the Skye ferry. Installation of a new VHF radio antenna and repeater station would be a potential benefit to all vessels in the area as well as emergency services.

It was commented that the Skye Bridge and its caissons had caused a bigger restriction to shipping than would be the case for the Project. Navigable width under the bridge is only 80m and there are significant tidal streams. However, vessels can slow down and wait it out before going under the bridge, so they are not committed like they would be in Kyle Rhea. The traffic management system at Skye Bridge is passive (i.e., voluntary reporting).

Overall, the Lifeboats Operations Manager did not consider there would be a major problem with the development.

5.8.2 Mallaig

The RNLI Mallaig lifeboat coxswain attended the meeting at Mallaig Harbour Trust (see meeting notes above, which also apply to the RNLI).

It was confirmed that any larger vessels (over about 30ft) involved in an incident at the site, would be responded to by Mallaig ALB, which would take approximately 30 minutes to reach the site.

Mitigation discussed at the meeting included pre-warning vessels so they can re-route if necessary, marking and lighting of the site, and traffic management.

6. Survey Data Analysis

6.1 *Introduction*

This section presents analysis of maritime traffic (radar, AIS and visual) collected for Kyle Rhea (Ref.vi). The raw survey data positions were obtained from the surveyors and re-plotted to be made compatible with Anatec's GIS Survey Analysis toolkit for more detailed analysis. As part of this process, further literature research was carried out on vessel types and sizes to fill in missing data and make corrections where necessary.

The survey periods totalled 35 days in the following periods:

- 15 days winter 2010 (18 February to 4 March); and
- 20 days summer 2010 (8-13 and 15-28 June).

Overall, about three-quarters of the vessels were recorded on radar, typically fishing and recreational vessels. AIS was used to record larger vessels which represented approximately 25% of the total.

It should be noted that the survey did not fully track the regular Isle of Skye Ferry which runs between Kylerhea and Glenelg. The ferry operation is discussed separately in Section 6.4.

(Further analysis of the survey tracks in terms of lateral distribution of tracks per vessels type is presented in Appendix C.)

6.2 *Overview of Survey Tracks*

Plots of the vessel tracks within the general Kyle Rhea area for the summer and winter periods, thematically mapped by vessel type as broadcast on AIS or identified visually for vessels tracked on radar, are presented in Figure 6.1 and Figure 6.2.

The busiest days in each period are presented in Figure 6.3 and Figure 6.4.

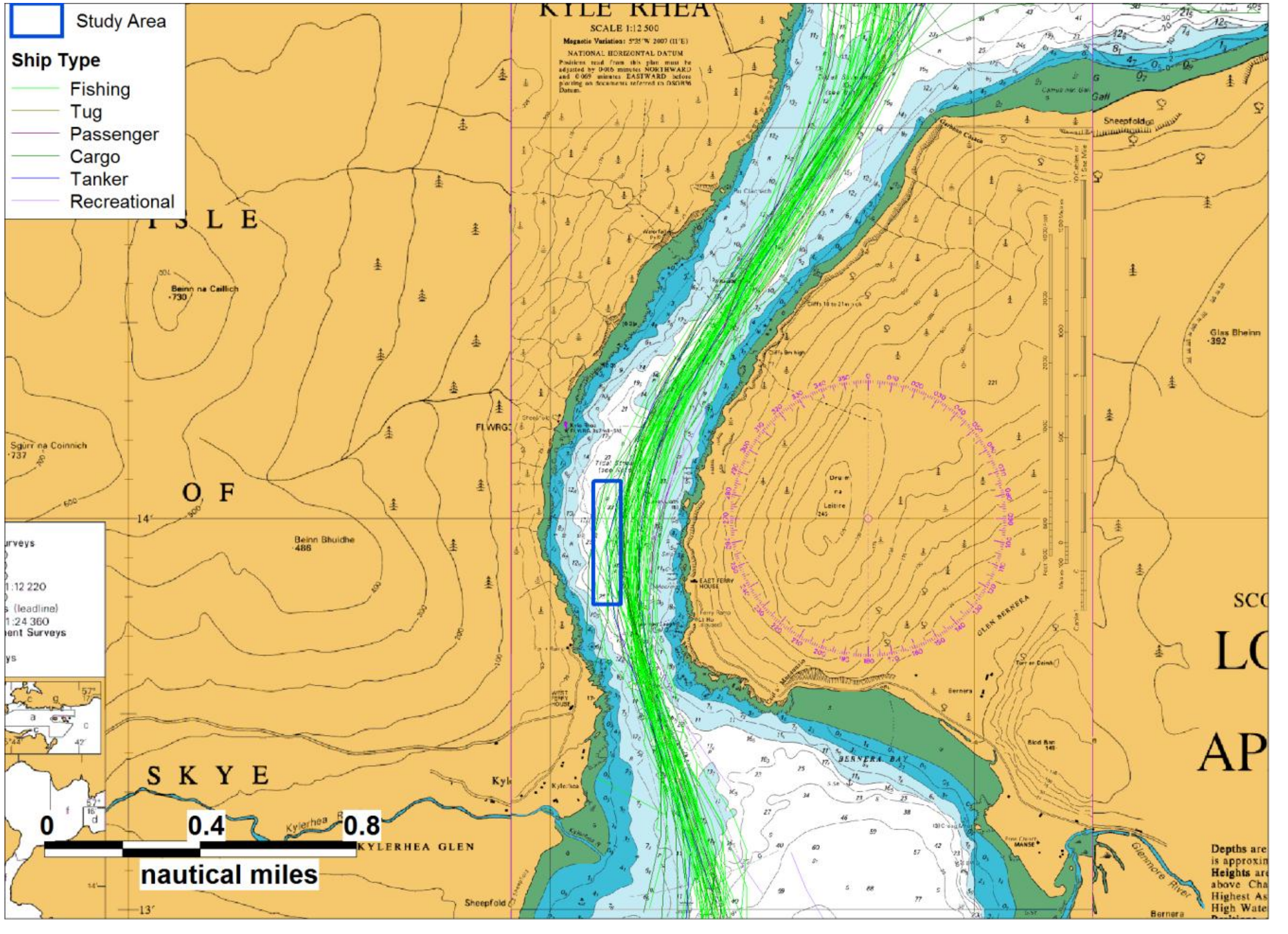


Figure 6.1 Winter 2010 Survey Data in General Area of Kyle Rhea (15 Days)

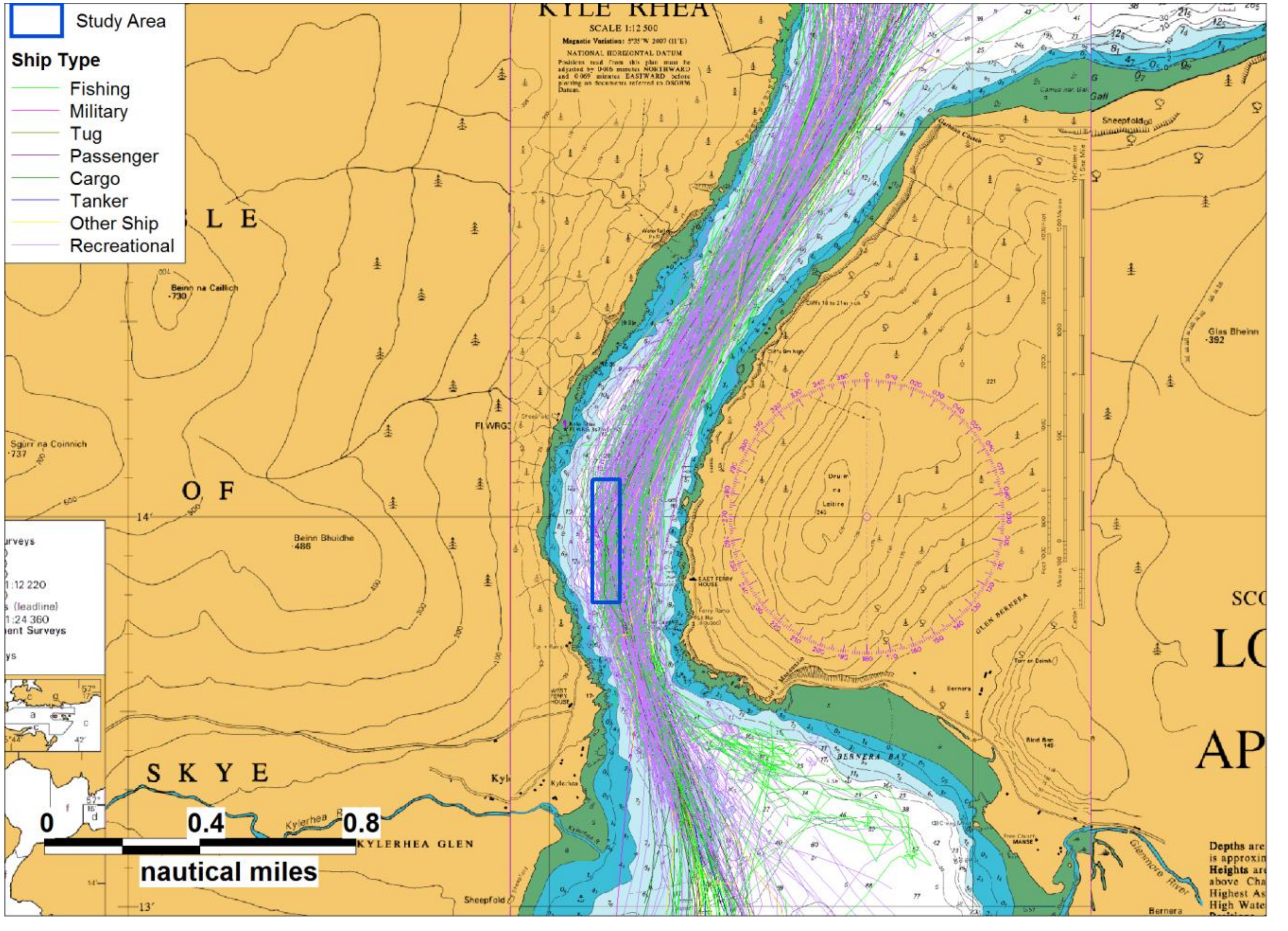


Figure 6.2 Summer 2010 Survey Data in General Area of Kyle Rhea (20 Days)

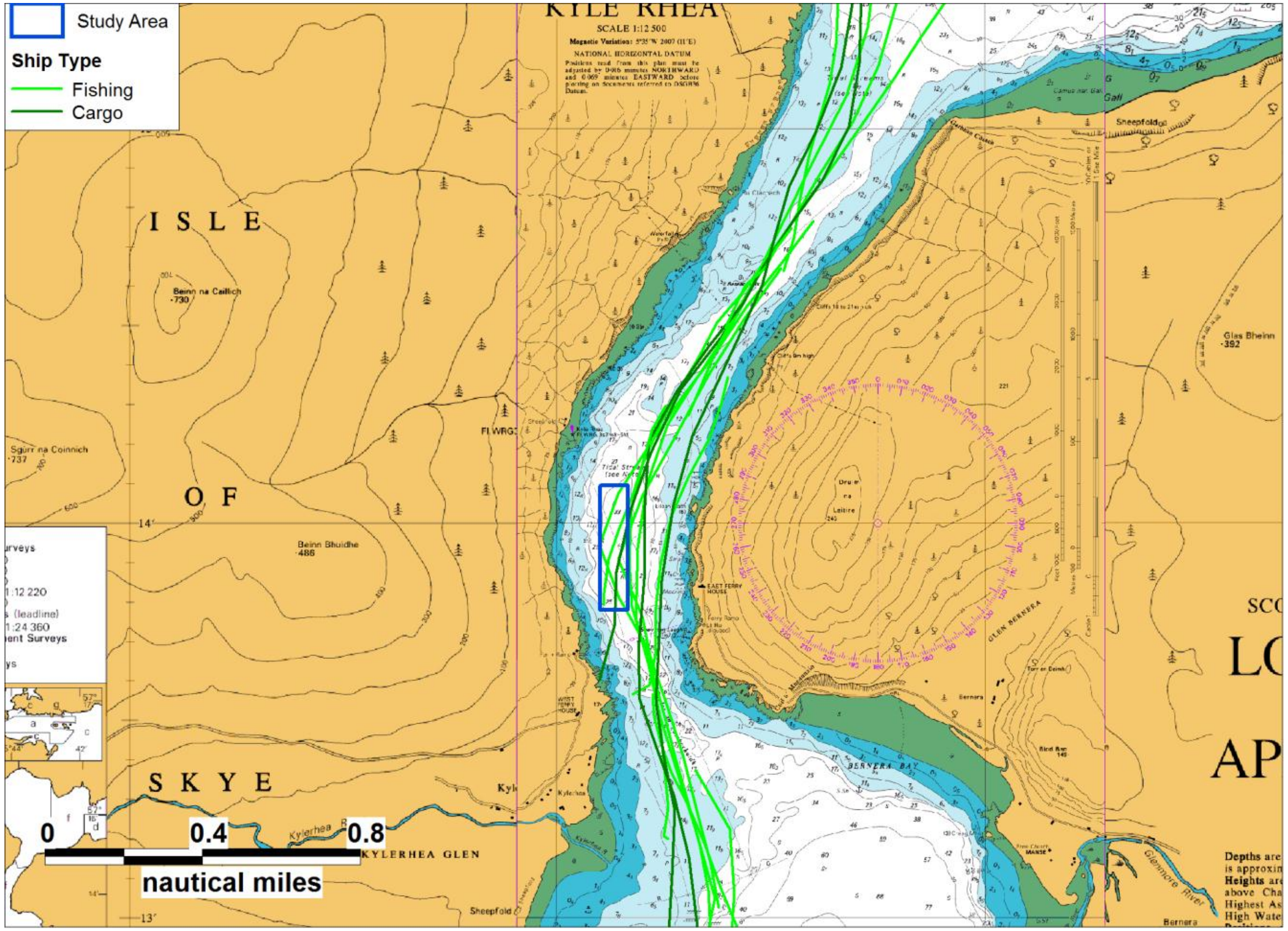


Figure 6.3 Busiest Day Winter (22 February 2010)

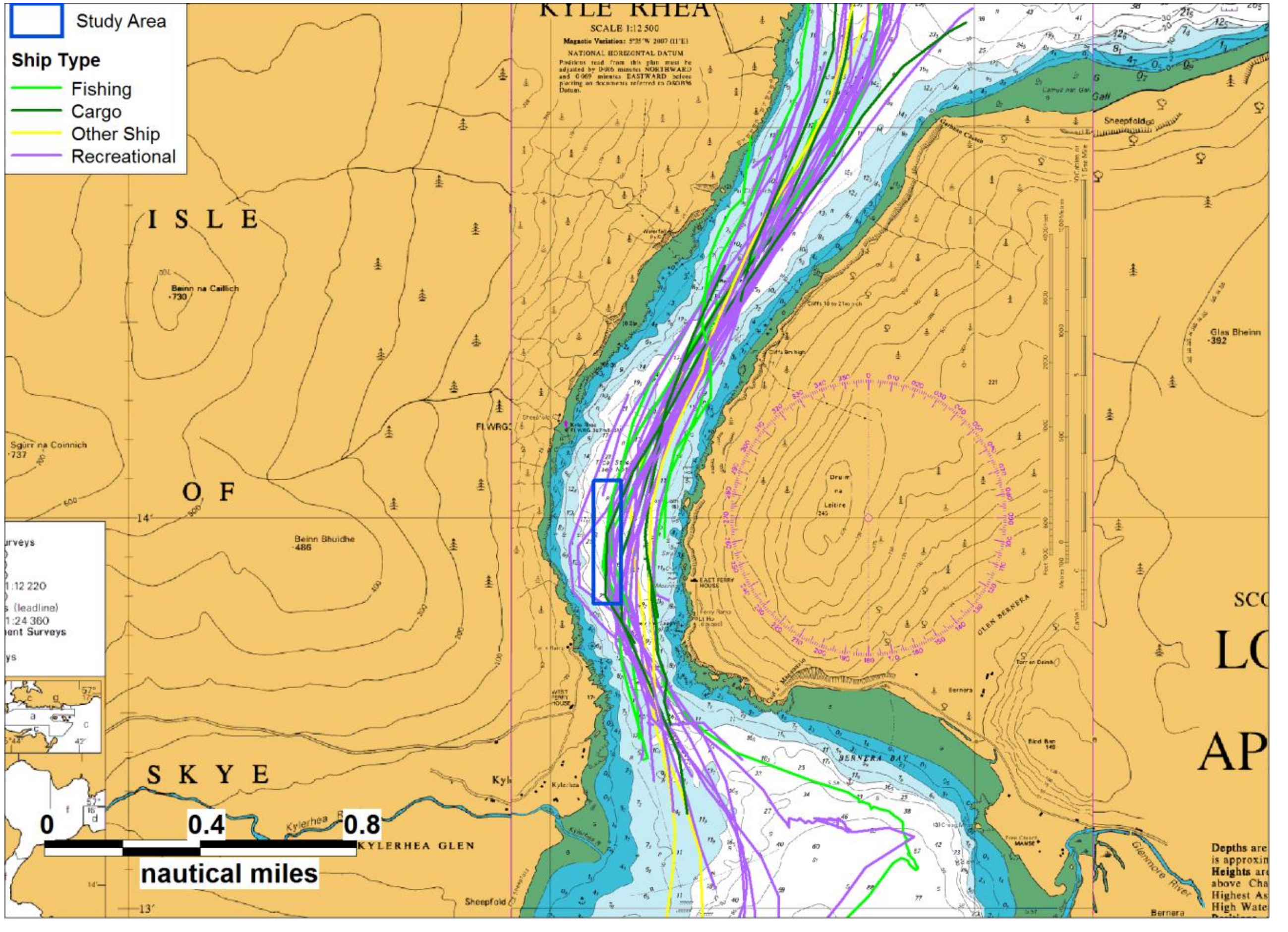


Figure 6.4 Busiest Day Summer (21 June 2010)

Figure 6.5 and Figure 6.6 present the number of vessels tracked per day in the winter and summer period, respectively.

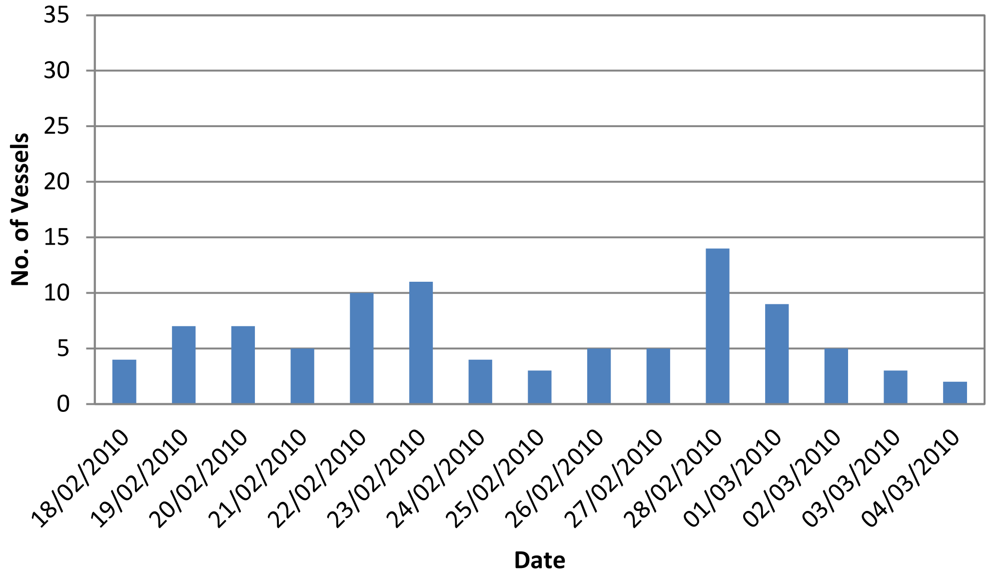


Figure 6.5 Winter 2010 Daily Count

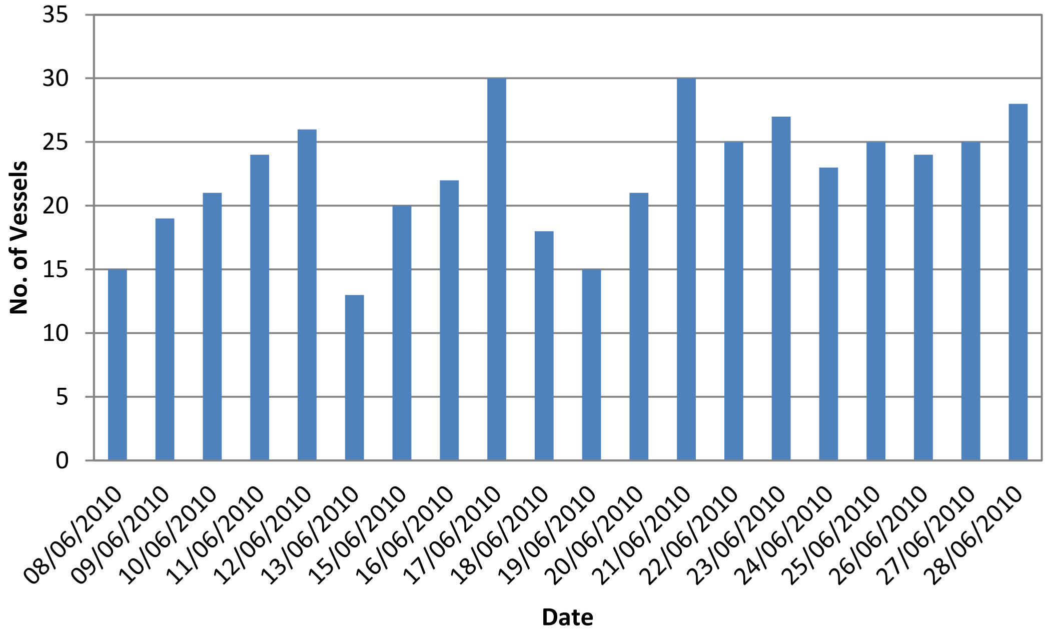


Figure 6.6 Summer 2010 Daily Count

During the winter period, there was an average of 6 unique vessels tracked per day. During the summer period, there was an average of 23 unique vessels tracked per day.

The vessel type distributions varied during the periods, as presented in Figure 6.7.

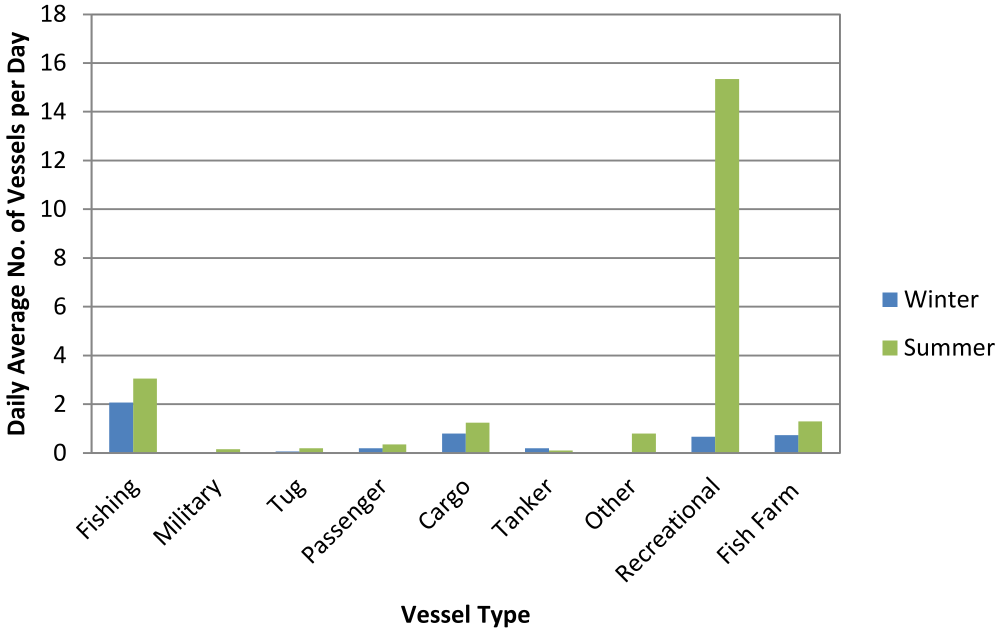


Figure 6.7 Vessel Type Distribution (Winter & Summer 2010)

It can be seen that there was much higher recreational vessel activity in summer compared to winter. The other vessel types were more consistent although most tended to be higher in summer than winter, especially passenger vessels.

6.3 Detailed Traffic Analysis

6.3.1 Numbers of Vessels by Type

More detailed analysis of the traffic transiting Kyle Rhea during each of the two survey periods has been carried out. This was performed by drawing a gate as a cross-section across Kyle Rhea, as can be seen in Figure 6.8, near the centre of the Study Area.

Figure 6.8 and Figure 6.9 present the tracks observed to intersect the gate during the entire winter and summer periods.

The busiest days in each period are presented in Figure 6.10 and Figure 6.11.

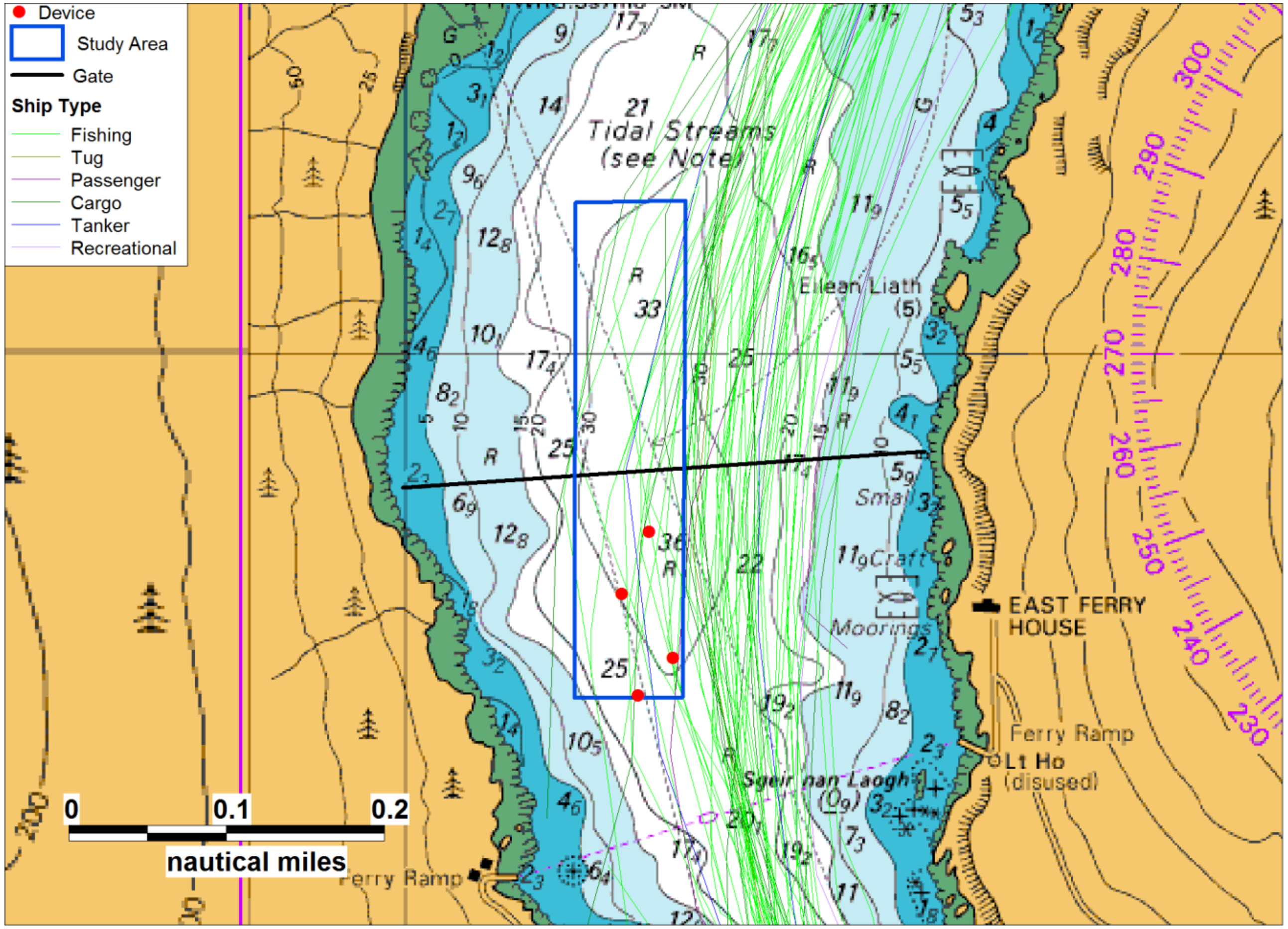


Figure 6.8 Winter 2010 Survey Tracks intersecting Gate (15 Days)

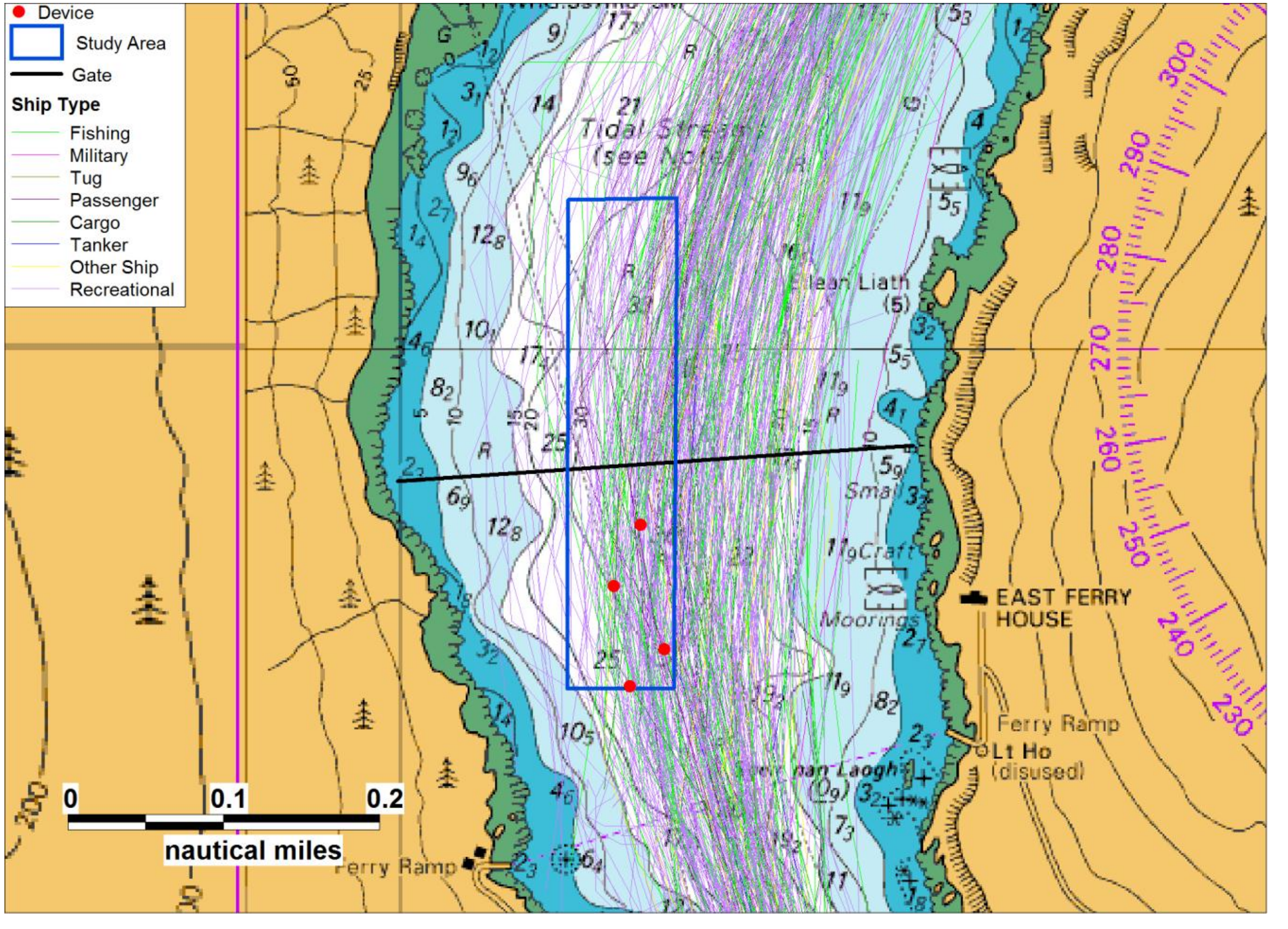


Figure 6.9 Summer 2010 Survey Tracks intersecting Gate (20 Days)

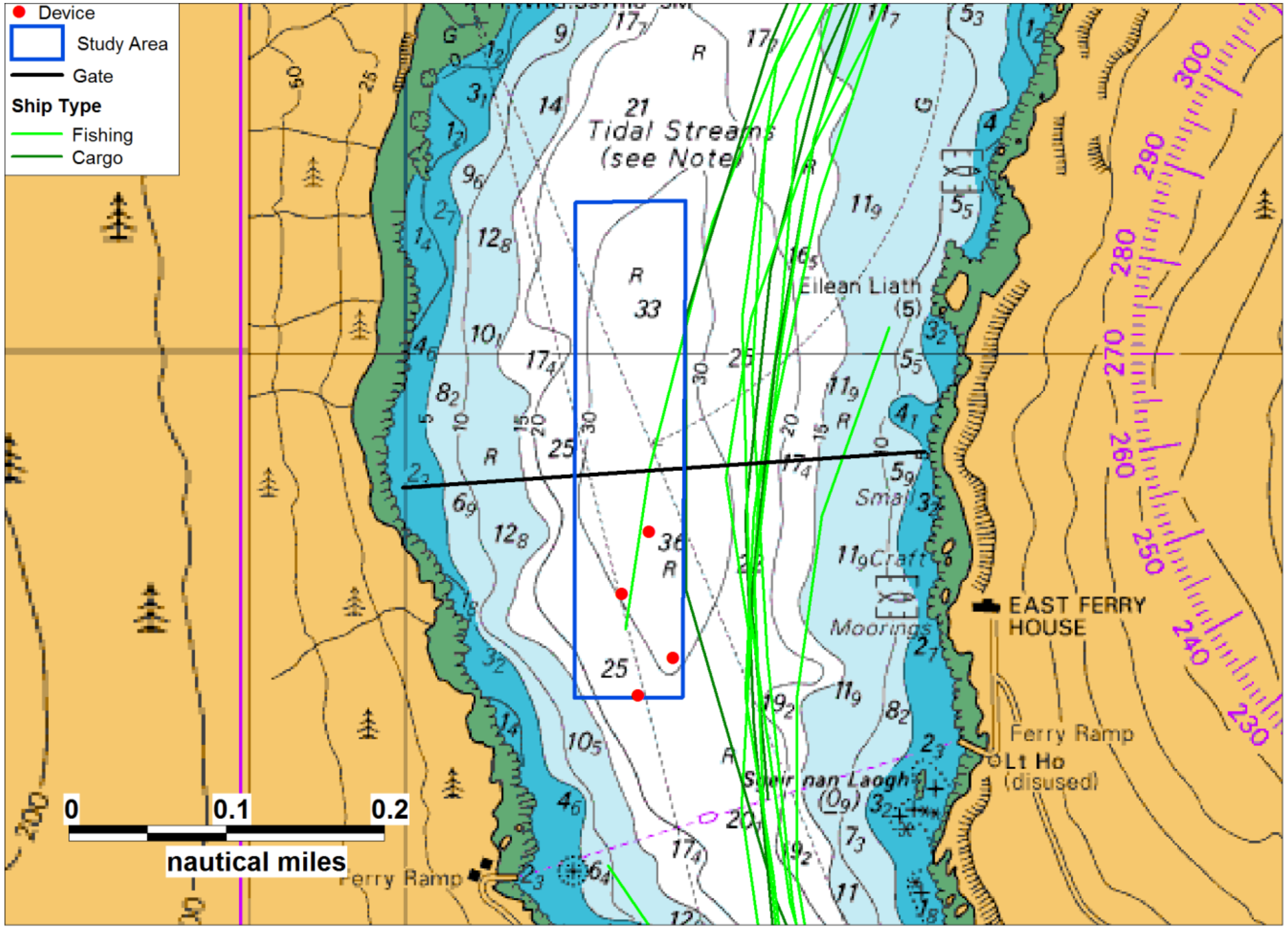


Figure 6.10 Busiest Day Winter (23 February 2010)

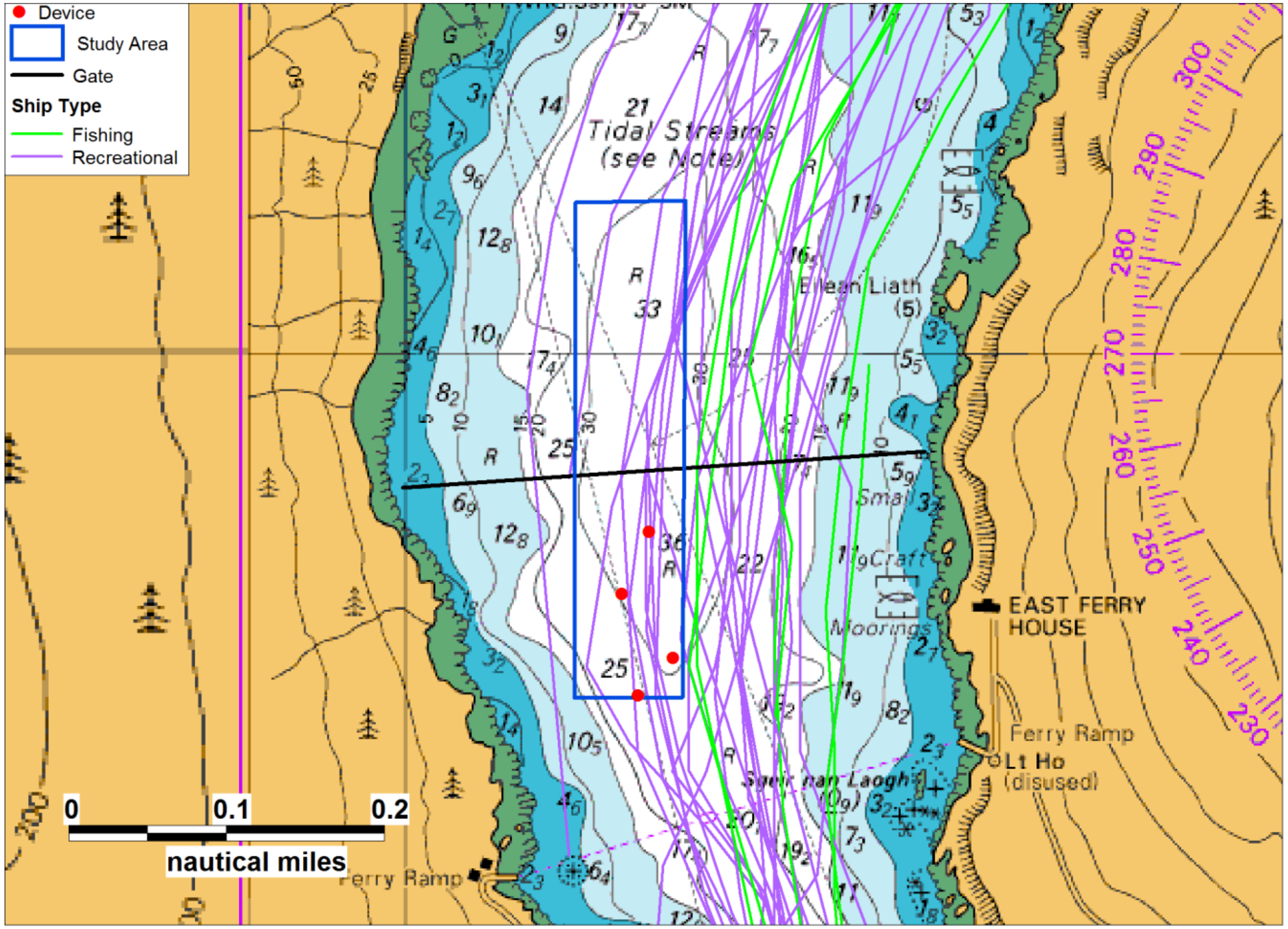


Figure 6.11 Busiest Day Summer (17 June 2010)

In total, 487 transits were made through the gate; 127 were AIS targets and 360 were radar targets. It is noted that the original survey report indicated an additional 57 radar transits. Further investigation revealed this was due to extrapolation of some tracks which, based on the recorded positions, did not cross the gate, e.g., they were dropped by the radar prior to this. This results in an overall 12% discrepancy in the number of crossings of the gate. The recorded and extrapolated transits in winter and summer are presented below.

Table 6.1 Total Transits – Winter and Summer

Survey Period	Winter	Summer
Recorded Tracks	73	414
Extrapolated Tracks	87	457

The extrapolated (higher) vessel numbers have been assumed within the risk modelling as these are considered to be the most accurate.

In terms of the vessel positions within the channel, 27% of vessels in winter and 50% in summer intersected part of the Study Area. This indicates smaller recreational vessels tend to take a more westerly course over ground when rounding the bend.

6.3.2 Vessel Lengths

A combined plot of the traffic which intersected the gate, thematically mapped by length, is presented in Figure 6.12.

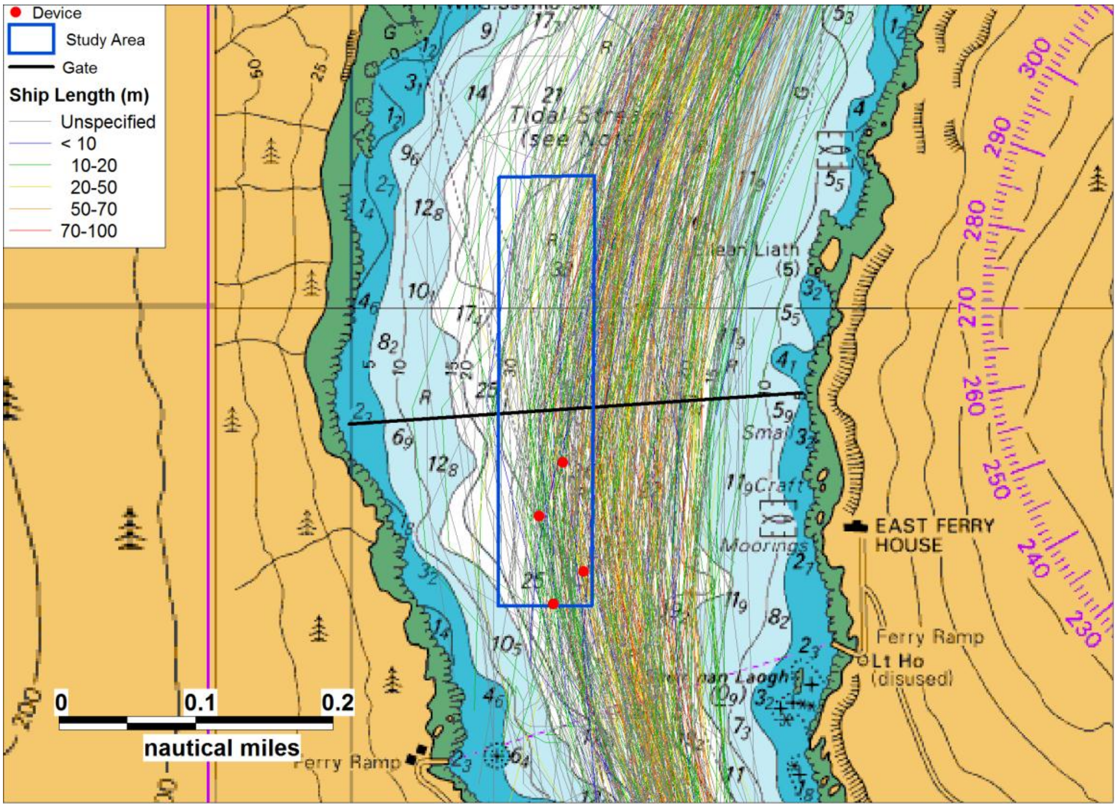


Figure 6.12 Combined Tracks by Length intersecting Gate

Figure 6.13 presents the length distribution of vessels, excluding a high proportion which were unspecified (mainly radar tracks).

The average length was 31.4m and the longest vessel was the passenger cruise ship *Sea Discoverer* at 91m, which passed through Kyle Rhea twice on 9 June 2010.

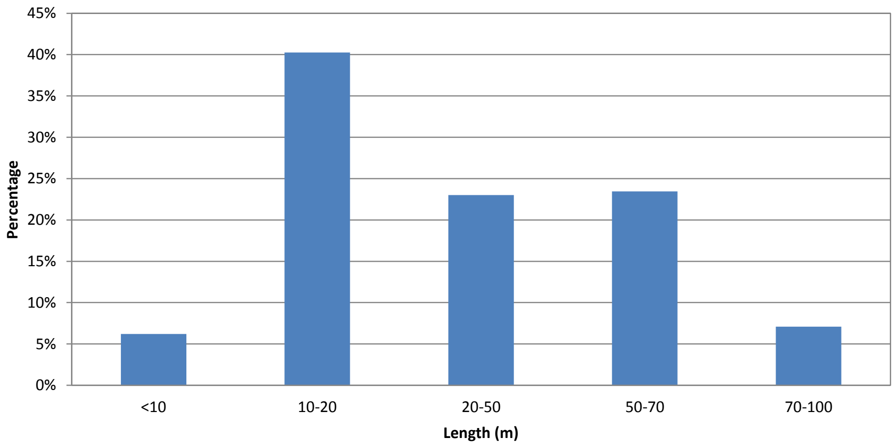


Figure 6.13 Vessel Length Distribution intersecting Gate (2010)

6.3.3 Vessel Draughts

Draught information was only available for 91 of the vessel tracks passing through the gate. The draughts of a further nine vessels were researched and conservatively estimated based on their design (maximum) draught. A combined plot of the transiting traffic by draught is presented in Figure 6.14.

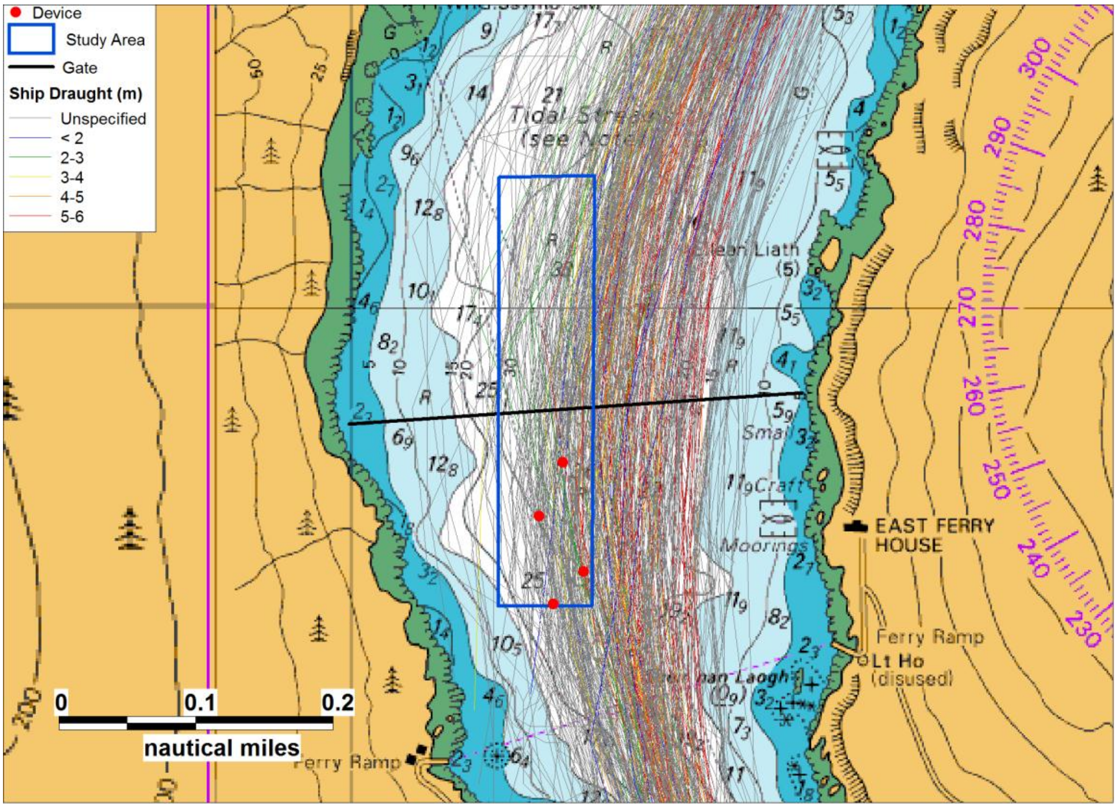


Figure 6.14 Combined Tracks by Draught intersecting Gate

The average draught of the identified vessels was 4.2m. However, this is weighted towards larger vessels. The majority of transits were by smaller recreational and fishing vessels which from consultation, typically have draughts in the range 1-3m.

The deepest draught vessel was the 87m long general cargo vessel *Alholmen* with a draught of 6m transiting to Pietarsaari, Finland on 19 June 2010. The next largest was also a general cargo vessel, *Arklow Raider*, at 5.8m en route to Odda in Norway on 12 June 2010.

6.3.4 Vessel Courses

The tracks, thematically mapped by average course (north or south), are presented in Figure 6.15.

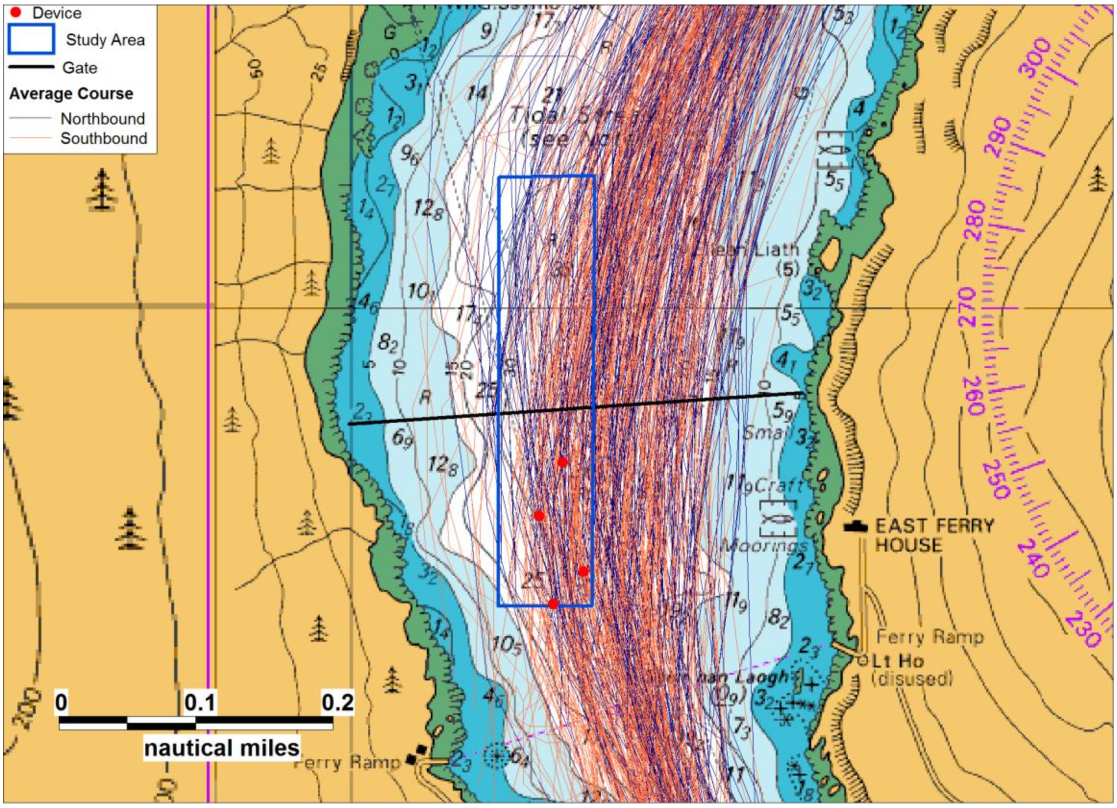


Figure 6.15 Combined Tracks by Average Course intersecting Gate

57% of vessels were heading southbound compared to 43% of vessels were heading northbound.

6.3.5 Destinations

The majority of tracks were identified by radar and, therefore, destination information was not available. Of the AIS tracks, destinations were broadcast by just over half the vessels. The main destinations are summarised in Figure 6.16.

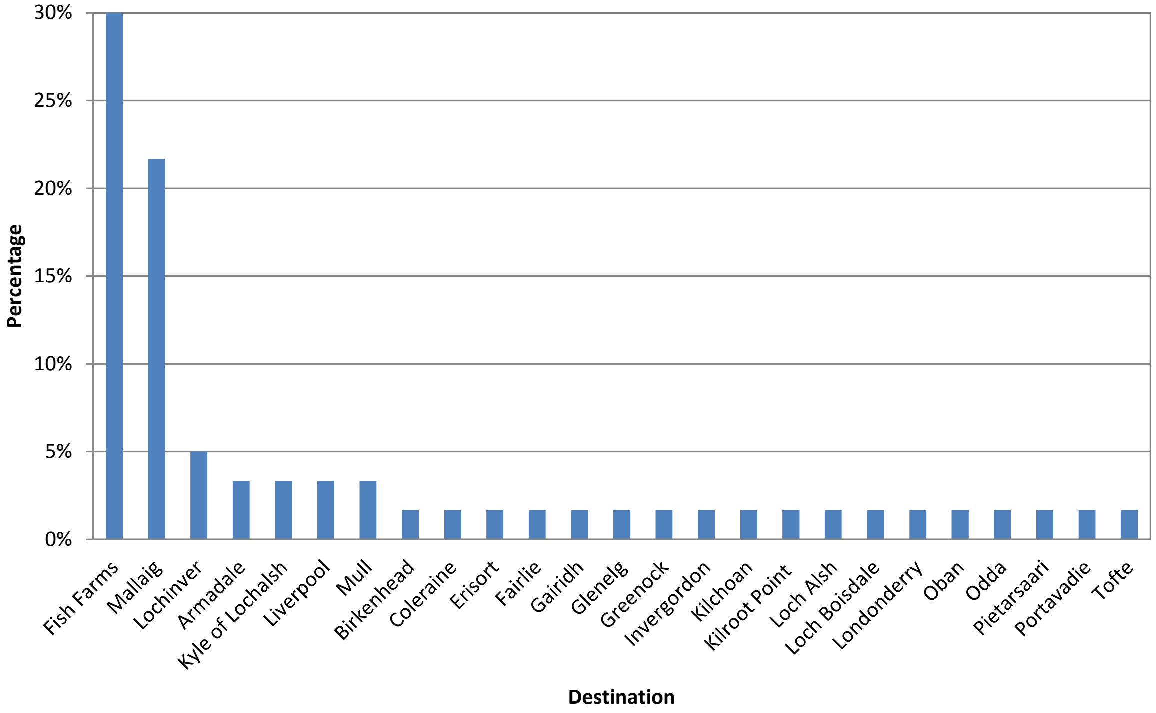


Figure 6.16 Main Destinations for AIS Vessels intersecting Gate in Kyle Rhea (2010)

6.3.6 Regular Runners

Details of vessels which were identified to transit the Kyle Rhea gate on at least three occasions during the combined survey period are presented in Table 6.2.

Table 6.2 Vessels Transiting Kyle Rhea (AIS / Radar 35 Days)

Name	Type	Destinations	Length (m)	Draughts (m)	Transits
Ronja Pioneer	Fish Carrier	Mallaig / Fish Farms	57	5 / 5.1	21
Helen Bruce BRD90	Fishing	--	10.4	-	19
Ronja Skye	Fish Carrier	Mallaig / Fish Farms	40	4.6	18
Ronja Commander	Fish Carrier	Mallaig / Fish Farms / Erisort / Mull / Kishorn / Gairidh	55	5	15
Mairead M OB164	Fishing	-	8.2	-	11
Our Catherine	Fishing	-	10	-	6

Name	Type	Destinations	Length (m)	Draughts (m)	Transits
BRD77					
Spanish John 2	Cargo	-	-	-	6
Blue Note	Recreational (Yacht)	-	10	-	5
TS Ocean Spirit	Recreational (Yacht)	-	24	-	5
Fame	Cargo	-	15	3.8 / 1	4
Harvest Anne	Cargo (Fishfood Carrier)	-	24	-	4
Henty Pioneer	Products Tanker	Lochinver / Liverpool / Invergordon	70	4 / 3.1 / 3	4
Lord of the Glens	Passenger Cruise Ship	Kyle of Lochalsh / Armadale	45	2.7	4
Margaret Sinclair	Cargo	-	21	-	4
Vermland	Cargo	Fish Farms / Loch Boisdale	50	4	4
Hebridean Princess	Passenger Cruise Ship	Fairlie	72	3	3
Ronja Nordic	Fish Processing	Mull / Loch Alsh / Portavadie	57	5	3
Sleat Princess	Recreational (Yacht)	-	10	1.5	3
Tiftie	Recreational (Yacht)	-	14	-	3
TS John Jerwood	Recreational (Motor Boat)	-	24	-	3

6.4 Kyle Rhea Ferry

A Ro-Ro ferry service operates in Kyle Rhea, between the mainland and the Isle of Skye. The *Glenachulish* manually operated turntable ferry operates 7 days a week from Easter to mid-October. Crossings are every 20 minutes 10:00 to 18:00 (April / May / October) and 10:00 to 19:00 (June / July / August), or as required.

This ferry route is only 500m long and, therefore, the radar equipment was unable to identify and track the target before it had completed a crossing. As a result, there is no accurate transit information from the ferry. The route is visible on the admiralty chart.

The Kyle Rhea ferry route was discussed previously in the Kyle Rhea Navigation Feasibility Study (Ref. vi). The ferry track varies from the rhumb line by around 50m. During the visual observations made as part of the maritime traffic survey, the ferry was not seen to deviate such that it would interact with the nearest device location 160m to the north. Consultation with the ferry Master also indicated that the *Glenachulish* would not deviate as far north as Device 1. This is presented in Figure 6.17.

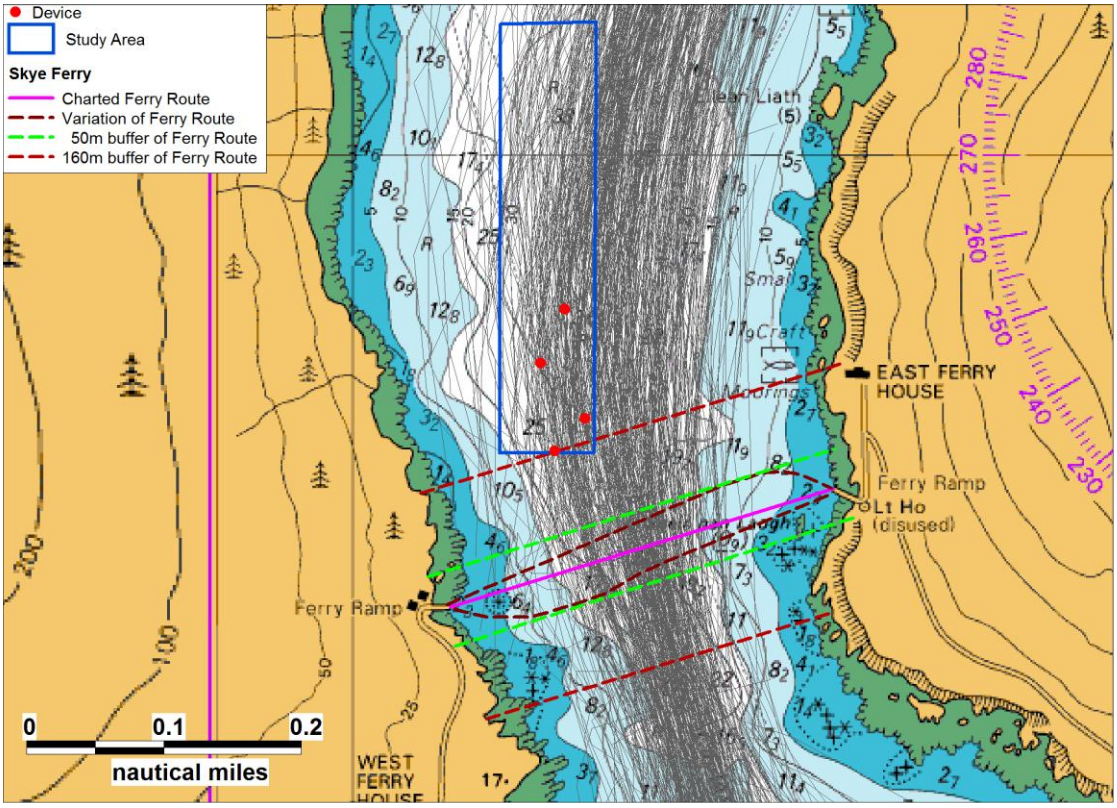


Figure 6.17 Kyle Rhea Ferry Route

7. Temporal Analysis and Encounters

7.1 Introduction

This section presents more detailed analysis of the maritime traffic survey data in terms of:

- Time of day of the passage;
- Speed of vessels;
- Tidal state (speed and direction) during passage;
- Concurrency Analysis; and
- Vessel-to-Vessel Encounters.

7.2 Time of Day

The times of day that vessels crossed the gate in Kyle Rhea are presented in Figure 7.1.

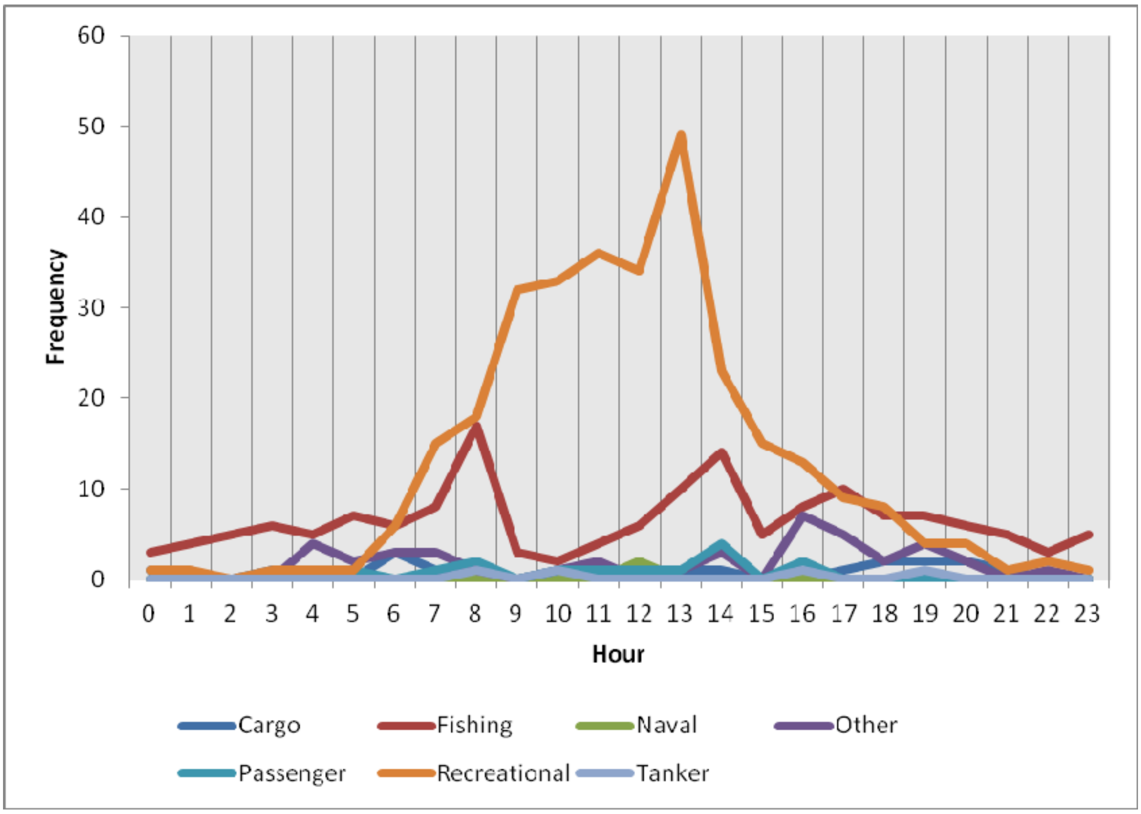


Figure 7.1 Vessel Transits by Time of Day

This clearly shows that the vast majority of recreational vessels, which were mainly observed in summer, transited during daylight hours, which is advised by the Pilot Book. Other vessels were more spread out through the day but overall most transits were in daylight.

7.3 Vessel Speed

The speed distribution of vessels when transiting the gate in Kyle Rhea is presented in Figure 7.1. Note, this is the speed over ground, taking into account tide.

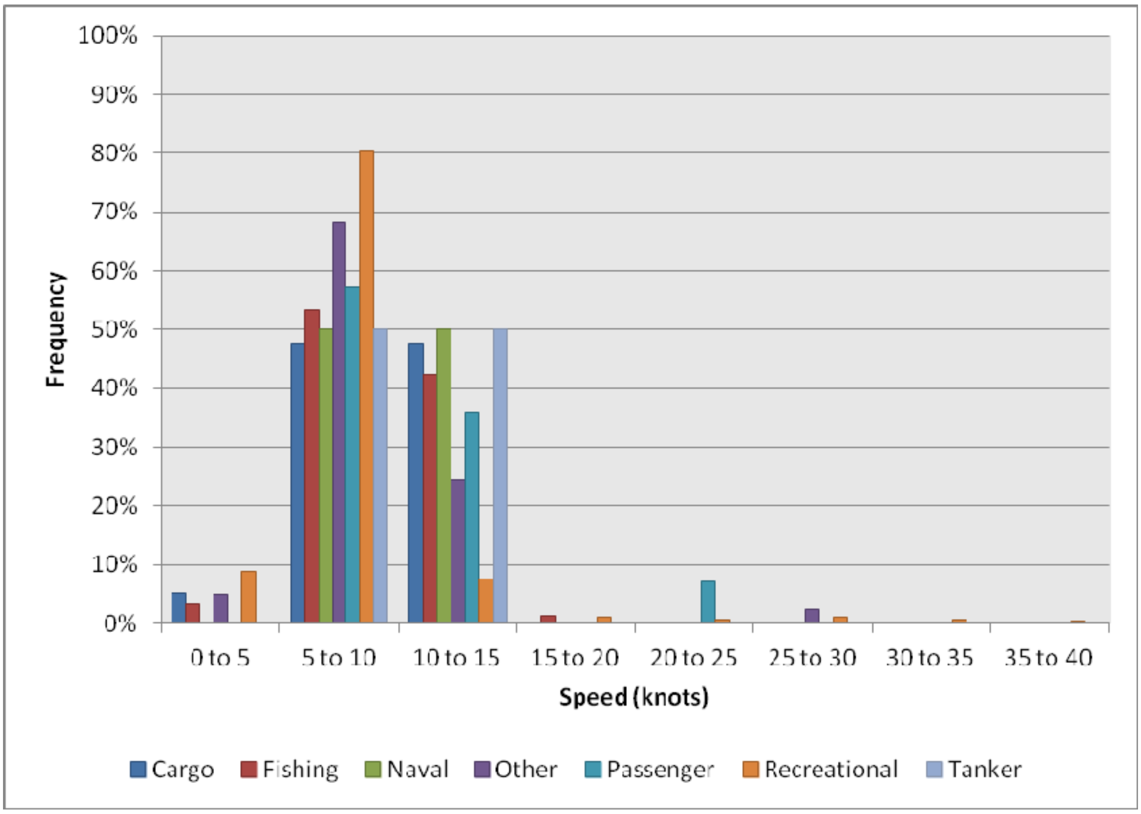


Figure 7.2 Vessel Speeds during Transits

The majority of vessels were travelling between 5-15 knots. The fastest vessel was a speed boat recorded at 37 knots.

7.4 Tidal State

Cross-referencing the times of transit with the tidal state, the following distribution was found:

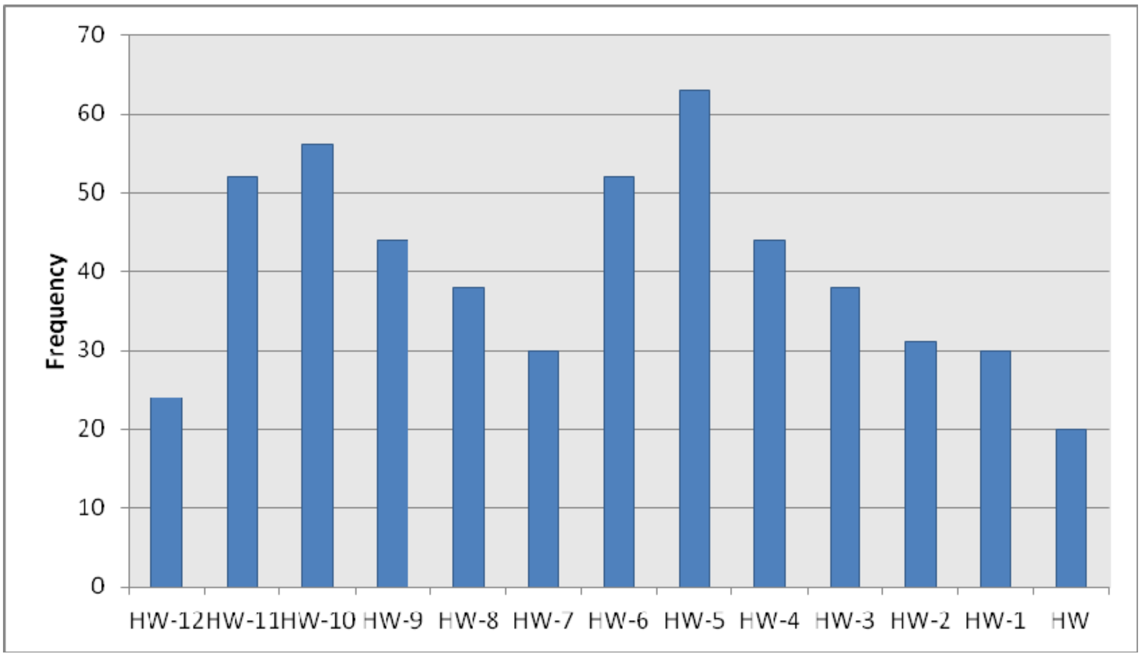


Figure 7.3 Vessel Transits per Tidal Hour

Transits can be summarised as follows:

- 68% transit with the tidal stream
- 11% transit at around slack water (HW or HW-6)
- 21% transit against the tidal stream

Further analysis indicated that the vessels making passage against the tidal stream tend to use the back eddies (particularly local vessels using the eastern side) or transited when the tidal stream had not built up to maximum velocity.

It was also found that fish farm vessels tended to run to a timetable rather than time their passages through Kyle Rhea with the tidal stream, i.e., these vessels have sufficient engine power to transit against the tide.

7.5 Swept Path Analysis

The AIS data was used by Marico to analyse the transit of seven larger vessels to examine the influence of tide in more detail. Some of the findings are illustrated in Figure 7.4 (transits with the tide) and Figure 7.5 (transits against the tide), in which the vessels involved have been drawn to scale (length x beam) according to their dimensions broadcast on AIS.

This analysis showed that vessels tend always to be set to the west whether making passage either to the north or to the south or when the tidal stream is with them or against.

Some vessels were set markedly to the west in the narrows, crossing into the red sector of the Kyle Rhea sector light.

An example is the *Hebridean Princess* (2,112 GT, 71.6m LOA cruise ship carrying up to 50 passengers and 38 crew. On all the occasions a draught of 3m was broadcast). In track (a) she is steaming north with a 4 knot tide where crossing the gate (horizontal purple line). It can be seen that her course over the ground is set to the west of her heading, i.e., towards the area of the proposed array, due to the tide as she rounds the bend. This is also shown in (b) for the same vessel where the tide is 1.5 knots when crossing the gate.

Other examples shown in Figure 7.4 for vessels going with the main tidal stream are:

(c) *Ronja Pioneer* (live fish carrier – well-boat, 1,256 GT, 57.1m LOA, 5m draught) where the tide at the gate was approx. 3.0 knots; and

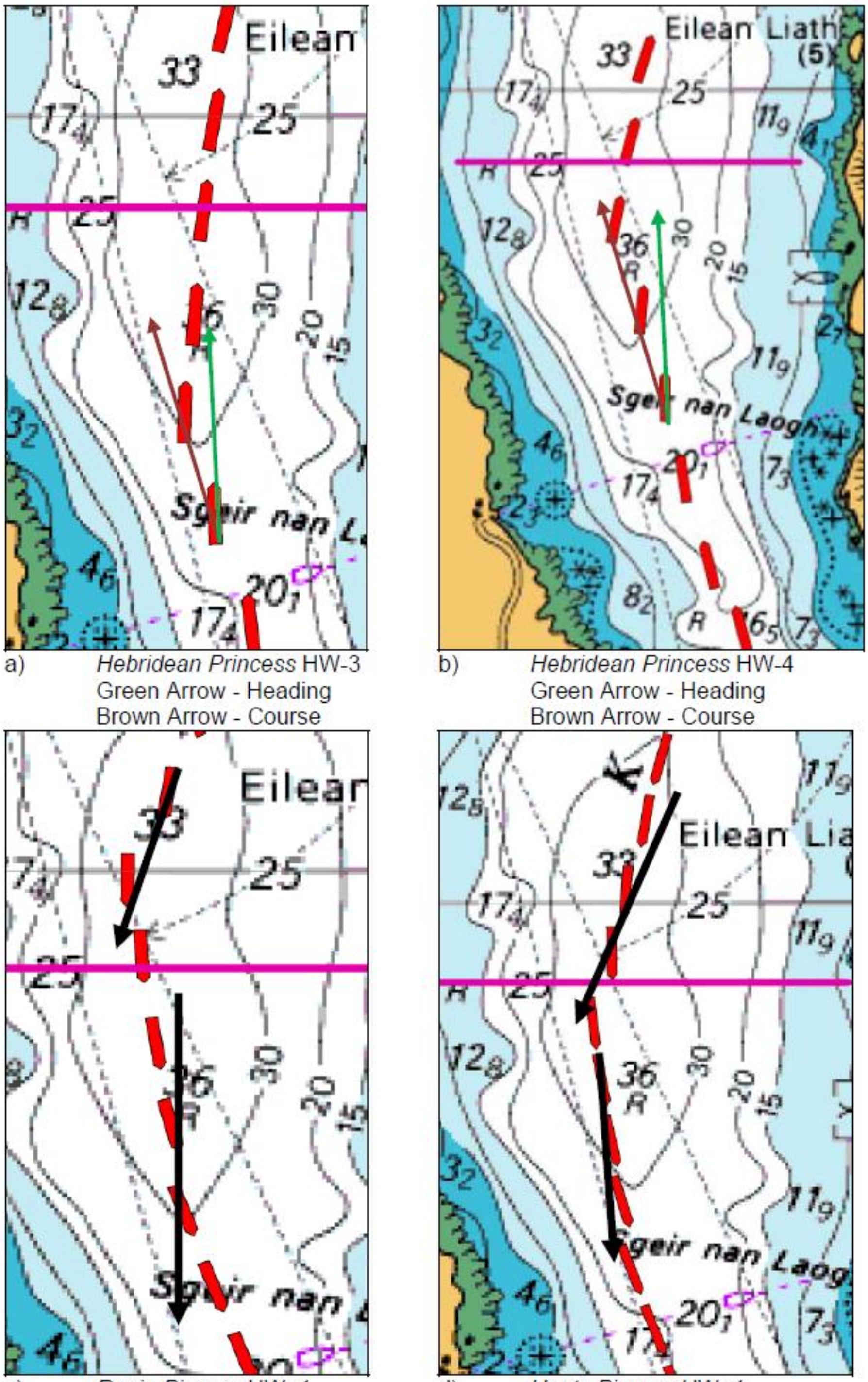
(d) *Henty Pioneer* (products tanker, 992 GT, 69.9m LOA, 3.1m draught) where the tide is 3.5 knots.

Three examples of vessels transiting against the main tide stream are given in Figure 7.5:

(A) *Ronja Commander* (well-boat, 1,021 GT, 54.1m LOA, 5m draught) where she kept to the port side and made use of the back eddy where the tide was weak;

(B) *Hebridean Princess*, where the tide is against at approx. 1 knot when crossing the gate but the vessel is set to the west when in the main flow to the south, which is not corrected sufficiently to ensure that the vessel stays within the white sector of the leading light when rounding the bend in the vicinity of the charted ferry track; and

(C) *Pharos* (light tender, 3,672 GT, 84.3m LOA, 4.25m draught) where the transit was near slack water (tide < 1 knot) and the vessel transits through the centre of the channel staying in the white sector with no apparent problems.



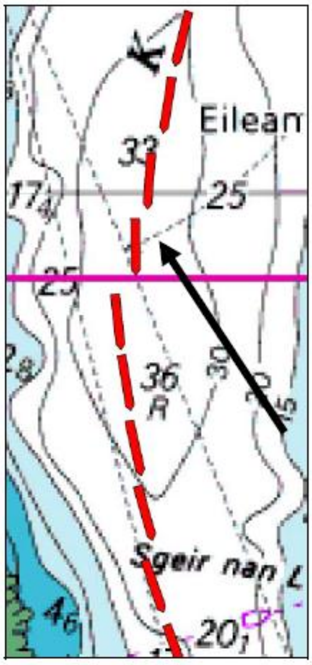
a) *Hebridean Princess* HW-3
Green Arrow - Heading
Brown Arrow - Course

b) *Hebridean Princess* HW-4
Green Arrow - Heading
Brown Arrow - Course

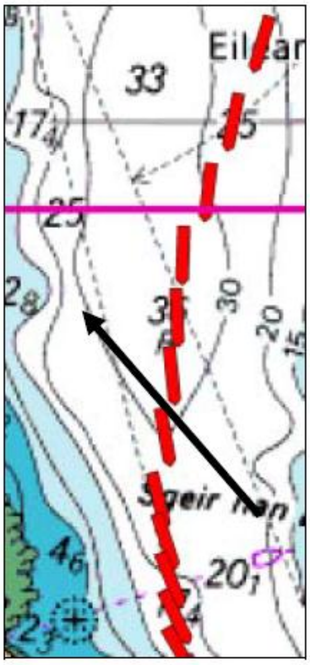
c) *Ronja Pioneer* HW+1

d) *Henty Pioneer* HW+1

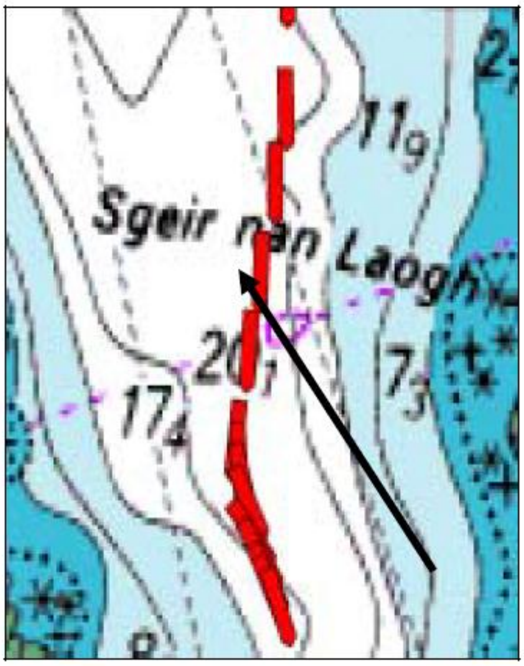
Figure 7.4 Swept Path Analysis of Vessels Transiting with the Tide



A) *Ronja Commander* HW-3



B) *Hebridean Princess* HW -3



C) *Pharos* HW-6

Figure 7.5 Swept Path Analysis of Vessels Transiting against the Tide

7.6 Concurrency Analysis

Concurrency analysis was carried out of the winter and summer data to identify any periods when two vessels were in the vicinity of the study area at the same time. The areas chosen for the analysis are presented in Figure 7.6 relative to the vessel positions recorded during the survey.

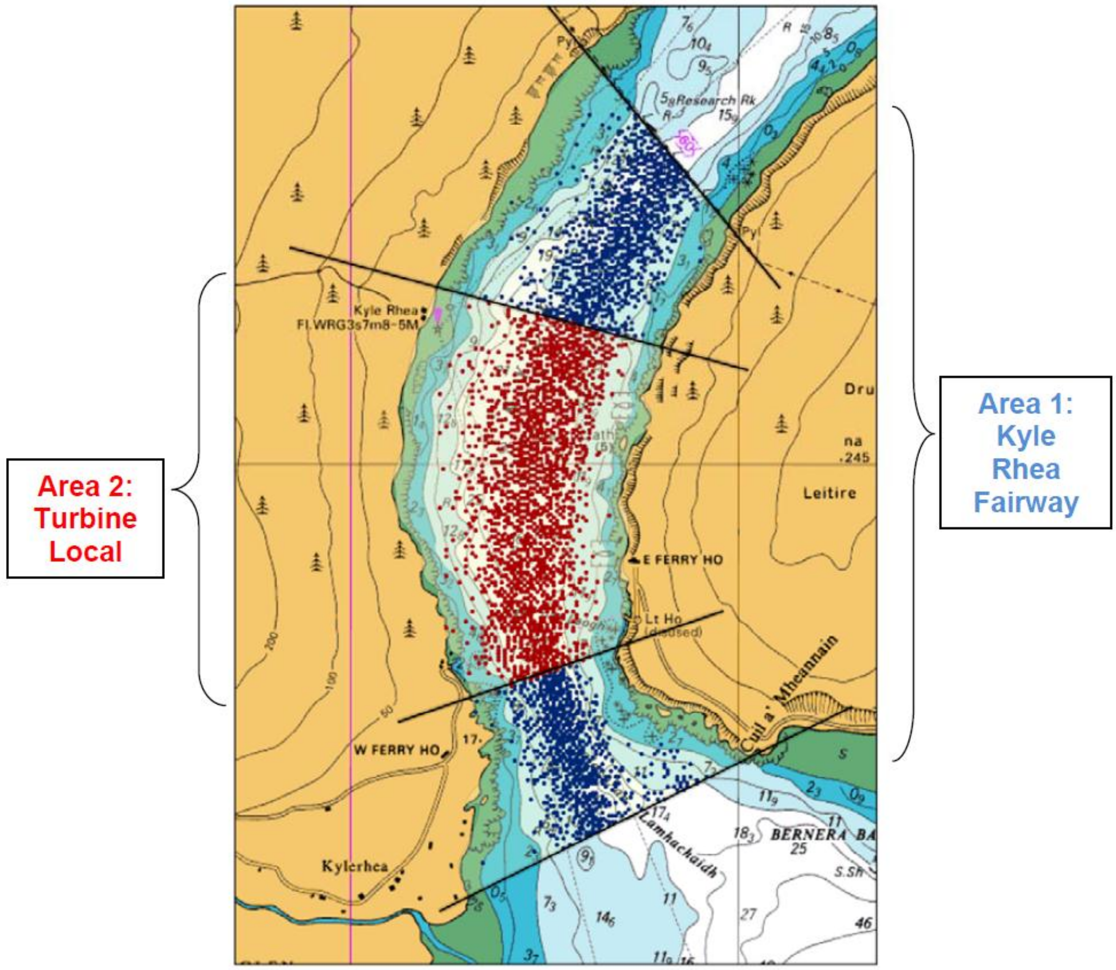


Figure 7.6 Concurrent Analysis Areas

For this study, the main focus is on vessel activity in Area 2, denominated by the red symbols. Area 2 is a 1km section of Kyle Rhea containing the proposed device array.

Based on the speed over ground analysis, the average vessel at 10 knots would transit Area 2 in around 3 minutes, with a slower vessel at 6 knots taking around 5 minutes. For the concurrency analysis, the 35 day survey duration was divided into 5 minute intervals based on the time taken by a slower vessel to traverse Area 2.

The number of vessels in Area 2 in each 5-minute interval is graphed in Figure 7.7, separated into the winter and summer periods.

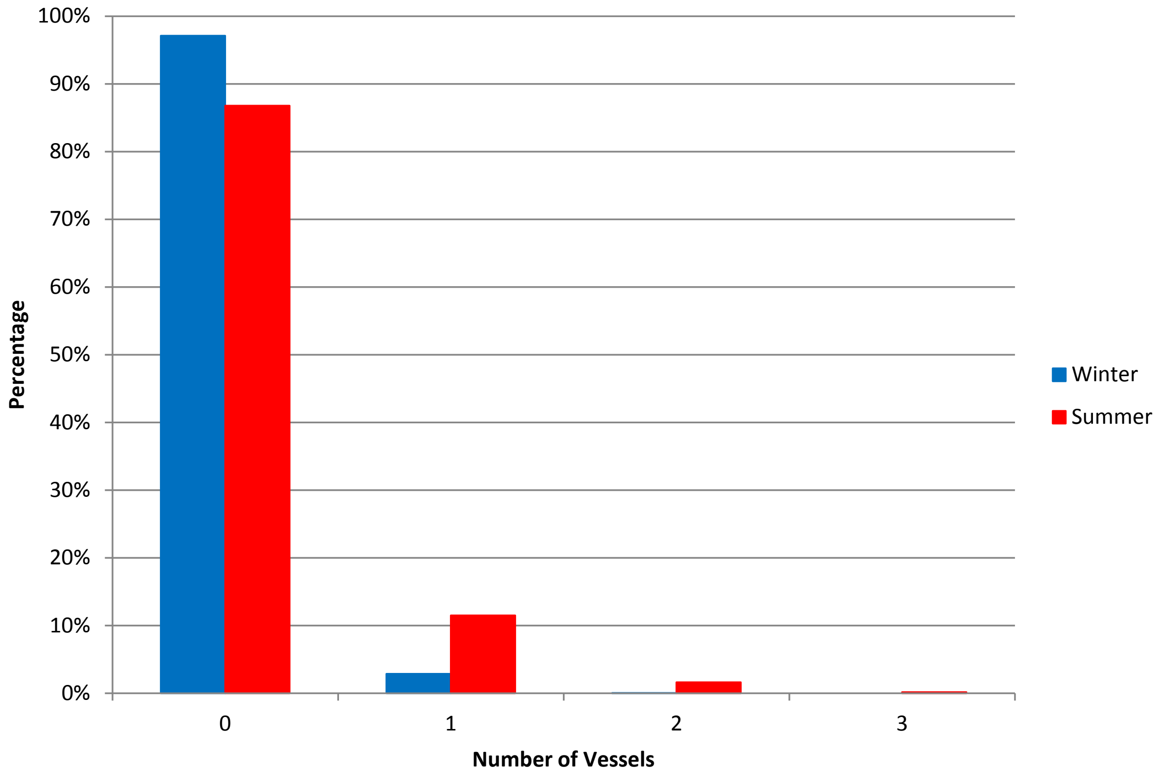


Figure 7.7 Winter and Summer Concurrency Analysis Results

In winter, there was just one occasion (0.02%) when two vessels were transiting in the same 5-minute interval. Both were going in the same direction.

In summer, when there was five times the traffic density due mainly to recreational vessels, there were 93 occasions (1.6%) of two vessels transiting in the same 5-minute interval. Of these, 67 were in the same direction and 26 in opposite directions.

There were nine occasions (0.2%) in summer when three vessels were transiting Area 2 during the same interval. On seven occasions all three vessels were proceeding in the same direction and in two, one of the vessels was opposing the others.

8. Fishing Vessel Activity Analysis

8.1 Introduction

This section reviews the fishing vessel activity at the Project area based on the latest available surveillance (sightings and satellite data), traffic survey, local consultation on fishing vessel navigation and review of the commercial fisheries assessment.

8.2 Surveillance Data - Geographical Division

Fisheries statistics in the UK are reported by ICES statistical Rectangles and Subsquares. The Project is located within ICES Rectangle 43E4 Subsquare 3 (43E4/3), as shown in Figure 8.1. The Subsquare area is approximately 245nm^2 (839km^2). Subsquare 43E4/3 and 43E4/1 to the north have been analysed as part of the baseline fishing assessment. Data was obtained for the five-year period 2007 to 2011.

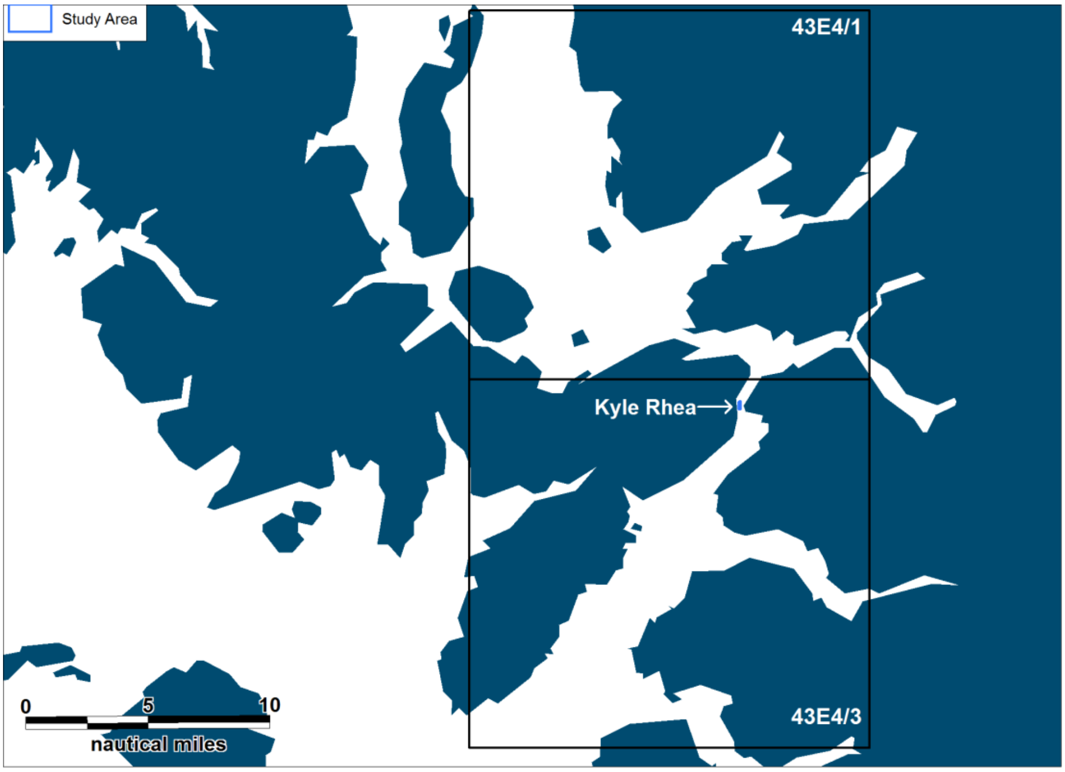


Figure 8.1 ICES Subsquares encompassing the Project

8.3 Sightings Data

8.3.1 Sightings per Patrol

Data on fishing vessel sightings were obtained from Marine Scotland Compliance who monitor the fishing industry in Scottish waters through the deployment of patrol vessels and surveillance aircraft. Each patrol logs the positions and details of fishing vessels within the

Rectangle being patrolled. All vessels are logged, irrespective of size, provided they can be identified by their Port Letter Number (PLN).

The numbers of fishing vessel sightings, surveillance patrols and hence average sightings per patrol within each ICES Subsquare encompassing the Project area in the three-year period 2007-09 are presented in Table 8.1. There were a further 52 sightings in 2010/2011, however records are no longer kept on the number of patrols.

Table 8.1 Average Sightings per Patrol (2007-11)

ICES Subsquare	Sightings	Patrols	Sightings per Patrol
43E4/1	49	171	0.3
43E4/3	52	171	0.3

The Subsquares had a relatively low sightings density per patrol, averaging less than one vessel per three patrols.

8.3.2 Sightings Analysis

The sightings data were imported into a GIS for mapping and analysis. A plot of the vessel sighting locations colour-coded by gear type is presented in Figure 8.2. It can be seen there were no vessels sighted in the vicinity of the devices. Most sightings were either to the south in the Sound of Sleat or north in Loch Alsh and Inner Sound

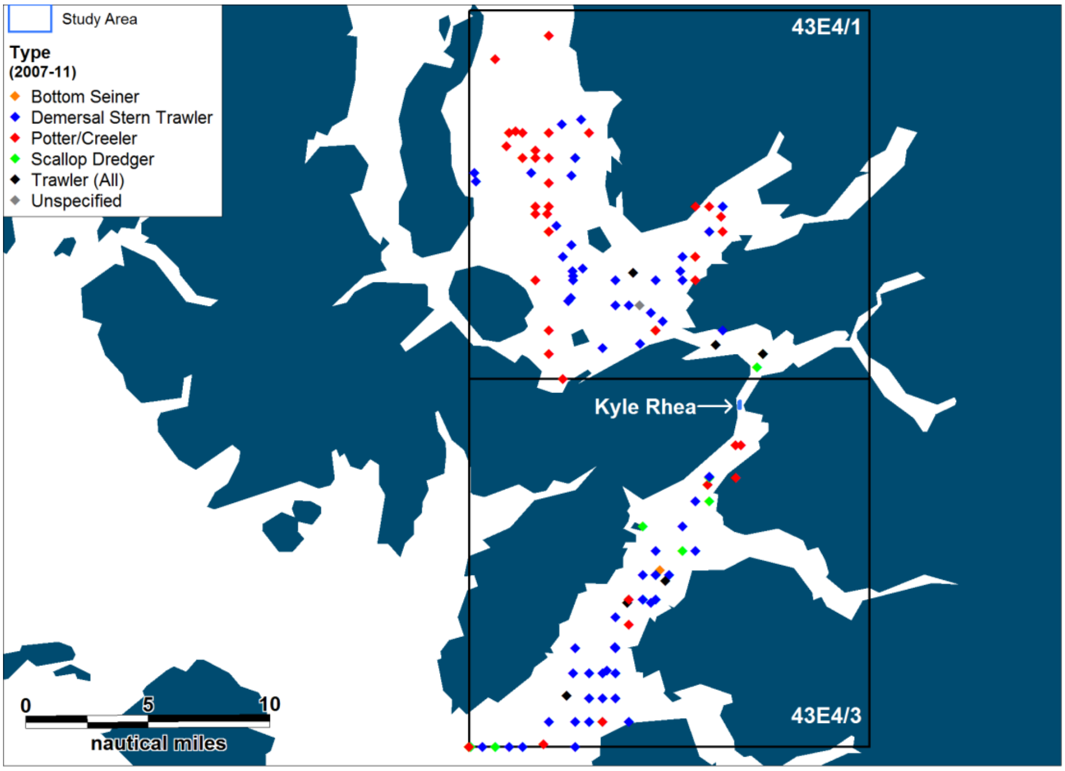


Figure 8.2 Fishing Vessel Sightings by Type (2007-11)

The main fishing type overall was demersal trawler (55%) followed by potter/creeler (32%).

Fishing vessel sightings colour-coded by vessel nationality are presented in Figure 8.3.

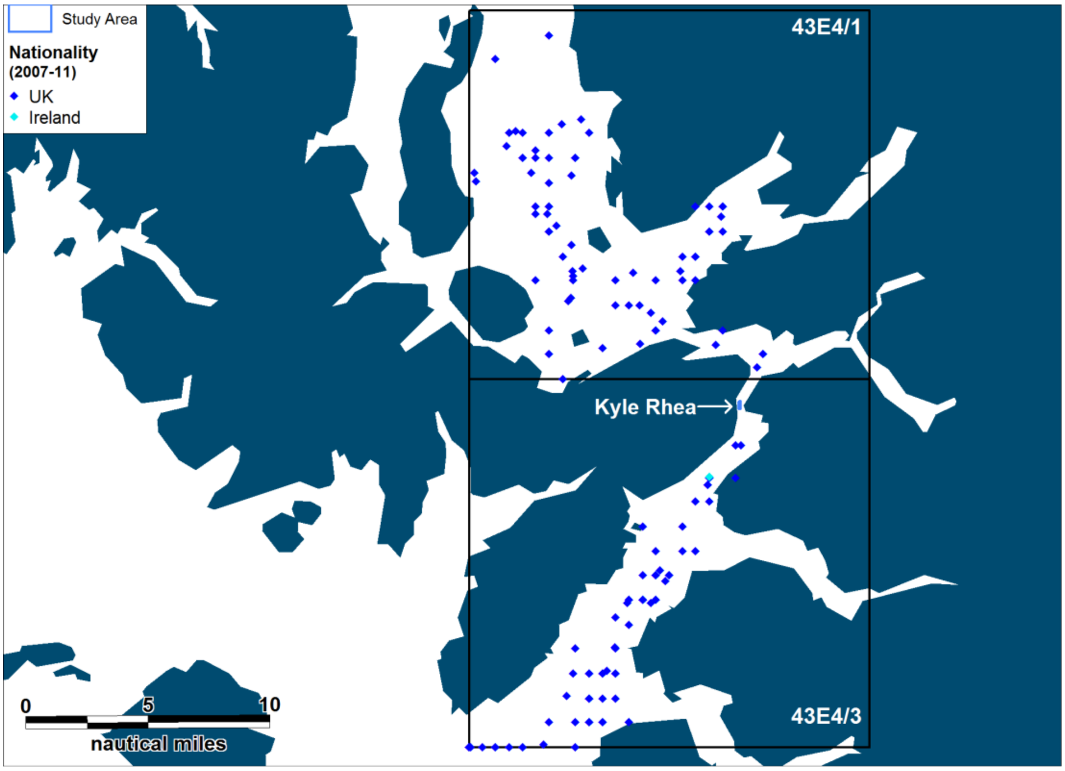


Figure 8.3 Fishing Vessel Sightings by Nationality (2007 – 11)

All but one fishing vessel was UK-registered, with the exception being an Irish vessel.

The fishing vessels colour-coded by activity when sighted are presented in Figure 8.4. The majority (79%) of vessels sighted were engaged in fishing, i.e., gear deployed, 20% were steaming (transiting to/from fishing grounds), and 1% were laid stationary (vessels at anchor or pair vessels whose partner vessel is taking the catch whilst the other stands by).

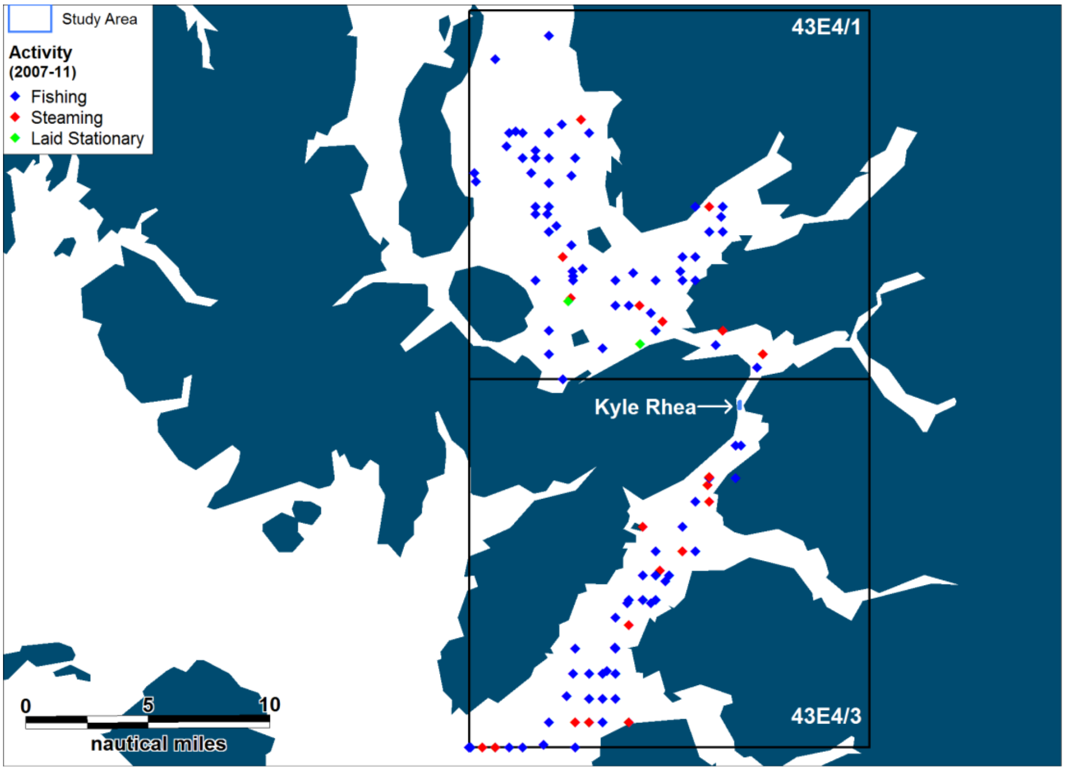


Figure 8.4 Fishing Vessel Sightings by Activity (2007 – 2011)

The lengths of vessels sighted are presented in Figure 8.5. The majority (83%) were below 15m, with 17% over 15m.

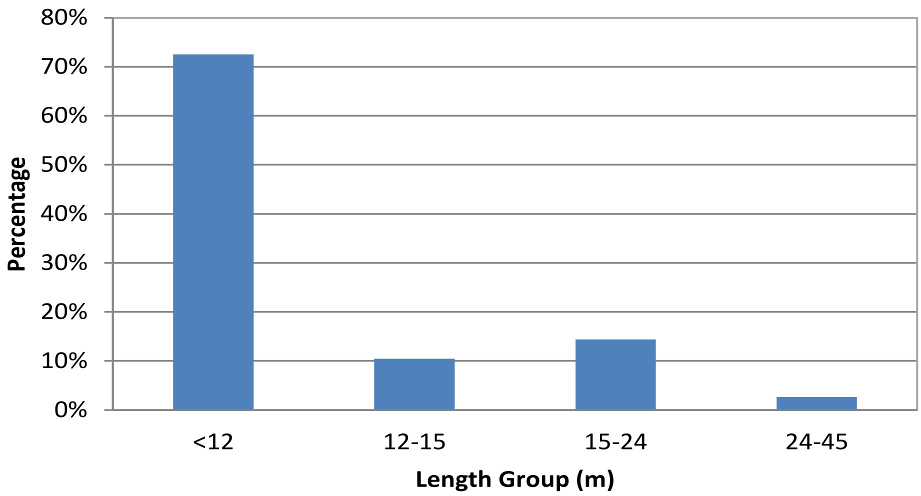


Figure 8.5 Fishing Vessel Sightings by Length Group (2007-11)

8.4 Satellite Data Analysis

Marine Scotland Compliance provided satellite vessel monitoring system (VMS) fishing data in digital image format for 2010 and 2011. The images were geo-referenced as accurately as possible within a GIS to allow the data to be plotted relative to the Project. It should be noted that these plots cover UK vessels only, which represented 99% of sightings. They also only cover vessels 15m and above in length, which are in the minority (17%). Therefore, overall the satellite data covers about one in six of the fishing vessels in the area, focused on larger vessels.

Plots of the satellite vessel positions, colour-coded by speed, are presented in Figure 8.6 and Figure 8.7 for 2010 and 2011, respectively.

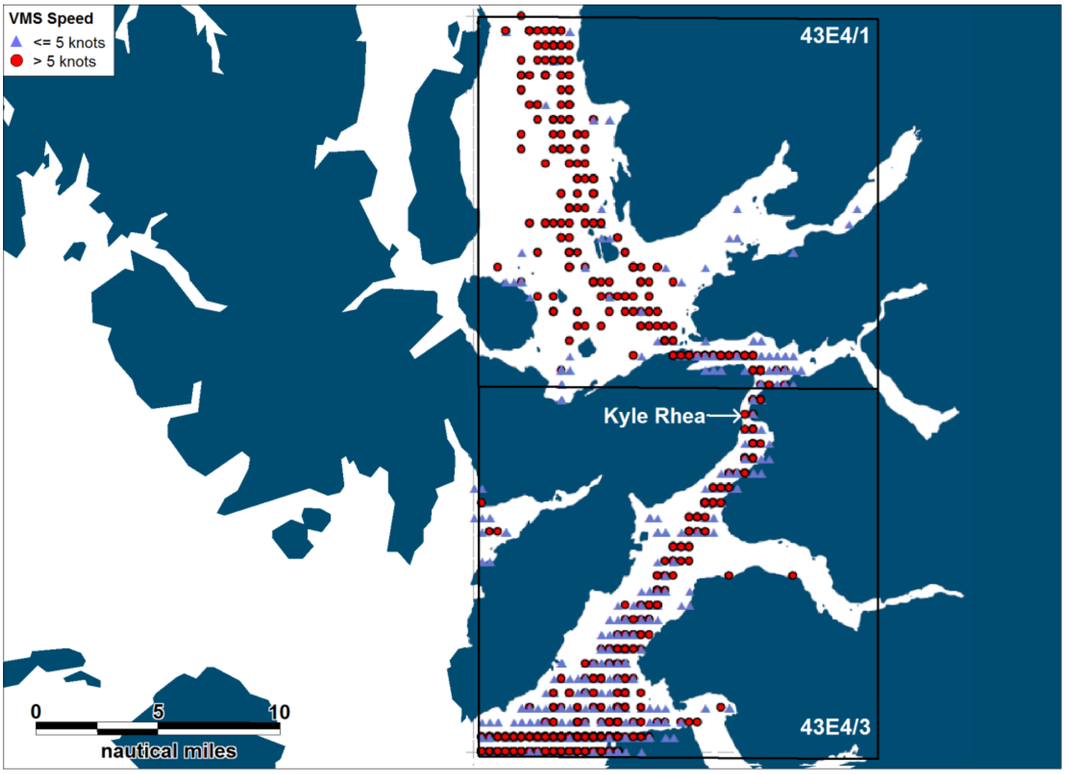


Figure 8.6 Fishing Vessel Satellite Positions by Speed (2010)

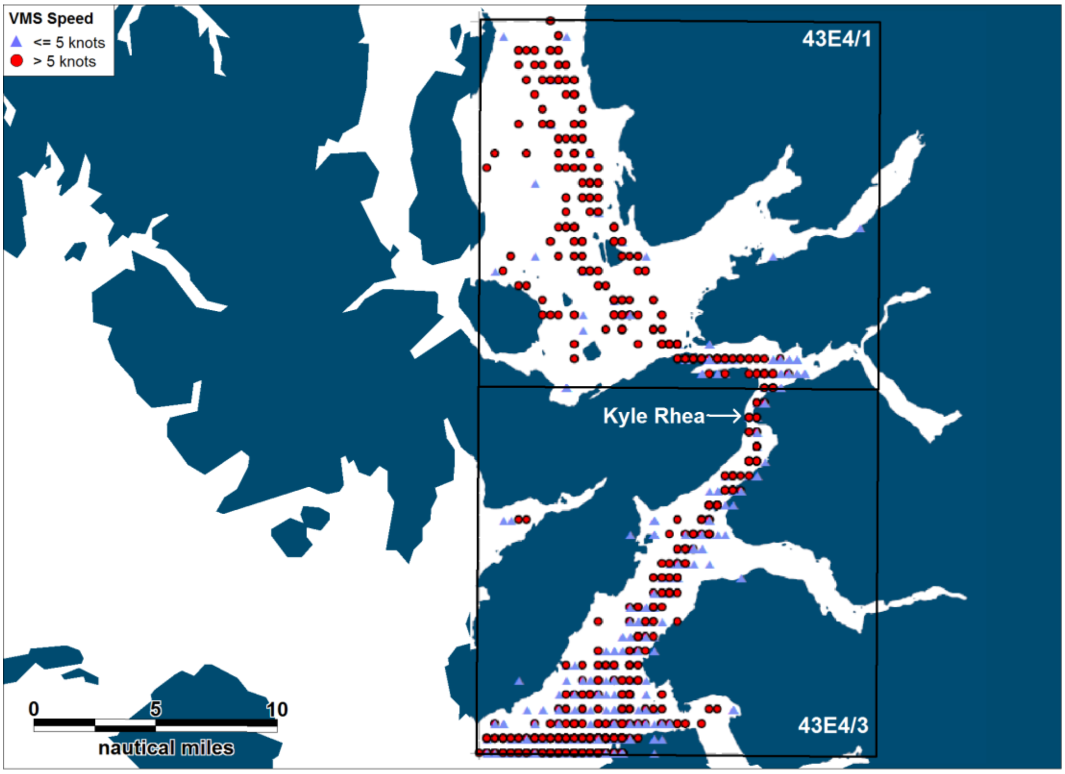


Figure 8.7 Fishing Vessel Satellite Positions by Speed (2011)

From the plots it appears that larger vessels tracked on satellite are mainly transiting the area.

8.5 *Traffic Survey Data*

All fishing vessel tracked passing through the gate in Kyle Rhea during the combined survey period (35 days in 2010) are presented in Figure 9.2. The plot has been colour-coded to distinguish fish carriers and processing vessels (e.g., fish farm well boats) from traditional fishing vessels, such as trawler and local creel vessels.

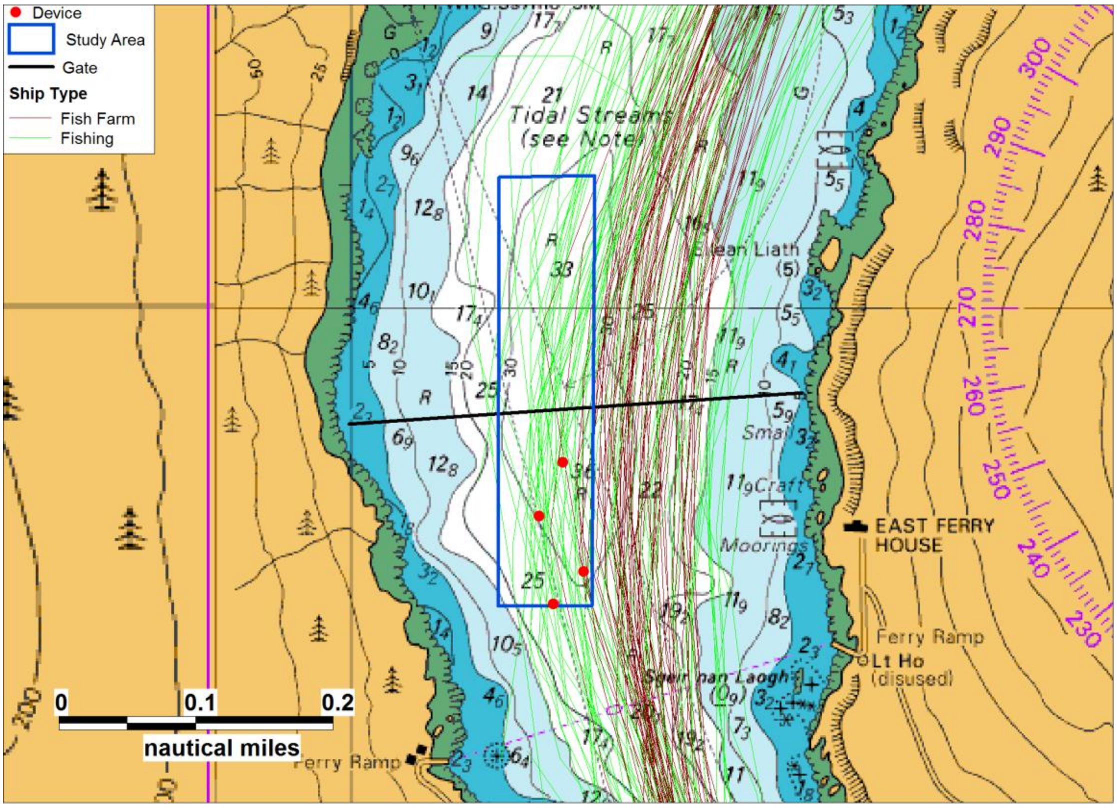


Figure 8.8 Fishing Vessels Tracked during Surveys (2010)

Fifty-two tracks were recorded during the winter period (an average of three to four per day) and 85 in the summer period (an average of four per day).

In the combined period there were 63 transits by fish carriers and processing vessels, an average of just under two transits per day. The vessels involved were *Ronja Pioneer*, *Ronja Skye*, *Ronja Commander*, *Ronja Nordic*, *Vitin*, *Ronja Viking*, *Oystrand* and *Roy Kristian*.

Seventy-four tracks were made by fishing vessels during the survey, an average of just over two transits per day. Eighteen of the vessels were identified by PLN. Details are presented in Table 8.2.

Table 8.2 Fishing Vessels

PLN	Name	Port	Gear Type	Transits
BRD90	Helen Bruce	Broadford	Pots and traps	19
OB164	Mairead M	Oban	Pots and traps	11
BRD77	Our Catherine	Broadford	Bottom otter trawl	6
BRD642	Paulona II	Broadford	Bottom otter trawl	2
BA87	King Challenger	Ballantrae	Boat dredger	1
BA829	King Explorer	Ballantrae	Boat dredger	1

PLN	Name	Port	Gear Type	Transits
BRD200	Sangsara	Broadford	Pots and traps	1
BRD632	Sea Ranger	Broadford	Bottom otter trawl	1
BRD663	Silver Steele	Broadford	Pots and traps	1
CN777	Gleaner II	Campbeltown	Bottom otter trawl	1
FR237	Our Heritage	Fraserburgh	Boat dredger	1
OB79	Madalia	Oban	Bottom otter trawl	1
TT74	Village Belle IV	Tarbert	Mechanised dredger	1
BW186	Ellen Mac	Barrow	Bottom otter trawl	1
FY115	Nemesis	Fowey	Pots and traps	1
N102	Willing Lad	Newry	Bottom otter trawl	1
BRD67	--	Broadford	--	1
KY151	Radiant Way	Kirkcaldy	--	1

All but three of the fishing vessels were tracked on radar. The exceptions tracked on AIS were *Gleaner* (24m length), *King Challenger* (22m length) and *Willing Lad* (19m length). These vessels were broadcasting on AIS voluntarily, as carriage was not mandatory at the time.

8.6 Commercial Fisheries Assessment

A Commercial Fisheries Assessment was carried out as part of the Environmental Statement for the Project (Ref. vii). This included face to face meetings with fishermen and an industry questionnaire.

The work concluded that there would be no direct impact, such as loss of grounds or gear loss, associated with the Project. Commercial fishing vessels do not fish in the area of the devices. The primary concern of the fishing industry was in relation to safety of navigation through the Kyle Rhea narrows.

9. Recreational Vessel Activity Analysis

9.1 Introduction

This section reviews recreational vessel activity in Kyle Rhea in more detail based on the traffic survey and other available desktop information.

9.2 RYA Data

The RYA, supported by the Cruising Association, has identified recreational cruising routes, general sailing and racing areas in the UK. This work was based on extensive consultation and qualitative data collection from RYA and Cruising Association members, through the organisations' specialist and regional committees and through the RYA affiliated clubs. The consultation was also sent to berth holder associations and marinas.

The results of this work were published in Sharing The Wind (Ref. viii) and updated GIS layers published in the Coastal Atlas (Ref. ix).

A summary plot of the recreational sailing activity and facilities identified in the vicinity of Kyle Rhea is presented in Figure.

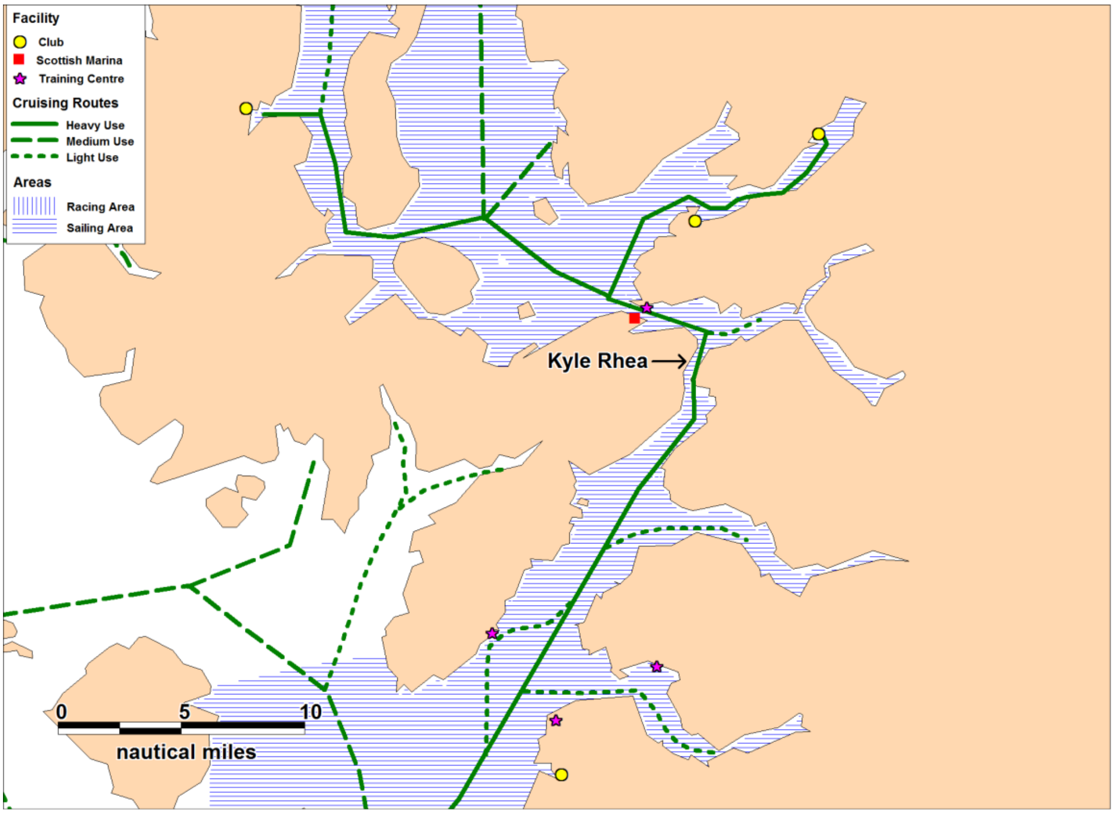


Figure 9.1 Recreational Information for North West Scotland Strategic Area

Based on the RYA published data, the west of Scotland is a general sailing area. A heavy-use route[1] transits west of the Scottish mainland, with a number of medium and light use routes branching from it.

The heavy use route which traverses the west of Scotland passes through Kyle Rhea. To the north of the Kyle, the route branches west, continuing as a heavy-use route, and east as a light-use route to the vicinity of Glas Eilean. The closest shore facility is Kyleakin Marina on the east coast of the Isle of Skye.

9.3 Clyde Cruising Club Sailing Directions

The Clyde Cruising Club produces Sailing Directions for various areas of Scotland. The publication for Ardnamurchan to Cape Wrath (Ref. x) covers Kyle Rhea. Relevant sections are summarised below:

The Kyle has no dangers in the fairway but there are drying rocks up to 0.75 cables off both shores throughout. The tidal streams are such that only well-engined vessels can afford to ignore them.

Tides are constant, -0047 Ullapool (-0507 Dover). The north going stream begins at +0600 Ullapool (+0140 Dover) and runs at 6 to 7kn spring. The south-going stream begins at high water Ullapool (-0420 Dover) and runs at 8kn spring. (Figure 4.2 and Figure 4.3 show the changes in direction and rate of the tidal stream.)

There are strong eddies on both shores with both the north and south-going streams. Prolonged south-westerly winds of any strength increase the duration and rate of the north-going stream and north-westerly winds have the same effect on the south-going stream. When the south-going stream is opposed by a strong south-westerly wind, dangerous overfalls occur up to 1 mile south and east of the south entrance. There are no overfalls at the north entrance.

Travelling mid-channel with the stream presents no problems. If tacking, it is necessary to be careful of eddies along both shores and note that at Sgeir nan Laogh, close south of the east ferry slip, eddies on both streams run strongly.

Anchorages can be found at Bernera Bay, Bagh Dunan Ruadh and west-northwest of Sgeir na Caillich. Bernera Bay is an open bay just to the east of the south entrance to the kyle and provides temporary anchorage while awaiting the tide. Bagh Dunan Ruadh, on the Skye shore, south of Kylerhea river mouth, provides good holding out of the tidal stream, 2 cables off shore. The shoal at the mouth of the river should be kept well south of. It is squally in northwest wind. West-northwest of Sgeir na Caillich. Provides temporary anchorage if

[1] Recreational boating, both under sail and power is highly seasonal and highly diurnal. A light use recreational route is classified by the RYA as a route known to be in common use but which does not qualify for medium or heavy classification. A medium use recreational route is classified as a popular route on which some recreational craft will be seen at most times during daylight hours.

awaiting the tide, but anchoring should not be carried out closer than 2 cables from the Sgeir to avoid off-lying rocks and shoal.

9.4 The Cruising Almanac

The Cruising Almanac (Ref. xi) includes information for the west coast of Scotland, for the stretch between Kyle Akin to Ardnamurchan. A summary is provided below:

Tides are strong in Kyle Akin and Kyle Rhea, but the channel is well marked and lit. It is essential to go with the tide in Kyle Rhea. To the south of Kyle Rhea, in the Sound of Sleat, Isle Ornsay is convenient if awaiting a favourable tide to pass through Kyle Rhea going north. There are anchorages towards the head of the bay. To the north of Kyle Rhea is Kyle Akin, which can be used as a temporary stopping place for stores. There are numerous hazards in Kyle Akin but these are well marked and lit. There are berthing facilities at Kyle of Lochalsh and Kyleakin.

9.5 Traffic Survey Data

All the recreational vessel tracks recorded to be transiting the gate during the combined survey period are presented in Figure 9.2.

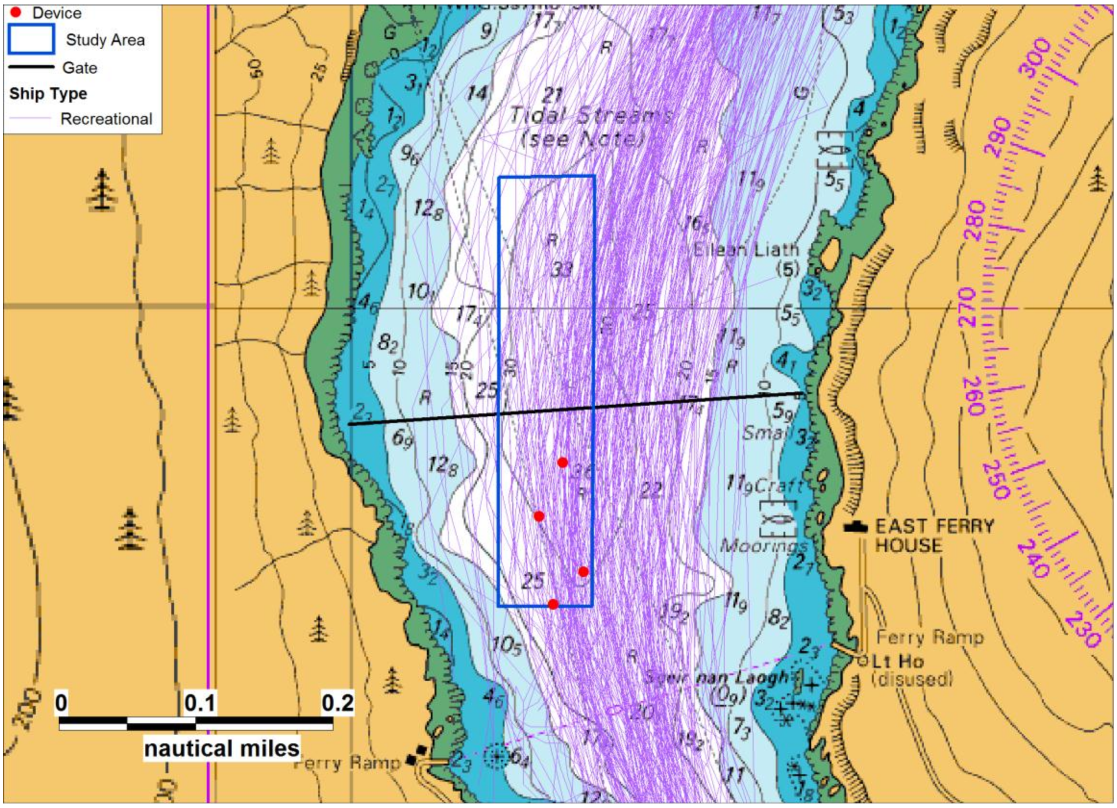


Figure 9.2 Recreational Vessels Tracked during Survey (2010)

There were 278 transits of Kyle Rhea during the traffic survey. Only two of these were made during the winter period, with the remaining 276 occurring in the summer survey period. This is an average of 14 per day during summer.

There is no requirement for recreational vessels to carry AIS, although 8% of transits were broadcast on AIS voluntarily.

10. Review of Historical Maritime Incidents

10.1 Introduction

This section reviews maritime incidents that have occurred in the vicinity of Kyle Rhea in recent years.

The analysis is intended to provide a general indication as to whether the area of the proposed development is currently low or high risk area in terms of maritime incidents. If it was found to be a particular high risk area for incidents, this may indicate that the development could exacerbate the existing maritime safety risks in the area.

Data from the following sources has been analysed:

- Marine Accident Investigation Branch (MAIB)
- Royal National Lifeboat Institution (RNLI)

In addition, some high profile incidents mentioned during the stakeholder consultation are summarised.

10.2 MAIB

All UK-flagged commercial vessels are required to report accidents to MAIB. Non-UK flagged vessels do not have to report unless they are within a UK port/harbour or within UK 12 mile territorial waters and carrying passengers to or from a UK port (including those in inland waterways). However, the MAIB will record details of significant accidents of which they are notified by bodies such as the Coastguard, or by monitoring news and other information sources for relevant accidents. The Maritime and Coastguard Agency, harbour authorities and inland waterway authorities also have a duty to report accidents to MAIB.

The locations[2] of accidents, injuries and hazardous incidents reported to MAIB within 5nm of the Kyle Rhea Study Area between January 2001 and December 2010 are presented in Figure 10.1, thematically mapped by type.

[2] MAIB aim for 97% accuracy in reporting the locations of incidents.

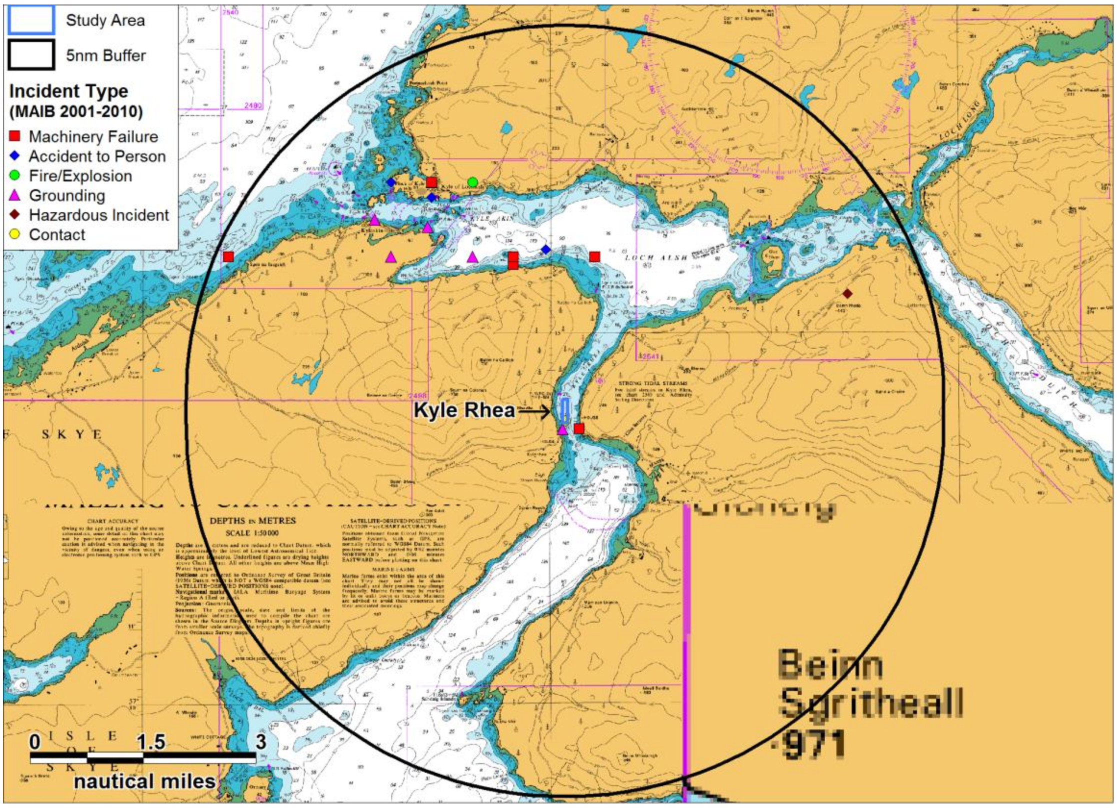


Figure 10.1 MAIB Incidents by Type within 5nm of Kyle Rhea Study Area

A total of 23 unique incidents were reported in the area within 5nm of the Study Area, corresponding to an average of 2 per year. The overall distribution by incident type is presented in Figure 10.2.

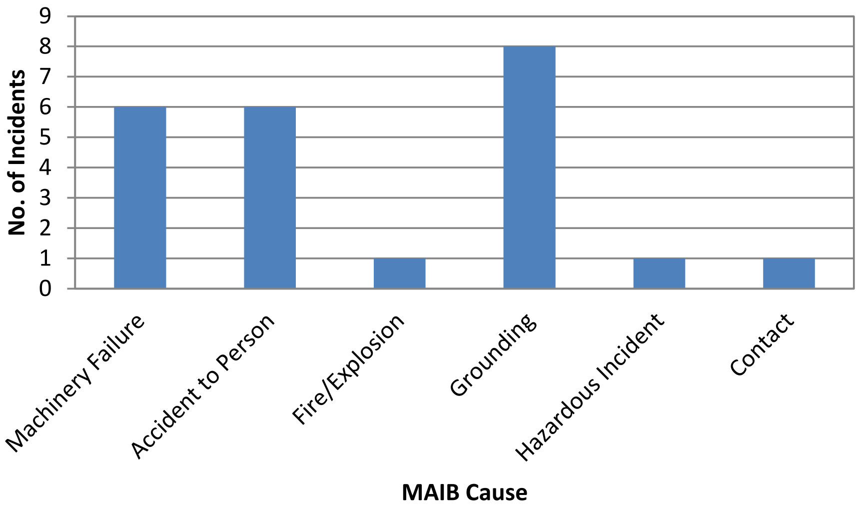


Figure 10.2 MAIB Incidents by Type within 5nm of Kyle Rhea Study Area (2001–10)

The most frequent incident type was grounding (35%). Following this, machinery failures (26%) and accidents to person (26%) were most common.

The majority of these incidents, however, occurred to the north of the Study Area in Kyle Akin. Only three incidents were reported in the immediate vicinity of Kyle Rhea. Figure 10.3 presents the three incidents which occurred in Kyle Rhea.

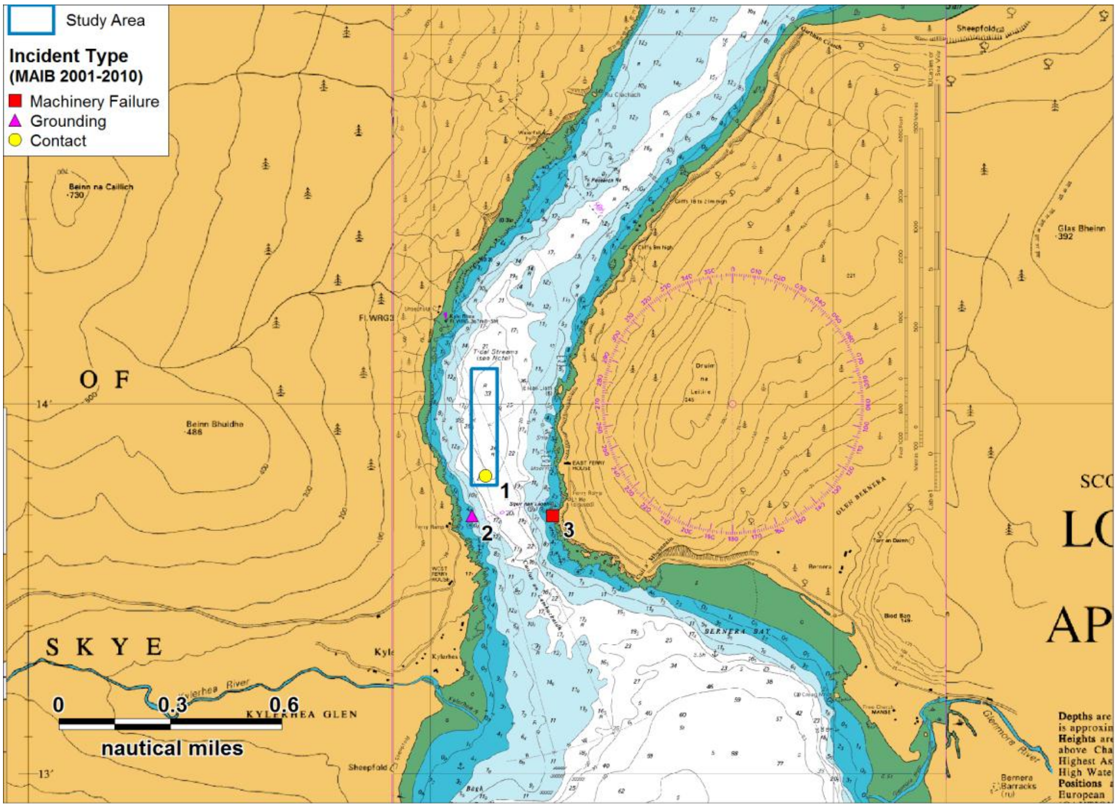


Figure 10.3 MAIB Incidents by Type in Kyle Rhea

Further details on the three incidents recorded in Kyle Rhea are presented below:

1. On 20 January 2003 a contact incident occurred when a small 11m vessel struck an unknown object and lost its propeller blade.
2. On 14 April 2006 the Kyle Rhea Ferry was involved in a grounding incident. It was leaving the slipway on its normal route with a force 4-5 northerly wind and strong ebb tide running. The combination of these factors caused the vessel to slew from its intended course, and one of the skegs of the vessel caught on a shallow rock, very close to low water, about 50m from shore. The vessel waited about 30 minutes and was then able to refloat with the assistance of a fishing vessel. Soundings were taken immediately and thereafter, and no ingress found or damage sustained, other than a dent in the skeg, which was later hammered out. The vessel at the time had old chain steering, which was heavy to operate & has now been replaced with hydraulically-

assisted power steering. The incident occurred on the first day of the season, and the captain had been operating the vessel for 5 years.

3. On 06 May 2006 a machinery failure occurred when the vessel’s chain steering gear jammed. It was released by crew and the vessel continued on passage. Consultation indicated that the vessel involved in this incident was the Skye Ferry.

No fatalities were recorded in any of the incidents which occurred within 5nm of the Study Area.

10.3 RNLI

Data on RNLI lifeboat responses within 5nm of the Kyle Rhea Study Area in the ten-year period between 2001 and 2010 have been analysed. A total of 77 launches were carried out in response to 61 unique incidents (excluding hoaxes and false alarms). This equates to an average of 6 incidents per year with some incidents being responded to by two or three lifeboats.

Figure 10.4 presents the geographical location of incidents within 5nm of the Kyle Rhea Study Area, thematically mapped by casualty type.

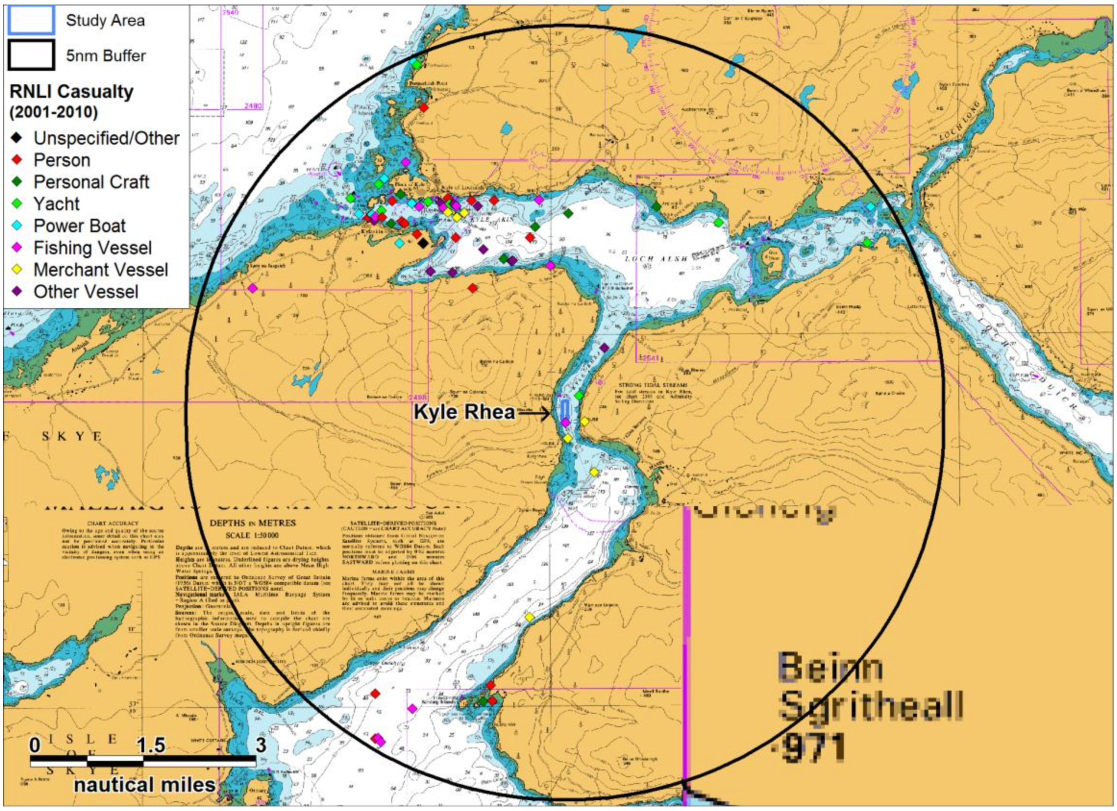


Figure 10.4 RNLI Incidents by Casualty Type within 5nm of the Kyle Rhea Study Area

The overall distribution by casualty type is summarised in Figure 10.5. The most common type was person, and tended to be at or near the shore.

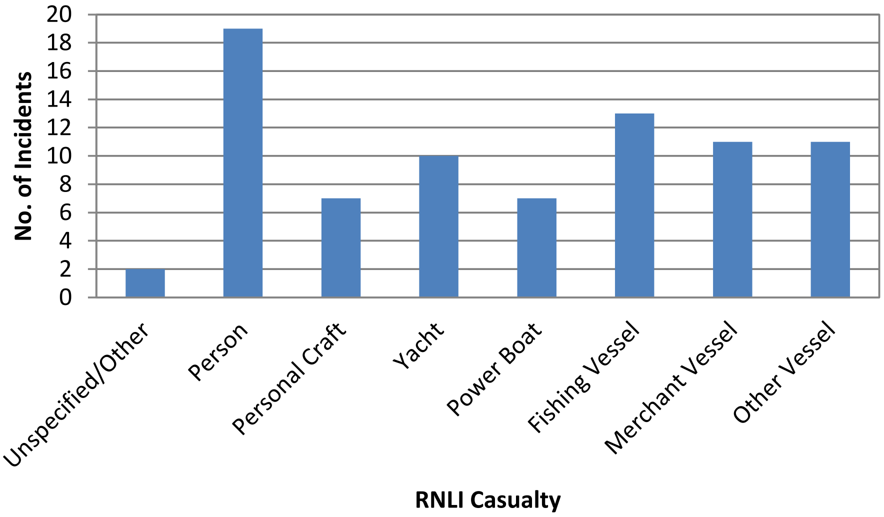


Figure 10.5 RNLI Incidents by Casualty Type within 5nm of the Kyle Rhea Study Area (2001-10)

A chart of the incidents within 5nm of the Kyle Rhea Study Area, thematically mapped by cause, is presented in Figure 10.6.

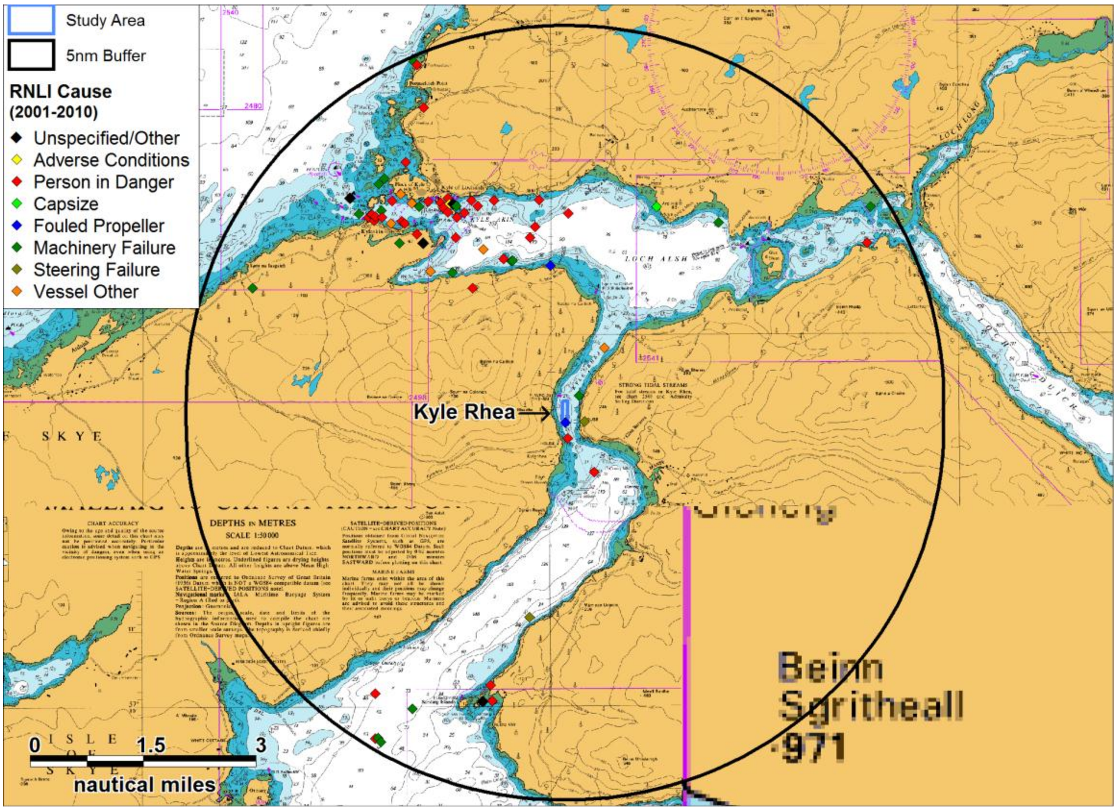


Figure 10.6 RNLI Incidents by Cause within 5nm of the Kyle Rhea Study Area

The reported causes are summarised in Figure 10.7. The two main causes were machinery failure (38%) and person in danger (32%).

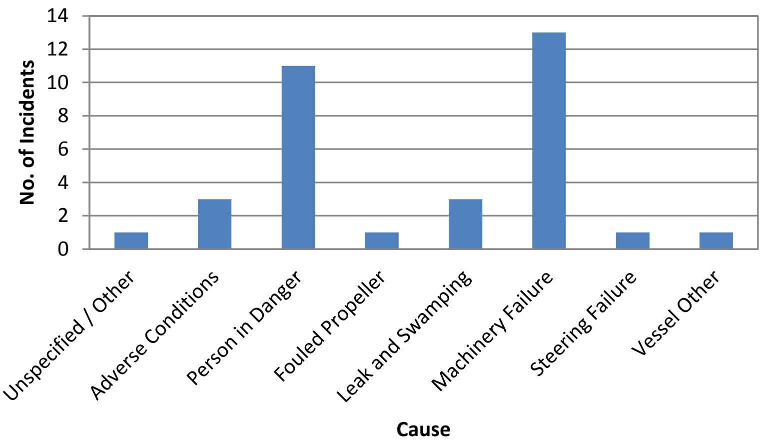


Figure 10.7 RNLI Incidents by Cause within 5nm of the Kyle Rhea Study Area (2001-10)

Figure 10.8 presents the incidents within 5nm of the Study Area colour-coded according to the RNLI station which responded to the incident.

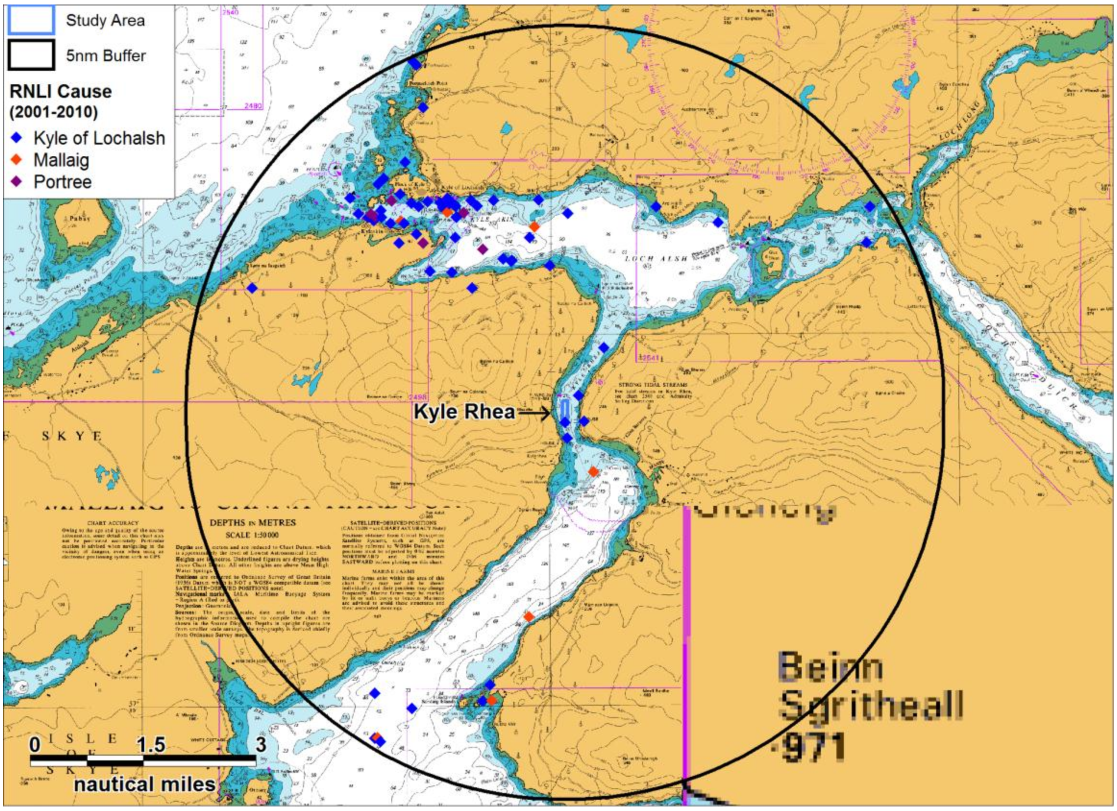


Figure 10.8 RNLI Incidents by Station within 5nm of the Kyle Rhea Study Area

Kyle of Lochalsh station responded to 65% of incidents, with the remainder being responded to by Mallaig (26%) and Portree (9%).

As with the MAIB data, the majority of RNLI incidents occurred to the north of Kyle Rhea, in Kyle Akin. Figure 10.9 presents the RNLI incidents in Kyle Rhea, thematically mapped by casualty type.

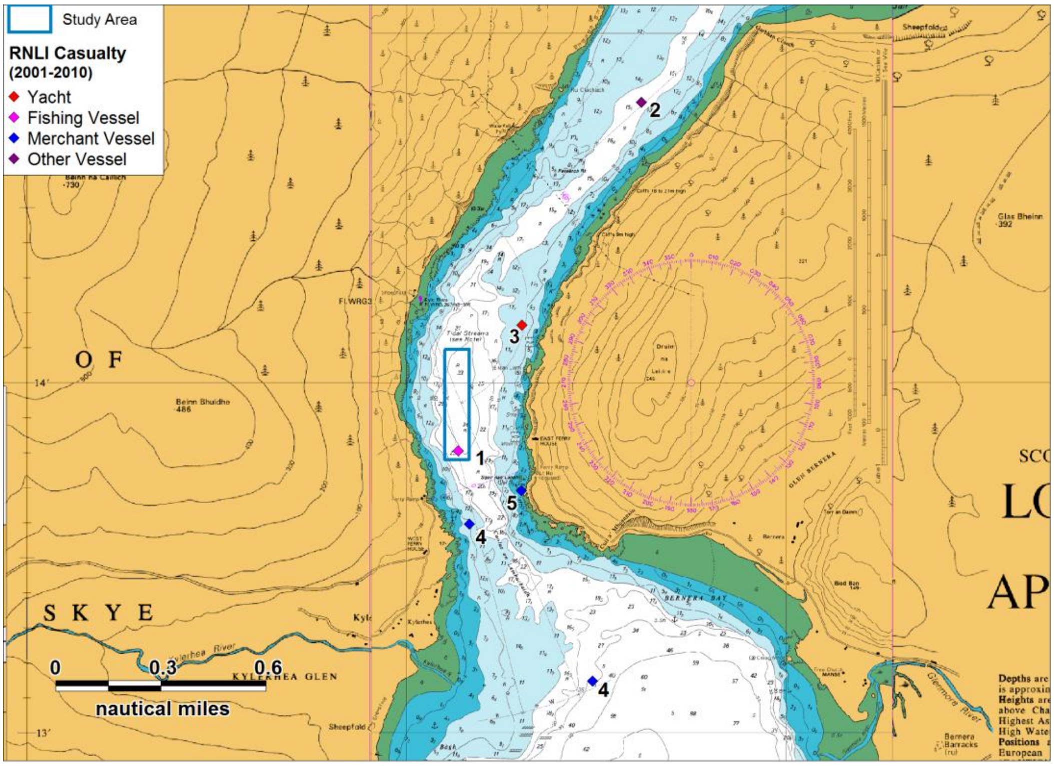


Figure 10.9 RNLI Incidents by Casualty Type in Kyle Rhea

Further details on the five incidents which occurred in Kyle Rhea are presented below:

1. On 20 January 2003 the Kyle of Lochalsh Inshore Lifeboat (ILB) responded to a small fishing vessel with a fouled propeller. (This incident was also recorded by MAIB.)

2. On 19 May 2003 Kyle of Lochalsh ILB launched to a rowing boat which was abandoned. The craft was saved.

3. On 30 July 2003 Kyle of Lochalsh ILB responded to an incident involving a yacht with machinery failure. A person was towed to Kyle by the ILB.

4. On 14 April 2006 Kyle of Lochalsh ILB and Mallaig ALB both responded to the Glenelg-Kylerhea Ferry in difficulty. Kyle of Lochalsh ILB gave assistance. This incident is represented by two points on the figure, due to the two launches.

5. On 6 May 2006 Kyle of Lochalsh ILB assisted when a merchant vessel suffered steering failure. This incident is also represented in the MAIB data and involved the Glenelg-Kylerhea Ferry.

11. Search and Rescue Review

11.1 Introduction

This section summarises the Search and Rescue (SAR) resources in the vicinity of Kyle Rhea which may be called upon in the event of a maritime incident.

11.2 SAR Helicopters

Figure 11.1 presents SAR helicopter resources relative to Kyle Rhea.

Figure 11.1 HMCG Stornoway and RAF Lossiemouth relative to Kyle Rhea Study Area

The closest SAR helicopter base is located at Stornoway, approximately 62nm north-northwest of Kyle Rhea. This base is operated by Her Majesty's Coastguard (HMCG) and has Sikorsky S92 helicopters with speeds of 165 knots and a range of 539nm. One helicopter is available at 15 minutes readiness between 0800 and 2200 hours. Between 2200 and 0800 hours, one helicopter is held at 45 minutes readiness. Up to 22 persons can be carried, however, this is dependent on weather conditions and the distance of the incident from the helicopter's operating base. All SAR helicopters are equipped with VHF (Marine and Air Band), UHF and HF radios. They are also capable of homing to all international distress frequencies.

Lossiemouth, operated by the RAF, is approximately 80nm northeast of the Study Area. This base has Sea King HAR3/3A helicopters with a top speed of 125 knots and a radius of action up to 250nm. One helicopter is available at 15 minutes readiness between 0800 and 2200 hours. Between 2200 and 0800 hours, one helicopter is held at 45 minutes readiness. Up to 18 passengers can be carried, however this is dependent on weather conditions and the distance of the incident from the helicopter's operating base.

Based on the above information, the day-time response to the Kyle Rhea Study Area will be in the order of 35 minutes from Stornoway and 55 minutes from Lossiemouth. At night-time, this will increase to 1 hour 5 minutes from Stornoway, and 1 hour 25 minutes from Lossiemouth, due to the additional response time at the base. It is noted that these calculations are based on still air and will vary depending on the prevailing conditions.

11.3 RNLI Lifeboats

The Royal National Lifeboat Institution (RNLI) maintains a fleet of over 400 lifeboats of various types at 235 stations round the coast of the UK and Ireland. The RNLI stations in the vicinity of the Kyle Rhea Study Area are presented in Figure 11.2.

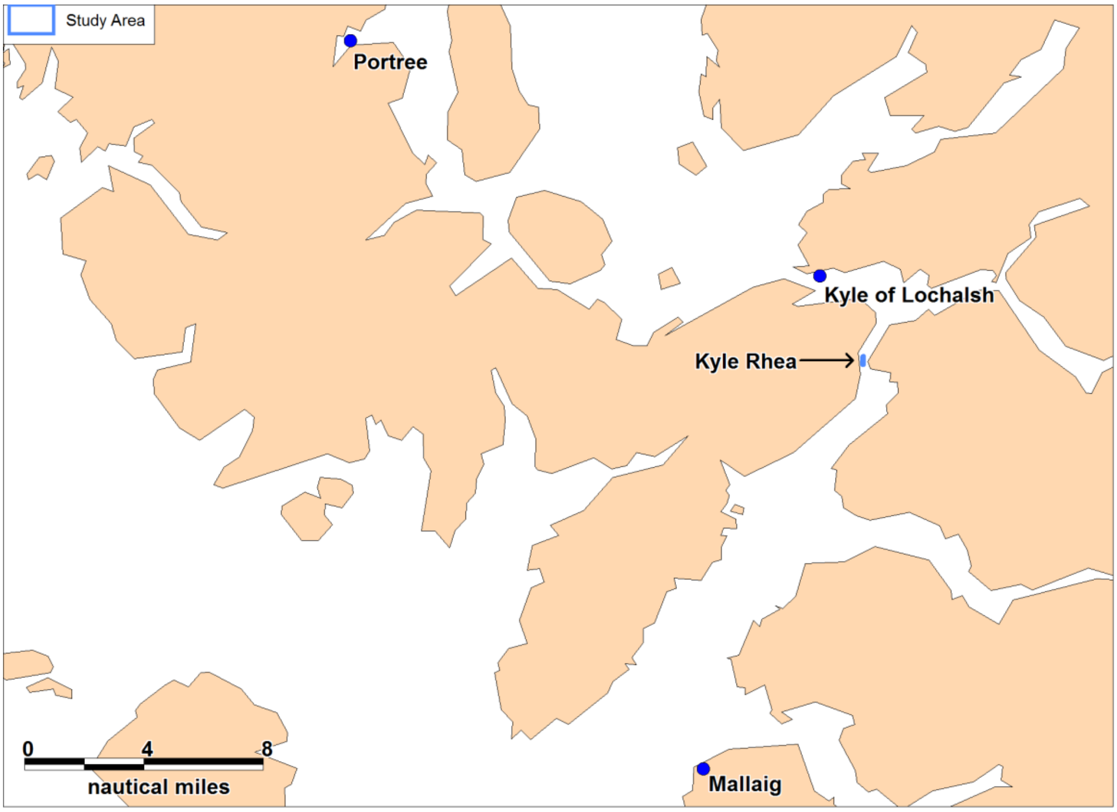


Figure 11.2 RNLI Stations closest to the Kyle Rhea Study Area

From the RNLI incident review presented in Section 10.3 it was identified that it would normally be one or more of these stations responding to an incident within 5nm of Kyle Rhea. The majority of incidents at Kyle Rhea were responded to by Kyle of Lochalsh RNLI as it is the closest, as shown in Table 11.1, although it only has an inshore lifeboat. Incidents involving larger vessels would be responded to by Mallaig, which has more towing capability.

Table 11.1 Lifeboats at RNLI Stations near Kyle Rhea

Station	Lifeboat Type	Name	Approx. Distance to Project Area by Sea (nm)
Kyle of Lochalsh	ILB B class Atlantic 85	*Spirit of Fred. Olsen*	4.5
Mallaig	ALB Severn	*Henry Alston Hewat*	15
Portree	ALB Trent	*Stanley Watson Barker*	20

The ILB B class Atlantic 85 lifeboat has a top speed of 35 knots and range of 2.5 hours. The B class type of lifeboat operates close to shore, in shallow water, close to cliffs and among rocks. The Atlantic 85 carries a full suite of communication and electronic navigation aids, including VHF radio, VHF direction finding, intercom, DGPS and electronic chart, radar and hand-held VHF, as well as searchlight, night-vision equipment and illuminating paraflares for night-time operations.

The ALB Trent and Severn lifeboats both have speeds of 25 knots, ranges of 250nm and can operate in all-weather. All-weather lifeboats are fitted with the latest in navigation, location and communication equipment, including electronic chart plotter, VHF radio with direction finder, radar and global positioning systems (GPS).

At each of these stations crew and lifeboats are available on a 24-hour basis throughout the year. Based on the distance between the RNLI bases and the Kyle Rhea study area, the speed of the lifeboats and consultation with personnel at the stations, the ILB from Kyle of Lochalsh could be on scene within 10-15 minutes, and the ALB at Mallaig could be on scene in approximately 30 minutes. However, this is also dependent on the strength and direction of tidal streams.

11.4 Coastguard Stations

11.4.1 Overview of Coastguard Stations

HM Coastguard is responsible for requesting and tasking SAR resources made available by other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

HM Coastguard co-ordinates SAR through its network of Maritime Rescue Co-ordination Centres (MRCC). A corps of over 3100 volunteer Auxiliary Coastguards around the UK coast form over 400 local Coastguard Rescue Teams (CRT) involved in coastal rescue, searches and surveillance.

All of the MCA's operations, including SAR, are divided into three geographical regions; the East of England Region, the Wales and West of England Region and the Scotland and Northern Ireland Region which covers the remainder of the UK coastline including the Western Isles, Orkney and Shetland.

Each region is divided into districts with a Maritime Rescue Co-ordination Centre (MRCC), which co-ordinates the Search and Rescue response for maritime and coastal emergencies within each district's boundaries.

The Kyle Rhea Study Area lies within the Scotland and Northern Ireland Region with the nearest rescue coordination centre being Aberdeen MRCC.

11.4.2 Changes to Coastguard Stations

MCA published a consultation document in December 2010 (Ref. xii) in order to modernise HM Coastguard. The main part of the document proposed the reduction in the number of MRCC stations around the UK coastline.

Revised plans were released by the UK Government (Ref. xiii) mid-way through 2011 with a second consultation period from 14 July 2011 to 6 October 2011. Under the revised proposals, the MCA intends to:

- Establish a single 24 hour Maritime Operations Centre (MOC) based in Fareham (the Southampton/Portsmouth area) with 96 operational coastguards. The MOC will act as a national strategic centre to manage Coastguard operation across the entire UK network as well as co-ordinating incidents on a day-to-day basis. The MOC will also generate a maritime picture using information from a variety of sources.

- Dover will be configured to act as a stand-by MOC for contingency purposes. Dover would have 28 staff and would retain its responsibilities for the Channel Navigation Information Service (CNIS).

- In addition to the MOC and Dover, there will be eight further centres, all of which would be connected to the national network and the MOC. All would be open 24 hours a day with a total staffing of 23 in each. These would be based at:

    - MRSC Aberdeen
    - MRSC Shetland
    - MRSC Stornoway
    - MRSC Belfast
    - MRSC Holyhead
    - MRSC Milford Haven
    - MRSC Falmouth
    - MRSC Humber.

  *NB: The station at London will be retained unchanged.

11.4.3 Effect of Changes to Coastguard Stations on the Project

The Kyle Rhea Study Area lies within the former Scotland and Northern Ireland region with the nearest MRSC being Stornoway. MRSC Stornoway's area of responsibility provides search and rescue coverage from Ardnamurchan Point to Cape Wrath on the west coast mainland and all the offshore islands in the Inner and Outer Hebrides, along with Saint Kilda. MRSC Stornoway will remain open.

11.5 Salvage

An Emergency Towing Vessel (ETV) provides an emergency towing service for the MCA for the waters around the Northern and Western Isles. *The Heracles*, a specialist anchor handling and towing vessel, is stationed in Orkney and will be funded by the UK Government until 2015.

Each MRSC holds a comprehensive database of harbour tugs available locally. Procedures are also in place with Brokers and Lloyd's Casualty Reporting Service to quickly obtain information on towing vessels that may be able to respond to an incident.

MCA has an agreement with the British Tug-owners Association (BTA) for emergency chartering arrangements for harbour tugs. The agreement covers activation, contractual arrangements, liabilities and operational procedures, should MCA request assistance from any local harbour tug as part of the response to an incident. From consultation, it is considered unlikely a suitable tug could be chartered in time to respond to a drifting vessel incident in or near Kyle Rhea.

11.6 SAR Liaison

The local RNLI stations and Stornoway Coastguard will be consulted about the devices to be deployed and provide any further information requested to assist SAR efforts. This will include:

- Precise location details;
- Device details and illustrations;
- Information on the feasibility of braking device (where relevant);
- Information on the buoyancy of device parts; and
- Emergency contact details.

An Emergency Response Cooperation Plan will be developed and agreed with the MCA prior to installation.

12. Hazard Review and Risk Ranking

12.1 Introduction

The hazard review and risk ranking were primarily based on a workshop held at the RNLI Station in Kyle of Lochalsh on 5 October 2012 attended by local stakeholders.

Following the Workshop, meeting minutes and a hazard ranking spreadsheet were circulated to attendees for comment and review. This section summarises the results with more details provided in Appendix A.

12.2 Workshop Attendees

Stakeholders representing the various types of vessel activity and emergency response organisations in the area were invited to ensure the review took into account local factors and benefited from expert local knowledge. The attendees list is presented in Table 12.1.

Table 12.1 Hazard Review Workshop Attendees

Name	Organisation
David Langston	MCT, representing SeaGeneration (Kyle Rhea) Ltd
Joseph Kidd	MCT, representing SeaGeneration (Kyle Rhea) Ltd
Phil Wilkinson	MCT, representing SeaGeneration (Kyle Rhea) Ltd
Scott Couch	MCT, representing SeaGeneration (Kyle Rhea) Ltd
John Beattie	Anatec
Judith Murray	Anatec
Donald Cameron	Kyle of Lochalsh, Deputy Harbour Master
Stuart Griffin	Mallaig Fisheries Officer
James Maclean	Mallaig Harbour Master
Murdo Macrae	Lochalsh Fishermen's Association
Clive Pearson	Isle of Skye Ferry (IOSFCIC)
Jim Coomber	Isle of Skye Ferry (IOSFCIC)
John Leiper	Plockton Harbour
Kenneth MacLennan	Serco Ship Master (Marine Support to BUTEC)
Douglas Southerland	RNLI DLA, Kyle of Lochalsh
Alexander Mathieson	RNLI Mallaig and Mallaig Fisheries and NW Fishermen's Association
Norman Finlayson	Ship Master (Ferguson Transport and Marine Harvest)

* Invitations were also sent to the MCA Navigation Safety Branch, NLB, RYA (Scotland), Isle of Skye Yacht Charters, Mallaig Marine, Master of *Hebridean Princess*, Svolberg and Stornoway Coastguard.

12.3 Hazard Identified

The key maritime hazards associated with the development were identified and associated scenarios prioritised by risk level.

Within each hazard scenario, vessel types were considered separately to ensure the risk review and control options were specific to each. It was emphasised at the outset that the discussion needed to take into account differences between types of vessels, e.g., sailing, low power, high power, towing etc.

All vessels will potentially be affected by activity during installation / maintenance / decommissioning work and therefore hazards during these phases were considered separately from the normal operations phase.

The following list of the main navigational hazards was reviewed:

NORMAL OPERATION:

1. Transiting vessel collision with device
   a. Sail-only vessel
   b. Low-powered vessel
   c. High powered vessel;
2. Drifting vessel collision with device;
3. Increase in vessel-to-vessel encounters / collisions;
4. Re-routeing of vessels – change in risk, e.g., grounding, foundering
   a. Within Kyle Rhea
   b. West of Skye; and
5. Loss of station – device or part of device.

MAJOR WORK ON SITE, E.G., INSTALLATION:

6. Vessel collision with working vessel / mooring line;
7. Vessel collision with device when cross-beam raised;
8. Re-routeing of vessels – change in risk, e.g., grounding, foundering
   a. Within Kyle Rhea
   b. West of Skye; and
9. Working vessel in difficulties on site.

The following general hazards were noted for future consideration by the project but were not discussed in detail at the meeting as they are non-navigational.

- Man overboard during work activities at site;
- Dropped object during work activities at site; and

- Deliberate damage to device.

12.4 Hazard Ranking Methodology

The ranking of the risks associated with the various hazards was subsequently carried out based on the discussion at the Workshop and review of the baseline data and other consultation. This was circulated to attendees after the meeting for feedback[3]. A risk matrix was used based on the frequency and consequence categories shown below.

Table 12.2 Frequency Bands

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely Unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably Probable	1 per 1 to 10 years
5	Frequent	Yearly

Table 12.3 Consequence Bands

Rank	Description	Definition			
		People	Environment	Property	Business
1	Negligible	No injury	<£10k	<£10k	<10k
2	Minor	Slight injury(s)	Tier 1: Local assistance required	£10k-£100k	£10k-£100k
3	Moderate	Multiple moderate or single serious injury	Tier 2: Limited external assistance required	£100k-£1M	£100k-£1M Local publicity
4	Serious	serious injury or single fatality	Tier 2: Regional assistance required	£1M-£10M	£1M-£10M National publicity
5	Major	More than 1 fatality	Tier 3: National assistance required	>£10M	>£10M International publicity

The five consequence scores were averaged and multiplied by the frequency to obtain an overall ranking (or score) which determined the hazard's position within the risk matrix shown below.

Table 12.4 Risk Matrix

[3] Further consultation is being carried out with the attendees on the effect of changing the minimum clearance of the devices from 4.3m below LAT discussed at the workshop to the newly planned 3.0m below LAT.

Risk		Frequency				
		Negligible	Extremely Unlikely	Remote	Reasonably Probable	Frequent
Consequence	Major	Moderate	Moderate	High	High	High
	Serious	Low	Moderate	Moderate	High	High
	Moderate	Low	Low	Moderate	Moderate	High
	Minor	Low	Low	Low	Moderate	Moderate
	Negligible	Low	Low	Low	Low	Moderate

where:

(green)	Broadly Acceptable Region (Low Risk)	Generally regarded as insignificant and adequately controlled. None the less the law still requires further risk reductions if it is reasonably practicable. However, at these levels the opportunity for further risk reduction is much more limited.
(orange)	Tolerable Region (Moderate Risk)	Typical of the risks from activities which people are prepared to tolerate to secure benefits. There is however an expectation that such risks are properly assessed, appropriate control measures are in place, residual risks are as low as is reasonably practicable (ALARP) and that risks are periodically reviewed to see if further controls are appropriate.
(red)	Unacceptable Region (High Risk)	Generally regarded as unacceptable whatever the level of benefit associated with the activity.

The hazard was ranked by expected risk (based on the estimated frequency versus consequence) with no mitigation measures applied, and residual risk following application of standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop. An example of the methodology and the full set of results are presented in Appendix A.

12.5 Results

12.5.1 Normal Operations Phase

Hazard 1: Transiting Vessel Collision with Device

A vessel transiting through Kyle Rhea may collide with either the tower or the underwater rotors while on passage. This impact has been divided into three scenarios to cover three types of vessel:

a. Sailing vessel
b. Low-powered vessel
c. High-powered vessel

Sailing vessels include a small minority of yachts that do not have auxiliary engines and therefore would be sailing under the influence of wind and tide. The draughts of these vessels are such that they are only likely to interact with the surface towers. However, it was identified during consultation that such sail-only vessel may choose not to pass through Kyle Rhea due to the constricted space.

Based on the Hazard Review, it is estimated that without mitigation the frequency of a transiting sailing vessel collision with a Project device would be **reasonably probable**, with **major** consequence and **unacceptable (high)** risk.

Low-powered vessels include the majority of yachts as well as local fishing vessels and small merchant craft. These will have more control of their heading by using their engines but their course and speed over ground may still be significantly affected by the conditions in Kyle Rhea, especially if transiting during strong tides. There is a low potential risk of collision with subsea rotors in certain wave and tidal conditions.

Collision of a low-powered transiting vessel with a device without mitigation was assessed to be **reasonably probable** frequency, with **major** consequence and **unacceptable (high)** risk. More powerful vessels, such as fish farm well boats, were seen from the survey analysis to have more control over their course when transiting the channel. Consultation indicated less concern about the devices amongst these Vessel Masters, although their vessel draughts are such that interaction with subsea rotors is possible for a higher proportion of the time.

Collision of a high-powered transiting vessel with a device without mitigation was assessed to be **reasonably probable** frequency, with **serious** consequence and **unacceptable (high)** risk.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- The Project will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance.
- Information about the devices will be distributed, e.g. liaison with local harbours, clubs and associations; Coastguard Maritime Safety Information broadcasts; Notices to Mariners; inclusion in Clyde Cruising Club Sailing Directions and other almanacs, etc.
- Marking and lighting of the Project will be decided by NLB once they have reviewed the NRA and consulted on the appropriate scheme to ensure devices are conspicuous and / or to mark a safe passage. The existing leading light will need to be altered.
- Fendering of towers (if practical) - a bumper surrounding the device to absorb the kinetic energy of a vessel in the event of a collision, could potentially mitigate the impact if a small vessel collided with a device. This would be effective only in a glancing collision with the device.

- VHF broadcasts on Channel 16 by vessels prior to transit. Improved VHF reception in the area.
- Traffic management / reporting system including VHF broadcasts on Channel 16 by vessels prior to transit to limit passage to single transits at a time (details of system to be agreed with MCA following assessment of options and consideration of practicality and cost).
- Timing of passage to transit near slack water during daylight hours.
- AIS as aid to navigation on device.
- Dedicated guard vessel on station in the initial operating period (e.g. first year of installation).
- ERCoP to be developed and agreed with the MCA prior to installation.
- Regular liaison with local RNLI stations.
- Broaden functionality of maintenance RIB to act as an emergency response vessel.
- Marker buoys off eastern shore to indicate safe inshore passage.
- Relocation of device 2 to the west (as far as practicable, subject to resource constraints).

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that for transiting sail-only vessel collision with Project device, the frequency would decrease to **remote** and consequence reduce to **serious**, making the residual impact **tolerable (moderate)**.

For low-powered transiting vessel collision with a Project device, the frequency would decrease to **remote** and consequence lessen to **serious**, with the residual impact being **tolerable (moderate)**. For high-powered transiting vessel collision with Project device, the frequency would lessen to **remote**, the consequence would reduce to **moderate** and residual impact would become **tolerable (moderate)**.

<u>Hazard 2: Drifting Vessel Collision with Device</u>

The impact of a vessel going adrift in the vicinity of the devices, being swept through Kyle Rhea under the influence of tide (and / or weather) and colliding with a device was assessed. The Skye ferry would have the most prolonged exposure to this hazard. In the recent past it has suffered engine failure but was able to anchor and rectify the problem. The ferry draught is approximately 1.3m so it will not be able to collide with the subsea rotors.
Other transiting vessels are typically in the area for only a few minutes per transit, therefore, have a lower exposure to this hazard.

Based on the Hazard Review, it is estimated that without mitigation the frequency of this impact would be **remote**, with **serious** consequence and **tolerable (moderate)** risk.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- ERCoP to be developed and agreed with the MCA prior to installation.
- Regular liaison with local RNLI stations.
- Broaden functionality of maintenance RIB to act as an emergency response vessel.
- Fendering of towers (if practical) could potentially mitigate the impact if a small vessel collided with a device. This would be effective only in a glancing collision with the device.
- Devices designed to be accessible, e.g. with ladders for people and moorings for vessels.
- Devices to provide first aid equipment onboard and means of raising alarm.
- Relocation of device 2 to the west (as far as practicable, subject to resource constraints).

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that the frequency would become **remote**, consequence would reduce to **moderate** and residual impact would be **tolerable (moderate)** for drifting vessel collision with Project device.

Hazard 3: Increase in Vessel-to-Vessel Encounters / Collisions

The Project could impact vessel-to-vessel collision risk, due to reduced sea room in Kyle Rhea, making close encounters and therefore collisions more likely. This is particularly the case in a head-on encounter as opposed to an overtaking encounter.

The survey analysis and consultation indicated that encounters within Kyle Rhea are rare but they have been observed on occasion, especially in summer when recreational traffic is much busier.

Based on the Hazard Review, it is estimated that the frequency of this impact without mitigation would be **reasonably probable**, with **serious** consequence and **unacceptable (high)** risk.

- Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:
- VHF broadcasts on Channel 16 by vessels prior to transit.
- Improved VHF reception in the area.
- Traffic management / reporting system including VHF broadcasts on Channel 16 by vessels prior to transit to limit passage to single transits at a time. (details of system to be agreed with MCA following assessment of options and consideration of practicality and cost).
- Marker buoys off eastern shore to indicate safe inshore passage.
- Timing of passage to transit near slack water during daylight hours.
- Relocation of device 2 to the west (as far as practicable, subject to resource constraints).

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that the frequency would reduce to **remote**, bringing the residual impact to **tolerable (moderate)** for vessel-to-vessel encounter / collision.

Hazard 4: Increased Risk to Re-routed Vessels

Re-routing of vessels due to the location of Project devices could lead to additional impacts. Two scenarios were considered:

a. Re-routing within Kyle Rhea
b. Re-routing west of Kyle Rhea

If re-routing within Kyle Rhea there is a danger of routing too far away from the central channel and increasing the risk of grounding. Re-routing west of Skye would entail vessels taking a longer and more exposed route through The Minches, increasing the risk of experiencing rougher sea conditions resulting in potential damage. The Minches experiences heavy vessel traffic. (See Impact 2 for more discussion.)

Based on the Hazard Review, it is estimated that re-routing within Kyle Rhea without mitigation would create a hazard with **reasonably probable** frequency, with **moderate** consequence and **tolerable (moderate)** risk. Re-routing west of Kyle Rhea would create a hazard with **remote** frequency, with **moderate** consequence and **tolerable (moderate)** risk.

- Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:
- Distribution of information about devices, e.g. depiction on charts, to allow vessels to pre-plan voyage.
- Marker buoys off eastern shore to indicate safe inshore passage.
- Hydrographic data collected by project to be shared with MCA / UKHO to allow update of charts (currently based on lead-line surveys).
- Improved VHF reception in the area.
- Timing of passage to transit near slack water during daylight hours.
- Relocation of device 2 to the west (as far as practicable, subject to resource constraints).

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that the frequency would decrease to **remote** and residual impact would be **tolerable (moderate)** for re-routing within Kyle Rhea. The frequency and consequence would remain the same for the scenario of re-routing west of Skye, leaving the residual impact as **tolerable (moderate)**.

Hazard 5: Loss of Station of Device or Component

If part of a device loses station, it could pose a risk to other vessels navigating through Kyle Rhea. Most components are negatively buoyant and therefore should sink rather than pose a floating hazard to passing vessels. A small object is likely to be swept through Kyle Rhea but then wash ashore.

Devices will be engineered to withstand extreme tidal flows and are subject to third party verification. Component parts will be made negatively buoyant where possible and foundations would be piled. Regular maintenance visits would be carried out. A similar device has been trialled and tested at Strangford Lough for four years.

Based on the Hazard Review, it is estimated that the frequency of this impact without mitigation would be **remote**, with **minor** consequence and **broadly acceptable (low)** risk. Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- Supervisory Control and Data Acquisition (SCADA) should provide a prompt alert if part of a device loses station.
- Component parts made negatively buoyant where possible.
- Regular maintenance visits carried out.
- ERCoP will have provisions for emergency response, such as informing the Coastguard who can broadcast warnings to vessels if required, and recovery of any debris.

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that the frequency would lessen to **extremely unlikely** and the residual impact would remain as **broadly acceptable (low)** for loss of station of device or component.

12.5.2 Major Work on Site

Hazard 6: Vessel Collision with Working Vessel / Mooring Line

The potential for a transiting or drifting vessel to collide with a work vessel or associated mooring line was assessed.

Based on the Hazard Review, it is estimated that the frequency of a transiting vessel collision with a work vessel without mitigation measures would be **reasonably probable**, with **serious** consequence and **unacceptable (high)** risk.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- Minimise duration of installation activity.

- Timing of activity to be off-season, with work in early spring, prior to the Skye ferry resuming operations in Easter.
- Pilot vessel / escort boat system to guide vessels past mooring lines.
- Support vessel(s) on site.
- Appropriate marking and lighting to ensure visibility of working vessels.
- Regular broadcasts on VHF Channel 16 from Stornoway Coastguard and intermediate broadcasts from working site.
- Liaison with local RNLI stations.
- Emergency Response Cooperation Plan (ERCoP) to be developed and agreed with the MCA prior to installation.

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered the collision frequency would reduce to **remote**, consequence would reduce to **moderate** and residual impact would be **tolerable (moderate)**.

Hazard 7: Vessel Collision with Device when Crossbeam Raised for Maintenance[4]

The potential of a transiting or drifting vessel colliding with the crossbeam when raised out of the water for maintenance was assessed. This is expected to be a relatively infrequent occurrence (estimated at four times per year for scheduled maintenance).

Based on the Hazard Review, it is estimated that without mitigation the frequency of a vessel collision with a device during major maintenance (cross-beam raised) would be **remote**, with **serious** consequence and **tolerable (moderate)** risk.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- Marking and lighting of device, e.g. floodlights on top of tower to light up crossbeam and blades.
- Planned maintenance to be carried out during neap tides when possible, so that exposed crossbeams are raised only when tides are weaker.
- Regular broadcasts of warnings that the crossbeam is raised.
- Advance notifications to local users, harbours, clubs and associations if works are to be of significant duration and / or overnight.
- Support vessel(s) on site.
- Marker buoys off eastern shore to indicate safe inshore passage.
- Relocation of device 2 to the west (as far as practicable, subject to resource constraints).

[4] Note, some routine maintenance will take place when the cross-beam is under the water. This involves a RIB which is kept on station at the device and therefore does not pose a significant additional collision risk compared to normal operations.

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered the frequency would remain as **remote** and consequence would reduce to **moderate**, with the residual impact remaining as **tolerable (moderate)** for vessel collision with device when crossbeam raised.

Hazard 8: Increased Risk to Re-routed Vessels

This impact considers re-routing of vessels during installation work within Kyle Rhea due to the obstruction / hazard caused by work vessels and associated mooring lines. Two scenarios were considered:

a. Re-routing within Kyle Rhea
b. Re-routing west of Skye

Re-routing within Kyle Rhea, which is considered most likely, leads to a danger of routing too far away from the centre of the Kyle and grounding. Sea room would reduce from the present 440m (between 5m contours) to 250m (between the eastern 5m contour and the maximum extent of Device 2). The eastern shore is also known to be 'dirty', with rocks posing a grounding hazard. Potential mitigation could include marking a safe inshore passage for smaller vessels to follow.

Re-routing to the west of Skye would mean vessels taking a longer and more exposed route, which increases the risk of experiencing rougher sea conditions, as well as of encountering heavy traffic in The Minches. The increased voyage time leads to more exposure to maritime risk in general, as well as having commercial consequences in terms of time and fuel consumption. Major re-routing to this extent is more likely for vessels with restricted manoeuvrability, such as towing cages, as well as any vessel whose Master considers it prudent to avoid Kyle Rhea in the anticipated conditions, e.g. strong spring tides.

Based on the Hazard Review, it is estimated that re-routing within Kyle Rhea, without mitigation measures, would create a hazard with **reasonably probable** frequency, **moderate** consequence and **tolerable (moderate)** risk. Re-routing west of Kyle Rhea would create a hazard with **remote** frequency, **moderate** consequence and **tolerable (moderate)** risk.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- Distribution of information about devices, e.g. depiction on charts, to allow vessels to pre-plan voyage.
- Marker buoys off eastern shore to indicate safe inshore passage.
- Hydrographic data collected by project to be shared with MCA / UKHO to allow update of charts (currently based on lead-line surveys).
- Minimise duration of installation activity.

- Timing of activity to be off-season, with work in early spring, prior to the Skye ferry resuming operations in Easter.
- Pilot vessel / escort boat.
- Support vessel(s) on site.
- Appropriate marking and lighting to ensure visibility of working vessels.
- Regular broadcasts on VHF Channel 16 from Stornoway Coastguard and intermediate broadcasts from working site.
- Improved VHF reception in the area.
- Suitable guidance in Sailing Directions to assist mariners in timing their passage, where considered necessary, taking into account tide times and daylight hours.

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that the frequency would reduce to **remote**, consequence would reduce to **minor** and residual impact would be broadly **acceptable (low)** for the re-routing scenario within Kyle Rhea. The frequency and consequence would remain the same for the scenario of re-routing west of Skye, leaving the residual impact as **tolerable (moderate)**.

Hazard 9: Working Vessel in Difficulty

The impact of a working vessel getting into difficulty due to the tide or weather conditions was assessed. This hazard is under the control of Sea Generation (Kyle Rhea) Ltd, and is therefore not a direct third party impact. However, it could lead to an increase in potential for call-outs for the emergency services, such as the RNLI.

Based on the Hazard Review, it is estimated that without mitigation this would create a hazard with **reasonably probable** frequency, **moderate** consequence and **tolerable (moderate)** risk.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- Contractors vetted and audited prior to appointment to ensure they are suitably qualified and experienced for the purpose of the task and are reputable.
- Industry standard operating and safety procedures / safety management systems, such as that specified within MGN 371, in place.
- Support vessel(s) on site.
- Site personnel trained in first aid and offshore survival.
- Personal protective equipment to be worn by all people working on site.
- Timing of activities in suitable tides.
- Weather forecasts and adverse weather working policy to be in place.
- Temporarily suspend operations until more suitable conditions.
- Liaison with local RNLI stations.
- ERCoP to be developed and agreed with the MCA prior to installation.

Residual impact: Based on applying these mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered that the frequency would reduce to **remote**, with the residual impact remaining as **tolerable (moderate)** for working vessels in difficulty.

12.6 Risk Rankings

Taking into account hazards that were subdivided, the hazard review considered 13 navigational hazards with the following overall breakdown by tolerability region, before and after mitigation.

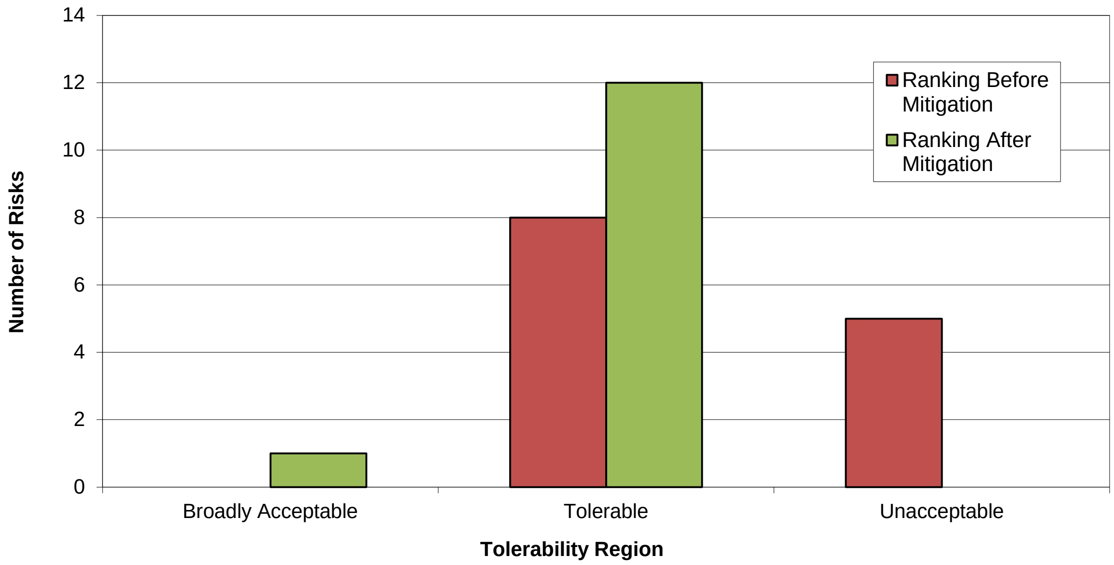


Figure 12.1 Hazard Ranking Results

Five hazards were assessed as being Unacceptable pre-mitigation. These were:

Normal Operation:

- Sailing transiting vessel collision with device;
- Low-powered transiting vessel collision with device;
- High-powered transiting vessel collision with device; and
- Vessel-to-vessel collision (increased risk).

Major Work On Site:

- Collision with work vessel.

By applying the appropriate mitigation identified, the risks were assessed to reduce to a Tolerable (ALARP) level.

Further details on all hazards identified (including phase of operation, causes, frequency and consequences ranking and potential risk control/mitigation measures) are recorded in the Hazard Log (see Appendix A).

It is noted that further consultation is being carried out with the workshop attendees on the effect of changing the minimum clearance of the devices from 4.3m below LAT discussed at the workshop to the newly planned 3.0m below LAT.

12.7 Other Impacts

12.7.1 Fishing Gear or Anchor Interaction

There is a hazard of fishing gear and/or anchor interaction with subsea cables and rotors associated with the project. This hazard did not merit significant discussion or ranking at the Workshop. There is no commercial fishing identified in the vicinity of the array, and vessels are not expected to anchor (except in an emergency). The export cable will be HDD and thus will not be exposed. Inter-array cables will be surface-laid, with protection likely to be double armoured.

Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

- Appropriate cable protection.
- As-laid coordinates to be marked on charts and provided to FishSafe.
- Post-installation survey of cable to ensure it has not moved.
- Further liaison with local fishermen.

Based on applying these standard mitigation measures, and by following industry good practice, such as that specified within MGN 371, it is considered the risk of interaction would be minimal.

12.7.2 Commercial Effect of Re-Routeing West of Skye

The NRA is primarily concerned with navigation safety but it is recognised that there may also be a commercial impact if vessels were to re-route west of Skye.

Figure 12.2 presents a comparison of routeing through Kyle Rhea and west of Skye, for a vessel travelling between Oban and the North Minch. The passage west of Skye through The Minches adds an extra 3nm to the journey.

An example vessel which could potentially re-route west of Skye is the fish farm vessels. Based on an average speed of 10 knots while transiting Kyle Rhea, this would add an additional 30 minutes journey time to the passage.

There may be further delays if vessels had to wait for a suitable weather window before making the more exposed passage west of Skye.

Also, depending on the departure and destination ports, the effect of re-routeing could be more significant, e.g. a vessel heading from Mallaig to Kyle of Lochalsh, avoiding Kyle Rhea, would virtually be circumnavigating the Isle of Skye.

Finally, potential knock-on effects on tourism and the economy were raised by RYA Scotland during consultation but these are not within the scope of the NRA.

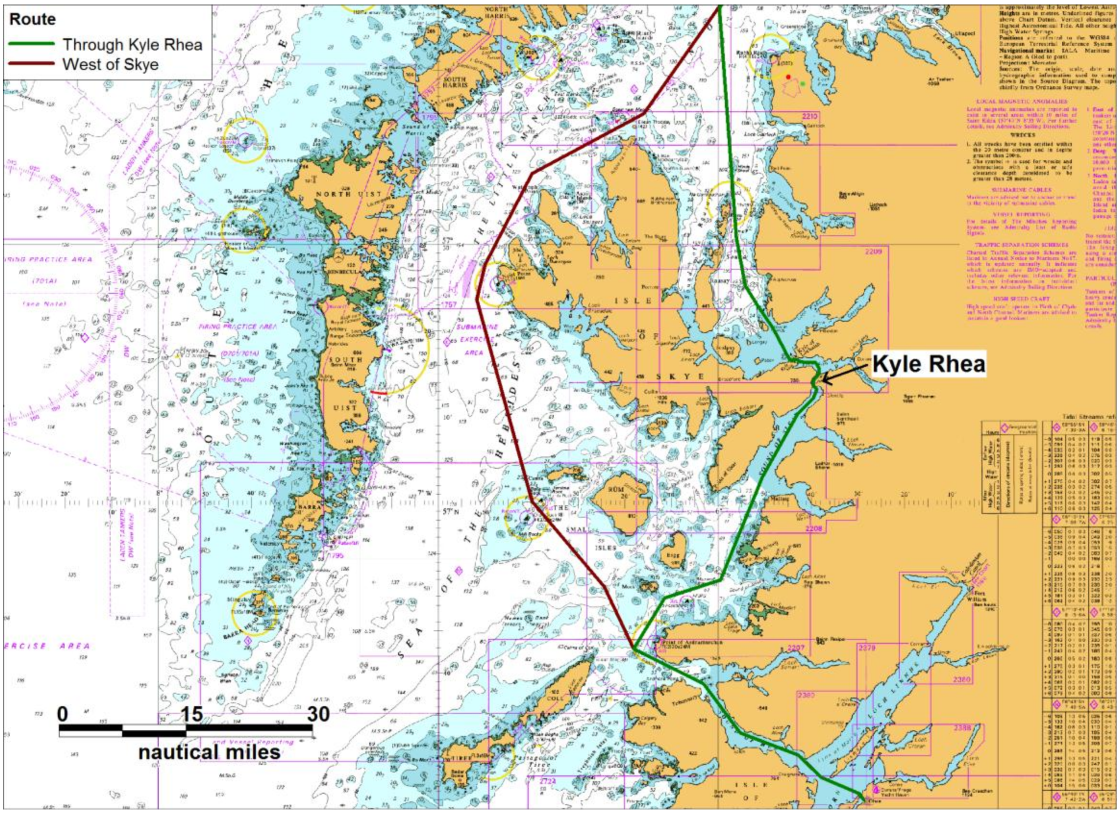


Figure 12.2 Example Routeing Options

13. Quantitative Collision Risk Modelling

13.1 Introduction

To supplement the Hazard Review rankings, Anatec carried out quantitative risk modelling of the following collision hazards:

- Transiting vessel collision
- Drifting vessel collision
- Change in vessel-to-vessel

The modelling has been carried out using Anatec's COLLRISK model, which has been widely used for UK energy projects (oil & gas, marine renewables and nuclear), including subsea collision risk assessments in the Pentland Firth and Orkney Waters, the North Sea, Irish Sea and Bristol Channel.

13.2 Transiting Vessel Collision with Device

This assessment considered the risk of a vessel colliding with a device during a transit, due to either human error and/or force of tidal streams (i.e., not due to equipment failure on the vessel, which is considered under Section 13.3).

The assessment considered the risk of collision with both the surface towers (3m diameter) and/or the two subsea rotor blades (each 20m diameter). All vessels have the potential to interact with the surface towers during all transits. The probability of vessels colliding with the subsea rotors depends mainly on the following factors:

- Rotor Blade Clearance below Water Depth at LAT
- Tidal Height Variations
- Wave-induced Vessel Motion
- Vessel Draughts

The rotor blade clearance is planned to be a minimum of 3.0m below the water level at Lowest Astronomical Tide (LAT). This is the lowest levels that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions. They are not extreme levels, as certain meteorological conditions can cause a higher or lower level (e.g., surge).

Tidal height variations were analysed in Section 3.4. This indicated that 96% of the time the tidal height is at least 1m above LAT and 77% of the time it is at least 2m above LAT. The distribution shown in Figure 3.7 has been input to the model

Draughts of vessels transiting Kyle Rhea were obtained from the survey data or literature where possible, otherwise conservative estimates were made based on consultation feedback.

Wave motions were based on the data presented in Section 3.3. This indicated that the probability of the significant wave height exceeding 0.5m is 1.3% and the probability of exceeding 0.75m is 0.03%. In addition, a wave motion value equal to 1.2 times the significant wave height has been applied based on recommendations of the US Army Corp of Engineers (Ref. xiv) for channel design.

It was assumed that transiting vessels would seek to achieve a safe clearance from the devices by taking a central course between the devices and the eastern shore 5m contour. The lateral distribution of vessels around this mean track was based on the current distribution identified in Appendix C, but narrowed in proportion to the reduced sea room following installation of the devices. This takes into account that vessels are affected by the tidal streams, with smaller vessels noticeably more affected than larger (high-powered) vessels.

The annual transiting vessel collision frequency with the four devices was estimated to be 0.21 per year, corresponding to an average of one collision in 5 years. In terms of point of impact, 98% of collisions were predicted to be with the surface towers, with only 2% of collisions associated with the subsea rotors. This indicates that in average conditions, the draughts of most vessels would pass safely over the subsea rotors.

The majority of this frequency was associated with smaller vessels (i.e., low powered fishing and recreational vessels). As discussed above, this reflects the fact that these vessels are less able to control their headings in the strong tidal streams often experienced by transiting vessels within Kyle Rhea.

The model assumes basic mitigation in the form of chart depiction, information circulation and marking and lighting of devices. It does not take into account the effect of the enhanced mitigation measures suggested at the workshop, such as marker buoys off the eastern shore (which would assist vessels keeping further east of the devices) and timing of passages by certain vessels (i.e., at or near slack water when tides are less likely to affect their planned course). These are anticipated to lower the collision frequency, in-line with the workshop review, although there is insufficient data to quantify the level of benefit.

The risk of a transiting collision involving the Skye Ferry were not modelled as the normal route passes safely to the south of the devices. Consultation with IOSFCIC and the Ferry Master indicated they can plan a safe passage even when the tidal flow causes them to take a more northerly route (i.e., ebb tide running southbound).

13.3 Drifting Vessel Collision with Device

The risk of a vessel losing power and drifting into a device was assessed using Anatec's COLLRISK model. This model is based on the premise that propulsion on a vessel must fail before a vessel will drift. The model takes account of the type and size of the vessel, number of engines and average time to repair in different conditions.

The exposure times for a drifting scenario are based on the ship-hours spent in proximity to the site. These have been estimated based on the traffic levels and speeds. The exposure is divided by vessel type and size to ensure these factors are taken into account within the modelling.

Using this information the overall rate of breakdown within the area surrounding the Kyle Rhea site was estimated. The probability of a vessel drifting towards a device location and the drift speed are assumed to be dominated by the tidal streams. The following drift scenarios were modelled:

- Peak Spring Flood Tide (north-going); and
- Peak Spring Ebb Tide (south-going).

The probability of vessel recovery from drift is estimated based on the speed of drift and hence the time available before reaching the device. Vessels that do not recover within this time are assumed to collide if they are on a collision course with a surface tower or if they pass over the subsea rotors and their dynamic draught (including wave and tidal effects) exceed the underwater clearance.

The annual drifting ship collision frequency with the devices was estimated to be 0.013 per year, corresponding to an average of one drifting ship collision in 79 years. Just over half the estimated collision frequency was associated with the Glenelg-Kylerhea ferry which spends the most time in the vicinity of the devices. The draught of the ferry (1.3m) is such that it is only capable of interacting with the surface towers.

Taking into account all vessels, 98% of drifting collisions were estimated to be with surface towers, with only 2% associated with the subsea rotors.

13.4 Change in Vessel-to-Vessel Collision Risk

The change in vessel-to-vessel collision risk due to the Kyle Rhea Project development, caused by reduced sea room in Kyle Rhea, was estimated by modelling the baseline and predicted traffic positions using Anatec's COLLRISK model.

The baseline (without the Project in place) vessel-to-vessel collision risk level is in the order of one collision in 103 years[5]. It is emphasised the model is calibrated based on major incident data at sea which allows for benchmarking but does not cover all incidents, such as where the consequences were minor.

[5] Note the vessel-to-vessel model is calibrated against 'serious' casualty data at sea. This excludes incidents in port, e.g., minor bumps during berthing, and requires the incident to be of a defined degree of seriousness in terms of loss of life, environmental damage and/or financial impact. Non-serious casualties are estimated to be in the order of four times more frequent than serious casualties. Using serious casualties minimises the probability of under-reporting and provides a benchmark level when comparing the frequency of accidents at different locations.

When the Project devices are installed, it is assumed the mean position of the transiting north-south route will be displaced to the east, and the route will be narrowed due to the reduction in sea room. Based on vessel-to-vessel collision risk modelling of the revised routes, the overall collision risk was estimated to be one major collision in 102 years.

This is a relatively small change which reflects the low occurrence of vessel-to-vessel encounters in the area, as demonstrated by the concurrency analysis in Section 7.6. This is related to the fact that the majority of vessels go through with the tide, and hence in the same direction.

It is noted that the model is calibrated based on historical data, and takes into account traffic density and sea room, but it does not take into account the effect of strong tidal streams in Kyle Rhea. User feedback indicated this is a complicating factor, which increases the hazard of an encounter, therefore, the model results should be treated with caution for this location.

14. Cumulative and In-Combination Impacts

14.1 Introduction

This section considers potential cumulative and in-combination impacts of the Project along with other projects in the area.

14.2 Cumulative

There are no potential cumulative impacts associated with the Project.

14.3 In-Combination

14.3.1 Infrastructure

There are two cables spanning the north end of the Sound of Sleat. To the north, at the Inner Sound end of Kyle Akin, are a number of submarine cable areas and submarine power cables. In the Kyle itself, there is an overhead power cable with pylons, which has 60m safe vertical clearance above Height Datum.

14.3.2 Military

Loch Duich and Loch Long, to the northeast of Kyle Rhea, and the Sound of Sleat to the south, are submarine exercise areas. Submarines exercise frequently, both on the surface and dived.

Military vessels were tracked transiting Kyle Rhea three times during the combined survey. These vessels were the university training vessels *HMS Puncher* and *HMS Express*, and an unrecognised vessel broadcasting as military type on AIS named *Quasar*.

Consultation with the MoD (Section 5.6Stakeholder Consultation5) indicated that use of Kyle Rhea by military vessels is limited, and is restricted to use by training vessels and the occasional frigate. Larger Royal Navy vessels do not tend to make passage through Kyle Rhea, nor do submarines. If a small submarine from another country transited through, it would do so on the surface.

Military vessels associated with BUTEC in the Inner Sound occasionally enter into Kyle Akin but would not normally travel as far south as Kyle Rhea. However, dive support vessels to and from BUTEC operated by Serco transit Kyle Rhea, and were recorded in the traffic survey (two transits by *SD Moorhen*, length 31m in June 2010). Serco were consulted and took part in the Hazard Review Workshop.

14.3.3 Aquaculture

There are a number of marine farms located on the west coast of Scotland which are marked on charts. Admiralty charts indicate that there are two positioned within Kyle Rhea, to the east of the proposed devices. However, Marine Scotland Compliance has confirmed these are no longer present. The closest farms to the Study Area are located within Loch Alsh, to the north of Kyle Rhea.

14.3.4 Other

There are no marine aggregates sites in the vicinity of the development.

15. Conclusions

Kyle Rhea separates the east coast of the Isle of Skye from the mainland of Scotland. It forms part of an inshore traffic route which allows vessels to avoid the more exposed passage west of Skye. The route is recommended only for small vessels, due to the limiting conditions of the Skye Bridge. It is known for its strong tidal stream rates.

The baseline maritime traffic survey identified an average of five to six vessels per day transiting Kyle Rhea in winter and 23 in summer, with the difference being largely due to increased recreational vessel activity in summer. The Glenelg-Kylerhea ferry was visually logged in the summer survey crossing to the south of the device locations (this ferry typically operates from April-October).

The device locations will reduce the sea room available in this part of the channel from approximately 440m (between 5m contours) to 250m (east of device 2). Consultation with stakeholders representing the different users of Kyle Rhea identified concerns the devices would pose a navigation hazard due to the reduced sea room and the fact the tidal streams make it difficult for vessels (especially sailing or low-powered vessels) to control their heading within the channel and will tend to sweep vessels towards the devices. The reduced sea room will also make avoiding action more difficult in the case of a vessel-to-vessel encounter, although the survey analysis indicated that such situations are relatively infrequent.

The hazards were reviewed and ranked at the Hazard Review Workshop attended by a range of stakeholders. Before applying mitigation, a number of the hazards were judged to have unacceptable risk. Separate quantitative modelling of the collision risks (taking into account basic mitigation such as chart depiction and marking and lighting) also predicted the risk of collision was relatively high, particularly for transiting vessels with the surface towers.

By applying appropriate mitigation identified at the workshop, the residual risk rankings were estimated to reduce to a moderate level (tolerable with mitigation). Further investigation of the suggested mitigation measures will be needed to determine if they can be implemented, in practice, to achieve the assumed benefit. Higher priority measures included a traffic management / reporting system, improved VHF coverage and relocation of Device 2 as far west as practicable (taking into account resource constraints). The specific details of a traffic management system would need to be agreed with MCA following assessment of options and consideration of practicality and cost. Specific measures were also recorded for when there is work on the site, i.e., installation, major maintenance and decommissioning.

Finally, it is noted that further consultation on the underwater clearance is being carried out with stakeholders as this changed during the course of the NRA from a minimum of 4.3m to 3.0m below LAT due to the results of further resource and water depth analysis by the project. The results of the quantitative modelling, which used the 3m minimum, suggests this will not have a major impact, as the risk picture is dominated by collisions with the surface elements of the project rather than the subsea elements.

16. References

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Hazard Review Workshop Minutes and Rankings

Kyle Rhea Tidal Array

(Appendix A)

Prepared by:	Anatec Ltd.
Presented to:	SeaGeneration (Kyle Rhea) Ltd
Date:	18 December 2012
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TABLE OF CONTENTS

A1. Introduction

This appendix minutes summarise the main points from the Kyle Rhea Hazard Review Workshop held in Kyle of Lochalsh on 5 October 2012.

The purpose of the workshop was to identify and review the potential navigational hazards associated with SeaGeneration (Kyle Rhea) Ltd's proposed tidal turbine development in Kyle Rhea, between the Isle of Skye and the mainland of western Scotland.

Hazard rankings are also presented.

A2. Attendees

The following people attended the workshop:

Name (Initials)	Organisation
David Langston (DL)	MCT, representing SeaGeneration (Kyle Rhea) Ltd
Joseph Kidd (JK)	MCT, representing SeaGeneration (Kyle Rhea) Ltd
Phil Wilkinson (PW)	MCT, representing SeaGeneration (Kyle Rhea) Ltd
Scott Couch (SC)	MCT, representing SeaGeneration (Kyle Rhea) Ltd
John Beattie (JB)	Anatec
Judith Murray (JFM)	Anatec
Donald Cameron (DC)	Kyle Deputy Harbour Master
Stuart Griffin (SG)	Mallaig Fisheries Officer
James Maclean (JM)	Mallaig Harbour Master
Murdo Macrae (MM)	Lochalsh Fishermen's Association
Clive Pearson (CP)	Isle of Skye Ferry (IOSFCIC)
Jim Coomber (JC)	Isle of Skye Ferry (IOSFCIC)
John Leiper (JL)	Plockton Harbour
Kenneth MacLennan (KM)	Serco Ship Master (Marine Support to BUTEC)
Douglas Southerland (DS)	RNLI DLA, Kyle of Lochalsh
Alexander Mathieson (AM)	RNLI Mallaig and Mallaig Fisheries
Norman Finlayson (NF)	Ship Master (Ferguson Transport and Marine Harvest)

The following people were invited but unable to attend:

Name	Company/Organisation
Captain Ian Stevenson	Master, Hebridean Princess
Michael Ian Currie	Mallaig RNLI
John Hermse	Mallaig Fishing
Ross McKerlich	Kyle RNLI

Name	Company/Organisation
James Ralston	Stornoway Coastguard
Graeme Proctor	MCA
Peter Douglas	NLB
David Vass	RYA Scotland
Mark Entwhistle	Isle of Skye Yacht Charters
Donald McDonnell	Mallaig Marine
Duncan Finlayson	Lochalsh Fishermen's Association
TBC	Svolberg Fish Farm Vessel Master

A3. Minutes

The key notes from the shipping and navigation hazard workshop for the Kyle Rhea tidal development are summarised in the following sub-sections.

3.1 Introduction

- The above attendees introduced themselves and the company they were representing.
- An overview of the project was given by SeaGeneration (Kyle Rhea) Ltd.
- This included details of site selection, feasibility assessments and environmental scoping studies which have been carried out.
- It was emphasised that SeaGeneration (Kyle Rhea) Ltd has an Agreement for Lease (AfL) area from The Crown Estate but they need to apply for and gain consent before they can develop the site.
- Energy yield and resource at the site was summarised. It was stressed that significant relocation of the turbines was unlikely to be economically feasible.
- Anatec presented baseline vessel activity and incident data for the area to set the context for the Hazard Review discussion. This included seasonal variations and concurrency analysis, i.e., the probability of vessels meeting in the channel.
- The methodology for the Hazard Review was outlined. The objective was to identify and review the various navigational hazards associated with the proposed project.
- Hazards were identified, possible causes discussed and potential risk control measures examined. Several of the risk control measures discussed under one hazard could be applicable to more than one hazard.

3.2 Hazard Review

The draft list of hazards prepared for the meeting were reviewed and agreed. The following hazards were discussed:

NORMAL OPERATIONS:

1. Transiting vessel collision with device
2. Drifting vessel collision with device
3. Vessel-to-vessel encounter / collision
4. Re-routeing of vessels – change in risk, e.g., grounding, foundering

5. Loss of station - device or part of device

MAJOR WORK ON SITE, E.G., INSTALLATION:

6. Vessel collision with working vessel / mooring line
7. Vessel collision with cross-beam / surface turbines
8. Re-routeing of vessels – change in risk, e.g., grounding, foundering
9. Working vessel in difficulties on site

It was emphasised at the outset that the discussion needed to take into account differences between types of vessels, e.g., sailing, low power, high power, towing, etc.

The key points from the discussion of each hazard are summarised below.

3.2.1 Hazard 1 (Normal Ops) - Transiting Vessel Collision with Device

Discussion

This hazard is that a vessel transiting through Kyle Rhea (under power or sail) collides with either the tower or the underwater axial flow rotors while steaming in transit.

Vessels currently make a course alteration just to the south of the ferry crossing (and south of turbine 1) where the channel is narrowest and tidal flows are strongest. For example, vessels coming from the south need to alter their course from NNW to NNE to pass through Kyle Rhea.

NF commented it would be more difficult to make the turn and avoid the turbines as the tide naturally pushes vessels towards the west, i.e., towards the proposed turbines. JB reported similar feedback from consultation with the Master of the *Hebridean Princess* which is a low-powered vessel.

JL noted it was also difficult for yachts to control their heading in this area because of the strong tidal currents. Wind can also cause problems at times. *Ocean Spirit* and *Blue Note* were identified as regular transiters. (**Action**: Anatec to contact operators.). NF noted that more cautious yacht skippers may slow down but that this would be the worst reaction.

CP stated that if a vessel were to get the course alteration wrong, it could be set onto devices. Timing of the transit at or near slack water when tidal strength is lowest makes the transit more straightforward.

JB reported other feedback during consultation, e.g., Marine Harvest consulted well boat skippers who were not too concerned as long as devices are well lit. Mallaig Marine who tows cages for Marine Harvest through Kyle Rhea (*Emma C*) indicated no major issues when towing barges about 6m wide, but larger cages up to 50m wide swing out behind the vessel. Re-routeing west of Skye is an option but others were sceptical due to added cost. MM suggested two vessels would be needed to control the cages, one in front and one behind. Also Coastguard warning broadcasts about the operation.

A major concern was if a second vessel simultaneously transits in the opposite direction. The survey analysis indicated this was a relatively rare event as most vessels transit with the tide. However, it was more frequent during summer with the increased recreational traffic. Consultation with the ferry and with other masters confirmed they had seen opposing vessels from time-to-time.

JB noted that the 10 years of incident data indicated it was not a hot-spot for accidents. MM cautioned that not all incidents will be reported to RNLI or MAIB, and he was aware of a few other incidents involving fishing vessel / well boats getting into difficulty in the area.

The scenario of relocating turbines to the centre of the channel (if constraints permitted) to allow traffic to pass either side of the turbines, creating a Traffic Separation Scheme (TSS), was raised. However, further discussion identified this would further reduce the sea room for vessels as they would be forced to pass on a given side, e.g., northbound vessels would be expected to pass east but the tide pushes them towards the centre.

It was agreed traffic management to prevent opposing vessels would be more appropriate as a minimum covering larger vessels. The consensus was that this would be essential if the development proceeds. SG noted that in a one-way scheme, vessels would be queuing up and going through at the same time. Alternative would be for priority to be given to larger vessels. Most difficulty likely to be in managing the movements of smaller vessels.

In terms of the Glenelg-Kylerhea ferry, CP indicated that when the tide is running southwards they set off on a more northerly heading to allow the tide to push them back. However, the proposed turbine locations were felt to be manageable.

It was noted that a proportion of larger vessels that transit the channel could interact with the subsea turbines which will be 4.3m below LAT. Dependent on wave and tide. It was considered that large vessels would seek to avoid passing over the turbines even in calm seas and suitable tides. Information on under water clearance needs to be prominent on charts. JM noted that fish farm vessels could be larger in future, i.e., 6m depth and 60m length.

Summary of Potential Causes

- Reduced sea room in the channel.
- Strong tidal flows (especially affecting low powered vessels and sailing yachts).
- Lack of awareness of devices pre-transit (visiting yachts highlighted).
- Poor visibility (especially during night-time passage).
- Encountering another vessel in the vicinity of the turbines.

Summary of Potential Risk Controls

- Promulgation of information about the devices, e.g., charts, liaison with local harbours, clubs and associations, Coastguard Maritime Safety Information broadcasts, Notices to Mariners, inclusion in Clyde Cruising Club Sailing Directions and other almanacs, etc.

- Chart depiction to include under water clearance information on subsea turbines.
- Marking and lighting of devices. NLB to be consulted on appropriate scheme to ensure turbines are conspicuous and/or to mark a safe passage. The existing leading light will need to be altered.
- Timing of passage i.e., transit at or near slack water and during hours of daylight. Many yachts currently time their arrival or wait at anchor to the south or north for an appropriate tide.
- VHF broadcasts: Some vessels broadcast their intentions on Channel 16 before committing to the passage of Kyle Rhea. A safety announcement could be made compulsory or as a minimum encouraged as good practice, e.g., in chart notes and sailing directions.
- Improved VHF reception: Consultees have mentioned the area is poor for VHF, such as the inshore lifeboat at Kyle. Facilities could be installed to improve coverage in the area.
- Traffic management / reporting system: A one-way system was suggested to limit or prevent head-on encounters. It was noted that Stornoway Coastguard operate a reporting scheme for the Skye Bridge but this is a passive system and applies only to larger vessels. A dedicated Vessel Traffic Service (VTS), such as those operated by several UK ports, could be another option with radar and VHF coverage of the area.
- Alternative to a one-way scheme would be a system to give certain vessels priority ("clear channel" procedure). For example, Coastguard could receive report from such a vessel and tell other vessels to keep clear.
- Guard vessel: A dedicated vessel on station, at least in the initial 1-2 years, was discussed but was generally felt to be ineffective for this hazard due to the short amount of time it would take for an incident to develop.
- Fendering: Fenders on the towers (if practical) could potentially mitigate the impact if a small vessel collided with a device. It was suggested that this would be effective only in a glancing collision with the device. For a vessel stemming the tower it would have little effect. MCT would need to investigate if this is practicable.
- Turbine relocation: Moving turbine 2 to the west was suggested, as this device causes the most concern as it is towards the narrow part of the channel and fairly central. SC reiterated that resource constraints would make this difficult but asked if a few metres, say 10m, would make any difference. NF stated any movement would help alleviate the navigational issues.
- AIS as aid to navigation on device: About one-quarter of vessels tracked during 2010 survey carried AIS but this proportion is growing, e.g., mandatory for fishing vessels $\geq$ 15m in length from summer 2014.

<u>Risk Review</u>

- This hazard was discussed as being of high frequency.
- Probable consequences of collision were assessed as being minor damage to large vessels but potential capsize of smaller vessels. Depends on angle of impact, conditions at the time, etc.

<u>Post Workshop Note:</u>

In the risk ranking sheet this hazard has been divided into three parts to cover three different types of vessel:

a. *Sailing vessel*
b. *Low-powered vessel*
c. *High-powered vessel*

3.2.2 Hazard 2 (Normal Ops) - Drifting Vessel Collision with Device

Discussion

A vessel which goes adrift in the vicinity of the turbines could be swept through Kyle Rhea under the influence of tide (and/or weather) and collide with a turbine.

JB commented that historically breakdowns are relatively infrequent but the risk is also proportionate to the time vessels spend in the area. The vessel most exposed would be the ferry.

Anchoring was not considered to be an effective control measure as the seabed is comprised of rock and therefore is poor holding ground.

The Glenelg Ferry has been known to anchor in the area. CP indicated the ferry could drop anchor most of the way but not in the middle due to deeper water. The ferry has suffered breakdowns in the recent past although CP considered a catastrophic engine failure was unlikely.

In terms of external recovery, there are no harbour tugs in the vicinity. There may be a navy boat in Kyle but it would be unlikely to be able to respond in time. RNLI at Kyle can get to the site in approximately 10-15 minutes but it is an ILB with limited towage. Mallaig lifeboat has more power so could possibly tow or at least hold a larger vessel but would take 30 minutes to reach the scene.

It was queried whether the ferry could respond to incidents during its hours of service. This could potentially put the ferry at risk and was only considered feasible at slack tide. Other vessels in the area at the time may be able to help but this is uncertain.

SeaGeneration (Kyle Rhea) Ltd plan to have a RIB stationed locally for maintenance. This could act like a local lifeboat and provide a quick response. Personnel could be suitably trained in emergency response and recovery.

The potential for vessels to moor to the towers in an emergency was discussed, e.g., lugs. Also providing First Aid equipment onboard for anyone seeking refuge and accessible ladders to facilitate this. However, the strong tidal flows were noted as making it difficult for persons in the water to reach the towers.

Summary of Potential Causes

- Vessel blackout (e.g., due to mechanical failure).

- Adverse weather.
- Fast tides reducing recovery time
- Poor holding ground for anchor.

Summary of Potential Risk Controls

- Emergency Response Cooperation Plan (ERCoP) to be agreed with MCA prior to installation.
- Liaison with local RNLI stations.
- Broaden functionality of the maintenance RIB to act as an Emergency Response vessel.
- Fendering (as Hazard 1) (if practical).
- Design devices to be accessible, e.g., ladders for people and moorings for vessels.
- First aid equipment onboard and means of raising alarm.

Risk Review

- Frequency considered to be lower than powered collision as historically black outs on vessels are infrequent. (MM noted that if vessels are struggling to make way against tide this could increase likelihood.)
- Consequences similar to Hazard 1 but collisions are likely to be at lower speed and hence lower energy. Fendering (if practical) may offer more mitigation. Also should be more warning of a problem.

3.2.3 Hazard 3 (Normal Ops) - Vessel-to-Vessel Encounter / Collision

Discussion

As discussed under Hazard 1, the development will reduce the sea room available to vessels which makes close encounters and therefore collisions more likely. This is particularly the case in a head-on encounter as opposed to an overtaking encounter.

The survey analysis indicated this was a relatively rare event. Users of Kyle Rhea stated they occasionally see yachts coming through in a convoy. Military vessels have also been observed travelling together. NF stated he has encountered other vessels but a lot of the time he sees nothing.

CP raised concern that the devices could affect line of sight of ferry to north from the Kylerhea side. Ferry master checks for approaching vessels before commencing the crossing. VHF calls and monitoring by all vessels would help.

Summary of Potential Causes

- Reduced sea room to east of device locations.
- Strong tides.
- Poor visibility (especially during night-time passage).
- Human error – failure to follow Rules of Road (collision regulations).

Summary of Potential Risk Controls

- VHF broadcasts (see Hazard 1)
- Improved VHF reception (see Hazard 1).
- Traffic management / reporting system (see Hazard 1).
- Turbine relocation (see Hazard 1)

Risk Review

- This hazard was considered to be relatively high frequency if there was no additional mitigation put in place, e.g., traffic management and improved VHF.
- Consequences will depend on the vessels involved but could range from minor damage to sinking of vessels, with potential fatalities.

3.2.4 Hazard 4 (Normal Ops) - Increased Risk to Re-Routed Vessels

Discussion

Re-routeing of vessels due to the devices could lead to additional hazards. Two main scenarios were considered

- Re-routeing within Kyle Rhea
- Re-routeing west of Skye

If re-routeing within Kyle Rhea, there is a danger of routeing too far away from the centre and grounding. For example, a vessel could be pushed closer to the eastern shore or cut the corner and encounter rocks on that side. Buoys were discussed as potential mitigation, e.g., a line of buoys along the mainland coast to the SE and east of the site (near Glenelg) to help guide small vessels (e.g., yachts) safely around the bend , allowing them to keep further in to shore while safely avoiding any rocks. These buoys would be out of the main tidal flow and could have 2 or 3 point mooring or be staked.

JB noted feedback from consultation that the ferry mooring sticks out into the channel (Glenelg side) and the ferry can swing out, which reduces the available sea room. CP said this was the optimal place but the discussion indicated there may be scope to improve the mooring to reduce the excursion.

Re-routeing west of Skye would mean vessels taking a longer and more exposed route which increases the risk of experiencing rougher sea conditions resulting in potential damage, foundering, etc. Also the Minches are heavily trafficked. This was not considered to be a practical option for most vessels but some prudent mariners may choose to re-route depending on tides, type of vessel and nature of operation, e.g., towing cages.

The hypothetical scenario of closing Kyle Rhea and re-routeing all vessels west of Skye was touched on. This was viewed as impractical due to both commercial and safety issues. It would not just affect local vessels but the wider economy, such as yacht visitors passing up the west coast.

Summary of Potential Causes

- Devices near centre of channel.

- Strong tidal flows.
- Human error, e.g., mis-timing passage.
- Bad weather / rougher seas west of Skye

Summary of Potential Risk Controls

- Promulgation of information about devices, e.g., depiction on charts, to ensure vessels can revise their passage plan in advance.
- Marker buoys especially on eastern shore.
- The issue was raised that, due to the tidal flow in the channel, the buoys would need to have 2/3 point moorings in order to hold station.
- These buoys would also have the effect that they would allow yachts to keep close to them, thus permitting larger vessels to pass.

Risk Review

- Re-routeing most likely to be within Kyle Rhea, therefore, main risk is grounding, especially on eastern shore. Moderate frequency.
- Consequences are damage to vessel, risk of capsize and associated fatalities.

Post Workshop Note:
In the risk ranking sheet this hazard has been divided into two parts to cover the two main re-routeing scenarios:

a. *Within Kyle Rhea*
b. *West of Skye*

3.2.5 Hazard 5 (Normal Ops) - Loss of Station of Device or Component

Discussion:
Loss of a device or part of a device presenting a potential navigation hazard to passing vessels.

It was noted this hazard is under the control of SeaGeneration (Kyle Rhea) Ltd and MCT. Devices will be engineered to be suitable for the tidal flows and there will be 3rd party certification. A SeaGen device, similar to the ones proposed for Kyle Rhea, has been tried and tested at Strangford Lough for 4 years.

Piled foundations rather than mooring lines reduce probability of loss of a device.

Most component parts are negatively buoyant and therefore should sink rather than pose a floating hazard to passing vessels. However, rotor blades may be neutrally buoyant.

A small object is likely to be swept through Kyle Rhea but then wash ashore. RNLI had an incident of a canoe going adrift and washing ashore at opposite end of Kyle Rhea. However, occurrences of objects being washed ashore in Kyle Rhea were also noted.

In the event of a significant failure of this kind, control room (or on-call personnel) should be alerted to the problem. ERCoP will have provisions for emergency response such as informing the Coastguard who can broadcast warnings to vessels if required, and recovery of any debris.

Summary of Potential Causes

- Failure of the device.
- Large vessel clipping / colliding with under water structure.

Summary of Potential Risk Controls

- SCADA - should be possible to have prompt alert of a problem.
- Engineering design.
- 3rd party verification.
- Tried and testing equipment.
- Regular maintenance visits.
- Piled foundations.
- Most component parts will be negatively buoyant.
- ERCoP.

Risk Review

- Low frequency due to MCT experience and regular maintenance.
- Consequences also low as object unlikely to pose a hazard for a long duration. Worst case would be at night when vessels may not be able to visually sight floating object. Could cause minor damage to large vessels but holing / sinking of small vessels, with potential fatalities. Smaller vessels less likely to transit at night.

3.2.6 Major Work on Site, e.g., Site Investigation / Installation / Maintenance

Introduction

- PW of MCT presented an overview of the site investigation and installation methods which could be used at the development.
- Geotechnical investigation options are diver coring, BGS seabed drilling, canyon seabed drilling and jackup coring.
- For BGS seabed coring, a construction barge vessel 30-40m long and 10-15m wide, with a crane on board, would be used. This vessel will use anchor wires. Operations will be restricted by tide.
- The canyon seabed drill would not use anchor wires and drilling would take 16h per hole.
- Jackup coring unlikely due to the cost involved. Jackup would not need anchor wires once positioned.
- PW considered worst case to be barge on site, 16 hours per location x 4 locations.
- Anchor wires used for the barge would be a combination of drag and gravity. The possible mooring spread of the anchor wires was displayed. Lengths of the anchor

wires would be 7 times the water depth, thus 150-200m extending out into the channel.

- Once the foundations had been installed, there would be a steel pile protruding 5-6m from the seabed.
- Vessels would differ in type between installation of the foundation and installation of the device.
- The most likely method for foundation installation would be a DP / moored construction barge, using a subsea drilling template and subsea drill.
- Foundations would be installed one season and devices the next.
- Preliminary timing of foundation installation was given as 2014.
- Foundation installation would take 7 days (total approx. one month), with device installation requiring 3-4 days (total about 2 weeks).

3.2.7 Hazard 6 (Major Work) - Vessel Collision with Work Vessel

Discussion

Potential hazard of a transiting or drifting vessel colliding with a work vessel / unit, e.g., barge, or associated mooring line.

Generally, it was recognised that these hazards were temporary and therefore stakeholders were more comfortable provided there was adequate warning. Methods of ensuring this include liaison with ports, clubs and associations, Notices to Mariners, Coastguard Maritime Safety Information Broadcasts, direct correspondence with known users of Kyle Rhea, etc.

Timing of the activity to avoid the peak season was identified as effective mitigation. There was five times the traffic in summer as winter according to the surveys.

PW indicated it should be possible to carry out the work in early spring. This would also allow the work to be completed before the ferry resumes operations in Easter. It was noted Easter varies year to year and further consultation would be necessary.

Safety / exclusion zones were not considered practicable. At Strangford Lough a pilot / escort vessel was employed to take vessels through the channel along a safe track, avoiding the mooring lines. This was considered to be essential for Kyle Rhea. It may also be possible to shorten certain anchor wires.

Support vessels should be available 24 hours per day in the event of a drifting vessel.

(Other relevant factors were discussed under Hazard 1.)

Summary of Potential Causes

- Large obstruction.
- Poor visibility.

Summary of Potential Risk Controls

- Short duration.

- Timing of activity to avoid ferry timetable and peak summer season.
- Pilot vessel / escort boat system to guide vessels past mooring lines.
- Support vessel(s) on site. One vessel nominated as rescue / guard vessel.
- Appropriate marking and lighting to ensure visibility of working vessels.
- Regular broadcasts from Stornoway coastguard and intermediate broadcasts from working vessel.
- Standard mitigation measures appropriate to the nature of the operations.

Risk Review

- Frequency is limited by the short duration of these operations.
- Consequences were noted to be damage to transiting vessel and / or working vessel, with the possibility of fatalities on either / both.

3.2.8 Hazard 7 (Major Work) - Vessel Collision with Cross-Beam / Surface Turbines

Discussion

During the maintenance period when the device cross-beam is raised above the water, there will be an additional obstruction to navigation and collision hazard to all vessels. The total extents (including rotor blades) of the structure will be approximately 49m.

This design has advantages in that it reduces the time required for maintenance and means that only a small RIB is needed for routine inspections rather than having larger vessels visiting the site.

It was questioned how long the device would be in the raised position. MCT stated that the time would be limited (normally 1-2 hours) and it was unlikely to be raised overnight as not in project's interests.

If it were raised in darkness then the surface structures would need to be well lit and marked.

All maintenance of this kind would be planned around neap tide, so exposed cross beams only up when tides are weaker.

Questioned how long it would take to lower the cross-beam. MCT stated it takes approximately an hour so would only help in a drifting scenario if sufficient warning. (Also about an hour to raise.)

Under no circumstance would all 4 cross-beams be raised at one time.

It was felt that the raised cross-beam of device number 2 would be the most hazardous to navigation and the one people would be trying to keep clear of.

The issue of the devices blocking the view of the Glenelg Ferry of transiting traffic was pointed out to be more serious when the cross-beam is raised.

Summary of Potential Causes

- Excessive maintenance.
- Poor operating procedures.
- Poor visibility.

Summary of Potential Risk Controls

- Marking and lighting. Searchlights on the top of the tower shining down on the crossbeam were mentioned as preferred. MCT stated this was the most likely option.
- Light positioned on the end of the turbine blades when raised. If a flashing light was to be used, it would be most effective with a quick repetition rate.
- Lowering of the cross-beam if sufficient time to avoid a collision. Only likely in a drifting scenario as a mitigation measure if it was observed that there was a vessel on course for the array.
- Planned maintenance during neap tides.
- Regular broadcasts warnings that cross-beam is raised, e.g., Coastguard MSI and intermediate broadcasts from the RIB, e.g., every 1-2 hours.
- Advanced notifications to local users and harbours, clubs and associations if significant durations, especially overnight.

Risk Review

- Low frequency based on low expected duration of this type of maintenance.
- Consequences of a collision were estimated to be higher as personnel working on the cross-beams would also be exposed. Injuries and/or fatalities.

3.2.9 Hazard 8 (Major Work) - Increased Risk to Re-Routed Vessels

Discussion

This is similar to Hazard 4 but it is noted that complete avoidance of Kyle Rhea and re-routeing of vessels to the west of Skye will be more likely during major geotechnical or installation work on site.

Advanced notification would be vital to allow vessels to revise their passage plan before setting off, e.g., cage towing vessels. This would also help vessels time their journey west of Skye in a suitable weather window.

Summary of Potential Causes

- See Hazard 4.

Summary of Potential Risk Controls

- Targeted notifications to regular users, such as cage towing vessels.
- See Hazard 4.

Risk Review

- Similar to Hazard 4 but shorter duration so lower frequency.

3.2.10 Hazard 9 (Major Work) - Working Vessel in Difficulties on Site

Discussion

Working vessel gets into difficulty due to the tidal or weather conditions within Kyle Rhea.

It was noted this hazard is under the control of SeaGeneration (Kyle Rhea) Ltd. Vessels and contractors can be selected based on safety record and experience. Audits can be carried out to check people and equipment / vessels to be used. Contractors working on the site will have their own procedures and Safety Management System.

Other Support vessels / personnel may be available in an emergency, e.g., man overboard.

ERCoP will be in place and relationships established with local RNLI and Coastguard.

Summary of Potential Causes

- Strong tides.
- Poor operating procedures.
- Lack of training and experience.
- Human error.

Summary of Potential Risk Controls

- Contractors appointed, vetted and audited.
- Industry standard operating and safety procedures in place.
- Site personnel trained in first aid and offshore survival.
- Personal protective equipment (PPE)
- Timing of activities in suitable tides.
- Weather forecasts and adverse weather working policy.
- ERCoP
- Invite RNLI for a site visit as a familiarisation exercise.
- Temporarily suspend operations until more suitable conditions.

Risk Review

- Consequences of this hazard were assessed as being potential injury to personnel, damage to vessel and delay in operations.

3.3 Other

It was asked if there were any other hazards or potential mitigation measures that had not yet been discussed.

MM asked if there would be any local effects on the tidal flow. SC stated that most impact will be under water and close to turbines. This dissipates very quickly downstream, hence, the reason for the six diameter spacing of devices. Not considered to be an issue. Design is being modified to make towers more hydrodynamic.

JB mentioned that the consultation had indicated kayakers also use Kyle Rhea. It was felt that the mitigation measures discussed would equally benefit kayakers.

A4. Hazard Ranking Methodology

After the meeting, the minutes were circulated to attendees along with a risk ranking sheet. Attendees were requested to comment on the estimated rankings (frequency x consequence) assigned to each hazard based on the meeting along with their knowledge and experience.

A risk matrix was used based on the frequency and consequence categories shown below. This was based on the DECC Methodology.

Table 4.1 presents the frequency bands and Table 4.2 presents the consequence categories which were applied.

Table 4.1 Frequency Bands

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely Unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably Probable	1 per 1 to 10 years
5	Frequent	Yearly

Table 4.2 Consequence Bands

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No injury	<£10k	<£10k	<10k
2	Minor	Slight injury(s)	£10k-£100k	Tier 1 Local assistance required	£10k-£100k
3	Moderate	Multiple moderate or single serious injury	£100k-£1M	Tier 2 Limited external assistance required	£100k-£1M Local publicity
4	Serious	serious injury or single fatality	£1M-£10M	Tier 2 Regional assistance required	£1M-£10M National publicity
5	Major	More than 1 fatality	>£10M	Tier 3 National assistance required	>£10M International publicity

The four consequence scores were averaged and multiplied by the frequency to obtain an overall ranking (or score) ranking which determined the hazard's position within the risk matrix shown in Table 4.3.

Table 4.3 Risk Matrix

Risk		Frequency				
		Negligible	Extremely Unlikely	Remote	Reasonably Probable	Frequent
Consequence	Major	Moderate	Moderate	High	High	High
	Serious	Low	Moderate	Moderate	High	High
	Moderate	Low	Low	Moderate	Moderate	High
	Minor	Low	Low	Low	Moderate	Moderate
	Negligible	Low	Low	Low	Low	Moderate

where:

(green)	Broadly Acceptable Region (Low Risk)	Generally regarded as insignificant and adequately controlled. None the less the law still requires further risk reductions if it is reasonably practicable. However, at these levels the opportunity for further risk reduction is much more limited.
(orange)	Tolerable Region (Moderate Risk)	Typical of the risks from activities which people are prepared to tolerate to secure benefits. There is however an expectation that such risks are properly assessed, appropriate control measures are in place, residual risks are as low as is reasonably practicable (ALARP) and that risks are periodically reviewed to see if further controls are appropriate.
(red)	Unacceptable Region (High Risk)	Generally regarded as unacceptable whatever the level of benefit associated with the activity.

The hazard was ranked by expected risk (based on the estimated frequency versus consequence) with no mitigation measures applied, and by estimated residual risk following application of standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop.

The worked example below illustrates the method of ranking hazards:

Hazard Title	Transiting vessel collision with device (sailing vessel).
Possible Causes	Reduced sea room, strong tidal flows, lack of awareness pre-transit, poor visibility, encountering another vessel near device.
Ranking Before Mitigation	Frequency x Consequence = Risk Reasonably Probable (4) x Major (5) = Unacceptable (High) (20)
Potential Mitigation Measures	Promulgation of information, marking and lighting, timing of passage, VHF broadcasts, traffic management, guard vessel. (Further measures presented in full discussion).
Ranking After Mitigation	Frequency x Consequence = Risk

	Remote (3) x Serious (4) = Tolerable (Moderate) (12)

Table 4.4 presents the risk ranking of this hazard.

Table 4.4 Risk Matrix: Transiting vessel collision with device (sailing vessel)

Consequence (Pre-Mitigation)						
	5				x	
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Frequency				

Consequence (Post-Mitigation)						
	5					
	4			x		
	3					
	2					
	1					
		1	2	3	4	5
		Frequency				

The risk for the hazard is calculated by multiplying the frequency by the consequence, i.e., 4 (reasonably probable) x 5 (major) to obtain a risk ranking of 20. A score of 20 puts this hazard in the Unacceptable region. Post-mitigation, the frequency is estimated to reduce to 3 (remote), consequence lessened to 4 (serious), to obtain a residual risk ranking of 12, putting it in the Tolerable region.

A5. Results

The hazard log contained 13 navigational hazards (following subdivision of selected hazards) with the following overall breakdown by tolerability region, before and after mitigation.

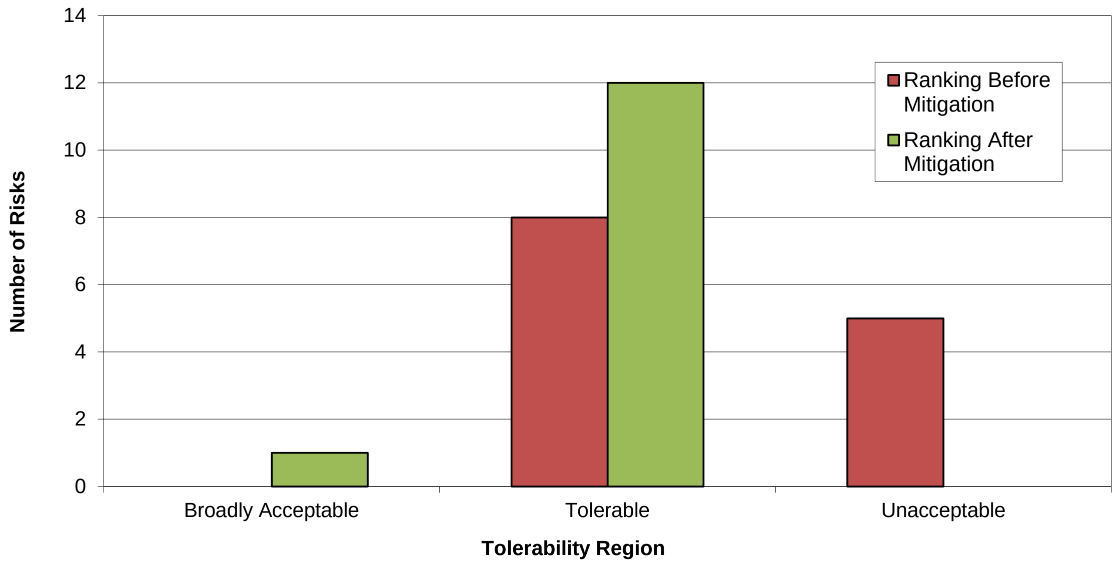

Figure 5.1 Risk Ranking Results

Five hazards were assessed as being Unacceptable pre-mitigation. These were:

Normal Operation:

- Sailing transiting vessel collision with device;
- Low-powered transiting vessel collision with device;
- High-powered transiting vessel collision with device; and
- Vessel-to-vessel collision (increased risk).

Major Work On Site:

- Collision with work vessel.

By applying the appropriate mitigation identified, the risks were assessed to reduce to a Tolerable (ALARP) level.

Full details of the logged and ranked hazards are summarised in Table 5.1.

It is noted that further consultation is being carried out with the workshop attendees on the effect of changing the minimum clearance of the devices from 4.3m below LAT discussed at the workshop to the newly planned 3.0m below LAT.

Table 5.1 Hazard Ranking Results

ID	Phase	Hazard	Description	Possible Causes	Ranking before Mitigation			Potential Mitigation Measures	Ranking after Mitigation		
					Frequency	Consequences	Risk		Frequency	Consequences	Risk
1a	NORMAL OPS	Sailing Transiting Vessel Collision with Device	A sailing vessel transiting through Kyle Rhea collides with either the tower or the underwater axial flow rotors while in transit.	• Reduced sea room • Strong tidal flows • Lack of awareness of devices pre-transit • Poor visibility • Encountering another vessel near turbine	4	5	20	• Promulgation of information • Chart depiction including subsea clearance • Marking and lighting of devices including alteration to leading light (in consultation with NLB) • Timing of passage i.e., transit at or near slack water and in daylight • VHF broadcasts by vessels prior to transit • Improved VHF reception • Traffic management / reporting system • Priority given to certain vessels / activities, e.g., towing cages • Guard vessel for initial operating period • Fendering on towers • Turbine relocation taking into account resource constraints, e.g., 10m west • AIS as aid to navigation on device • Broaden functionality of maintenance RIB to act as an Emergency Response vessel • Emergency Response Cooperation Plan (ERCoP) • Marker bouys off eastern shore to indicate safe inshore passage	3	4	12
1b	NORMAL OPS	Low-Powered Transiting Vessel Collision with Device	As above for low-powered vessel, e.g., yacht with aux. engine or small fishing vessel	As 1a	4	5	20	As 1a	3	4	12
1c	NORMAL OPS	High-Powered Transiting Vessel Collision with Device	As above for higher-powered vessel, e.g., large fishing vessel or well boat	As 1a	4	4	16	As 1a	3	3	9
2	NORMAL OPS	Drifting Vessel Collision with Device	A vessel which goes adrift in the vicinity of the turbines could be swept through Kyle Rhea under the influence of tide (and/or weather) and collide with a turbine.	• Vessel blackout (e.g., due to mechanical failure) • Adverse weather • Fast tides reducing recovery time • Poor holding ground for anchor	3	4	12	• Emergency Response Cooperation Plan (ERCoP) • Liaison with local RNLI stations • Broaden functionality of maintenance RIB to act as an Emergency Response vessel • Fendering • Design devices to be accessible. • First aid equipment onboard and means of raising alarm	3	3	9
3	NORMAL OPS	Vessel-to-Vessel Collision (increased risk)	Due to the reduction in available sea room, encounters and hence collisions between vessels are more likely to occur. Particular problem highlighted as a head-on encounter	• Reduced sea room to east of devices • Strong tides • Poor visibility (especially during night-time passage) • Human error – failure to follow Rules of Road (collision regulations)	4	4	16	• VHF broadcasts by vessels prior to transit • Improved VHF reception • Traffic management / reporting system • Turbine relocation taking into account resource constraints, e.g., 10m west • Marker bouys off eastern shore to indicate safe inshore passage	3	4	12
4 (a)	NORMAL OPS	Re-Routeing of vessels within Kyle Rhea (grounding risk)	Re-routeing of vessels within Kyle Rhea due to the devices leads to increased grounding hazard as vessels move closer to shore	• Displacement away from centre of channel • Strong tidal flows • Human error, e.g., mis-timing passage	4	3	12	• Promulgation of information • Marker bouys off eastern shore to indicate safe inshore passage	3	3	9
4 (b)	NORMAL OPS	Re-Routeing of Vessels West of Skye (foundering risk)	Re-routeing of vessels west of Skye increases the likelihood of a vessel encountering rougher seas resulting in potential vessel damage, foundering etc.	• Avoidance of Kyle Rhea • Bad weather / rougher seas west of Skye	3	3	9	• Promulgation of information about devices to allow vessels to pre-plan voyage	3	3	9

ID	Phase	Hazard	Description	Possible Causes	Ranking before Mitigation			Potential Mitigation Measures	Ranking after Mitigation		
					Frequency	Consequences	Risk		Frequency	Consequences	Risk
5	NORMAL OPS	Loss of Device Component	Loss of a device or device component presenting potential navigation hazard to passing vessels.	• Failure of the device • Large vessel clipping / colliding with under water structure	3	2	6	• SCADA - should be possible to have prompt alert of a problem • Engineering design • 3rd party verification • Tried and testing equipment • Regular maintenance visits • Piled foundations • Most component parts will be negatively buoyant • ERCoP	2	2	4
6	MAJOR WORKS ON SITE	Collision with Work Vessel	Any type of transiting or drifting vessel colliding with a work vessel / unit or associated mooring line.	• Large vessel could be used • Mooring spread could limit sea room • Poor visibility	4	4	16	• Short duration of activity • Timing of activity to be off-season • Pilot vessel / escort boat system to guide vessels past mooring lines • Support vessel(s) on site • Appropriate marking and lighting to ensure visibility of working vessels • Regular broadcasts from Coastguard and working site • Standard mitigation measures appropriate to the nature of the operations	3	3	9
7	MAJOR WORKS ON SITE	Vessel Collision with Surface Turbine or Cross-Beam when Raised	During major maintenance with cross-beam raised out of the water there is an additional navigation obstruction and increased collision risk to all vessels.	• Excessive maintenance • Poor operating procedures • Poor visibility	3	4	12	• Marking and lighting of devices, e.g., floodlights on top of cross beam • Lowering of the cross-beam if sufficient time to avoid a collision • Planned maintenance during neap tides • Regular broadcasts warnings that cross-beam is raised • Advanced notifications to local users, harbours, clubs and associations if significant duration and/or overnight • Support vessel(s) on site • Marker bouys off eastern shore to indicate safe inshore passage	3	3	9
8(a)	MAJOR WORKS ON SITE	Re-Routeing of vessels within Kyle Rhea (grounding risk)	Re-routing of vessels during geotechnical / installation work within Kyle Rhea due to obstruction caused by work vessels and associated mooring lines (if applicable). This could lead to an increase in the incidence of grounding if vessels re-routes away from centre towards shore and rocks.	• Devices near centre of channel • Strong tidal flows • Human error, e.g., mis-timing passage	4	3	12	• Promulgation of information • Marker bouys off eastern shore to indicate safe inshore passage	3	2	6
8(b)	MAJOR WORKS ON SITE	Re-Routeing of Vessels West of Skye (foundering risk)	Re-routing of vessels west of Skye during geotechnical / installation work increases the likelihood of encountering rough seas resulting in potential vessel damage, foundering etc.	• Bad weather / rougher seas west of Skye	3	3	9	• Promulgation of information about major works on site to allow vessel to pre-plan voyage	3	3	9
9	MAJOR WORKS ON SITE	Working Vessel in Difficulty	Working vessel gets into difficulty due to the tide or weather conditions.	• Strong tides • Poor operating procedures • Lack of training and experience • Human error	4	3	12	• Contractors appointed, vetted and audited • Industry standard operating and safety procedures / SMS in place • Site personnel trained in first aid and offshore survival • Personal protective equipment • Timing of activities in suitable tides • Weather forecasts and adverse weather working policy • ERCoP • Invite RNLI for a site visit as a familiarisation exercise • Temporarily suspend operations until more suitable conditions	3	3	9

MCA MGN 371 Checklist

Kyle Rhea Tidal Stream Array

(Appendix B)

Prepared by:	Anatec Ltd.
Presented to:	SeaGeneration (Kyle Rhea) Ltd
Date:	18 December 2012
Revision No.:	00
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B1. Introduction

This report presents the Maritime and Coastguard Agency (MCA) checklist based on the requirements set out in Marine Guidance Note (MGN) 371 which was the guidance set by the MCA during the NRA preparation.

Reference notes/remarks made within Table 1 in Section C2 are based on which sections of the Navigational Risk Assessment or other documents, address the issue noted in the MGN 371 checklist.

B2. MGN 371 Compliance Checklist

Table C2.1 MGN 371 Compliance Checklist for Kyle Rhea Tidal Array

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
Annex 1 : Considerations on Site Position, Structures and Safety Zones			
1. Site and Installation Co-ordinates: Developers are responsible for ensuring that formally agreed variations in the co-ordinates of site perimeters and individual OREI structures are made available, on request, to interested parties at all project stages, including application for consent, development, array variation, operation and decommissioning. This should be supplied as authoritative Geographical Information System (GIS) data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided in latitude/ longitude formats.			
2. Traffic Survey			
All vessel types	✔		***Section 6: Survey Data Analysis.*** *Tracking of all vessel types was achieved by recording AIS and radar data supplemented by visual observations.*
Four weeks duration, within 12 months prior to submission of the Environmental Statement	✔		***Section 6: Survey Data Analysis.*** *Survey period comprised 15 days AIS and radar survey from February and March 2010 and 20 days AIS and radar survey from June 2010. This exceeds the 28 day requirement although it is noted the data is now over two years old. Consultation with local stakeholders indicated 2010 should be representative of current traffic levels. The MCA have indicated they would like to see the data refreshed during any future work at the site, which the Project have agreed to.*
Seasonal variations	✔		***Section 6: Survey Data Analysis.*** *Surveys were carried out in summer and winter to take account of seasonal variations in traffic patterns.*
Recreational and fishing vessel organisations	✔		***Section 6: Survey Data Analysis.*** *Consultation carried out during the NRA indicated the traffic survey is still reasonably representative of fishing*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			and recreational vessel traffic levels. July would be the peak month for recreational traffic but June is the next busiest month. *Fishing vessel transits are less predictable through the year as they vary according to external factors such as quotas. Fishing vessel traffic levels were fairly consistent in the February and June data.*
Port and navigation authorities	✔		***Section 6: Survey Data Analysis.*** *Consultation carried out during the NRA indicated the traffic survey data is still considered representative of present day traffic levels.*
Assessment			
a. Proposed OREI site relative to areas used by any type of marine craft.	✔		***Section 5: Stakeholder Consultation.*** *Vessel activity in the area discussed during stakeholder consultation with MCA, NLB, RNLI, RYA Scotland, Clyde Cruising Club, Cruising Association, fish farm vessel operators, local harbours, local passenger vessel operators, Lochalsh Fishermen's Association, Mallaig Fisheries Officer and Ministry of Defence.* ***Section 6: Survey Data Analysis.*** *Tracking of all vessel types was achieved by recording AIS and radar data supplemented by visual observations.* ***Section 7: Temporal Analysis.*** *Reviews the maritime traffic survey data in more detail, including: time of passage, speed of vessel, tidal state, concurrency analysis.* ***Section 8: Fishing Vessel Activity Analysis.*** *Reviews fishing vessel activity in the area based on the survey data and surveillance (sightings and satellite) data.* ***Section 9: Recreational Vessel Activity Analysis.***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			Examines recreational vessel activity within the area based on the available desktop information.
b. Numbers, types and sizes of vessels presently using such areas	✔		***Sections 5, 6, 7, 8 & 9:*** *as listed in point a. above.*
c. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✔		***Section 5: Stakeholder Consultation.*** *Non-transit uses of the area discussed during stakeholder consultation.* ***Section 6: Survey Data Analysis.*** *Summarises the results of the traffic surveys.* ***Section 8: Fishing Vessel Activity.*** ***Section 9: Recreational Vessel Activity.*** *(More details on each section under point a. above)*
d. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✔		***Section 4: Navigational Features.*** *Reviews navigational features in the vicinity.* ***Section 6: Survey Data Analysis.*** *Determines whether these areas contain transit routes used by coastal or deep-draught vessels on passage, by examination of draught details in traffic survey data.*
e. Alignment and proximity of the site relative to adjacent shipping lanes	✔		***Section 6: Survey Data Analysis.*** *This section identifies and assesses the alignment and proximity of the site relative to adjacent shipping lanes, by analysis of maritime traffic survey data.*
f. Whether the nearby area contains prescribed routeing schemes or precautionary areas	✔		***Section 4: Navigational Features.*** *Based on review of Admiralty Charts and IMO Ship Routeing report.* ***Section 6: Survey Data Analysis.*** *Determines whether vessels follow prescribed routeing schemes and avoid precautionary areas by examination of vessel tracks.*
g. Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✔		***Section 4: Navigational Features.*** *Reviews prescribed zones based on Admiralty Charts and IMO Ship Routeing Report.* ***Section 6: Survey Data Analysis.***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			Reviews actual traffic behaviour based on real-time data.
h. Proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas.	✔		***Section 4: Navigational Features****.* *Examines the proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas, from analysis of Admiralty Charts and Sailing Directions (NP66).* ***Section 6: Survey Data Analysis.*** *Reviews actual traffic behaviour and provides information on the proximity and speeds of vessels to the site.*
i. Whether the site lies within port limits, etc. jurisdiction of a port and/or navigation authority.	✔		***Section 4: Navigational Features****.* *Examines whether the site lies within port limits of jurisdiction of a port and/or navigation authority using information from Admiralty Charts and Sailing Directions (NP66).*
j. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✔		***Section 8: Fishing Vessel Activity Analysis.*** *Reviews the fishing vessel activity at the proposed development area based on the maritime traffic survey and the latest available Government surveillance (sightings and satellite) data.*
k. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✔		***Section 4: Navigational Features.*** *Analysis of Admiralty Charts, Admiralty Sailing Directions NP66 and PEXA Charts to determine proximity to military areas.*
l. Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, marine archaeological sites or wrecks, or other exploration/exploitation sites	✔		***Section 4: Navigational Features.*** *Uses Admiralty Charts and published oil & gas infrastructure data to assess proximity to oil/gas platforms. Analyses GIS files based on published data from The Crown Estate to determine proximity to marine aggregate dredging sites. Analysed Hydrographic Charts for positions of wrecks in the area.*
m. Proximity of the site relative to any designated areas for the disposal	✔		***Section 4: Navigational Features.*** *Examined positions of dredging spoil*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
of dredging spoil			*grounds taken from Hydrographic Charts.*
n. Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.	✔		***Section 4: Navigational Features.*** *Examined Admiralty Charts and Sailing Directions (NP66) for positions of navigational aids and proximity to VTS.*
o. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density.	✔		*Not applicable.*
p. Type(s) of simulation used in analysis Limitation of system(s)	✔		*Not applicable.*
3. OREI Structures			
a. Whether any features of the OREI, including auxiliary platforms outside the main generator site and cabling to the shore, could pose any type of difficulty or danger to vessels underway, performing normal operations, or anchoring.	✔		***Section 5: Stakeholder Consultation.*** *Vessel activity in the area discussed during consultation with a number of relevant stakeholders.* ***Section 6: Survey Data Analysis.*** *Considers whether any features of the OREI could pose a danger to vessels underway, performing normal operations or anchoring.* ***Section 8: Fishing Vessel Activity.*** *Assesses the impact of the OREI on vessels engaged in fishing or transiting to fishing grounds.* ***Section 9: Recreational Vessel Activity.*** *Assesses the impact of the OREI on vessels engaged in recreational activities.* ***Section 10: Review of Historical Maritime Incidents.*** *Reviews the maritime incidents that have occurred in the vicinity of the OREI over the last 10 years.* ***Section 11: Search and Rescue.*** *Summarises the Search and Rescue features of the area.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			Reviews the navigational hazards associated with the OREI based on the baseline data analysis, stakeholder consultation and discussions at the Hazard Review Workshop held for the project. ***Section 13: Quantitative Collision Risk Modelling.*** *Quantitatively assessed hazards of transiting vessel collision, drifting vessel collision and change in vessel-to-vessel collision.*
Clearances of wind turbine blades above the sea surface *not less than 22 metres*	✔		*Not applicable.*
Least depth of current turbine blades	✔		***Section 2: Site Details, 2.2: Devices.*** *States least depth of current turbine blades.* ***Section 3: Metocean Data.*** *Reviews wave height and tidal level in Kyle Rhea.* ***Section 4: Navigational Features.*** *Examines navigational features in vicinity.* ***Section 5: Stakeholder Consultation.*** *Least depth of current turbine blades discussed during stakeholder consultation.* ***Section 6: Survey Data Analysis.*** *Examination of draught details in traffic survey data.* ***Section 12: Hazard Review Workshop and Risk Ranking (and Appendix A).*** *Issue of least depth of current turbine blades discussed at Hazard Review Workshop.* ***Section 13: Quantitative Collision Risk Modelling.*** *Quantitatively assessed hazards of transiting vessel collision and drifting vessel collision.*
The burial depth of cabling	✔		***Section 2: Site Details.*** *Reviews cable installation methods.* ***Section 12: Hazard Review and Risk***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			Ranking. *Examined the hazard of fishing or anchor interaction with subsea cables.*
b. Whether any feature of the installation could create problems for emergency rescue services, including the use of lifeboats, helicopters and emergency towing vessels (ETVs)	✔		***Section 11: Search and Rescue.*** *Summarises the SAR features of the area.* ***11.2: SAR Helicopters*** *Summarises SAR helicopter assets in the vicinity of the Project.* ***11.3: RNLI Lifeboats*** *Summarises RNLI lifeboat stations in the vicinity and response times of their vessels to Project.* ***11.5: Salvage*** *Examines options for salvage in the vicinity of the project. Determines whether the installation could create problems for salvage vessels.*
c. With respect to specific OREI devices, how rotor blade rotation, other exposed moving mechanical parts and/or power transmission, etc., will be controlled by the designated services when this is required in an emergency.	✔		***Section 11: Search and Rescue, 11.6: SAR Liaison.*** *Developers will require to consult and liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
4. Assessment of Access to and Navigation Within, or Close to , an OREI: To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:			
a. Navigation within or close to the site would be safe:			
i. by all vessels, or ii. by specified vessel types, operations and/or sizes. iii. in all directions or areas, or iv. in specified directions or areas. v. in specified tidal, weather or other conditions	✔ ✔ ✔ ✔ ✔		***Section 5: Stakeholder Consultation.*** *Feasibility of navigation discussed during consultation with a number of relevant stakeholders.* ***Section 6: Survey Data Analysis.*** *Reviews traffic survey to determine whether navigation within the site would be safe.* ***Section 7: Temporal Analysis.*** *Reviews the maritime traffic survey data in more detail, including: time of passage, speed of vessel, tidal state, concurrency analysis.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			Section 8: Fishing Vessel Activity Analysis. *Reviews fishing vessel activity in the area based on the survey data and surveillance (sightings and satellite) data.* ***Section 9: Recreational Vessel Activity Analysis.*** *Examines recreational vessel activity within the area based on the available desktop information.* ***Section 10: Review of Historical Maritime Incidents.*** *Reviews the maritime incidents that have occurred in the vicinity of the OREI over the last 10 years.* ***Section 11: Search and Rescue.*** *Summarises the Search and Rescue features of the area.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Reviews the navigational hazards associated with the OREI based on the baseline data analysis, stakeholder consultation and discussions at the Hazard Review Workshop held for the project.* ***Section 13: Quantitative Collision Risk Modelling.*** *Quantitatively assessed hazards of transiting vessel collision, drifting vessel collision and change in vessel-to-vessel collision.* ***Section 15: Cumulative and In-Combination Impacts.*** *Considers potential cumulative and in-combination impacts of the Project along with other proposed projects in the area and the impacts on navigation within and close to the site.*
b. Navigation in and/or near the site should be:			
i. prohibited by specified vessels types, operations	✔		*Relevant sections are cross-referenced under point a. (above)*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
and/or sizes. ii. prohibited in respect of specific activities, iii. prohibited in all areas or directions, or iv. prohibited in specified areas or directions, or v. prohibited in specified tidal or weather conditions, or simply vi. Recommended to be avoided.	✔ ✔ ✔ ✔ ✔		*At this moment in time, there are no plans to implement safety/exclusion zones around the devices. The MCA guidance suggests three options, in simple terms, for mariners operating in OREI areas:* *a) Avoid the area completely* *b) Navigate around the edge* *c) Navigate, with caution, through the array.* *The choice will be influenced by a number of factors including the vessel's characteristics, the weather and sea conditions.*
c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area. e.g. by causing a vessel or vessels to follow a less than optimum route.	✔		*Relevant sections are cross-referenced under point a. (above)*
Relevant information concerning a decision to seek a "safety zone" for a particular site during any point in its construction, operation or decommissioning should be specified in the Environmental Statement accompanying the development application	✔		***Section 2: Site Details.*** *Safety zones not considered practicable.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Safety zones not considered appropriate during discussions at Workshop.*
Annex 2 : Navigation, collision avoidance and communications			
1. The Effect of Tides and Tidal Streams : *It should be determined whether:*			
i. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✔		***Section 2: Site Details.*** *States water depth of devices below LAT.* ***Section 4: Metocean Data.*** *Examines various states of the tide in the area. Assesses tidal data, storm surge, wave data and wind data.* ***Section 6: Survey Data Analysis.*** *Assesses current maritime traffic flows and operations in the general area.* ***Section 7: Temporal Analysis.*** *Reviews the maritime traffic survey data in more detail, including: time of passage, speed of vessel, tidal state,*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			concurrency analysis. ***Section 10: Review of Historical Maritime Incidents.*** *Reviews maritime incidents that have occurred in the vicinity of the Project over the last 10 years including those related to the water depth.* ***Section 12: Hazard Review Workshop (and Appendix A).*** *Reviews maritime traffic flows and operations in the general area with specific focus on water depths based on the baseline data analysis, stakeholder consultation and discussions at the Hazard Review Workshop held for the project.* ***Section 13: Quantitative Collision Risk Modelling.*** *Reviews device under-keel clearance. Vessel draught and water depth data used as inputs to COLLRISK model.*
ii. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✔		*Relevant sections are cross-referenced under point i. (above).*
iii. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✔		***Section 3: Metocean Data.*** *Assesses tidal stream in the area.*
iv. The set is across the major axis of the layout at any time, and, if so, at what rate.	✔		***Section 3: Metocean Data.*** *Assesses tidal stream in the area.*
v. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.	✔		***Section 3: Metocean Data.*** *Assesses tidal stream in the area.*
vi. The structures themselves could cause changes in the set and rate of the tidal stream.	✔		*Refer to coastal processes study.*
vii. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the wind farm area or adjacent to the	✔		*Refer to coastal processes study.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
area			
2. Weather: *It should be determined whether:*			
i. The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✔		***Section 2: Site Details, 2.1: Location Overview.*** *States the depth of water at LAT in which the Project is situated.* ***Section 3: Metocean Data.*** *Presents Metocean statistics in the area.* ***Section 6: Survey Data Analysis.*** *Assesses routeing of vessels which pass in close proximity to the Project based on conditions experienced during 35 days summer and 56 days winter.* ***Section 10: Review of Historical Maritime Incidents.*** *Reviews maritime incidents that have occurred in the vicinity of the Project over the last 10 years including those related to bad weather or restricted visibility.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Weather conditions at the site were discussed during the Hazard Review Workshop.* ***Section 13: Quantitative Collision Risk Modelling.*** *Weather data used as input to COLLRISK model.*
ii. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✔		*Not applicable.*
iii. In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred to in 2.1 (v) above	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Drifting vessels discussed during the Hazard Review Workshop.* ***Section 13: Quantitative Collision Risk Modelling.*** *Quantitatively assessed hazard of drifting vessel collision.*
3. Visual Navigation and Collision Avoidance: *It should be determined whether:*			
i. The structures could block or hinder	✔		***Section 12: Hazard Review and Risk***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
the view of other vessels under way on any route.			***Ranking (and Appendix A).*** *Visual navigation discussed during the Hazard Review Workshop and ranking.*
ii. The structures could block or hinder the view of the coastline or of any other navigational feature such as aids to navigation, landmarks, promontories, etc.	✔		***Section 2: Site Details.*** *Assesses details of the site, including existing sector light in Kyle Rhea.* ***Section 4: Navigational Features.*** *Determines presence of aids to navigation and landmarks in the vicinity.* ***Section 5: Consultation, 5.3: Northern Lighthouse Board.*** *Discusses existing sector light in Kyle Rhea.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Danger of obstruction of existing light and potential mitigation discussed.*
4. Communications, Radar and Positioning Systems : *To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:*			
i. The structures could produce radio interference such as shadowing, reflections or phase changes, with respect to any frequencies used for marine positioning, navigation or communications, including Automatic Identification Systems (AIS), whether ship borne, ashore or fitted to any of the proposed structures.	✔		***Section 5: Stakeholder Consultation, Section 5.3: Northern Lighthouse Board.*** *Recommended to obtain feedback on the radar return of the device in Strangford Lough.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Communications, radar and positioning systems discussed at Hazard Review Workshop.*
ii. The structures could produce radar reflections, blind spots, shadow areas or other adverse effects: a. Vessel to vessel; b. Vessel to shore; c. VTS radar to vessel; d. Racon to/from vessel.	✔		***Section 5: Stakeholder Consultation, Section 5.3: Northern Lighthouse Board.*** *Recommended to obtain feedback on the radar return of the device in Strangford Lough.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Communications, radar and positioning systems discussed at Hazard Review Workshop.*
iii. The OREI, in general, would comply with current	✔		*Not applicable.* *No impact considered or assessed.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
recommendations concerning electromagnetic interference.			
iv. The structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✔		*Not applicable.* *No impact considered or assessed.*
v. The site might produce acoustic noise which could mask prescribed sound signals.	✔		*Not applicable.* *No impact considered or assessed.*
vi. Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✔		*Not applicable.* *No impact considered or assessed.*
5. Marine Navigational Marking : *It should be determined:*			
i. How the overall site would be marked by day and by night taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances.	✔		***Section 2: Site Details.*** *Assesses details of the site, including existing sector light in Kyle Rhea.* ***Section 5: Consultation, 5.3: Northern Lighthouse Board.*** *Discusses existing sector light in Kyle Rhea. Consultation sought advice on lighting and marking of the Project. The final navigational markings will be agreed with the NLB. Lights on the southern and northern turbines would likely be 5nm range, as per IALA. They could be sectored to present the impact onshore, mimicking existing lights. Other turbines would have small yellow lights (1-2nm range) but would need to surround the devices.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Marking and lighting discussed at Hazard Review Workshop.*
ii. How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night.	✔		*Relevant sections are cross-referenced under point i. (above).*
iii. If the specific OREI structure would be inherently radar conspicuous from all seaward	✔		*Relevant sections are cross-referenced under point i. (above). No plans for passive enhancers.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
directions (and for SAR and maritime surveillance aviation purposes) or would require passive enhancers.			
iv. If the site would be marked by one or more radar beacons (Racons).	✔		*Relevant sections are cross-referenced under point i. (above). No plans for Racons.*
v. If the site would be marked by an Automatic Identification System (AIS) transceiver, and if so, the data it would transmit.	✔		***Section 5: Consultation, 5.3: Northern Lighthouse Board.*** *Benefit of AIS transceiver discussed during consultation with NLB.*
vi. If the site would be fitted with a sound signal, and where the signal or signals would be sited	✔		*Relevant sections are cross-referenced under point i. (above). No plans for sound signals.*
vii. If the structure(s) would be fitted with aviation marks, and if so, how these would be screened from mariners or potential confusion with other navigational marks and lights resolved	✔		*Relevant sections are cross-referenced under point i. (above).*
viii. Whether the proposed site and/or its individual generators would comply in general with markings for such structures, as required by the relevant General Lighthouse Authority (GLA) or recommended by the Maritime and Coastguard Agency, respectively.	✔		*Relevant sections are cross-referenced under point i. (above).*
ix. The aids to navigation specified by the GLAs are being maintained such that the 'availability criteria', as laid down and applied by the GLAs, is met at all times. Separate detailed guidance is available from the GLAs on this matter.	✔		*Relevant sections are cross-referenced under point i. (above).*
x. The procedures that need to be put in place to respond to casualties to the aids to navigation specified by the GLAs, within the timescales laid down and specified by the GLAs.	✔		*Relevant sections are cross-referenced under point i. (above).*
6. Hydrography: In order to establish a baseline, detailed and accurate hydrographic surveys are required to IHO Order 1a standard multibeam bathymetry with final data being supplied as a digital full density data set, and erroneous soundings flagged as deleted but include in the data set. A full report detailing survey methodology and equipment should accompany the surveys.			

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
Annex 3: MCA template for assessing distances between wind farm boundaries and shipping routes			
Annex 4: Safety and mitigation measures recommended for OREI during construction, operation and decommissioning.			
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the Environmental Impact Assessment (EIA).The specific measures to be employed will be selected in consultation with the Maritime and Coastguard Agency and will be listed in the developer's Environmental Statement (ES). These will be consistent with international standards contained in, for example, the Safety of Life at Sea (SOLAS) Convention - Chapter V, IMO Resolution A.572 (14)3 and Resolution A.671(16)4 and could include any or all of the following:	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Reviewed mitigation and safety measures appropriate to the OREI development.*
i. Promulgation of information and warnings through notices to mariners and other appropriate media.	✔		*Relevant sections are cross-referenced above at beginning of Annex 4.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Promulgation of information and warnings through notices to mariners and other appropriate media discussed as mitigation during Hazard Review Workshop.*
ii. Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Discussed at Hazard Review.*
iii. Safety zones of appropriate configuration, extent and application to specified vessels	✔		***Section 2: Site Details*** *Discusses safety zones. No plans to implement safety/exclusion zones around the devices at this moment.*
iv. Designation of the site as an area to be avoided (ATBA).	✔		*Not applicable.*
v. Implementation of routeing measures within or near to the development.	✔		*Not applicable.*
vi. Monitoring by radar, AIS and/or	✔		***Section 5: Consultation, 5.3:***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
closed circuit television (CCTV).			***Northern Lighthouse Board.*** *Benefit of AIS transceiver discussed during consultation with NLB.*
vii. Appropriate means to notify and provide evidence of the infringement of safety zones or ATBA's.	✔		*Not applicable.*
viii. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✔		*Relevant sections are cross-referenced above at beginning of Annex 4.*
ix. Creation of an Emergency Response Cooperation Plan with the relevant Maritime Rescue Coordination Centre (from construction phase onwards)	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *ERCoP discussed during impact assessment.*
Annex 5: Standards and procedures for wind turbine generator shutdown in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm.			
1. Design Requirements: The OREI should be designed and constructed to satisfy the following design requirements for emergency rotor shut-down in the event of a search and rescue (SAR), counter pollution or salvage operation in or around a wind farm or other OREI site:			
i. All wind turbine generators (WTGs) and other OREI individual structures will each be marked with clearly visible unique identification characters which can be seen by both vessels at sea level and aircraft (helicopters and fixed wing) from above.	✔		*The final navigational markings will be agreed with the NLB.*
ii. The identification characters shall each be illuminated by a low-intensity light visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting should be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, stationed 3 metres above sea levels, and at a distance of at least 150 metres from the turbine. It is recommended that lighting for this	✔		*The final navigational markings will be agreed with the NLB.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
purpose be hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks. (Precise dimensions to be determined by the height of lights and necessary range of visibility of the identification numbers)			
iii. For aviation purposes, OREI structures should be marked with hazard warning lighting in accordance with CAA guidance and also with unique identification numbers (with illumination controlled from the site control centre and activated as required) on the upper works of the OREI structure so that aircraft can identify each installation from a height of 500ft (150 metres) above the highest part of the OREI structure.	✔		*The final navigational markings will be agreed with the NLB.*
iv. Wind Turbine Generators (WTG) shall have high contrast markings (dots or stripes) placed at 10 metre intervals on both sides of the blades to provide SAR helicopter pilots with a hover reference point.	✔		*Not applicable.*
v. All OREI generators and transmission systems should be equipped with control mechanisms that can be operated from the OREI Central Control Room or through a single contact point.	✔		***Section 11: Search and Rescue, Section 11.6: SAR Liaison.*** *Developers will require to consult and liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
vi. Throughout the design process for an OREI, appropriate assessments and methods for safe shutdown should be established and agreed, through consultation with MCA Navigation safety Branch, Search and rescue Branch and other emergency support services.	✔		***Section 11: Search and Rescue, Section 11.6: SAR Liaison.*** *Developers will require to consult and liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
vii. The OREI control mechanisms should allow the Control Room Operator to fix and maintain the	✔		***Section 11: Search and Rescue, Section 11.6: SAR Liaison.*** *Developers will require to consult and*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
position of the WTG blades, nacelles and other appropriate OREI moving parts to configurations determined by the Maritime Rescue Co-ordination Centre (MRCC). This same operator must be able to immediately effect the control of offshore substations and export cables.			*liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
viii. Nacelle hatches and other OREI enclosed spaces in which personnel are working should be capable of being opened from the outside. This will allow rescuers (e.g. helicopter winch-man) to gain access to the tower if tower occupants are unable to assist and when sea-borne approach is not possible.	✔		***Section 11: Search and Rescue, Section 11.6: SAR Liaison.*** *Developers will require to consult and liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
ix. Access ladders, although designed for entry by trained personnel using specialised equipment and procedures for turbine maintenance in calm weather, could conceivably be used, in an emergency situation, to provide refuge on the turbine structure for distressed mariners. This scenario should therefore be considered when identifying the optimum position of such ladders and take into account the prevailing wind, wave and tidal conditions.	✔		***Section 11: Search and Rescue, Section 11.6: SAR Liaison.*** *Developers will require to consult and liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
x. Although it may not be feasible for mariners in emergency situations to be able to use wave or tidal generators as places of refuge, consideration should nevertheless be given to the provision of appropriate facilities.	✔		***Section 11: Search and Rescue, Section 11.6: SAR Liaison.*** *Developers will require to consult and liaise with the local RNLI stations and the Coastguard about the devices to be deployed and provide any further information requested to assist SAR efforts.*
2. Operational Requirements			
i. The Central Control Room, or mutually agreed single point of contact, should be manned 24 hours a day.	✔		*Design will meet MCA requirements.*
ii. The Central Control Room, or	✔		*Design will meet MCA requirements.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
mutually agreed single point of contact, should have a chart indicating the Global Positioning System (GPS) position and unique identification numbers of each of the WTGs in the wind farm, or individual devices in other types of OREI.			
iii. All MRCCs will be advised of the contact telephone number of the Central Control Room, or mutually agreed single point of contact.	✔		*Design will meet MCA requirements.*
iv. All MRCCs will have a chart indicating the GPS position and unique identification number of each of the WTGs in all wind farms or all devices in other types of OREI.	✔		*Design will meet MCA requirements.*
v. All search and rescue helicopter bases will be supplied with an accurate chart of all the OREI and their GPS positions.	✔		*Design will meet MCA requirements.*
vi. The Civil Aviation Authority shall be supplied with accurate GPS positions of all OREI structures for civil aviation navigation charting purposes	✔		*Design will meet MCA requirements.*
3. Operational Procedures			
i. Upon receiving a distress call or other emergency alert from a vessel which is concerned about a possible collision with a WTG or is already close to or within the wind farm, or when the MRCC receives a report that persons are in actual or possible danger in or near a wind farm and search and rescue aircraft and/or rescue boats or craft are required to operate over or within the wind farm, the MRCC/SC will establish the position of the vessel and the identification numbers of any WTGs which are visible to the vessel. This information will be passed	✔		*Design will meet MCA requirements.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
immediately to the Central Control Room, or single contact point, by the MRCC. A similar procedure will be followed when vessels are close to or within other types of OREI site.			
ii. The control room operator, or single point of contact, should immediately initiate the shut-down procedure for those WTGs as requested by the MRCC and maintain the WTG in the appropriate shut-down position, again as requested by the MRCC, or as agreed with MCA Navigation Safety Branch or Search and Rescue Branch for that particular installation, until receiving notification from the MRCC that it is safe to restart the WTG.	✔		*Not applicable.*
iii. The appropriate procedure to be followed in respect of other OREI types, designs and configurations will be determined by these MCA branches on a case by case basis, in consultation with appropriate stakeholders, during the Scoping and Environmental Impact Assessment processes	✔		*Design will meet MCA requirements.*
iv. Communication procedures should be tested satisfactorily at least twice a year. Shutdown and other procedures should be tested as and when mutually agreed with the MCA	✔		*Design will meet MCA requirements.*

Offshore Renewable Energy Installations

Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (Compliance with recommended DTI Methodology)

General Comments:

Section	Yes	No	Reference notes/Remarks
A1: Overview and guidance on navigation safety issues.	✔		***Section 1: Introduction.***
A2: Overview of FSA.	✔		***Section 1: Introduction.***
A3: Lessons learned.	✔		*Lessons learned during deployment of device at Strangford Lough considered throughout NRA.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Takes into account experience and lessons learned.*
B1: Base case traffic densities and types.	✔		***Section 6: Survey Data Analysis.*** *Summarises the results of the maritime traffic surveys.*
B2: Future traffic densities and types.	✔		***Section 5: Stakeholder Consultation.*** *Reviews how traffic may change in the future.* ***Section 6: Survey Data Analysis.*** *Summarises the results of the maritime traffic surveys.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Discusses future traffic levels.*
B3: The marine environment :			
B3.1 Technical & operational analysis	✔		***Section 2: Site Details.***
B3.2 Generic TOA	✔		***Section 1: Introduction.***
B3.3 Potential accidents	✔		***Section 12: Hazard Review Workshop (and Appendix A).*** *Discusses navigational hazards associated with the development.*
B3.4 Affected navigational activities	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Discusses navigational activities which may be affected by the development.*
B3.5 Effects of wind farm	✔		***Section 12: Hazard Review and Risk***

Section	Yes	No	Reference notes/Remarks
structures			***Ranking (and Appendix A).*** *Discusses potential effects of devices.*
B3.6 Development phases	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Discusses development phase of the Project.*
B3.7 Other structures & features	✔		***Section 2: Site Details, 2.2: Devices.*** *Reviews associated structures.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Other structures and features discussed at Hazard Review Workshop.*
B3.8 Vessel types involved	✔		***Section 2: Site Details, 2.3: Support Vessels.*** *Details potential vessel types involved.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Possible vessel types discussed at Hazard Review Workshop.*
B3.9 Conditions affecting navigation	✔		***Section 3: Metocean Data.*** *Discusses tidal, storm surge, wave, wind and visibility conditions in the vicinity.* ***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Mentions conditions affecting navigation in the vicinity of the site.*
B3.10 Human actions	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** *Discusses potential human actions in vicinity.*
C1: Hazard Identification	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
C2: Risk Assessment	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
C3: Hazard log	✔		***Appendix A: Hazard Log.***
C4: Level of risk	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** ***ES Chapter 17: Shipping and Navigation.***
C5: Influences on level of risk	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** ***ES Chapter 17: Shipping and Navigation.***

Section	Yes	No	Reference notes/Remarks
C6: Tolerability of residual risk	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).*** ***ES Chapter 17: Shipping and Navigation.***
D1 : Appropriate risk assessment	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
D2 : MCA approval for assessment tools and techniques	✔		***Section 1: Introduction***. The assessment methodology principally followed the Department of Energy and Climate Change (DECC) Risk Assessment Methodology and the Maritime and Coastguard Agency's (MCA) Marine Guidance Notice 371 (MGN 371). ***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
D3: Demonstration of results	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
D4 : Area traffic assessment	✔		***Section 6: Survey Data Analysis, Section 6.2: Overview of Survey Tracks.*** *Summarises the results of the maritime traffic survey.*
D5 : Specific traffic assessment	✔		***Section 6: Survey Data Analysis, 6.3: Overview of Survey Tracks.*** *Summarises the results of the maritime traffic survey for vessels transiting through Kyle Rhea.* ***Section 7: Temporal Analysis.*** *Presents detailed traffic analysis.* ***Section 8: Fishing Vessel Activity Analysis.*** *Presents detailed satellite fishing positions relative to the Project.* *Examines fishing transits through the site.* ***Section 9: Recreational Vessel Activity Analysis.*** *Examines recreational vessel activity within the area based on the available desktop information.*
E1 : Risk control log	✔		***Appendix A.***
E2 : Cost benefit assessment	✔		*Cost benefit assessment will be carried out if required.*
E3 : Assessment of equity to	✔		*Assessment of equity to stakeholders will*

Section	Yes	No	Reference notes/Remarks
stakeholders			*be carried out if required.*
F1: Tolerability of risk claim	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A). ES Chapter 17: Shipping and Navigation.***
G1 : Hazard identification checklist	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
G2 : Risk control checklist	✔		***Section 12: Hazard Review and Risk Ranking (and Appendix A).***
G3 : MCA MGN 371 compliance checklist	✔		***Appendix B MGN Checklist.***

90% Lane Boundary Analysis
Kyle Rhea Tidal Array
(Appendix C)

Prepared by:	Anatec Ltd.
Presented to:	SeaGeneration (Kyle Rhea) Ltd
Date:	18 December 2012
Revision No.:	00
Ref.:	A2748-KR-NRA-1 (App C)

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TABLE OF CONTENTS

C1. Introduction

This appendix presents a detailed analysis of the lane width (lateral distribution) of traffic by vessel type using the Kyle Rhea channel both in the vicinity of the planned tidal devices and to the north and south. This has been used to inform the ship collision modelling.

C2. Methodology

The lane analysis was conducted to identify the lateral distribution of traffic using the channel, including the 90% lane width, which has been adopted in many traffic analyses studies for offshore renewable developments in the UK following publication of the MCA Offshore Windfarm Shipping Route Template (Ref. i). The 90% boundary is illustrated in Figure 2.1.

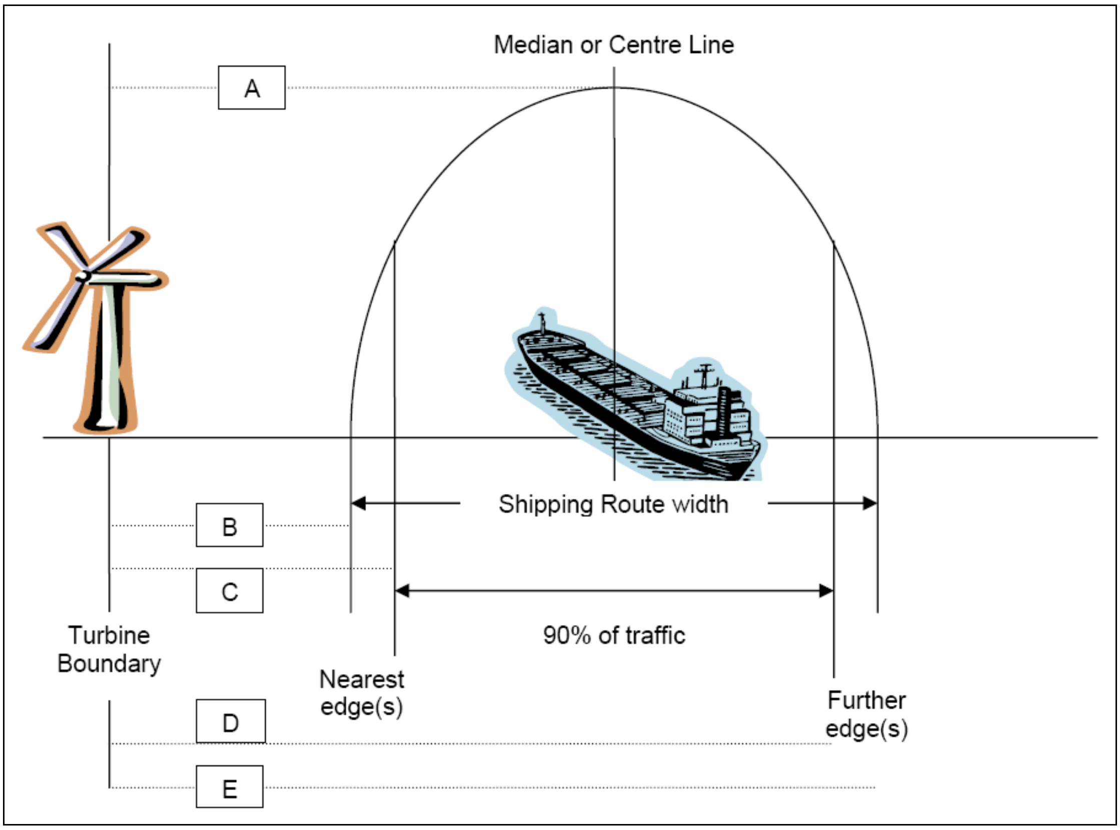

Figure 2.1 Potential Shipping Lane Boundaries, with 90% Width

A- Turbine boundary to the shipping route median or centre line
B- Turbine boundary to nearest shipping route edge
C- Turbine boundary to nearest shipping 90% traffic level*
D- Turbine boundary to further shipping 90% traffic level*
E- Turbine boundary to further shipping route edge

(* - or another percentage to be determined)

Vessel tracks that pass through Kyle Rhea were analysed to estimate the 90% lane width, i.e., the width within which 90% of the traffic passes on that route.

Reference points along the route were defined and the Closest Point of Approach (CPA) of each track to the reference point was calculated. The reference points used to calculate the route taken through Kyle Rhea are presented in Figure 2.2.

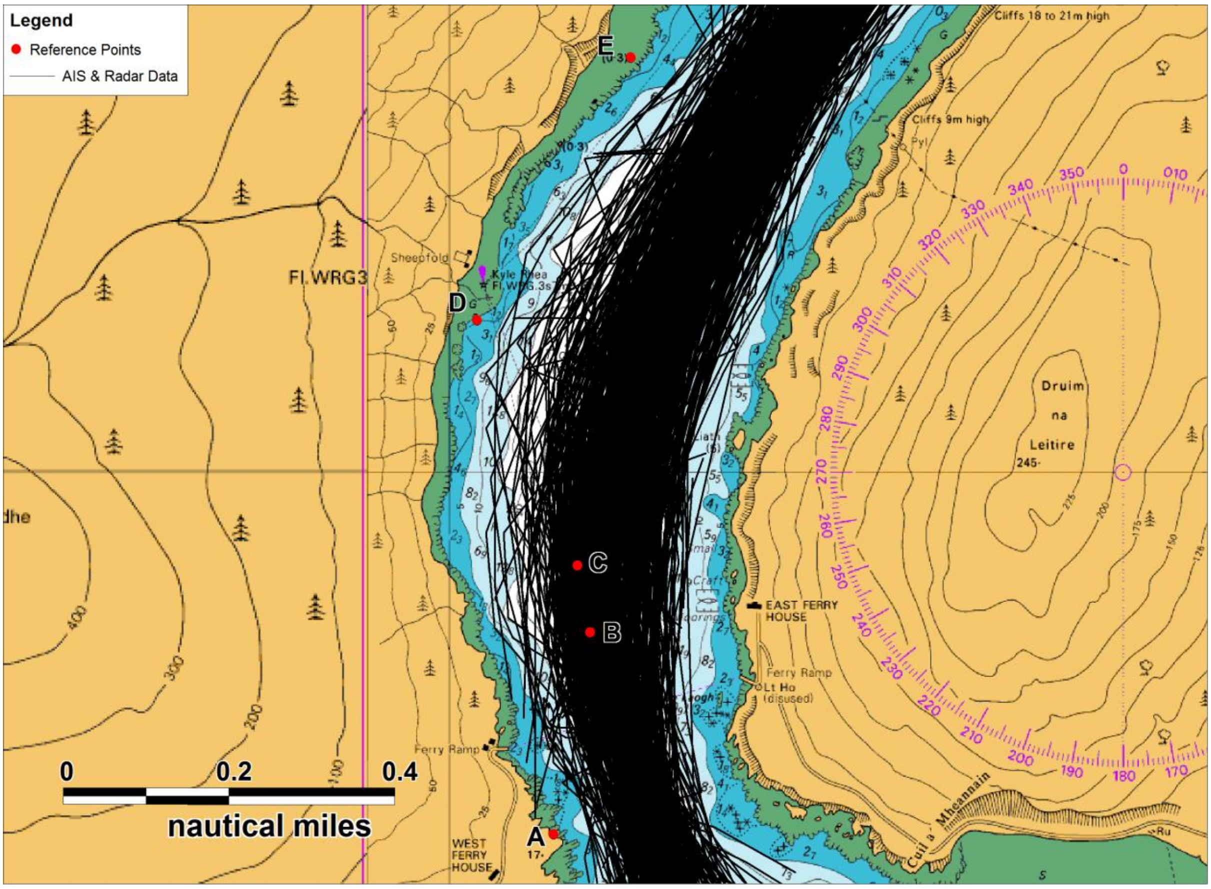

Figure 2.2 Reference Points Adjacent to Tracks

Reference points A, D and E were selected in order to characterise lane width before, during and after navigation of the turn. Reference points B and C represent the locations of Devices 2 and 4 and were selected in order to obtain the current distribution in the vicinity of the array.

C3. Lane Analysis Results

3.1. All Vessels

The resultant CPA distributions for the five reference locations for all vessel types are presented below (Figure 3.1). It can be seen that the traffic conforms reasonably closely to a normal (bell-shaped) distribution when heading both north and south.

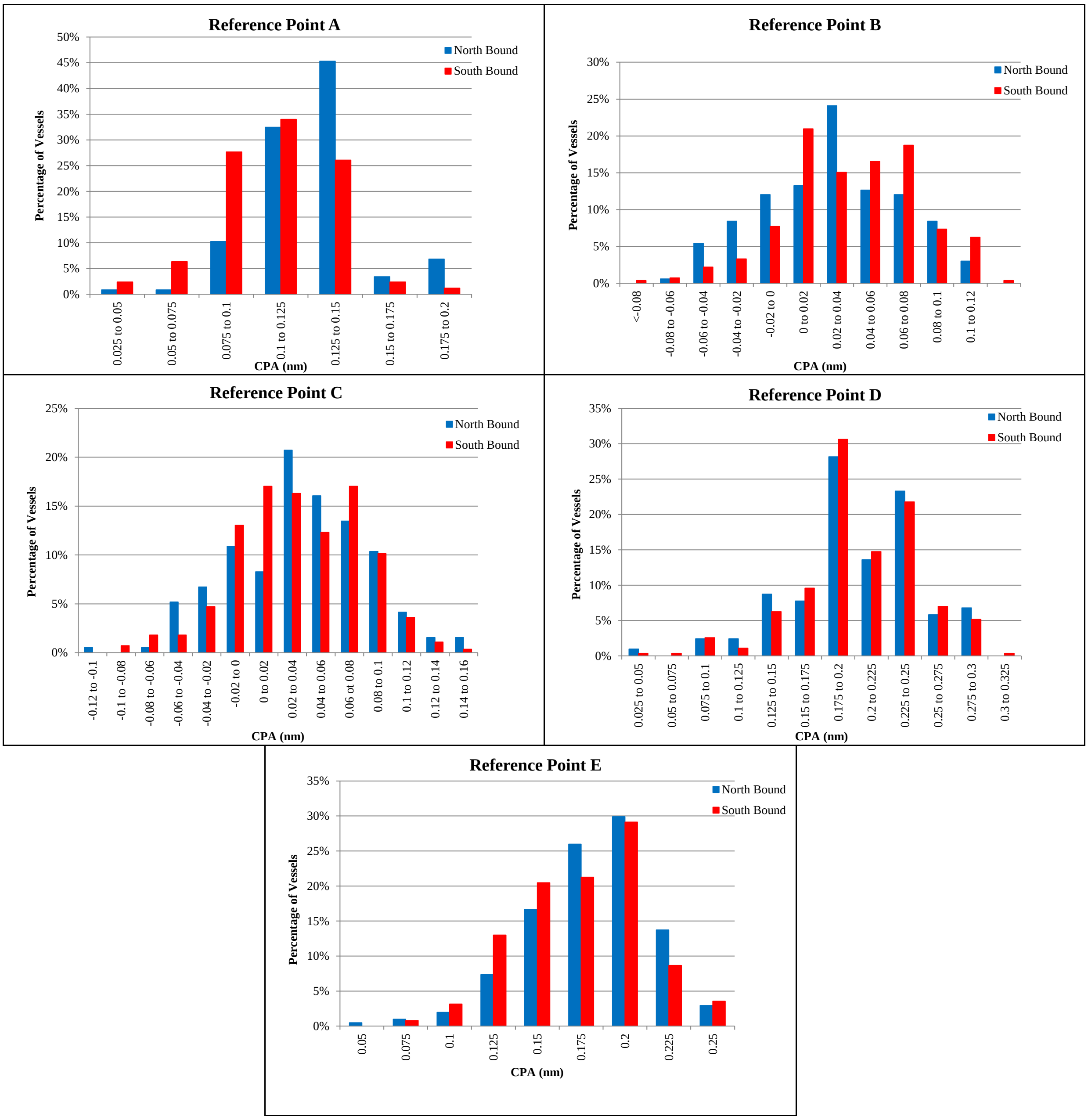

Figure 3.1 All Vessels - CPA Distribution passing Kyle Rhea Reference Points

Table 3.1 summarises the results of the complete vessel lane width analysis for Kyle Rhea.

Table 3.1 All Vessels - Lane Analysis

Parameter	Reference Point				
	A	B	C	D	E
Min and Max CPA (mid-90%) (nm)	0.07 & 0.16	-0.05 & 0.09	-0.04 & 0.11	0.13 to 0.28	0.10 & 0.22
90% Width (nm)	0.09	0.14	0.15	0.15	0.12
Standard Deviation (nm)	0.03	0.04	0.04	0.05	0.04

Therefore, the width of the lane is narrower to the north and south but increases as traffic rounds the bend, including points B and C which correspond to Devices 2 and 4.

A plot of the 90% lane boundary for all vessel types overlaid on the survey tracks is presented in Figure 3.2.

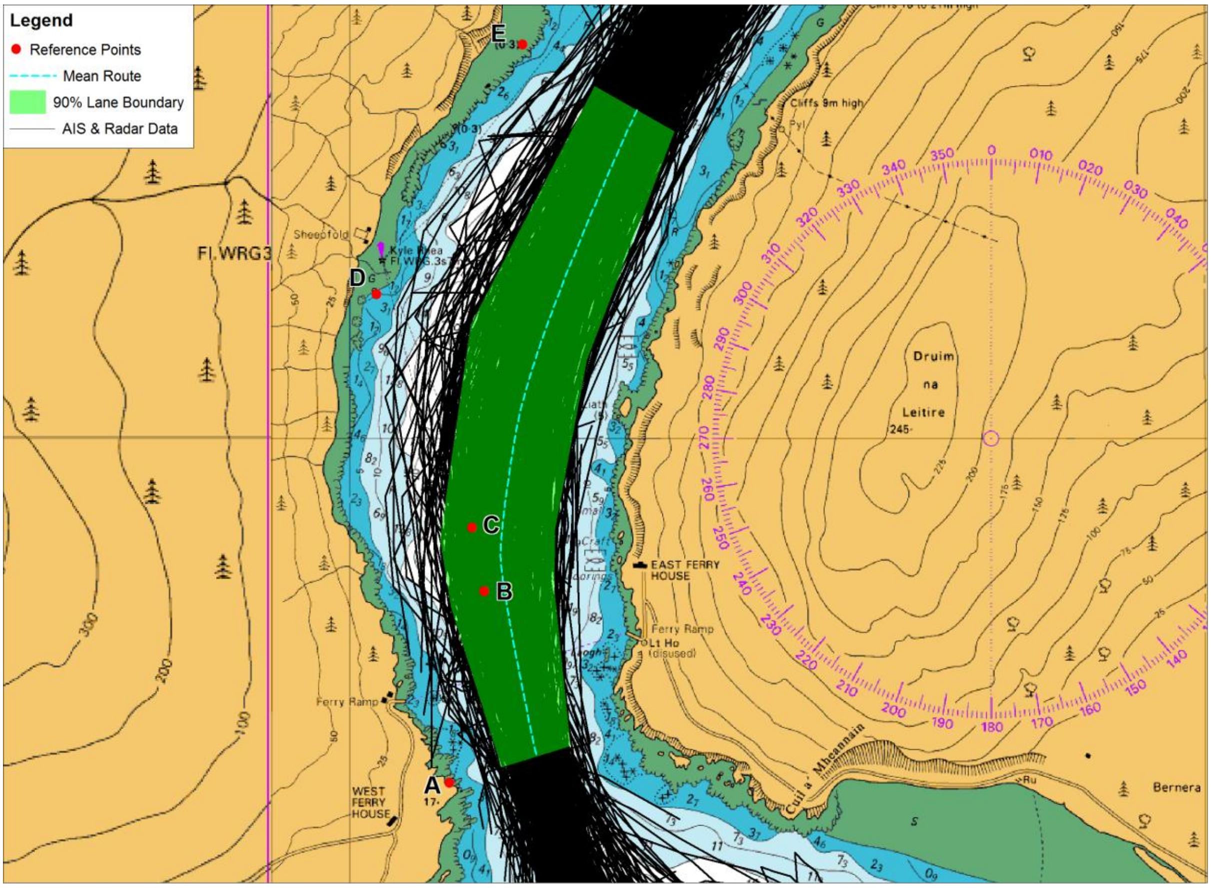

Figure 3.2 All Vessels - 90% Lane Boundary

Separate analyses by vessel type are presented in the following subsections. Types have been divided into the following categories:

- Recreational Vessels
- Fishing Vessels
- Fish Farm Vessels
- Merchant / Other Vessels

3.2. Recreational Vessel Lane Analysis

The CPA distributions for recreational vessels transiting Kyle Rhea are presented in Figure 3.3. (It should be noted recreational vessels represent the majority of the combined traffic.)

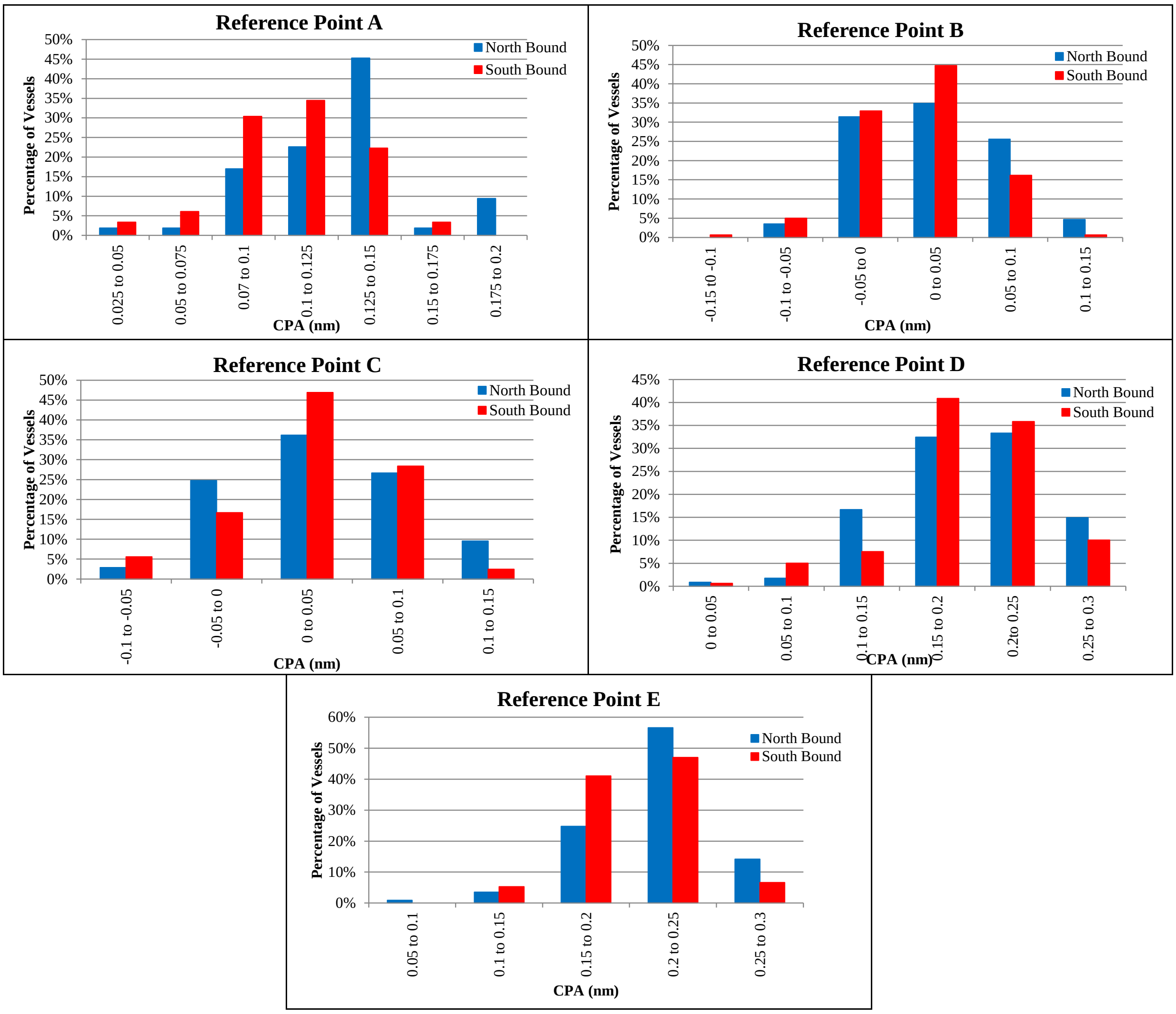

Figure 3.3 Recreational Track CPA Distribution

Table 3.2 summarises the results of the recreational vessel lane width analysis for Kyle Rhea.

Table 3.2 Recreational Vessel Lane Analysis

Parameter	Reference Point				
	A	B	C	D	E
Min and Max CPA (mid-90%)	0.08 & 0.15	-0.05 & 0.08	-0.05 & 0.10	0.11 & 0.28	0.10 & 0.22
90% Width (nm)	0.07	0.13	0.15	0.17	0.12
Standard Deviation (nm)	0.03	0.04	0.05	0.05	0.04

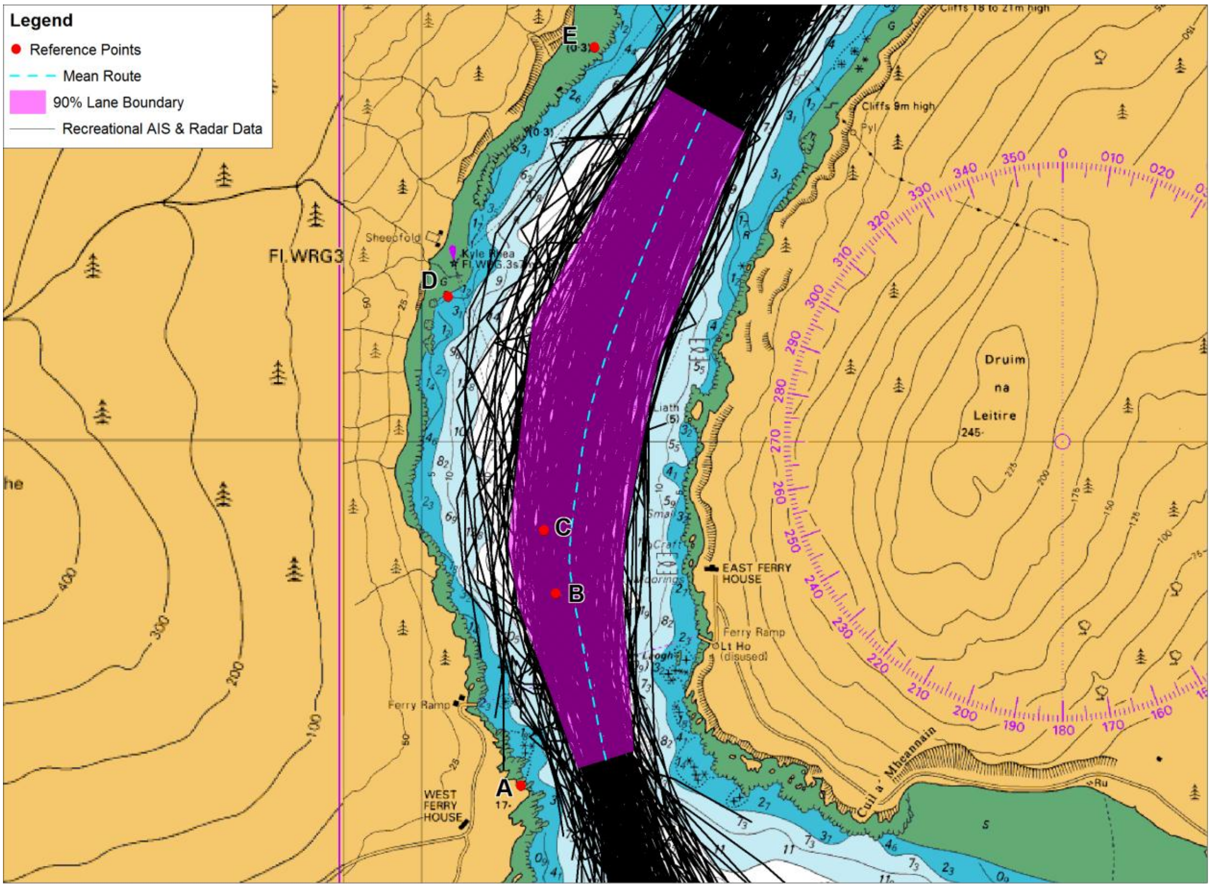

Figure 3.4 Kyle Rhea Recreational Vessel 90% Lane Boundary

As with the combined traffic, the recreational 90% lane also widens through navigation of the turn before narrowing again to the north and south. However, the recreational lane width is slightly wider at reference point D compared to all vessels. This widening occurs mainly to the west of the channel and is likely to reflect the greater influence of tidal streams on smaller (low-powered or sail) recreational vessels.

3.3. Fishing Vessel Lane Analysis

The CPA distributions for fishing vessels at each reference point are presented in Figure 3.5. It can be seen that the traffic does not conform as closely to a normal distribution as other vessel types which may be partly due to the lower population of vessels in the data as well as tidal variations and local knowledge by some fishing vessels, e.g., use of back eddies.

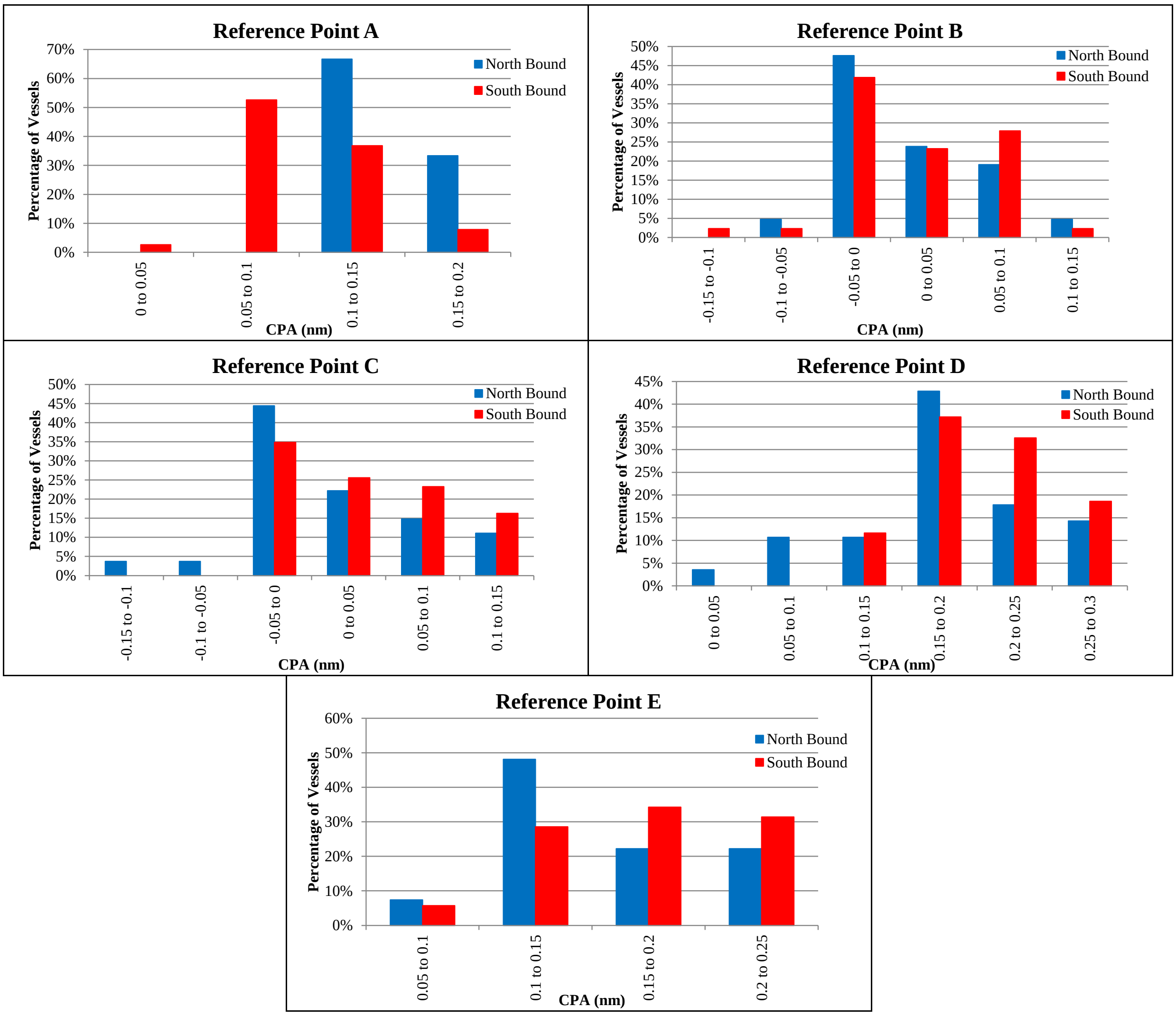

Figure 3.5 Fishing Vessel Track CPA Distribution

Table 3.3 (below) summarises the results of the fishing vessel lane width analysis for Kyle Rhea.

Table 3.3 Fishing Vessel Lane Analysis

Parameter	Reference Point				
	A	B	C	D	E
Min and Max CPA (mid-90%)	0.06 & 0.18	-0.05 & 0.10	-0.04 & 0.11	0.13 & 0.28	0.10 & 0.24
90% Width (nm)	0.12	0.15	0.15	0.16	0.14
Standard Deviation (nm)	0.04	0.05	0.05	0.05	0.05

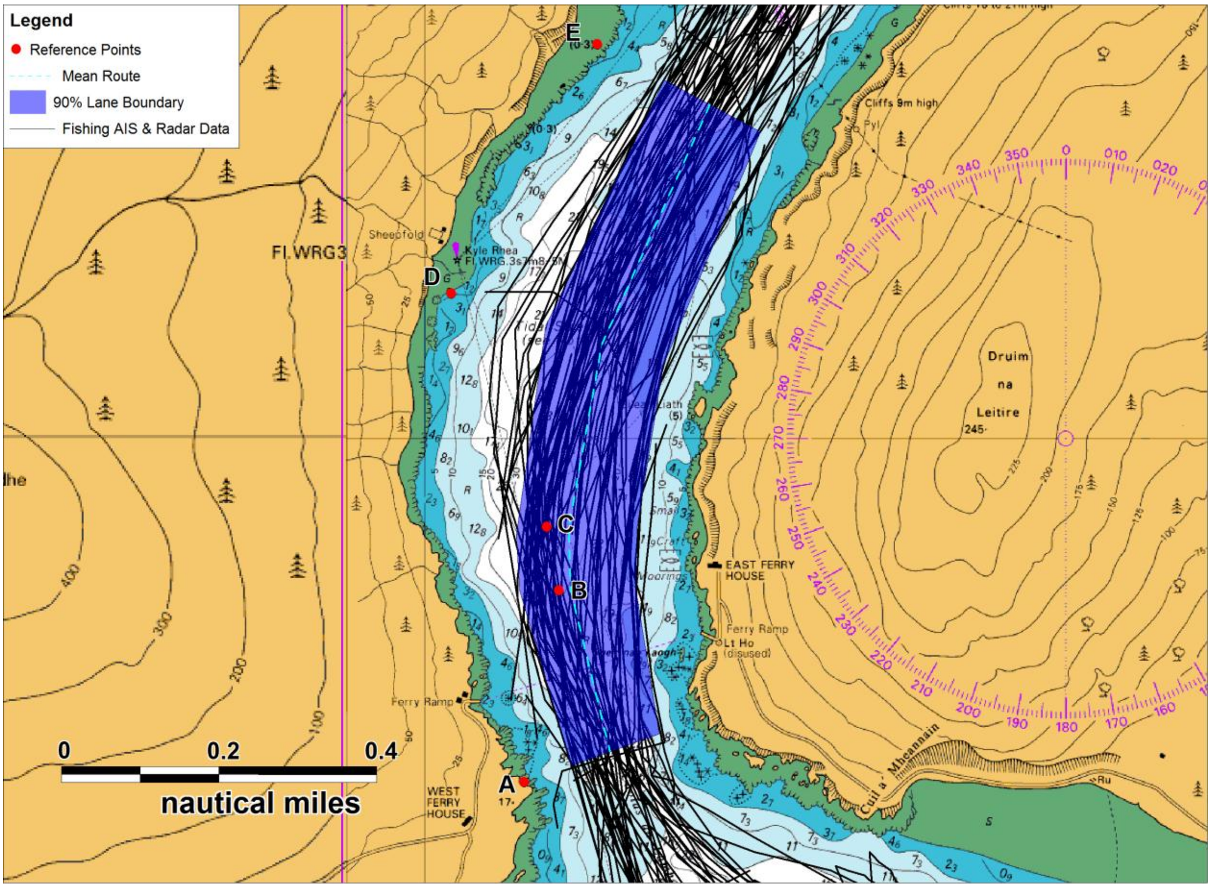

Figure 3.6 Kyle Rhea Fishing Vessel 90% Lane Boundary

As with other traffic, the fishing vessel 90% lane widens when rounding the bend and is narrower to the north and south.

3.4. Fish Farm Vessels Lane Analysis

The resultant CPA distributions for fish farm (processing / carrier vessels) are presented in Figure 3.7. (It should be noted the distributions are based on a lower population of survey tracks.)

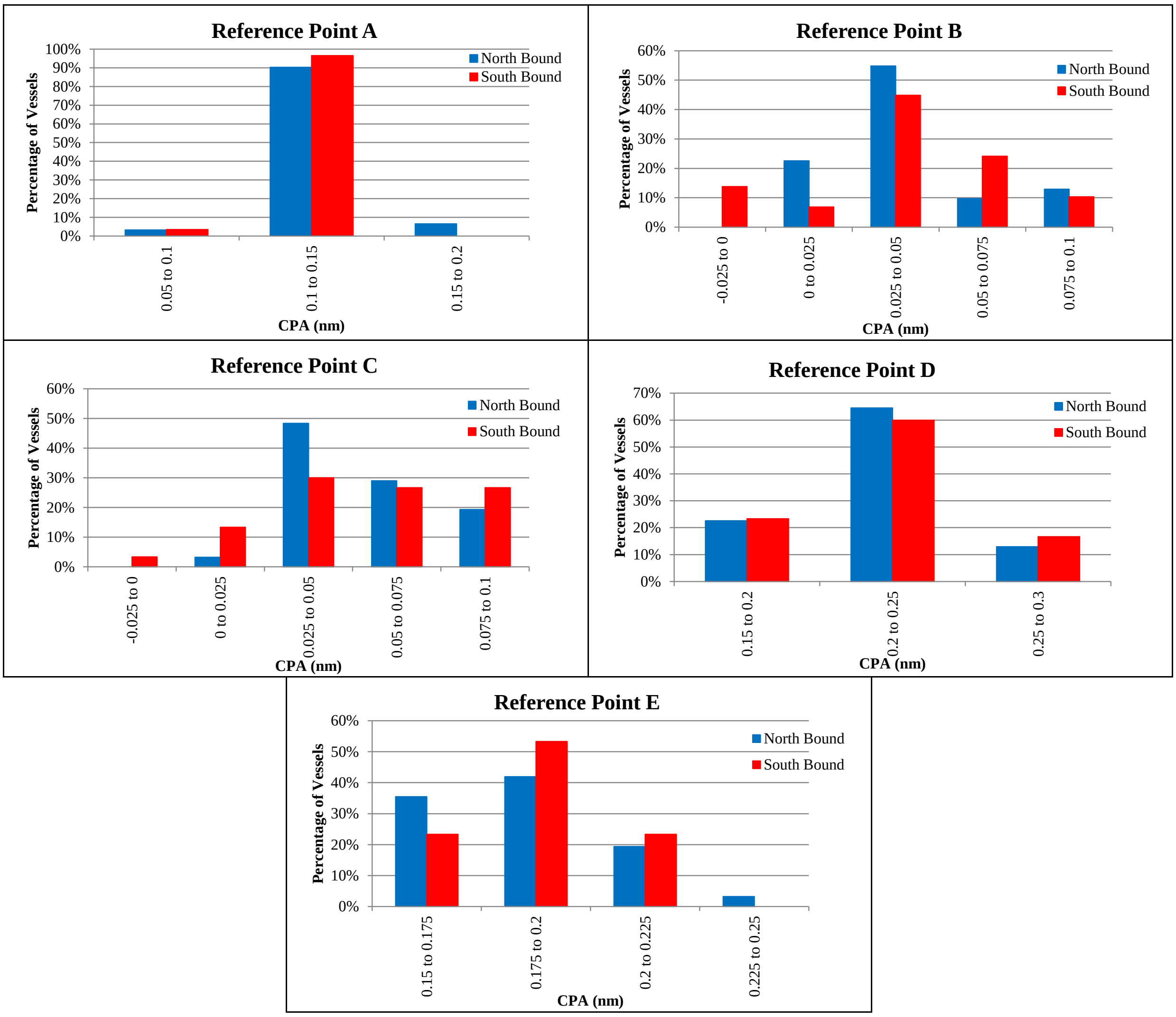

Figure 3.7 Fish Farm Vessel CPA Distribution

Table 3.4 summarises the results of the fish farm vessels lane width analysis for Kyle Rhea.

Table 3.4 Fish Farm Vessels Lane Analysis

Parameter	Reference Point				
	A	B	C	D	E
Min and Max CPA (mid-90%)	0.11 & 0.15	-0.002 & 0.77	0.01 & 0.09	0.19 & 0.27	0.16 & 0.22
90% Width (nm)	0.04	0.079	0.08	0.08	0.05
Standard Deviation (nm)	0.01	0.02	0.02	0.02	0.02

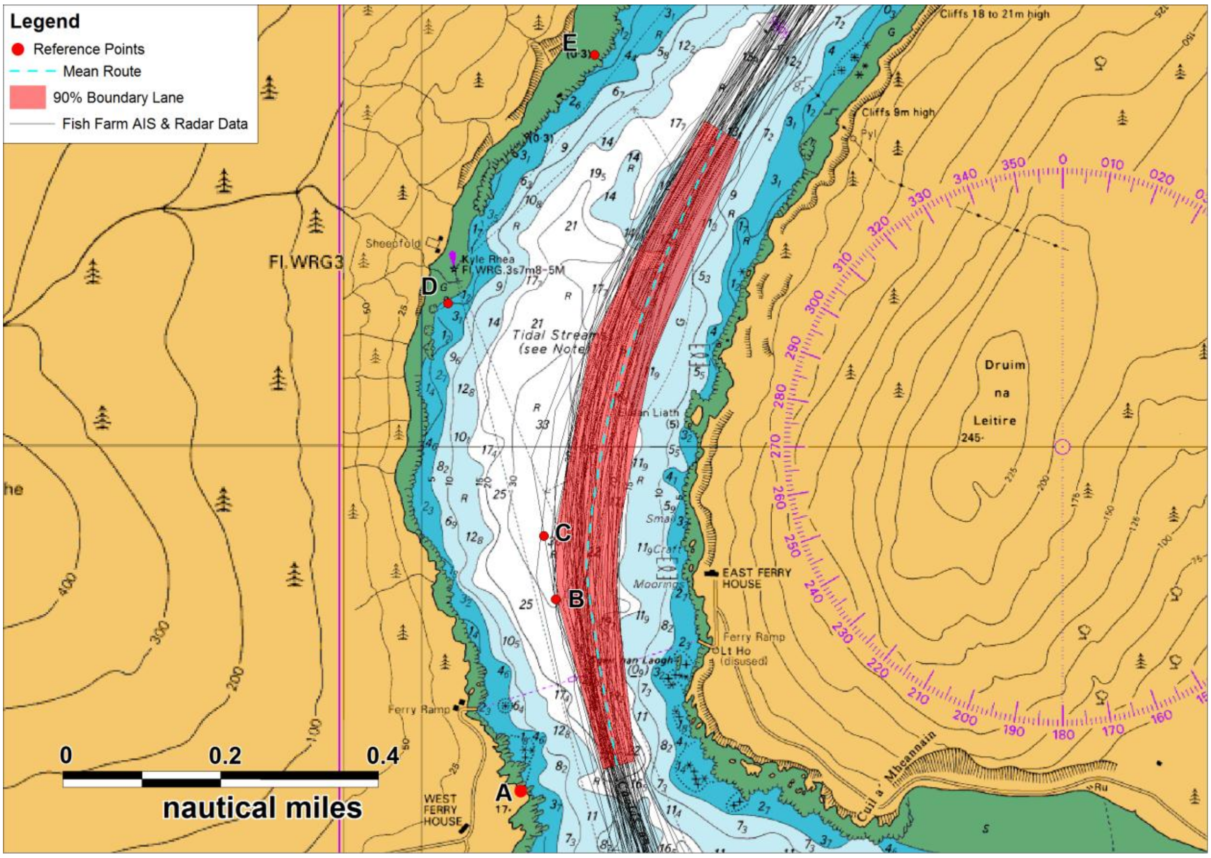

Figure 3.8 Kyle Rhea Fish Farm 90% Lane Boundary

The fish farm vessels maintain a much tighter distribution when transiting Kyle Rhea. This is considered to be because these vessels tend to be more powerful and therefore the tidal streams have less effect on their course over the ground.

3.5. Merchant / Other Vessel Lane Analysis

The CPA distributions for merchant / other vessels are presented in Figure 3.9. This category includes general cargo vessels, passenger cruise ships, tugs and towing vessels, coastal tankers and salvage vessels. (It should be noted the distributions are based on a lower population of survey tracks.)

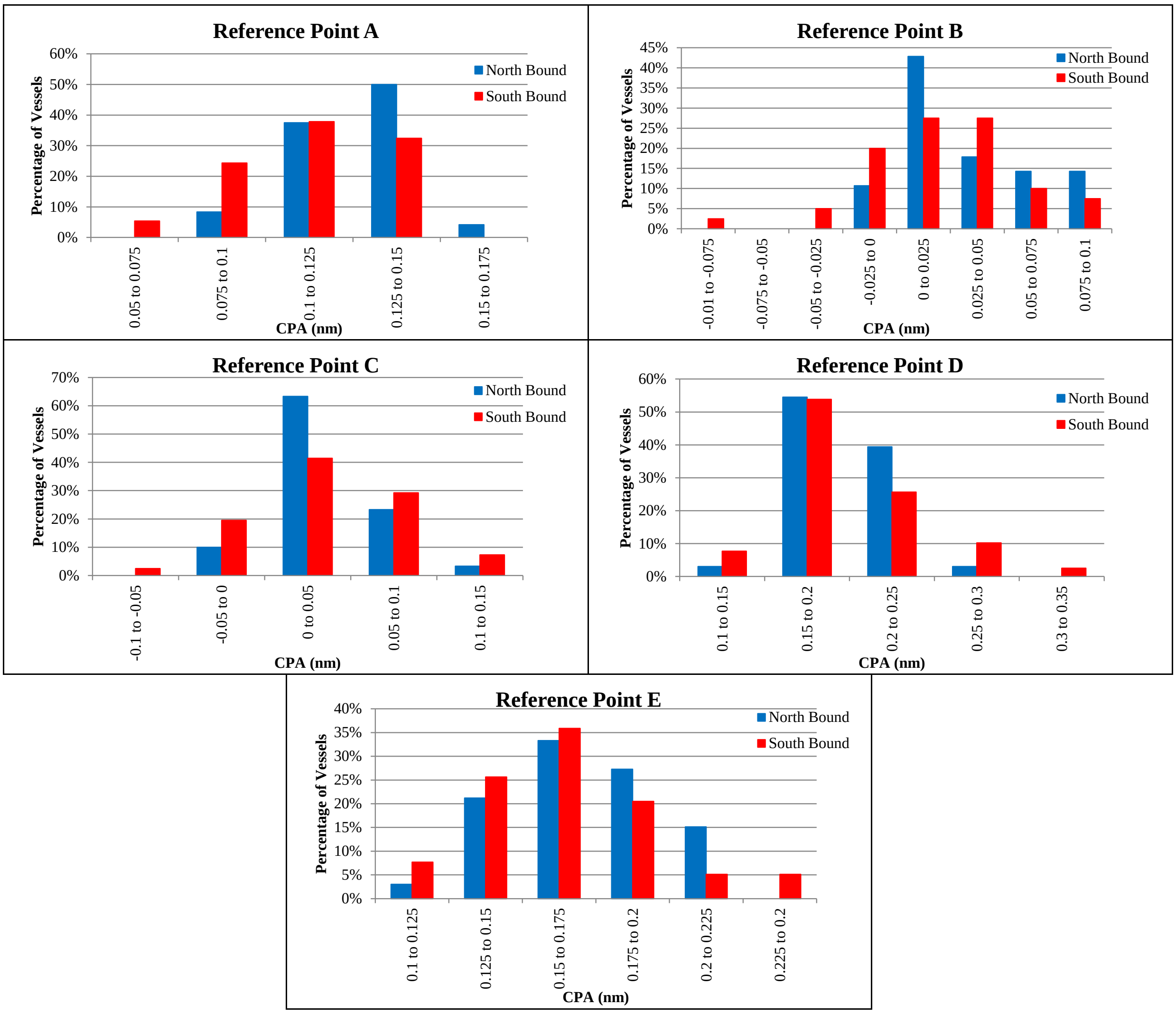

Figure 3.9 Merchant / Other Vessel CPA Distribution

Table 3.5 summarises the results of other vessel lane width analysis for Kyle Rhea.

Table 3.5 Merchant / Other Vessel Lane Analysis

Parameter	Reference Point				
	A	B	C	D	E
Min and Max CPA (mid-90%)	0.09 & 0.14	-0.002 & 0.09	-0.01 & 0.10	0.16 & 0.26	0.13 & 0.22
90% Width (nm)	0.06	0.11	0.11	0.10	0.10
Standard Deviation (nm)	0.02	0.03	0.04	0.03	0.03

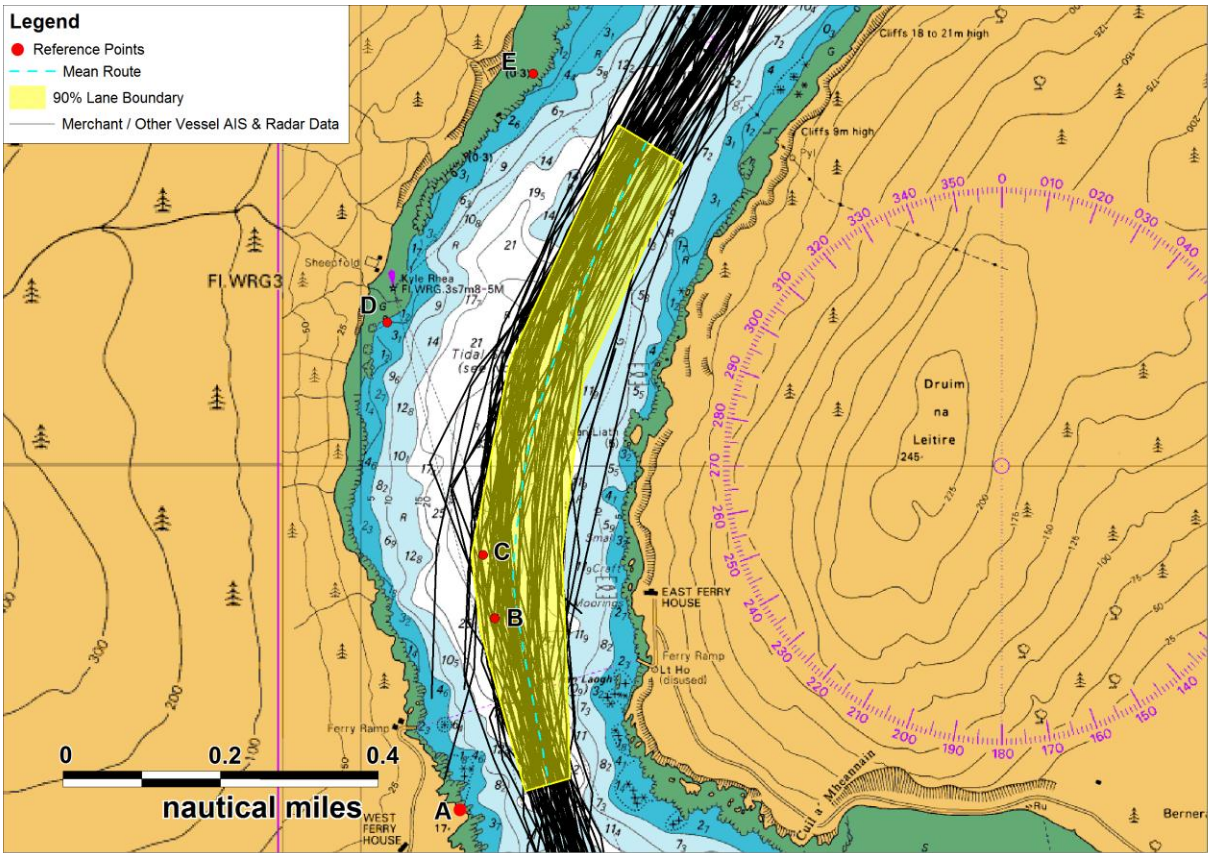

Figure 3.10 Kyle Rhea Merchant / Other Vessel 90% Lane Boundary

The 90% lane follows the pattern of widening when rounding the bend and being narrower to the north and south. The lane is significantly narrower than both the recreational and fishing vessel lanes but wider than the fish processing/carrier. This reflects the fact these vessels vary in size and power but generally have more control of their heading than smaller vessels.

C4. Summary

A summary of the 90% lane boundaries for each vessel type is presented in Figure 4.1

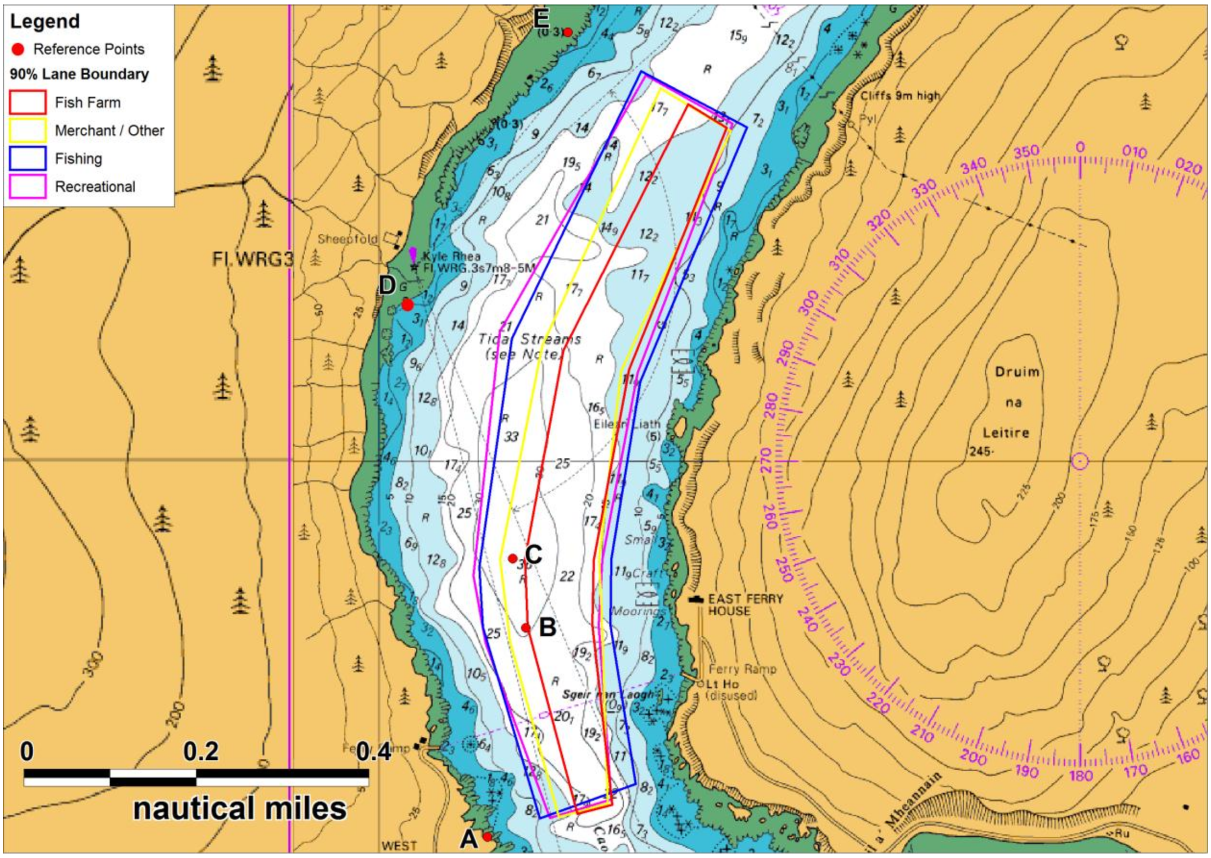

Figure 4.1 All 90% Lane Boundaries

Figure 4.2 illustrates the mean route positions for each vessel type relative to the device locations.

All the mean positions pass closest to Device 2 with minimum mean passing distances (from the surface tower) as follows:

- Fishing: 36m
- Recreation: 42m
- Fish Farm: 81m
- Merchant / Other: 55m

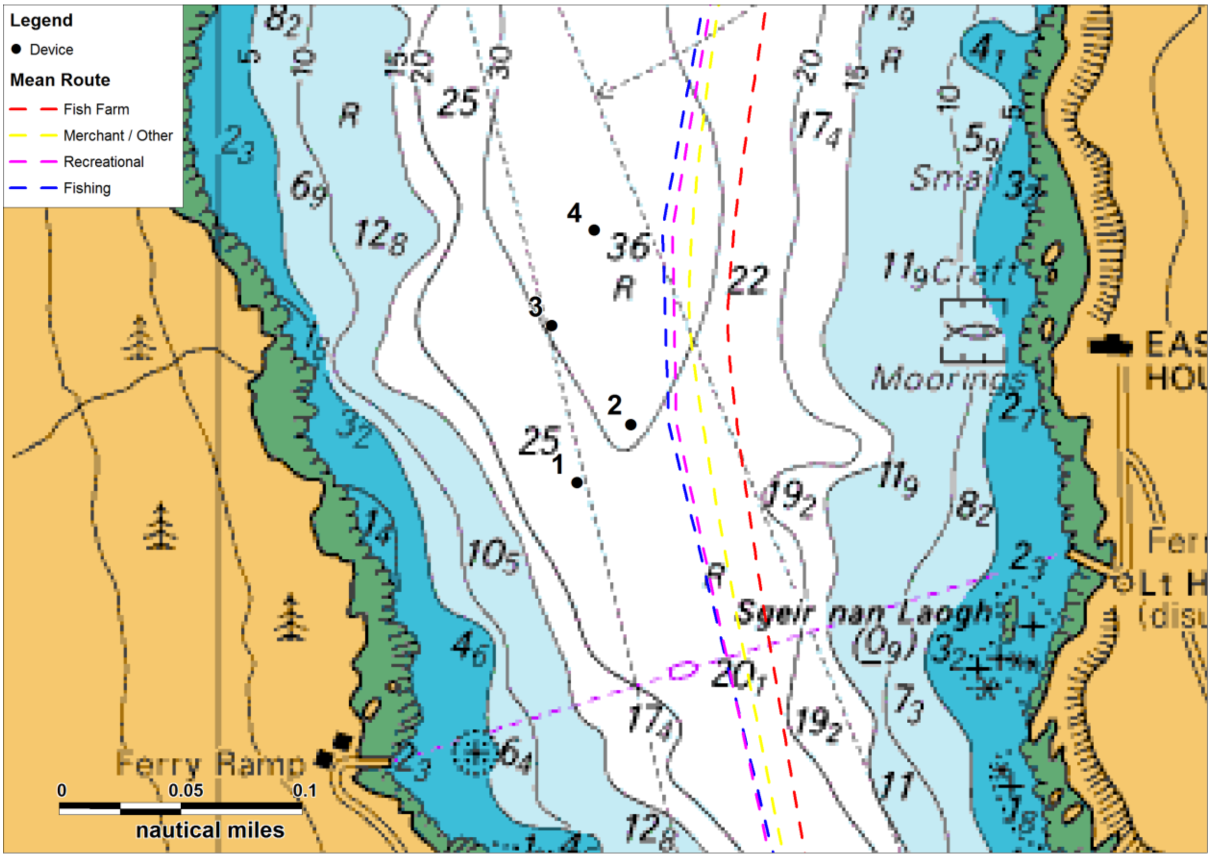

Figure 4.2 All Mean Routes & Device Locations

C5. References

i MCA Windfarm: Shipping Route Template from MGN 371.

Kyle Rhea Tidal Stream Array

Appendix 18.1

APPENDIX 18.1. TRAFFIC COUNTS

Table 1. Traffic point data from the Department of Transport for the A87 east to west between count point 50772 (Sgurr Aoide) and 10943 (Drochaid Lusa).

Year	Pedal Cycles	Motorcycles	Car / Taxi	Buses / Coaches	Light Goods Vehicles	All HGVs	All Motor Vehicles
50772							
2007	4	37	1673	36	244	175	2165
2008	4	37	1645	37	255	176	2150
2009	4	39	1655	39	275	177	2185
2010	4	35	1594	44	282	177	2132
2011	4	35	1583	44	295	180	2137
768							
2007	8	24	2383	81	422	147	3057
2008	8	24	2343	84	442	147	3040
2009	9	26	2357	88	476	147	3094
2010	9	23	2269	101	488	148	3029
2011	8	23	2253	101	512	152	3041
80594							
2007	14	156	2196	74	381	155	2962
2008	14	156	2158	77	399	157	2947
2009	16	166	2171	80	431	157	3005
2010	16	149	2091	91	443	157	2931
2011	14	151	2077	91	465	162	2946
10943							
2007	1	61	2554	59	359	214	3247
2008	1	61	2511	60	376	218	3226
2009	1	65	2526	62	406	218	3277
2010	1	58	2433	71	416	217	3195
2011	1	58	2416	71	436	227	3208

Table 2. Transport Scotland traffic count points from west to east from ATCNW006 (Broadford) to ATCNW004 (Dornie).

Site	ATCNW006	JTC00147	174100	ATC01055	ATCNW003	ATCNW004
Location	A87 Kyleakin Roundabout to Broadford	A87 Kyle of Lochalsh to Skye Bridge Toll Booths	A87 Kyle of Lochalsh (WiM)	A87 - Auchtertyre to Kyle of Lochalsh	A87 - Dornie to Auchtertyre Junction	A87 - Glensheil to Dornie
Eastings	174318	175674	181050	181400	186200	188450
Northings	826416	827211	827250	827200	827200	825600
Direction 1	W	W	S	E	W	W
Direction 2	E	E	N	W	E	E
AADT	3417	3887	3577	3552	2979	2429
AADT August	5091	5560	5319	5244	4621	3873
AM Peak Hour Flow	305	335	321	317	274	240
PM Peak Hour Flow	327	366	344	342	288	237

Table 3. Count points of sections of the A87 north of Kylerhea.

Count Point	Easting, Northing	Road	Road category	Start Junction	End Junction	Link length (miles)
50772	190000 ,823900	A87	TR	A890	C-road Shiel Bridge	10.5
768	179900 ,827760	A87	TR	Stoney Rd, Kyle of Lochalsh	A890	5.4
80594	176000 ,827250	A87	TR	Kyleakin roundabout	Stoney Rd, Kyle of Lochalsh	1.61
10943	169600 ,824300	A87	TR	A851	Kyleakin roundabout	5.59

Kyle Rhea Tidal Stream Array

Appendix 19.1

HEADLAND
ARCHAEOLOGY (UK) Ltd

Kyle Rhea Tidal Array

Maritime Cultural Heritage Baseline Technical Report

APPENDIX 19.1

1/29/2013

This document was produced by

HEADLAND ARCHAEOLOGY (UK) Ltd

For Royal Haskoning on behalf of Sea Generation (Kyle Rhea) Ltd

Document Owner	Headland Archaeology
Project Manager	Tom Joyce
Document Status	Final
File Name	HEADLAND- Cultural Heritage Baseline Report.docx

Revision	**Date**	**Description**	**Originated By**	**Checked By**	**Approved By**
v.3	29/01/13	For review	AM	TJ	

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Summary

This technical report presents the results of an Offshore and Onshore Cultural Heritage Baseline Assessment, incorporating an archaeological desk-based assessment; archaeological assessment of geophysical data; and an archaeological assessment of geotechnical data for the Kyle Rhea Tidal Array. The assessment was undertaken by Headland Archaeology (UK) Ltd. for Royal Haskoning on behalf of SeaGeneration (Kyle Rhea) Ltd. The purpose of the report is to identify any sites of cultural heritage significance that may be affected within and in proximity to the proposed development, and to outline the archaeological potential of the marine and terrestrial environment in which the development is proposed.

The offshore assessment has established that there are no Designated Wrecks or other offshore cultural heritage assets with legal designations within the Immediate Study Area (ISA). The report identified 1 'Dead' wreck in the Wider Study Area (WSA). The archaeological geophysical assessment identified five targets considered to be of medium archaeological potential within the offshore ISA. The RCAHMS and HER datasets list a large number of documented losses within the general area without accurate locations.

There are 4 designated onshore cultural heritage assets and 26 undesignated cultural heritage assets within the WSA.

There is one Scheduled Ancient Monument (SAM) and two Category A Listed Buildings within 5 Km of the ISA and within the Zone of Theoretical Visibility (ZTV).

It is considered that there is at least moderate potential for the discovery of unexpected onshore, intertidal and offshore cultural heritage assets including paleoenvironmental remains to be identified within the proposed development area.

Glossary of Terms

AD	Anno Domini
Anomaly	Possible manmade or unnatural target identified in the geophysical survey data.
Assets	Parts of the historic environment that have local and national significance such as listed buildings and war memorials.
Bathymetry	The measurement of the depth of the seabed from the water surface
BGS	British Geological Survey
BC	Before Christ
BP	Before Present
COWRIE	Collaborative Offshore Wind Research into the Environment
CPT	Core Penetration Tests
DEAD Wreck	Not detected by repeated surveys, therefore considered not to exist
Designated Wreck	A protection put on historic wrecks so they are not put at risk from unauthorised access, undisciplined activities or investigation, the Protection of Wrecks Act 1973.
EIA	Environmental Impact Assessment
Fauna	Animals both invertebrates and vertebrates
Flint	Form of quartz mineral (chert) used to made tools in prehistoric societies
Geophysical Survey	A non-intrusive investigative survey method including sidescan sonar, magnetometer and sub-bottom profiler for on and below the seabed features.
Geotechnical Survey	An intrusive survey method that penetrates the seabed recovering samples for analysis.
GIS	Geographical Information System
Grab Samples	A sample taken from the seafloor
GPS	Global Positioning System
HA	Headland Archaeology
Holocene	Period of geological time spanning from 12,000 years BP
ICOMOS	International Council on Monuments and Sites

JNAPC	Joint Nautical Archaeology Policy Committee
Lithic	Stone tools that may be associated with prehistoric cultures
LIFT Wreck	A salvaged wreck
LIVE Wreck	Wreck considered to exist
MBES	Multibeam Echosounder:
Mesolithic	Archaeological period of time of past cultures approximately 9,000 – 4,000BC.
Macrofossils	Fossils that can be identified by eye e.g. shell fragments
Microfossils	Small fossils that can only be viewed under a microscope e.g. pollen
MOD	Ministry of Defence
Neolithic	Archaeological period of time of past cultures approximately 4,000-2500BC.
NMRS	National Monument Records of Scotland
Palaeochannel	Submerged former course of a river typically filled with sediment
Palaeoenvironmental	Past environmental conditions
Palaeolithic	Prehistoric era distinguished by the development of stone tools, 18,000-780,000 years BP.
PCPT	Piezocone Cone Penetration Test
Peat	An organic material formed by decayed vegetation matter that can preserve important environmental and archaeological evidence.
Pleistocene	Period of geological time spanning 1.8million years ago to the Holocene.
Quaternary	Of or belonging to the geologic time, system of rocks, or sedimentary deposits from the end of the Tertiary Period through to the present
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
Receptor	Any environmental or other defined feature that is sensitive to or has the potential to be affected by an impact.
ROW	Receiver of Wreck
Scheduled Monument	Nationally important archaeological sites which have legal protection assigned to them.
SeaZone	SeaZone Solutions Ltd
SEPA	Scottish Environment Protection Agency

Silt	A geological deposit that can contain evidence of past sea levels and landscapes
SNH	Scottish Natural Heritage
SBP	Sub-bottom Profiler: Low frequency echosounder that maps the seabed and underlying sediments.
SSS	Sidescan Sonar: A sonar survey system that maps the seabed.
TCE	The Crown Estate
UKHO	United Kingdom Hydrographic Office
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VC	Vibrocore

1. Introduction

Headland Archaeology (UK) Ltd was commissioned by Royal Haskoning on behalf of Sea Generation (Kyle Rhea) Ltd to prepare a Maritime Cultural Heritage Assessment for the proposed Kyle Rhea Tidal Array between Skye and the Scottish mainland (Figure 1). The report outlines the cross referenced results of an archaeological desk-based assessment; an archaeological review and assessment of geophysical data collected; and considers the 'setting' of key onshore and island cultural heritage receptors.

Project Background

Sea Generation (Kyle Rhea) Ltd secured an Agreement for Lease (AfL) from the Crown Estate for a proposed tidal array at Kyle Rhea. Kyle is a narrow strait of water between the Isle of Skye and the west coast of Scotland. Offshore, four devices are proposed (Figure 2). The devices will be linked by interarray cabling that will be laid on the seabed, with one export cable directionally drilled between the array and an onshore substation. The onshore substation measuring approximately 6 m x 3 m is proposed to provide a link to the grid network. Two options for the substation are proposed. Option 1 would see the substation constructed in the vicinity of an existing toilet block while Option 2 would see the use of an existing building at the ferry slipway. A trenched cable will be routed between the HDD pit and the substation, most likely following the road/ track where possible for both options. A detailed methodology for the offshore and onshore installation is set out in Chapter 5.

2. Aims and Objectives

The aim of this archaeological assessment is to review the known and potential archaeology within the area that could be subject to impacts from the proposed development and to summarise the potential for the presence of hitherto unknown sites with particular reference to:

- Shipwrecks, aircraft and wreck material;
- Geophysical anomalies of anthropogenic origin;
- Submerged prehistoric sites;
- Designated and undesignated onshore sites in proximity to the proposed landfall and substation site.

3. Methodology

The Desk-top baseline study and assessment incorporates the results of an archaeological desk-based assessment; archaeological assessment of marine geophysical data; and an archaeological assessment of marine geotechnical data collected for the Kyle Rhea Tidal Array. The Desk-top baseline study and assessment has been compiled in line with industry best practice and the relevant offshore renewables and marine historic environment guidance. These include:

- Institute for Archaeologists (IfA) guidelines: Standard & Guidance for Archaeological Desk Based Assessment (2008);
- Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development (2008);
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (2007);

- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore renewable Energy (2008);
- COWRIE Guidance for Offshore Geotechnical Investigations and Historic Environment Analysis: guidance for the renewable energy sector (forthcoming);
- The Crown Estate (2010). Offshore Renewables Protocol for Archaeological Discoveries;
- The Crown Estate (2010). Round 3 Offshore Renewables Projects Model Clauses for Archaeological Written Schemes of Investigation; and
- Towards a Strategy for Scotland's Marine Historic Environment (Historic Scotland 2009).

This assessment takes account of the following legislative procedures and guidelines:

- Marine (Scotland) Act 2010;
- Protection of Wrecks Act 1973;
- The Protection of Military Remains Act 1986;
- Ancient Monuments and Archaeological Areas Act 1979;
- Merchant Shipping Act 1995;
- Valetta Convention
- ICOMOS;
- UNESCO;
- Ancient Monuments and Archaeological Areas Act 1979;
- Scottish Planning Policy (2010);
- Listed Buildings and Conservation Areas (Scotland) Act 1997;
- Planning Advice Note 2/2011.

Full details of these legislative and guidance procedures is given in Annex F.

3.1. The Study Area

The Study Area for this cultural heritage technical report includes the geophysical survey extents referred to as the 'Offshore Study Area' and an 'Onshore Study Area' within which the proposed onshore infrastructure will be installed. A 'Wider Study Area' has also been examined in order to identify the archaeological potential of the main study area (Figure 2). The 'setting' study area was determined by the Zone of Theoretical Visibility (ZTV) (Figure 6). All cultural heritage assets are given Headland Archaeology (HA) numbers and full details of each entry where available are given in Annexes A - C.

3.2. Desk- Based Assessment

The desk-based assessment is a documentary and cartographic search utilising a number of sources in order to locate all known cultural heritage assets within the constraints area and within the general location of the proposed development, and to identify the archaeological potential of the area. Sources used for this assessment include:

- Databases of designated cultural heritage assets maintained by Historic Scotland including designated wrecks;

- Maritime records held by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS);

- UK Hydrographic Office Wrecks and Obstructions Database (SeaZone);
- National Library (for historic charts and maps only);
- Ministry of Defence (military remains only);
- Receiver of Wreck (ROW);
- Relevant SEA reports and Coastal Survey Assessment reports; and
- Other readily available published sources and grey literature e.g. marine geophysical and geotechnical survey reports.

All records of known sites were combined into a gazetteer and plotted using the ArcGIS. The Universal Transverse Mercator (UTM Zone 30N) co-ordinate system, based on the WGS84 datum, was used throughout. All records of known wrecks are listed in Annex A & B and illustrated in Figure 3.

3.3. Site Visit & Walkover

The study area was visited in order to verify the data gathered through desk-based research and identify possible variations in archaeological potential. Initial visits to Kyle Rhea were carried out for a baseline assessment on the archaeology and built heritage on Kyle Rhea's coastal zone (Wickham-Jones & Dawson, 2006). A site visit was carried out on the 31st May and the 1st June 2012 . The surrounding area was examined and visits made to cultural heritage assets in order to establish the potential for impacts upon their setting and to gather data to allow impacts to be assessed.

3.4. Assessment of Marine Geophysical Data

Geophysical survey was undertaken by Osiris Projects on board survey vessel MV 'So Fyne' between the 4th and the 8th May 2010. Survey data collected for the site included high resolution sidescan sonar, swath multi-beam, single beam bathymetry, magnetometer and sub-bottom profiler data (see Annex C, Geophysical Survey Methodology). The geodetic parameters used throughout the survey were WGS84 UTM Projection Zone 30 North.

All survey data was supplied to Headland Archaeology by Royal Haskoning and reviewed in its 'raw' digital state with appropriate software. This allowed for the data to be replayed and interrogated in order to effectively assess the position, extent and nature of identified targets. All information with regard to the survey conditions was provided by Osiris Projects (Hill, 2010; Walters, 2010) in order to gauge the quality of the data for the identification of potential cultural heritage assets.

After reviewing the methods of data collection utilised by Osiris Projects it was confirmed that the survey 'tracks' or 'lines' are more than sufficient enough to provide accurate coverage of the survey area. The survey techniques and equipment employed on site were again found to be of a high standard for the acquisition of survey data needed to complete a marine geophysical survey assessment. Where equipment was found to be unsatisfactory it was soon rectified or replaced. All of the data collected has been rated as very good for archaeological assessment purposes.

The data was subject to an initial scan for any targets of potential cultural heritage interest, after which the data was assessed in detail to:

- familiarise the maritime archaeologist with the survey area;
- correlate anomalies with previously recorded sites;
- identify the absence of anomalies in the vicinity of previously recorded sites;
- identify anomalies indicative of hitherto unrecorded sites;
- check the accuracy of the position, nature and extent of known wrecks; and
- locate and assess unrecorded targets identified by the survey contractors.

All targets were 'tagged' and then assessed as to their archaeological potential. The initial potential of identified targets was gauged using a ranking system (see Table 1 below) as a means of prioritising potential assets in order to inform upon subsequent interpretation. It must be stressed that the ranking system is only seen as a guide and is not used as a substitute for professional judgment.

Table 1: Criteria for Identifying Archaeological Potential of Targets	
Potential of asset	**Character of anomaly**
High	A target that is identified as a known archaeological asset or in the vicinity of such; or a target that is clearly recognisable as a well preserved feature or maritime loss such as a vessel or aircraft (or parts of) and any associated debris
Medium	A target that exhibits characteristics likely to represent the remains of a feature or maritime loss such as a vessel or aircraft including any associated debris; or fragments of the same
Low	An isolated or fragmentary target that is recognised to be of some interest but may represent a natural feature

The position and dimensions of identified targets along with any additional anomalies were recorded into a gazetteer (Annex A, B & D) and sample images of these targets were acquired (Table 5), further maps and images are shown in Figures 1-6. The data was cross-referenced with the desk based assessment and the anomalies identified by Osiris Projects. The position of these identified sites and geophysical targets have been mapped in GIS (see Figure 4); all positions are given in Eastings and Northings.

3.5. Assessment of Marine Geotechnical Data

Six grab samples were taken within the ISA and the results were archaeologically assessed by Headland Archaeology. The aim of the assessment was to examine the palaeoenvironmental and archaeological potential of sediments affected by the proposed development. The locations of the samples taken are presented in Table 2 and illustrated on Figure 5.

Table 2. Grab Samples		
Sample	**X**	**Y**
Grab 1	339439	6346815
Grab 2	339449	6346215
Grab 3	339508	6346292
Grab 4	339522	6347064
Grab 5	339265	6346796

Table 2. Grab Samples		
Sample	**X**	**Y**
Grab 6	339273	6346355

4. Baseline Environment

The Study Area for this cultural heritage technical report includes the geophysical survey extents referred to as the 'Immediate Study Area' (ISA) and a 1 Km buffer zone called the 'Wider Study Area' (WSA) in order to identify the archaeological potential of the main study area. For the setting study area all Scheduled Monuments and Category A Listed Buildings within 5 Km were considered, and thereafter the 'setting' study area was determined by the Zone of Theoretical Visibility (ZTV) (Figure 6). All cultural heritage assets with known locations within the ISA and WSA are given Headland Archaeology (HA) numbers and full details of each entry where available are given in the Appendices.

4.1. Bathymetry, Geology, Geomorphology & Sedimentology

Kyle Rhea is a narrow Strait of sea that lies between the Scottish mainland and the Isle of Skye and located within Scottish territorial waters. The water strait is around 4km in length and orientated north to south against the mainland with an approximate width of 0.7km. The name Kyle Rhea comes from King Hakon of Norway's expedition in 1262 and is translated as 'the King's Strait' (Groome, 1882).

Recent strategic environmental assessment of the area has suggested that submerged landscapes and associated deposits with palaeoenvironmental potential may occur on a local basis around Kyle Rhea in particular where there are low beach and off-shore gradients, topographic shelter and a context of cohesive deposits, such as peat, in which archaeological remains are embedded (Wickham-Jones and Dawson, 2006). In particular, areas falling within the depth range of 4.5 to 10 m below sea level may contain submerged archaeological remains of Mesolithic (c. 8000BC-4000BC) or early Neolithic (4000BC-2500BC) date.

The west coast of Scotland comprises a complex network of firths, sea lochs, islands, sounds and archipelagos, all of which have provided a backdrop for a rich historic and cultural past, some of the tangible links for which survive in the archaeological record. The area of the proposed demonstration tidal array in Kyle Rhea is intrinsically linked to this maritime landscape.

There are two elements to the proposed development which require assessment with regard to potential for palaeoenvironmental and archaeological deposits: the location of the main tidal array with associated cable route and the location of the on-shore cable route and substation.

The tidal array is to be located within the narrows that run between Loch Alsh to the north and Sound of Sleat to the south. These narrows are between 500m and 650m wide and run from NNE-SSE, through N-S to NNW-SSE, forming a curved feature. Geological mapping and sonar survey indicates that the basal sediments of the channel are sands and gravels, often with outcroppings of bedrock. The seabed levels within the immediate study area range from 2.3m below CD in the northwest, to deeper than 33.0m below CD.

The strait of sea and recurrent exposed bedrock indicates a rapid current, capable of shifting suspended material. Such an environment would be highly erosive of any relatively soft material, such as peat or submerged topsoil. On this basis, the survival of in situ submerged archaeological remains is highly unlikely. However, durable redeposited material, such as lithics, may survive.

4.2. Relative Sea Level Change

In a study on relative sea level change focussed on the Isle of Skye, three episodes of high sea-level changes were recorded in the bio-stratigraphic record. The first appears to have occurred within the Late Devensian before c. 12600 BP or soon after, possibly relating to regional deglaciation. The second high sea-level stand is recorded at 8850 ± 170 to 5440±50 BP in the early to middle Holocene period and relates to the Main Postglacial Transgression. The last recorded high relative sea level change in Inver Aulavaig Skye occurred in the late Holocene period at 3160±40 to 3070±60 BP, with the sea then falling rapidly after 2850±100 BP to the present day level (Selby et al, 2002;).

Changes in relative sea level since the end of the Pleistocene and the beginning of the Holocene period around 12,000 years ago appear to have been complex, with changes in absolute sea level interacting with changes in land level due to isostatic rebound. Sea-level studies on Skye at Inver Aulavaig have been completed based on radiocarbon dates and borehole samples that have revealed three episodes of high sea-level changes recorded in the bio-stratigraphic record (Selby et al, 2000).

During the last glacial maximum most of the development area would have been covered by ice and uninhabitable Following this is the Devensian glacial maximum when human occupation in the British Isles is re-established However, the chances of survival of archaeological remains for any human occupation during these periods are low (Wessex Archaeology, 2006). This is due to the repeated ice sheet succession and retreat that may have destroyed or buried evidence of such remains. However Wickham-Jones and Dawson (2006) state that “There is a high likelihood of surviving prehistoric archaeology (10,000 – 5000 years old) in certain areas … and in and among the islands elsewhere (particularly around Islay, Jura, Mull and the Small Isles) along the coast and between South Scotland and Northern Ireland” due to the highly variable sea-level changes across the Western coast of Scotland and thus the likelihood of submerged prehistoric landscapes existing.

The development lies in a highly mobile environment and the seabed surrounding it may well have been exposed a number of times during repeated glacial periods. The material accumulated during these periods is known as Marine Aggregate Deposits (MAD) which are comprised of sands and gravels that make up the top layer of highly variable sediments on the seabed. Survival of archaeological remains is possible in these, though repeated deposition and reworking of sediments, particularly in the strait, could have also destroyed them.

Later Prehistoric sites are no less important, there is a great likelihood of finds relating to the Mesolithic (10,000BP – 6,000BP) and Neolithic (6,000BP – 4,000BP) periods on the shallower parts of the Scottish continental shelf (down to c.-45m) in the SEA7 area. A large amount of investigative works have been carried out on the archaeological potential of this area of Scotland known as the SEA7 assessment. These reports are part of the Strategic Environmental Assessment (SEA) appraisal process through which environmental protection and sustainable development may be considered for an area to help inform groups working on offshore energy developments. Kyle Rhea is covered in the SEA7 environmental survey carried out in 2006 and 2007 (offshore-sea.org.uk), Kyle Rhea is a deep and narrow stretch of water subject to fast flowing tidal streams. There are few navigational hazards within the central part of the channel, the shores are rocky with occasional outcrops and small islands. The comparatively sheltered topography of the Strait and its proximity to Skye and the mainland makes it useful as a crossing point and harbour. The channel represents a natural maritime passage, suitable for smaller vessels.

4.3. Potential for Submerged Archaeology & Palaeolandscapes

A significant factor in assessing the archaeological potential of an onshore and offshore study area such as this is the relative change in sea level which is known to have occurred during the period of human occupation. The seabed along the western coastline of Scotland and particularly around its islands are thought to have potential for archaeological sites which were formerly on dry land to be found at depths up to 20m below current sea level (Wessex Archaeology, 2006).

Studies of human occupation on the west coast of Scotland suggest it was populated by human communities from as early as 7500 BC (Hardy K & Wickham-Jones, 2004). The area around Kyle Rhea dates back to prehistoric times, with many Mesolithic sites densely distributed around the coast. There is a wealth of evidence for human occupation from the Mesolithic period such as at Camas Daraich where a Mesolithic site full of stone tools and flaked lithic material was identified on the south eastern coast of Skye. Evidence showed that the the knappers used a range of raw materials, including both local stone and from slightly further afield (Wickham-Jones & Hardy, 2004).

The coastal location of Kyle Rhea means that there is potential for both archaeological and palaeoenvironmental remains in the form of palaeochannels, peats and coastal and marine prehistoric sites.

Table 3: Archaeological and Geological Chronology

Age in years BP / BC / AI	British Stages	Archaeological Period
42AD - Present Day	Holocene	Roman; Early Medieval/Medieval; Post-Medieva Modern
700BC - 42AD		Iron Age
2,500BC - 700 BC		Bronze Age
4,000 BC – 2,500AD		Neolithic
9,000 BC – 4,000BC		Mesolithic
10.000 BP	Younger Dryas (Loch Lomond Sta	Palaeolithic
11,000 BP	Windermere Interstadial	
13,000 BP	Dimlington Stadial	
70,000 BP–16,000 BP	Devensian	
110,000BP	Ipswichian	
339,000BP – 130,000BP	Wolstonian	
380,000BP	Hoxnian	
423,000BP	Anglian	
860,000BP – 478,000BP	Cromerian Complex	

4.4. The Potential for Unrecorded Maritime Cultural Heritage Assets

4.4.1. Palaeolithic 800,000-9,000BP

The Palaeolithic period covers the time between the first occupation of mainland Britain and is understood to be approximately 800,000BP to 9000BP. The first known settlement in northern Europe was identified in East Anglia at Happisburgh, where an assemblage of 78 flint artefacts were identified in fluvial gravels and laminated estuarine sands (Parfitt et al. 2010).

During this time period there have been a number of major environmental changes and cycles that have affected human occupation, including advancing and retreating glaciation periods and changes in sea level. Much of the offshore area to the west of Skye was for long periods of time exposed as dry land, offering the possibility to examine palaeoenvironmental evidence as well as cultural material. Studies of human occupation on the west coast of Scotland suggest it was populated by human communities from as early as 7500 BC (Hardy & Wickham-Jones, 2004).

While there have been no reported Palaeolithic finds or deposits of archaeological significance from the study area, the discovery of an array of flint tools and associated faunal remains believed to have been deposited during the Devensian Ice Age c.10,000BP were uncovered after offshore dredging works eight miles east of Great Yarmouth in Norfolk (Wessex, 2007). This demonstrates the potential for Palaeolithic evidence to survive in offshore submerged contexts. Elsewhere in the British Isles, Palaeolithic cave sites on the Welsh coast are well documented (Lynch et al 2000), a cluster of which occur at Colwyn Bay including Pontnewyyd Cave which contained the remains of at least three individuals. Similarly, a late Palaeolithic site from coastal England is known at Blackpool (Manley, 1989: 19).

4.4.2. Mesolithic 9,000-4000BC

Mesolithic sites can be difficult to locate and identify but are known from many coastal locations on the Scottish coast. Much of the evidence for Mesolithic settlement on west coast Scottish islands is found along the shorelines in the form of shell middens, flint scatters and ephemeral settlement sites (Saville, 2004). Coastal locations were extremely attractive to hunter-gatherer societies accessing a large range of resources readily available for exploitation.

The earliest known remains of human settlement in Scotland to date have been uncovered at Cramond near Edinburgh where stone tools, debitage and hazelnut shells from what was believed to be a Mesolithic hunting camp overlooking the Forth Estuary have been radiocarbon dated to about 8500 BC (Telford, 2002). The earliest recorded settlement located in the Western Isles of Scotland comes from the islands and dates back to the ninth millennium BC. This relates to the Mesolithic hunter-gatherers who settled in Scotland after the end of the last glacial period (Wickham-Jones & Dawson, 2006).

There is a wealth of evidence for Mesolithic occupation on Islay's coastline. Possible house remains dating to the 7th millennium BC were identified at Newton (Wickham-Jones & Dawson, 2006) and two stone tool assemblages at Bolsay Farm Glean Mor on Islay which have been widely documented (Mithen, 1996). Although as yet no Mesolithic vessels have been discovered in the study area, their existence is likely from the wealth of archaeological remains identified on the coastal zones (Wessex, 2007).

Evidence in the marine zone in the northern North Sea is the isolated discovery of a flint scraper recovered from a borehole core sample on the Viking Bank in the North Sea further demonstrates that prehistoric deposits can survive within submerged landscape contexts (Fleming 2004).

4.4.3. Neolithic 4000-2500BC

Neolithic sites are widely known from coastal locations on the west coast of Scotland including a large number of examples from the Angus coastal fringes (Jones, 1996). Wessex Archaeology (2007) state that on some coastal areas, the crossover between the Mesolithic and Neolithic period is a lot less distinguished than mainland sites. From the Neolithic period there is also an evident change in the types of site that are surviving,the settlements still having poor preservation but more permanent structures such as standing stones, tombs and stone circles such as Ardnacross in Mull surviving (Wickham-Jones & Dawson, 2006).

Evidence for maritime travel in the Neolithic is demonstrated through a number of examples of sea-faring vessels recovered from coastal locations throughout the British Isles. This includes an example from the east of Ireland which was recovered under 2 metres of sand during offshore trenching at a landfall site at Gormanstown, County Meath (Brady, pers. comm). The author suggested that this example was modified with outriggers to accommodate long distance sea travel (ibid.). Trade of goods, common ritual ideas and possible migrations are the other main indications of maritime contact during the Neolithic period. Trade was an important aspect of Neolithic settlements and the use of logboats during this period is highly likely. Additionally, crops and domesticated animals would need to have been brought from Europe by boat, and the major tidal streams of western Britain are known to have formed the main communication routes with continental Europe in prehistory (Wessex, 2007).

4.4.4. Bronze Age 2500-700BC

Logboats continued to be utilised in the Bronze Age with the earliest Bronze Age example in Scotland recovered at Locharbriggs in Dumfriesshire dated to 1,800 BC. More than 150 logboats have been recovered across Scotland (Mowat, 1996) and a number of examples are known from Bronze Age contexts including one from the intertidal zone of the Tay estuary near Newburgh that has been radiocarbon-dated to 1130-970 BC (Strachan 2010).

Advances in boat building technology during the Bronze Age demonstrates the ability for long distance maritime travel and is best witnessed by the Dover boat discovered in September 1992 between Dover and Folkestone. The boat is c. 3,500 years old and was damaged but may have originally measured 18 metres long and 2.4 metres wide, making it capable of crossing the channel and carrying a substantial cargo. The boat was made up of at least six oak timbers strewn together with yew wood, with all the joints reinforced with a thin lath of oak, covering moss pushed into the joint. The two central planks are joined by the use of wedges pushed through a central rail and a series of cleats (Clark 2002).

Other similar type of boats recovered from this period include three examples discovered at North Ferriby on the Humber near Hull, however no examples of this type of craft have ever been recovered from the west coast of Scotland though there is always the potential particularly with the wealth of Bronze Age settlement and coastal sites in the region.

4.4.5. Iron Age & Roman

This area of the Scottish west coast was densely populated from the 1st millennium BC, particularly with territorial structures such as brochs and duns examples of which are seen at Kyle Rhea, Dun Telve and Dun Troddan (Close-Brooks 1986). The archaeological evidence for maritime travel is evident in the common culture and traditions across much of Europe and the British Isles. We know that Wales, Scotland, the Isle of Man and Ireland adopted a Celtic culture at this time and this could not have occurred without maritime travel. The type of craft used for transportation at this time is known to have evolved to that known as the Romano-Celtic type, similar to one discovered in the Severn Estuary (Lawler & Nayling, 1993). However it is likely that skin covered vessels and dugout canoes continued to be used. A gold ornament representing a boat discovered as part of an Iron Age hoard in Co. Derry in Northern Ireland is generally accepted to represent the type of vessel in use at that time. The detail includes a mast and yard arm, 18 miniature oars and rower's benches, a type of rudder or steering oar, a grappling hook and other tools (Raftery, 2008). According to Raftery, it gives us a unique insight into the type of vessel used for open sea and ocean travel but the one detail that cannot be discerned is whether the vessel was intended to represent a boat of hide or of timber (ibid.).

Archaeological and documentary evidence for Roman occupation in Scotland is well documented and discussed with the utilisation of the sea around Scotland also being postulated (Martin, 1991). Even though the Romans did not directly conquer the west coast of Scotland, the influence of its Roman neighbours is apparent (Wickham-Jones & Dawson, 2006). There is no question that both military and merchant maritime traffic would have been extensively employed during this period, connecting with the many Roman forts and settlement networks on the major east coast Firths; notably Cramond on the Forth and Carpow on the Tay.

Although archaeological evidence for Roman maritime activity is yet to be forthcoming, it has to be a distinct possibility that evidence of such activity may well survive within the vicinity of the study area. Many Roman artefacts and remains have been discovered on the west coast such as at Dun Ardtreck in Skye (Mackie, 2000).

There are two well preserved Iron Age Brochs in the area, Dun Telve and Dun Troddan. These are stone built 'cooling tower' shaped defensive structures with internal stairs and chambers within. Dun Telve is situated on the valley floor of the River Abhainne and Dun Troddan is built on a terrace on the side of a hill (Close-Brooks 1986). It is believed that building material from the brochs was used to construct parts of the later dated barracks at Bernera discussed below.

4.4.6. Early Medieval & Medieval 410AD-1550AD

The Early Medieval Period witnessed increasing contact between cultural groups throughout the British Isles, particularly between Ireland and Scotland. The Dalriadic Scots integrated and settled among the native groups of the west coast of Scotland and this interaction is embodied in maritime contact, evidence for which is suggested in pictorial graffiti, such as that discovered at the early Christian site on Inchmarnock opposite the Isle of Bute (Atkinson in Lowe 2008). The depiction of vessels on stones discovered at the site suggests evidence for the potential admixture of maritime boatbuilding traditions during this period.

The chronicle of medieval Irish history, 'Annals of the Four Masters', refer to an assembled fleet of Dalriada travelling to Coll and Islay in 564 AD. A paddle of this period was discovered at a crannog site in Loch Glashan 12km east of the Sound of Jura and it is possible that further remains of this type could be found off the coast of Islay (Wessex, 2007). The site at Kilellan on Islay which was exposed by wind and water erosion included remains from the Bronze Age through to early medieval occupation (Wickham-Jones & Dawson, 2006).

Maritime links assumed renewed importance in the early medieval period, especially in relation to the spread of Christian culture and the written record from this period makes constant reference to journeys undertaken by those involved with the church between Scotland and Ireland, Wales, Cornwall and Brittany. Well documented voyages include those of Colm Cille, who travelled with a group of monks from Northern Ireland to set up a monastery in Iona and Columbanus who travelled to Gaul (Ó Cróinín 2005). The medieval text *Navigatio Sancti Brendani Abbatis* (The Voyage of St Brendan the Abbot) tells how a group of 6th century monks built a leather skinned 'curragh' type boat and set sail west over the ocean.

The Irish Sea and North Channel were frequently navigated by Danish and Norse Vikings and they had a major impact on the western seaboard of Britain as well as the Isle of Man and Ireland. This is evident in both documentary evidence and in the material culture. The Annals of Ulster tell us of intermittent raids being carried out by the Norse at monastic sites on the west coast of Scotland at Iona; the east coast of Ireland at Lambeg Island in 795AD; and Northern England at Lindisfarne in 793AD. The Viking longship, clinker built vessels, was a major factor in the success of their raids and voyages as they were suited to rough seas but also with the ability to navigate shallow estuaries and waterways.

Evidence for Viking vessels has been found on Orkney, the Isle of Man, at Portrush in County Antrim and on Rathlin Island off the coast of County Antrim, in close proximity to Islay. These Viking trade and maritime routes were commonplace up until around the 12th Century. However, the Western Isles were not incorporated into feudal Scotland before the 13th century, with Lewis remaining in Norwegian hands until 1266 (Wessex, 2007).

During the medieval period it was military campaigns, migration and consequent commercial expansion that accounted for much of the sea travel of the time. During this time the English, Spanish and French had significant naval forces and the west coast of Scotland saw the construction of many medieval castles. The importance of ports grew, as did significant populations, prompting an expansion in seaborne trade and commerce. Custom accounts from the 15th century provide evidence of a thriving import and export industry (Rodger 1997).

The coastline around western Scotland, particularly between the islands, was and still is a very hazardous route. Apart from wind and waves the major hazard for vessels travelling in this area throughout the medieval period was the presence of pirates and vagrants. Trading routes with Europe boomed post 12th Century onwards and with this the increase in ship building and evolution.

The infamous Spanish Armada fleet after being broken up by the English fleet in the North Sea attempted to return home via the west coast of Scotland and many of their ships were wrecked in the unfamiliar and dangerous waters off the west coast. There is the possibility that more of these wrecks lie undiscovered on the seabed.

4.4.7. Post-Medieval – Modern 1550-Present

The post-medieval period saw a steady increase in coastal activity where military activity and the expansion of world-wide trade meant further growth in the volume of shipping. From the 18th century onwards comprehensive records of ship losses became widespread and from the middle of the 19th century these records became far more comprehensive. This is reflected in the NMRS data collected that shows over 1240 wrecks in the Western Isles area alone. Many of the recorded losses occurred during major storms, including the Great Storm of 1800 and other famous storms in 1852, 1874, 1875 and 1876. In the 1875 storm at least 15 vessels were lost and in 1876 there appears to have been at least 31 sinking's (Ferguson 1991, 58). So severe were these losses that they encouraged the adoption of steam power for cargo vessels and by the end of WWI most of the larger vessels in the area were steam powered.

Fishing has also been a significant industry in the area, with the rise of numerous fishing settlements along the Scottish west coast during the 18th and 19th centuries with major increases in the population - driven mainly by the growth of herring fishing. It is not surprising therefore, that many of the reported losses in this area are of smaller fishing vessels of various designs. It was not until the 20th century that metal hulls came into use in the herring trade and many of the earlier losses of wooden vessels are likely to be highly degraded and difficult to detect.

4.4.8. Military Remains

Vessel losses: A large number of identified shipwrecks in the seas around Scotland are the result of military activity during WWI and WWII. Initial losses during WWI were caused by the extinguishing of coastal lights which resulted in numerous wrecks concentrated along the shoreline. In 1944 an ex-German submarine was lost and on the 20th March "GRAPH" (the captured "U-570") broke her tow and ran aground on Islay shores (www.naval-history.net). Records for shipping casualties are somewhat incomplete between 1939 and 1945 due to censorship but approximately 50 merchant vessels were sunk off the north-east coast as well as numerous military boats, ships, submarines and Allied and German aircraft losses.

Aircraft: There is a moderate concentration of offshore aircraft losses along the west coast of Scotland resulting from military operations. A number of air bases are located in the vicinity of the proposed development, including the operational base at Benbecula and the base at RRH Saxa Vord, both operational since World War 1 and throughout the 20th century as military bases. Military remains are covered by the Protection of Military Remains Act 1986, this is an Act 'to secure the protection from unauthorised interference of the remains of military aircraft and vessels that have crashed, sunk or been stranded and of associated human remains; and for connected purposes' (http://www.legislation.gov.uk).

To the south of the proposed site on the mainland coast lies Bernera Barracks, which were built in the 1720s-30s to control the narrow crossing from the mainland to Kyle Rhea (Close-Brooks 1986). Bernera Barracks is one of four such structures built in Scotland during the early 1700s by the Hanovarian Government to suppress the Jacobites. Before 1745 the barracks held one or two companies of infantry and after this time the numbers of soldiers was vastly reduced. The shell remains of Bernera still stands today

The coastline of Islay has a huge maritime historic and archaeological record and the potential for the discovery of unknown archaeological remains is great.

5. Cultural Heritage Assets

5.1. Limitations of Data

One of the greatest limitations when researching known and potential offshore cultural heritage is the difficulty of locating recorded maritime losses. For many losses the location of the sinking of the vessel can be in the form of a general area description, as in 'Western Isles' or 'Atlantic', which is not practically useful for the purpose of accurate assessment, except to show the potential exists to encounter cultural remains. Recorded losses are far more numerous than confirmed wrecks but are usually very poorly located and as such are useful only to characterise the type of shipwrecks in the area and assess the potential for further discoveries. Other wrecks have been identified through sonar survey, but this too presents difficulties as many of these wrecks have been located using GPS which until relatively recently were only accurate to 100m (Baird, 2009), or by DECCA which can give locations accurate to only a kilometre. Another important point about the recorded maritime losses is that they are heavily biased towards 19th and 20th century losses when more comprehensive records of losses began to be compiled by the UK Hydrographic Office.

The details for specific offshore cultural heritage assets are derived from two main sources, SeaZone Hydrospatial Data (itself largely derived from UK Hydrographic Office data) and the National Monuments Record of Scotland held by the Royal Commission on Ancient and Historic Monuments of Scotland (RCAHMS). These databases are both derived in turn from a variety of sources including various published lists of marine losses and marine surveys (e.g. Baird, 2009 & Larne and Larne, 1998). There is consequently an overlap between the datasets.

Definitions of the state of wrecks and obstructions are as follows

- *LIVE: All wrecks and anomalies found by UKHO survey;*
- *DEAD: Wrecks not detected by repeated surveys;*
- *LIFT: A salvaged wreck.*

The discussion and tables below covers all UKHO entries within the study area including 'Live' and 'Dead' entries. This is due to the fact that while in some cases there may be vessels which have failed to show up on recent geophysical surveys, the locations may still contain remains of cultural heritage interest. In other cases, however, it is clear from the details of the entry that there is no reason to believe that there are now, or ever have been, archaeological remains. These entries have also been included in the text and illustrations and are discussed on a case by case basis below.

5.2. Sites of Cultural Heritage Interest in the Study Area

The baseline environment has been sub-divided into the following categories, each of which is addressed individually below. These are as follows:

i. Known wrecks and obstructions from UKHO Database/ Receiver of Wreck and from the RCAHMS;
ii. Documented maritime sites and losses listed by the RCAHMS/ HER (position unconfirmed);
iii. Maritime archaeological sites, features and deposits identified through the assessment of marine geophysical and geotechnical data.
iv. Onshore cultural heritage assets listed in the National Monuments Record of Scotland (NMRS) and Historic Environment Record (HER).

v. Archaeological Potential.

All sites of cultural heritage interest with known locations within the study area are depicted on Figures 3 and 4.

5.2.1. Known Wrecks

The desk based assessment established that there are no Designated Wrecks or other offshore cultural heritage assets with legal designations within the ISA.

One '*Dead*' wreck has been identified within the WSA of the development (HA100, Figure 3), this is UKHO-WO-1966, however this wreck has not been detected by repeated survey and as such is thought to not to exist.

Table 4. UKHO Wrecks and Obstructions					
HA REF	**UKHO REF**	**Description**	**STATE**	**LATITUDE**	**LONGITUDE**
100	UKHO-WO-1966	Unknown wreck, sinking position given as 571330N, 053830W"	DEAD	57.22474	-5.64281

5.2.2. Documented Maritime Losses

Although numerous stranding's and wrecking episodes are recorded around Kyle Rhea, accurate co-ordinates are only available for a few loss events, and even then the NMRS record their locations as arbitrary or tentative. In addition, it is likely that many of the vessels involved were later recovered or dispersed. The following documented losses have been taken from the RCHAMS and HER records.

Table 5. Undesignated Offshore Cultural Heritage				
HA No	**NMRS REF**	**HER REF**	**Description**	**Position**
101	NG72SE.8001.	MHG27587	Unknown Steamship (20th Century)	arbitrary
102	NG72SE.8003.	MHG47225	*William Akins*: Brigantine (19th Century)	tentative
103	NG72SE.8004.	MHG48360	*Harmony:* Craft (19th Century)	arbitrary
104	NG72SE.8005.	MHG48462	*Richard:* Craft (19th Century)	tentative
105	NG72SE.8006.	MHG48742	Bromley: Craft (19th Century)	tentative
106	NG72SE.8007.	MHG49883	*Countess Of Liverpool*: Schooner (19th Century).	tentative
107	NG72SE.8008.	MHG50304	*Alliance:* Schooner (19th Century)	tentative
108	NG 79 22	MHG52128	*James Renwick:* Smack (19th Century .: Kyle Rhea	tentative
109	NG72SE 8010 c. 79	MHG52129	*Ocean Gleaner:* Drifter (20th Century).	tentative
110	NG72SE 8011 c. 7922	MHG52130	*Grantley*: Steamship (20th Century)	tentative
111	NG72SE 8012 c. 7922	MH52131	*Albertine:* Yacht (19th Century . Kyle Rhea	tentative
112	NG82SW.8001.	MHG14809	*Deerpark [Possibly]:* Steamship (20th Century)	tentative

5.3. Results of the Archaeological Assessment of Geophysical Survey Data

Anomalies with High Archaeological Potential

No targets of high archaeological potential were identified in the Kyle Rhea geophysical survey.

Anomalies with Medium Archaeological Potential

Five targets of medium archaeological potential were identified within the survey area (Figure 4). These are detailed in Table 6 below.

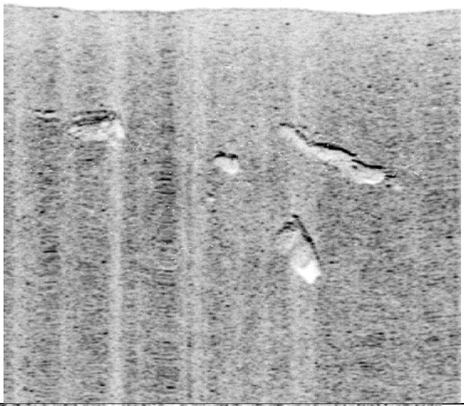
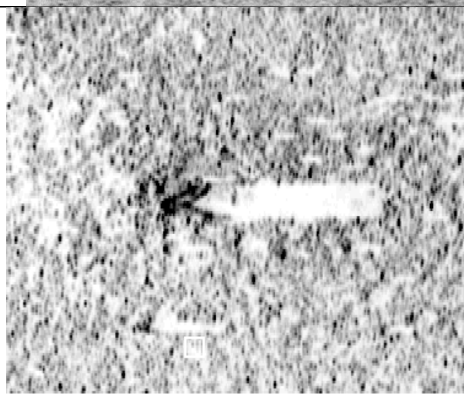
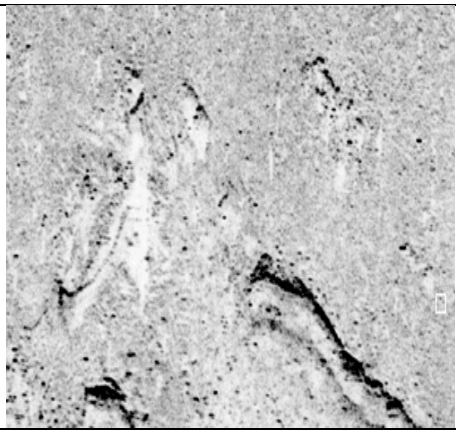
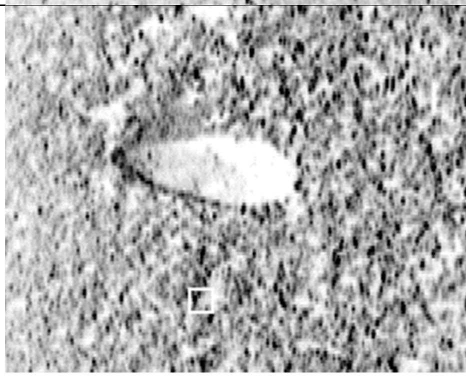
Table 6. Medium Potential Targets in the ISA		
Ha No.	**Description**	**Image**
2	HA2 is a dark and light reflector identified in the central area of the survey site at coordinates 339433.19mE and 6346404.92mN. The target is linear in shape and slightly fragmented with dimensions of 11.82m length, 2.98m width and a geophysical height of 0.57m. The seabed surrounding the debris also has two low potential sidescan targets associated with it.	
6	HA6 is located in the northern half of the survey area at coordinates 339526.35mE and 6346874.61mN and exhibits anthropogenic qualities. The target is triangular in shape and made up of individual pieces and possible scattering across the seabed. The target has dimensions of 2.2m length, 1.55m width and a geophysical height of 0.12m.	
8	HA8 and HA9 are within 30m of one another to the south eastern extent of the survey area, coordinates 339601.75mE and 6346145.31mN. HA8 is a dark and long linear debris remain with measurements of 21.77m length, 0.83m width and geophysical height of 1.16. The debris looks a bit like the remains of a chain.	

Table 6. Medium Potential Targets in the ISA		
Ha No.	**Description**	**Image**
9	HA9 is located at coordinates 339598.73mE and 6346110.44mN. The remains are slightly curvilinear shaped with a rectangular edge and dimensions of 3.31m length, 0.65m width and geophysical height of 0.13m. The remains could be associated with HA8 given that they are within 30m of one another.	
13	HA 13 appears to be a partially buried debris remains identified at coordinates 339309.5mE and 6346925.47mN. The debris has dimensions of 5.72m length, 2.63m width and a geophysical height of 0.59m. This target is located within the Turbine Array ISA in the central western area of the survey.	

A further 10 anomalies considered to be of low archaeological potential were identified within the ISA. These have been identified as small and large boulders that were seen scattered across the area and frequently found around the edges of outcropping rocks. A table of all geophysical anomalies is provided in Annex D.

5.4. Results of the Archaeological Assessment of Geotechnical Data

There were no deposits of palaeoenvironmental potential identified in any of the samples taken. Six grab samples were taken within the ISA (Figure 5), two of which had no recovery (Grab 5 and Grab 6). The results are presented in Table 7. The sediments recovered from the grab samples consisted of gravels, sands and shells.

Table 7. Grab Samples			
Sample	**Sediment**	**X**	**Y**
Grab 1	Limited recovery of medium to coarse gravel	339439	6346815
Grab 2	Grey brown medium to coarse sand, with a little fine to medium gravel and broken shells.	339449	6346215
Grab 3	Grey brown medium to coarse sand and fine to medium gravel and broken shells	339508	6346292
Grab 4	Limited recovery of coarse gravel.	339522	6347064
Grab 5	No recovery	339265	6346796
Grab 6	No recovery	339273	6346355

5.5. Onshore Cultural Heritage Assets

Four designated sites were identified within the WSA (Table 8, Figure 3). These consist of four Category B Listed Buildings, two of which are the Kyle Rhea ferry slipways and two old ferry inns.

HA 113 & 114 are Category B Listed buildings; these are two ferry slipways that give access to Skye from mainland Scotland. The slipways were constructed by the Highland Road Commission in 1818 by Thomas Telford, Joseph Mitchell and John Davidson. The design of the slipways is quite unique as they were built with a separate slip to allow cattle to swim across the strait annually. The ferry boat that uses the crossing with its swivel deck is also rare.

HA 115 is an old inn house built on the ferry slipways in 1801-3 and was a template of the old ferry house on the Glenelg side of the strait (HA 116). The inn was constructed by James Gillespie who was known as one of Scotland's most fashionable architects by the second decade of the 19th Century.

HA 116 is the Old Ferry House built around 1801 and is the twin of HA 115 old inn house on the opposite side of the ferry crossing, both of which were built by James Gillespie.

Table 8. Designated Onshore Cultural Heritage

HA REF	NMRS REF	HER REF	NMRS NAME	Designation	NGR_E	NGR_N	CLASS
113	NG72SE.35.-	MHG5370	Skye, Kylerhea, Pier.	Category B Listed	178891	821183	PIER, SLIPWAY
114	NG71152SE.36.-	MHG5371	Glenelg, Ferry Slipway.	Category B Listed	179454	821315	SLIPWAY
115	NG72SE.42.-	MHG16796	Skye, Kylerhea, Old Inn.	Category B Listed	178862	820912	INN
116	NG72SE.45.-	MHG16774	Kylerhea, Old Ferry Inn.	Category B Listed	179472	821480	INN

Fourteen undesignated sites were identified within the WSA (Table 9, Figure 3). These consist of cultivation remains, farmsteads, townships, enclosures, a mound, a cairn and an axe head findspot.

HA 117 is the remains of a large cairn feature immediately to the rear of a cottage. The original diameter of the cairn is recorded as being 25m, however the monument has been disturbed and now measures 16.5m east to west and 11.5m south to north. The monument stands at a height of 2.5m.

HA 118 is a depopulated township and cultivation remains that overlook the Kyle Rhea at about 200 feed OD. The township consists of around 30 ruinous houses and 6 small enclosures/garths. Surrounding the township on the hill slopes are large areas of lazy-bed cultivation areas.

HA 119 is the Kylerhea lighthouse recorded in the NMRS data, the offshore position and absence of foot or vehicular access suggest that this structure is an unmanned beacon, rather than a true lighthouse.

HA 120 comprises a single unroofed building that is depicted on the first edition of the OS 6-inch map (Ross-shire 1880, sheet cxxvii), but it is not shown on the current edition of the OS 1:10000 map.

HA 121 is a farmstead with two unroofed buildings again depicted on the first edition of the OS 6-inch map (Ross-shire 1880, sheet cxxvii), but it is not shown on the current edition of the OS 1:10000 map (1971).

HA 122 is a township comprising two roofed, three unroofed buildings and a head-dyke that are shown of the 1st edition of the OS 6-inch map (Inverness-shire, Isle of Skye 1876-80, sheet xlviii). One unroofed building and a head-dyke are shown on the current edition of the OS 1:10560 map (1968).

HA 123 is a crofting township comprising twenty-six roofed buildings and four unroofed buildings. Eighteen roofed, two partially roofed and twelve unroofed buildings are shown on the current edition of the OS 1:10000 map (1986).

HA 124 is a Late Bronze Age socketed axehead found in 1995 amongst fallen scree in a roadside gravel quarry. The axehead belongs to the so-called Meldreth type characterised by their slender proportions and faceted bodies.

HA 125 is an enclosure situated on the south bank of the Kyle Rhea at a height of 5m OD. It is a stone walled enclosure with dimensions of 12m north to south and 17m east to west with walls 1m thick. The entrance is in the centre of the east wall.

HA 126 are two ovoid mound features located at the south side of the Kylerhea River at a height of 8m OD. The mounds have dimensions of 6m by 1.5m and have stones visible on the ground surface.

HA 127 is a rectangular farmstead building in close proximity to HA 126. The structure has measurements of 8m by 3.5m and walls of 0.75m thickness.

HA 128 is a ruinous farmstead building situated by the shore at a height of 5m OD. The structure measures 13m by 3.5m with walls 1m thick. A second rectangular structure also abuts the north gable, incorporating this wall as its boundary.

HA 129 is another farmstead remains with dimensions of 10m by 4m internally and walls 1m thick. The remains of two rectangular structures (byres) lie to the south, both with 4m x 4m internally and walls 1m thick

HA 130 is a byre which is situated by the shore at a height of 5m OD, it is a large rectangular structure measuring 10m x 4m internally with walls thick. The north gable still stands, the remainder collapsed at time of recording. Remains of two rectangular structures (byres) lie to the south, both 4m x 4m internally and walls 1m thick

Table 9. Undesignated Cultural Heritage							
HA REF	**NMRS REF**	**HER REF**	**NAME**	**Designation**	**NGR_E**	**NGR_N**	**CLASS**
117	NG72SE.1.-	MHG5435	Skye, Kylerhea.	-	178690	820540	Cairn, Cinerary Urn
118	NG72SE.2.-	MHG41907	Skye, Runicaleach.	-	179100	823100	Cultivation Remains, Township
119	NG72SE.43.-	-	Skye, Kylerhea L.	-	179361	823010	Beacon
120	NG82SW.12.-	MHG27262	Teanga Na Comhstri	-	180500	823190	Building
121	NG82SW.13.-	MHG27263	Teanga Na Comhstri	-	180590	823330	Farmstead
122	NG72SE.39.-	MHG27856	Skye, Kylerhea.	-	178800	821200	Head Dyke, Township
123	NG72SE.40.-	MHG27857	Skye, Kylerhea	-	178600	820600	Building(S), Township
124	NG82SW.24.	MHG51702	Glenelg, Bernera.	-	180000	820900	Axehead
125	NG72SE31	MHG5366	Kylerhea	-	178610	820360	Enclosure
126	NG72SE32	MHG5367	Skye, Kylerhea	-	178420	820350	Mound
127	NG72SE33	MHG5368	Skye, Kylerhea	-	178350	820360	Farmstead
128	NG72SE30	MHG5365	Skye, Kylerhea	-	178580	820300	Farmstead
129	NG72SE29	MHG5363	Skye, Kylerhea	-	178590	820230	Farmstead
130	NG72SE29	MHG44086	Skye, Kylerhea	-	178590	820230	Byre

5.6. Cultural heritage onshore key receptors

There is one Scheduled Ancient Monument (SAM) and two Category A Listed Buildings within 5 Km of the ISA and within the Zone of Theoretical Visibility (ZTV) (see Tables 10 & 11 and Figure 6). Bernera Barracks is also listed as an SAM and as a Category A Listed Building. Nearby Glenelg War Memorial is also a Category A Listed Building.

Scheduled Monument (950) and Category A Listed Building (HB 7152) is Bernera Barracks (Table 10) which was constructed between 1719 and 1723. These barracks were the last of the four Highland forts built by the government at strategic points across the Highlands, in this case to guard the Skye crossing. The barracks were partially constructed from stone plundered from the numerous Glenelg brochs in the area. The barracks were built to accommodate regular garrisons patrolling potential nests of insurrection after the Jacobite risings of the early 1700s. The remains of the Bernera barracks today are still very impressive structures.

Table 10. Scheduled Monuments				
SM No	**Name**	**Area**	**NGR E**	**NGR N**
950	Bernera Barracks	Highland	-3544128	-22091616

Category A Listed Building (HB 7236) Glenelg War Memorial (Table 11)was made in 1920 by Sir Robert Lorimer and Louis Reid Deuchars. The monument is situated south of the village of Glenelg and on the shores of Glenelg Bay, facing the land. The sculpture is made of Bronze and is representative of a Cameron Highlander, together with a kneeling female figure and winged Peace raised upon a stone plinth against the Sound of Sleat. The soldier is said to look more forlorn than victorious and winged victory is holding her laurel wreath well out of reach. There is a bronze inscription panel at the front of the pedestal and the memorial stands some 18 feet high.

Table 11. Category A Listed Buildings				
HB No	**Name**	**Area**	**NGR E**	**NGR N**
7236	Glenelg War Memorial	Council: Highland Parish/Burgh: Glenelg Item No: 8		
7252	Bernera Barracks	Council: Highland Parish/Burgh: Glenelg Item No: 2		

5.6.1. Archaeological Potential

It is considered that there is at least moderate potential for the discovery of unexpected intertidal and offshore cultural heritage assets including paleoenvironmnetal remains to be identified within the development area. The substation location is positioned above a car park area on rough and disused terrain; there is low potential for unknown archaeological remains to be present in this area.

6. Conclusions

The assessment has established that there are no Designated Wrecks or other cultural heritage assets with legal designations within the Kyle Rhea Tidal Array. The offshore assessment has established that there are no Designated Wrecks or other offshore cultural heritage assets with legal designations within the Immediate Study Area (ISA). The report identified 1 'Dead' wreck in the Wider Study Area (WSA). The archaeological geophysical assessment identified five targets considered to be of medium archaeological potential within the offshore ISA. The RCAHMS and HER datasets list a large number of documented losses within the general area without accurate locations.

There are 4 designated onshore cultural heritage assets and 26 undesignated cultural heritage assets within the WSA.

There is one Scheduled Ancient Monument (SAM) and two Category A Listed Buildings within 5 Km of the ISA and within the Zone of Theoretical Visibility (ZTV).

It is considered that there is at least moderate potential for the discovery of unexpected onshore, intertidal and offshore cultural heritage assets including paleoenvironmental remains to be identified within the proposed development area.

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Databases of Cultural Heritage Asset Consulted Designated wreck data was downloaded from Historic Scotland's website © Historic Scotland

Offshore Sites and Monuments Record information derived from NMRS data (dated 15/02/2011) © Crown Copyright RCAHMS

Wrecks and Obstructions information derived from SeaZone data © Copyright UKHO

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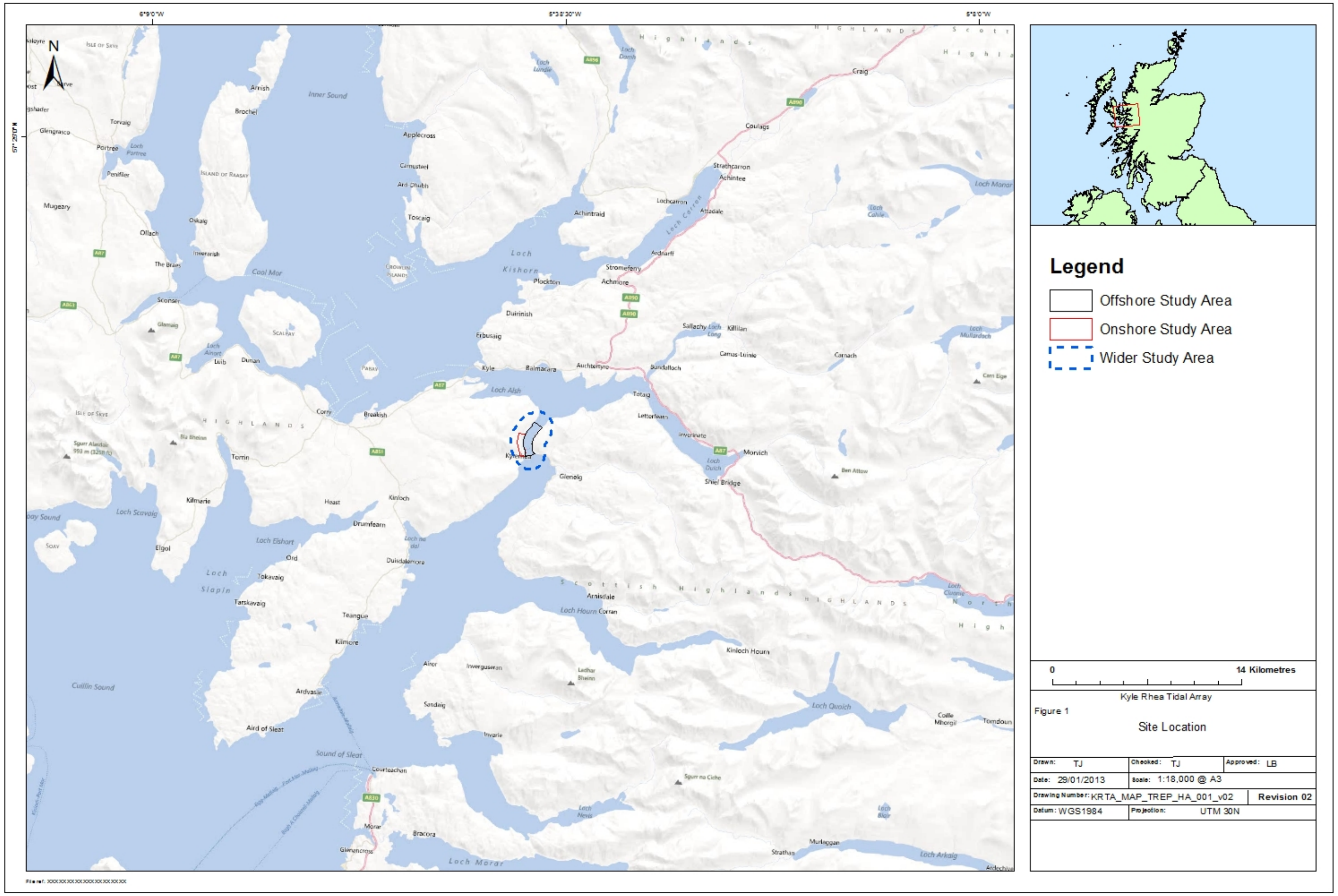
FIGURES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Legend
Offshore Study Area
Onshore Study Area
Wider Study Area
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Kyle Rhea Tidal Array
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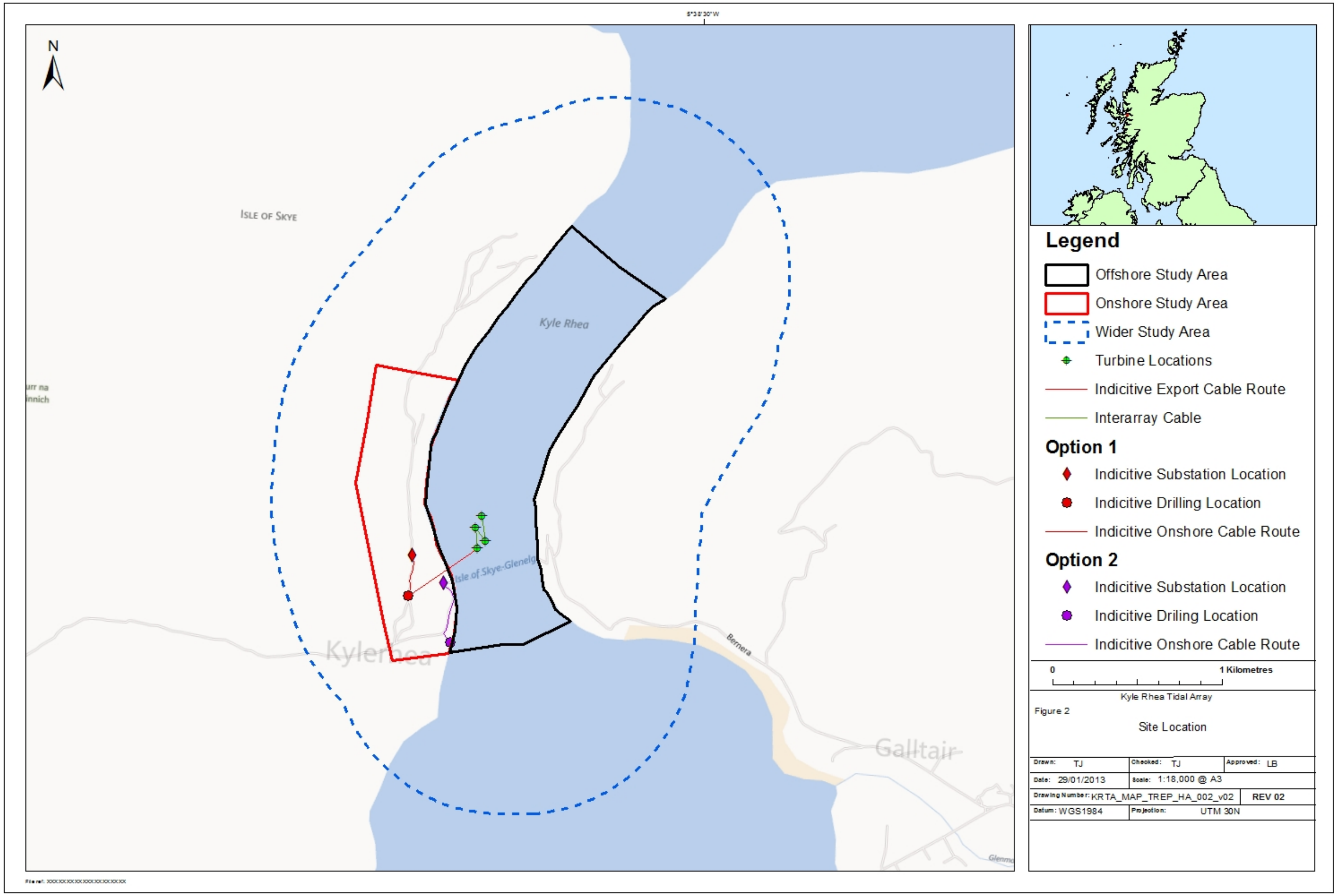
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Turbine Locations
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Option 1
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Indicitive Onshore Cable Route
Option 2
Indicitive Substation Location
Indicitive Driling Location
Indicitive Onshore Cable Route
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Kyle Rhea Tidal Array
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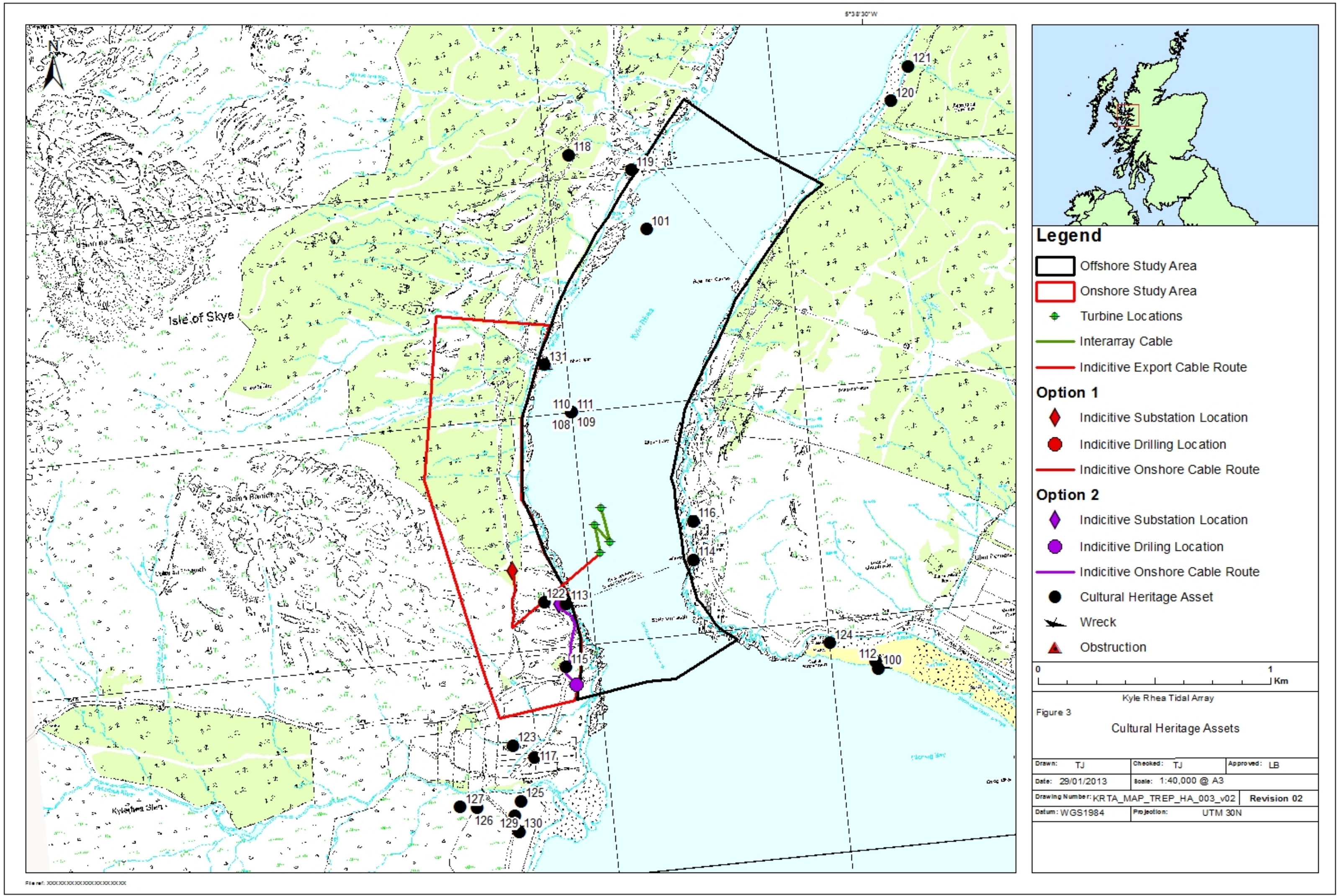
Isle of Skye
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Legend
Offshore Study Area
Onshore Study Area
Turbine Locations
Interarray Cable
Indicitive Export Cable Route
Option 1
Indicitive Substation Location
Indicitive Drilling Location
Indicitive Onshore Cable Route
Option 2
Indicitive Substation Location
Indicitive Driling Location
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Cultural Heritage Asset
Wreck
Obstruction
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Kyle Rhea Tidal Array
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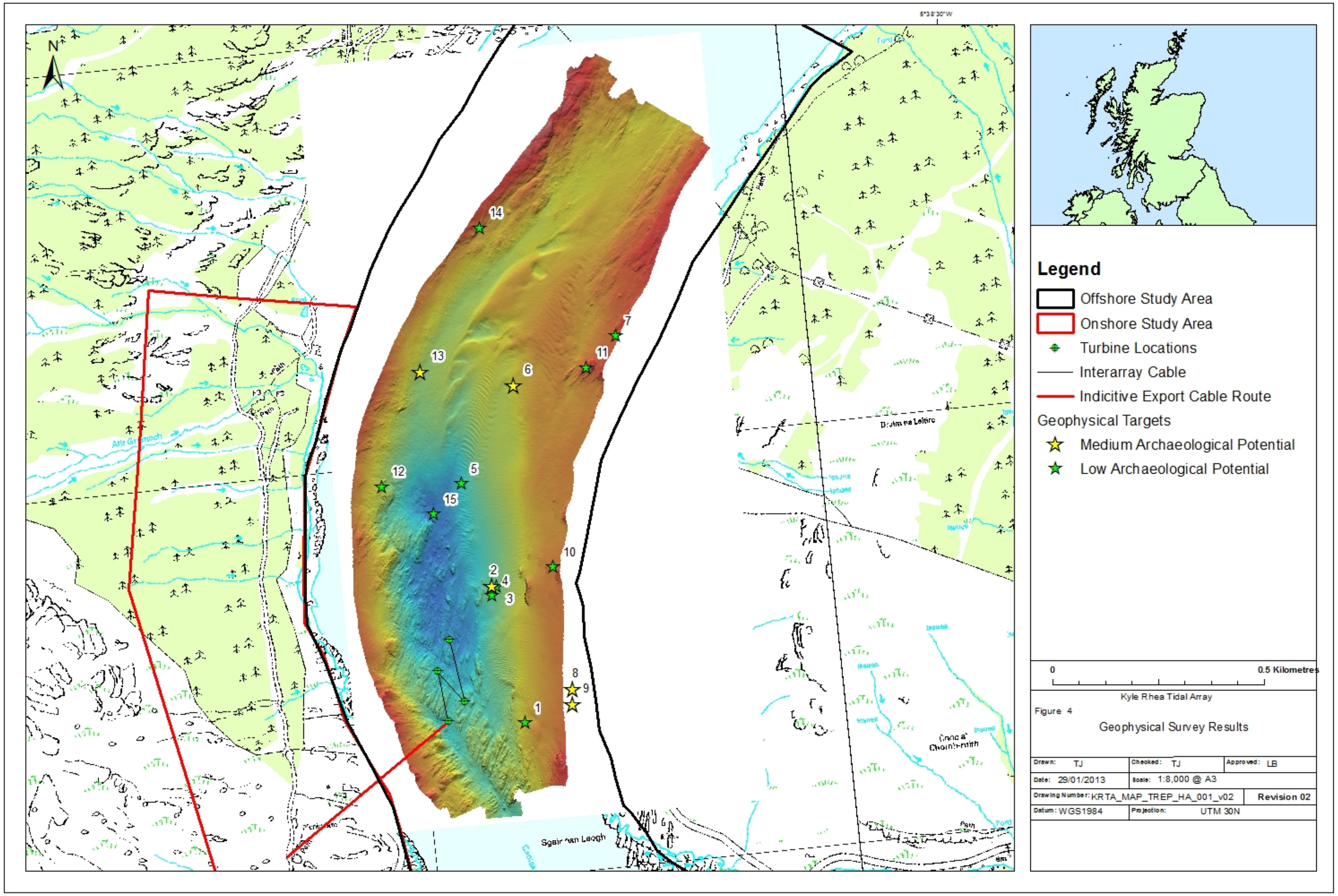
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Low Archaeological Potential
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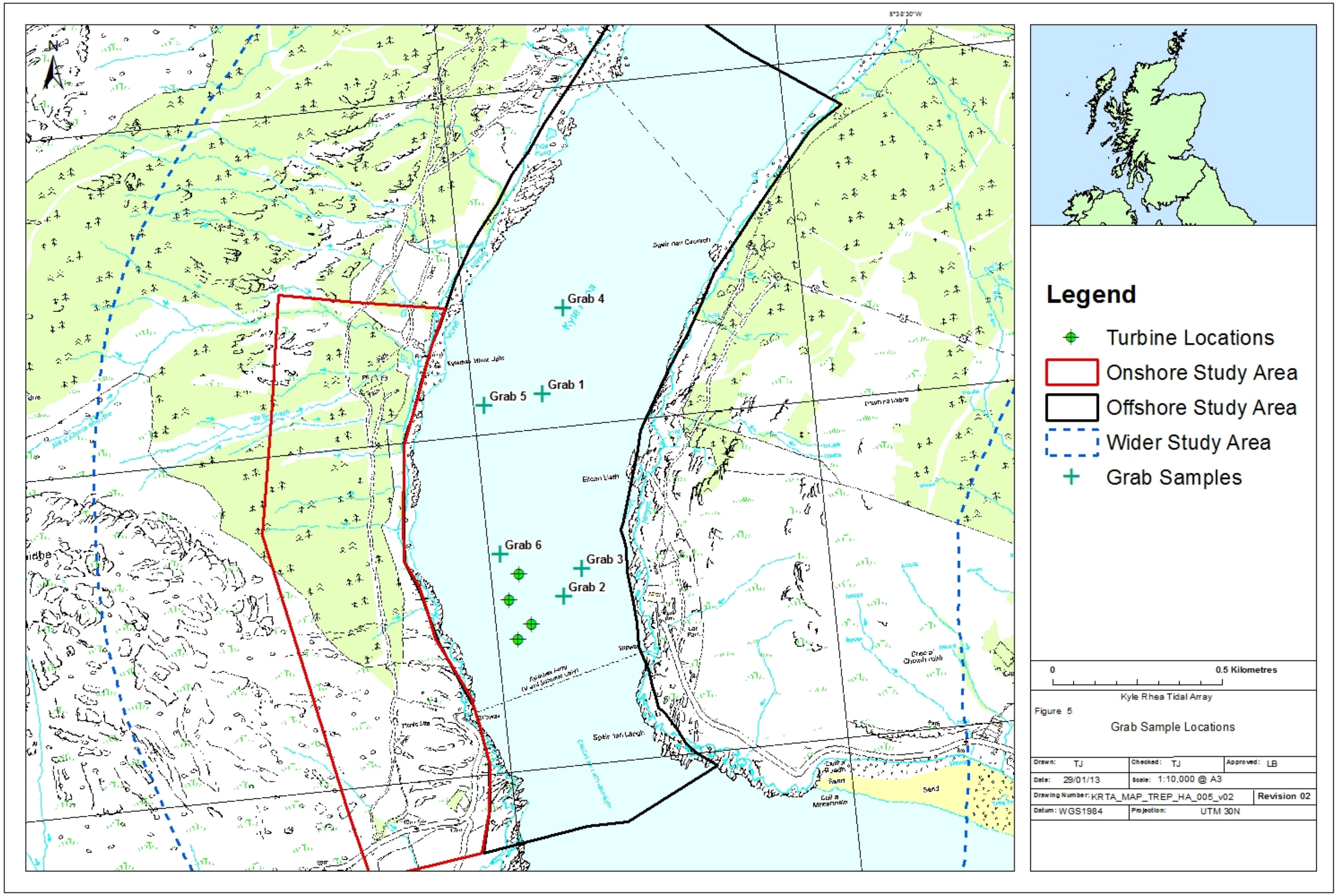
Legend
Turbine Locations
Onshore Study Area
Offshore Study Area
Wider Study Area
Grab Samples
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Grab 2
Grab 3
Grab 4
Grab 5
Grab 6
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Kyle Rhea Tidal Array
Figure 5
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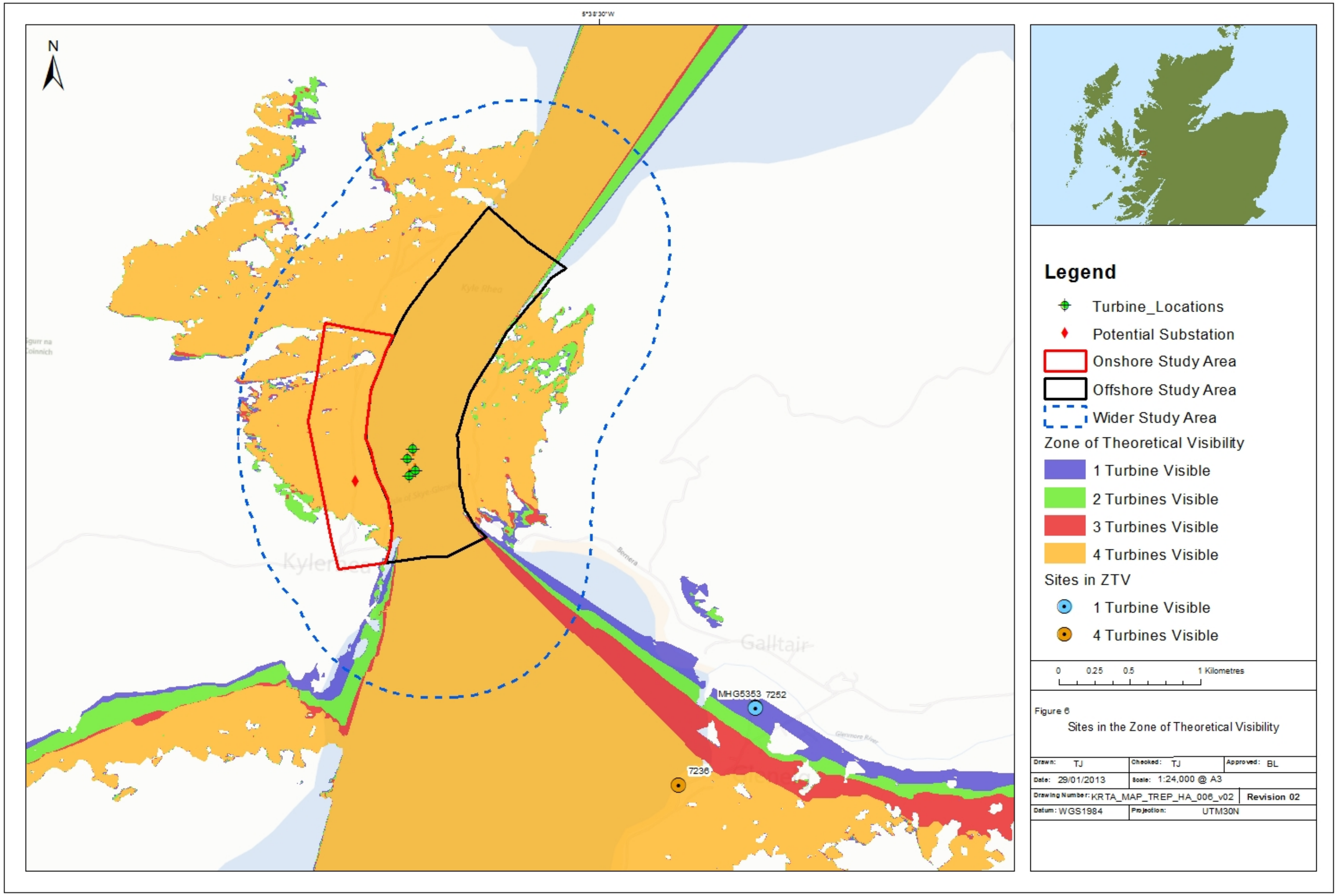

Figure 6
Sites in the Zone of Theoretical Visibility

ANNEX A - GAZETTEER AND CONCORDANCE OF CULTURAL HERITAGE ASSETS AND POTENTIAL CULTURAL HERITAGE ASSETS WITH KNOWN LOCATIONS WITHIN THE OFFSHORE STUDY AREA.

HA No	UKHO	NMRS	HER	Area	Name	Designation	X	Y
100	UKHO-WO-1966			Offshore	Unknown Wreck	-	180197	820769
101	-	NG72SE.8001.	MHG27587	Offshore	Unknown Steamship (20th Century)	-	179400	822750
102	-	NG72SE.8003.	MHG47225	Offshore	William Akins: Brigantine (19th Century)	-	179000	822000
103	-	NG72SE.8004.	MHG48360	Offshore	Harmony:Craft (19th Century)	-	179000	822000
104	-	NG72SE.8005.	MHG48462	Offshore	Richard: Craft (19th Century)	-	179000	822000
105	-	NG72SE.8006.	MHG48742	Offshore	Bromley: Craft (19th Century)	-	179000	822000
106	-	NG72SE.8007.	MHG49883	Offshore	Countess Of Liverpool: Schooner (19th Century).	-	179000	822000
107	-	NG72SE.8008.	MHG50304	Offshore	Alliance: Schooner (19th Century)	-	179000	822000
108	-	NG 79 22	MHG52128	Offshore	James Renwick: Smack (19th Century .: Kyle Rhea	-	179000	822000
109	-	NG72SE 8010 c. 79	MHG52129	Offshore	Ocean Gleaner: Drifter(20th Century).	-	179000	822000

HA No	UKHO	NMRS	HER	Area	Name	Designation	X	Y
110	-	NG72SE 8011 c. 7922	MHG52130	Offshore	Grantley: Steamship (20th Century)	-	179000	822000
111	-	NG72SE 8012 c. 7922	MH52131	Offshore	Albertine: Yacht (19th Century . Kyle Rhea	-	179000	822000
112	-	NG82SW.8001.	MHG14809	Offshore	Deerpark [Possibly]: Steamship (20th Century)	-	180190	820800

ANNEX B - GAZETTEER AND CONCORDANCE OF CULTURAL HERITAGE ASSETS WITH KNOWN LOCATIONS WITHIN THE ONSHORE STUDY AREA.

HA No	NMRS	HER	Area	Name	Designation	X	Y	Class
113	NG72SE.35.-	MHG5370	Onshore	Skye, Kylerhea, Pier. Alternative: Ferry Slipway, Glenelg	Category B Listed	178891	821183	Pier, Slipway
114	NG72SE.36.-	MHG5371	Onshore	Glenelg, Ferry Slipway. Alternative: Kyle Rhea	Category B Listed	179454	821315	Slipway
115	NG72SE.42.-	MHG16796	Onshore	Skye, Kylerhea, Old Inn. Alternative: -	Category B Listed	178862	820912	Inn
116	NG72SE.45.-	MHG16774	Onshore	Kylerhea, Old Ferry Inn. Alternative: -	Category B Listed	179472	821480	Inn
117	NG72SE.1.-	MHG5435	Onshore	Skye, Kylerhea. Alternative: -	-	178690	820540	Cairn, Cinerary Urn
118	NG72SE.2.-	MHG41907	Onshore	Skye, Runicaleach. Alternative: -	-	179100	823100	Cultivation Remains, Township
119	NG72SE.43.-	-	Onshore	Skye, Kylerhea Lighthouse. Alternative: Kylerhea Beacon, Kylerhea Minor Light, Kyle Rhea, Sound Of Sleat, Loch Alsh	-	179361	823010	Beacon
120	NG82SW.12.-	MHG27262	Onshore	Teanga Na Comhstri. Alternative: -	-	180500	823190	Building
121	NG82SW.13.-	MHG27263	Onshore	Teanga Na Comhstri. Alternative: -	-	180590	823330	Farmstead

HA No	NMRS	HER	Area	Name	Designation	X	Y	Class
122	NG72SE.39.-	MHG27856	Onshore	Skye, Kylerhea. Alternative: -	-	178800	821200	Head Dyke, Township
123	NG72SE.40.-	MHG27857	Onshore	Skye, Kylerhea. Alternative: -	-	178600	820600	Building(S), Township
124	NG82SW.24.	MHG51702	Onshore	Glenelg, Bernera. Alternative: -	-	180000	820900	Axehead
125	NG72SE31	MHG5366	Onshore	Kylerhea	-	178610	820360	Enclosure
126	NG72SE32	MHG5367	Onshore	Skye, Kylerhea	-	178420	820350	Mound
127	NG72SE33	MHG5368	Onshore	Skye, Kylerhea	-	178350	820360	Farmstead
128	NG72SE30	MHG5365	Onshore	Skye, Kylerhea	-	178580	820300	Farmstead
129	NG72SE29	MHG5363	Onshore	Skye, Kylerhea	-	178590	820230	Farmstead
130	NG72SE29	MHG44086	Onshore	Skye, Kylerhea	-	178590	820230	Byre

ANNEX C - GEOPHYSICAL SURVEY METHODOLOGY & SUITABILITY FOR ARCHAEOLOGICAL ASSESSMENT

Survey Specifications & Suitability for Archaeological Assessment

The following outlines the methodology used by Osiris Projects during the geophysical survey and the methodology employed for the archaeological assessment of the data.

Osiris Projects Survey Methodology & Specifications

Geophysical data was undertaken by Osiris Projects on board survey vessel MV 'So Fyne' between the 4th and the 8th May 2010. The survey consisted of the collection of high resolution sidescan sonar, swath multi-beam, single beam bathymetry, magnetometer and sub-bottom profiler data. The geodetic parameters used throughout the survey were WGS84 UTM Projection Zone 30 North.

Survey Parameters

The marine geophysical survey undertaken by Osiris Projects was initiated with a view to satisfying a number of requirements (e.g. geological, engineering etc.) of the proposed development. The main survey lines were run at 50m spacing and in addition to this a number of grab samples and video footage were taken to ground truth the seabed classifications (Hill, 2010).

Sidescan Sonar

A digital Klein 3000 simultaneous dual frequency (100 kHz and 455 kHz) side scan sonar system was utilised for the geophysical survey. The Klein 3000 system is based on new transducer designs along with specifically developed high resolution circuitry and multi-beam focused sonar technologies which provide outstanding imaging with high-range performance.

Magnetometer

A Geometrics G882 caesium vapour marine magnetometer was used for the survey area. The unit provides absolute readings of total magnetic field, with a resolution of 0.004nT/Hz RMS (Route Mean Square). The magnetometer survey equipment is used to identify magnetic anomalies and variations in the total magnetic field of an area, particularly ferrous objects on or below the seabed.

Sub-Bottom Profiling System

The Boomer Sub-Profiling System comprised of a CSP1000 Portable Seismic Energy Source, an Applied Acoustics AA200 Boomer Plate, a CAT200 Catamaran and Applied Acoustics AAE 8 Element Hydrophone Streamer. Sound energy from the sub-bottom profiler is reflected from the seabed and subsequent sub-surface layers. The percentage of acoustic energy reflected is dependent upon the composition of the seabed and as a rule, the denser the seabed, the stronger the reflected signal

Echo Sounder/Multibeam Echo Sounder

A RESON Seabat 7125 high resolution multi-beam echo sounder system was used to collect high density bathymetry data set within the survey area. This is a beam-forming system that creates virtual 'beams' mathematically and detects the range to the seabed for each beam returned. The data was acquired using QPS QINSy software.

Archaeological suitability of the survey methodology and specifications

The following assesses the suitability of the specifications for the survey methods for archaeological assessment and takes into consideration the guidelines presented by English Heritage 'Marine Archaeological Geophysical Survey Note 1' (2006).

After reviewing the methods of data collection utilised by Osiris Projects it is thought that the survey 'tracks' or 'lines' are more than sufficient enough to provide accurate coverage of the survey area. The survey techniques and equipment employed on site were again found to be of a high standard for the acquisition of survey data needed to complete a marine geophysical survey assessment. Where equipment was found to be unsatisfactory it was soon rectified or replaced. All of the data collected has been rated as very good for archaeological assessment purposes.

ANNEX D - GEOPHYSICAL TARGETS IDENTIFIED BY HEADLAND ARCHAEOLOGY

HA No	Site Description	Sidescan Potential	Geophys Length m	Geophys Width m	Geophys Height m	DDM Long	DDM Lat	UTM30N mE	UTM30N mN
1	Possible natural feature	Low	7.06	0.95	0.78	-0 20.4528	57 13.7758	339484.07	6346076.84
2	Possible debris	Medium	11.82	2.98	0.57	-0 20.3896	57 13.9511	339433.19	6346404.92
3	Possible debris	Low				-0 20.4036	57 13.9512	339446.79	6346404.38
4	Possible debris	Low				-0 20.3912	57 13.9395	339433.93	6346383.34
5	Possible natural feature	Low	6.96	0.83	0.4	-0 20.3320	57 14.0841	339385.04	6346653.25
6	Possible debris	Medium	2.2	1.55	0.12	-0 20.4639	57 14.2064	339526.35	6346874.61
7	Possible natural feature	Low	13.72	0.68	0.22	-0 20.7092	57 14.2618	339777.78	6346969.81
8	Chain	Medium	21.77	0.83	1.16	-0 20.5669	57 13.8143	339601.75	6346145.31
9	debris	Medium	3.31	0.65	0.13	-0 20.5652	57 13.7962	339598.73	6346110.44
10	Possible natural feature	Low	7.98	1.07	1.02	-0 20.5359	57 13.9722	339581.82	6346438.75
11	Possible natural feature	Low	3.77	0.64	0.24	-0 20.6384	57 14.2239	339703.07	6346900.57
12	Possible natural feature	Low	5.82	0.93	0.23	-0 20.1454	57 14.0848	339196.99	6346662.94

HA No	Site Description	Sidescan Potential	Geophys Length m	Geophys Width m	Geophys Height m	DDM Long	DDM Lat	UTM30N mE	UTM30N mN
13	Buried debris?	Medium	5.72	2.63	0.59	-0 20.2463	57 14.2294	339309.5	6346925.47
14	Possible natural feature	Low	13.64	15.86	0.08	-0 20.4031	57 14.4080	339480.54	6347252.23
15	Possible natural feature	Low	11.99	1.4	0.53	-0 20.2639	57 14.0473	339313.36	6346587.48

ANNEX E - KEY ONSHORE RECEPTORS

Listed Buildings						
LB No	**Name**	**Category**	**X**	**Y**	**Link**	**Visibility**
7236	Glenelg War Memorial	A	180972	819198	http://hsewsf.sedsh.gov.uk/hslive/portal.hsstart?P_HBNUM=7236	4 Turbines Visible
7252	Bernera Barracks	A	181518	819741	http://hsewsf.sedsh.gov.uk/hslive/portal.hsstart?P_HBNUM=7252	1 Turbine Visible

Scheduled Monuments					
MonUID	**Name**	**RecordType**	**Easting**	**Northing**	**Visibility**
MHG16774	Old Ferry Inn, Kylerhea Ferry	Monument	179472	821480	4 Turbines Visible
MHG16796	Old Inn, Kylerhea	Monument	178862	820912	4 Turbines Visible
MHG24464	Balmacara, Crofts	Monument	180000	820000	4 Turbines Visible
MHG24466	Balmacara, Shooting Lodge	Monument	180000	820000	4 Turbines Visible
MHG25518	Reraig	Monument	180000	820000	4 Turbines Visible
MHG27587	Portaferry: Kyle Rhea	Maritime	179400	822750	4 Turbines Visible
MHG27856	Kylerhea	Monument	178800	821200	4 Turbines Visible
MHG35194	Kylerhea, Old Ferry Inn	Monument	179400	821500	4 Turbines Visible
MHG35205	Skye, Kylerhea Old Inn	Monument	178870	820900	4 Turbines Visible
MHG41907	Runicaleach	Monument	179100	823100	4 Turbines Visible
MHG46429	Caroline Alice: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG47225	William Akins: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG47808	Union: Glenelg Bay, Sound Of Sleat	Maritime	180300	819800	4 Turbines Visible
MHG47913	James: Glenelg Bay, Sound Of Sleat	Maritime	180300	819800	4 Turbines Visible
MHG48360	Harmony: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG48371	Harmony: Glenelg Bay, Sound Of	Maritime	180300	819800	4 Turbines Visible

Scheduled Monuments					
MonUID	**Name**	**RecordType**	**Easting**	**Northing**	**Visibility**
	Sleat				
MHG48462	Richard: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG48742	Bromley: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG49883	Countess Of Liverpool: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG50062	Medora: Glenelg Bay, Sound Of Sleat	Maritime	180300	819800	4 Turbines Visible
MHG50304	Alliance: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG52128	James Renwick: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG52129	Ocean Gleaner: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG52130	Grantley: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG52131	Albertine: Kyle Rhea	Maritime	179000	822000	4 Turbines Visible
MHG5353	Bernera Barracks, Glenelg	Monument	181519	819745	1 Turbine Visible
MHG53629	Route Of Drovers Road, Kinloch To Kylerhea, Skye	Monument	175281	817423	4 Turbines Visible in parts, also 1, 2 & 3
MHG5370	Slipway, Kylerhea	Building	178891	821183	4 Turbines Visible
MHG5371	Slipway, Glenelg	Building	179454	821315	4 Turbines Visible
MHG5424	Runicaleach	Monument	179100	823100	4 Turbines Visible

HER Designated Landscapes						
DL No	**No**	**Name**	**X**	**Y**	**Link**	**Visibility**
748	EHG940	Area 2 - Kinloch Forest 2003	6270.187	1654434	http://her.highland.gov.uk/SingleResult.aspx?uid=EHG940	4 Turbines Visible
925	EHG673	Kinloch Forest	46298.46	12540995	http://her.highland.gov.uk/SingleResult.aspx?uid=EHG673	4 Turbines Visible
2444	EHG3275	An Archaeological Survey of the Drovers Road running between Kinloch and Kylerhea	19910.23	99496.92	http://her.highland.gov.uk/SingleResult.aspx?uid=EHG3275	4 Turbines Visible

Kyle Rhea Tidal Stream Array

Appendix 24.1

Kyle Rhea Tidal Stream Array

Appendix 24.1:
Post consent environmental monitoring

Drafted by	Frank Fortune	
Checked by	Gemma Keenan	
Date/initials check	…13/12/12………	…FF……………….
Approved by	Frank Fortune	
Date/initials approval	…13/12/12………	…FF……………….

12.1 Introduction

Sea Generation (Kyle Rhea) Ltd is committed to working with Marine Scotland and SNH to develop an appropriate Environmental Monitoring and Adaptive Management Plan (EMAMP) to monitor potential impacts of the Kyle Rhea tidal stream array following installation.

The EMAMP may include monitoring of the following key receptors:

- Marine mammals and basking sharks;
- Diving birds;
- Benthic ecology; and
- Terrestrial ecology.

It is important to note, however, that in the rapidly developing tidal energy sector, research and environmental monitoring works are already either on-going, or planned, at a number of locations in the UK and internationally. In this evolving climate, it is not appropriate to propose detailed monitoring plans, given that the details and premise of which will require considerable revision in the light of new knowledge expected post consent. For example, it is anticipated that data from the SeaGen project in Northern Ireland will be available in 2013 / 2014, which may radically revise our understanding of the potential for collision between tidal turbines and marine mammals, with consequences for monitoring at other tidal array sites.

12.2 Marine mammals

Based on marine mammal monitoring works undertaken at other tidal turbine sites, some aspects of the following approaches to data collection may be appropriate:

- Vantage point surveys of the array area to monitor use and behaviour in the array area;
- Active sonar to monitor near field behaviour of any animals passing close to the devices;
- Passive acoustic monitoring to monitor use of the Kyle by cetaceans and ensure passage is maintained;
- Carcass surveys.

12.3 Diving birds

Monitoring studies of greatest value are likely to include surveys to quantify changes in the distribution, abundance and behaviour of diving seabirds, particularly shag and cormorant, using the Project area. The surveys should collect evidence of changes in behaviour in response to the Project; including disturbance, displacement, attraction and habituation. All data will be collected from vantage point surveys and might include:

- Monitoring of diving behaviour of cormorant and shag including evidence for device avoidance response;
- Monitoring of the foraging behaviour and success of white-tailed eagle at Kyle Rhea;
- The potential benefits to bird species such as cormorants, shags, gulls, terns, and white-tailed eagle through provision of perches on surface piercing towers and any associated enhanced feeding opportunities.

12.4 Benthic

Based on data collected for one SeaGen device in Strangford Lough, Northern Ireland, it can be suggested that impacts on the seabed are unlikely to be extensive, or extend beyond the physical footprint of the devices. However, as at Strangford Lough, some elements of post construction monitoring of key habitats may be appropriate. It is anticipated that such works could include:

- Randomised or stratified randomised visual sampling within Kyle Rhea, using remote methods (drop video); and
- Acoustic seabed mapping.

12.5 Terrestrial ecology

The data collected from Vantage Point surveys for marine mammals will be interrogated to identify any changes in otter behaviour (in particular crossing of the Kyle) associated with the construction and operation of the Project.