SCOTTISHPOWER RENEWABLES
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Sound of Islay Demonstration Tidal Array

Volume 2: Technical Appendices

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Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 2 – Scoping and Assessment Methodology

Appendix 2.1: “The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000: Response to a request for a Scoping Opinion for the Proposed Demonstration Tidal Site, Sound of Islay.”

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The Scottish Government

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12 January 2009

Dear Ms Becker

THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000: RESPONSE TO A REQUEST FOR A SCOPING OPINION FOR THE PROPOSED DEMONSTRATION TIDAL SITE, SOUND OF ISLAY

I attach the response to your request made under Regulation 7 of The Electricity Works (Environmental Impact Assesment) (Scotland) Regulations 2000, ("the Regulations") to the Scottish Ministers on 8 August 2008 for a scoping opinion on the proposed demonstration tidal site, Sound of Islay. I apologise for the delay in replying.

The Scottish Ministers have consulted with the appropriate bodies and other persons who were likely to be concerned by the proposed development by reason of their environmental responsibilities. Having regard to the responses received from all parties, it is the Scottish Ministers opinion that in accordance with Part 1 of Schedule 4 of the Regulations, in addition to your submitted proposal, your environmental statement should address these further concerns.

Our response has been structured in accordance with Part 1 of Schedule 4 of the Regulations.

Regulation 10(1) of the Regulations requires that a copy of this response is forwarded to the planning authority/authorities within whose area the land which is subject to the proposed application is situated. For the purposes of this request, a copy of this response has been duly forwarded to Argyll and Bute Council.

Argyll and Bute Council shall take steps to ensure that this document is made available for public inspection at all reasonable hours at the place where its Register is kept. If an application is subsequently made, the opinion and related documents should be transferred to Part 1 of the Register together with the application.

You should note that this opinion is based on the information available to the Scottish Ministers as at 12 January 2009. I would like to advise you to have regard to subsequent proposals which are submitted to planning authorities or the Scottish Ministers prior to the determination of any future application. To this end, I would recommended that you approach both the planning authority and the Scottish Ministers at the point of application to

ascertain if further proposals have come forward which may have a bearing on the information you have been asked to provide.

If you have any queries please do not hesitate to contact me.

Yours sincerely

MARK CHRISTIE

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THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000.

SCOPING OPINION FOR THE PROPOSED DEMONSTRATION TIDAL SITE AT SOUND OF ISLAY

1. Introduction

I refer to your letter of 8 August 2008 requesting a scoping opinion under the Electricity Works (Environmental Impact Assessment)(Scotland) Regulations 2000 enclosing a scoping report dated August 2008 (Reference Number: HMF/LET/02/110/075).

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 Scottish Planning Policy 6 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 SEPA, Historic Scotland (HS), Argyll and Bute Council, Scottish Natural Heritage (SNH), Royal Society for Protection of Birds (RSPB), Chamber of Shipping, Forestry Commission, Civil Aviation Authority (CAA), National Air Traffic Services (NATS), The Crown Estate, Health and Safety Executive, Marine and Coastguard Agency (MCA), Northern Lighthouse Board (NLB), Scottish Wildlife Trust (SWT), Scottish Fisherman Federation (SFF) and The Royal Yachting Association (RYA). Responses have been received from all of these organisations except for the Forestry Commission and Scottish Wildlife Trust. If we subsequently receive responses, we will forward them directly to you.

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 Sound of Islay Tidal Energy Project. 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 has 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 a proposed Demonstration Tidal Site with the approximate electrical output of 20 Megawatt (MW) in the Sound of Islay. The Tidal Site will consist of up to 20 submerged demonstration tidal stream generating devices each with an individual capacity of 1-1.5MW.

4. Land Use Planning

Scottish Planning Policy SPP 6, Renewable Energy sets out the national planning policies for renewable energy developments. It outlines the process of encouraging, approving and implementing renewable energy proposals to ensure the delivery of renewable energy targets. The SPP identifies the issues that Scottish Ministers will take into account when considering applications for off-shore electricity generation schemes under Section 36 of the Electricity Act 1989 .

The whole series of SPPs (and those National Planning Policy Guidelines (NPPGs) which have yet to be replaced) should be taken as an integral policy suite and considered along with the supporting advice and information in Planning Advice Notes (PANs) and Circulars. Planning documents that a developer should particularly consider include:

- Planning Authority Supplementary Planning Guidance
- National Planning Framework for Scotland

- SPP1: The Planning System
- SPP6. Renewable Energy
- SPP7: Planning and Flooding
- SPP15: Planning for Rural Development (2005)
- SPP17: Planning for Transport (2005)
- SPP 21: Green Belts
- NPPG5: Archaeology and Planning
- NPPG14: Natural Heritage
- NPPG18: Planning and Historic Environment
- PAN42: Archaeology–Planning Process and Scheduled Monument Procedures
- PAN45: 2002 Renewable Energy Technologies
- PAN 50: Controlling the Environmental Effects of Surface Mineral Workings
- PAN 51: Planning, Environmental Protection and Regulation
- PAN56: Planning and Noise
- PAN58: Environmental Impact Assessment
- PAN60: Planning for Natural Heritage
- PAN68: Design Statements
- PAN69: Planning and Building Standards Advice on Flooding
- PAN 75: Planning for Transport
- PAN 79: Water and Drainage
- Marine Guidance Note 275 (M)

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 SPP 6. 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 occur.

Site selection and alternatives

First, there is the general choice of site in the broader context, and the applicant should demonstrate that a fairly wide set of environmental and economic parameters have been used to narrow down choice of sites. Secondly, there should be a detailed examination on these parameters to minimise the impact of the proposal by sensitive design and layout

Tidal potential and access to the grid are key to initial sieve-mapping exercises for site selection, but environmental constraints should also be included in this initial site selection process.

Argyll and Bute Council have advised that the Environmental Statement should address site selection in the context of available alternatives and also with regard to the cumulative impact of the development with other relevant projects. In addition to the consideration of alternative locations, alternative methods should also be considered. The Scoping Report states that the devices will be seabed mounted with gravity based foundations and ballast weights and that if the seabed conditions show that this is not appropriate then other alternatives will be considered. The EIA should consider these alternative methods of attachment.

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.

Description of the development

Your description of the proposed development in the Environmental Statement should comprise information on the site boundary, design layout, and scale of the development.

Where it is required to assess environmental effects of the development (see EIA regulation 4 (1)(b), the Environmental Statement should include;

(a) a description of the physical characteristics of the whole development and the onshore land use requirements during the construction, operation, decommissioning and restoration phases:

(b) a description of the main characteristics of the production processes and nature and quality of the materials used; and

(c) an estimate by type and quantity of expected residues and emissions resulting from the operation of the proposed development.

Decommissioning

The subsequent application and supporting environmental statement should include a programme of work complete with outline plans and specifications for the decommissioning and reinstatement of the site. Information should be provided on the anticipated working life of the development and after use site reinstatement.

Grid Connection Details

The impacts of constructing, installing and operating the following infrastructure components should be considered and assessed by developers, if known;

- Substation
- Cabling (Underground)
- Cabling (Overhead)
- Monitoring and control centre.

8. **Baseline Assessment and Mitigation**

This section should clearly set out a description of the environmental features of the proposed development site, the likely impacts of the development on these features, and the measures envisaged to prevent, mitigate and where possible remedy or offset any significant effects on the environment. It should incorporate details of the arrangements and the methodologies to be used in monitoring such potential impacts, including arrangements for parallel monitoring of control sites, timing and arrangements for reporting the monitoring results.
It should be noted that there is a danger that these measures could themselves have secondary or indirect impacts on the environment.

Air, Climate and Carbon Emissions

The Environmental Statement should fully describe the likely significant effects of the development on the environment, including direct effects and any indirect, secondary, cumulative, short, medium and long term, permanent and temporary e.g. construction related impacts positive and negative effects of the development which result from:

a) the existence of the development.
b) the use of natural resources.
c) the emission of pollutants, the creation of nuisances and the elimination of waste.

SEPA have advised that other aspects of the process may have to be controlled by the Section 36 consent therefore SEPA recommends that a dust management strategy would need to be a condition of any consent. Further advice should be sought from the environmental health officers at the local authority.

SEPA have advised that any impact upon air quality through terrestrial elements such as construction of roads should be assessed through the ES. If crushing of rock or grading or screening of rock or road stone coating is proposed as part of road accesses then the applicant should note the regulatory advice contained in paragraph 14 below.

Design, Landscape and the Built Environment

SNH have advised that reference is made to the key documents in the scoping report including the relevant landscape character assessments:

> Landscape Assessment of Argyll and the Firth of Clyde. Report to Scottish Natural Heritage. Environmental Resources Management. 1996

SNH have advised that this is supplemented by the seascapes assessment which SNH commissioned in respect of (offshore) windfarms. Although the technology differs, the seascapes report has relevance in the description it provides for the Sound of Islay, a pdf is free to download from SNH's publications website: **http://www.snh.org.uk/pubs/**

> Scott K.E., Anderson C. and Benson J.F. (2005). An assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Windfarms. Scottish Natural Heritage Commissioned Report No.103.

SNH have advised that the following good practice guidance sets out the principles of undertaking a landscape and visual assessment (the principles will equally apply to seascapes):

> LI-IEMA (2002). Guidelines for Landscape and Visual Impact Assessment.
> There is also:

Swanick, C (2002) Landscape Character Assessment Guidance for England and Scotland

SNH have advised that the applicant may also find it helpful to refer to:

PAN 68- Design Statements: and
SNH(2001). Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydroelectric Schemes.

SNH have advised that this guidance may be helpful in outlining the importance of providing a design statement for a development proposal, and in considering the design of the onshore ancillary elements of the proposed Tidal Site, including the control building, grid connection and access tracks.

SNH have advised that onshore facilities such as grid connections and substations should be sympathetic to the outstanding quality of the landscape in the area if they are sited within the NSA or can be viewed from the NSA (Islay side of Sound of Islay). Details such as design and colour of external building materials, routing of tracks and overhead lines and landscaping works should be designed to minimise visual impacts on the landscape.

SNH have advised that it is these onshore elements of the proposal which are of primary importance for the applicant to address in the Landscape/Seascape Visual Impact Assessment, however, they should also consider any requirements for marker buoys and/or night time lighting around the location for the Tidal Site itself. And while this proposed Tidal Site is the first of its kind in this location, it will be important for the applicant to consider any cumulative landscape and visual impacts of the proposal in combination with other types of development in the area.

Construction and Operation

Fisheries Research Services (FRS) have advised that they cannot foresee a major FEPA problem with the deployment of one of these devices into Scottish waters. However, FRS believe that for an array/site to be considered a new application should be submitted and circulated around consultees, only once the single device has been successfully trialled. This allows the unknown critical information to be evaluated prior to the FEPA licence being issued for the actual site.

FRS are confused to the time periods given for phase 1&2 of the development. FRS query how the time period for phase 1 be similar to that of phase 2 when it involves implementing 20 devices in phase 2 and only 1 device in phase 1. The operational life cycle of the tidal site is 25 years in phase 2, to be followed by decommissioning or an extension to the use of the site by up grading the devices in place.

FRS have advised that if the current is too strong for the gravity based foundations to work, what other installation methods can be used if the current force is too strong for these devices.

FRS have queried if a Gantt chart can be supplied for each operational stage

FRS have advised that the EIA should focus on the full force of the current through all modelling procedures. The worst case scenario is the best approach to take for the EIA process but it should be noted that this project has so many unknown factors including the collision factors of young seal pups. The most substantial part of the device has to be the actual foundation in which it attaches to the sea bed the hydrodynamics of the base unit need to be discussed and detailed within the EIA. From an FRS point of view there has to be a precedent for this device to stay put on the sea bed and not drift, especially in high tidal stream areas.

FRS would like it to be stipulated within the ES that it will be Scottish Power Renewables' responsibility to find and retrieve any lost pieces of kit during and after construction.

FRS have advised that the substructure is lowered from the specially adapted barge onto the sea bed, with weights docked to the footing of the three legged structure after it is lowered onto the sea bed to enable station keeping. FRS would like to know what type of vessel will be conducting this piece of work as a Jack up barge would be required due to the sheer force of the current. FRS have also noted that the barge pictured on page 25 of the Scoping report would drift and drag its anchor within a very limited working time period

FRS have advised that the turbine Blades were mounted onto the Nacelle on the surface and by means of Guide wires (Rough seas); has a jack up barge been considered.

FRS have advised that alternatives to the Gravity based foundations and ballast weights should be considered, dependant on sea bed conditions. FRS also advise that engineering advice will be required for developments in Scottish Waters.

FRS have advised in regards to the maintenance of the Nacelle Structures, has any contingency plan been submitted for maintenance during the winter months? FRS also request the time scale needed to remove/repaired and then replace a Nacelle structure.

FRS have queried if the umbilical cables holding the devices together have been trialled in Scottish water conditions. FRS also query if the cables require rock armour and if so, where from and what quantities as the current will remove the armour.

FRS have advised that the 12 month installation period is questionable. If SNH stipulate work restriction conditions regarding seal breeding seasons, the 12 month target may not be achieved.

Sensitive Breeding Season	*Moulting Season*
Common Seals – June/July	Common Seals – August
Grey Seals – September/November	Grey Seals – April/May

FRS have advised that the prototype has been trialled in Norway Fjords however there is no comparison between the conditions within the static Fjords and the Sound of Islay currents.

FRS have advised that this project device is at the very early stages as the design stages still have to be finalised for these Scottish conditions. Trying to pre-judge the direction of the current is going to be the hardest aspect of the development.

FRS have advised that it was stated in the Scoping report that the work would be favoured to take place in the summertime due to the smaller wave height. However the Sound of Islay is sheltered from the Atlantic storms but the currents are extremely volatile and the force during construction causes concern. FRS recommends this should now state that all works must take place in the summer for Health and Safety reasons.

Maintenance was discussed briefly but the time line should be entered into removal of the nacelle and how do you predict the guide wires to work in stormy conditions for the installation process.

FRS have advised that the issue regarding entanglement of fishing gear also shows concern, especially from a creeling point of view and hauling pots to the surface.

Health and Safety Executive have advised that the Environmental Statement should not include measures which would conflict with the requirements of the Health and Safety at Work Act 1974 and its relevant statutory provisions.

SEPA have advised that it is unclear whether any borrow pits are proposed as part of this development. Experience suggests that there may be a considerable need for borrow pits. SEPA seeks in relation to substantial new development that developers demonstrate that the development includes construction practices to minimise the use of raw materials and maximise the use of secondary aggregates and recycled or renewable materials. Further information is available from AggRegain (www.aggregain.org.uk/) which provides a unique 'one-stop' source of practical information on the use of recycled and secondary aggregates. It is a free service, designed to assist anyone interested in specifying, purchasing or supplying these types of products.

SEPA suggests it is sometimes the case that the need for borrow pits or the detailed location of borrow pits appears only after an application has been determined, but the impact of such facilities (including dust, blasting and impact on water) needs to be appraised as part of the overall impact of such facilities as part of the EIA process.

SEPA have advised that where borrow pits are proposed the ES should include information regarding the location, size and nature of these borrow pits, including information on the depth of the borrow pit floor and the borrow pit final reinstated profile.

SNH have advised that the initial installation of a single turbine may not be beneficial in assessing the impacts of an array of 20 turbines. SNH is of the view

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that should the development proceed, an initial installation of 10 turbines to allow monitoring of the effects of an array may be more beneficial.

The ES should set out mechanisms to ensure that workers on site, including sub-contractors, are aware of environmental risks, and are well controlled in this context. The ES should state whether or not appropriately qualified environmental scientists or ecologists are to be used as Clerk of Works or in other roles during construction to provide specialist advice. Details of emergency procedures to be provided should be identified in the ES.

The process whereby a method statement is consulted upon before commencement of work is satisfactory at many sites where sensitivities are non-critical. However for environmentally sensitive sites it is recommend that, following consultation, method statements be approved by the planning authority in consultation with SNH, prior to the commencement of construction work.

Scottish Natural Heritage would normally only wish to comment on Construction Method Statements where there are relevant and significant natural heritage interests involved. Developers should avoid submitting multiple versions of the Construction Method Statement to SNH.

Archaeology and Cultural Heritage

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.

The "historic environment" is defined in section 2 of Scottish Historic Environment Policy (SHEP) 1 Scotland's Historic Environment (www.historic-scotland.gov.uk/index/policyandguidance/sheps/shep1.htm.

National policy for the historic environment is set out in the following key documents:

- National Planning Policy Guideline (NPPG) 5, Planning and Archaeology: www.scotland.gov.uk/Publications/1998/10/nppg5
- National Planning Policy Guideline (NPPG)18, Planning and the Historic Environment. www.scotland.gov.uk/Publications/1999/04/nppg18.
- Scottish Historic Environment Policies (SHEPs) - a new series of Scottish Government policy documents which set out Scottish Ministers strategic policies for the historic environment. The series can be viewed at www.historic-scotland.gov.uk/index/policyandguidance/sheps.htm.
- The Memorandum of Guidance on Listed Buildings and Conservation Areas, 1998:www historicscotland.gov.uk/index/policyandguidance/memorandu mofguidance.htm.

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Amongst other things, NPPG 5 stresses that scheduled monuments should be preserved in situ and within an appropriate setting, whilst NPPG 18 confirms that legislation requires that special regard must be had to the desirability of preserving the building or its setting or any features of special architectural or historic interest which it possesses. Consequently both direct impacts on the resource itself and indirect impact on its setting must be addressed in Environmental Impact Assessment.

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=500:1:6448412299472048421::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 our 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.

Historic Scotland have advised that it is possible that a development in this location could affect the setting of cultural heritage resources across a wide area beyond the boundary of both your search are and development site. Historic Scotland note that you have already considered some scheduled monuments and listed buildings in your draft opinion report. Sites which lie closest to your search area are included in the following list:

Scheduled Monuments
Kellis House, cross shaft 280m NNE of (Index No.2362)
Cil Challium Chille, chapel, Kiells (Index No. 2361)
Cil Sleabhan, chapel 1000m SSE of kiells (Index No. 2371)
Dun Bhoraraic, dun ENE of Lossit Farm (Index No.3959)
Cill Eilegain, chapel 750m N of Mulreesh (Index No. 2356)

Historic Scotland have advised that this list is not exhaustive and there may be other archaeological sites that may be subject to impacts beyond the boundary of your development site.

Historic Scotland have advised that it is strongly recommended that your cultural heritage consultant carries out out an assessment of the likely impacts of proposed development on these sites reporting the findings of such an assessment in any ES produced. Some general considerations which we advise your cultural heritage consultant takes into account in undertaking such an

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The scoping report should aim to present sufficient information to enable a conclusion to be drawn on this test, i.e. as to whether there is likely to be a significant effect on the site. If that information is provided, SNH will be able to advise, when consulted upon the scoping request, whether an appropriate assessment will be necessary. In the event that detailed survey or analysis is required in order to reach a view, the survey and analysis should be regarded as information contributing to that assessment. Note that such information should be provided for the wind farm itself together with any ancillary works such as grid connections and vehicle tracks, and cumulatively in combination with any other wind farm consented or formally proposed in the vicinity.

SNH have advised that the report identifies South east Islay Skerries Special Area of Conservation (SAC) Treshnish Islands SAC and Eileanan agus Sgeirean Lios mor (the Isles and Skerries of Lismore) SAC as Natura sites where the baseline conditions and potential effects of the proposed development need to be considered in an Environmental Statement. SNH agree that South east Islay Skerries SAC needs to be included within the considerations of the ES, due to the presence of common seals and the fact that this species is expected to routinely range 50km or more from their haul out site in the SAC. However SNH consider that Treshnish Islands SAC and Lismore SAC are too far from the proposed development site to be affected, therefore do not need to be included within the considerations of the ES.

SNH have advised that the ES should consider the potential effects of the development on the Firth of Lorn SAC, which lists harbour porpoise as an interest. A site's status as a SAC under the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the "Habitats Directive"), means that the Conservation (Natural Habitats, &c.) Regulations 1994 as amended, (the "Habitats Regulations") apply.

SNH have advised the requirements are summarised in SE 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 200 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".

SNH have advised the need for appropriate assessment extends to plans or projects outwith the boundary of the site in order to determine their implications for the interest protected within the site. Under regulation 48 of the Habitats Regulations, this means that Scottish Ministers, as competent authorities, have a duty to:

Determine whether the proposal is directly connected with or necessary to site management for conservation; and, if not, determine whether the proposal is likely to have a significant effect on the site either individually or in combination with other plans or projects, and, if so, then make an appropriate assessment of the implications (of the proposal) for the site in view of that site's conservation objectives.

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SNH have advised that the competent authority can only agree to the proposal under Regulation 48 after having ascertained that it will not adversely affect the integrity of the site. If this is not the case, and there are no alternative solutions, the proposal can only be allowed to proceed if there are imperative reasons of overriding public interest, which in this case include those of a social or economic nature. If you propose to approve the plan on the grounds of imperative reasons of overriding public interest then Regulation 49 states that you must inform Scottish Ministers and you must not issue approval for a period of 21 days after receipt by Scottish Ministers unless notified otherwise. If proposals are allowed to proceed in accordance with Regulation 49 then it should be noted that Regulation 53 requires that Scottish Ministers shall secure that any necessary compensatory measures are taken to ensure that the overall coherence of Natura 2000 is protected. If this is not the case, and there are no alternative solutions, the proposal can only be allowed to proceed if there are imperative reasons of overriding public interest.

SNH have advised that they have considered potential impacts on Special Protection Areas (SPAs) in the area which support internationally important colonies of breeding seabirds. The closest of these to the proposed development site is North Colonsay and Western Cliffs SPA, which is important for guillemots (Uria aalge), kittiwakes (Rissa tridactyla) and razorbills (Alca torda). These birds will forage at sea for their prey fish species. However, the demonstration Tidal Site is proposed at 25km from the SPA, and this is too far away for there to be any regular (i.e. daily) foraging activity of seabirds coming from the SPA.

SNH have advised that there are two SSSIs which are located on the coastline adjacent to the Sound of Islay, both notified for their geological importance. They are West Coast of Jura SSSI and Rubh a Mhail to Uamhannan Donna Coast SSSI. Scottish Power Renewables indicated at a meeting with SNH staff on 15 September 2008 that the proposed development is likely to require land based development in areas outwith these SSSIs. If this is the case there is no need to consider effects on these sites within the ES. However, if the landward part of the proposed development is likely to require development on or close to these sites, the ES should consider the effects on the notified interests.

SNH have advised that the report does not mention Oronsay and South Colonsay SSSI which lies approx. 7km north-west of the proposed development site. The skerries and offshore islands to the south west and south east of Oronsay support a nationally important colony of breeding grey seals. The number of seal pups recorded over a 21 year period in this site shows it to be consistently one of the 2 largest grey seal colonies on the Inner Hebrides and west mainland coast of Scotland. It is likely that the range of these seals included the Sound of Islay therefore the baseline conditions and potential effects of the proposed development on the notified feature of the SSSI needs to be considered in an ES.

SNH have advised that the Southern part of the island of Jura is designated as Jura National Scenic Area (NSA). Jura forms the western visual limit of a large-scale coastal tract which encompasses Mid Argyll, but it is the southern part of the island which has outstanding scenic interest. The island is made up of quartzite, which usually results in remarkable upland landforms and Jura is no

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exception. The Paps of Jura, all three between 700 and 800 metres in height, are dominant in views from the mainland Islay. The coastal fringe has dramatic raised beaches and cliff lines on the west side of the island, and indented bays and islets on the east shore, with some woodland, both semi-natural and planted.

Habitats

SNH suggest that the ecological survey methods are agreed with their specialist advisers and all ecological survey data collected during ES survey work should be made available by the applicant to SNH, in a form which would enable them to make future analyses of the effects of tidal developments if appropriate. Surveys should be carried out at appropriate times or periods of the year by appropriately qualified and experienced personnel, and suitability of the timing needs to be considered within the ES.

The ES should provide a comprehensive account of the habitats present on the proposed development site. It should identify rare and threatened habitats, and those protected by European or UK legislation, or identified in national or local Biodiversity Action Plans, Habitat enhancement and mitigation measures should be detailed.

SNH have advised that they are aware of a number of records of maerl in the Sound of Islay primarily in the north of the Sound. As stated in the Request for a Scoping Opinion maerl is a UK Biodiversity Action plan (BAP) Habitat for which an Action Plan has been developed. The Plan's objectives are to maintain in the range, variety and quality of the habitat.

SNH have noted that Scottish Power Renewables have already conducted a broad scale seabed mapping survey of the Sound of Islay and would appreciate sight of this to aid in developing further advice we provide on this case. SNH would expect the seabed survey to have identified and mapped any UKBAP habitats and species in the Sound to at least a low resolution.

SNH have advised that if UKBAP habitats and species have been identified in the general vicinity of the proposed final turbine location SNH may require a further more detailed seabed survey to aid in decision making on the overall suitability of the site and mirco-siting of the turbines. SNH can advise on the appropriate methodology for this survey if required.

Species : Plants and Animals

The ES needs to show that the applicants have taken account of the relevant wildlife legislation and guidance namely, 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

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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, before 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.

Plants

SEPA have advised that they welcome the fact a full Phase 1 habitat survey will be undertaken, which will flag up any further work required via target notes and if necessary a more detailed Phase 2 survey. Having a full National Vegetation Classification (NVC) survey undertaken would also greatly contribute to NVC coverage of Scotland where gaps still exist in the geographic distribution of sampling. One of the locations where gaps exist is either side of the Sound and coverage of these coastal, transitional environs would assist in the move towards a more complete classification for Scotland and this application presents a good and timely way to plug this lacuna.

SEPA have advised that Lichens and relict ancient or semi-natural woodlands are the main terrestrial issue that the report highlights and often very important lichens, those which are indicators of long undisturbed conditions are found as a component of these woodlands, in this location possibly coastal woodland species or species of sheltered ravine. Those same habitats that are vital to lichens are also important for bryophytes and SEPA encourages a full lower plant survey (lichens and bryophytes) of the proposed land based work site and its surrounds. Some species will thrive in specific niches provided by the tidal and splash zone conditions or in sheltered rocky clefts so caution and good surveys should be undertaken if the proposed application, short term construction elements and associated infrastructure could impact on these types of habitats.

SEPA have advised that they also expect this development to identify opportunity to improve ecological interests within the site and surrounding area in line with the Local Biodiversity Action Plan (LBAP) both for the terrestrial and marine environments. For example, habitat restoration/remediation on part of the site or debris removal from the shoreline should be explored.

FRS have advised that the Sound of Islay is in an area with large Algae and red seaweed accumulation and wish to know, with the strong currents pulling these down the tidal stream, will the device be endangered by entanglement.

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Birds

RSPB have advised that the Sound of Islay provides a habitat for a variety of bird species; those potentially most at risk are 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 are vary seasonally. Those species most likely to be impacted would include black Guillemot, Guillemot, Razorbill, Cormorant and Shag, Eider, Common Scoter, Great and Red Throated Divers. Black Guillemots occur within the area at relatively low densities and may potentially be affected on a local scale through displacement and collision. The EIA should consider the placement of suitable nest structures away from the development area as a potential mitigation measure.

RSPB have advised that it is noted in considering potential impacts from contamination via leakage from the structure that no mention is made of the likely quantities of oil/anti-fouling 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 impact 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 structure free of growth.

RSPB have advised that the EIA and subsequent mitigation/post proliferation may also wish to consider what opportunities there are to enhance the area as a wildlife resource. Installation of false reefs combined with a no-take (trawl/dredge) area, for example between the structures, may benefit marine life and act as a nursery ground for breeding fish species. There may be potential to expand this to support a sustainable coastal and marine management zone.

RSPB have advised that in considering the potential layout a very standardised pattern is given (256-544m by 320-680). However, data on the Sound of Islay suggests it is relatively shallow with a deeper trench. An early attempt to show a more realistic layout based upon the bathymetry and water depth would be welcomed.

SNH confirm they do not consider that the proposed development is likely to have any effect on seabird populations within any sites designated for nationally or internationally important colonies of seabirds. Whilst not required for any SPA (or SSSI) bird species, SNH does advise that it would be helpful if the EIA for this demonstration Tidal Site still considered potential impacts on seabirds. Such a study may be invaluable for future projects if the developer wishes to propose a development in an area that is used by SPA and/ or other sensitive bird species.

SNH have advised that the Sound of Islay could be an appropriate location for carrying out such a study as it is a site which is relatively easily monitored given

the proximity of its two coastlines, and it could be relatively easily modelled given the bi-polar direction of tidal flow. The developer could use this site to gain an understanding of the interactions between marine renewables developments and seabirds: the nature and significance of impacts (or, indeed, whether there are any impacts).

SNH have advised that sources of information which could inform such a study include:

JNCC"Seabirds at Sea"
http://www.jncc.gov.uk/page-1547

JNCC"Seaduck Survey Programme"
http://www.jncc.gov.uk/page-1551

And of particular help, with reference to the Sound of Islay, may be the most recent seaduck survey report (available from the latter web-page):

Lewis, M., Wilson,L.J.,Sohle, I.,Dean,B.J.,Webb,A.and Reid,J.B. (2008). Wintering sea ducks, divers and grebes in UK inshore areas: Aerial surveys and shore based counts 2006/7. JNCC Report, no.414.

We also recommend that the developer discusses the issue with Tim Dunn at JNCC. The office address and his email address are as follows:

JNCC
Dunnet House
7 Thistle Place
Aberdeen
AB10 1UZ
Telephone: 01224 655704
Email: tim.dunn@jncc.gov.uk

Mammals

FRS have advised that as these turbines actually come into direct contact with the marine environment consequently the impacts associated with Seal and Otter collision maybe extremely high, therefore it is SNH who will advise FRS on any conditions that should be stipulated on the FEPA licence.

SNH have advised that the following European Protected Species (EPS) occur on passage or feeding in the Sound of Islay. common dolphin (Delphinus delphis), bottlenose dolphin (Tursiops truncatus), Risso's dolphin (Grampus griseus, Atlantic white sided dolphin (Lagenorhynchus acutus), white beaked dolphin (Lagenorhynchus albirostris), harbour porpoise (Phocoena phocoena), killer whale (Orcinus orca) and minke whale (Balaenotera acutorostrata). Pilot whales (Globicephala melas) and humpback whales (Megaptera novaengliae) are also occasional visitors. Otter (lutra lutra) can be found along the coast on both Islay and Jura.

SNH have advised that EPS are given protection under the Conservation Regulations 1994 (as amended). This means it is illegal to:

deliberately kill, injure, disturb or capture/take European Protected Species.
damage or destroy the breeding sites or resting places of such animals.

SNH have advised that it does not have to be deliberation, reckless or intentional for an offence to have been committed. Where it is proposed to carry out works which will affect EPS or their shelter/breeding places, whether or not they are present, a licence is required from the licensing authority. Further information on EPS and development can be found in the former Scottish Executive document European Protected Species, Development Sites and the Planning System: Interim guidance for local authorities on licensing arrangements (October 2001 via the Scottish Government publications website:

http://www.scotland.gov.uk/library3/environment/epsg.pdf

SNH have advised that as highlighted in the Interim Guidance, three tests must be satisfied before the licensing authority can issue a licence under Regulation 44(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) to permit otherwise prohibited acts. An application for a licence will fall unless all of the three tests are satisfied. The three tests involve the following considerations:

Test 1 – The licence application must demonstrably relate to one for the purposes specified in Regulation 44(2) (as amended). For development proposals, the relevant purpose is likely to be Regulation 44(2) for which Scottish Government is currently the licensing authority. This regulation states licences may be granted by Scottish Government only for the purpose of " preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment".

Test 2 – Regulation 44(3)(a) states that a licence may not be granted unless Scottish Government is satisfied "that there is no satisfactory alternative".

Test 3 – Regulation 44(3)(b) states that a licence cannot be issued unless Scottish Government is satisfied that the action proposed "will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range" (Scottish Government will, however, seek the expert advice of Scottish Natural Heritage on this matter).

SNH have advised that consideration of EPS must be included as part of the planning application process, not as an issue to be dealt with at a later stage. Any planning consent given without due consideration to these species is likely to breach European Directives with the possibility of consequential delays or the project being halted by the EC, as has happened previously

SNH have advised that the application should establish the distribution and usage of the Sound of Islay by marine mammals (cetaceans and seals) and basking sharks. We advised that fieldwork will be required in addition to a literature and desk-bases work. For this, the applicant should contact the Sea Mammal Research Unit (SMRU) for advice on appropriate survey methods. We envisage that a minimum of one years' survey data will be required to adequately ascertain usage of these areas by marine mammals and basking sharks, and we request that we are given the opportunity to review and comment upon the programme before it is formally approved. The relevant person at SMRU is:

Prof Ian Boyd
Sea Mammal Research Unit
Gatty Marine Laboratory
University of St Andrews
St Andrews
Fife
KY16 8LB

SNH have advised the results of a field survey should then be considered by the application in combination with their literature review in order to establish the probability and significance of marine mammals and basking sharks colliding with the proposed tidal turbines. We suggest that the applicant may wish to discuss approaches for ascertaining this with Dr Ben Wilson of the Scottish Association of Marine Science (SAMS) in Oban

The Scottish Association for Marine Science
Dunstaffnage Marine Laboratory
Oban
Argyll
PA37 1QA

SNH have advised that there is a potential for construction work to disturb seal at their haul out sites particularly during pupping and moulting. Disturbance during pupping can effect the survival rate of pups since entering the water more than necessary increases energetic demand. SNH advise that Scottish Power Renewables assess the potential for distribution at South east Islay Skerries SAC depending on the method of installation of the turbines and the proximity of the final location of the development to the seal haul out. Mitigation to prevent disturbance may include avoiding the following sensitive periods for common seal: pupping, end of June to mid-July and moulting, mid-August to early September.

Reptiles, amphibians

A baseline survey of the species and number of reptiles and amphibians present on the site should be undertaken. Particular attention should be paid to specially protected and/or vulnerable species, especially European Protected species, and those potentially affected by the development

Fish

SNH have advised that Common Skate (Raja batis) is a UKBAP species and a population in Argyll may be some of the last of this species remaining in the UK. SNH would like to see this species taken into account in the seabed mapping work (any egg cases present) and any investigation into the effects of electromagnetic fields.

SNH have advised that Basking Sharks (Cetorhinus maximus) are seen in the Sound of Islay and there is a risk of collision with this species during installation and operation. Basking sharks are a UKBAP species and it is illegal to kill, injure or recklessly disturb basking under Schedule 5 of the Wildlife and Countryside Act (1981). Work by SNH/Colin Speedie on "hotspots" for basking sharks is due to be published shortly. This work will provide an indication of the number of basking sharks in the Sound of Islay and therefore the risk of collision with boats during construction and turbines during operation. We do not at present expect the Sound of Islay to emerge as a basking shark 'hotspot'; however we advise that the application includes them as a target species in undertaking survey work as set out in the following section.

Invertebrates

A baseline survey of invertebrates present on the site and in the waterbodies and watercourses on and around the site throughout the year should be undertaken. This should be guided by existing information on the presence, distribution and abundance of notable invertebrates. Sampling of aquatic invertebrates should extend to watercourses which may be affected by run-off from the site during construction, operation or decommissioning. Particular attention should be paid to specially protected and/or vulnerable species, especially European Protected species, and those potentially affected by the development.

Sub-tidal benthic ecology

SEPA have advised that in relation to Benthic ecology and the comments made above regarding Table 8, it is recommended that these two situations should be ruled as 'Effect significance unknown at this stage until further data collated and assessed' and that further consideration of benthic ecology is required.

SEPA have advised at present the freshwater impacts are considered mainly under the Fish and Shell Fish sections of the Scoping Report in the context of effects in migratory (Fish and Shell Fish sections of the Scoping Report in the context of effects in migratory (fish (lampreys - if present), non-migratory fish and other components if the freshwater biota be considered too.

SEPA have advised that there will be considerable works both onshore and offshore. The assessment should assess both marine and terrestrial interests. Assessment of the potential impacts on the intertidal habitats and species found along this stretch of coast should be based on a suitable survey. Assessment of terrestrial impacts upon the water environment and associated habitats and species vulnerable to damage and measures that can be put into place to minimise impacts upon them. Further guidance on appropriate surveys should

be sought from SNH. It is vital that any survey, impact assessments and mitigation, if required, are carried out appropriately for the species or habitat in question. Walk over surveys are important in gathering information but these need to be undertaken at the appropriate time of year and time of day depending on the species in question.

10. 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. You may be required to obtain from SEPA an authorisation under the terms of the Water Environment (Controlled Activities) Regulations 2005 for some aspects of the development.

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.

SEPA have advised that dependant on the historical use of the sites on the route an assessment may need to consider whether land contamination is present on the sea bed or land.

SEPA have advised that advice from the Argyll and Bute Council, who takes the lead on other land or sea bed contamination issues, should be taken into consideration when deciding upon the scope and level of detail of the assessment on other contamination issues. SEPA understands that the Local Authority can consult with SEPA as necessary about pollution of the water environment. In this regard, SEPA would be happy to advise the Local Authority as required.

There are a number of designated shellfish waters in that area (Islay, Loch Gruinart; Colonsay; Linne, Mhurich; Loch Stornoway and Keills, Knapdale; Leaft Loman's Bay and Small Isles, Jura) Their designation under the Shellfish Water Directive (2006/113/EC) which requires that chemical and microbiological quality standards are met in order to protect human health.

SNH have advised that the applicant will also need to consider impacts, if any, arising through construction activity and the probability and significance of the proposed array presenting a barrier - whether due to noise, turbulence or physical presence – preventing or discouraging the passage of cetaceans, seals and or basking sharks through the Sound. We advised that, in their assessment, the applicant should identify appropriate mitigation for any such effects which appear, potentially, significant. Because of the potential for underwater noise arising through operation of the turbines to cause disturbance or displacement we endorse the proposal set out in the Request for a Scoping Opinion to conduct further research on this issue. We suggest that in addition ambient noise is measured within the Sound in order that the sound generated through device operation may be placed in context.

SNH have advised that, as this proposal is for a demonstration array, it will be importance for the applicant to validate their predictions of collision risk and displacement through post-construction monitoring. SNH will therefore be advising that a requirement for relevant post-construction monitoring should be a condition of any consent for this proposal. We consider that the information

yielded by such monitoring work will be very important in considering the potential impacts of such tidal turbines and in informing further proposals by the applicant for such arrays, here or elsewhere, in the future. SNH recommend that liaison with SMRU to determine the most appropriate approaches to such monitoring and request that SNH be given the opportunity to review and comment upon the programme before it is agreed and implemented.

SNH have advised that the applicant refers to the collision risk report prepared as part of that more general work programme for the SEA. This can be found at:

http://www.seaenergyscotland.net/public_docs/Appendix%20C7.B%20Collisions_report_final_12_03_07.pdf

Apart from these, there is a wealth of data on marine species distribution available through BERR's Offshore Energy SEA website, specifically the reports relating to the SEA 7 Area.

Hydrology and Hydrogeology

The ES should contain detailed statements of the nature of the hydrology and hydrogeology of the site and of the potential effects the development on these. Developers should be aware that Tidal Sites will have considerable construction implications and these can be conducted without proper regard or understanding of the potential impacts on hydrology, water courses, water quality, water quantity and on aquatic flora and fauna. The assessment should include statements on the effects of the proposed development at all stages on;

- Hydrology
- Water Quality and quantity
- Flood Risk

Impacts on watercourses, lochs, groundwater, other water features and sensitive receptors, such as water supplies, need to be assessed. Measures to prevent erosion, sedimentation or discolouration will be required, along with monitoring proposals and contingency plans.

The applicant should refer to SEPA policy on groundwater which can be found at www.sepa.org.uk/pfd/policies/19/.pfd which will assist in identifying potential risks. It should also be noted that 1:625000 groundwater vulnerability map of Scotland often referred to in Environmental Statements has been superseded by the digital groundwater vulnerability map of Scotland (2003) and the digital aquifer map of Scotland (2004) and it is the information used on these newer maps, available on request from SEPA, that should be used in any assessment.

If culverting should be proposed, either in relation to new or upgraded tracks, then it should be noted that SEPA has a policy against unnecessary culverting of watercourses. Schemes should be designed to avoid by preference crossing watercourses, and to bridge watercourses which cannot be avoided. Culverting is the least desirable option.

The ES must identify all water crossings and include a systematic table of watercourse crossings or channelising, with detailed justification for any such elements and design to minimise impact. The table should be accompanied by photography of each watercourse affected and include dimensions of the watercourse. It may be useful for the applicant to demonstrate choice of watercourse crossing by means of a decision tree, taking into account factors including catchment size (resultant flows), natural habitat and environmental concerns.

Culverts are a frequent cause of local flooding, particularly if the design or maintenance is inadequate. The size of culverts needs to be large enough to cope with sustained heavy precipitation, and allow for the impact of climate change. This must be taken into account by developers and planning authorities. SPP7 and PAN69 provide more information on this aspect.

Measures to avoid erosion of the hillside associated with discharge from road culverting need to be set out in the ES.

All culverts must be designed with full regard to natural habitat and environmental concerns. Where migratory fish may be present (such as trout, salmon or eels) the culvert should be designed in accordance with the Scottish Government guidance on River Crossings and Migratory Fish. This guidance can be found on the Scottish Government website at: www.scotland.gov.uk/consultations/transport/rcmf-05.asp

Where the watercourse is used as a pathway by otters and other small mammals, the design of culverts will need to be modified to accommodate this.

The need for, and information on, abstractions of water supplies for concrete works or other operations should also be identified in the ES.

SEPA have advised that the key interest in relation to this development is pollution prevention during the periods of construction, operation, demolition and restoration. All aspects of site work that might impact upon the environment (both marine and terrestrial), proposed prevention and mitigation measures, and an assessment of residual impact, need to be addressed systematically throughout the ES. Such information is necessary in order to assess the environmental impact of the proposals prior to determination and can also usefully provide the basis for more detailed method statements which may be requested as conditions.

SEPA have advised that the production of work method statements will be essential in ensuring pollution prevention measures are fully implemented and that above information should form a basis for these. These work method statements will relate to any site construction, site operation and maintenance (including transport, cable burying, oil storage etc.) and site restoration.

SEPA have advised that during both the construction and operational phases it is vital that good working practice is adopted and the appropriate steps taken to prevent water pollution and minimise disturbance to sensitive receptors. It is SEPA's experience that well planned operations can still give rise to problems

due to the use of sub-contractors who are not aware of site specific concerns or are inadequately managed.

SEPA have advised that particular care needs to be taken to ensure particulate or chemical contamination of the water environment will not occur due to conservation and water quality issues, for example management of sea water ingress or dewatering of excavations. Any proposed discharges should be set out and dilution data provided. Sensitive uses including private water supplies and abstractions and any impacts needs to be assessed. Some interests of the water environment such as protected species are particularly vulnerable to pollution. SEPA advises that there may be an impact upon marine water quality from various elements, for example discharges from vessels or the turbines themselves, anti-foulant chemicals, hydraulic fluids, oil, storage, dredgings and sediment disturbance. For the avoidance of doubt the ES should included a profile diagram of how the sea floor will appear post construction. For example will the cables be buried under the existing sea floor or will it be placed under imported materials? In addition, the use of any chemicals such as low toxicity drilling mud and any discharges should be included.

SEPA have advised that within the terrestrial environment risks from sediment and mineral oils such as those associated with operations including stockpile storage, storage of weather sensitive materials at lay down areas, haul routes, access roads, earthworks to provide landscaping, mechanical digging of new or existing drainage channels, vehicle access over watercourses, construction of watercourse crossings and digging of excavations (particularly regarding management of water ingress) should be assessed. Details of any permanent surface water drainage from elements such as access roads or roof water should be included within the ES.

SEPA have advised that the ES should specifically address any issues to fuel transport and storage management. There are issues of whether addition to designated bunded fuel stores there are to be mobile bunded stores, whether or not auxiliary power supplies are required in relation to excavation machinery which may require fuel storage or whether fuel storage for vessels is required. Maintenance of machinery can involve usage of oil and oil management needs to be considered. Details of any transformer area bunding at substations should also be submitted. SEPA would prefer to see the establishment of a site compound to avoid having fuel and other chemicals stored at numerous locations along the route. Maintenance of vehicles and plant should be carried out only on impermeable areas where any oil spillage can be contained. With regards to oil, it is imperative that there is a detailed contingency plan to deal with large oil spills that cannot be dealt with at a local level. Information should be provided on if oil-cooled power cables are to be used (in which case contingency measures for rapid response to burst cables should be set out).

SEPA have advised that another aspect that needs to be specifically addressed is working arrangements in relations to concrete production. If there is to be a concrete batching plant, then SEPA would expect this element to be developed and measures to prevent discharge to watercourses set out in detail. Potential requirement for authorisation for the concrete batching process should be discussed at an early stage with SEPA. Measures to avoid pH impact on peatland from use of cement/concrete (e.g. use of blinding cement on roadways, wash-out during construction, integrity of shuttering) should be set out. Further details on the use of this and any pollution prevention measures should be detailed within the ES.

SEPA have advised that on similar projects applicants have proposed to install temporary vehicular access to landfall points and along whole cable routes. SEPA requests that the location, design details and construction methods for all permanent and temporary access routes are detailed within the ES.

SEPA have advised that if there are to be hardstanding pads associated with cabling, then clarification is needed as to whether they will be removed and ground reinstated or if they are to be retained for future maintenance works. The ES should clarify this and assess impact.

SEPA have advised that it is assumed that on land facilities for workers will be required. Proposed temporary and long term welfare arrangements for workers on land need to be set out including whether sub-stations will incorporate foul drainage facilities. Reference can be made to SEPA's guidance note PPG4 'Disposal of sewage where no mains drainage is available'. In addition the applicant should refer to Pollution Prevention Guidance Note 14 ' Marinas and Craft'. Information on what waste facilities would be represent for vessel disposal of foul drainage should be provided. If sites lie within EC designated waters where water quality is of considerable importance then it would be essential that vessels do not discharge foul drainage directly to these waters but make use of shore facilities.

SEPA have advised that is it unclear how fault repairs on the cables or turbines will be carried out. SEPA requests that details of how pollution risks will be minimised during an emergency repair works are contained within the ES.

SEPA have advised that the proposed lifetime of the project is 27 years. SEPA requests details of how the site will be restored or renewed are included within the ES.

SEPA have advised that on similar projects they have found various construction methods are referred to which consenting bodies may have limited experience of assessing. For example the use of water jetting technology, trenching, cable armouring. SEPA advises that the ES provides detailed explanations of the proposed construction methods including detailed drawings, plans and photos. This will enable all interested parties the opportunity to provide meaningful comments when assessing the ES

SEPA have advised that the need to plan the works in order to avoid construction of roads, dewatering of excavations and other potentially polluting activities during periods of high rainfall is important. The ES needs to demonstrate which periods of the year would be best practice for construction for the site, taking into account need to avoid pollution risks and other environmental sensitivities affecting timing.

SEPA have advised that the proposals for onshore cabling, access tracks and facilities such as construction compounds. Schemes should be clearly designed to avoid impacts upon the water environment and therefore SEPA's preference

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would be for watercourses to be avoided where possible. National Planning Policy Guidance 14 ' Natural Heritage ' Paragraph 55 states Lochs, ponds, watercourses and wetlands are often both valuable landscape features and important wildlife habitats, and planning authorities should seek to safeguard their natural heritage value within the context of a wider framework of water catchment management.

SEPA have advised that where watercourses cannot be avoided they should be bridged (either traditional style bridge or arched culvert) or directional drilled for larger watercourses. SEPA provides guidance on watercourse crossings which can be found at

http://www.sepa.org.uk/pdf/wfd/guidance/engineering/WAT-SG-25.pdf.

Culverting is the least desirable option. If culverting should be proposed then it should be noted that SEPA has a policy against unnecessary culverting of watercourses.

SEPA have advised that the ES must identify all watercourse crossings and include a systematic table of watercourse crossings or channelising, with detailed justification for any such elements and design to minimise impact. The table should be accompanied by photography of each watercourse affected and include dimensions of the watercourse. It may be useful for the applicant to demonstrate choice of watercourse crossing by means of a decision tree, taking into account factors including catchment size (resultant flows), natural habitat and environmental concerns including water supplies, fisheries, FWPM and otters, Where the watercourse is used as a pathway by fisheries, otters and other small mammals, the design of culverts will need to be modified to accommodate this.

SEPA suggest culverts are a frequent cause of local flooding, particularly if the design of maintenance is inadequate. The size of culverts needs to be large enough to cope with sustained heavy precipitation, and allow for the impact of climate change. This must be taken into account by developers and planning authorities. Scottish Planning Policy 7 'Planning and Flooding' and Planning Advice Note 'Planning and Building Standards Advice on Flooding' 69 provide more information on this aspect.

SEPA have advised if any water engineering is proposed as part of the development then the applicant should note the regulatory advice contained below under The Water Environment (Controlled Activities)(Scotland) Regulations 2005 (CAR).

SEPA have advised that the proposals for on-shore facilities should be in line with Scottish Planning Policy 7 'Planning and Flooding', SEPA would expect the sites to be assessed for flood risk from both coastal and fluvial sources. If a flood risk is identified then a Flood Risk Assessment should be carried out in line with guidance in SPP7 Planning and Flooding.

SNH have advised that since the tidal flow at the Sound of Islay is relatively simple, and they are not aware of any sensitive benthic habitats in the vicinity of proposed development, expected changes to waterflow and sedimentation are

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to be minimal and insignificant. However, as in paragraphs 8.2 and 8.3 of the SNH scoping response, other studies might be conducted at the Sound of Islay that could prove invaluable for informing developments of similar Tidal Sites in other sites, more sensitive to changes in waterflow and sedimentation, specifically:

> Establishing the zone of seabed or shoreline affected by modifications to water flow, modelling the changes to sedimentation or erosion that will result and predicting the implications of this habitat distribution.

11. Other Material Issues

Waste

SEPA state that Paragraph 51 of the Scottish Planning Policy (SPP10) on Planning for Waste management promotes the use of Site Waste Management Plans (SWMP) with all new applications. This will ensure that building materials are managed efficiently, waste is disposed of legally, and that material recycling, reuse and recovery is maximised; by implementing a SWMP sites are likely to benefit form a reduction in waste arising and associated costs. SEPA advises the applicant to prepare a site specific site waste management plan (SWMP) during the formulation of the ES. It is unclear the extent of the on-shore works so not all of these comments may be relevant. The applicant should determine their relevance in the context of the proposals put forward.

In order to comply with National Waste Strategy, SEPA advises that the applicant identifies all of the waste streams (such as peat and other materials excavated in relation to infrastructure) associated with the works detailing measures for handling, managing and minimising the waste produced. The SWMP should also include a soils balance carried out to demonstrate need for importation/export of materials including any backfill of excavations.

SEPA have advised that consideration be given to the possibility to recycled or reprocessed waste soils into a form that allows them to be reclaimed as a secondary raw material. The production and use of secondary aggregates is encouraged. Given experience on other sites, clarification is sought specifically on whether or not waste material is to be imported. Clarification of the amount of any surplus materials to be permanently deposited in mounds and scale of these mounds should also be included.

SEPA have advised that the reuse of demolition and excavation materials is encouraged and the Waste and Resources Action Programme (WRAP) provides information on recycled materials and products (www.aggregain.org.uk). The reuse of construction and excavation material on the application site in encouraged for example, for landscaping and screening purposes.

SEPA have advised that any proposals for reuse or recycling of materials, such as soils from other sites, may require to be registered with SEPA under a Waste Management Exemption or license and the advice of SEPA regulatory staff should be sought in all cases. There are specific criteria which, if met, will

constitute an exemption from licensing. more information on these exemptions can be found on SEPA's website at www.sepa.org.uk/regulation/waste/exemptions.htm or sought from the local SEPA office.

SEPA advise it should it be proposed that peat should be used at depth to restore excavations such as borrow pits, the applicant would need to demonstrate that this could be done without the release of carbon through oxidisation and without risk to people and the environment. SEPA have advised that waste peat or soil from excavations spread on this land would not necessarily be to ecological benefit; if excavated peat or soil is to be used in landscaping the site, then this should be included in the plans, and not dealt with in an ad-hoc fashion as it arises.

SEPA have advised that the assessment should consider any proposals to transport refuse from the cable laying vessels to shore for treatment and disposal. This should include consideration of opportunities segregation of this waste and where possible waste should be recycled once transported to shore. Further details can be found in Pollution Prevention Guidance Note No.14 'Marinas and Craft'.

Further information on the preparation of these plans can be obtained from Envirowise (www.envirowise.gov.uk/scotland) or the Department Energy and Climate Change

www.constructingexcellence.org.uk//resources/publications/view.jsp?id=2568;

or the Net Regs website (www.netregs-swmp.co.uk). The applicant should also note the regulatory advice attached.

SNH advise the ES should include a risk assessment detailing the types and volumes of possible contaminants which may be released at any point during the lifespan of the proposed development. This should include possible contaminants from vessels used during installation and maintenance as well as from turbines themselves. It should also include information on mitigation measures should an accidental spill occur, detailing how this would be controlled and cleaned up.

Noise

There is the potential for noise to be an issue during the construction of the Tidal Site. Noise predictions should be carried out to evaluate the likely impact of noise from the Tidal Site and associated construction activities.

The Royal Yachting Association have advised that an assessment of what the visual and noise impacts would be and whether these may deter visitors to the area.

FRS have advised that installation of the Subsea cabling may require trenching or piling which will contribute to the underwater noise elements, during the construction particularly when encountering bedrock. These methodologies need to be discussed further in the ES. other offshore activities have been licensed in the past through FEPA that involved dredging, trenching and piling of bed rock it may be that a condition would be set on the licence to mitigate against potential impacts e.g. time restrictions through seal breeding. Presence of suitably trained marine mammal observer.

FRS also state that underwater noise generated during construction of the Tidal Site or the actual operation of the turbines and the potential to impact on the marine environment is not considered in the scoping opinion. Background noise in the marine environment surrounding the Sound of Islay will be substantial due to the ferries and the wave element, but the construction will have an impact and should be described in context.

Traffic Management

The Environmental Statement should provide information relating to the preferred route options for delivering components for the scheme 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.

The Northern Lighthouse Board have advised that the impact on both lifeline ferry services and the marine transport system in general should be considered

FRS advised that the size of Port Askaig has to be considered as the devices are arriving at the site by sea, vessel accumulation due to the arrival/maintenance of these devices will have to be pre-approved.

Navigation

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

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

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The Northern Lighthouse Board have advised that the impact of this development on Marine Navigation with regard to all classes of vessel in the constricted waters of the Sound of Islay should be considered of high significance within the Environmental Statement. Such impacts will be of a temporary nature during deployment, maintenance and decommissioning of the project, but will also be long lasting with respect to hazards attached to the operation of tidal energy devices.

The Northern Lighthouse Board have advised that full consultation for this project should also be undertaken via the Coast Protection Act 1949: Section 34 process, which should include the submission of a full Navigational Risk Assessment and Marine Traffic Survey where appropriate. Thereafter on receipt of the Section 34 Application, Northern Lighthouse Board will advise on any temporary or permanent navigational lighting or marking, which may be required during the construction, installation and operational phases of the proposed development.

The Chamber of Shipping have assumed that there will be sufficient underwater clearance between the top of the rotor blades and the underside of ships (ferries) which routinely ply the routes through the Sound of Islay so as not to present a hazard at all. In this it is assumed that the mass concrete foundations will be sufficiently robust to prevent any units breaking away.

The Chamber of Shipping have advised that while the actual site, at its extremities, covers most of the Sound of Islay, they would ask you to note that when ferries are berthing and departing from Port Askaig they need plenty of sea room because of the need to take into account the strong tidal currents present and the hazard/difficulty this presents to ships. Any navigational hazard, however temporary which restricts the ships freedom to manoeuvre in the area around Port Askaig must be avoided.

The Maritime and Coastguard (MCA) Agency have advised they see no reason why the navigation review in the Scoping Report be limited to vessels over 100 tonnes.

The MCA have advised that the Navigational Risk Assessment will be expected to comply with the recommendations in MGN 371 (Formerly MGN 275) and the developers will be expected to comply with the requirements in those references above as applicable to the development.

The MCA have advised that while the turbines will be in depths of 40 metres, the height to blade tip above the seabed is given as 30-39 metres will present a danger to surface navigation and the statement that potential effects during operation are not anticipated is questioned.

The MCA have advised that the main potential effects, in table 8, on Commercial Fisheries and Marine Navigation should be commensurately reflected in the EIA which should include recreational craft in the Marine Navigation section.

The MCA have advised that concerns over the use of weights being docked to the footings of the structure and the security of these devices. Additionally they

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have concerns over the use of nitrogen or air in the nacelle and the subsequent behaviour of any detached turbine.

Argyll and Bute Council have advised that in relation to the assessment of potential impacts on Maritime Navigation, it may be useful to contact Operational Services, Argyll and Bute Council (Martin Gorringe) in relation to the potential use of Argyll and Bute Council piers and consideration of the Council's Oil Spill Contingency Plan.

The Royal Yachting Association (RYA)have advised that an evaluation of loss of cruising routes, sailing and racing areas, both on a temporary and/ or permanent basis and estimate what the economic impact of this would be.

RYA advise that a detailed map of sailing, racing and cruising routes around the UK coast which proved to be a valuable source of information on recreational boating areas for offshore renewable developers around the UK is available from kate.moore@rya.org.uk

Cumulative Impacts

The Scottish Ministers are of the view that in assessing cumulative effects, it is unreasonable to expect this to extend beyond developments in the vicinity that have been built, those which have permission and those that are currently the subject of undetermined applications. Applicants should therefore have regard to developments within these parameters before finalising their proposals.

12. General ES Issues

In the application for consent the applicant should confirm whether any proposals made within the Environmental Statement, eg 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

Argyll and Bute Council have advised that in addition to the proposed list of consultees in Appendix A, the following stakeholders should also be considered as consultees:

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Commercial Fisheries:
Clyde Fishermen's Association (CFA), Mallaig and North West Fishermen's Association (M&NWFA), Mull Aquaculture and Fisheries Association (MAFA).

Recreation: -
West Highland Anchorages & Moorings Association; Argyll Charter Boat Association. There are dive sites and a chartered anchorage within the Sound of Islay. The location of these interests can be found in the report – Benfield, S. and McConnell, S. (2007) 'Marine and Coastal Visitor Management, Public Engagement and Interpretation in Argyll and the Islands: the way forward.' Marine and Coastal Development Unit, Argyll and Bute Council.

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 shapefile 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

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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 considered 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
Authorised by the Scottish Ministers to sign in that behalf.

Enclosed - Developer Application Checklist

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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.

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Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 8 – Benthic Ecology.

Appendix 8.1: “SeaStar Drop Down Camera Survey Report ”

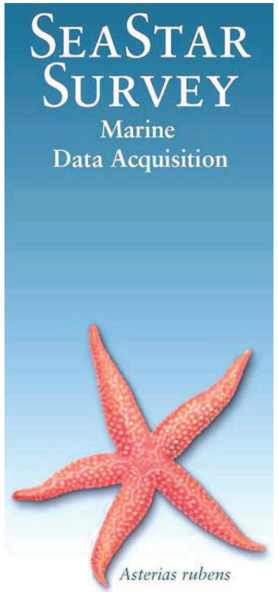
Scottish Power Renewables

Islay Demonstration Tidal Array - Site Surveys 2009

Drop-down camera survey report

Axelsson, M.B.

August 2009



Seastar Survey Ltd, Ocean Quay Marina, Belvidere Road, Southampton, SO14 5QY
Tel/Fax: 023 8063 5000 Email: info@seastarsurvey.co.uk

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APPENDICES

1 INTRODUCTION

1.1 Project background

Renewable energy is an integral part of the UK Government's longer-term aim of reducing carbon dioxide emissions by 20% by 2020 (BERR, 2008; 2009). In November 2007 the Scottish Government set a target to generate 50% of Scotland’s electricity from renewable sources by 2020, with an interim target of 31% by 2011 (Scottish Government, 2007).

ScottishPower Renewable Energy Limited (also referred to as ScottishPower Renewables or SPR) is proposing to develop a site in the Sound of Islay, Scotland. The site will be a ‘Demonstration Tidal Site’ and will be one of the first for the demonstration tidal device. The proposed Tidal Site will generate energy produced during the tidal cycle and will have a capacity to generate up to approximately 10 MW of renewable power for export to the grid. The energy produced would be from tidal power and would contribute to meeting the Scottish Governments targets of providing 50% of Scotland’s energy generation from renewable sources by 2020 (SPR, 2008).

The seabed mounted turbines to be installed in the Sound of Islay are based on a 300 kW prototype marine current turbine (see figure 1) designed by Hammerfest Strøm installed in Kvalsund in Finnmark, Norway (Hammerfest Strøm, 2009). The turbines will comprise a tripod-base support structure (20 m in height), modular nacelle, hub and blades resulting in the hub being 22 m above the seabed (SPR, 2008). The tidal devices will generate electricity by converting the kinetic energy produced during the tidal cycle and electricity will be produced in both directions of water flow.

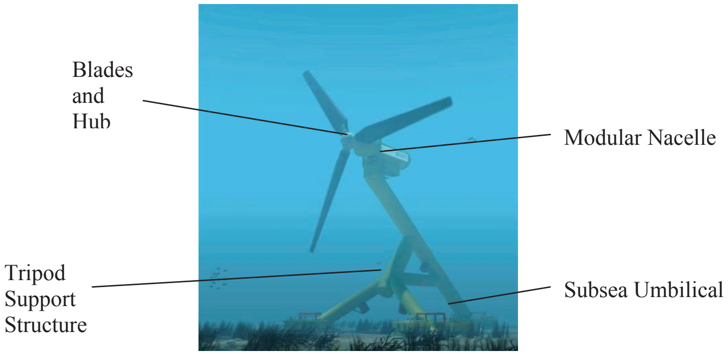


Figure 1. Graphical representation of the 300kW tidal device developed by Hammerfest Strøm, installed in Kvalsund in Finnmark, Norway (SPR, 2008).

1.1.1 The drop-down camera survey – habitat mapping

Seastar Survey Ltd was contracted by Scottish Power Renewables (SPR) to conduct a habitat mapping and ground-truthing survey using a drop-down video and still photography camera system in the Sound of Islay, Scotland. The survey was part of an Environmental Impact Assessment (EIA) for the deployment of ten commercial demonstration tidal devices in the Sound of Islay.

The main objective of the habitat mapping survey was to establish the characteristics of the seabed communities within the potential areas of device deployment and subsea cable routing. The aims of the habitat mapping survey were to fully describe the survey area in terms of the physical composition, distribution and extent of interesting features and its biotope and species composition as far as possible as well as confirming the presence, status and extent of the potential maerl beds and other UKBAP species and habitats. The survey was also meant to allow ground-truthing of existing sidescan sonar data by confirming the iX Survey sidescan sonar interpretation (carried out in a previous phase of the project by iX Survey) from the Sound of Islay using the drop-down video and stills camera seabed footage.

1.1.2 Survey location

Islay is the most southerly island of the Inner Hebrides in Scotland and is separated from the neighbouring island of Jura by the Sound of Islay (figure 2). The Sound is a narrow, deep channel approximately 1 km wide (figure 2) and reaches over 60 m in depth at the deepest point (figure 3). The deepest part of the Sound is located towards the centre, between Jura and Islay. The proposed location (figure 3) for the installation of the tidal devices is in the central and northern part of the Sound of Islay, in water deeper than 48 m.

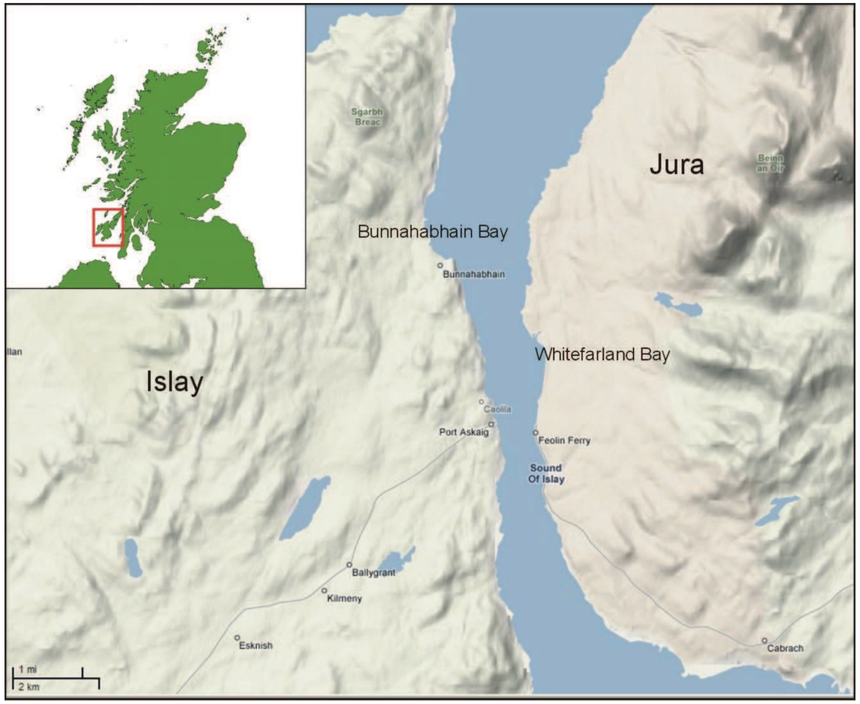


Figure 2. The Sound of Islay between the islands of Islay and Jura (courtesy of Google Maps ©).

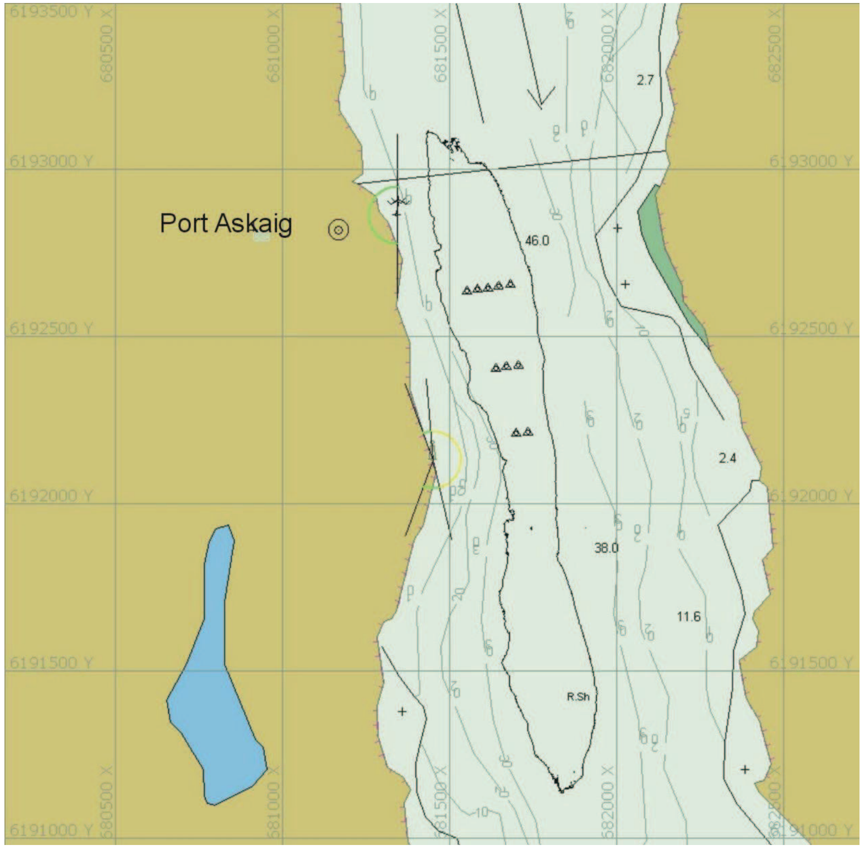


Figure 3. Proposed location for the tidal devices in the Sound of Islay (the 48 m contour shown in black and the proposed turbine sites (black triangles) within the 48 m contour).

1.2 The benthic environment of the Sound of Islay

1.2.1 Physical environment

1.2.1.1 Bathymetry

The bathymetry of the Inner Hebrides is complex. The main reason for this complexity is the deepening of sea lochs and channels by scouring action of ice during the last glaciation, which created locally enclosed deeps with shallower seaward (sills) terminations (BGS, 1997; Wilding *et al.*, 2005). The Sound of Islay is mostly sheltered from wave action, but experiences strong tidal streams through the narrow channel. At the northern and southern entrances to the Sound, the seabed environment generally varies between 10 m and 20 m below chart datum (bcd). In the centre of the Sound there is a trench where the seabed depth drops to depths below 60 m.

1.2.1.2 Coastal environment

The outline of the coast around the Sound of Islay is illustrated in figure 2. The western side of the Sound of Islay is fringed by Bunnahabhainn Bay, a shallow embayment, encroaching inland onto a raised rock platform. The coast following the Sound of Islay south from Port Askaig to Ardtalla has three major components, a gradual to steeply sloping cliff with a poorly preserved raised rock platform near the base of the slope, a fossil cliff and narrow raised shoreline platform and a fringing beach of mixed sediment. This pattern is only interrupted at McArthur’s Head (located to the south of the image in figure 2) where the platform phases out, replaced by cliffs with fringing beaches at their bases, marking the southern entrance to the Sound (Ritche and Crofts, 1974). Little or no sediment material is in circulation along this coast, and waves have a negligible impact, merely causing some redistribution of the sediments within the beach and nearshore sectors (Ritche and Crofts, 1974).

The eastern side of the Sound is fringed by the coast of Jura. The characteristic Jura coastline is a rock abrasion platform which continues from below sea level to an altitude of 5 to 30 m above sea level. The Jura coast of the Sound of Islay is steep and lacks any from of coastal lowland except at Whitefarland Bay a deltaic-like gravel and shingle foreland approximately midway along the Sound of Islay (Ritche and Crofts, 1974).

1.2.1.3 Sediments

There is little available information regarding the sediment characteristics within the Sound of Islay. To the north of the Sound the seabed sediments primarily comprised of gravely sand and sand, to the south of the Sound the seabed sediments are comprised of gravely sand, sand, muddy sand and mud (BGS, 1997). Farrow *et al*. (1979) describe the seabed at the northern entrance of the Sound of Islay as areas of *Lithothamnium* (maerl) gravel (some of it live), megaripples, megarippled sand and shell gravel.

1.2.2 Biological environment

The Sound of Islay is sheltered from wave action but experiences strong tidal streams. This is reflected by the types of marine life recorded in previous surveys (Farrow *et al*., 1979; Hiscock 1983; Seasearch, 1999). The marine life typically associated with strong tidal streams is abundant in animals fixed on or in the seabed, and include soft corals, hydroids (sea firs), bryozoans (sea mats), large sponges, anemones, mussels and brittlestars in dense beds. In shallow water, bedrock and boulders often support kelp and sea oak macroalgae, which grow very long in the tidal currents, and have a variety of animals growing on them (UKBAP, 2008).

Biological information from previous surveys is limited and is largely restricted to the description of sublittoral sites in the central and northern parts of the Sound but virtually no information is available with regards to the exact positions of the survey locations. Hiscock (1983) studied seven sublittoral sites in the central and northern parts of the Sound and a single site at the south eastern entrance to the Sound but the exact positions of these sites are not given. In the centre of the Sound a kelp forest was found to extend to 15 m depth, with the biota of the underlying rock dominated by encrusting coralline algae as a result of heavy grazing by urchins *Echinus esculentus*. Rich communities of algae and sessile animals were noted on kelp stipes. Small boulders and pebbles at depths greater than 12 m were observed to support a diverse hydroid and byrozoan turf. Two of the sites in the centre of the Sound showed characteristic species of tidal narrows and sounds including *Halichondria* sp. (sponges), *Pachymatisma johnstonia* (elephant’s hide sponge), *Tubularia indivisa* (oaten pipes hydroid), *Eudendrium rameum, Sertularia cupressina* (sea cypress hydroid), *Hydrallmania falcata* (sickle hydroid), *Actinothoe sphyrodeta* (sandaled anemone), *Alcyonium digitatum* (dead man’s fingers) and *Pholis gunnellus* (butterfish).
In the northern part of the Sound along the Jura coastline, a shallow sandy seabed was recorded merging into a plain of mostly dead maerl (calcified red seaweed) and tide swept boulders between depths of 4 m and 14 m. Foliose red algae and sabellid polychaetes were noted among the associated flora and fauna (Hiscock, 1983). At the south eastern entrance to the Sound the rocky slopes were dominated by very

dense *Laminaria hyperborea* but from 4.0 m to 5.5 m were replaced by a slope of boulders and small stones dominated by *Laminaria saccharina* (sugar wrack). The species found living in the shelter of the Kelp included *Gibbula cineraria* (grey top shell) and *Anemonia sulcata* (snakelock anemone). In deeper water (9 m) a bed of maerl with estimated 10% living cover was present and between 10-11 m high densities of *Virgularia mirabilis* (slender sea pen) as the sediments became finer (Hiscock, 1983).

A Seasearch dive through the centre of the Sound of Islay revealed a seabed colonised by kelp and moderately dense horse mussels (*Modiolus modiolus*). To the south of Port Askaig a steep bedrock and boulder slope extending down to depths of over 40 m was found to be colonised by epifauna including dead man’s fingers (*Alcyonium digitatum*), boring sponges (*Cliona celata*), elephant’s hide sponge (*Pachymatisma johnstonia*), with patches of the antenna hydroid (*Nemertesia antennina*) and oaten pipe hydroids (*Tubularia indivisa*).

The Seasearch survey also indicated that many of the sites dived around Islay showed signs of having been heavily grazed by sea urchins (*Echinus esculentus*) resulting in a reduction in cover by the usual plant and animal species, which tend to be replaced by large areas of pink encrusting algae (Seasearch, 1999). This supports the findings of Hiscock (1983), a study that recorded high numbers of sea urchins in the Sound of Islay.

1.2.3 Habitats and species of ecological importance in the Sound of Islay

1.2.3.1 Habitats - tidal rapids

Tide-swept channels are included in the UK Biodiversity Action Plan (UK BAP, 2008) list of priority habitats. Under the Habitat Action Plan the term ‘tidal rapids’ is used to cover a broad range of high energy environments including deep tidal streams and tide-swept habitats. Strong tidal streams result in characteristic marine communities rich in diversity typically comprising soft corals, hydroids, bryozoans, sponges, anemones, mussels and brittle stars in dense beds. In deeper water, such as between islands, strong tidal streams may be felt down to 30 m. In shallow water, bedrock and boulders often support kelp and sea oak plants, which grow very long in the tidal currents, and have a variety of animals growing on them. Other smaller red and brown seaweeds grow on cobbles and pebbles, many of these being characteristic of tide-swept situations (UK BAP, 2008).

1.2.3.2 Species - maerl

Maerl beds are closely identified with the conditions found in tidal narrows and rapids and have been recorded in the south-west (the Fal estuary) and the north of the British Isles (Orkney Islands) (UKBAP, 2008). Maerl beds are on the UKBAP Habitat Action Plan list of priority habitats. In addition to being listed as a priority habitat on the UKBAP’s Habitat Action Plan, maerl beds are covered by four different types of Annex I habitats of the EC Habitats Directive ‘sandbanks which are slightly covered by seawater at all times’, ‘large shallow bays and inlets’; ‘estuaries’ and the priority habitat ‘lagoons’ (UK Biodiversity Group, 1999) with ‘sandbanks which are slightly covered by seawater at all times’’ being most relevant to the current study.

Maerl is the collective name for several species of calcified red seaweed. There are three species of maerl in the UK, *Phymatolithon calcareum*, *Lithothamnion glaciale* and *Lithothamnion corallioides* with *Phymatolithon calcareum* (near Port Ellen) and ‘*Lithothamnion* gravel’ (at northern entrance to the Sound of Islay) recorded in a previous study in the Sound of Islay (Hiscock, 1983). Maerl grows as unattached nodules on the seabed and under favourable conditions can form extensive beds. Maerl is slow growing but over long periods its dead calcareous skeleton can accumulate into deep deposits (an important habitat in its own right), overlain by a thin layer of pink living maerl. Maerl beds form an important habitat for a wide variety of marine plants and animals which live amongst or attached to the maerl or burrow into the coarse gravel of the dead maerl beneath the living top layer (UK Biodiversity Group, 1999).

Although maerl beds cover a very small area of UK waters, all of the beds studied to date have been found to support a disproportionately high diversity and abundance of associated organisms in comparison with surrounding biotopes; some of these species are confined to maerl habitat or rarely found elsewhere (Nunn, 1992; Hall-Spencer and Moore 2000). A red seaweed species (*Gelidiella calcicola*) is a nationally rare species found in association with maerl that has been recorded in the waters around Islay and Jura (Plaza and Sanderson, 1997).

2 METHODOLOGY

2.1 Survey effort

The planned habitat mapping and ground-truthing survey comprised a total of 38 drop-down camera survey transects (table 1) in a central survey area and two potential cable landing sites as well as areas of ‘megaripples’ as interpreted from the sidescan sonar imagery (interpretation carried out by iX Survey). The central survey area encompassed the area south of Port Askaig, below the 48 metre contour line (figure 4), where three Acoustic Doppler Current Profilers (ADCPs) and one Acoustic Wave And Current (AWAC) profiler were to be deployed. The two potential cable landing sites are located just off the eastern coast of Islay (see figure 4) whilst the areas of ‘megaripples’ identified from the sidescan sonar imagery were found in both the shallow and deep water in the Sound of Islay.

Survey area	Number of transects	Transect numbers	Total transect length (km)
Central	25	1-18, 23-25, 30-32, 35	5.936
Cable landing N	1	33	1.339
Cable landing S	3	19-22	2.000
Megaripple 1	4	36-39	2.000
Megaripple 2	4	26-29	2.631
Total (km)			**13.906**

Table 1. Planned Islay demonstration tidal array ground-truthing survey effort (number of transects, transect identification and lengths of transects).

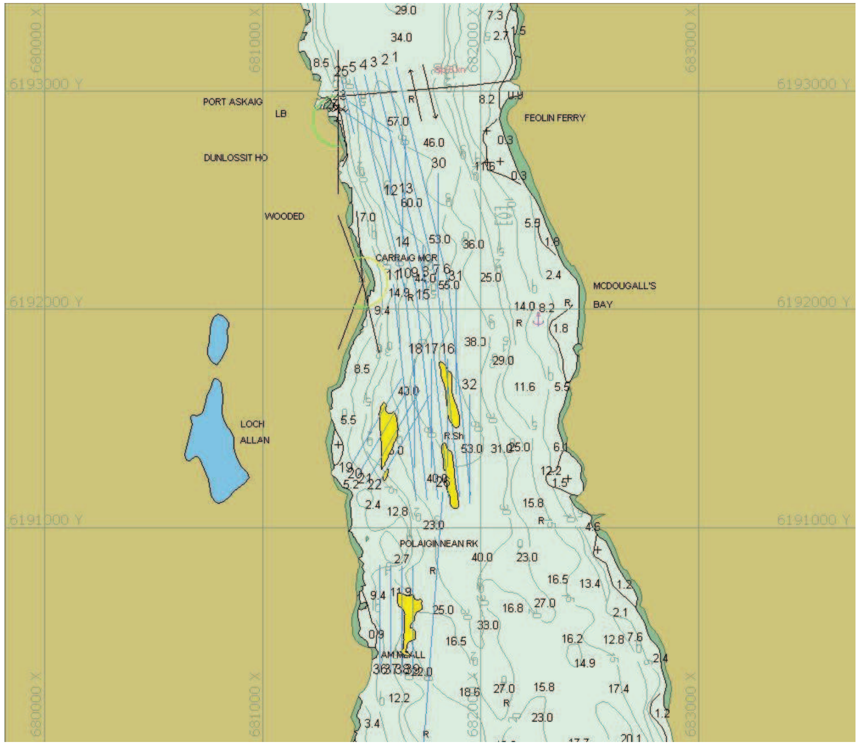


Figure 4. Planned drop-down camera survey transects in the Sound of Islay (planned survey transects together with potential ‘megaripples’ (highlighted in yellow) as identified on sidescan sonar imagery by iX Survey).

2.2 Drop-down camera survey equipment

The camera system used for the drop-down camera survey was a Kongsberg OE DTS-6000 drop-down camera system (figure 5). This was used in conjunction with a Mariamatech E-Sea sound dual frequency (33/200KHz) echosounder and a Leica RTK GPS (GX1230 Real Time Rover System) to acquire navigational positions (for further details see appendix I).

Figure 5. The DTS-6000 camera system onboard MV Margaret Sinclair used during the survey operations.

2.3 Camera operation and deployment

The drop-down camera survey was carried out in suitable weather conditions by a team of experienced personnel. Before each deployment a ‘clapper board’ containing site name, date and weather conditions was recorded using video and a still photograph taken as a quality assurance (QA) record.

All camera deployments were carried out along pre-determined transects across sites of interest (as described above). The vessel was positioned at one end of a transect using DGPS. The camera was then deployed and lowered to the seabed. Once the camera system was settled at the seabed, the onboard surveyors started to log navigation and the skipper was given approval to move along the transect at about 0.5 knots.

During the deployment the winch was controlled solely by the camera operator from the winch remote control in the survey laboratory. The photographs were taken using a surface trigger in the survey laboratory. The DTS-6000 camera system sent a continuous real-time video feed to the surface when the feed was monitored and the camera and winch were controlled. The video feed was recorded digitally using Mini Digital Video (miniDV) tapes and backed up using super VHS tapes. The video was recorded to tape rather than DVD as the life expectancy of tape is much greater. Individual still photographs were taken using a surface controlled trigger. Photographs were taken at the discretion of the camera operator to obtain a regular record of the seabed along each transect (not at a set time or distance interval) but also to capture changes in boundaries, interesting features and characteristic biological communities. The miniDV tapes were removed from the vessel every evening and stored securely onshore.

Throughout each camera deployment, navigation data was recorded. All camera deployment log keeping was synchronised to the navigation data from the RTK GPS. The log keeper recorded the time from the GPS at the start and end of each deployment and the time each photograph was taken. After 4-5 deployments the camera was removed from the frame and secured in the survey laboratory. The digital photographs were then uploaded from the camera to a laptop computer via a USB lead (the software used for this was Canon Zoom Browser EX). During the upload process each photograph was named with the site-name and photograph number.

2.4 Data handling

The photographs and video footage were subsequently used for specific analysis and inclusion in the GIS. When the camera survey was completed the miniDV tapes were taken back to Seastar Survey Ltd. offices and the digital miniDV tapes were up-loaded to a computer, edited, titled and burnt to DVD as mpeg files. All DVDs, photographs and logs were checked for errors as part of Seastar Survey Ltd’s standard quality control procedures and all data supplied to the client. Finally the client was supplied with DVDs with mpeg video files, sets of all seabed photographs and the seabed photographs were also incorporated into the ArcView GIS.

2.5 Video and still photography analyses

The analyses of the video and still photography records were carried out ‘blind’ without any prior knowledge about the survey apart from information about depth ranges. The video analysis was carried out using a SONY (DSR-1500P) digital videocassette recorder and a television monitor, the former system allowing for slow-motion, freeze-frame and standard play analysis. The still photographs were analysed using a personal computer and a high resolution television monitor.

The analyses included an initial assessment of a deployment to get a broad understanding of the substratum, flora and fauna as well as the identification of the different biotopes/habitats on the seabed. The detailed analysis consisted of a classification of the substrata resulting in a detailed assessment and a summary of the seabed environment in the ArcView GIS (see the accompanying ArcView GIS). The detailed analysis also consisted of faunal and floral identification to the lowest practical level and the abundance data were recorded using the SACFOR scale. A list of the encountered fauna were produced for each deployment / photograph using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997) to avoid problems in species nomenclature. The photographs were subsequently classified into designated biotopes according to Connor *et al.* (2004) and the results were incorporated into ArcView GIS.

2.6 Survey limitations

2.6.1 Weather conditions

The weather conditions throughout the survey period were suitable for survey operations and there was no weather downtime.

2.6.2 Obstructions

During the drop-down camera survey only one transect (line 20) was affected by any form of obstruction. A series of creel pots were obstructing the planned survey course along line 20. It was therefore decided not to deploy the camera along this line to avoid potential snagging and damage to equipment and the vessel.

3 RESULTS

The drop-down camera survey took place between the 8th and the 16th June 2009 with all survey operations conducted from MV *Margaret Sinclair* (see figure 5). The mobilisation and de-mobilisation took place on the 8th June and the 16th June respectively. During the survey the vessel was moored overnight in Port Askaig, Islay.

The survey coverage and effort for the 2009 Islay drop-down camera survey are given in figure 6 and appendix II. A total of 1083 still photographs together with 15 hours and 48 minutes of video footage were acquired during the Islay drop-down camera survey. Seastar Survey Ltd. was instructed to analyse 22 out of the 37 drop-down camera lines surveyed (see table 2). This resulted in a total of 793 still photographs and 11 hours 15 minutes of video footage to be used during the analysis phase of the project. The remaining footage has been stored for potential future analysis.

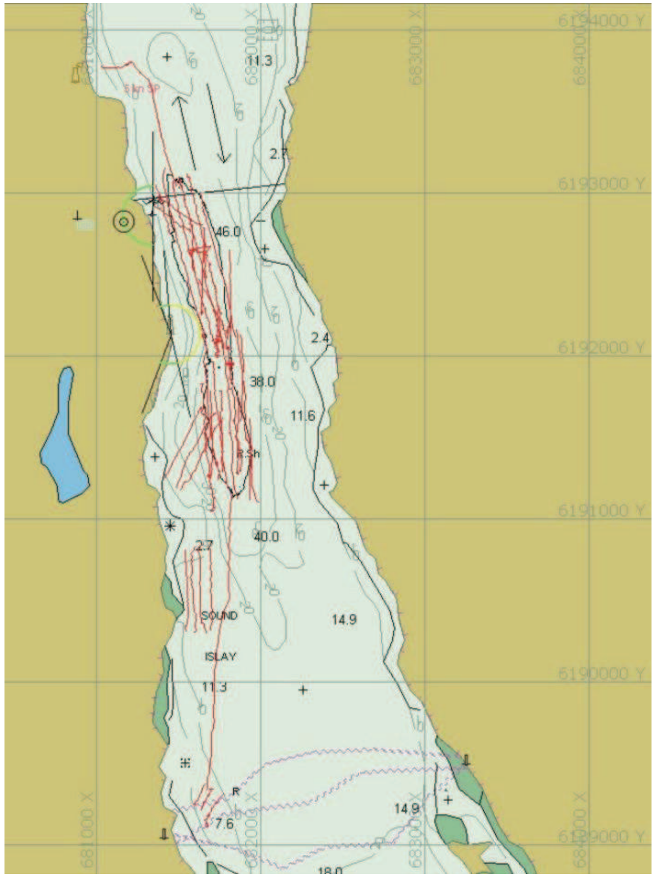


Figure 6. Track plot for the 2009 Sound of Islay drop-down video survey.

DATE	Location	Video Duration	miniDV Tape No.	Number of Photos	Start Of Line Position East (m)	North (m)	Depth (m)
13/06/2009	01	00:34:52	11	32	681844.01	6192121.17	45.63
11/06/2009	02	00:41:57	3	51	681551.63	6193100.05	46.12
12/06/2009	03	00:53:51	6	65	681772.81	6192040.72	58.67
12/06/2009	04	00:50:14	7	61	681736.26	6192036.63	55.51
12/06/2009	05	00:42:28	10	66	681410.63	6193140.06	47.44
13/06/2009	06	00:55:52	16	54	681983.46	6191105.52	38.37
11/06/2009	07	00:46:46	4	48	681796.52	6192164.65	51.70
13/06/2009	08	00:54:04	13	48	681858.93	6191129.83	48.94
11/06/2009	09	00:23:58	5	38	681698.62	6191961.59	53.41
12/06/2009	10	00:44:20	9	58	681644.52	6192123.71	45.93
11/06/2009	15	00:15:05	1	21	681747.68	6191998.88	54.91
13/06/2009	18	00:22:06	15	18	681692.66	6191784.90	51.18
12/06/2009	19	00:17:08	8	25	681637.55	6191677.67	45.98
12/06/2009	21	00:17:49	8+9	24	681722.48	6191649.02	53.35
13/06/2009	22	00:20:04	14	23	681510.03	6191181.46	10.33
11/06/2009	23	00:09:00	2	17	681621.08	6192808.87	53.85
11/06/2009	24	00:10:32	2	21	681571.65	6192770.08	56.59
12/06/2009	25	00:12:59	5	21	681438.57	6192761.13	44.35
12/06/2009	30	00:16:28	8	20	681816.15	6192137.54	47.72
13/06/2009	31	00:20:31	15	21	681875.54	6192126.56	32.69
13/06/2009	33	00:47:03	12	42	681482.33	6193045.48	50.63
13/06/2009	35	00:18:19	11	19	681579.69	6192629.94	60.65

Table 2. The drop-down camera survey lines included in the seabed analysis.

3.1 The sedimentary environment

The seabed environment (see summary in figure 7) within the study area in the Sound of Islay can be characterised by a mixed coarse sedimentary environment of sandy gravelly cobbles and small boulders (coloured orange and red in figure 7). The small-scale seabed environment is complex and mapping in terms of delineating larger features is difficult. An additional assessment of the ArcView GIS data is therefore recommended.

Bedrock and boulders are present along the 48 m contour and particularly along the western edge of the 48 meter contour of the survey area but also to a lesser extent along the eastern boundary (brown colour code in figure 7). There is also a relatively smaller central section of bedrock and boulders in the middle of the 48 m contour.

The most common sedimentary type is characterised by sandy gravely cobbles and small boulders (brown colour code) and cover the vast majority of the seabed environment within the drop-down camera survey area. These sedimentary features appear stable in character with considerable amounts of epi-fauna present.

Relatively large central sections of the deeper waters in the southern and northern sections of the study area are dominated by gravel and cobbles (green colour code). Some of these areas consist of unstable gravel and cobbles (with little or no epi-fauna) while others grade into more stable environments (brown colour code) also comprising gravel and cobbles (with epi-fauna). The transitional nature of these seabed environments makes any clear boundaries between habitats difficult.

Sandy sediment (coarse sand) with some broken shell material is found in the shallow waters at the potential landing and cable routing site (lines 19 – 23). Coarse sand is also found in the central region of the study area but these are largely mixed with cobbles and gravel making the overall grain size much larger than those seen in the shallow water areas.

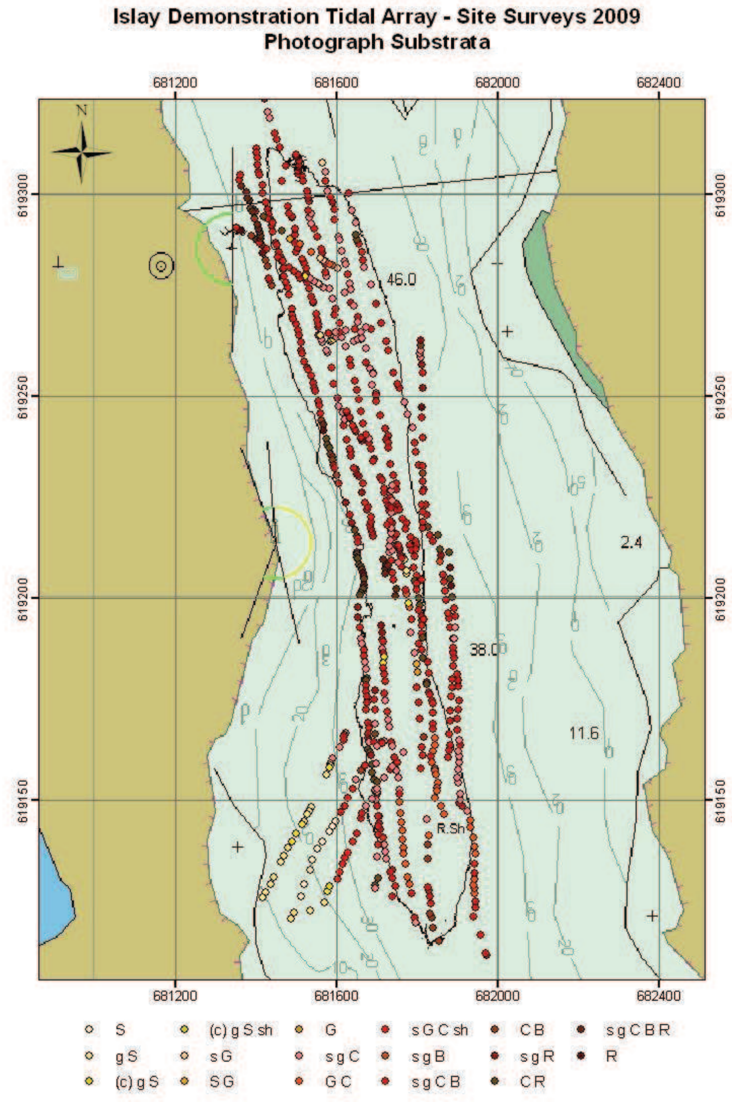


Figure 7. A summary of the substrata identified in the still photographs part of the Islay drop-down camera survey (S: Sand; g S: gravely sand; (c) g S: slightly cobbled gravely sand; (c) g S sh: slightly cobbled gravely sand and shell material; s G: sandy gravel; G C: gravel and cobbles; sandy gravel and cobble with shell material; s g B: sandy and gravely boulders; s g C B: sandy gravely cobbles and boulders; C B: cobbles and boulders; s g R: sandy gravely bedrock; C R: cobbles and bedrock; s g C B R: sandy gravely cobbles, boulders and bedrock; R: bedrock).

3.2 The biological environment

3.2.1 Fauna and flora

A total of 80 different taxa were identified in the Islay 2009 drop-down camera survey (see the list of species / taxa in appendix III). The majority of these were identified in the deeper waters (>40 m) of the study area with only a few different species of flora and fauna being observed in the shallow water.

The vast majority of the survey area covered by the Sound of Islay Demonstration Tidal Array survey was dominated by similar biological communities, communities typically found in sounds, narrows and around tide-swept promontories exposed to strong tidal streams but sheltered from wave exposure. Overall dead man’s fingers (*Alcyonium digitatum*), hydroids (*Tubularia indivisa*), anemones (*Urticina* sp., *Actinothoe sphyrodeta* and *Corynactis virdis*) and bryozoans (*Flustra foliacea* and *Alcyonidium diaphanum*) were widespread and dominant (see figure 8). Sponges (*Halichondria panicea*, *Esperiopsis fucorum* and *Pachymatisma johnstonia*), crustaceans (e.g. *Cancer pagurus*), molluscs (e.g. *Calliostoma zizyphinum*) and echinoderms (e.g. *Echinus esculentus, Asterias rubens, Henricia* sp. and *Crossaster papposus*) were also commonly identified. The fauna did vary slightly along transects but the overall composition was very similar throughout the deeper sections of the survey area apart from some sections of the deeper water where barnacles and serpulid worms (e.g. *Pomatoceros triqueter*) were dominant (unstable cobbles and small boulders).

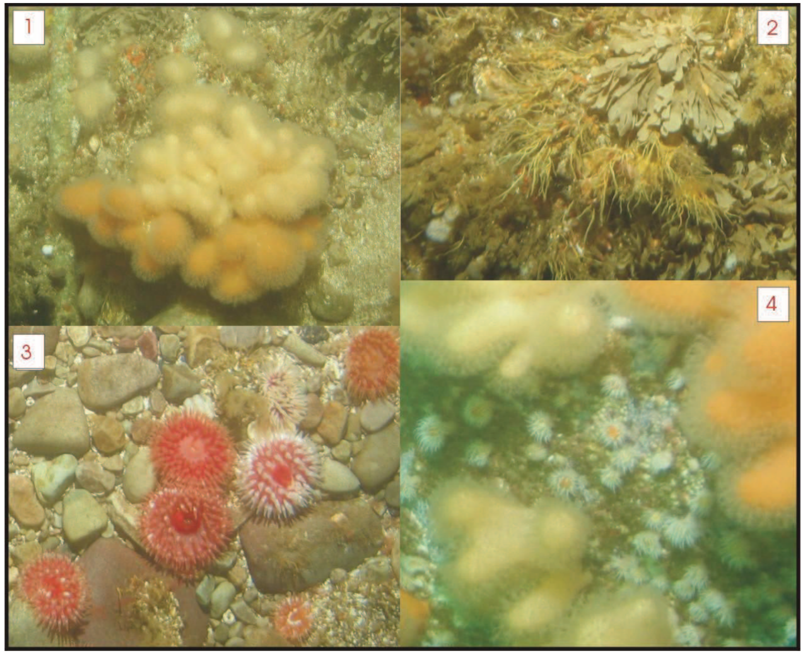


Figure 8. Examples of the dominant taxa identified in the deep water of the Islay Demonstration Tidal Array project with 1) Alcyonium digitatum, 2) Tubularia indivisa and Flustra foliacea, 3) Urticina sp., and 4) Actinothoe sphyrodeta and A. digitatum.

The shallower-water area (potential landing sites and cable route) were dominated by 1) kelp communities, mainly *Laminaria hyperborea* and *L. saccharina* with a relatively sparse understory of red seaweeds; and 2) sandy sediments with little visible epifauna. A single thallus of maerl was also identified in one of these areas with an additional large maerl bed identified in an area not included in the current analysis (see below).

Some species are very difficult to distinguish on seabed photographs. In this study it was particularly difficult to distinguish the difference between *Actinothoe sphyrodeta* and *Sagartia elegans* as the column has to be visible to be entirely certain (see photographs 4 in figure 8). Species of *Urticina* spp. are also difficult to distinguish. The majority in this study have been identified as *Urticina eques* as a result of the colour combinations and the shape and positions of the tentacles but it is possible that at least some individuals of these are *Urticina felina*.

3.2.2 Biotope classification

A total of eight biotopes were recognised (table 3) among the drop-down camera survey transects analysed in the Islay Demonstration Tidal Array survey area. There are gradual changes between many of these biotopes and these transitional boundaries often cover several photographs. This is exemplified by an area described as a transitional biotope (recorded as Trans IR.MIR.KT.(XKTX) / SS.SMx.CMx.FluHyd), a habitat that could not be designated as a particular biotope. The data acquired from the still photography analysis is more detailed than the data gathered from the video analysis as the quality of the stills photographed are of a higher quality in terms of species identification and therefore biotope classification (see below). These results are therefore illustrated in preference of the video records.

Code	Habitat description with dominant taxa	Biotope designation	Stills
	Bedrock and boulders with *Tubularia indivisa*, *Alcyonium digitatum* and *Urticina* sp.	CR.HCR.FaT.CTub.Adig	102
	Mixed sediment with *Tubularia indivisa*, *Alcyonium digitatum* and *Urticina* sp., a faunal community similar to CR.HCR.FaT.CTub.Adig but a slightly different substratum similar to SS.SMx.CMx.FluHyd.	SS.SMx.CMx.(CTub.Adig) **NEW**	518
	Gravel and cobbles with barnacles and serpulid worms.	SS.SCS.CCS.PomB	104
	Coarse sand and gravel.	SS.SCS.CCS	9
	Coarse sand (shell fragments) with sand ripples.	SS.SCS.ICS	27
	Coarse sandy gravel and cobbles with kelp, hydroids and bryozoans. A transitional zone between two biotopes.	Trans IR.MIR.KT.(XKTX) / SS.SMx.CMx.FluHyd	2
	Kelp on boulders, cobbles and mixed sediment.	IR.MIR.KT.XKTX	3
	Kelp and red seaweeds on gravelly sand.	SS.SMP.KSwSS.LsacR.Sa	5
	Coarse sand with *Laminaria* sp. (e.g. *L. saccharina*) and red seaweed and one thallus of *Phymatolithon calcareum*	SS.SMPMrl.Pcal	1

Table 3. The habitats, main taxa and designated biotopes in the 2009 Islay Demonstration Tidal Array camera survey (the colour codes refer to codes on the ArcView GIS maps and associated spreadsheets) with the total number of designated still photographs within each biotope.

The dominant taxa (as described above) in the survey area were *Tubularia indivisa*, *Alcyonium digitatum*, *Urticina* sp., various hydroids and bryozoans (e.g. *Flustra foliacea*). This community is closely associated with CR.HCR.FaT.CTub.Adig (see Connor *et al.*, 2004), a biotope found on circalittoral bedrock and boulders (see figure 9) in sounds, narrows and around tide-swept promontories in strong tidal streams. However, a very similar faunal community, with some small variations (e.g. *Hydrallmania falcata* and *Sertularia* sp. as well as a higher abundance of *Urticina* sp.), was found on the majority of stations in the survey (67 %) but the substrata varied from bedrock and boulders to a mixed sedimentary environment (consisting of a mixture of sand, gravel, cobbles and small boulders). The latter substrata would be classified within SS.SMx.CMx, and considering some of the fauna present there are many similarities with SS.SMx.CMx.FluHyd in particular. However, as some of the dominant and most abundant taxa (e.g. *Tubularia indivisa*) are different to the taxa found within SS.SMx.CMx.FluHyd, a new biotope (SS.SMx.CMx.(CTub.Adig)) has been suggested to describe this habitat (figure 10). The main differences, apart from the type of substrata, are the presence of hydroids such as *Hydrallmania falcata* and *Sertularia* sp. and the relatively higher abundance of *Urticina* sp. and relatively lower abundance of *Tubularia indivisa, Alcyonium digitatum* and sponges in SS.SMx.CMx.(CTub.Adig) compared to CR.HCR.FaT.CTub.Adig but essentially the faunal community is very similar in both of these seabed environments and this combination of taxa does not allow for a designation into either SS.SMx.CMx.FluHyd or CR.HCR.FaT.CTub.Adig. The current classification system (Connor *et al.*, 2004) is based on either epi- or infaunal sample data but it appears as if not all habitats are included and in the future new biotopes are likely to be added to ensure all biological communities are covered by the classification system. The suggested biotope, SS.SMx.CMx.(CTub.Adig), may not be included in any future classification system but for the purposes of this report it allows this habitat to be designated, described and mapped as far as possible.

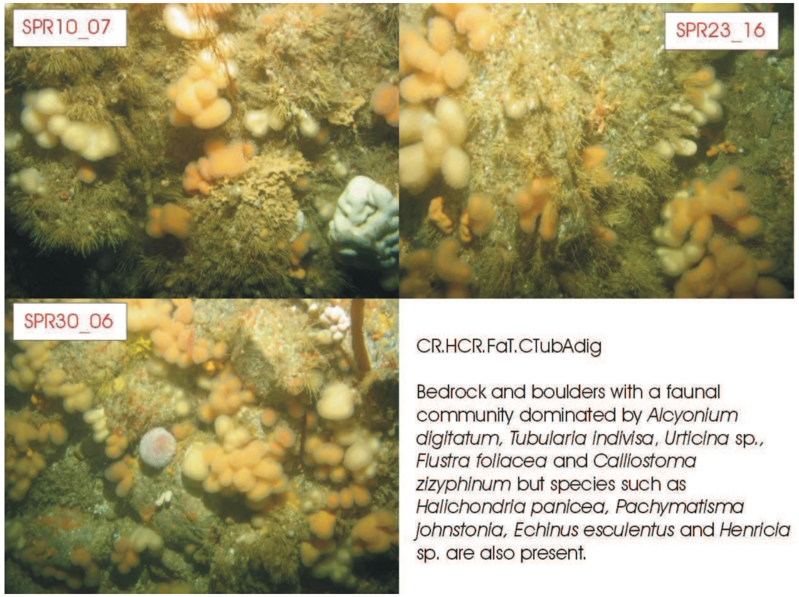


Figure 9. Photographs classified as CR.HCR.FaT.CTubAdig from the Islay drop-down camera survey in 2009.

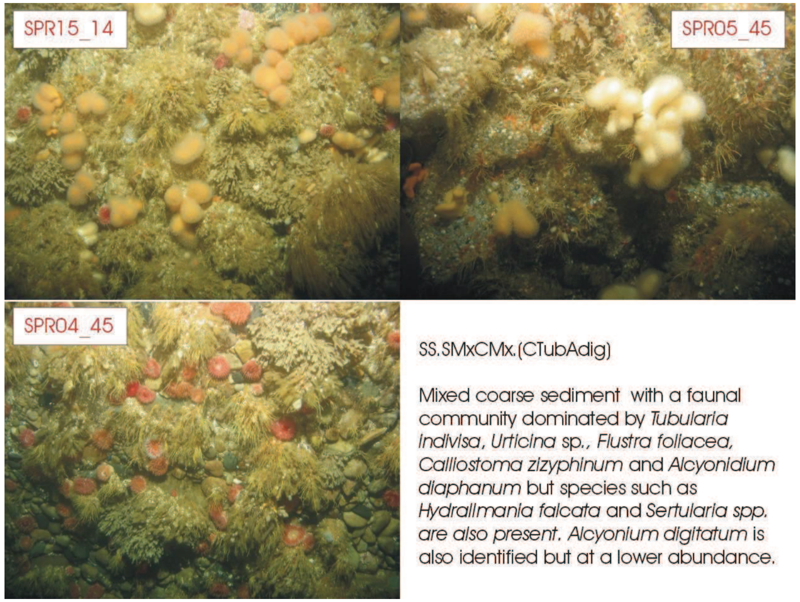


Figure 10. Photographs classified as SS.SMx.CMx.(CTubAdig) in the Islay drop-down camera survey in 2009.

By far the most dominant biotope in the 2009 Islay drop-down camera survey (see table 3 and figure 12 below) was SS.SMxCMx.(CTubAdig). SS.SMxCMx.(CTubAdig) is found on mixed coarse sediments (boulders, cobbles or pebbles with gravel and sand) with fauna characterised by *Tubularia indivisa, Urticina* sp., *Flustra foliacea* and the hydroids *Hydrallmania falcata* and *Sertularia argentea* (Connor *et al*., 2004). The soft coral *Alcyonium digitatum* was also present but at lower abundance compared to the dominant taxa. Other hydroids such as, *Nemertesia ramosa* did also occur together with the barnacle *Balanus crenatus* and tube worm *Pomatoceros triqueter*. The robust bryozoan *Alcyonidium diaphanum* was often difficult to identify among the other bryozoans and hydroids but this taxon was also relatively abundant.

One of the other three main biotopes found in the 2009 Islay drop-down camera survey (see table 3) was CR.HCR.FaT.CTubAdig. Connor *et al.* (2004) described this biotope to typically be found on exposed circalittoral bedrock and boulders in sounds and narrows in accelerated tidal streams. It is dominated by dead man's fingers *Alcyonium digitatum*, and dense clumps or continuous cover of the robust hydroid *Tubularia indivisa*. Anemones such as *Sagartia elegans*, *Urticina felina*, *Actinothoe sphyrodeta* and *Corynactis viridis* also form a prominent component of the community. All of these features and taxa were identified in the Islay data but as with the biotope descriptions there are also the occasional massive sponge, such as *Pachymatisma johnstonia* and *Esperiopsis fucorum*, present. Other fauna included in the biotope are *Pomatoceros triqueter, Balanus crenatus, Calliostoma zizyphinum, Flustra foliacea, Asterias rubens, Crisia denticulata* and *Alcyonidium* diaphanum. All of these taxa were recorded in the 2009 drop-down camera survey but at lower abundances.

In addition to these two biotopes in the 2009 Islay survey, six other biotopes were identified (examples of the other six biotopes are given in figure 11). Out of these six biotopes SS.SCS.CCS.PomB was the most common (see table 3 and figure 12 below), particularly in the southern section of the deep-water section (see ArcView GIS images below). SS.SCS.CCS.PomB is characterised by a few ubiquitous robust and/or fast growing ephemeral species which are able to colonise pebbles and unstable cobbles which are regularly moved by wave and tidal action. The main organisms are calcareous tube worms such as *Pomatoceros triqueter (*or *P. lamarcki)*, small barnacles including *Balanus crenatus* and *B. balanus*, and a few bryozoans and coralline algal crusts. Scour action from the mobile substratum prevents colonisation by more delicate species. Occasionally in tide-swept conditions tufts of hydroids such as *Sertularia argentea* and *Hydrallmania falcata* are present. This biotope often grades into SS.SMX.CMx.FluHyd (Connor *et al*., 2004) and similarities between these areas and those designated as SS.SMx.CMx.(CTunAdig) are seen. The transitional nature of some of the sections in this study therefore made some designations and delineations difficult.

Biotopes SS.SCS.CCS and SS.SCS.ICS appear similar in the footage (figure 11) but in this study the former is found at depth (>40 m) while the latter is found in shallow water. There is no visible epifauna in these areas and grab sampling would be required to designate these biotopes further but the former has been described as a biotope found in tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20 m. This habitat may be found in tidal channels of marine inlets and as with shallower coarse sediments, it may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves.

The designation of SS.SCS.ICS is based on the biotope description which describes it to typically be found in moderately exposed habitats with coarse sand, gravely sand, shingle and gravel in the infralittoral, subject to disturbance by tidal steams and wave action (see Connor *et* al., 2004). Such habitats are typically found on the open coast or in tide-swept marine inlets and are characterised by a robust fauna of infaunal polychaetes such as *Chaetozone setosa* and *Lanice conchilega*, cumacean crustacea such as *Iphinoe trispinosa* and *Diastylis bradyi*, and venerid bivalves. SS.SCS.ICS was identified in the shallow water at transects 19, 21 and 22 but again, sediment sampling would be required to assess the infauna and fully classify the biotope.

SS.SMP.KSwSS.LsacR.Sa was also identified in the shallow water at transect 19 (potential landing or cable route site). This biotope is described as a shallow kelp community found on sand and slightly gravelly sand, in moderately exposed and sheltered conditions, with weak tidal currents (Connor *et al*., 2004). The community is characterised by occasional *Laminaria saccharina* with an undergrowth of red algae (see figure 11). Within the sandy sediments a variety of typical sand dwelling infauna including polychaetes (*Scoloplos armiger* and *Exogone hebes*), amphipods (*Ampelisca brevicornis*), and bivalves (*Abra alba*) can typically be found (see Connor *et* al., 2004) but additional sediment sampling would be required to assess this fully.

The seabed habitat designated as IR.MIR.KT.XKTX is described (see Connor *et al*., 2004) as a mixed substrata of boulders, cobbles, pebbles and gravel, typically found in tidal rapids with kelp such as *Laminaria saccharina* and *L. hyperborea* and red seaweeds. The kelp in these tidal rapids does not form the same dense canopies associated with stable tide-swept bedrock, but generally occurs at lower abundance (as seen in figure 11). The sponges associated with more stable, tide-swept conditions are generally absent, but the cobbles and pebbles are encrusted by the ubiquitous polychaete *Pomatoceros triqueter* and provide shelter for *Pagurus bernhardus, Gibbula cineraria, Echinus esculentus* and *Asterias rubens*.

There was only one single photograph with one identified thallus of *Phymatolithon calcareum* (see red rectangle in photograph SPR19_15 in figure 11). The video footage did not allow for any further identification of this taxon but the photograph was designated SS.SMPMrl.Pcal to ensure it was noted as part of the study but also as a maerl bed was identified in a different section of the study area suggesting that similar biological features might be present elsewhere. This biotope is characterised by maerl beds with *Phymatolithon calcareum* in gravels and sands. The associated fauna and flora including epiphytes (*Dictyota dichotoma* and *Plocamium cartilagineum*), polychaetes (e.g. *Lanice conchilega*, *Kefersteinia cirrata* and *Mediomastus fragilis*) and Gastropods (e.g. *Gibbula cineraria*) were not identified in the footage. Additional sampling would therefore be required to fully assess this area and verify the size of this potential maerl population present.

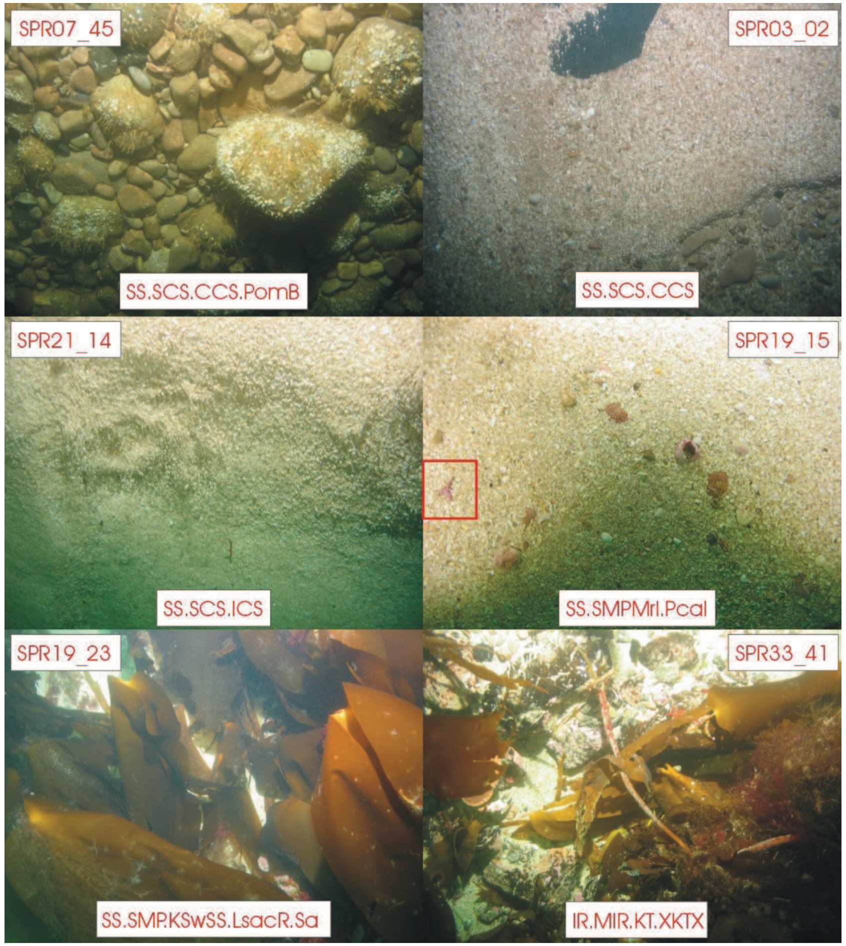


Figure 11. Photographs exemplifying the different biotopes identified in the Islay Demonstration Tidal Array survey 2009.

3.2.3 Biotope distribution

The results of the photographic analysis and biotope distribution within the 2009 drop-down camera survey area are given in figure 12. The vast majority of photographs (see table 3 and figure 12) have been classified as SS.SMx.CMx.(CTunAdig). There are some sections of CR.HCR.FaT.CTubAdig along the boundaries of the 48 m contour with the southern and central sections being dominated by CC.CSC.CCS.PomB. The change in depth and biotope classification can be seen near the landing and cable route site in the south-western part of the study area (see figure 12).

The results in figure 12 illustrate the complex seabed environment described above with several different biotopes within relatively small distances of the study area. As mentioned above, there are also areas that are transitional in character between different biotopes. Creating delineations or boundaries between the different biotope areas in the form of a habitat map is therefore difficult and the results are best illustrated using the still photographs. The still photograph analysis furthermore results in a greater amount of detail (e.g. better species identification) acquired during the analysis stage compared to the analysis of the video material allowing a more detailed chart in terms of the biotope distribution to be illustrated.

3.2.4 Additional important biological features

As mentioned above a total of 22 of the 37 drop-down camera survey lines were fully analysed in terms of the substrata and the biological and biotope distributions present within the survey area. However, it should be noted that in addition to the features described along the selected 22 transects, transect 26 is also of significant biological interest. Maerl beds were identified along the shallower section of transect 26. The dominant species shown to be present is *Phymatolithon calcareum*, a species protected under the UKBAP species list and as ‘Reefs’ under the EU Habitats Directive. Further analysis is required to fully assess this area.

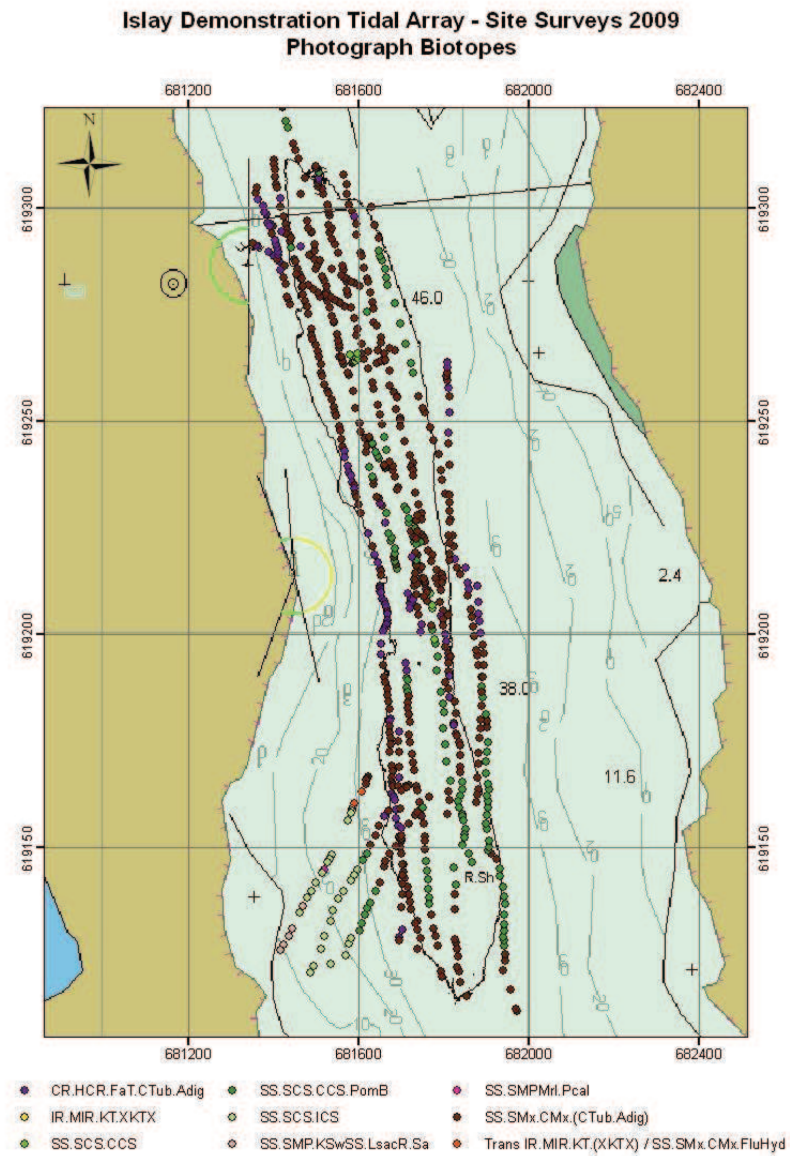


Figure 12. Biotope distribution derived from still photography analysis of the 2009 Islay drop-down camera survey.

3.3 Ground-truthing of sidescan sonar interpretation

The sidescan sonar interpretation carried out by iX Survey has been combined with the photographic biotope classification from the 2009 drop-down camera survey (given in figure 13). These results illustrate some areas of relatively good agreement between the two methods but there are some differences.

The positions of the bedrock features illustrated in the sidescan sonar interpretation appears to coincide relatively well with the photographic material. These areas have been classified as CR.HCR.FaT.CTubAdig with bedrock and boulders and the associated fauna as described above.

The sub-rock feature identified during the sidescan sonar interpretation appears to be less obvious in the photographic material. The exact definition of this feature is unclear so it is difficult to assess this feature fully. However, several different biotopes appear to be found on these sections of the interpretation and there does not seem to be a consistent pattern across the study area. It is possible that this could at least in part be explained by the fact that there often is some level of transition between biotopes but additional information about this feature would be required to assess it fully. Another issue is that the sidescan sonar survey was carried out a year prior to the ground-truthing survey and some of the seabed features may have moved or changed in that time (e.g. thin veneers of sand are likely to move as a result of the strong tidal currents present).

The drop-down camera footage results across vast expanse of ‘gravel’ across the site are also somewhat inconclusive. The sedimentary material is very mixed across the majority of the area with some considerable gradation of sizes of the material present. There are patches of coarse sand (as mentioned above) together with gravel and cobble on the central section in the north (near one of the original ADCP sites) whilst other areas are coarser with less sand and more gravel and cobbles. It is therefore difficult to assess these areas fully and a detailed study of the data on the ArcView GIS is recommended to get a better understanding of this section of the seabed.

Of particular note is the lack of ‘megaripples’ (figures 13 and 14) in the photographic material (figure 15) in the deep-water in the southern section (assuming ‘megaripples’ refer to areas dominated by sand as defined in Leeder, 1982 and Brown *et al*., 1989). These deep-water areas have been shown to consist of unstable gravel and cobbles (see example in figure 15) with some photographs showing a change into more stable environments of gravel and cobbles with fauna such as hydroids and bryozoans covering at least part of the uppermost surface. It is possible that the drop-down camera survey covered sediments outside the ‘megaripple’ areas (see survey limitations below) but as these features were relatively large together with the fact that the camera transects crossed at least part of the ‘megaripples’, this explanation is less likely even when allowing for potential positional errors.

An inspection of the original sidescan sonar imagery reveals the presence of features similar to ‘megaripples’ but as the substratum is of a different type a new classification is required. The inspection of the sidescan sonar also revealed a potential problem with the lay-back of some of the sidescan sonar lines as the ‘megaripple’ features identified on the original sidescan sonar do not appear to line up correctly in the imagery. This may not be the case but further inspection and analysis of the sidescan sonar data is therefore recommended.

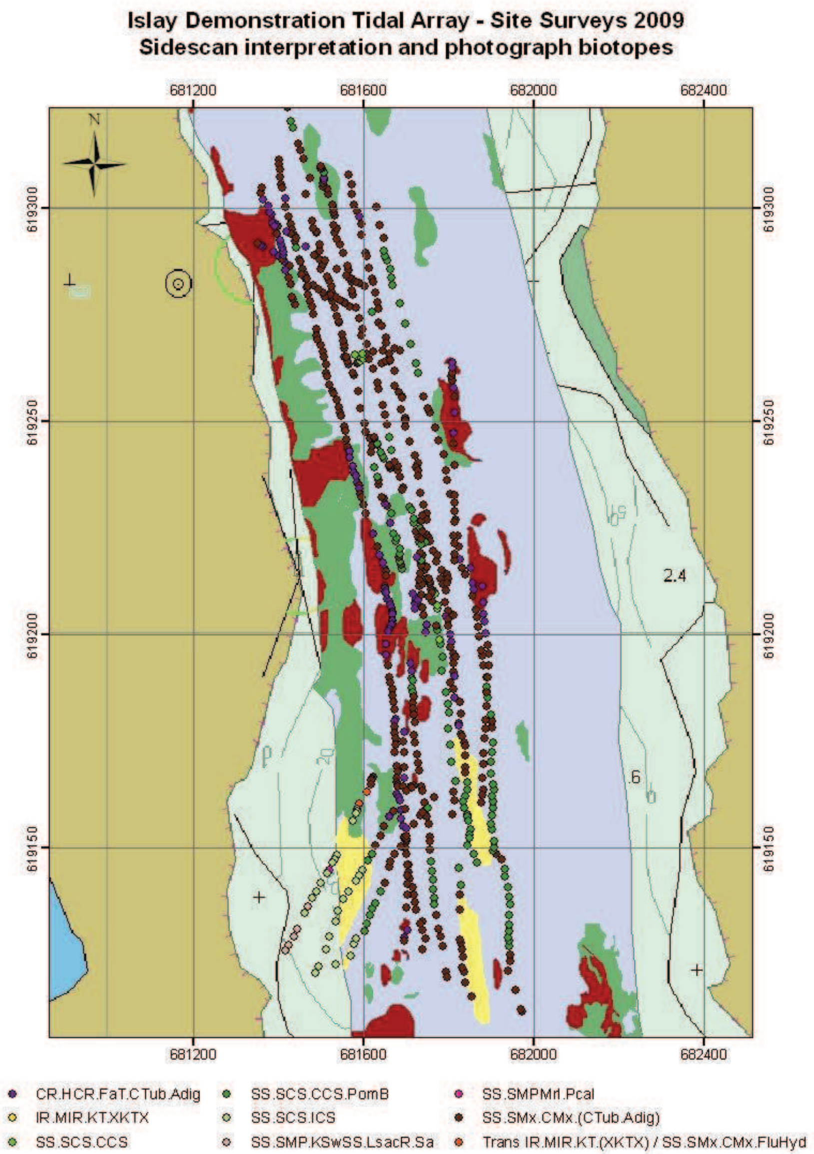


Figure 13. The biotope distribution (derived from still photography analysis of the 2009 Islay drop-down camera survey) overlying the iX Survey sidescan sonar interpretation.

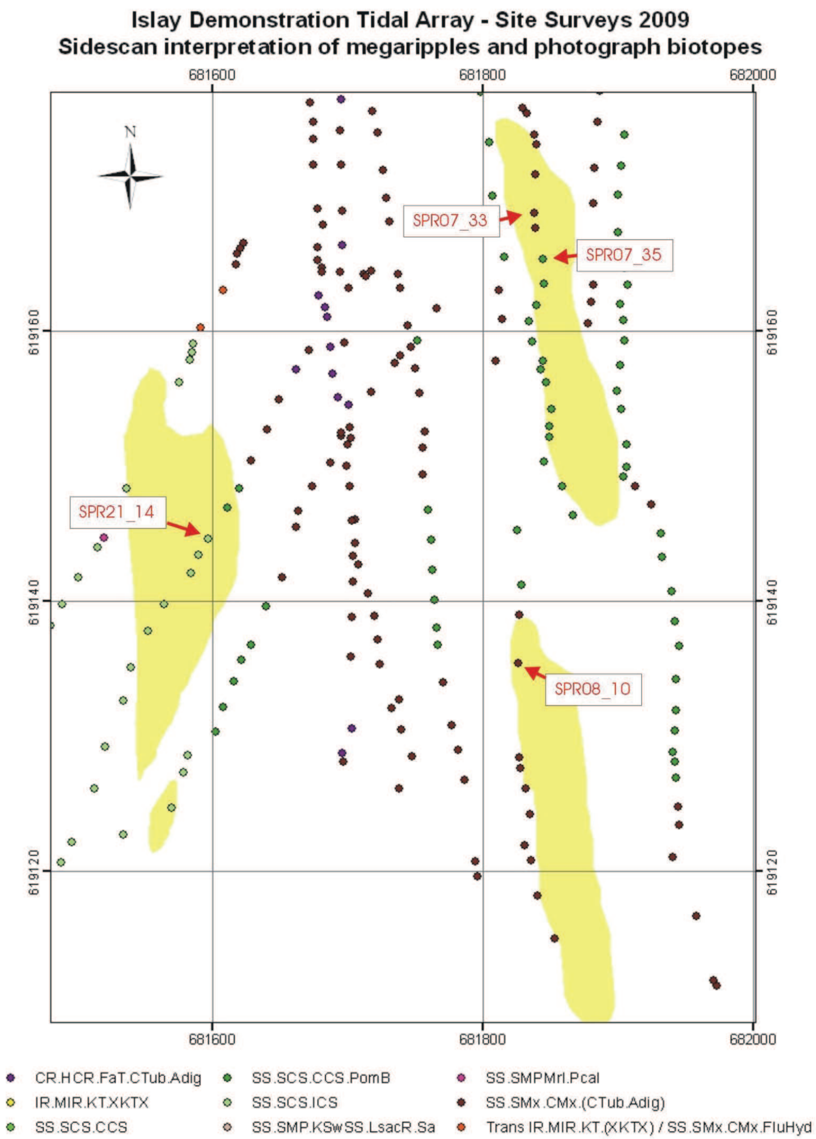


Figure 14. Close-up of features classified as 'megaripples' (from iX Survey sidescan interpretation) with 2009 ground-truth survey photographs.

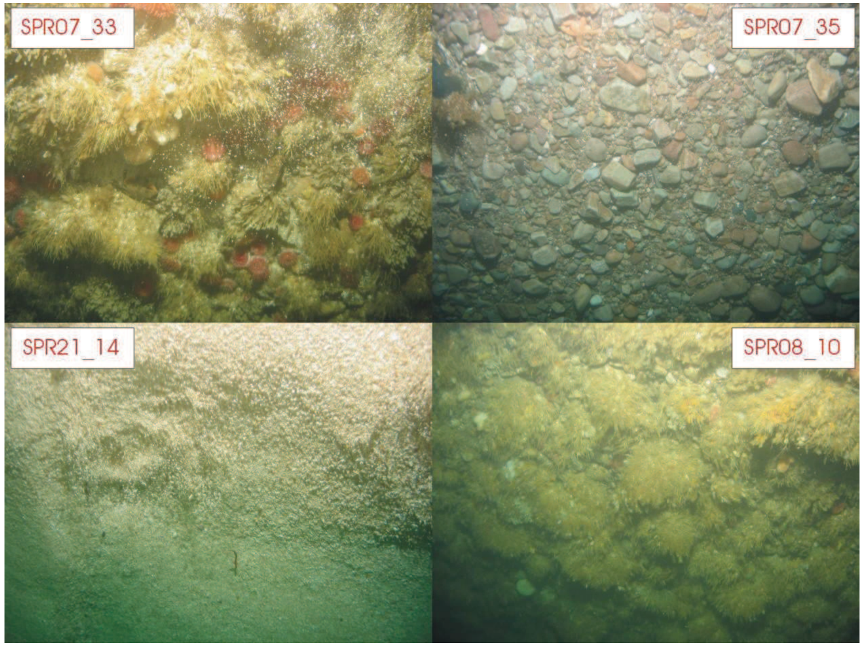


Figure 15. Photographs from the areas classified as 'megaripples'.

There is, however, a small (relatively) area of coarse sand (classified as SS.CSC.CCS and illustrated in light green) in the central section of the study area (see figure 14) but these photographs are not located within the area identified as 'megaripples' from the iX Survey interpretation (figure 13). There is also an area of coarse sediments potentially associated with 'megaripples' in the shallower section (photographic lines 19 – 23). The coarse sand forms sand ripples / waves (wave lengths of ≤1 m) as identified on the stills photography (see SPR21_14 in figure 15). However, the ground-truthing is unable to confirm the presence of any larger features such as 'megaripples' as these are at a scale beyond the detection capability of the stills photographs. Equally, the video material has not been able to confirm the presence of 'megaripples' but the presence of sand ripples / waves (as defined in Leeder, 1982) can be confirmed.

3.4 Current speed profiler (ADCP, HFADCP and AWAC) locations

The relative positions of the AWAC, HFADCP and ADCPs are given in figures 16 and 17. The sidescan sonar interpretation suggests the presence of 'gravel' (as interpreted by iX Survey from the sidescan sonar imagery) at all of these locations. There are no photographs positioned *exactly* over the various current profilers but a number of photographs nearest to these locations have been selected (table 4 and figure

18). These ground-truthing photographs reveal the presence of mixed coarse sediments (sandy gravel, cobbles and small boulders) but also some coarse sand.

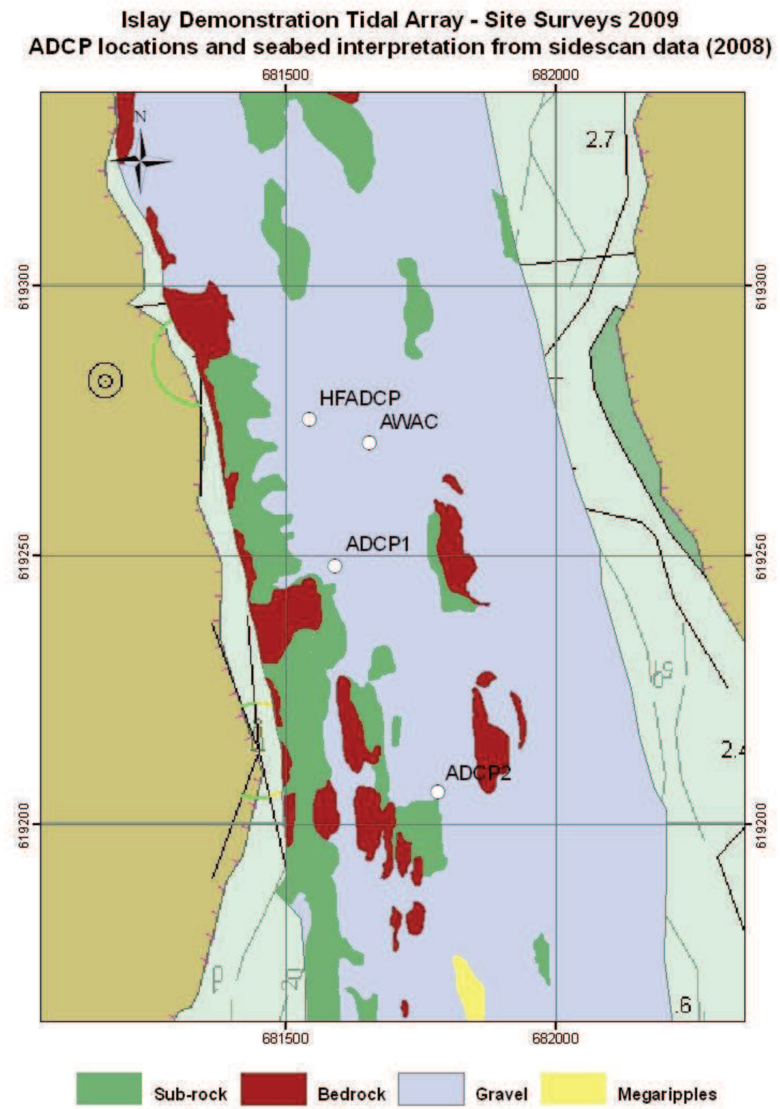


Figure 16. ADCP, HFADCP and AWAC locations within the 2009 Islay survey.

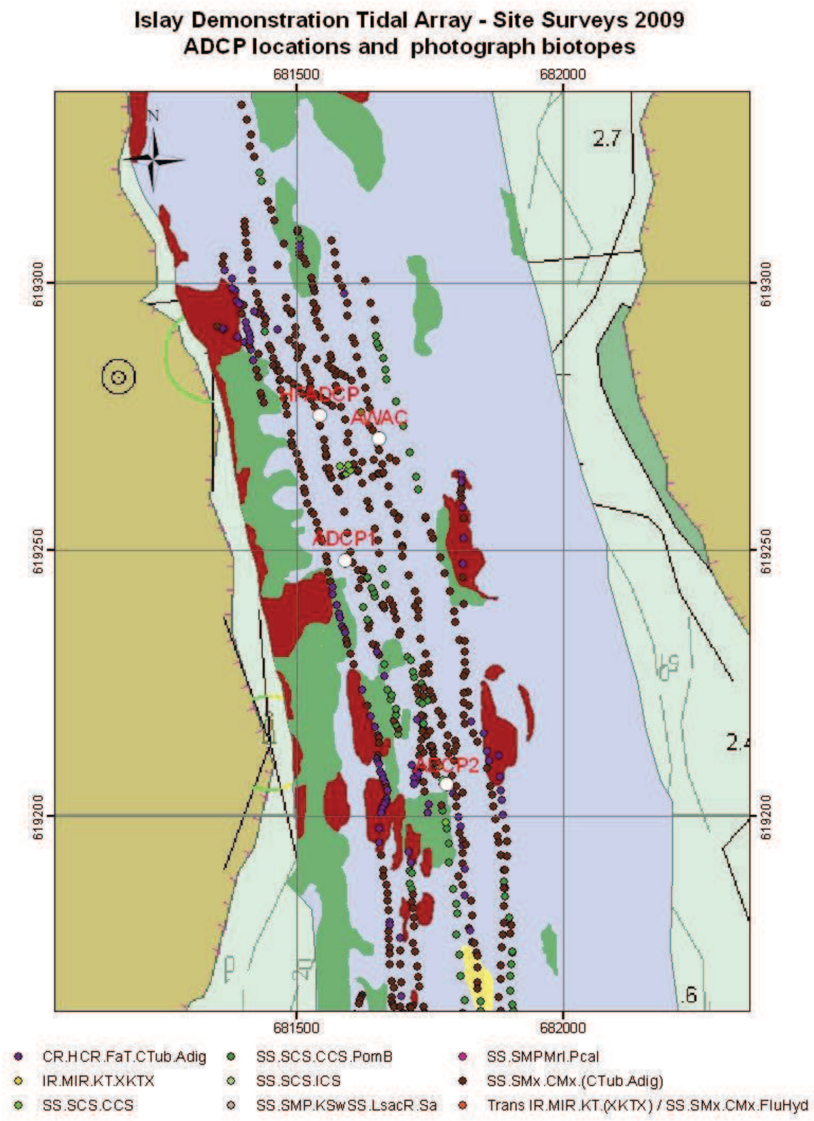


Figure 17. *ADCP, HFADCP and AWAC locations with still photography biotope classifications within the 2009 Islay survey.*

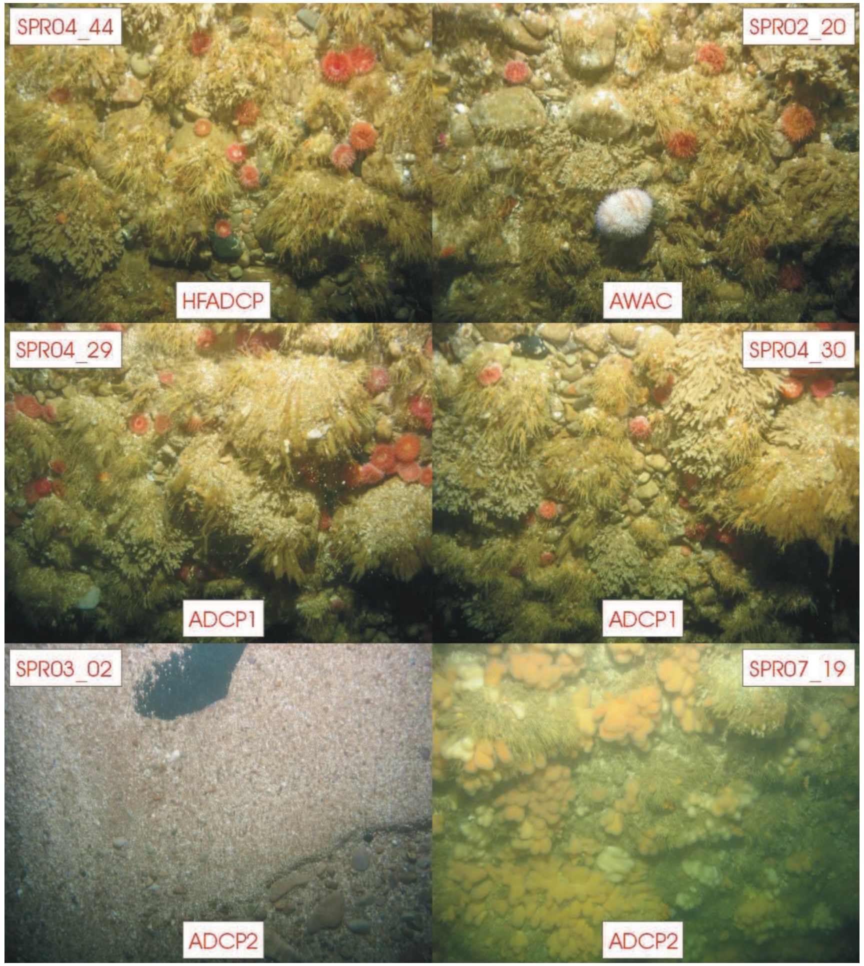


Figure 18. Photographs from the current profiler locations.

Photograph	Biotope	Current profiler	Distance from profiler
SPR04_44	SS.SMx.CMx.(CTubAdig)	HFADCP	7 m
SPR02_20	SS.SMx.CMx.(CTubAdig)	AWAC	10 m
SPR04_29	SS.SMx.CMx.(CTubAdig)	ADCP1	15 m
SPR04_30	SS.SMx.CMx.(CTubAdig)	ADCP1	19 m
SPR03_02	SS.SCS.CCS	ADCP2	9 m
SPR07_08	SS.SMx.CMx.(CTubAdig)	ADCP2	19 m

Table 4. Distance from photographs to current profiler locations.

Specifically, the photographic ground-truthing data reveal a mixed coarse sediment environment with a SS.SMxCMx.(CTubAdig) community at the ADCP1, AWAC and HFADCP locations (see figure 18). The exact seabed environment at the ADCP2 location is unclear as the position of this location is between a number of photographs with different seabed environments (see figure 18 and table 4). The sediment on these ADCP2 photographs have been recorded as mixed coarse sediments or coarse sand with cobbles with a faunal community classified as either SS.SMxCMx(CTubAdig) and SS.SCS.CCS respectively (see figure 18).

3.5 Man-made structures

A few man-made features were identified on the seabed footage including a battery (photographs SPR25_19) and a net or pot (photograph SPR08_07). However, it should be noted that there were not many man-made objects present in the survey area as a whole.

4 DISCUSSION

4.1 Survey methodology

An integrated approach using a range of survey techniques to study an area of seabed has been shown to be successful in many studies and the use of sidescan sonar and photography together with traditional survey techniques (e.g. grab sampling and trawling) have become more commonly used in recent years (e.g. Bett and Masson, 1998; Brown *et al.*, 2002; Axelsson, 2003; Masson *et al.*, 2003; Brown *et al.*, 2004a; Brown *et al.*, 2004b; Stevens and Connolly, 2005; Axelsson *et al.*, 2006). The use of video and still photography in surveys has been shown to be cost-effective with large areas being covered in a relatively short time (Brown *et al.*, 2004a; Stevens and Connolly, 2005) with a number of studies concluding that video and still photography are appropriate for the assessment of the presence and extent of biotopes (Sanderson and Holt, 2001; Service and Golding, 2001) as well as ground-truthing of acoustic images (Brown *et al.*, 2002; Brown *et al.*, 2004a; Brown *et al.*, 2004b). However, it is acknowledged that there is some loss in the taxonomic resolution when using photography rather than biological sampling techniques (e.g. Stevens and Connolly, 2005) and some video records are not of a sufficient quality to allow biotope classifications to be carried out. Still photography should be carried out simultaneously to supply meaningful images (Hiscock and Seeley, 2006). Even though these suggestions may reflect some of the difficulties associated with the biotope classification system, combining digital video and still photography with sediment sampling in surveys appears to have advantages over a single system and allows an overall higher quality assessment to be carried out.

The assessment of the interpretation of the sidescan sonar (carried out separately by iX Survey) using the drop-down camera system has proven to be a very successful method for studying the large-scale features in the Islay Demonstration Tidal Array project and allow for the sidescan sonar interpretation to be ground-truthed. The differences seen using the two methods justifies the need for the ground-truthing survey. Additional sediment sampling in the deeper water within the survey area would not be possible due to the coarse nature of this substratum. Sediment sampling within the shallow areas would be possible but not a requirement at this stage.

4.1.1 Survey limitations

The interpretation of the sidescan sonar and the subsequent ground-truthing resulted in some discrepancies in the boundaries between different sidescan sonar features and those seen in the photographic analysis. This discrepancy has a number of possible explanations including: 1) positioning of camera frame relative to navigation data; 2) boundaries of biotope / habitat designations; 3) depth of acoustic signal penetration; and 4) mosaic problems during the processing and analysis of the sidescan sonar.

1) Positioning of camera frame relative to navigation data
During the survey operations, the position of the camera frame was calculated relative to the vessel by use of the lay-back function within Hypack survey management software. This is calculated through the use of vessel position, heading, water depth, vessel speed and length of the cable deployed. This would typically give positional accuracies of approximately ± 5 m. However, during the Islay 2009 drop-down camera survey the camera frame was deployed in powerful tidal currents resulting in some streaming. In addition, the survey was carried out at considerable depths (> 40 m) potentially affecting the lay-back positions more than would be the case in shallow water. The positional accuracies of the camera deployments are therefore estimated to be ± 5-10 m (see field report for further information).

2) Biotope / habitat designations
The exact positions of the boundaries between different biotopes were often difficult to determine as many boundaries were transitional in nature. The change in sediment tended to be gradual along the transect and the determination of the boundary between two types became difficult. Some of the boundaries identified from the camera deployments did therefore not match exactly with those seen on the sidescan sonar imagery but overall the results were good.

3) The depth of the acoustic signal
It has been shown that some sidescan sonar frequencies (e.g. 30 kHz) penetrate into the sediment and therefore return volume backscatter rather than a backscatter signal from the uppermost sediment surface (Blondel and Murton, 1997; Axelsson, 2003; Masson *et al.,* 2003). The lower frequencies penetrate the most (Blondel and Murton, 1997) and at 30 kHz the signal could penetrate tens of centimetres (Masson *et al.*, 2003). It is therefore possible that in certain sediments, the acoustic signals could penetrate the sediment to some degree and therefore generate results different to those seen on seabed photographs.

4) Mosaic problems during the processing and analysis of the sidescan sonar
There appears to be some areas of the sidescan sonar trace that do not match (the northern 'megaripples' feature in particular), which has translated onto the sidescan sonar interpretation. This might have been caused by lay-back problems during the processing of the sidescan sonar but further investigation is required to assess this fully.

4.2 Comparisons with previous studies

4.2.1 Sedimentary environment

There is very little available information regarding the seabed environment in the Sound of Islay (see section 1.2). The available information regarding the geological environment is particularly limited. The sediment in the north of the Sound have been described to primarily be comprised of gravely sand and sand, whilst the seabed sediments in the south of the Sound have been described to be comprised of gravely sand, sand, muddy sand and mud (BGS, 1997). The exact locations and the extent of the coverage of these sediments are unknown but as the substrata within the current study area are much coarser than those reported by BGS (1997) it is assumed that these records are from areas further north and south respectively. Some of the sedimentary descriptions by Farrow *et al*. (1979), Hiscock (1983) and Seasearch (1999) are similar but the lack of any other comparative data has not allowed for any further comparisons.

4.2.2 Faunal communities

Previous comparable biological surveys are also limited and largely restricted to the description of sublittoral sites in the central and northern parts of the Sound. The two most relevant studies were carried out by Hiscock (1983) and Seasearch (1999), both of which show considerable similarities in terms of the faunal communities present to the current study. Hiscock (1983) described sites in the centre of the Sound with characteristic species of tidal narrows and sounds including *Halichondria* sp. (sponges), *Pachymatisma johnstonia* (Elephant's hide sponge), *Tubularia indivisa* (Oaten pipes hydroid), *Eudendrium rameum, Sertularia cupressina* (sea cypress hydroid), *Hydrallmania falcata* (Sickle hydroid), *Actinothoe sphyrodeta* (Sandaled anemone), *Alcyonium digitatum* (Dead man's fingers) and *Pholis gunnellus* (Butterfish). All of these species were recorded in the 2009 survey and overall the habitat and species descriptions are very similar in the two studies.

The Seasearch survey along the Islay coastline (Seasearch, 1999) also recorded very similar results to the 2009 Islay survey. The Seasearch survey included a dive to the south of Port Askaig, where steep bedrock and a boulder slope extending down to depths of over 40 m was found to be colonised by epifauna including 'Dead man's fingers (*Alcyonium digitatum*), Boring sponges (*Cliona celata*), Elephant's hide sponge (*Pachymatisma johnstonia*) and patches of the antenna hydroid (*Nemertesia antennina*) as well as Oaten pipe hydroids (*Tubularia indivisa*)'. The Seasearch survey also indicated that many of the sites dived around Islay showed signs of having been heavily grazed by sea urchins (*Echinus esculentus*) resulting in a reduction in cover by the usual plant and animal species, which tend to be replaced by large areas of pink encrusting algae (Seasearch, 1999).

In addition to these records from the relatively deep water, Hiscock (1983) described a shallow sandy seabed environment in the northern part of the Sound along the Jura coastline but the fauna present was not described further. A plain of mostly dead maerl calcified red seaweed was also identified in this area as well as tide swept boulders between depths of 4 m and 14 m with foliose red algae and sabellid polychaetes noted among the associated flora and fauna (Hiscock, 1983). Some similarities have been seen in the current study with the sandy sediments at the landing and cable route sites in the southern section of the study area.

Rocky slopes dominated by very dense *Laminaria hyperborea* at the south eastern entrance to the Sound were also recorded by Hiscock (1983). These kelp communities were replaced by *Laminaria saccharina* (sugar wrack) from 4.0 m to 5.5 m. Other recorded species found living in the shelter of the Kelp included *Gibbula cineraria* (grey top shell) and *Anemonia sulcata* (Snakelock anemone). Whilst kelp was also found in the shallow waters in the 2009 survey, there was no evidence of snakelock anemones. Top shells were observed in many places but the vast majority were *Calliostoma zizyphinum* whilst other species such as *Gibbula cineraria* could not be identified with any certainty.

4.3 Habitats and species of ecological importance in the Sound of Islay

4.3.1 Rare and scarce taxa in high-energy environments

There are a number of potential rare or scarce species (table 5) known to be found in high-energy environments (Plaza and Sanderson, 1997). None of these ten species were identified on the photographic material acquired during the 2009 Islay drop-down camera survey. However, some of these species are small and as species identification is known to be difficult (see Stevens and Connolly, 2005), it is possible that these species are present but remain undetected. Some of these taxa were definitely not observed (e.g. *Arachnanthus sarsi* and *Ophiopsila annulosa*) and there are no current records of one of the other taxa (e.g. *Synoicum incrustatum*) in Scottish waters.

Species	Type	Habitat
Tethyspira spinosa	Sponge	Wave exposed sub-tidal rock
Plocamilla coriacea	Sponge	Vertical, subtidal rock or on other sponges
Arachnanthus sarsi	Anemone	Sand and shell material
Phellia gausapata	Anemone	Rocks in kelp zone
Austrosyrrhoe fimbriatus	Amphipod	Possibly associated with maerl
Synoicum incrustatum	Ascidian	Horizontal surfaces subject to sand-scour
Ophiopsila annulosa	Brittlestar	Subtidal, coarse gravel
Gelidiella calcicola	Red alga	Maerl beds
Schmitzia hiscockiana	Red alga	Sublitttoral on tide-swept cobbles
Carpomitra costata	Brown alga	Epilithic on small stones and shells in strong currents

Table 5. Rare and scarce species known to be found in high-energy environments (from Plaza and Sanderson, 1997).

4.3.2 Faunal communities in tidal rapids and narrows

The tidal rapids in deeper situations (more than five meters) are found at the entrances to fjordic sea lochs, between islands, or between islands and the mainland, particularly where tidal flow is funnelled by the shape of the coastline (UKBAP, 2009). The strong tidal streams generate favourable conditions for diverse marine habitats and result in characteristic marine communities rich in diversity, nourished by a constantly renewed food source brought in on each tide (NIHAP, 2003; UKBAP, 2009). The marine life associated with these habitats is 'abundant in animals fixed on or in the seabed, and typically include soft corals, hydroids (sea firs), bryozoans (sea mats), large sponges, anemones' (UKBAP, 2009). UKBAP (2009) also states that in deeper water, such as between islands, strong tidal streams may be felt down to 30 m but it appears from the Sound of Islay camera survey that these habitats occur down to depths of around 40 m or more.

Currently only a small number of UK tidal rapids are partly (e.g. Loch Sween being part of a SSSI) or wholly (e.g. the tidal rapids at Strangford Lough in Northern Ireland being part of a Marine Nature Reserve) legally protected. Tidal rapids could be included in protected sites as Special Areas of Conservation (SACs) under the EC Habitats Directive as 'reefs'; under 'large shallow inlets and bays', or in the priority habitat 'lagoons' (UKBAP, 2009) but the Sound of Islay is not protected under any current legislation and tidal rapids are not specifically listed under the EC Habitats Directive (NIHAP, 2003). Furthermore, these habitats are not currently listed as biotopes recognised to be of national importance (Hiscock and Jones, 2004) but the UKBAP (2009) states that the importance of UK rapids in an international context means that current protection through site designation is inadequate. In addition, Hiscock (1983) concluded that the habitats seen in the Sound of Islay exposed to very strong water movement are rare and of high conservation importance as well as of high scientific interest.

UKBAP (2009) has suggested that some tidal power generation plants (particularly in conjunction with bridge construction) and tidal barriers in areas with strong tidal flow as a means of generating electricity could have a devastating effect on communities in rapids. However, the type of tidal power generation suggested in the Sound of Islay has not been mentioned in this context (see NIHAP, 2003; UKBAP, 2009). Other environmental impacts include loss of substratum, smothering, decrease in flow velocity, collision risks (with fauna and vessels), anti-fouling and direct physical impact during construction as identified in the literature review (Doran, 2009) and other documents (SPR, 2008; MCT, 2009a, b) but these aspects are most likely going to be dealt with during the EIA process.

4.3.3 Maerl beds

The maerl bed seen along line 26 is protected by the EC Habitats Directive as maerl beds are included in four different types of Annex I habitats; ‘sandbanks which are slightly covered by seawater at all times’, ‘large shallow bays and inlets’; ‘estuaries’ and the priority habitat ‘lagoons’ (UK Biodiversity Group, 1999). Maerl beds are also on the UKBAP Habitat Action Plan list of priority habitats. The single thallus of live *Phymatolithon calcareum* seen along line 19 does not represent a maerl bed as such but it might form part of a larger feature. It is therefore recommend that further investigations around this location is carried out should it be decided that this landing area (or cable route) is likely to be used as part of the tidal generation project.

4.4 Conclusions

The dominant biological communities found during the 2009 drop-down camera survey are typical of communities exposed to very strong water movement. These communities were dominated by *Tubularia indivisa,* other hydroids, *Alcyonium digitatum, Urticina* sp. and bryozoans (e.g. *Flustra foliacea*). Similar communities have been recorded from this area during previous studies in 1983 and 1999 (Hiscock, 1983 and Seasearch, 1999). According to Hiscock (1983) typical faunal communities of tidal rapids are rare in the UK and these are of scientific and conservation interest. However, there is currently no legal protection of the habitats in the Sound of Islay.

Another noteworthy feature is the presence of a maerl bed along line 26 in the south of the study area. In addition, one thallus of live *Plocamium cartilagineum* was identified along line 19, a feature that might require further investigation as additional individuals and even maerl beds might be present near this location. Maerl bed habitats are protected under both the EU Habitats Directive and included in the UKBAP habitats list (UKBAP, 1998; UK Biodiversity Group, 1999).

The ground-truthing of the sidescan sonar interpretation showed some correlations but also a number of differences. There was no apparent evidence of any ‘megaripples’ in the deep water in the southern section as interpreted from the sidescan sonar imagery. The coarse sand observed (with sand ripples / waves) on the photographs in the shallow-water could potentially be associated with ‘megaripples’. However, apart from the presence of sand ripples there was no apparent evidence on the photographic material of ‘megaripples’ in this area either. The correlation between the seabed environment described as ‘gravel’ was also inconclusive, a result potentially explained by the many transitional areas seen across the study area but there is also a need for an exact definition of this term. Additional analysis of features seen might be required to explain these results further. There was, however, a good correlation in the positioning of the bedrock features present within the study area.

The locations selected for the current profiler equipment (ADCP, HFADCP and AWAC) are dominated by mixed coarse sediments with typical fauna found within the Sound of Islay (hydroids dominated by *Tubularia indivisa*; anemones dominated by *Urticina* sp.; and bryozoans including *Flustra foliacea*).

5 REFERENCES

Axelsson, M.B. (2003). *The deep seabed environment of the UK continental margin – integration and interpretation of geological and biological data*. Ph.D. thesis, University of Southampton, 266 pages.

Axelsson, M., Dewey, S., Chaddock, S. and Duke, S. 2006. *Survey of the reef habitat around Eddystone Rocks, Plymouth*. Report to English Nature, 55 pages.

BERR (2008). UK Renewable Energy Strategy Consultation. Available (online): http://www.berr.gov.uk/files/file46799.pdf (Retrieved 11/09/09).

BERR (2009). Department for Business Enterprise and Regulatory Reform (2009). Renewable Energy. [online]. Available from: http://www.berr.gov.uk/energy/sources/ renewables/index.html (retrieved 30/04/2009).

Bett, B.J. and Masson, D.G. (1998). Atlantic Margin Environmental Surveys. In, *In depth, Southampton Oceanography Centre*, issue 3, pages 4-5.

BGS (1997). Geology and Physical Environment. By the British Geological Survey, in. Barne, J. H., Robson, C. F., Kaznowska, S. S., Doody, J. P., Davidson, N. C. and Buck, A. L. (eds.). *Coasts and seas of the United Kingdom. Region 14. South-west Scotland. Ballantrae to Mull.* Peterborough: Joint Nature Conservation Committee. 229pp.

Blondel, P. and Murton, J.M. 1997. *Handbook of seafloor sonar imagery.* John Wiley & Sons Ltd., 314 pages.

Brown, J., Colling, A., Park, D., Phillips, J., Rothery, D and Wright, J. (1989). *Waves, tides and shallow-water processes.* The Open University, Pergamon Press, 187 pages.

Brown, C.J., Cooper, K.M., Meadows, W.J., Limpenny, D.S. and Rees, H.L. (2002). Small-scale mapping of seabed assemblages in the Eastern English Channel using sidescan sonar and remote sampling techniques. *Estuarine, Coastal and Shelf Science*, **54**, 263-278.

Brown, C.J., Hewer, A.J., Limpenny, D.S., Cooper, K.M., Rees, H.L. and Meadows, W.J. (2004a). Mapping seabed biotopes using sidescan sonar in regions of heterogeneous substrata: case study east of the Isle of Wight, English Channel. *International Journal of the Society for Underwater Technology*, **26**, 27-36.

Brown, C.J., Hewer, A.J., Meadows, W.J., Limpenny, D.S., Cooper, K.M. and Rees, H.L. (2004b). Mapping seabed biotopes at Hastings Shingle Bank, eastern English Channel. Part 1. Assessment using sidescan sonar. *Journal of the Marine Biological Association of the United Kingdom,* **84**, 481-488.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. and Reker, J.B. (2004). *The marine habitat classification for Britain and Ireland (version 04.05)*. Joint Nature Conservation Committee, 49 pages.

Doran, J. (2009). Islay Demonstration Tidal Array – Site Surveys 2009. Literature review. A report produced for Scottish Power Renewables, 20 pages.

Farrow, G., Scoffin, T., Brown, B. and Cucci, M. (1979). An underwater television survey of facies variation on the inner Scottish shelf between Colonsay, Islay and Jura. *Scottish Journal of Geology.* **15**, 13-29.
Hall-Spencer, J. M. and Moore, P. G. (2000). Scallop dredging has profound, long-term impacts on maerl habitats. *ICES Journal of Marine Science.* **57**, 1407-1415.

Hammerfest Strøm (2009). Environmental Studies in Kvalsund Finnmark. [online]. Available from: http://www.hammerfeststrom.com/content/view/56/82/lang,en/.

Hiscock, K. (1983). Sublittoral survey of Jura and Islay. A report to the Nature Conservancy Council from the Field Studies Council, volume 1, survey report, 31 pages.

Hiscock, K. and Seeley, B. (2006). Quality assurance of biotope classification from drop-down video footage. *Report to Countryside Council for Wales from the Marine Life Information Network (MarLin).* Plymouth: Marine Biological Association of the UK, 20 pages.

Howson, C.M. and Picton, B.E. 1997. *The species directory of the marine fauna and flora of the British Isles and surrounding seas.* Ulster Museum Publication, 276. The Ulster Museum: Belfast, UK.

Leeder, M.R. (1982). *Sedimentology – process and product*. Chapman and Hall, 344 pages.

Masson, D.G., Bett, B.J., Billett, D.S.M., Jacobs, C.L., Wheeler, A.J. and Wynn, R.B. (2003). The origin of deep-water, coral-topped mounds in the northern Rockall Trough, Northeast Atlantic. *Marine Geology*, **3288**, 1-22.

MCT (2009a). *Marine Current Turbines (MCT) - Turning the Tide.* Outling plans by Marine Current Turbines for SeaGen's Installation in Strangford Lough [online]. Available from: http://www.marineturbines.com/3/news/article/4/marine_current_turbines_outlines_plans_for_seagen_s_installation_in_strangford_lough/ (retrieved in June 2009).

MCT (2009b). *Baseload supply strategy – environmental impact.* An assessment of Marine Current Turbines [online]. Available from: http://www.esru.strath.ac.uk/EandE/Web_sites/03-04/marine/env_impact.htm#ref (retrieved in June 2009).

NIHAP (2003). Northern Ireland Habitat Action Plan – tidal rapids. Available (online) http://www.ni-environment.gov.uk/natural/biodiversity/tidal_rapids_web_version_april_03.pdf (retrieved in August 2009).

Nunn, J. 1992. The molluscan fauna associated with maerl. *Conchologist's Newsletter*. **125**. 161-167.

Plaza, J. and Sanderson, W. G. (1997). Rare sea-bed species. In. Barne, J. H., Robson, C. F., Kaznowska, S. S., Doody, J. P., Davidson, N. C. and Buck, A. L. (eds.). *Coasts and seas of the United Kingdom. Region 14. South-west Scotland. Ballantrae to Mull.* Peterborough: Joint Nature Conservation Committee, 229pp.

Ritche, W. and Crofts, R. (1974). *The Beaches of Islay, Jura and Colonsay*. University of Aberdeen, Department of Geography. The Countryside Commission for Scotland (June 1973), 194pp.

Sanderson, W.G. and Holt, R.H.F (2001). Update to: Procedural guideline No. 3-5 identifying on adjacent fisheries. *Science*, **294**, 1920-1923.

Scottish Government (2007). Renewable Energy Potential 27/11/2007. *Scottish Government News*. Available from: http://www.scotland.gov.uk/News/Releases/2007/11/27095600.

Seasearch (1999). Islay Seasearch Survey July/August 1999 Summary Report. [online]. Available from www.seasearch.co.uk.

Service, M. and Golding, N. (2001). Procedural guideline No. 3-14 *In-situ* survey of sublittoral epibiota using towed sledge video and still photography. In, *Marine Monitoring Handbook,* (eds) Jon Davies, John

Baxter, Martin Bradley, David Connor, Janet Khan, Eleanor Murray, William Sanderson, Caroline Turnball, Malcolm Vincent, JNCC, Peterborough.

SPR (2008). *Proposed Demonstration Tidal Site, Sound of Islay*. Request for a Scoping Opinion by Scottish Power Renewables. Available [online] from http://www.scottishpowerrenewables.com/userfiles/file/Scoping%20Report-Islay.pdf.

Stevens, T. and Connolly, R.M. (2005). Local-scale mapping of benthic habitats to assess representation in a marine protected area. *Marine and Freshwater Research*, 56, 111-123.

UKBAP (2008). *UK Biodiversity Action Plan Priority Habitats Descriptions*. Edited by Ant Maddock [online]. Available from: http://www.ukbap.org.uk/library/UKBAPPriorityHabitat DescriptionsfinalAllhabitats20081022.pdf (retrieved in June 2009).

UKBAP (2009). Habitat Action Plan – tidal rapids. UK Biodiversity Action Plan. Available (online): http://www.ukbap.org.uk/UKPlans.aspx?ID=39#1 (retrieved on 20 August 2009).

UK Biodiversity Group (1999). *Volume V: Marine Habitats and Species*. UK Biodiversity Group Tranche 2 Action Plans (Vol V), 161 [online]. Available from: www.ukbap.org.uk/ UKPlans.aspx?ID=40 (retrieved in June 2009).

Wilding, T. A., Hughes, D. J. and Black, K. D. (2005). The benthic environment of the North and West of Scotland and the Northern and Western Isles: sources of information and overview. Report 1 to *METOC* by the Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

APPENDIX I. EQUIPMENT SPECIFICATIONS

Positioning
Leica RTK GPS (GX1230 Real Time Rover System)
Accuracy: Horizontal: 10mm + 1ppm, kinematic
Vertical: 20mm + 1ppm kinematic

Survey management software
Hypack 2008

Single beam echosounder
Mariamatech E-Sea sound dual frequency (33/200KHz) echosounder

Sound velocity probe
Marimatech HMS 1820-P CTD
Range: 0-250m. Temperature -55˚C - +55˚C. Salinity 1-60
Resolution: Depth 1cm, Temperature 0.01˚C, Salinity 0.001
Accuracy: Depth 0.1% of range, temperature ± 0.1˚C. Salinity ±0.001

APPENDIX II. STILL PHOTOGRAPHY AND VIDEO RECORDS ACQUIRED DURING THE DROP-DOWN CAMERA SURVEY 2009

Client	Scottish Power Renewables	Job Number	J/09/179
Location	Sound of Islay	Vessel	MV Margaret Sinclair
Survey	Islay Demonstration Tidal Array - Camera Survey 2009	Date	June 2009

DATE	Site name	Location	SOL/EOL Time (GMT)	Video duration	miniDV tape no	Photos	Start/End Of Line Position East (m)	North (m)	Depth (m)
13/06/2009	Islay	01	07:44:18	00:34:52	11	32	681844.01	6192121.17	45.63
	Islay	01	08:19:10				681625.86	6193010.8	48.8
11/06/2009	Islay	02	13:19:55	00:41:57	3	51	681551.63	6193100.05	46.12
	Islay	02	14:01:52				681794.93	6192108.48	52.1
12/06/2009	Islay	03	07:59:45	00:53:51	6	65	681772.81	6192040.72	58.67
	Islay	03	08:53:36				681500.44	6193100.05	48.83
12/06/2009	Islay	04	09:45:33	00:50:14	7	61	681736.26	6192036.63	55.51
	Islay	04	10:35:47				681462.71	6193075.79	49.65
12/06/2009	Islay	05	16:19:14	00:42:28	10	66	681410.63	6193140.06	47.44
	Islay	05	17:01:42				681651.05	6192105.99	47.39
13/06/2009	Islay	06	09:03:23	00:55:52	16	54	681983.46	6191105.52	38.37
	Islay	06	09:59:15				681851.67	6192162.48	40.26
11/06/2009	Islay	07	14:18:46	00:46:46	4	48	681796.52	6192164.65	51.7
	Islay	07	15:05:32				681879.29	6191291.98	50.97
13/06/2009	Islay	08	10:07:08	00:54:04	13	48	681858.93	6191129.83	48.94
	Islay	08	11:01:12				681621.04	6192474.12	60.96
11/06/2009	Islay	09	17:27:33	00:23:58	5	38	681698.62	6191961.59	53.41
	Islay	09	17:51:31				681798.03	6191183.26	49.26
12/06/2009	Islay	10	14:27:26	00:44:20	9	58	681644.52	6192123.71	45.93
	Islay	10	15:11:46				No Data	No Data	No Data
10/06/2009	Islay	11	08:58:16	00:26:44	1	36	681676.81	6191265.16	39.22
	Islay	11	09:25:00				No Data	No Data	No Data
11/06/2009	Islay	12	12:28:01	00:08:54	2	14	681591.35	6192545.85	60.13
	Islay	12	12:36:55				681581.27	6192807.43	54.91
12/06/2009	Islay	13	11:22:19	00:11:31	8	15	681667.11	6192479.78	59.2
	Islay	13	11:33:50				681650.65	6192786.88	52.71
11/06/2009	Islay	14	11:40:23	00:14:13	2	21	681638.68	6192272.34	56.2
	Islay	14	11:54:36				681658.62	6192692.06	54.51
11/06/2009	Islay	15	11:06:42	00:15:05	1	21	681747.68	6191998.88	54.91
	Islay	15	11:21:47				681737.59	6192315.94	55.91
13/06/2009	Islay	16	12:56:38	00:22:02	14	23	681862.84	6191278.97	50.84
	Islay	16	13:18:40				681855.09	6191786.67	47.32
13/06/2009	Islay	17	14:06:00	00:19:27	14	19	681747.64	6191783.88	54.46
	Islay	17	14:25:27				681759.34	6191282.23	49.55
13/06/2009	Islay	18	14:37:16	00:22:06	15	18	681692.66	6191784.90	51.18
	Islay	18	14:59:22				No Data	No Data	No Data
12/06/2009	Islay	19	13:26:02	00:17:08	8	25	681637.55	6191677.67	45.98

	Islay	19	13:43:10				681411.46	6191247.30	9.89

Client	Scottish Power Renewables						Job Number	J/09/179	
Location	Sound of Islay						Vessel	MV Margaret Sinclair	
Survey	Islay Demonstration Tidal Array - Camera Survey 2009						Date	June 2009	
12/06/2009	Islay	21	13:55:56	00:17:49	8+9	24	681722.48	6191649.02	53.35
	Islay	21	14:13:45				681484.68	6191193.27	11.36
13/06/2009	Islay	22	13:33:40	00:20:04	14	23	681510.03	6191181.46	10.33
	Islay	22	13:53:44				681771.29	6191626.83	54.23
11/06/2009	Islay	23	12:47:42	00:09:00	2	17	681621.08	6192808.87	53.85
	Islay	23	12:56:42				681363.17	6192978.94	25.99
11/06/2009	Islay	24	12:06:55	00:10:32	2	21	681571.65	6192770.08	56.59
	Islay	24	12:17:27				681350.34	6192913.71	16.4
12/06/2009	Islay	25	07:28:38	00:12:59	5	21	681438.57	6192761.13	44.35
	Islay	25	07:41:37				681362.91	6193054.02	37.71
13/06/2009	Islay	26	14:52:28	01:01:44	19	38	681825.51	6191148.98	47.31
	Islay	26	15:54:12				681668.72	6189337.92	8.76
13/06/2009	Islay	27	12:02:20	00:10:15	17	12	681672.17	6189131.63	8.44
	Islay	27	12:12:35				No Data	No Data	No Data
13/06/2009	Islay	28	12:19:31	00:07:59	17	13	681636.44	6189219.26	8.27
	Islay	28	12:27:30				681714.23	6189344.88	10.44
13/06/2009	Islay	29	12:35:12	00:04:43	17	8	681588.39	6189249.85	8.13
	Islay	29	12:39:55				681660.08	6189374.28	9.33
12/06/2009	Islay	30	10:54:47	00:16:28	8	20	681816.15	6192137.54	47.72
	Islay	30	11:11:15				681808.67	6192646.99	38.96
13/06/2009	Islay	31	15:09:57	00:20:31	15	21	681875.54	6192126.56	32.69
	Islay	31	15:30:28				681877.42	6191597.14	52.42
13/06/2009	Islay	32	15:41:08	00:18:17	15	19	681932.35	6191611.07	44.09
	Islay	32	15:59:25				681930.30	6191113.36	44.21
13/06/2009	Islay	33	09:00:53	00:47:03	12	42	681482.33	6193045.48	50.63
	Islay	33	09:47:56				681030.12	6193781.22	11.82
13/06/2009	Islay	35	08:29:43	00:18:19	11	19	681579.69	6192629.94	60.65
	Islay	35	08:48:02				681575.54	6192652.11	60.13
13/06/2009	Islay	36	12:56:25	00:15:31	17	22	681538.90	6190788.48	13.3
	Islay	36	13:11:56				681542.22	6190310.16	13.83
13/06/2009	Islay	37	13:19:04	00:20:25	17	19	681594.66	6190307.09	17.15
	Islay	37	13:39:29				No Data	No Data	No Data
13/06/2009	Islay	38	13:51:23	00:14:35	18	18	681667.64	6190307.60	22.43
	Islay	38	14:05:58				681647.45	6190846.81	14.28
13/06/2009	Islay	39	14:14:33	00:16:38	18	13	681687.44	6190829.82	16.23
	Islay	39	14:31:11				681692.51	6190315.45	20.77

APPENDIX III. SPECIES LIST

No	Phylum / Group	MCS alpha	MCS num	Genus	Species
1	**ALGAE**	ZM	1	RHODOPHYCOTA	Red algae
2		ZM	255	*Phymatolithon*	*calcareum*
3		ZM	507	*Ceramium*	*sp.*
4		ZR	349	*Laminaria*	*sp.*
5		ZR	351	*Laminaria*	*hyperborea*
6		ZR	354	*Laminaria*	*saccharina*
7		ZR	393	*Sargassum*	*muticum*
8	**PORIFERA**	C	1	**PORIFERA**	sp.
9		C	233	*Pachymatisma*	*johnstonia*
10		C	358	*Polymastia*	*boletiformis*
11		C	457	*Stelligera*	*stuposa*
12		C	480	*Cliona*	*celata*
13		C	651	*Halichondria*	*panicea*
14		C	758	*Amphilectus*	*fucorum*
15		C	943	*Hymedesmia*	*paupertas*
16		C	1420	*Haliclona*	sp.
17	**CNIDARIA**	D		Hydroid	sp. SAT
18		D	166	*Tubularia*	*indivisa*
19		D	167	*Tubularia*	*larynx*
20		D	227	*Eudendrium*	*ramosum*
21		D	397	*Halecium*	*plumosum*
22		D	409	*Abietinaria*	*abietina*
23		D	413	*Diphasia*	*sp.*
24		D	424	*Hydrallmania*	*falcata*
25		D	434	*Sertularia*	*argentea*
26		D	462	*Nemertesia*	sp.
27		D	463	*Nemertesia*	*antennina*
28		D	466	*Nemertesia*	*ramosa*
29		D	520	*Obelia*	*geniculata*
30		D	583	Anthozoa	sp.
31		D	597	*Alcyonium*	*digitatum*
32		D	662	*Actiniaria*	sp.
33		D	682	*Urticinia*	sp.
34		D	683	*Urticinia*	*eques*
35		D	684	*Urticinia*	*felina*
36		D	715	*Sagartia*	*troglodytes*
37		D	719	*Actinothoe*	*sphyrodeta*
38		D	775	*Corynactis*	*viridis*
39		P	811	*Chaetopterus*	tubes
40		P	1324	Serpulidae	sp.
41		P	1339	*Pomatoceros*	sp.
42		P	1360	*Salmacina*	sp.
43		P	1391	*Spirorbis*	sp.
44	**CRUSTACEA**	R	14	Cirripedia	sp.
45		S	1276	Decapod	sp.
46		S	1445	Paguridae (Hermit crab)	sp
47		S	1512	Majidae	sp.
48		S	1566	*Cancer*	*pagurus*
49		S	1577	*Liocarcinus*	sp
50	**MOLLUSCA**	W	1	**MOLLUSCA**	sp. egg spawn
51		W	88	Gastropoda	sp.
52		W	156	Topshell	TROCHINAE
53		W	182	*Calliostoma*	*zizyphinum*
54		W	439	*Crepidula*	*fornicata*
55		W	708	*Buccinum*	*undatum*
56		W	1560	Bivalvia (PELECYPODA)	sp.
57		W	1695	*Mytilus*	*edulis*
58		W	1771	*Pecten*	*maximus*
59	**BRYOZOA**	Y	4	Crisiidae	sp.
60		Y	76	*Alcyonidium*	*diaphanum*
61		Y	187	*Flustra*	*foliacea*
62		Y	194	*Securiflustra*	*securifrons*
63		Y	240	*Bugula*	sp.
64	**ECHINODERMATA**	ZB	10	*Antedon*	*bifida*
65		ZB	18	Asteroidea	sp.
66		ZB	74	*Crossaster*	*papposus*
67		ZB	82	*Henricia*	sp.
68		ZB	100	*Asterias*	*rubens*
69		ZB	104	*Marthasterias*	*glacialis*
70		ZB	198	*Echinus*	*esculentus*
71	**TUNICATA**	ZD	2	ASCIDIACEA	sp.
72		ZD	83	*Ascidiella*	sp.
73		ZD	125	*Botryllus*	sp.
74	**EUCHORDATA**	ZG	7	TELEOSTEI (Fish indet.)	sp.
75		ZG	282	*Taurulus*	sp.
76		ZG	386	Labridae (Wrasse indet.)	sp.
77		ZG	397	*Ctenolabrus*	*rupestris*
78		ZG	399	*Labrus*	*bergylta*
79		ZG	400	*Labrus*	*mixtus*
80		ZG	440	*Pholis*	*gunnellus*

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 8 – Benthic Ecology.

Appendix 8.2: “Sound of Islay Proposed Tidal Array Cable Route – Drop Down Video Survey”

Sound of Islay Proposed Tidal Array Cable Route

Drop Down Video Survey

10 Bernard Street
Leith
Edinburgh EH6 6PP
United Kingdom

+44 (0)131 555 0506	Telephone
	Fax
info@edinburgh.royalhaskoning.com	E-mail
www.royalhaskoning.com	Internet

Document title	Sound of Islay Proposed Tidal Array Cable Route Drop Down Video Survey
Document short title	
Status	Final Report
Date	12th April 2010
Project name	
Project number	9T3474
Client	Scottish Power Renewables
Reference	9T3474/R/303719/Edin

Scottish Power Renewables

12th April 2010
Final Report
9T3474

Drafted by	Gemma Bedford	
Checked by	Frank Fortune	
Date/initials check	…………………..	…………………..
Approved by	Frank Fortune	
Date/initials approval	…………………..	…………………..

CONTENTS

1 INTRODUCTION

1.1 Project Background

Scottish Power Renewables (SPR) is proposing to develop a demonstration tidal array in the Sound of Islay, with up to 10 Hammerfest Strøm devices with a capacity of 1MW each. The deployment will be subject to the required Consents and Licenses being obtained. The tidal array will be the first of its kind and because of its scale (10MW of under) is viewed as a ‘demonstration tidal array’ by The Crown Estate and Marine Scotland.

In addition to the tidal devices within the proposed array, there will be associated infrastructure including subsea and landfall cable(s), control building, substation and onshore access. Following the inclusion of three landfall options on Jura to the east of the Sound of Islay, Royal Haskoning was commissioned to carry out a cable route survey from 23rd to 25th March 2010 in collaboration with Campbell Marine Contracts and Aquatic Survey and Monitoring Ltd (ASML). The cable route survey augmented the data adds to the data collected by a drop down video survey the turbine array area undertaken by Seastar Ltd in 2009.

1.2 Site Location

Islay is the most southerly of the main Inner Hebridean Islands on the west coast of Scotland. The proposed turbine array will be located within the Sound of Islay, the stretch of water that separates the islands of Jura (to the east) and Islay (to the west). The Sound is approximately 1km wide and reaches 62m in depth. The proposed site lies within the local authority area of Argyll and Bute Council.

The layout of the tidal turbines within the Sound of Islay is shown in Figure 2.1 along with the proposed cable routes to the preferred landfall sites on Jura.

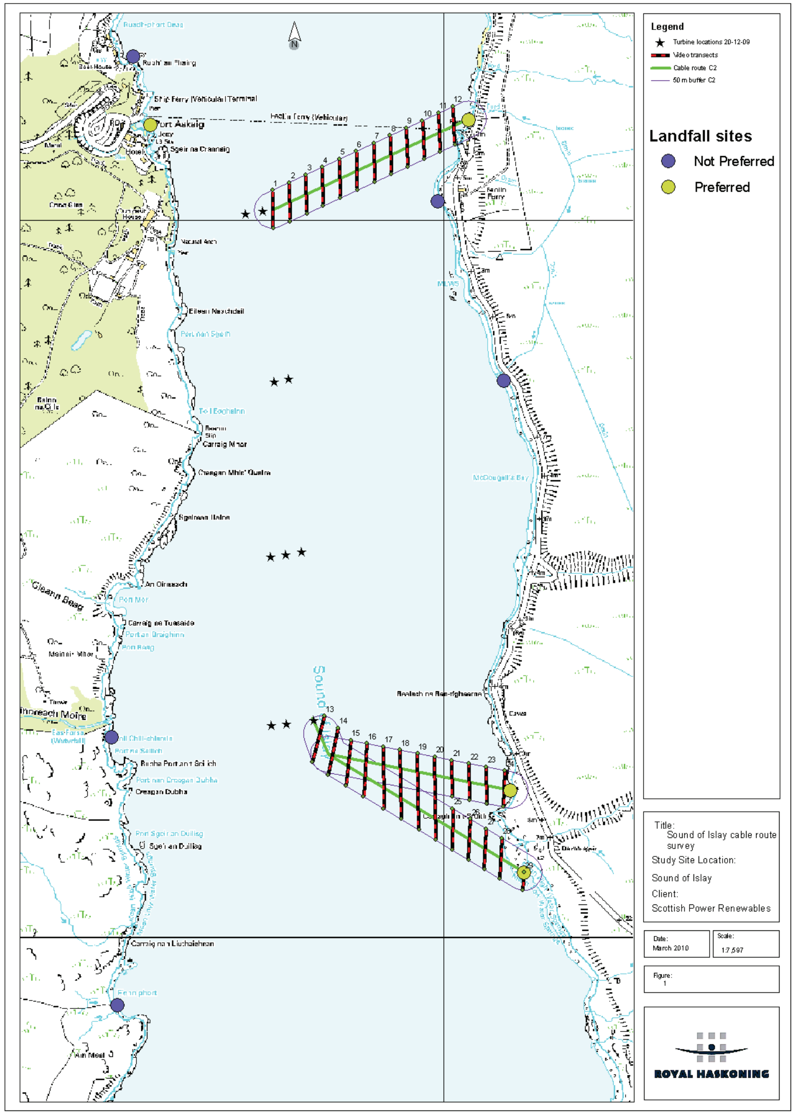


Figure 2.1 Location of proposed cable routes and drop video transects

2 METHODOLOGY

2.1 Transect Selection

Three possible cable routes were surveyed following correspondence with SPR to confirm the potential routes being considered.

Because of the strong tidal conditions in the sound a series of transects were planned which approximately bisected the cable routes at a number of locations along each cable route, with start and end coordinates generated prior to the survey. Each transect was orientated so that they ran in the approximate direction of the prevailing tidal currents, at 50m intervals (Figure 2.1) along the cable route. As a result, each transect provided data for a buffer area of 25m on either side of the proposed cable route, along the length of each transect.

Transects 24, 28 and 29 were not complete due to their shallow depth and proximity to either the shore or rocky outcrops.

2.2 Equipment

2.2.1 Camera

The ASML drop-down video system (Figure 2.2) uses a Sony DRV 950 camera in an aluminium housing rated to 130m. The lights are powered by an independent surface 110v system (generator or vessel supplied) and so do not rely on battery power.

Figure 2.2 Drop down camera equipment

The system can be controlled from the surface. The digital video footage can be recorded in the camera and simultaneously relayed to the surface via the umbilical where it is viewed and recorded on a Sony mini digital VCR. The surface control box provides remote control facilities for both the camera and the lights, and it is possible to toggle between the camera and mini DV recorder to record on either, enabling an instant back up to be obtained during the fieldwork if required.

Contemporaneous notes are made whilst the video is deployed, so that the operators have an idea of the variety of biotopes that have been encountered as well as the depths and habitat type present on the seabed, as the survey progresses.

2.2.2 Vessel

A small survey vessel was used for the cable route survey (Figure 2.3, below). One outboard engine providing high manoeuvrability was used with a small backup outboard engine which was not used. A cover was placed over the vessel to protect the electrical equipment when required. The small draft on the vessel allowed very shallow sites inshore sites to be surveyed.

Figure 2.3 Survey vessel used for cable route survey

2.3 Field work

Drop down video proved most practicable within the period of 2 hours either side of slack water at high and low tide.

In the morning of 24th March 2010 winds were too strong and survey did not commence until approximately 2pm when the winds dropped sufficiently. Successful footage was achieved for each of the further inshore transects, following the predetermined transect lines with relatively good accuracy.

On the 25th March transects 1-6 were attempted early in the morning, however due to an error with the published tide table the currents were too strong and as the footage not of satisfactory quality the survey was postponed to wait for better conditions. Survey was restarted when currents had dropped to suitable speeds, however the wind had picked up, with the canopy on the survey vessel adversely affecting manoeuvrability as a result. The transect lines were followed with greater difficulty due to the conditions, however, good quality footage was obtained and sufficient drop down video was collected to satisfactorily bisect the proposed cable routes at multiple locations along the transect..

2.4 Video analysis

Analysis of the videos was carried out using AVS DVD player, with video footage viewed using a high-specification desktop computer. This system allows frame-by-frame and standard play analysis.

During video analysis the following information was recorded:

- MiniDV number;

- Transect number;
- Survey date;
- Start and end waypoints;
- Time on the tape at start and end of transect;
- Substrate description; and
- Species.

2.4.1 SACFOR

During video analysis tally marks were used to count the number of individuals or an estimated percentage was assigned to appropriate species.

An approximate width of view and transect length was used to estimate the area of each transect. This area was used to assign semi-quantitative abundances as per the SACFOR scale.

Where a clear biotope change was encountered within a transect the time of the footage was noted and the species counts started from zero again. In these instances the length of the biotope was estimated using GIS plotted positions and the area for estimation and use with the SACFOR scale was calculated accordingly.

2.4.2 Biotopes

Biotopes (as per Connor *et al*. 2004) were assigned to each transect using the protocol outlined in table 2.1.

Table 2.1 Protocol for tagging video samples according to the heterogeneity of the seabed as viewed on the video. Adapted from Moore & Bunker (2001).

Heterogeneity of the video	**Protocol for tagging samples**
Recording is of one single, unambiguous biotope representing 100% of the record.	One biotope tag.
Record is of two or more biotopes along a transect.	Transect is divided into two or more records. Each record is given one biotope tag.
Key features or species can not be recognised from the video.	The record is tagged with a higher level biotope classification.
The record shows a mixture of two or more biotopes arranged patchily within a single video transect.	The record is tagged with the predominant biotope but the other biotopes present are noted.
The record has features which indicate that it could be regarded as lying between two or more biotope classes.	The record is tagged with the most likely biotope but a record is made as to the issues with the assigned biotope

3 RESULTS

3.1 Substrate

The study area for this cable route survey was predominantly found to have a substrate of boulders, cobbles and pebbles. Some small areas of bedrock and sand overlying bedrock were also recorded.

3.2 Biotopes

Details of the biotopes recorded during the cable route survey can be found in table 3.1 with example pictures in table 3.2 and a map shown in figure 3.1.

Large areas of kelp were recorded during the cable route survey resulting in high numbers of kelp park (IR.MIR.KR.LhypTX.Pk) and kelp forest (IR.MIR.KR.LhypTX.Ft) biotopes.

Red seaweeds were found in high numbers throughout the infralittoral zone and were the dominant species in transect 7, resulting in the classification of the ‘*Polyides rotundus, Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock’ (IR.HIR.KSed.ProtAhn) although no *Ahnfeltia plicata* was visible on the footage.

High abundances of red coralline algae were recorded throughout the study area providing one record of the ‘coralline crusts in surge gullies and scoured infralittoral rock’ biotope (IR.FIR.SG.CC) being found in a highly tidal environment rather than the surge gullies as described by Connor *et al* 2004. . With this algal crust high numbers of echinoderms were also found in some areas and so the ‘echinoderms and crustose communities’ biotope (CR.MCR.EcCr) was assigned.

Areas with high abundance of *Flustra foliacea, Urticina* spp. and *Alcyonium digitatum* were assigned the biotopes CR.MCR.EcCr.FaAlCr.Flu, CR.MCR.EcCr.UrtScr and CR.MCR.EcCr.FaAlCr.Adig respectively.

One inshore transect was found to have high levels of *Sabella pavonica* and so the SS.SMx.IMx.SpavSpAn biotope was assigned. On the outskirts of kelp forest at the northern cable route option an area of dense *Ulva* spp. was recorded and the LR.FLR.Eph.Ent assigned. Areas dominated by foliose red seaweeds and *Fucus serratus* were assigned the LR.HLR.FR biotope.

Table 3.1: Biotopes recorded during cable route survey

Biotope Code	JNCC Biotope Description	Comments from survey	Number of Occurrences
SS.SMx.IMx.SpavSpAn	*Sabella pavonina* with sponges and anemones on infralittoral mixed sediment	No sponges recorded	1
LR.HLR.FR	Robust fucoid and/or red seaweed communities	Dense with red seaweeds or *Fucus serratus*. Green and brown algae, including kelps and *Ulva* spp. were also present.	2
LR.FLR.Eph.Ent	*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock	Biotope a good fit with JNCC description except substrate of boulders, cobbles & pebbles instead of sand/ mud. *Enteromorpha* recorded as *Ulva* due to recent taxonomic changes.	1
IR.FIR.SG.CC	Coralline crusts in surge gullies and scoured infralittoral rock	Tidal rather than surge gully	1
IR.MIR.KR.LhypTX.Pk	*Laminaria hyperborea* park and foliose red seaweeds on tide-swept lower infralittoral mixed substrata	Biotope a good fit with JNCC description	7
IR.MIR.KR.LhypTX.Ft	*Laminaria hyperborea* forest and foliose red seaweeds on tide-swept upper infralittoral mixed substrata	Biotope a good fit with JNCC description	3
IR.HIR.KSed.ProtAhn	*Polyides rotundus*, *Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock	No *Ahnfeltia plicata* recorded	1
CR.MCR.EcCr.UrtScr	*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock	Biotope a good fit with JNCC description	1
CR.MCR.EcCr.FaAlCr.Flu	Flustra foliacea on slightly scoured silty circalittoral rock	Biotope a good fit with JNCC description	2
CR.MCR.EcCr.FaAlCr.Adig	*Alcyonium digitatum*, *Pomatoceros triqueter*, algal and bryozoan crusts on wave-exposed circalittoral rock	No bryozoan crusts recorded	1
CR.MCR.EcCr	Echinoderms and crustose communities	Most records were infralittoral with red foliose algae as well as Echinoderms, pink coralline crustose algae and occasionally indeterminate orange crusts.	7
CR.HCR.FaT.CTub.Adig	*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock	Biotope a good fit with JNCC description	2

Figure 3.1 Biotope Map

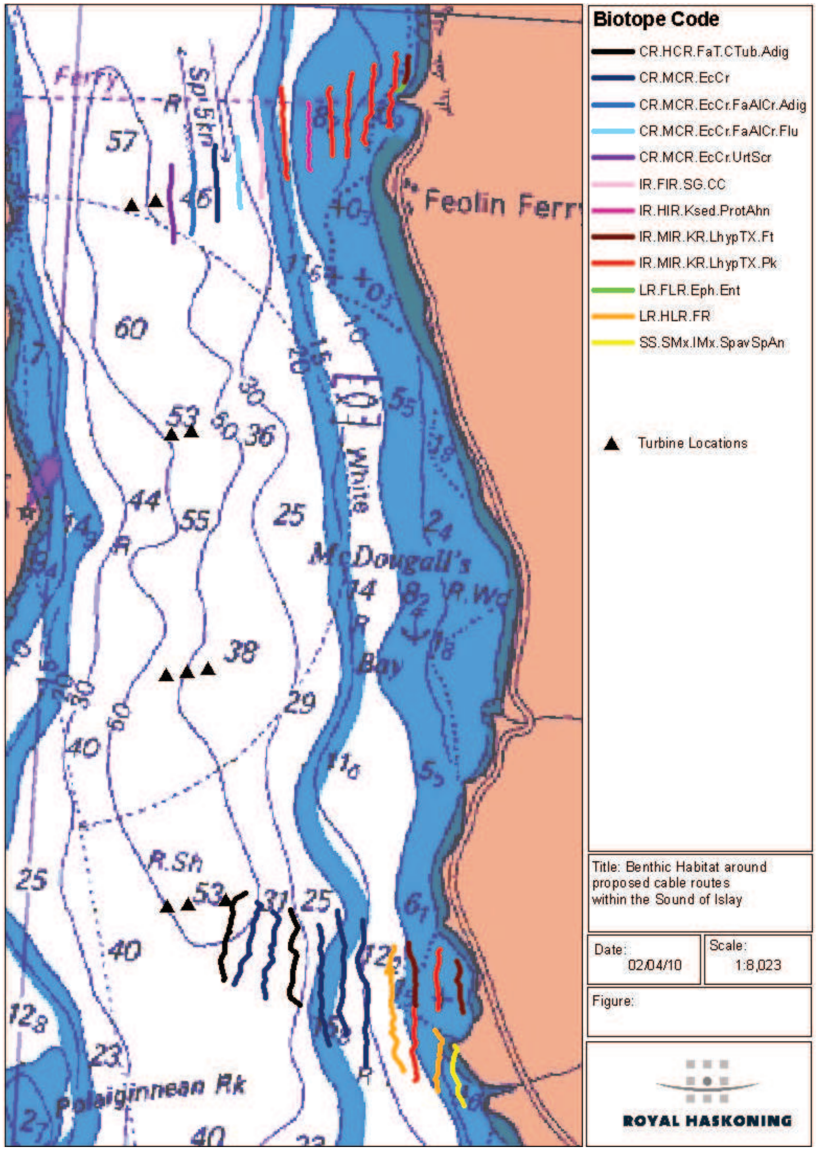
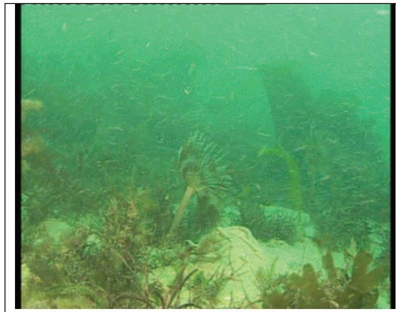
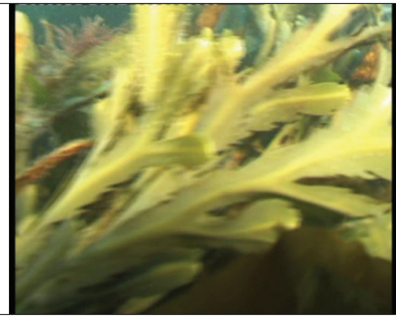
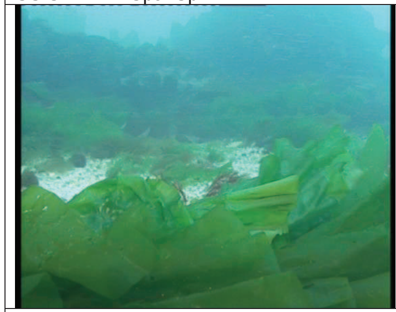
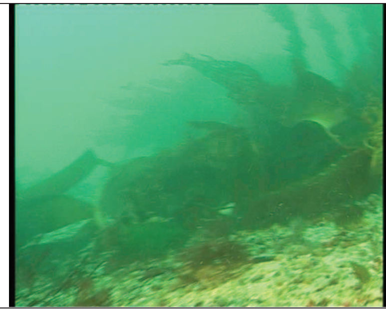
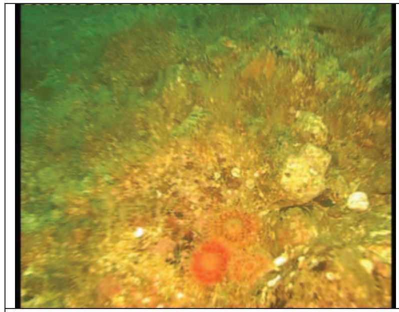


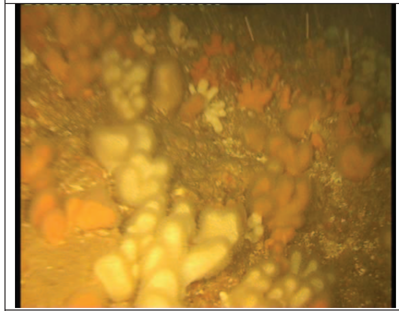
Table 3.2 Biotope pictures

	
SS.SMx.IMx.SpavSpAn	LR.HLR.FR
	
LR.FLR.Eph.Ent	IR.MIR.KR.LhypTX.Pk
	
IR.MIR.KR.LhypTX.Ft	IR.HIR.KSed.ProtAhn



CR.MCR.EcCr.UrtScr

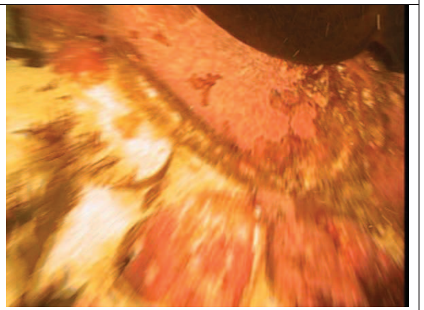
CR.MCR.EcCr.FaAlCr.Flu



CR.MCR.EcCr.FaAlCr.Adig

CR.MCR.EcCr

CR.HCR.FaT.CTub.Adig



IR.FIR.SG.CC

3.3 Species of Interest

No species of conservation interest were recorded during the cable route survey.

Common species which are widely distributed around the UK were recorded including kelps and fucoids, the echinoderms *Urticina* spp., *Crossaster papposus* and *Asterias rubens*, and red seaweeds including *Chondrus crispus, Polyides/ Furcellaria, Palmaria palmata, Porphyra* and *Delesseria.*

4 DISCUSSION

4.1 Survey limitations

Strong winds limited the survey time with the 23rd March not survey and survey on the 24th not commencing until around 14:00hrs. Tidal currents also limited survey effort with approximately 2hrs either side of slack water at high and low tide providing suitable conditions for the drop down video survey. Due to an error on the tide tables on the 25th March the early morning slack water was missed and so the survey continued and was completed during late morning and the afternoon.

A number of attempts were made at some transects in order to capture footage of suitable quality for video analysis.

4.2 Video analysis limitations

Drop down video provides a useful methodology for assessing the habitat and species composition over a broad area and in environments potentially hazardous to divers.

Identification of some marine fauna to species level is not possible using video and so the highest taxonomic name was used where necessary.

Given strong tidal currents and wind driven surface currents footage was occasionally blurred if moving quickly along the seabed. In these circumstances the possible species identification was limited.

5 CONCLUSION

The species recorded during this survey are typical of a tide swept, high energy site. The infralittoral transects were dominated by kelp and red seaweeds and the circalittoral zones had high numbers of echinoderms, including *Crossaster papposus, Asterias rubens* and *Echinus esculentus,* the anemone *Urticina* spp. and dead man’s fingers, *Alcyonium digitatum.*

All species recorded are common and widely distributed around Scotland and the UK.

No species of conservation interest were recorded.

6 APPENDIX I RAW SPECIES DATA

	Transect																														
Species	**1**	**2 biotope 1**	**2 biotope 2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12 biotope 1**	**12 biotope 2**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Abietinaria abietina			o												o	o										Transect abandoned - too shallow				Transect abandoned - too shallow	Transect abandoned - too shallow
Alaria esculenta							o			o	o	f										o		o				f			
Alcyonium digitatum		a													o		o	a	o												
Asterias rubens	f	o	f	o	o	o	o								f	o	o	o	o	o	o	r									
Balanus balanus/ crenatus																							r								
Barnacles indet															r	r	r	f													
Indet bivalve	o																														
Brown filamentous algae														r															f		
Buccinum undatum	o														o																
Calliostoma zizyphinum	r																					o									
Callophyllis laciniata											o	r																			
Cancer pagurus	o		o	o											o																
Chondrus crispus								f	r	o		r		o								o	r	r	r		r	o			
Chorda												o		f											o				r		
Cliona																		r	r	r											
Codium												r																			
Coralline crusts				r		o	c	o	r	f	r	r	r		r	r		r	o	f	o	c	f	r	r		c				
Corynactis viridis																	o ?														
Crossaster papposus	f		f												f	f	o	o													
Cryptopleura ramosa																						r	o		o			o			
Decapoda																						r									
Delesseria sanguinea								o		o	o	r							f	r		r		o				r			
Desmarestia aculeata											o	r										r		r	r						
Dictyota dichotoma												r								r				r	o						
Dilsea carnosus								o			o	o							r			o		o	o		r	o	o		
Diphasia																	o														
Echinus esculentus	f	f	f	o					r		o				o	f	f	f	o	r		o	o				o				
Flustra foliacea	f		f	o	o										c	c	c	o	o												
Fucus serratus																						r			r		r	r	c		
Green filamentous													o	o																	
Halichondria							r																								
Halidrys siliquosa											o	o												r	r			r			
Henricia oculata																o	r														
Himanthalia elongata																								o	o						
Hydroids indet	o						r								o	f		f													
Hydroid turf	o		a	o	o										c	o			c	f											
Laminaria spp.					r	o													c	r											
Porifera encrusting (orange)						o											r	r	r		r	o									
Laminaria digitata												r											f		f			f			
Laminaria hyperborea							c	c	c	c	c	r	s								f	r	s	c	c		f	f	f		
Littorina littorea								o	o	o												r		o	o			r			
Luidia ciliaris	f		o																												
Lomentaria																								r							
Maja											o														r						

	Transect																														
Species	**1**	**2 biotope 1**	**2 biotope 2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12 biotope 1**	**12 biotope 2**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Marthasterias glacialis																f															
Membranoptera membranacea																						r	r								
Necora puber										r																					
Nemertesia Ramosa																o															
Odonthalia dentata												o										r									
Pagurus bernhardus	r		r							r					o	r									r						
Palmaria palmata								o		r														r				r	f		
Phycodrys rubens																						o	r	o			r				
Phyllophora crispa								r																							
Plocamium cartilagineum											r	f										r	o	o	o			r			
Polyides/ Furcellaria								o	o	o														r	r			r			
Polymastia sp																o															
Pomatoceros triqueter	c		f	f	f				r	r		r			f	c	r	r										r			
Porifera																							r								
Porphyra										r		r												r	r						
Red algae								c										r													
Red algae foliose					r	c	r					r								o	o										
Red filamentous algae											r	r		r									r	o							
Sabella																												o	f		
Saccharina latissima							o		o	o	f	f										r	o	f	c			f			
Saccorhiza polyschides												r	f										o	o							
Sertularia argentea															o	o															
Spirorbidae									r		r	r	r											r	r			r	r		
Tubularia indivisa															o	o	r	f													
Ulva									o	r		o	f	a										f	f		r	o	c		
Urticina spp.	f		o				r								f	f	f	o	r	r		r									

7 APPENDIX II RAW SUBSTRATE DATA

Transect	Bedrock	Large Boulders	Medium Boulders	Small Boulders	Cobbles	Pebbles	Empty Shells	Modiolus Shells	Gravel	Sand	Mud	Biotope
1		1	1	10	38	40			10			CR.MCR.EcCr.UrtScr
2 biotope 1	5	65	25						5			CR.MCR.EcCr.FaAlCr.Adig
2 biotope 2		10	10	10	40	20			10			CR.HCR.FaT
3				5	20	5			70			CR.MCR.EcCr
4					50	20			20	10		CR.MCR.EcCr.FaAlCr.Flu
5			20	20	20					40		IR.FIR.SG.CC
6			10	20	20	10				40		IR.MIR.KR.LhypTX.Pk
7					20	20			10	50		IR.HIR.KSed.ProtAhn
8					10	70				20		IR.MIR.KR.LhypTX.Pk
9					20	60			20			IR.MIR.KR.LhypTX.Pk
10				7	30	20			30	13		IR.MIR.KR.LhypTX.Pk
11		30			30	30			10			IR.MIR.KR.LhypTX.Pk
12 biotope 1			90		10							IR.MIR.KR.LhypTX.Ft
12 biotope 2				30	50	20						LR.FLR.Eph.Ent
13				20	70	10						CR.HCR.FaT.CTub.Adig
14			2	3	65	10			20			CR.MCR.EcCr
15		50		20	20	10						CR.MCR.EcCr
16	25		70		5							CR.HCR.FaT.CTub.Adig
17		30	20	20	10	10				10		CR.MCR.EcCr
18		20	20	30	30							CR.MCR.EcCr
19				15	80					5		CR.MCR.EcCr
20			5	10	75					10		LR.HLR.FR
21	30		30	20	10				2	8		IR.MIR.KR.LhypTX.Ft
22				20	20	20				40		IR.MIR.KR.LhypTX.Pk
23			50		20	20				10		IR.MIR.KR.LhypTX.Ft
25	5			20	75							IR.MIR.KR.LhypTX.Pk
26						50				50		LR.HLR.FR
27				10	30	30				30		SS.SMx.IMx.SpavSpAn

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 9 – Marine Mammals

Appendix 9.1: “Sound of Islay Marine Mammal Data for Environmental Statement”

Project Name:	Sound of Islay –marine mammal data for Environmental Statement
Reference:	MMM 0309 SPR - Sound of Islay
Project Manager:	Beth Mackey

Drafted by:	Evelyn Philpott
Checked by:	Sam du Fresne
Approved by:	Kate Grellier
Date:	4th March 2010

1 Contents

2 Executive summary

In order to inform the Environmental Impact Assessment for the installation of an array of tidal turbines in the Sound of Islay, marine mammal data from a variety of sources were collated and examined.

Cetacean data gathered by the Hebridean Whale and Dolphin Trust (HWDT) and the public between the years 2000-2009 have been collated by HWDT and presented here. This includes data collected from boat based line transect surveys and acoustic surveys from both within the Sound of Islay and a larger region outside the Sound itself. Off the west coast of Scotland, the HWDT data suggest the Sound of Islay **Region** has high sightings rates of harbour porpoises, bottlenose dolphins and seals. The main findings from the HWDT study with regard to the Sound of Islay are:

- Boat based visual and acoustic surveys suggest relatively low abundances (relative to the Sound of Islay region) of harbour porpoise, other cetaceans and basking sharks. Moderate abundances of grey and harbour seals were recorded.
- The public sightings data indicate the presence of: harbour porpoise, bottlenose dolphin and whales. Due to biases in the way the data has been collected, this data cannot not be used to inform relative abundances.

A marine mammal monitoring programme, specifically focused on the development site in the Sound of Islay, was designed and implemented in April 2009. Land based marine mammal surveys are currently being undertaken from four vantage points; two on Jura and two on Islay. The observer carries out separate scans for birds and marine mammals.
The preliminary findings from these surveys with regard to the Sound of Islay are:

- Harbour seal, grey seal, harbour porpoise, bottlenose dolphin, otter and basking shark have been recorded.
- Low numbers of cetacean, otter and basking shark seem to occur within the Sound of Islay.
- Both grey and harbour seal frequently use the Sound of Islay.

The Sea Mammal Research Unit (SMRU) carried out aerial surveys of harbour and grey seals along coast surrounding the Sound of Islay, including Islay, Jura, West Kintyre, Colonsay and Oronsay, on 10th and 12th August 2009. In the overall survey area, there was no substantial difference in harbour seal numbers compared with previous surveys (five since 1990). Locally, however, there were changes in harbour seal numbers with a decline in West Kintyre and an increase on Jura. Reasons for these differences are not known and may be, at least in part, due to redistribution. The greatest concentration of harbour seals was on the south-east Islay Skerries, a Special Area of Conservation for harbour seals designated by Scottish Natural Heritage as part of the European Union's Habitats Directive. The key finding of this work is:

- Aerial surveys indicate moderate abundances of seals, relative to the wider Sound of Islay Region, occur within the Sound of Islay.

The tidal array development in the Sound of Islay could potentially have a negative impact on local populations of harbour and grey seals and also on individual cetaceans passing through the area. Some direct impacts such as noise disturbance and indirect impacts on prey resources may have far reaching effects beyond the Sound of Islay.

3 Introduction

A marine mammal monitoring programme, to inform the Environmental Impact Assessment for the installation of an array of tidal turbines in the Sound of Islay, was designed and implemented in April 2009. This monitoring programme consisted of land based visual observations and also an aerial survey for seals. The monitoring programme was agreed in consultation with Scottish Natural Heritage and SMRU Ltd on the 3rd of November 2009.

This monitoring programme was initiated to provide sufficient data to inform the Environmental Impact Assessment of:

- What species are present? (seals, cetaceans, birds, otters and basking sharks).
- What animals use the area for? (behavioural data).
- Where in the area the animals use? (location data such as habitat selection – calm, laminar flow etc).
- When animals use the area? (seasonal, tidal and diurnal influences on relative density).

This document is to inform the Environmental Statement. It includes an introduction to the marine mammals (seals and cetaceans) and basking sharks likely to be found in or around the Sound of Islay and details the methods used to carry out initial baseline data collection and presents the results of this monitoring to date. Only preliminary results of the land based monitoring are presented here as further data collection is currently being undertaken which will allow a more powerful statistical analysis to be carried out. Thus some of the results given here may be subject to change when updated. Historical data gathered by the Hebridean Whale and Dolphin Trust on cetacean distribution in the area around the Sound of Islay and the Southern Sound of Jura (Mandleberg *et al.*,

2010) is also presented here. This dataset is valuable in terms of putting the data collected by the focused marine mammal monitoring programme within the Sound of Islay into a regional context.

3.1 Aerial surveys for seals

The Sea Mammal Research Unit (SMRU) at the Scottish Oceans Institute, University of St Andrews, carries out surveys of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) to contribute to the Natural Environment Research Council's (NERC) statutory obligations under the Conservation of Seals Act 1970 to provide 'scientific advice on matters relating to the management of seal populations' to the UK government. An essential component of this advice is information on the size and distribution of seal populations around the UK, particularly Scotland where over 85% of both species of UK seals are found. The annually submitted advice can be found on SMRU's website at: http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411.

Harbour seals are surveyed during their annual moult, when groups of hauled out seals are at their largest and most consistent in size. Harbour seals hauling ashore on rocky coasts are very well camouflaged and difficult to detect visually. To overcome the problem of detecting seals, SMRU uses a thermal imaging camera mounted in a helicopter to survey groups of seals onshore. Surveys of harbour seals around the Scottish coast are conducted at approximately 5-yearly intervals. Although it takes two or three seasons to complete one full survey, some areas may be surveyed more frequently than others, according to demand for information from any particular area. Although grey seals are also counted during the August harbour seal surveys, numbers during the summer months can be highly variable from day to day. The August grey seal numbers presented here should be interpreted with caution for this reason. The main grey seal surveys are of pups born during their autumn breeding season; all the main breeding colonies in Scotland are surveyed annually. The requirement for developing marine renewable power generating sources has increased the requirement for information on seal distribution and abundance, particularly in areas with strong tidal currents. This report summarises the results of a survey of harbour and grey seals around the Sound of Islay carried out in August 2009 by the Sea Mammal Research Unit. Grey seal pup production estimates from breeding colonies in the vicinity of the Sound of Islay are included.

4 Background information on marine mammals in the area

The waters around the west coast of Scotland and the proposed tidal array development site in the Sound of Islay are used by variety of marine mammals (see Table 1). Cetaceans (whales, dolphins and porpoises) and seals occupy a wide range of ecological niches and are all predators, primarily consuming fish, crustaceans and squid. Cetaceans are classified into two groups by their foraging methods; odontocetes (toothed whales) and mysticetes (baleen whales). Odontocetes are raptorial feeders that attack and consume individual prey items. This group includes the sperm whale (*Physeter macrocephalus*), beaked whales (Family *Ziphiidae)* and all dolphins and porpoises including the killer whale (*Orcinus orca*) and bottlenose dolphin (*Tursiops truncatus*). With the exception of the sperm whale, these animals tend to be smaller than the baleen whales. High frequency sound (several kHz or more) appears to be especially important for these animals as they use it for echolocation to locate prey, communicate and navigate. Mysticete whales have stiff baleen plates

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on the upper and lower jaws which act as filters to remove water and trap food inside the mouth. Estimates for the total number of cetacean species occupying UK waters vary between 13 (Evans & Hammond, 2004) to 15 (Weir *et al.*, 2001). The waters to the west of Scotland have a relatively high diversity of marine mammals (Evans 1992; Shrimpton & Parsons 2000; Reid *et al.*, 2003; Jeewoonarain *et al.*, 2000; Macleod *et al*. 2003). The SCANS II survey (Small Cetaceans in the European Atlantic and North Sea) (Hammond, 2008) estimated abundances for some cetacean species observed off the west coast of Scotland (see Table 2).

Table 1: Marine mammal species seen off the west coast of Scotland

Marine mammal species regularly seen	
Scientific name	*Common name*
Phoca vitulina vitulina	Harbour seal
Halichoerus grypus	Grey seal
Phocoena phocoena	Harbour porpoise
Balaenoptera acutorostrata	Minke whale
Lagenorhynchus albirostris	White beaked dolphin
Tursiops truncatus	Bottlenose dolphin
Grampus griseus	Risso's dolphin
Delphinus delphis	Common dolphin
Orcinus orca	Killer whale

Table 2: Abundance estimates and 95% confidence intervals (CI) for cetaceans seen within Block N (west coast of Scotland) during SCANS-II surveys.

Species	Abundance	95% CI (abundance)
Harbour porpoise	12,076	4,685 – 27,239
Bottlenose dolphin	246	41 – 1,479
Common dolphin	2,322	730 – 7,383
White beaked dolphin	9,731	1,879 – 50,408

4.1 Baleen whales

4.1.1 Minke whale

The minke whale (*Balaenoptera acutorostrata*) is the smallest of the baleen whales, growing to around 8.5 m in length. It is widely distributed throughout the world and is found from the subtropics to Polar Regions in both the Northern and Southern Hemisphere. In Europe it is generally found in coastal waters on the continental shelf from Norway to France and the northern North Sea.

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Minke whales are known to feed in areas of strong currents and around small islands and headlands (Anderwald *et al.*, 2008). There are about 174,000 minke whales in the north-eastern and central Atlantic stock[1]. Within UK waters, minke whales are most frequently sighted in the north-western North Sea, the Hebrides and in the Irish Sea (Northridge *et al.*, 1995; Reid *et al.*, 2003; Macleod *et al.*, 2004). Minke whales have been found to be seasonally resident off the Inner Hebrides (Gill *et al.*, 2000) although some may be present year round (Macleod *et al.*, 2004). Regular surveys in the area have shown that minke whales tend to move northward as the summer season progresses, with the areas around Tiree and Coll being more important during May and June. Since 2005 there has been a slight temporal shift in distribution, with peak numbers being observed earlier in the year (July; Sea Watch Foundation unpublished data, P. Anderwald, pers. comm.). These results are similar to those from Northridge *et al.* (1995) who found more minke whales in the Hebrides later in the third quarter of the year. Off the Isle of Mull, minke whales tend to occur in sandeel habitat in early summer and pre-spawning herring habitat in late summer (Macleod *et al.*, 2004). In the waters around Mull, shifts in prey distribution and abundance occur between March and November and are the most likely factors governing the distribution and abundance of minke whales. In a study of the diet of minke whales stranded along the coast of Scotland, Pierce *et al.*, (2004) found the diet was comprised mainly of sandeels and clupeids.

4.2 Toothed whales

4.2.1 Harbour porpoise

Harbour porpoises are found in cool temperate to sub polar coastal waters in the Northern Hemisphere. They are the most common small cetacean in the eastern north Atlantic and are abundant in waters off north - west Scotland (Goodwin & Speedie 2008). Surveys in coastal waters west of the UK in July 2004 estimated harbour porpoise abundances of 387 individuals (95% Confidence Interval (CI)= 170-877) off Northern Ireland and 1,645 individuals (95% CI = 823-3,289) in the Firth of Clyde, with estimated densities of 0.387 and 0.823 animals per km^2 throughout the study areas respectively (Goodwin & Speedie 2008). The SCANS II aerial survey of Block N (which extended northwards from the North Channel, through the Minches to Cape Wrath) produced an abundance estimate of 12,076 (95% CI = 4,685 – 27,239; Burt *et al.* 2008).

Studies on habitat preference indicate harbour porpoise may be preferentially recorded in waters closer to the coast than 14.6 km (7.7 nm) and deeper than 60 m (MacLeod *et al.* 2007)[2]. Those that were found in shallower waters exhibited a preference for a larger local range in sea surface temperature (SST) values. The Sea Watch Foundation carried out boat based surveys in West Scotland in the month of August in 1993, 1994, 1996 and 1997. Harbour porpoise sightings data collected indicated a preference for waters within 15 km from the shore and between 50 and 150 m depth and also a relationship between tidal variables and porpoise distribution, with more sightings predicted for high tidal stream speed areas and times of high tide (Marubini *et al.*, 2009). These results are in good agreement with those of MacLeod *et al.* (2007). This study identified four areas with high relative abundance of harbour porpoises: (1) the region between Ardnamurchan, Coll and the Small Isles, (2) southeast of Barra, (3) northeast of Skye to Gairloch, and (4) west of Pairc

[1] http://www.iwcoffice.org/conservation/estimate.htm, accessed 5th January 2010
[2] Data were collected over 33 days in June 2004, and June/July 2005.

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Peninsula (Isle of Lewis) to the Shiant Islands. This study also found a high variability in the number of sightings within the study period (Marubini *et al.*, 2009). Some sources report that the Inner Hebrides are particularly important harbour porpoise habitat, with feeding hotspots around Mull, the Small Isles and the Sound of Jura[3]. A recent paper by Embling *et al.* (2009) identified four potential sites for marine protected areas for harbour porpoises in the Inner Hebrides (the Sound of Jura, the Firth of Lorne, the area between Mull and the Treshnish Isles, and the Sound of Sleat). This study found that higher relative densities of porpoises were detected during *low* tidal currents in contrast to the study further north mentioned previously where porpoises were detected at higher rates during *high* tidal currents (Marubini *et al.*, 2009) but this is explained by the fact that the tidal regime in the southern inner Hebrides is unique with much higher tidal speeds.

In UK waters, mating and calving are estimated to take place between May and September (Learmonth 2006) with a peak around June and July (Lockyer 2007). In Scottish waters harbour porpoise diet consists predominately of small shoaling fish from both demersal and pelagic habitats. Porpoises tend to feed primarily on two to four main species in Scottish waters e.g. whiting and sandeels (Santos & Pierce, 2003; Santos *et al.*, 2004). Porpoises occur in small groups or singly and frequently use narrow sounds or bays. They are characteristically shy of boats and other anthropogenic activities and consequently are likely to be easily disturbed.

4.2.2 Bottlenose dolphin

Bottlenose dolphins are widely distributed and are found in coastal waters from the tropics to temperate regions where they occur in groups of one to several dozen individuals but also in large groups of up to a hundred or more individuals. Contrasting with the east coast of Scotland, comparatively few bottlenose dolphins use the west coast. During one west coast study, bottlenose dolphins were widespread although most were close to the coast around Argyll; sightings were recorded in all months of the year, suggesting possible year-round residency (Mandelberg, 2006). Others are more site-faithful e.g., a small group of 6-15 individuals have been repeatedly observed in the Sound of Barra in the Outer Hebrides (Grellier & Wilson, 2003). These Inner Hebrides and Sound of Barra communities appear to be segregated. Bottlenose dolphin abundance was estimated for block N of the SCANS-II survey from aerial survey data as 246 individuals (95% CI = 41 – 1,479) (Burt *et al.*, 2008a; see Table 2). Bottlenose dolphins have a diverse diet and studies on the Scottish east coast suggest that areas with strong tidal flows are favoured for foraging (Mendes *et al.*, 2002). Santos *et al.*, (2001) published dietary information for ten stranded bottlenose dolphins off the east coast of Scotland, the main prey items being cod, saithe and whiting. Bottlenose dolphins are inquisitive and frequently approach boats.

4.2.3 Common dolphin

Common dolphins have a widespread oceanic distribution in tropical to temperate waters in the Atlantic and Pacific. These dolphins are common in the Sea of Hebrides and southern part of the Minch especially in the summer. Around the Hebrides, common dolphins have occasionally been

[3] The Hebridean Whale and Dolphin Trust: http://www.whaledolphintrust.co.uk/research-research-results.asp, accessed 5th January 2010.

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seen during the monthly summer surveys carried out by the Hebridean Whale and Dolphin Trust between 2003 and 2005. They appear to be absent from the southern part of the Inner Hebrides, encountered most often off the west and to the north of Coll & Tiree. The majority of sightings from these surveys have been concentrated in July and August (Hammond *et al.,* 2006). Macleod (2001) noted high encounter rates with common dolphins during autumn on the Stanton Banks, just south of Coll, during year round opportunistic surveys. During the SCANS-II survey, common dolphins were recorded throughout the Minch and abundance for block N was estimated at 2,322 (CI = 730 – 7,383; Burt *et al.,* 2008 see Table 2). The mating/calving period for this species in the Northeast Atlantic extends from May to September (Murphy *et al.,* 2005; Murphy & Rogan, 2006). In European waters they are known to feed on a variety of fish and squid. MacLeod *et al.,* (2005) reported an increase in the occurrence of common dolphins off the west coast of Scotland, with a corresponding decline in white beaked dolphins.

4.2.4 White beaked dolphin

The white-beaked dolphin has a more limited range than most of the species present in UK waters, being found only in cool temperate and subarctic waters of the North Atlantic (Reid et al., 2003). White beaked dolphins are one of the most abundant dolphin species observed in shelf waters around the UK (Hammond *et al.,* 2002). They are mainly distributed over the continental shelf and in the northern North Sea (off Scotland and northeast England) and adjacent areas, generally in waters between 50 m and 100 m in depth, and rarely out to the 200 m isobath (Northridge *et al.,* 1995; Reid *et al.,* 2003). White-beaked dolphin abundance was estimated for block N of the SCANS-II survey from aerial data as 9,731 (CI = 1,879 – 50,408); most sightings were recorded in the northern end of the Minch (Burt *et al.,* 2008; see Table 2). Research by MacLeod *et al.* (2005, 2007 & 2008) indicates that white-beaked dolphin numbers are decreasing in north western Scotland and are being replaced by common dolphins. While these two species both display a preference for shelf waters, clear differences are seen in SST preferences, with white-beaked dolphins preferring SSTs of less than 12°C (MacLeod *et al.,* 2007). Changes in distribution could thus be reflective of changes in SST. Weir *et al.* (2009) found that white-beaked dolphins occurred in deeper waters further from shore than common dolphins. Behavioural observations indicated that both species differed in their foraging strategy with white-beaked dolphins foraging sub surface and common dolphins feeding nearer the surface and more associated with birds (Weir *et al.,* 2009). A study on white-beaked dolphins in UK waters found that all sightings were reported in summer and early autumn and that calves were recorded only during July and August (Canning *et al.,* 2008). A dietary study of white beaked dolphins in Scottish waters identified a wide variety of prey species with fish representing more than 95% of the diet (the most important prey species being haddock and whiting; Canning *et al.,* 2008).

4.2.5 Risso's dolphin

Risso's dolphins are found in both hemispheres in continental slope areas from the tropics to temperate regions. Risso's dolphins have been sighted on occasion in Scottish waters, mainly off the Outer Hebrides, and appear to be most frequent in the area between June-September (they are rarely found in the area before June; Hammond *et al.,* 2006). Very little is known about the diet of Risso's dolphin in western European waters but they are generally assumed feed on cephalopods

(Clarke *et al.,* 1985) although they may also consume crustaceans and occasionally small fish (Santos *et al.,* 1995).

4.2.6 Killer whale

Killer whales have the widest distribution of all marine mammals and are found from the equator to the poles, commonly in near shore temperate waters. Most sightings in UK waters are of single animals or groups of less than eight individuals, although groups of up to 100 have been reported (Reid *et al.,* 2003). In UK waters, killer whales are found along the shelf edge, especially north of Shetland, in inshore Scottish waters around the Northern and Western Isles, where sightings are concentrated around Mull and the Treshnish Isles (Bolt *et al.,* 2009), and in the northern North Sea (Reid *et al.,* 2003). There are reports of killer whales predating upon grey seals, harbour seals and porpoises around Scotland (Weir 2002). A study on killer whale sightings showed an overlap in the regions of greatest sighting frequency and the largest declines in harbour seal counts (Lonergan *et al.,* 2007). Killer whales also forage near pelagic trawlers, taking advantage of the mackerel and herring fisheries off Northern Scotland, primarily between January and February (Luque *et al.,* 2006).

4.3 Conservation considerations: cetaceans

The Scottish Government has responsibility for the conservation and protection of all cetaceans within Scottish waters. All cetaceans are protected under the Conservation (Natural Habitats, &c.) Regulations (1994) as amended and the Offshore Marine Conservation (Natural Habitats, & c.) Regulations (2007) as amended. Under this legislation it is an offence to deliberately capture, kill or recklessly disturb cetaceans. Other UK, European Commission (EC) and International Laws and Conventions offer additional protection to cetaceans. All cetaceans are protected under the EU's Habitats Directive and are listed in Annex IV (species of community interest in need of strict protection) meaning it is illegal to deliberately kill, capture or disturb any of these species. Additionally, harbour porpoise and bottlenose dolphin are Annex II species which means the presence of sufficient numbers of these species can result in the designation of a Special Area of Conservation (SAC). SACs are chosen on the basis that they will make a significant contribution to species or habitat conservation. Thus, presence of a particular species is not (by itself) justification for an SAC; however where SACs have been established, care must be taken not to compromise the integrity of such sites, or their qualifying features. There are currently no SACs designated for harbour porpoises or bottlenose dolphins off the west coast of Scotland.

All cetaceans (except minke whales) that occur frequently off the west of Scotland are listed in Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) providing them with strict protection.

The Joint Nature Conservation Committee (JNCC) is currently finalising guidance notes on the deliberate disturbance of marine European Protected Species[4], which is relevant to the marine renewable energy sector. European Protected Species (EPS) are species of plants and animals (other than birds) protected by law throughout the EU. EPSs include all cetaceans and otters but not seals.

[4] http://www.jncc.gov.uk/page-4227, accessed 18th January 2010.

4.4 Pinnipeds

4.4.1 Grey seal

Grey seals are only found in the North Atlantic and have three population centres; Canada, the British Isles and the Baltic Sea. About 45% of the world population is found in Britain with over 90% of British grey seals breeding in Scotland, the majority on remote islands and coastlines in the Hebrides and Orkney from September to late November (SCOS, 2008). Their other prolonged period ashore occurs when they moult (from February to April). At other times of the year they come ashore to haul-out and rest between foraging trips at sea. Mature female grey seals give birth to a single white-coated pup each year, which is nursed for approximately three weeks before weaning and moulting (SCOS, 2008). Information gathered from telemetry studies of grey seals has shown that they can feed up to several hundred kilometres offshore during foraging trips lasting several days (SCOS, 2008). Individual grey seals based at a specific haul-out site often make repeated trips to the same region offshore but will occasionally move to a new haul-out and begin foraging in a new region (SCOS, 2008). However, it has also been reported that mature seals of both sexes are usually faithful to particular breeding sites, and may return within 10-100m of previous pupping sites (Pomeroy *et al.,* 2000).

Grey seals are large marine predators. Males can grow up to 350kg and females up to 250kg (SCOS, 2008). UK grey seal diet has been assessed in the 1980s (Prime & Hammond, 1990; Hammond & Prime, 1990; Hammond *et al*., 1994), 1990s (Hall et al., 2000), and 2002 (Hammond & Grellier 2006; Hammond & Harris, 2006). Of the commercial species consumed in the North Sea in 2002, grey seals mainly ate sandeel, cod and haddock (Hammond & Grellier, 2006). Sandeel, gadoids and herring were the main prey of grey seals in the Hebrides in 2002 (Hammond & Harris, 2006). Benthic species (especially in the Inner Hebrides) and flatfish (especially in summer) were also important (Hammond & Harris, 2006). Satellite telemetry data for grey seals shows that they spend approximately 40% of their time near or at haul-out sites, 12% of their time foraging and the remainder travelling between foraging areas and haul-out sites (McConnell *et al.,* 1992; McConnell *et al.,* 1999). Foraging trips usually last between two and five days, and seals generally feed within 50 km of the haul-out site (McConnell *et al.,* 1999). The shelf waters off the west coast of Scotland are clearly very important as foraging habitat for the large numbers of grey seals hauling out in the Inner and Outer Hebrides (Hammond *et al.,* 2006). Waters west of Islay and Jura, and east of Lewis are extensively used by grey seals. Preliminary results are available from a telemetry study in Ireland where eight grey seals were tagged in the Blasket Islands (SAC for grey seals) off the south west coast. Four out of the eight animals tagged travelled up to the Western Isles (Michelle Cronin pers. comm.).

Grey seal pup production in Scotland is stable or slowly increasing (SCOS, 2008). The main sites of importance for grey seals near the Sound of Islay are the Monach Isles and the Treshnish Isles which are both Special Areas of Conservation[5] (SACs) for grey seals (Table 3).

4.4.2 Harbour seal

Harbour seals have a widespread distribution and are found along most coastlines in the northern hemisphere from polar to temperate regions. There are five subspecies and *Phoca vitulina vitulina*

[5] http://www.jncc.gov.uk/

occurs in the eastern north Atlantic. Adult harbour seals usually weigh about 80-100kg and probably consume 3-5 kg per seal per day depending on the prey species (SCOS, 2007). Harbour seals normally feed within 40-50 km of their haulout sites, and feed on a variety of prey including gadoids, particularly whiting, pelagic scad and herring in the Inner Hebrides (Pierce & Santos, 2003). Harbour seal pupping occurs in June and July while moulting takes place in August and September. Both events occur on land so this is when the greatest numbers of harbour seals are found on shore. Harbour seals haul-out on tidally exposed areas of rock, sandbanks or mud. Individuals are generally faithful to particular haul-out sites within a season.

Approximately 85% of the UK harbour seal population is found in Scotland, with 11% in England and 4% in Northern Ireland. The combined results of the 2006 and 2007 harbour seal surveys indicate significant population declines in Orkney (approx 40%-50%), Shetland (approx 40%), Strathclyde (approx 25%) and the Firth of Tay (>50%) since 2000. Only the west coast of Highland region and the Outer Hebrides numbers (based on a partial survey in 2006) appear to be stable and at levels equivalent to those seen in the 1990s (SCOS, 2008).

The Sound of Islay tidal development area is near an important site for harbour seals (South East Islay Skerries; Table 3). The movements of 24 harbour seals tagged in Jura and Islay in September 2003 and April 2004 and in northwest Skye in September 2004 and March 2005 were tracked (Cunningham *et al.,* 2009). Most trips were short (within 25 km of the haul-out site), often (40% of the time) returning to the same site thus a degree of site-fidelity and coastal foraging was apparent. However, some individuals made longer trips of over 100 km, indicating that animals hauling out at different sites were not completely isolated. Longer distance movements in southwest Scotland showed some seasonality, occurring predominantly at the end of September and the end of March. Almost half of the trips lasted between 12 and 24 hours although some trips lasted several days, with the longest recorded trip lasting more than 9 days. The waters of the Minch and the Hebridean Sea are clearly important foraging areas for the large numbers of harbour seals in the area (Hammond *et al.*, 2006).

Table 3: Special Areas of Conservation (SACs) off the west coast of Scotland where seals are a primary reason for site selection.

Special Area of Conservation	Annex II species primary reason for site selection	Importance to UK populations	Distance to Sound of Islay (kms)
South-East Islay Skerries	Harbour seals	This area is extensively used as pupping, moulting and haul-out sites by harbour seals, which represent between 1.5% and 2% of the UK population.	~20km
Eileanan agus Sgeiran Lios mór	Harbour seals	Lismore comprises five groups of small offshore islands and skerries which are extensively used as haul-out sites by harbour seals representing over 1% of the UK population.	~90km
Treshnish Isles	Grey seals	This site supports a breeding colony of grey seals contributing just under 3% of annual UK pup production	~70km
The Monach Isles	Grey seals	These islands hold the largest grey seal breeding colony in the UK, contributing over 20% of annual UK pup production	~210km
Ascrib, Isay and Dunvegan	Harbour seals	This site represents one of the larger colonies of harbour seals in the UK, holding around 2% of the UK population	~180km

Any proposed development which may affect European sites (SACs and SPAs) as well as candidate SACs is required by law to undergo an ‘appropriate assessment’. Under the EU Habitats Directive (92/43/EEC), Article 6(3) (implemented in the UK via regulation 48 of the Conservation (Natural Habitats, & c.) Regulations (2004)) of the directive states that, that; “any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives.” The national authorities shall agree to a project only after having determined that it will not adversely affect the integrity of the site concerned.

4.5 Conservation considerations: seals

Under the Conservation of Seals Act 1970, Scottish seals are protected during their moulting and breeding periods (close seasons); September-December in the case of grey seals and June-August in the case of harbour seals. “Orders” offer additional protection to potentially vulnerable populations and are currently in force in the Moray Firth, Northern Isles and an area between Stonehaven and Dunbar. However, licences to shoot seals may be granted by the Scottish Government and, out with the closed seasons, no licence is *currently* required to shoot seals in other areas. Under the forthcoming Marine (Scotland) Bill, regulations regarding management of seals may change and it may become necessary to obtain a licence to shoot or otherwise intentionally harass seals at any

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time of the year. Harbour seals and grey seals are also Annex II species under the EU Habitats Directive. There are five SACs on the West coast of Scotland where seals are a primary reason for site selection (Table 3).

4.6 Otters

Whilst not technically a marine mammal, otters are often observed and recorded during coastal marine mammal surveys. The otter is semi-aquatic occurring in lakes, rivers, marshes, estuaries and coastal waters. The otter can reach up to 100cm length and weighs about 7-12kg. Populations of otters living along the coast use shallow, inshore areas for feeding but require fresh water for grooming and terrestrial areas for resting and breeding holts. An estimated 90% of the total British population of otters is resident in Scotland[6]. The Scottish population, which suffered only a relatively minor decline compared with England and Wales, is of international importance. It comprises a particularly high proportion (perhaps 50% or more) of coastal-dwelling otters which feed predominantly in the sea. Fish is the major prey of otters but a whole range of other prey items have been recorded in their diet such as insects, reptiles, amphibians, birds, small mammals and crustaceans. In coastal habitats, tidal patterns influence otter activity, with significant preference shown for feeding at low tide in both Shetland and on the Scottish west coast.

4.7 Conservation considerations: otters

Otters are protected under the Conservation (Natural Habitats, &c.) Regulations (1994) as amended whereby it is illegal to deliberately or recklessly kill, injure or take (capture) an otter, deliberately or recklessly disturb or harass an otter, damage, and destroy or obstruct access to a breeding site or resting place of an otter. They are also found in Annex II &IV of the EC Habitats Directive. There are no SACs designated for otters in the vicinity of this tidal development.

5 Methods

5.1 Site Description

The sound of Islay is a narrow channel between the islands of Jura and Islay off the west coast of Scotland. It is approximately 1km wide and up to 60m deep. The elevation on either side of the Sound varies but around the area of interest the cliff height is approximately 30m on the coast of Islay and 25m on Jura. Given the width of the Sound, the elevation of the cliffs on either side creates many good vantage positions for land based marine mammal monitoring.

5.2 Hebridean Whale and Dolphin Trust data

5.2.1 HWDT boat based survey

Line-transect visual and towed-array acoustic surveys (focusing on harbour porpoises but other cetacean and basking shark records were also noted) were conducted between 2003 – 2009 and 2004 – 2008, respectively, from the HWDT survey vessel *Silurian*. These surveys were conducted on the west coast of Scotland (see Figure 1) between April and September (inclusive) during daylight

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

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hours. 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. Data analysis focused on a core region around the Sound of Islay (see **Figure 1**).

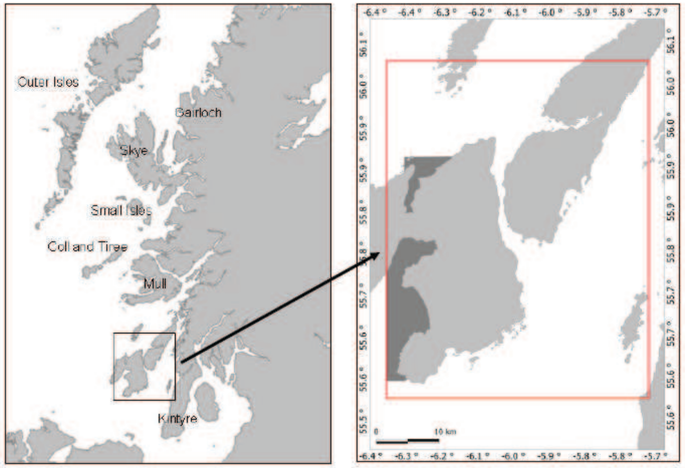

Figure 1: Map of west coast of Scotland and survey area for HWDT visual and acoustic surveys. The region included in the analysis presented here is outlined in red. The dark grey area was not surveyed.

Visual surveys were carried out by teams of two trained observers, one situated on either side of the mast on the front deck of the Silurian, (2 m above water level). Each observer surveyed one side each from 0° (ahead of the vessel) to 90° (abeam of the vessel) with the naked eye and 7 x 50 binoculars. Observers were rotated every hour to avoid fatigue. Visual data were collected in sea conditions of Beaufort sea state ≤ 5. A survey speed of 6 knots was maintained during surveys; the majority of survey time was spent under motor but when sufficient wind was available surveys were carried out under sail. Weather, sighting conditions, boat activity and degree of effort were recorded during the survey. When marine mammals (or basking sharks) were sighted, the species was identified and the time of first sighting, the estimated distance to the animal(s), the bearing to the animal(s) relative to the boat (determined from angle boards on deck) and the heading of the animal(s) relative to the boat were recorded. Group size and behaviour of the animal(s) were also recorded. These sighting data were relayed to a data-recorder, who manually entered them into the data recording software *Logger 2000* (developed by the International Fund for Animal Welfare – IFAW) which ran continuously, logging GPS positional and NMEA feed data and storing it in a Microsoft Access database in real-time.

5.2.2 HWDT Acoustic Surveys

Passive acoustic monitoring (PAM) was conducted using a towed hydrophone array on surveys from 2004 to 2008. Acoustic surveys were carried out in all sea states, during daylight hours and in waters >10 m depth. The signal from the hydrophone array was fed into a computer running porpoise detection software (Porpoise Detector was used in 2004-2005 and Rainbow Click was used in 2006-2008) which automatically detected 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*, with the number of animals logged for each porpoise detection. 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 -2009 were analysed using Manifold (Version 8.00). These data were broken down by grid cells. For this analysis a grid cell of 4 x 4 km was used as it provided approximately equal effort across the study region. All dolphin species were grouped together and treated as a single category in this analysis. Similarly all whale species and seal species were grouped. Basking sharks, sightings of harbour porpoises and porpoise acoustic detections were treated separately. In each grid cell, detections per unit of effort (per kilometre completed trackline) maps were produced for each of these species groups (with two maps produced for harbour porpoises – one using visual data and one using acoustic data).

5.2.3 Public sightings data

Sightings reports were collated by HWDT from local boat operators and members of the public between 2000 and 2008. In order to maximize the accuracy of each sighting, all of the information was checked by a trained member of staff. For those sightings where a definite species identification could not be ascertained, sightings were either classified as unidentified whale or unidentified dolphin. For this analysis, harbour porpoises, bottlenose dolphins and basking sharks were treated separately whilst other dolphin species and whale species were grouped together. Unidentified whales and dolphins were grouped in the respective whale or dolphin categories. The dataset also included sightings data collected during ferry surveys conducted in 2003 along the two routes from Kennacraig to Port Askaig and Port Ellen by trained observers.

5.3 Land based visual monitoring for seals and cetaceans

Land based visual observations are being carried out from a series of observation sites situated along the Sound of Islay on both Jura and Islay. Observations are carried out from both sides of the Sound to help estimate the potential decreases in detection probability with range from land; an integral component when estimating animal density. Furthermore, by using both sides of the Sound, the observer will be able to monitor more habitats. Four observation sites are being used with two on either side of the Sound, south of Port Askaig (see Figure 2 –sites I3, I4, J2, J3). In order to obtain data on marine mammal species abundance and distribution north of the development site in the Sound of Islay some effort is also focused on collecting observational data from sites north of the main observation sites (see Figure 2–sites I1,I2,120,J1).

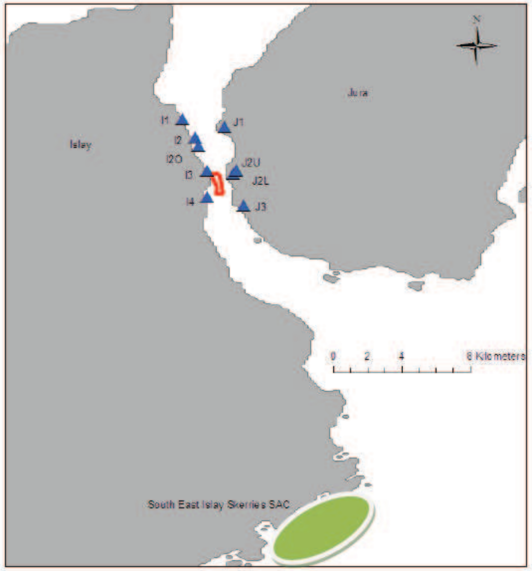

Figure 2: Position of land based observation sites (blue triangles), the proposed development site (outlined in red) and the South East Islay Skerries SAC (green).

One experienced observer undertakes observations during predefined ‘watches’ at each site. A range of environmental and effort related variables were recorded along with positional and behavioural data for each sighting. In order to maximise effort and reduce costs, observations for birds and marine mammals were carried out from the same vantage points. Separate scans were carried out for marine mammals and birds to reduce observer bias.

Watches have been divided into 45minute cycles incorporating separate bird and marine mammal scans. This 45min watch cycle will be repeated 4 times in a 3 hour watch period in each of the 4 observation sites once a week. The total combined effort for bird and marine mammal observations is (4x45mins) x4 observation sites or 12hours effort a week or 48 hours a month. This will result in a total marine mammal survey effort of 2 hours per observation point, per week which is a total of 8 hours per week or 32 hours per month (see Table 4).

In collaboration with Natural Research (Projects) Ltd, who have been contracted to carry out bird and marine mammal surveys and bird data analysis, the watch cycle has been broken down into the following scan system;

1: 15 minute marine mammal scan

2: 10-15 minute seabird scan

3: 5 minute flying bird scan

4: 15 minute marine mammal scan

Table 4: Land based marine mammal survey effort

	Marine mammal effort	Total marine mammal effort
Weekly	4 Obs site x (8x15min)	8 hours
Monthly	4 weeks x 4 Obs site x (8x15min)	32 hours

The amount of effort required to detect changes in temporal and spatial variation in marine mammal density and habitat use depends on sightings rates or probabilities. It is difficult to predict these rates without prior data collection so it is anticipated that effort may have to be increased or decreased to provide sufficient statistical power to measure changes with respect to these variables.

The main challenge likely to be encountered during land based marine mammal observations is a decrease in sighting probability due to poor weather conditions. Although the Sound of Islay is largely sheltered from easterly and westerly winds, northerly and southerly winds can funnel down the sound and have the potential to create large white caps in the centre channel. This could be particularly problematic for small cetaceans and seals that are likely to be sighted in this area. For example, in sea states over 2 it is very difficult to observe harbour porpoises (Evans & Hammond 2004). Furthermore, in a site such as this, sea state often varies spatially; it is common for the near shore areas to be quite calm while the increased tidal flow in the centre of the channel creates choppy white water conditions. In these situations it may be difficult to observe whether porpoises are present in this turbulent area. Watches are therefore limited to times when the sea is calm with minimal white caps. Survey effort is as much as possible equally distributed over all states of tide and time of day to take into account any tidal and temporal variation in animal distribution. The tidal cycle has been divided into 6 periods and is equally sampled in spring and neap tides.

A number of scans are carried out during a watch. Using a combination of telescope and/or binoculars, the observer scans from left to right, slowly and steadily. The first part of the scan is focussed on examining the further parts of the observational area with a telescope while binoculars or the naked eye are used to examine the nearest shore area. A full scan of the area takes about 15 minutes. There is a short period of time set aside between scans to record data and reduce observer fatigue. It is important to record the position of the sighting. The location of an animal(s) can be estimated using horizontal and vertical angle information from the land based observation site. In the Sound of Islay study site graticule binoculars with an in built compass are used to measure horizontal angle. These provide sufficient information for accurate animal locations within the study area.

There are occasions where marine mammals are seen before a scan commences i.e. while setting up equipment at a site or are reported by a member of the public. These sightings are recorded as 'incidental' sightings. Due to the expected lower frequency of marine mammal sightings, marine mammals sighted during a dedicated bird scan are also recorded. Once an animal is observed during a scan the time of that sighting and the species are recorded immediately on a Dictaphone or data sheet.

Walk over surveys carried out specifically for bird data collection take place 6 times a year (February, April, June, July, September and November). Effort data is recorded i.e. dates and times of surveys. If any marine mammal carcasses are observed and are accessible, photos and positional data are recorded and SMRU Ltd contacted immediately for advice.

5.4 Monthly ferry surveys

To put the density estimates made from the land based study into a regional context, cost effective boat based surveys for birds and marine mammals are also being carried out. During summer months a Caledonian MacBrayan (Cal Mac) ferry travels through the Sound on route from Kennacraig to Port Askaig and Colonsay. The observer makes this trip once a month (on a good weather day (sea state <2) to carry out a marine mammal and bird survey throughout the entire Sound and beyond to the north and south. The aim is to provide both an index of the relative importance of the Sound of Islay for marine mammals and birds, and the information required to evaluate whether there is a graded response in the distribution of animals with distance from the proposed array site i.e. whether potential changes in animal numbers in the proposed site represent a localised change or are consistent throughout the region.

The observer stands at the highest permitted forward position on the ferry and carries out visual observations using the naked eye and binoculars. The observer surveys a 45 degree angle to either side of the bow. Each time a sighting of a marine mammal(s) or bird(s) is sighted, the location (a hand held GPS is used to record the ferry track and its position when each sighting is made), estimated range, angle from the bow, species, number, and heading are recorded.

5.5 Aerial survey for seals

Surveys to determine harbour seal abundance are usually carried out during their annual moult (approximately 1st – 25th August) when seals spend longer on shore to encourage growth of new hair. The helicopter surveys described here were carried out on 10 and 12 August 2009 using a thermal imager (*Barr and Stroud* IR18) which is sensitive to infrared radiation in the 8-14 µm waveband and is equipped with a dual telescope (x2.5 and x9 magnification). The imager was mounted on a pan-and-tilt head and operated out of the helicopter window.

When surveying, the helicopter operated at a height of 150-250 m and a distance of 300-500 m offshore to ensure that seals were not disturbed. A digital video camcorder (*Canon* MV3i), attached to the imager, provided a colour image to match the thermal image. Both images were displayed continuously on a monitor placed in front of the camera operator and simultaneously recorded to a digital video recorder (D4, *Dedicated Micros*). Seals were detected and counted on the monitor using the thermal image. For each sighting the location, time, species and number of seals were recorded directly onto Ordnance Survey 1:50 000 maps. Most groups of seals were also digitally photographed using a Canon 20D camera equipped with an image-stabilised 70-300mm lens.

In general, differentiating between harbour and grey seals using a thermal image is possible on account of their different thermal profile, size and head-shape. When hauled out, their group structure also differs. Grey seals form tight and disorganised aggregations close to the water while harbour seals have greater inter-individual distances and are usually a bit further from the water's edge. Species identification in the field was aided by the camcorder image and by direct observation using binoculars. Species identity and the number of seals in groups were later confirmed by reviewing both the digital thermal video and the digital still images.

To maximise numbers counted, surveys were carried out no more than two hours before or after the local low tide times and over low tides occurring between approximately 12:00 and 17:30hrs local time. To further reduce the effects of environmental variables on number of seals counted, surveys were not carried out on rainy days. The thermal imager cannot 'see' through heavy rain and seals often abandon their haul-out sites and return to the water in medium to heavy prolonged rain.

6 Results

6.1 HWDT Results

6.1.1 Boat based surveys

Harbour Porpoise

Harbour porpoises were the most common species in the study area (the Sound of Islay region), followed by seals. Harbour porpoise acoustic detections were widespread throughout the Sound of Islay region with higher densities in the Sound of Jura (Figure 3). There were less acoustic detections of porpoises in the Sound of Islay itself and to the north, between Colonsay and Jura (Figure 3). Harbour porpoise sightings were concentrated in the Sound of Jura and to the east and west of Colonsay (Figure 4).

This data suggest low abundances of harbour porpoise within the Sound of Islay relative to the wider Region.

Seals

Sightings of seals were also widespread throughout the region but concentrations were highest in the Sound of Jura and in the waters between Islay and Colonsay (Figure 5). There were few seal sightings in the waters between Islay and the Kintyre peninsula (Figure 5).

This data suggest moderate abundances of grey and harbour seals within the Sound of Islay, relative to the wider Region.

Other Species

There were very few sightings of dolphins or basking sharks in the Sound of Islay region (Figure 6 & Figure 7). Whale sightings were widely dispersed throughout the region, with higher concentrations off the east coast of Colonsay and in the Sound of Jura (Figure 8).

This data suggests very low abundances of dolphin, basking shark and whales within the Sound of Islay, relative to the wider region.

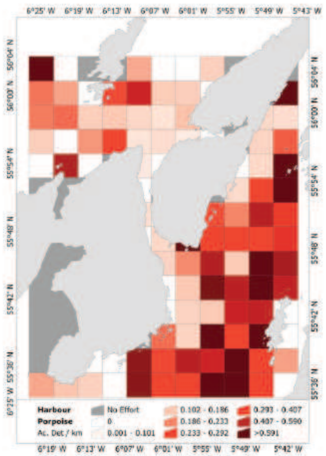

Figure 3: Harbour porpoise acoustic detections per unit effort in the Sound of Islay region (shown in shades of red – darker shades indicate higher detection rates). Grid cells not surveyed shown in dark grey (HWDT).

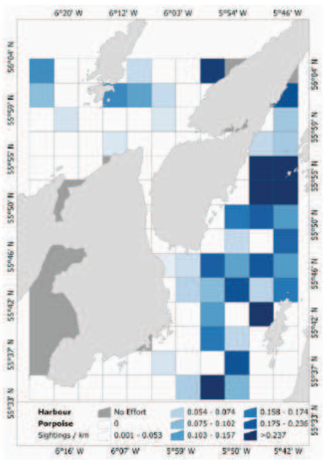

Figure 4: Sightings per unit effort of harbour porpoises in the Sound of Islay region (shown in shades of blue – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey.

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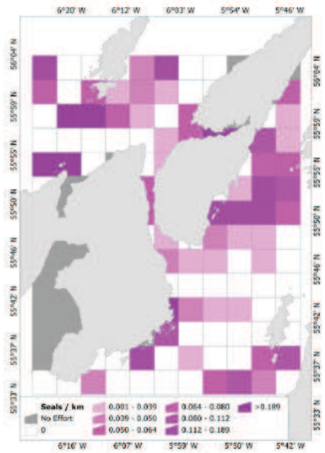

Figure 5: Sightings per unit effort of grey, harbour and unidentified seals in the Sound of Islay region (shown in shades of purple – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (HWDT).

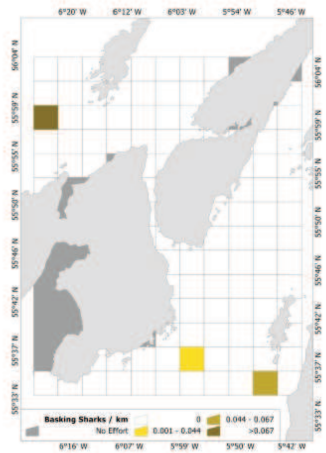

Figure 6: Sightings per unit effort of basking sharks in the Sound of Islay region (shown in shades of yellow – darker shades indicate higher sighting rates). Grid cells not surveyed is shown in dark grey.

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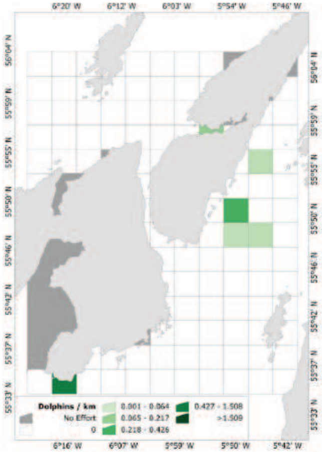

Figure 7; Sightings per unit effort of dolphin species in the Sound of Islay region (shown in shades of green – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (HWDT).

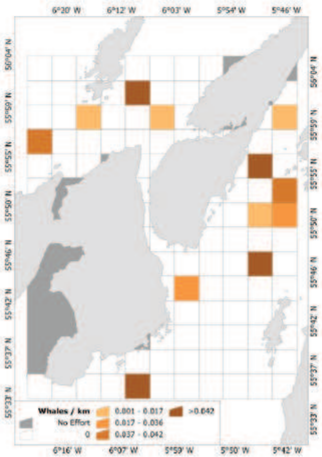

Figure 8: Sightings per unit effort of whale species in the Sound of Islay region (shown in shades of orange – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (HWDT).

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6.1.2 HWDT Public sightings data

As a result of the inherent bias within this type of data, it is only accurate in providing an indication of the presence or absence of species within the Sound of Islay Region.

Harbour porpoises were the most frequently reported species in the region, followed by bottlenose dolphins. Whilst the dataset used for this analysis was biased due to repeated transects along the two ferry routes, the data showed harbour porpoises to be the most common species in the Sounds of Islay and Jura (Figure 9). Sightings of bottlenose dolphins were concentrated in the Sound of Islay, Loch Indaal, Port Ellen and around the Isle of Gigha (Figure 10). There were also a high number of other dolphin species sighted, in particular in the Sound of Islay (although this is likely to be due to the majority of observations being taken from the ferry which will hugely bias observations), Loch Indaal and along the south and west coasts of Islay (Figure 11). Whale sightings were distributed widely across the Sound of Jura, with a few sightings further north between Colonsay and Jura (Figure 12). There were no sightings of basking sharks in the Sound of Islay study region.

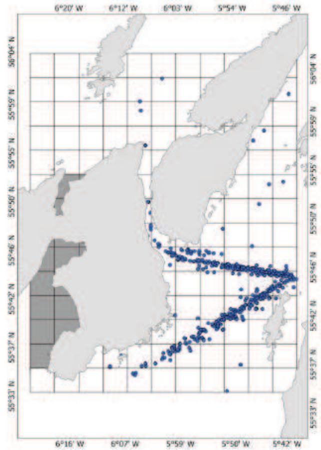

Figure 9: Harbour Porpoise public sightings 2000-2008 (blue dots) in the Sound of Islay region (HWDT)

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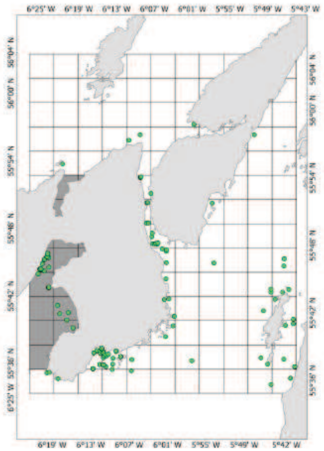

Figure 10: Bottlenose dolphin public sightings 2000-2008 (light green dots) in the Sound of Islay region (HWDT)

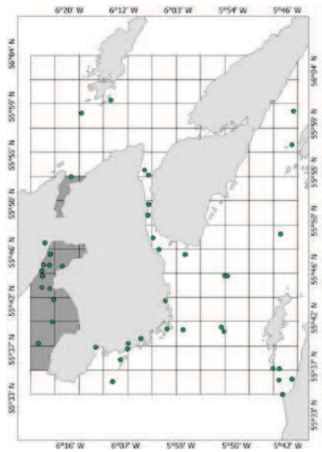

Figure 11: Dolphin public sightings 2000-2008 (dark green dots) in the Sound of Islay region (HWDT)

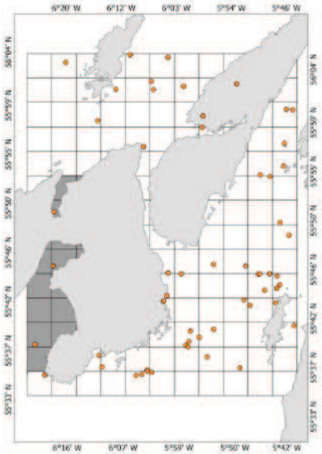

Figure 12: Whale public sightings 2000-2008 (orange dots) in the Sound of Islay region (HWDT)

6.2 Land based visual observations

A total of 11138 minutes (185.6 hours) of dedicated marine mammal scans were carried out from April–November 2009 with 98% of this effort concentrated in the months July to November (see Table 5). Table 6 indicates all marine mammal, basking shark and otter sightings recorded from all observation sites combined. A total of 992 marine mammal sightings were recorded. The most frequently recorded marine mammal is the harbour seal followed by the grey seal. Seals make up 93% of sightings followed by otters at 6%. <1% of sightings consisted of cetaceans. As well as mammals, very low densities of basking shark have also been observed (Table 5; Table 6). Figure 13 indicates raw positional data for all seals observed during marine mammal scans. Further analysis will be undertaken following one year's data collection to refine the distributional data taking effort (as well as other factors) into account.

During the Sound of Islay pre-feasibility study (Maxwell *et al.*, 2008), marine mammal and bird data were collected by the University of Aberdeen in June 2008. Land based observations were carried out from 5 sites, 2 of which were on Islay and 3 on Jura. Two observers carried out the scans – one based on each side of the Sound. Two hour observations were made per site twice a day. A watch consisted of ten minute scans of the area using binoculars. The times of the watches were designed to ensure equal numbers of hours were spent scanning in mornings and afternoons and during all tidal states. Harbour seals, bottlenose dolphins, grey seals and otters were observed. The results of the University of Aberdeen study are consistent with the marine mammal results presented in this report from both NRP and HWDT combined.

Table 5 : Land based marine mammal sightings and observer effort per month (marine mammal scans only 2009).

Month	Harbour seal	Grey seal	Un-id seal	Otter	Basking shark	Bottlenose dolphin	Harbour porpoise	Effort mins
April	2	1	0	0	0	0	0	45
May	0	0	0	0	0	0	0	0
June	1	0	0	0	0	0	0	225
July	50	12	2	1	0	0	0	1239
August	53	16	10	6	2	0	0	1577
September	125	28	29	9	2	0	0	2967
October	118	26	48	17	0	1	1	3346
November	49	3	22	6	0	0	0	1739
Totals	398	86	111	39	4	1	1	11138

Table 6: All marine mammal sightings from land based observations (April-November 2009).

April-November 2009	Marine Mammal Scan	Bird snapshot scan	Flying bird scan	Totals
Grey seal	86	46	2	134
Harbour seal	398	230	8	636
Unidentified seal	111	36	5	152
Bottlenose dolphin	1	2	0	3
Harbour porpoise	1	0	0	1
Otter	39	21	1	61
Basking shark	4	1	0	5
Total	**640**	**336**	**16**	**992**

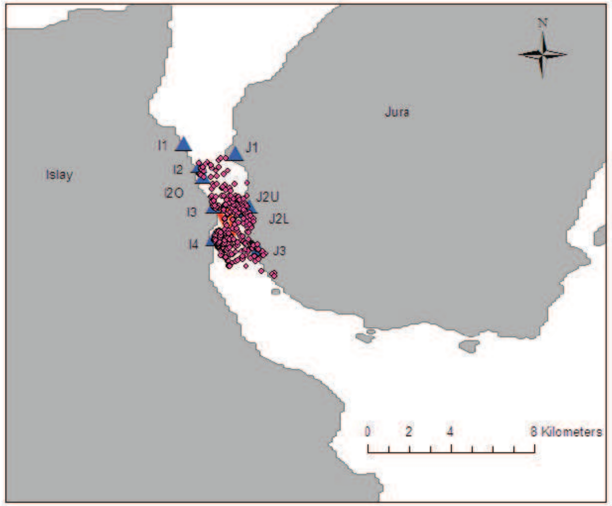

Figure 13: Seal positional data –care must be taken when interpreting this map as effort is not taken onto account. Blue triangles indicate the observation sites and red outlines the proposed development area.

As much as is possible, observer effort has been representatively allocated across all sites, times of day and tidal states. Table 7 indicates marine mammal observer effort over all observation sites. Most effort is concentrated in the southern most sites most relevant to the development area in the Sound. Table 8 indicates how observer effort has been spread over all tidal states and Table 9 shows how observer effort is spread over time of day.

Table 7: Marine mammal observer effort per observation site (marine mammal scans April-November only).

Islay		Jura	
Observation site	Marine mammal scan effort (mins)	Observation site	Marine mammal scan effort (mins)
I1	45	J1	90
I2	620	J2L	780
I3	1777	J2U	690
I4	5410	J3	1726

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Table 8: Marine mammal observer effort per tidal state (marine mammal scans April-November only).

Tide period	Effort (mins)
1 (high)	1828
2 (Mid-ebb)	1428
3 (low)	1720
4 (low)	1908
5 (mid -flow)	2314
6 (high)	1895

Table 9: Time of day effort coverage at each observation site (marine mammal scans April-November only).

Start hour of watch	Number of scans started in each hour of daylight							
	I1	I2	I3	I4	J1	J2L	J2U	J3
0600	0	0	1	0	0	0	0	0
0700	0	0	2	12	0	2	0	1
0800	0	0	3	9	0	5	0	12
0900	1	2	0	19	0	8	5	12
1000	1	10	15	48	0	8	13	10
1100	0	7	20	32	0	9	3	15
1200	1	6	17	33	1	4	3	11
1300	0	1	15	40	2	1	7	10
1400	0	3	7	63	0	3	2	5
1500	0	6	12	61	0	1	7	8
1600	0	6	7	28	0	6	1	11
1700	0	0	10	9	1	1	2	7
1800	0	0	3	6	2	1	0	7
1900	0	0	6	6	0	1	0	4
2000	0	0	0	0	0	2	0	2
2100	0	0	0	0	0	0	1	1
2200	0	0	0	0	0	0	2	0

The most frequently observed seal behaviour in the area was swimming, followed by bottling and hauled out (see Figure 14).

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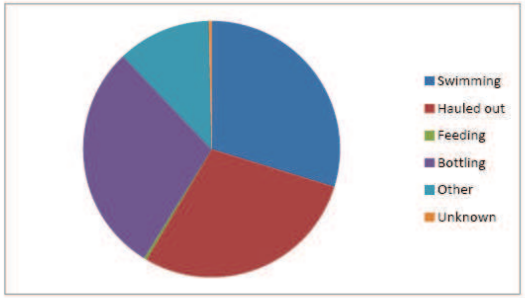

Figure 14: Seal behaviour (harbour and grey seals combined) recorded in Sound Of Islay April-November 2009 (marine mammal scans only).

6.3 Monthly ferry surveys

A total of 14 opportunistic surveys were undertaken on the Kennacraig-Port Askaig ferry as well as 9 surveys on the Port Askaig–Colonsay ferry. Preliminary sightings results from those surveys are summarised below in Table 10. Harbour porpoises were the most frequently sighted species on the Kennacraig-Port Askaig route followed by harbour seals. Harbour seals were the only species sighted on the Port Askaig-Colonsay route. Positional data for these sighting are as yet unavailable. The ferry route from Oban to Colonsay was not surveyed using dedicated observers but incidental sightings were recorded with harbour porpoises being the most frequently sighted species.

Table 10: Kennacraig-Port Askaig ferry survey marine mammal sightings data

Date	Harbour seal	*Unidentified seals*	Harbour porpoise	Minke whale
12/05/2009	0	0	0	0
17/05/2009	0	0	1	0
02/06/2009	1	0	4	0
07/06/2009	1	1	10	0
30/06/2009	2	0	3	2
04/07/2009	0	0	1	0
28/07/2009	0	0	0	0
30/07/2009	0	0	0	0
17/08/2009	0	0	0	0
21/08/2009	2	0	0	0
08/09/2009	0	0	0	0
11/09/2009	3	0	10	0
13/10/2009	1	0	4	0
13/11/2009	0	0	1	0
Totals	**10**	**1**	**34**	**2**

Table 11: Port Askaig-Colonsay ferry survey marine mammal sightings data

Date	Harbour seal
13/05/2009	0
13/05/2009	0
03/06/2009	1
03/06/2009	0
01/07/2009	1
01/07/2009	0
09/09/2009	0
09/09/2009	0
14/10/2009	3
Total	**5**

6.4 Aerial survey for seals

On the 10th August 2009, continuous sunshine heated the rocks along the coast of southern Islay to such an extent there was little or no thermal contrast between seals and the rocks on which they were resting. Seals were seen, with difficulty, round the Mull of Oa but, surprisingly, none were seen around Port Ellen and Texa (the small bay and island to the west of the harbour seal SAC's western boundary, Figure 15). When it became obvious that seals were being missed using the thermal imaging camera, a visual survey was carried out from the western edge of the south-east Islay SAC, through the southern part of the Sound of Islay, finishing at the starting point on the southern tip of Jura. On 11th August, persistent heavy rain prevented any aerial surveying. The south-east Islay SAC was resurveyed on 12th August, when conditions were suitable for the thermal imager. The counts used in this report are from the second, more reliable, survey.

The numbers of harbour seals counted in all sub-regions of Strathclyde surrounding the Sound of Islay, including the Sound of Islay, are listed in Table 12 with counts of grey seals listed in Table 13. Table 12 also shows the number of harbour seals recorded within the south-east Islay Skerries Special Area of Conservation (designated for harbour seals). For comparison, both tables include counts from four previous surveys carried out in the Augusts of 1990, 1996, 2000 & 2007. The distribution of harbour seals counted in August 2009 is shown in Figure 15 and of grey seals in Figure 16

6.4.1 Harbour Seals

The counts of harbour seals in Table 12 represent the minimum number of seals within each sub-region because, at the time of the survey, a proportion of the local population will be at sea (or at least in the water) and therefore not counted. In August, when the largest and most consistent numbers of harbour seals are believed to be on shore, the number of seals at haul-out sites is thought to represent between 50 and 70% of the total population.

In the overall survey area while there have been changes in harbour seal numbers locally there were no substantial changes in numbers compared with previous years. The reasons for this are unknown but may be due to redistribution. The August 2009 survey produced the second lowest total number of harbour seals counted in the sub-regions surrounding the Sound of Islay (subregions 8 to 11 & 13), however counts were fairly similar in different years and so no obvious population trend for this area could be determined. The survey of Jura and Islay in 1996 was affected by rain and ultimately had to be abandoned as the rainfall steadily increased. Part of the area was resurveyed the following day (SE Islay Skerries) but not the whole area. This might, at least in part, account for counts being lower for Jura and Islay in 1996 than any other survey.

In the area surveyed (Jura, Islay, Colonsay, Oronsay and West Kintyre), the main areas used by harbour seals in August 2009 were to the south and east of the Sound of Islay (see Figure 14 for locations). The most important locations were: south-east Islay (the SAC); Craighouse Bay, Lowlandman’s Bay and small islands off the south coast of Jura and Loch Tarbert (Jura); Bowmore (Islay). There were smaller numbers of harbour seals on West Kintyre than in previous years (Table 12) although the locations of haulout sites were similar (Danna and Loch Sween, Loch Caolisport, West Loch Tarbert and Gigha).

As in previous years, by far the highest concentration of harbour seals was recorded within the south-east Islay Skerries SAC, just south of the Sound of Islay (32% of the surveyed area total). This SAC is situated just to the west of the southern end of the Sound of Islay (boxed area, Figure 14).

6.4.2 Grey seals

Numbers of grey seals on shore can vary widely from day to day during the summer months and the numbers in Table 13 should be interpreted with caution since they are unlikely to represent accurately the size of the local grey seal population. The distribution of hauled out grey seal groups was very different to that of harbour seals in this study area. The most important grey seal haulout sites were to the north and west of the Sound of Islay (Figure 15). Large grey seal haul-out sites were almost exclusively found on western coastlines with direct access to open Atlantic waters. The largest groups were: Rubha a’Mhail, Loch Gruinart, Nave Island and the Mull of Oa (Islay); Eilean nan Ron, Eilean an Eoin (Oronsay). There are important grey seal breeding colonies on Nave Island, Eilean nan Ron, Eilean an Eoin (including Eilean Ghaoideamal), Oronsay and Oronsay Strand (see Figure 15). The numbers of pups born on these colonies in 1995, 2000 and in the past four years are in Table 14.

Table 12: Harbour seals around the Sound of Islay. The distribution of harbour seals in August 2009 is shown in Figure 15. Sub-regions are numbered in Figure 15 and the Sound of Islay is enclosed in the box.

Location (Sub-region no.)	**Aug 1990**	**Aug 1996**	**Aug 2000**	**Aug 2007**	**Aug 2009**
Colonsay (8)	109	83	102	59	87
Jura (9)	375	122	548	539	601
Islay (10)	724	605	1108	1001	792
West Kintyre (11)	1,153	1,012	796	644	629
Oronsay (13)	24	0	75	2	0
Total for above	**2,385**	**1,822**	**2,629**	**2,245**	**2,109**
Sound of Islay (boxed area)	85	8	163	93	101
SE Islay SAC	**493**	**552**	**812**	**739**	**666**
Strathclyde Total	**5,317**	**6,333**	**7,909**	**5,760**	**(6,298)***

*Strathclyde total for 2009 combines data from areas surveyed in 2009 and in 2007.

Table 13: Grey seals around the Sound of Islay. The distribution of grey seals in August 2009 is shown in Figure 16. Sub-regions are numbered in Figure 16 and the Sound of Islay is enclosed in the box.

Location (Subregion no.)	**Aug 1990**	**Aug 1996**	**Aug 2000**	**Aug 2007**	**Aug 2009**
Colonsay (8)	17	35	57	21	63
Jura (9)	38	27	19	59	39
Islay (10)	170	441	415	551	657
West Kintyre (11)	17	6	35	21	13
Oronsay (13)	303	230	342	395	392
Total for above	**545**	**739**	**868**	**1,047**	**1,164**
Sound of Islay (box)	29	24	22	46	35
Strathclyde Total	**1,267**	**2,125**	**1,761**	**1,933**	**(2,012)***

*Strathclyde total for 2009 combines data from areas surveyed in 2009 and in 2007.

Table 14: Grey seal pup production at colonies close to the Sound of Islay. Individual colonies are marked in Figure 16.

Year	Nave Is.	Eilean an Eoin	Eilean nan Ron	Oronsay	Oronsay Strand	Inner Hebrides
1995	339	440	454	0	0	**3,050**
2000	402	406	617	0	0	**3,223**
2005	462	417	569	152	40	**3,427**
2006	479	432	565	179	9	**3,470**
2007	478	331	508	179	47	**3,118**
2008	505	354	579	194	40	**3,396**

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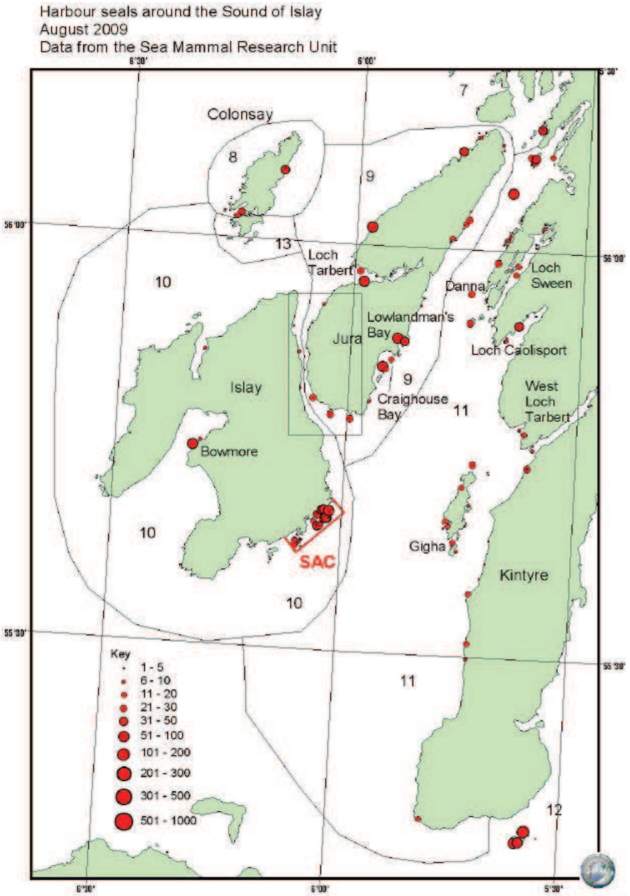

Figure 15: The distribution of harbour seals around the Sound of Islay from a survey carried out in August 2009. Counts of seals in the numbered sub-regions are provided in Table 12. The Sound of Islay is outlined in black and the designated Special Area of Conservation for harbour seals is outlined in red.

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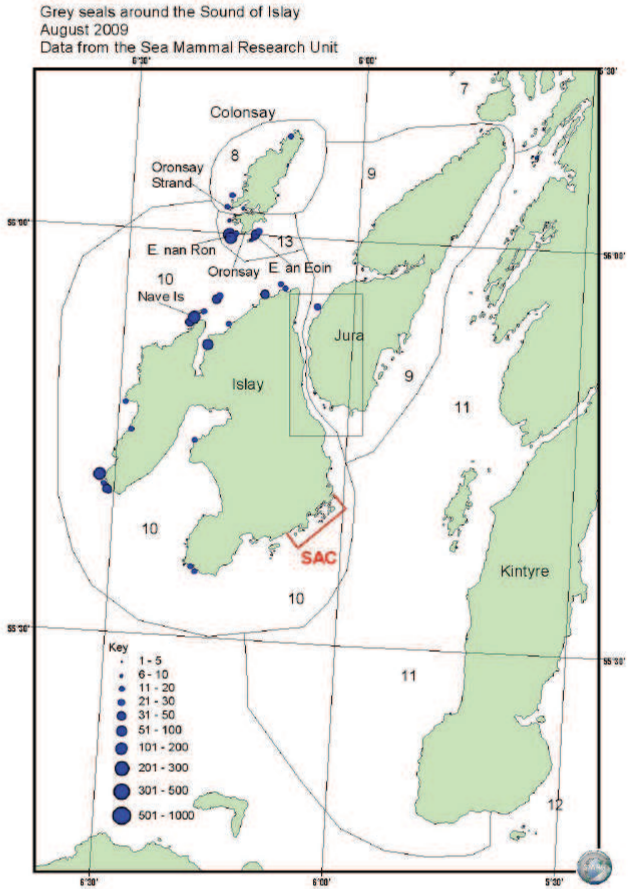

Figure 16: The distribution of grey seals around the Sound of Islay from a survey carried out in August 2009. Counts of seals in the numbered sub-regions are provided in Table 13. The Sound of Islay is outlined in black and the designated Special Area of Conservation for harbour seals is outlined in red. Important local grey seal breeding colonies are labelled.

7 Discussion and Conclusions

This report has brought together existing data relevant to the Sound of Islay collated by HWDT, initial results from ongoing land based marine mammal monitoring, as well as data collected during the Sound of Islay pre-feasibility study (Aberdeen University). Results from the pre-feasibility study are consistent with previous studies and datasets discussed in this report. The following sections detail the key conclusions of this survey work to date. It should be noted that these results only cover the first 8 months and may be subject to change after further data collection and more rigorous analysis.

7.1 Cetaceans

Porpoise

While a variety of marine mammal species may be encountered in the area, the waters surrounding Islay in particular the Sound of Jura appears to be of regional importance for harbour porpoises with high densities of animals (Embling *et al.,* 2009). It has been suggested by HWDT that the Sound of Islay may provide a corridor, linking different populations and areas. However porpoise detection rates were low in the Sound itself and further research is required to test this hypothesis. HWDT data is focussed on summer distributional data therefore little is known about movements of porpoises during the winter months. Also there is little data on habitat use so there is no indication on how porpoises use the area e.g. whether there are specific foraging areas within the Sound.

Considering the results from the visual observations to date, combined with the HWDT data, the Sound of Islay seems to be of low importance for harbour porpoise, relative to the Sound of Islay Region.

Bottlenose Dolphin

Bottlenose dolphins are sighted sporadically in the Sound of Islay with most sightings recorded during 2001-2003. Considering the results from the visual observations to date, combined with the HWDT data, the Sound of Islay seems to be of low importance to bottlenose dolphin, relative to the Sound of Islay Region. Nevertheless, to assess the full importance of this area to the Hebridean bottlenose dolphin population, additional data would be required. Photo-identifications studies for example might be used to investigate if known individuals from other studies in the west of Scotland are often seen in the area.

Public sightings data is year round and only validated sightings of definite identification were used in this report. Therefore the quality of this data is high for indicating presence or absence, however, the dedicated visual and acoustic surveys carried out by HWDT and the dedicated land based visual observations by NRP are more appropriate for indicating relative abundance and species diversity. Data collected during the year round land based observations currently ongoing should help measure the usage of the Sound of Islay by cetaceans seasonally and in all states of tide.

7.2 Seals

In addition to the cetaceans mentioned above, the area is also used by seals, with several SACs designated for seals in the vicinity of the Sound of Islay. In particular the South East Islay Skerries SAC is extensively used as a pupping, moulting and haul-out site by harbour seals. This area represents between 1.5% and 2% of the UK harbour seal population. Numbers of harbour seals using the Sound of Islay in comparison to counts of harbour seals on the entire island are detailed in **Table 12**. The Scottish harbour seal population is in decline in many areas however in the Sound of Islay region the numbers are stable. In the last site condition monitoring report the SAC was deemed in favourable maintained condition (SNH 2005). Aerial survey results indicate that within the Sound of Islay region, there was no substantial difference in harbour seal numbers compared with previous surveys. Locally, however, there were changes in harbour seal numbers with a decline in West Kintyre and an increase on Jura. The importance of the area for seals is relatively easy to put into a national context due to the regular breeding and moult site surveys undertaken by SMRU.

Ongoing land-based observations focussing on the development site in the Sound of Islay have confirmed moderate abundance of harbour seals in the Sound of Islay and, to a lesser extent, grey seals. Seals are frequently seen hauled out along the banks of the Sound. Seals have been observed travelling, resting and feeding in the Sound of Islay and it's likely that these animals are part of the SAC population. Harbour seals generally forage near their haul out sites (within 40-50km) and so the development site is well within the foraging range for the SAC population. The nearest grey seal SAC is the Treshnish Isles up to 70km from the development site. The Treshnish Isles supports a breeding colony of grey seals contributing just fewer than 3% of annual UK pup production. Grey seals however travel and forage greater distances from their breeding sites.

7.3 Otters

Otters are frequently seen in the Sound of Islay. The overall importance of the site to the local otter population is unknown however. Seasonal and tidal distributional data are as yet unavailable.

8 References

Anderwald, P., Evans, P.G.H, Hoelzel, A.R, & Papastavrou, V. (2008). Minke whale *Balaenoptera acutorostrata*. In: Harris S, Yalden DW (eds) *Mammals of The British Isles*. Handbook 4th Edition. The Mammal Society, pp 665-669

Bolt, H.E., Harvey, P.V., Mandleberg, L & Foote, A (2009). Occurrence of killer whales in Scottish inshore waters: temporal and spatial patterns relative to the distribution of declining harbour seal populations. *Aquatic Conservation: Marine and Freshwater Ecosystems* –online

Burt, M. L., Borchers, D. L. & Samarra, F. (2008a). Aerial survey abundance estimates for minke whale and dolphins. Appendix D3.3 of the SCANS-II Final Report, 2008.

Canning, S.J., Santos, M.B., Reid, R.J., Evans, P.G.H., Sabin, R.C., Bailey, N. & Pierce, G.J. (2008). Seasonal distribution of white beaked dolphins (*Lagenorhynchus albirostris*) in UK waters with new information on diet and habitat use. *Journal of the Marine Biological Association of the United Kingdom* 88(6) 1159-1166.

Clarke, M. & Pascoe, P.L. (1985). The stomach contents of a Risso's dolphin (*Grampus griseus*) stranded at Thurlestone, South Devon. *Journal of the Marine Biological Association UK* 65:663-665.

Cunningham, L., Baxter, J.M., Boyd, I.L., Duck, C.D., Lonergan, M. Moss, S & McConnell, B., (2009). Harbour seal movements and haul out patterns: implications for monitoring and management. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 19:398-407.

Embling, C. B., Gillibrand, P.A., Gordon, J., Shrimpton, J., Stevick, P.T. & Hammond, P.S. (2009). Using habitat models to identify suitable sites for marine protected areas for harbour porpoises (*Phocoena phocoena*). *Biological Conservation* doi:10,1016/j.biocon.2009.09.005

Evans, P.G.H (1992). Status of cetaceans in British and Irish waters. UK Mammal Society Cetacean Group, Oxford

Evans, P.G.H. & Hammond, P.S. (2004). Monitoring cetaceans in European waters. Mammal Review 34(1) 131-156.

Gill, A., Reid, R.J. &Fairbairns, B.R. (2000). Photographic and strandings data highlighting the problem of marine debris and creel rope entanglement to minke whales (*Balaenoptera acutorostrata*) and other marine life in Scottish waters. European Research on Cetaceans 14 (ed. P.G.H. Evans, R. Pitt-Aiken & E. Rogan), p. 173-178. Cork: European Cetacean Society.

Goodwin, L. & Speedie, C. (2008). Relative abundance, density and distribution of the harbour porpoise (*Phocoena phocoena*) along the west coast of the UK. *Journal of the Marine Biological Association of the United Kingdom*, 2008, 88(6), 1221–1228.

Grellier, K & Wilson, B. (2003). Bottlenose dolphins using the Sound of Barra, Scotland. Aquatic Mammals 29(3) 378–382.

Hall, A.J., McConnell, B., Pomeroy, P., Duck, C.D., Fedak, M.A., Matthiopoulos, J. & Walton, M.J. (2000). The diet of grey seals using faecal and fatty acid analysis. In Chapter 6, Variation in the diet, distribution consumption and breeding population parameters of grey seals in The effect of large-scale industrial fisheries on non-target species. Final Report to the European Commission. Pages 5-79.

Hammond, P. S. & J. H. Prime (1990). The diet of British grey seals, *Halichoerus grypus*. *Canadian Journal of Fisheries and Aquatic Sciences*. 222:243-254.

Hammond, P. S., A. J. Hall & J. H. Prime (1994). The diet of grey seals around Orkney and other island and mainland sites in north-eastern Scotland. (*Halichoerus grypus*) *Journal of Applied Ecology* 31(2):340-350.

Hammond, P.S (2008). Small cetaceans in the European Atlantic and North Sea (SCANS-II). Final report to the European Commission under contract LIFE04NAT/GB/000245.

Hammond, P.S, Berggren, P, Benke, H, Borchers ,D.L, Collet, A, Heide-JØrgensen, M.P, Heimlich, S, Hiby, A.R, Leopold, M.F & Øien, N. (2002). Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. *Journal of Applied Ecology* 39: 361-376

Hammond, P.S. & Grellier, K. (2006). Grey seal diet composition and prey consumption in the North Sea. Final report to Department for Environment, Food and Rural Affairs on project MF0319.

Hammond, P.S. & Harris, R.N (2006). Grey seal diet composition and prey consumption off western Scotland and Shetland. Final report to Scottish Executive Environment and Rural Affairs Department and Scottish Natural Heritage.

Hammond, P.S. Northridge, S.P. Thompson, D. Gordon, J.C.D. Hall, A.J. Duck, C.D. Aarts, G. Cunningham, L. Embling C.B. & Matthiopoulos J. (2006). Background information on marine mammals for Strategic Environmental Assessment 7 SMRU.

Jeewoonarain, T., Parsons, E.C.M. & Evans P.G.H. (2000). Operation Sightings: Sightings of cetaceans in the southern Hebrides, Scotland. In European Research on Cetaceans 913. 237-241.

Learmonth, J (2006). Life history and fatty acid analysis of harbour porpoises (*Phocoena phocoena*) from Scottish waters. PhD thesis.

Lockyer, C. (2007). "All creatures great and smaller: a study in cetacean life history energetics." *Journal Of The Marine Biological Association Of The United Kingdom* 87: 1035-1045.

Lonergan, M, Duck, C.D, Thompson, D., Mackey, B.L, Cunningham, L. & Boyd, I.L. (2007). Using sparse survey data to investigate the declining abundance of British harbour seals. *Journal of Zoology* 271: 261–269.

Luque, P.L., Davis, C.D., Reid, D.G., Wang, J., & Pierce, G.J. (2006). Opportunistic sightings of killer whales from Scottish pelagic trawlers fishing for mackerel and herring off North Scotland (UK) between 2000 and 2006. *Aquatic Living Resources* 19: 403-410

MacLeod, C.D., Bannon, S.M., Pierce, G.J., Schweder, C., Learmonth, J.A., Reid, R.J. &Herman, J.S. (2005). Climate change and the cetacean community of north-west Scotland. *Biological Conservation* 124, 477–483.

MacLeod, C.D., Weir, C.R., Pierpoint, C. & Harland E. (2007). The habitat preferences of marine mammals west of Scotland (UK). *Journal of the Marine Biological Association of the United Kingdom* 87, 157–164.

MacLeod, C.D., Weir, C.R., Santos, B.M. & Dunn, T.E. (2008). Temperature-based summer habitat partitioning between white-beaked and common dolphins around the United Kingdom and Republic of Ireland. *Journal of the Marine Biological Association of the United Kingdom*. 88(6), 1193-1198.

Macleod, K, Fairbairns, R., Gill, A., Fairbairns, B., Gordon, J., Blair-myers, C. & Parsons, E.C.M. (2004). Seasonal distribution of minke whales (*Balaenoptera acutorostrata*) in relation to physiography and potential prey off the Isle of Mull, Scotland. *Marine Ecology Progress Series* 277: 263-274

Macleod, K. (2001). The spatial and temporal distribution of cetaceans off the west coast of Scotland in relation to environmental factors: the implications for marine management. PhD Thesis, University Greenwich, London.

Macleod, K., Simmonds, M. & Murray, E. (2003). Summer distribution and relative abundance of cetacean populations off northwest Scotland. *Journal of the Marine Biological Association. of the United Kingdom* 83:1187-92.

Mandelberg, L. (2006). Bottlenose dolphins of the Hebrides: A summary report from five years of research (2001-2005) Hebridean Whale and Dolphin Trust Prepared for: Biodiversity Action Grants Scheme.

Mandleberg, L., Booth, C., Gordon, J & Calderan, S. (2010). Report to ScottishPower Renewables in the marine mammal species and basking sharks occurring in the Sound of Islay study region. Hebridean Whale and Dolphin Trust.27pp.

Marubini, F., Gimona, A., Evans, P.G. H., Wright, P. J., & Pierce, G. J, (2009). Habitat preferences and interannual variability in occurrence of the harbour porpoise (*Phocoena phocoena*) off northwest Scotland *Marine Ecology Progress Series* Vol. 381: 297–310, 2009.

Maxwell, P., Owen, A., Scott, E & Ogilvie (2008) Sound of Islay Pre-Feasibility study. Islay Energy Trust.

McConnell, B.J., Chambers, C., Nicholas, K.S. & Fedak, M.A. (1992) Satellite tracking of grey seals (*Halichoerus grypus*). *Journal of Zoology* 226: 271-282.

McConnell, B.J., Fedak, M.A., Lovell, P. & Hammond, P.S. (1999). Movements and foraging areas of grey seals in the North Sea. *Journal of Applied Ecology* 36: 573-590.

Mendes, S., Turrell , W.R., Lutkebohle, T. & Thompson, P.M. (2002). Influence of the tidal cycle and a tidal intrusion front on the spatio-temporal distribution of coastal bottlenose dolphins. *Marine Ecology Progress Series* 239:221-229.

Murphy, S. Collet, A. & Rogan, E. (2005). Mating strategy in the male common dolphin (*Delphinus delphis*): What gonadal analysis tells us. *Journal of Mammology* 86(6):1247-1258.

Murphy, S. & Rogan, E. (2006)/ External morphology of the short-beaked common dolphin, *Delphinus delphis* : growth, allometric relationships and sexual dimorphism. *Acta Zoologica* 87 : 315–329.

Northridge, S. P., Tasker, M. L., Webb, A., & Williams, J. M. (1995). Distribution and relative abundance of harbour porpoises (*Phocoena phocoena L.*), white-beaked dolphins (*Lagenorhynchus albirostris* Gray), and minke whales (*Balaenoptera acutorostrata* Lacepede) around the British Isles. - ICES Journal of Marine Science, 52: 55-66.

Pierce, G.J. & Santos, M.B. (2003). Diet of harbour seals (*Phoca vitulina*) in Mull and Skye (Inner Hebrides, western Scotland). *Journal of the Marine Biological Association of the United Kingdom* 83: 647-650

Pierce, G.J., Santos, M.B., Reid, R.J., Patterson, I.A.P. & Ross, H.M. (2004). Diet of minke whales *Balaenoptera acutorostrata* in Scottish (UK) waters with notes on strandings of this species in Scotland 1992-2002. *Journal of the Marine Biological Association of the UK* 84: 1241-1244

Pomeroy PP, Twiss SD, Duck CD (2000). Expansion of a grey seal *(Halichoerus grypus)* breeding colony: changes in pupping site use at the Isle of May, Scotland. *Journal of Zoology* 250: 1-12.

Reid, J., Evans, P.G.H. & Northridge, S.P. (2003). *Cetacean Distribution Atlas*. Joint Nature Conservation Committee, Peterborough.68pp.

Santos, M.B, Pierce, G.J, Wijnsma, G, Ross, H.M, Reid, R.J (1995). Diets of small cetaceans stranded in Scotland 1993-1995. ICES CM 1995/N:6

Santos, M.B. & Pierce, G.J. (2003). The diet of the harbour porpoise (*Phocoena phocoena*) in the Northeast Atlantic. *Oceanography and Marine Biology: an Annual Review* 41: 355–390

Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J, Ross, H.M., Patterson, I.A.P., Reid, D.G.& Beare, D. (2004). Variability in the diet of harbour porpoises (*Phocoena phocoena*) in Scottish waters 1992-2003. *Marine Mammal Science* 20:1-27.

Santos, M.B, Pierce, G.J, Wijnsma, G, Ross, H.M, Reid, R.J (1995). Diets of small cetaceans stranded in Scotland 1993-1995. ICES CM 1995/N:6

Santos, M.B. & Pierce, G.J. (2003). The diet of the harbour porpoise (*Phocoena phocoena*) in the Northeast Atlantic. *Oceanography and Marine Biology: an Annual Review* 41: 355–390

Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J, Ross, H.M., Patterson, I.A.P., Reid, D.G.& Beare, D. (2004). Variability in the diet of harbour porpoises (*Phocoena phocoena*) in Scottish waters 1992-2003. *Marine Mammal Science* 20: 1–27

Santos, M.B., Pierce, G.J., Reid, R.J., Patterson, I.A.P., Ross, H.M. & Mente, E. (2001). Stomach contents of bottlenose dolphins (*Tursiops truncatus*) in Scottish waters. *Journal of the Marine Biological Association of the UK* 81: 873-878

SCOS (2008). Scientific Advice on Matters Related to the Management of Seal Populations: 2008. Available from http://www.smru.st-andrews.ac.uk/

Shrimpton, J.H. & Parsons, E.C.M., (2000). Cetacean conservation in west Scotland. Isle of Mull, Scotland: Hebridean Whale and Dolphin Trust.

Weir, C.R. (2002). Killer whales (*Orcinus orca*) in UK waters. British Wildlife 14: 106–108

Weir, C.R., Pollock, C., Cronin, C. &Taylor, S. (2001). Cetaceans of the Atlantic frontier, north and west of Scotland. *Continental Shelf Research* 21: 1047-1071

Weir, R. C. Macleod, C.D & Caldaran, S.V. (2009). Fine-scale habitat selection by white-beaked and common dolphins in the Minch (Scotland, UK): evidence for interspecific competition or coexistence? *Journal of the Marine Biological Association of the United Kingdom*, 2009, 89(5), 951–960.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 9 – Marine Mammals

Appendix 9.2: “Report to Scottish Power on the marine mammal species and basking sharks occurring in the Sound of Islay study region”

Report to Scottish Power on the marine mammal species and basking sharks occurring in the Sound of Islay study region

by

The Hebridean Whale and Dolphin Trust

Contents

2

Summary

Background

The west coast of Scotland is an area of high biological productivity with a rich species biodiversity. In terms of cetaceans, the area is particularly important for harbour porpoises, with some of the highest densities in Europe (SCANS-II, 2008; Evans and Wang, 2008); it is home to one of the UK's three populations of bottlenose dolphins, and a resident population of killer whales. The area is also important for basking sharks and seals (common and grey).

This report provides information on the importance of Sound of Islay study region for marine mammal species and basking sharks, both in a local context, and in the context of the west coast of Scotland as a whole. For this report, the Sound of Islay study region is defined as (56.04°N 6.41°W – 55.58°N 5.70°W) and encompasses a core region around the Sound of Islay including the southern Sound of Jura (Figure 2b). Data from two separate sources have been processed and analysed for this report:

1) effort-corrected visual and acoustic data collected between 2003 and 2009 during HWDT vessel-based line transect surveys and
2) sightings data reported by members of the public between 2000 and 2008.

Main findings

- Visual and acoustic data indicated relatively high sighting densities of harbour porpoises throughout the Sound of Islay study region. The highest densities were found in the Sound of Jura and to the north of Islay.

- Visual data revealed the study area also has relatively high densities of common and grey seals, particularly in the Sound of Jura and the waters to the north of Islay.

- Public sightings data indicated the Sound of Islay study region was important for bottlenose dolphins, with the highest numbers of sightings in the Sound of Islay, Loch Indaal, Port Ellen and around the Isle of Gigha.

- Whale sightings were distributed widely across the Sound of Jura, with a few sightings further north between Colonsay and Jura

- There was a low number of basking sharks sighted in the study region

Conclusions

- The Sound of Islay study region contains important habitat for harbour porpoises, in particular the Sound of Jura, which has been highlighted as one of four key areas for harbour porpoises on the west coast of Scotland (Embling et al. 2009 *in press*). It is likely that the Sound of Islay provides an important corridor between the Sound of Jura and neighbouring high-use areas e.g. the Firth of Lorne (Booth, *pers. comm*).

- The relatively high sighting densities of common and grey seals observed at sea in the study region during HWDT surveys are consistent with seal count data collected at haul out sites in the region which have shown the skerries and coastline of south-east Islay to hold a nationally-important population of the common seal *Phoca vitulina*. The south-east coastline areas are extensively used as pupping, moulting and haul-out sites by the seals, which represent between 1.5% and 2% of the UK population (SMRU report, 2001).

- The Sound of Islay study region is important for the Hebridean bottlenose dolphin population with frequent sightings reported around Islay between 2001 and 2003. This population is extremely mobile and wide-ranging and the factors that influence their movements within the study region are poorly understood. It is probable that narrow channels such as the Sound of Islay are important ‘corridors’ between foraging locations.

Introduction

The Hebridean Whale and Dolphin Trust (HWDT) is a non-governmental organisation based on the Isle of Mull and is dedicated to enhancing the knowledge and understanding of Scotland's whales, dolphins and porpoises and the Hebridean marine environment. It achieves this goal through education, research and working within local communities as a basis for the lasting conservation of local species and habitats. The work of HWDT involves:

- long term monitoring of cetacean distribution, abundance and habitat use through boat-based visual and acoustic surveys and a community sightings programme
- education of a wide range of people about cetaceans and the marine environment with a focus on school education
- working within local communities to ensure long-term sustainability of the marine environment.

The aim of HWDT's monitoring work is to provide those who manage Scotland's marine wildlife and habitats with information they need to achieve effective conservation of the area's biodiversity. The primary emphasis of this monitoring is the study of cetacean populations through visual and acoustic surveys conducted from the research vessel *Silurian*, an 18m yacht, specifically adapted for cetacean research. Survey coverage spans the entire west coast from the Kintrye peninsula to the north Gairloch coast to the Outer Isles (Figure 2a). Visual data for cetaceans, seals and basking sharks has been collected since 2003 and acoustic data for harbour porpoises has been collected since 2004.

Understanding the fine-scale distribution of the harbour porpoise (*Phocoena phocoena*) has been one of the core research aims of HWDT since the Hebrides is of significant importance for this species in Europe (SCANS-II, 2008; Evans and Wang, 2008).

Other monitoring activities include working with local tour operators who collect data from their vessels; maintaining a Commmity Sightings Programme - a network for recording sightings made by the public; responding to reports of dead or stranded cetaceans and maintaining photo-identification catalogues for local populations of minke whales (*Balaenoptera acutorostrata*), killer whales (*Orcinus orca*) and bottlenose dolphins (*Tursiops truncatus*).

The Community Sightings Programme encourages members of the public to report sightings of whales, dolphins and porpoises to HWDT. HWDT receives incidental sightings reports year-round from people whose work or leisure activities take them on or near the sea. They include fishermen, fish farmers, local boat operators, coastguards, ferry personnel, holidaymakers and ornithologists. Despite biases involved with data collected in this non-systematic way (variations in visitor numbers, levels of experience and interest in reporting sightings, weather conditions, numbers and distribution of cetaceans from year to year), these sightings are a valuable source of data and widen HWDT's monitoring capacity. This enables a more continuous picture of cetacean activity over a larger area to be achieved. The gradual accumulation of sightings reports from members of the public complements the survey data collected from *Silurian* and has helped our understanding of where and when particular species occur. This is particularly true for smaller populations, such as those of bottlenose dolphins and killer whales that, due to their wide-ranging nature, are extremely difficult to survey.

The Community Sightings Programme has been in operation since 2000. The most commonly reported species are the harbour porpoise and minke whale, followed by bottlenose dolphins. Traditionally, most sightings reports have been concentrated around the Mull area due to the raised levels of awareness about the programme locally. However, more recently the sightings network has expanded further across the Hebrides and the distribution of sightings has reflected this.

Between 2000 and 2003 there was a particular focus on collecting sightings from around the Isle of Islay. This was in response to a high number of bottlenose dolphin sightings in this area. A small team of HWDT researchers set up a base on the island and encouraged members of the public to report their sightings. Ferry surveys were also carried out as part of this project in order to investigate cetacean abundance and distribution in this area.

Species review

The west coast of Scotland a topographically diverse region with: shallow, inshore areas (e.g. the Sound of Mull), coastal islands (e.g. the Garvallach islands), offshore islands (e.g. Barra) and deeper, open water (e.g. the Sea of Hebrides) and a number of underwater banks and submarine canyons. The oceanographic features of the west coast of Scotland are complex; the two main influences are the Coastal Current arising from the Clyde and Irish Sea, and Atlantic water moving over the continental shelf north of Ireland (Ellett, 1979). Strong tidal streams and currents induce the complex mixing of these waters, especially around headlands and islands, making the west coast of Scotland an area of high biological productivity with a rich species biodiversity. This is evident in the high numbers of cetaceans recorded in the region.

The most commonly sighted cetacean species in the study area are the harbour porpoise, bottlenose dolphin, common dolphin (*Delphinus delphis*), minke whale, Risso's dolphin (*Grampus griseus*), white-beaked dolphin (*Lagenorhynchus albirostris*) and killer whale (Shrimpton and Parsons, 2000).

Harbour porpoises

The harbour porpoise is both the smallest and most abundant cetacean species found off the west coast of Scotland. It is now understood that the west coast of Scotland has one of the highest densities of harbour porpoises in Europe (SCANS-II, 2008; Evans and Wang, 2008) and they are thought to be present year-round. Harbour porpoises have lower detection rates than other cetacean species during visual surveys. This is mainly due to their small size, small group sizes and shy surface behaviour. Furthermore, sea state has a strong negative effect on 'detectability'. Passive acoustic monitoring is therefore a valuable survey technique to complement visual surveys since animals' detection probability is less affected by sea state.

HWDT surveys have shown harbour porpoises to be widely distributed throughout the west coast of Scotland, particularly in coastal areas (Figure 1a). Key regions of high density are in the Sound of Jura, the Firth of Lorne, between Mull and the Treshnish Islands, around the Small Isles and in the Sound of Sleat (between Skye and the mainland).

Bottlenose dolphins

There are two discrete groups of dolphins inhabiting the west coast of Scotland; one using the waters around the Sound of Barra in the Outer Hebrides; and the other using the

waters of the Inner Hebrides and mainland coast. There is no evidence to suggest mixing between these two groups (Thompson *et al.* 2009 *in press*). There is thought to be between 12 and 15 individuals in the Barra group and between 25 and 30 in the Hebridean group. Unlike the Barra group, which is thought to have an extremely small home-range, the Inner Hebridean group is wide-ranging. Due to the low number of individuals in this group and their wide-ranging nature, sightings rates of this species are low during *Silurian* surveys. Public sightings reports and photographs therefore provide valuable, additional data which have contributed greatly to our understanding of this species.

Sightings are most frequent in the southern and central parts of the west coast, around the Kintyre and Islay coast up to and around the Mull coastline. Sightings are reasonably high around the Skye coast but less common along the northern coastline and the Outer Isles. The vast majority of sightings are within close proximity to the coast (Figure 1d).

Other dolphin species

Other species of dolphin occurring off the west coast of Scotland include common dolphins, Risso's dolphins, white-beaked dolphins and Atlantic white-sided dolphins (*Lagenorhynchus acutus*). Of these, the most frequently sighted species is the common dolphin. Dolphin sightings are widespread throughout the west coast of Scotland. The majority of sightings are away from the coast, as expected due to the offshore ecology of dolphins (Figure 1c). There is a small, resident population of killer whales on the west coast of Scotland. Sightings are infrequent and widely distributed across the area.

Whale species

The most common whale species occurring in the Hebrides is the minke whale. Minke whales are seasonal visitors to the west coast of Scotland and arrive in the area to feed on small pelagic fish between April and September. Photo-identification studies have shown that many of the individuals identified are seasonally resident in the Hebrides, with some returning year after year to the same feeding grounds (Gill, 2000).

Other whale species recorded occasionally in the Hebrides are humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*) and Sei whales

(*Balaenoptera borealis*). Other toothed whale species recorded include sperm whales (*Physeter macrocephalus*) and northern bottlenose whales (*Hyperoodon ampullatus*), although sightings are rare.

The highest density of minke whale sightings on the west coast of Scotland is to the north and west of Mull (Figure 1b).

Basking sharks

Basking sharks (*Cetorhinus maximus*) are found globally in cold to temperate waters. In the Hebrides, basking sharks are frequently encountered in the summer months between May and October when they are feeding on plankton in the surface waters. Seasonal distribution is related to plankton availability, and basking sharks favour areas of high productivity, for example where there is a high degree of oceanic mixing, or fronts. Basking sharks are seen in the highest numbers in the waters off the west coast of Mull, around the Treshnish Isles and around the coasts of Coll and Tiree (Figure 1e).

Seals

There are two species of seal in the UK; the grey (*Halichoerus grypus*) and the common or harbour seal (*Phoca vitulina*). The grey seal is the larger of the two species and is more abundant. Population studies estimate that just under half of the world's grey seals live in the waters around the UK, and the Hebrides is home to significant populations (SMRU report, 2001). Grey seals spend most of their time at sea, and may range widely in search of prey.

Compared with grey seals, common seal distribution is more coastal, and they are often seen in estuaries, river mouths and may even venture upstream. Important grey seal colonies in the Hebrides are on the Treshnish Isles and the Monach Islands. Important sites for common seals are on the Island of Lismore, the skerries and coastline of south-east Islay, and the rugged coastline of north-west Skye.

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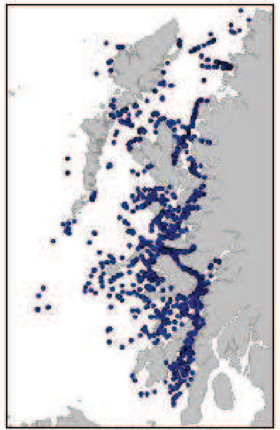

Figure 1a Harbour porpoise sightings data collected during *Silurian* surveys 2003-2007 (blue dots - not corrected for effort)

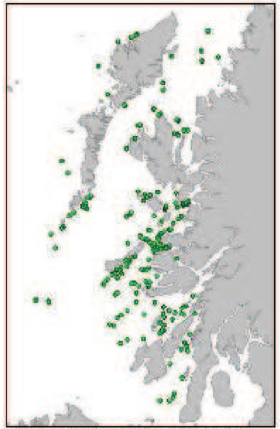

Figure 1b. Visual sightings data for all whale species collected during *Silurian* surveys 2003-2007 (green dots - not corrected for effort)

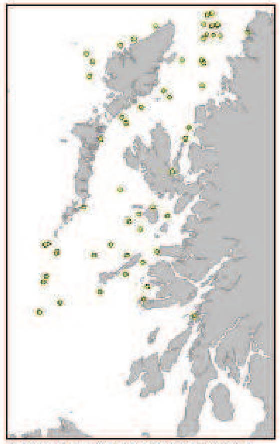

Figure 1c. Visual sightings data for all dolphin species collected during *Silurian* surveys 2003-2007 (yellow dots - not corrected for effort)

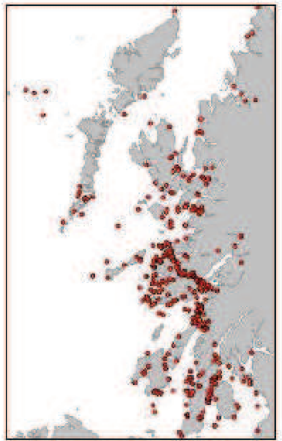

Figure 1d. Public sightings data for bottlenose dolphins 2003-2007 (red dots)

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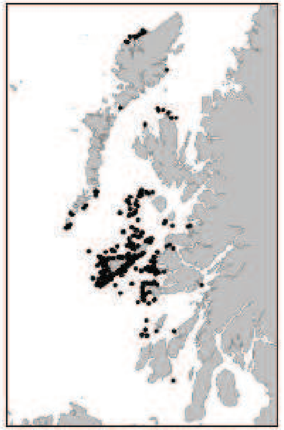

Figure 1e. Sightings data for basking sharks collected during *Silurian* surveys 2003-2007 (black dots - not corrected for effort)

Methodology

1) Silurian Data

Designed line-transect visual and towed-array acoustic surveys (focusing on harbour porpoises) were conducted between 2003 – 2009 and 2004 – 2008, respectively, from the Hebridean Whale and Dolphin Trust (HWDT) survey vessel *Silurian*. Sightings of dolphin, whale, porpoise, seal species and basking sharks were recorded during systematic line transect surveys carried out from the Hebridean Whale and Dolphin Trust’s (HWDT) 18m motor-sailor vessel *Silurian*. Towed stereo hydrophones and a specialized acoustic monitoring system were used to detect small cetaceans acoustically, with the most useful data being collected for harbor porpoises. These surveys were conducted on the west coast of Scotland (55° 10′–58° 40′ N, 5° 0′–8° 35′ W; Figure 2a),

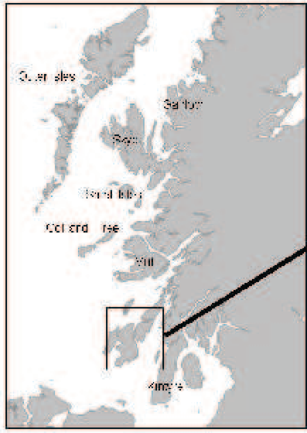

Figure 2a Map of west coast and survey area for HWDT visual and acoustic surveys.

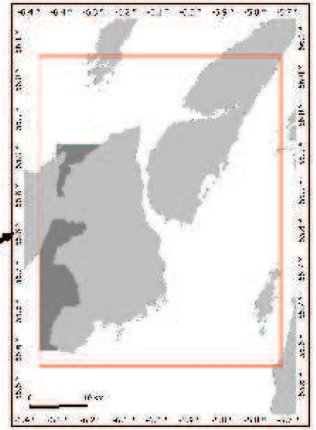

Figure 2b Study region for the Sound of Islay analysis (red line). Area not surveyed is shown in dark grey. Scale is shown in the bottom left corner.

between April and September (inclusive) during daylight hours. 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. The constraints of the weather and finding safe anchorages at night were considered when designing and executing these surveys. This analysis focused on a core region around the Sound of Islay (56.04°N 6.41°W – 55.58°N 5.70°W – Figure 2b).

Visual Surveys

Visual surveys were carried out by teams of two trained observers, one situated on either side of the mast on the front deck of the vessel, (2 m above water level). Each observer surveyed one side each from 0° (ahead of the vessel) to 90° (abeam of the vessel) with the naked eye and 7 x 50 binoculars (Marine Optricon and Plastimo). Observers were rotated every hour to avoid fatigue. Visual data were collected in sea conditions of

Beaufort sea state ≤ 5. A survey speed of 6 knots was maintained during surveys; the majority of survey time was spent under motor. When sufficient wind was available surveys were carried out under sail, with the boat's engines off. Weather, sighting conditions, boat activity and degree of effort were recorded during the survey. When marine mammals (or basking sharks) were sighted, the species was identified and the time of first sighting, the estimated distance to the animal(s), the bearing to the animal(s) relative to the boat (determined from angle boards on deck) and the heading of the animal(s) relative to the boat were recorded. Group size and behaviour of the animal(s) were also recorded. These sighting data were relayed to a data-recorder, who manually entered them into the data recording software *Logger 2000* (developed by the International Fund for Animal Welfare – IFAW) which ran continuously, logging GPS positional and NMEA feed data (described more below), and stored this in a Microsoft Access database in real-time (see *Logger 2000* section below for further details).

Logger 2000

The data collection software *Logger 2000* ran continuously and was connected through a serial interface to the vessel's NMEA feed. Positions (from GPS) were logged every 10 seconds along with the vessel's speed, course, wind speed and direction. Survey effort status was also recorded in Logger. When visual observers were in place, the vessel's effort status was "On Effort". Often when a sighting occurred, the survey vessel broke survey and deviated from the transect line to identify species and/or carry out photo-identification of dolphin species and minke whales. During such deviations from track-line, the vessel survey effort was changed to "With Whales". Once the sighting was over, the vessel returned to its survey lines and the visual observers resumed their positions and the survey effort status was changed 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 (PAM) was conducted using a towed hydrophone array on surveys from 2004 to 2008. Acoustic surveys were carried out in all sea states, during daylight hours and in waters >10 m depth. The hydrophone array was comprised of two

high-frequency elements (HS150 elements - Sonar Research & Development Ltd) and was towed 100 m behind the boat attached by Kevlar-strengthened towing cable. The signal from the hydrophone array was fed into a computer running porpoise detection software (Porpoise Detector was used in 2004-2005 and Rainbow Click was used in 2006-2008) which automatically detected 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*, with the number of animals logged for each porpoise detection. 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 -2009 were analysed using Manifold (Version 8.00). These data were broken down by grid cells. For this analysis a grid cell of 4 x 4 km was used as it provided approximately equal effort across the study region. All dolphin species were grouped together and treated as a single category in this analysis. Similarly all whale species and seal species were grouped. Basking sharks, sightings of harbour porpoises and porpoise acoustic detections were treated separately. In each grid cell, detections per unit of effort (per kilometre completed trackline) maps were produced for each of these species groups (with two maps produced for harbour porpoises – one using visual data and one using acoustic data).

Results

Harbour porpoises were the most common species in the study region, followed by seals. Harbour porpoise detections were widespread throughout the Sound of Islay region with higher densities in the Sound of Jura. There were fewer detections in the Sound of Islay itself and to the north, between Colonsay and Jura (Figure 3a). Harbour porpoise sightings were concentrated in the Sound of Jura and to the east and west of Colonsay (Figure 3b).

Sightings of seals were also widespread throughout the region but concentrations were highest in the Sound of Jura and in the waters between Islay and Colonsay. There were few seal sightings in the waters between Islay and the Kintyre peninsula (Figure 3c).

There was a dispersed distribution of whale sightings throughout the region, with higher concentrations off the east coast of Colonsay and in the Sound of Jura. (Figure 3f).

There were very few sightings of dolphins or basking sharks in the Sound of Islay region (Figures 3d and e).

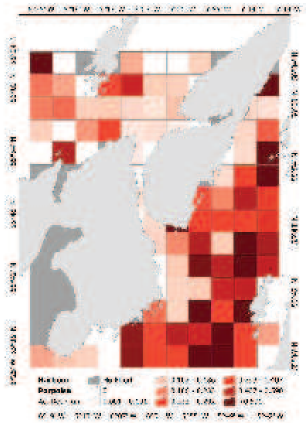

Figure 3a. Harbour porpoise acoustic detections per unit effort in the Sound of Islay region (shown in shades of red). Grid cells not surveyed shown in dark grey.

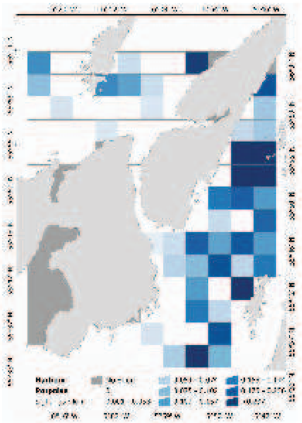

Figure 3b. Sightings per unit effort of harbour porpoise in the Sound of Islay region (shown in shades of blue). Grid cells not surveyed shown in dark grey.

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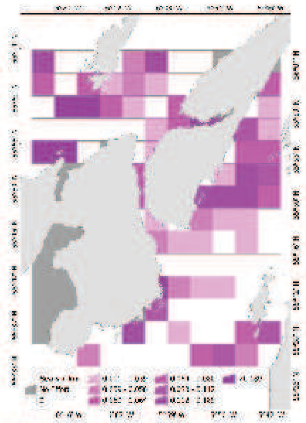

Figure 3c Sightings per unit effort of grey, common and unidentified seals in the Sound of Islay region (shown in shades of purple). Grid cells not surveyed shown in dark grey.

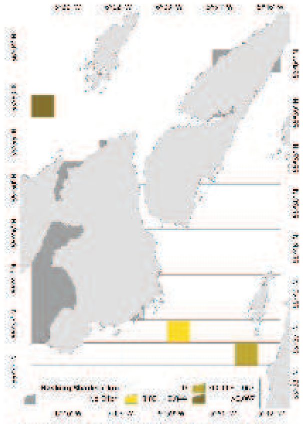

Figure 3d Sightings per unit effort of basking sharks in the Sound of Islay region (shown in shades of yellow). Grid cells not surveyed is shown in dark grey.

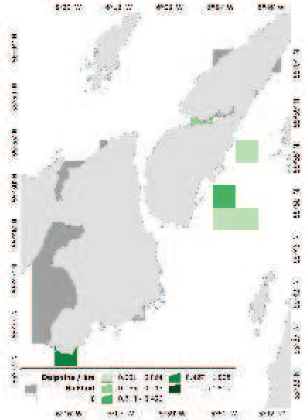

Figure 3e Sightings per unit effort of dolphin species in the Sound of Islay region (shown in shades of green). Grid cells not surveyed shown in dark grey.

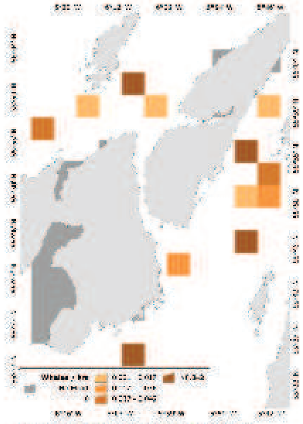

Figure 3f Sightings per unit effort of whale species in the Sound of Islay region (shown in shades of orange). Grid cells not surveyed shown in dark grey.

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2) Public sightings data

Sightings reports were collated from local boat operators and members of the public between 2000 and 2008 using a standard sightings form. The sightings form requires the following information from the reporter about the sighting; date and time of sighting, species location (latitude and longitude), approximate group size and direction of travel. The reporter is also required to give a confidence score on their species identification (possible = 1, probable = 2, definite = 3). This scoring system is taken into account when validating sightings. In order to maximize the accuracy of each sighting, all of the information is checked by a trained member of staff. In many cases, the reporter is contacted to minimize bias due to species misidentification. For those sightings where a definite species identification could not be ascertained, sightings were either classified as unidentified whale or unidentified dolphin.

For this analysis, harbour porpoises, bottlenose dolphins and basking sharks were treated separately whilst other dolphin species and whale species were grouped together. Unidentified whales and dolphins were grouped in the respective whale or dolphin categories.

The dataset also included sightings data collected during ferry surveys conducted in 2003 along the two routes from Kennacraig to Port Askaig and Port Ellen by trained observers.

Results

Harbour porpoises were the most frequently reported species in the region, followed by bottlenose dolphins. Whilst the dataset used for this analysis was biased due to repeated transects along the two ferry routes, the data showed harbour porpoises to be the most common species in the Sound of Jura and in the Sound of Islay (Figure 4a). Sightings of bottlenose dolphins were concentrated in the Sound of Islay, Loch Indaal, Port Ellen and around the Isle of Gigha (Figure 4b). There were also a high number of other dolphin species sighted, in particular in the Sound of Islay, Loch Indaal and along the south and west coasts of Islay (Figure 4c). Whale sightings were distributed widely across the Sound of Jura, with a few sightings further north between Colonsay and Jura (Figure 4d). There were no sightings of basking sharks in the Sound of Islay study region.

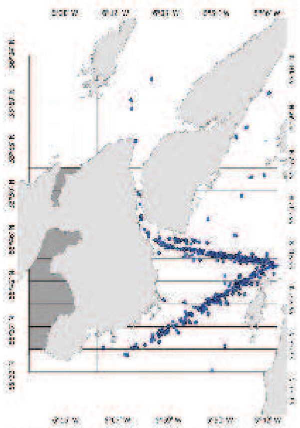

Fig 4a Harbour Porpoise public sightings 2000-2008 (blue dots) in the Sound of Islay region

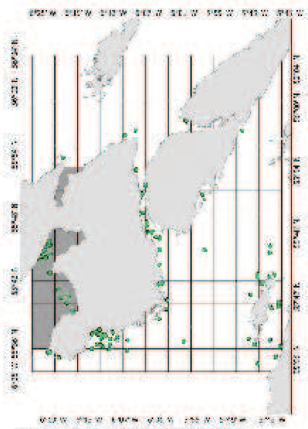

Fig 4b Bottlenose dolphin public sightings 2000-2008 (light green dots) in the Sound of Islay region

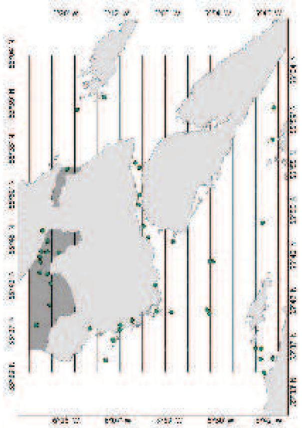

Fig 4c Dolphin public sightings 2000-2008 (dark green dots) in the Sound of Islay region

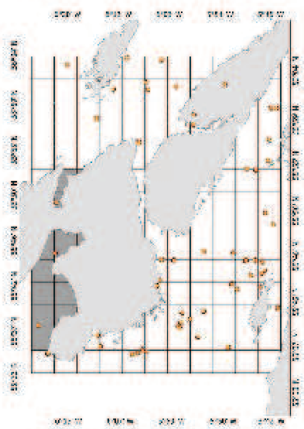

Fig 4d Whale public sightings 2000-2008 (orange dots) in the Sound of Islay region

Conclusions

The goal of this analysis was to indicate important areas for marine mammal species in the Sound of Islay study region and to discuss their significance in a local context and in the context of the west coast as a whole. The combined results of this analysis indicate that the Sound of Islay study region contains important habitat for harbour porpoises, dolphins and seals. The study region also appears to be relatively important for whales, but less important basking sharks.

The highest densities of harbour porpoises within the study region were found in the Sound of Jura. Acoustic and visual detections were less in the Sound of Islay itself. However, the public sightings data indicated the presence of harbour porpoises in this area. It should be noted that the higher tidal currents in the Sound of Islay resulted in above average vessel speeds. This factor should be taken into consideration when interpreting these data since it may have reduced the 'detectability' of harbour porpoises in the Sound of Islay.

The Sound of Jura is not only significant for harbour porpoises in the study region defined in this report, but also in the context of the west coast of Scotland as a whole. In recent years, the Sound of Jura has had the highest detection rates for harbour porpoises on the west coast (Booth, *pers. comm*). Furthermore, the Sound of Jura has been identified as one of four core areas for harbour porpoises on the west coast of Scotland and has recently been highlighted as a potential area suitable for a Special Area of Conservation (SAC) in accordance with EU Habitats Directive criteria, within a region of high relative density in a European context. (Embling et al. 2009 *in press*). Other high-use areas are the Firth of Lorne, the region between Mull and the Treshnish Islands, the Small Isles and the Sound of Sleat (between Skye and the mainland).

Harbour porpoises are highly mobile and are thought to move widely across the Hebrides. It is therefore probable that certain areas are important as corridors for harbour porpoises travelling between foraging locations and high-use areas. Unfortunately, little is known about the movements between different foraging locations though it is likely that narrow channels such as the Sound of Islay provide important corridors between core habitats.

Due to the relatively low number of sightings of the Hebridean bottlenose dolphin group, broad-scale surveys provide limited power for detecting animals. Despite the biases associated with public sightings data (reliability of species identification and spatial and temporal variation in sightings effort), these data can be a valuable source of information. The public sightings data suggest that the Sound of Islay region is important for bottlenose dolphins. Sightings were frequently reported around Islay between 2001 and 2003 (Mandleberg 2006), although no sightings were reported in this area during 2006 and only a few in 2007 and 2008. Small scale range shifts such as this are not unlikely with such a widely ranging group of animals and may be due to changes in prey distribution between years for example.

Public sightings reports and photo-identification encounters show that bottlenose dolphins are widely distributed throughout the Hebrides but that they may use waters north of the Isle of Skye less regularly than the more southern parts of the west coast such as mid-Argyll and Kintrye (Thompson *et al.* 2009 *in press*). This distribution is similar to that on the east coast where bottlenose dolphins are more rarely encountered north of the Moray Firth (Bailey 2006) and this may be an indication that these northernmost coasts are approaching the latitudinal limit for coastal populations of this species in the NE Atlantic.

Given the highly mobile and wide-ranging nature of the Inner Hebridean bottlenose dolphins, it is likely that narrow channels such as the Sound of Islay and the Sound of Mull serve as important routes or 'short-cuts' between foraging grounds.

There were also numerous public sightings of other dolphin species reported around the coast of Islay. However, the majority of these reports were of unidentified dolphins and it is probable that they were of bottlenose dolphins since confirmed sightings of other dolphin species are less common in this region compared to the rest of the west coast of Scotland.

Both datasets suggest the presence of whales in the study region, with highest numbers being in the Sound of Jura. However, the study region appears to be less important for whales than other parts of the west coast of Scotland; the highest sightings rates for minke whales for example, are concentrated north of Islay, in the waters north and west of Mull, where prey availability is likely to be higher (Booth, *pers. comm*).

The high sighting densities of seals observed in the surrounding area during HWDT surveys are consistent with seal count data collected at haul out sites in the region which have shown the skerries and coastline of south-east Islay to hold a nationally-important population of the common seal. The south-east coastline areas are extensively used as pupping, moulting and haul-out sites by the seals, which represent between 1.5% and 2% of the UK population (SMRU report, 2001). This area has been designated as a marine special area of conservation in order to protect the common seal. Relatively high sightings densities of seals in the Sound of Islay itself indicate that seals are present in this area.

In conclusion, the species most likely to interact with tidal turbine installations in the Sound of Islay are likely to be harbour porpoises, bottlenose dolphins and seals, with the most likely risks being collision and habitat displacement. It is clear that the region holds important habitat for all three species and it is seems that the Sound of Islay itself may be an important 'corridor' between foraging grounds. However, more information is needed on individual movement patterns before the full impact on local populations can be assessed.

Acknowledgements

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References

Bailey, H., Clay, G., Coates, E.A., Lusseau, D., Senior, B. & Thompson, P.M. (In Press) Using T-PODS to assess variations in the occurrence of coastal bottlenose dolphins and harbour porpoises. *Aquatic Conservation: Marine and Freshwater Ecosystems.*

Ellett, D.J., 1979. Some oceanographic features of Hebridean waters. Proceedings of the Royal Society Edinburgh B 77:61-74

Embling, C. B., Gillibrand, P. A., Gordon, J., Shrimpton, J., Stevick, P.S., Hammond, P.S. (In Press). Using habitat models to identify suitable sites for marine protected areas for harbour porpoises (*Phocoena phocoena*). *Biological Conservation.*

Evans, P.G.H., Wang, J., 2008. Harbour porpoise spatial modelling to identify possible hotspots for Marine Protected Areas. In: Evans, P.G.H. (Ed.), Proceedings of the ECS/ASCOBANS/ACCOBAMS Workshop: Selection Criteria for Marine Protected Areas for Cetaceans. ECS Special Publication Series No. 48.

Gill, A., Fairbairns, B., Fairbairns, R. 2000. Photo-identification of the minke whale (*Balaenoptera acutorostrata*) around the Isle of Mull, Scotland. Report to the Hebridean Whale and Dolphin Trust.

Mandleberg, L. (2006). Bottlenose dolphins of the Hebrides; a summary report from five years of research (2001-2005). Hebridean Whale and Dolphin Trust unpublished report 19pp.

SCANS-II, 2008. Small Cetaceans in the European Atlantic and North Sea. Final Report to the European Commission Under Project LIFE04NAT/GB/000245. Available from SMRU, Gatty Marine Laboratory, University of St. Andrews, St. Andrews, Fife KY16 8LB, UK.

Sea Mammal Research Unit, 2001. Surveys of harbour seals on the west and east coasts of Scotland. Report no. F00PA41.

Shrimpton, J.H., Parsons E.C.M (2000). Cetacean conservation in the Hebrides. Hebridean Whale and Dolphin Trust, Isle of Mull, Scotland, UK. 99 pp.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 9 – Marine Mammals

Appendix 9.3: “Acoustic characterisation of the proposed Sound of Islay tidal energy site”

Acoustic characterisation of the proposed Sound of Islay tidal energy site

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15.1 Introduction

Commercial scale tidal-stream turbines are new technologies entering the coastal marine environment and their interactions with native fauna are currently unknown. One area of specific concern is whether large vertebrates (particularly marine mammals) will be negatively impacted by these devices through physical collisions or disturbance and consequent habitat exclusion. While marine mammals use a range of senses to navigate within their environment, active or passive hearing is thought to be the dominant sense. This is because of the excellent acoustic propagation properties of water in contrast to the low visibility and complex patterns of scent diffusion. Thus sound is used to navigate, detect predators and prey as well as communicate between individuals. Animals may be active in sound production, i.e. produce their own noises or be passive and listen to the sounds produced by other organisms or their environment itself. Hence the acoustic relations between tidal-stream energy devices and marine mammals are likely to be key factors influencing both collision risk and habitat exclusion issues.

Marine mammals and sound: Recent decades have seen intensification in the human activities at sea and a consequent increase in the acoustic energy entering the marine environment. The high sound intensity and high profile nature of several of these (principally naval activities, shipping and hydrocarbon exploration) have prompted focussed research into the potential impacts on marine organisms and marine mammals in particular. These studies have resulted in better information on hearing sensitivities, thresholds of physical harm and information on how marine mammals respond to disturbance.

Of the marine mammal species that occur in UK waters only a subset are known to occur in or transit the tidal narrows of the Sound of Islay (SMRU Ltd, 2010) in such a way that they may encounter at close range operating tidal turbines. These species are pinnipeds (harbour *Phoca vitulina* and grey *Haliochoerus grypus* seals), otters (*Lutra lutra*) and odontocete cetaceans (bottlenose dolphins *Tursiops truncatus* and harbour porpoises *Phocoena phocoena*). A third odontocete (killer whales, *Orcinus orca)* and a mysticete cetacean (minke whales, *Balaenoptera acutorostrata*) may not have been recorded in the development area but their occurrence in adjoining waters and general habitat preferences make it possible for occasional transits of the inner Sound to occur. Thus there are five species of marine mammal that are known to pass through the intended development area of the Sound of Islay and two that may occur on occasion. Together these seven species represent species with a broad range of hearing capabilities and specialisations (reviewed in Richardson *et al*., 1995). Other species, particularly Risso’s, white-beaked & common dolphins, occur around Islay but their habitat preferences (open and/or deeper water) make it unlikely that they would normally or pass through the Sound of Islay.

The underwater hearing capabilities of seals are relatively well known with harbour seals, in particular, being extensively studied. The spectrum of sounds audible to them range from around 100 Hz to 60 kHz with peak sensitivities from 1 to 30-50 kHz at around 70 dB re 1 μPa. These seals also have higher frequency capabilities but only if sounds are very loud. Less is known about grey seal hearing but it is likely to be similar.

While otters use the Sound of Islay their diving abilities and depth preferences limit them to shoreline habitats (<10m) and so they are unlikely to venture into close proximity to operating turbines (Nolet *et al*., 1993). In terms of their hearing, to date, no audiometric data have been published on the underwater hearing sensitivities of otters. Behavioral measures of hearing in air for North American river otters, *Lutra canadensis* indicate a functional hearing range in air of approximately 0.45 to 35 kHz, with peak sensitivity at 16 kHz (Gunn, 1988).

In contrast, the underwater hearing sensitivities of odontocete cetaceans (reviewed in Richardson *et al*., 1995) are well known. Bottlenose dolphin hearing is relatively poor at low frequencies but extends to as low as 40-70 Hz as long as the amplitude is high. Hearing improves steadily with increasing frequency to be able to detect sounds at 100 dB re 1 μPa at 1 kHz then 70 dB re 1 μPa at 10 kHz to a peak sensitivity of around 50 dB re 1 μPa at around 50 kHz. Hearing then drops off so that they are insensitive to sounds above 200 kHz. Harbour porpoise hearing is broadly similar. Killer whale hearing is more sensitive at mid frequencies (8-20 kHz) but they appear to have poorer high frequency capabilities with an upper limit of hearing around 120 kHz.

Very little is known about the hearing sensitivities of mysticete whales primarily because of the technical difficulties of performing hearing tests on them. However their auditory anatomy, vocalisations and responses to man-made sounds strongly suggest that they are low frequency specialists. They are likely to best hear sounds below 1 kHz but can probably hear sounds up to 8 kHz or higher. The sensitivity of this hearing is currently unknown.

As described above, marine mammals use sound for a variety of functions. All species are likely to be listening to the ambient underwater sounds in the environment to help them avoid predators (e.g. calling Killer whales), avoid man-made threats (motorized vessels) and hear the communication calls of conspecifics. In addition, sound may be used for navigation, either by using the natural sounds of the environment to orientate or by actively producing sound and interpreting the fraction returning as echoes. The echolocating capabilities of odontocete cetaceans are relatively well known but similar capabilities of other species (e.g. seals and mysticetes) are enigmatic and contentious. The importance of the use of passive listening by marine mammals to locate prey (either the incidental noises they happen to make or by calling) is being increasingly recognised.

Because marine mammals use sound in a diversity of functions, anthropogenic sound similarly has the potential to impact them in a range of ways. Intense sounds have the capability to cause injury. At the extreme, high energy sound or shock waves can cause physical damage due to differential acceleration or impedance mismatch between the animal's tissues and the surrounding water. Among injuries, intense sounds can cause temporary or permanent auditory damage. The exact sound pressure threshold that such damage occurs at is unknown. A rule of thumb of 180 dB re 1µPa has been used widely though more precise criteria have been developed (Southall *et al*., 2007).

These and lower intensity sounds also have the capability to affect marine animals in more subtle ways with the nature of these impacts being modulated by the natural behaviour of the animals. Non-injurious acoustic impacts may therefore be species, time and site dependent. Behavioural impacts can take several forms. At the most basic, anthropogenic sound may directly alter the behaviour of the animals in receipt of them. These behavioural changes may be clearly negative (fright, flight or panic-like responses) or elicit more subtle avoidance behaviours. Conversely, novel sounds may attract curious animals, elicit predator-inspection (approach a potentially threatening stimulus to gain more information) or precipitate an aggressive reaction. A second mode of disturbance results from the masking capacity of anthropogenic sound. This can have a wide range of undesirable impacts including the capacity to alter the abilities of animals to navigate, catch prey, avoid predators or interact with conspecifics.

The sphere of relevance of an acoustic source is the spatial range at which its sound outputs are likely to be perceptible to a receiver. Due to spreading loss, physical damage from sounds are likely to be limited to only loud sounds and be in the immediate vicinity of the source while the maximum range of behavioural responses will be bounded by the distance at which the sound output sufficiently exceeds background noise at frequencies relevant to the hearing sensitivity of the target animals. Therefore, to assess the likely spatial impact of a point source of noise pollution, information is required on three key variables (1) the likely hearing sensitivities of the animals of concern (see above); (2) the acoustic output of the source; and, (3) the level of background noise in the environment. It is this final topic that this report initially addresses, before putting the receiver species, sound source (Akvaplan-niva 2009) and background sound information together to determine the potential spatial extent of audibility of the proposed turbine development in the Sound of Islay.

The Sound of Islay acoustic environment: While it is possible to determine (theoretically or empirically) the acoustic output and hence audibility of tidal energy devices, this information is only useful when set against the levels of ambient noise already in the environment. If ambient noise is very low then the acoustic output of devices has the potential to exceed background noise and hence the devices will be audible over wide ranges giving animals the potential to respond at a wide range of distances. Conversely if ambient noise is high then device acoustic output will not propagate as far before dropping below background and hence device audibility will be less, leading to reduced likelihood of disturbance. However, a high ambient noise level may potentially mean that animals may not hear the turbines until they are in close proximity to them.

In order to assess how audible tidal-stream energy devices are likely to be, it is important to combine studies of device noise output with the levels of ambient noise at the intended development site. A study of the acoustic output of the Hammerfest Strøm device 300 kW has recently been completed[1]. In parallel, this study sets out to investigate the ambient soundscape of a proposed development site: the Sound of Islay.

Existing literature on underwater ambient sound is mainly limited to open sea environments and no quantitative data currently exists for ambient sound levels in areas of strong tidal flow off the west coast of Scotland. Therefore, to assess the device to ambient noise relationship, it was necessary to empirically measure the actual soundscape of the site. To do this we carried out a series of field measurements in the Sound of Islay over and around the location of the proposed tidal-energy development. Surveys were carried out in the autumn of 2009 over a period spanning neap and spring tides to encapsulate a significant component of the acoustic site variability.

15.2 Materials and methods:

How: SAMS in conjunction with the European Marine Energy Centre (EMEC) developed a method for monitoring sound in tidal raceways – the so called "*Drifting Ears Method*" (Wilson & Carter, 2008). For this, an autonomous hydrophone, sound and location recorder are attached to a free floating drogue (Figure 1).

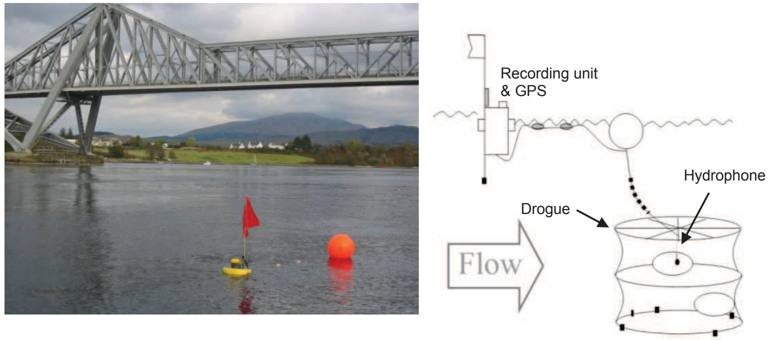


Figure 1. Deployment and structure of the "Drifting Ears" recorders developed by SAMS in collaboration with EMEC. These devices were built to measure ambient sound in areas of strong tidal flow where conventional methods of sound recording have proved inappropriate.

The unit is then set adrift upstream of the site of interest and allowed to flow with the current, recording sound and location as it goes. The drifter is then recovered at the downstream end of the site and the onboard recordings saved. Because the drogue ensures that the hydrophone effectively sits stationary within a parcel of water flowing over the site of interest the hydrophone does not experience the flow-past noise that would contaminate recordings made by a conventional fixed or towed hydrophone. A small rigid inflatable boat (RIB) is used to deploy and retrieve this equipment with its engines cut during the actual recording sessions. Because the drifter is autonomous, several can be deployed at once allowing multiple transects of the site to be measured at the same time.

For this study we employed this Drifting Ears Method and used four drifters simultaneously. Each drifter was fitted with a Cetacean Research Technologies omnidirectional hydrophone (C54XRS) with an effective sensitivity of -165 dB re1VµPa and a broadband frequency response (0.2- 44kHz +2/-3dB). Hydrophone outputs were recorded on M-Audio Microtrack 24/96 flashcard recorders (dynamic range 101 dB). Data were saved as .WAV files and sampling rates set at 96kHz, 16 Bits. The recorder and locating *Global Positioning System* (GPS) were surface mounted with the drogue set such that the hydrophone was held at five meters below the water surface. A depth of five meters was chosen as it keeps the hydrophone in the water column, below wave action and provides sufficient clearance above potential future operating tidal turbines so that a follow up trial can be carried out if necessary after device installation has taken place.

For drifter deployments we used Aberdeen University's 6m RIB "*Uisge*" (Figure 2) as the support boat. Drifters were launched upstream of the site, in a line-abreast formation so that their subsequent drifts would span the body of the channel and in doing so provide a suitable assessment of the area of proposed development.

Where: Surveys were conducted in the Sound of Islay between 55˚ 51' N and 55˚ 49' N and at a range of distances from shore to cover the breadth of the channel. The northern boundary was limited by the Port Askaig to Feolin ferry crossing and the southern boundary was drawn just north of the existing submarine cable crossings.

Figure 2. The low-noise RIB *Uisge* tied up in Port Askaig harbour and used to deploy and retrieve drifters (seen here stowed).

What: Recordings were aimed to document the ambient soundscape of the site. Though motorised vessel traffic (including ferries, fishing boats and transiting craft from coasters to pleasure boats) are a frequent feature of the Sound their highly transient nature makes characterisation of their acoustic output with respect to the audibility of a tidal turbine development for marine mammals extremely difficult to meaningfully assess. Instead attempts were made to document the long term soundscape of the site without these transient sources. Accordingly periods with significant vessel traffic were avoided in both the data collection and analysis phases. That said, the almost continuous daylight passages of the Port Askaig to Feolin ferry and its associated slip based activities were impossible to avoid, featured as a low level in the recordings and should be considered an inherent characteristic of the site.

The Drifting Ears recorders were set to sample at 96 kHz and so were capable of recording sounds up to 48 kHz. However, to avoid aliasing related acoustic artefacts, sound levels up to 20 kHz were assessed. Seven frequencies were quantified in detail spanning the most likely overlap from maximal turbine acoustic output (low frequency) to the lower to middle ranges of marine mammal hearing (high frequency). These frequencies were: 0.05, 0.1, 1, 2, 5, 10 & 20 kHz.

> ***Calibration:*** *Following the recording sessions in the Sound of Islay, the recording sensitivities of the four drifters were calibrated against a control hydrophone. To do this a sound source was moored off SAMS Scottish Marine Institute pontoon and each drifter in turn individually hung in the water 24m distant. The control hydrophone (calibrated Brüel & Kjaer 8104) was inserted into the drogue such that it hung alongside the Drifter’s own hydrophone. Recordings were then taken simultaneously from the two hydrophones so that the received signals could be later compared and correction values determined for each Drifter. The process was repeated for all four drifters. The B&K control hydrophone was itself calibrated at Aberdeen University’s Oceanlab test facility.*

Drifter analyses: Because of pseudoreplication and discontinuous rates of drift it would be inappropriate to analyse the entire sound files resulting from recorder drifts. Instead the GPS records of each drifter were used to determine a series of post-hoc sampling locations and at each sampling location a one minute sound sample was retrieved and analysed. It was not possible to derive these sampling locations across a grid because there was no opportunity to steer the drifters after they were deployed. However, because the ebb and flood drifts ran approximately north-south a series of lines of latitude spaced 250 meters apart were used to select the sampling locations (for points see left hand panel in Figures 6 to 9). The longitude value for each sampling location depended on the path of each drifter.

To retrieve the appropriate sound samples, the GPS records from each drifter were interrogated until one of the latitude gates was reached then the precise time was used as a cross reference to extract a sixty second sample from the sound files. The choice of a one minute sound sample was derived from trials of sound files collected at the EMEC tidal-test site and found to be an optimal compromise between an averaged inclusion of short term variations (breaking waves, snapping shrimps etc) and a point location with respect to the drift speed.

Each sound sample was then checked on a spectrogram for contamination (hydrophone bumping, boat noise etc). If there was contamination, then the next nearest clean minute was used. The resulting samples were then loaded into sound analysis software (Avisoft SASLab Pro) along with the appropriate hydrophone sensitivity values to provide sound level statistics for the seven target frequencies.

The sound level results of multiple drifts were then pooled into four bins by tide direction and drift speed: a) $>2 m.s^{-1}$ flood b) $<2 m.s^{-1}$ flood c) $>2 m.s^{-1}$ ebb d) $<2 m.s^{-1}$ ebb, and the data imported into ArcGIS. Soundscape maps were calculated using interpolation of each point into a grid with a cell size of 150m. The interpolation method was Ordinary Krigging with a maximum of 12 points, a variable radius and a spherical semivariogram. The final grid was then displayed using a cubic convolution method. The colour scale relates to values in dB re 1 $\mu Pa^2/Hz$ and is scaled differently in each plot to emphasise the contouring.

15.3 Results:

Initial surveys were attempted by running day trips from Dunstaffnage, Oban to the Sound of Islay in suitable weather windows. However this approach proved unsuccessful with only one day of sampling possible due to a run of particularly poor weather in August 2009. Instead our base was relocated to Port Askaig harbour in the Sound of Islay and a continuous period of sampling running from neap to spring tides carried out in September 2009. Sampling started on the 14th and ran to the 18th of September (Figure 3). While sampling was attempted each day, no usable recordings were possible on the 16th of September because of the day-long presence of a transiting coaster which chose to stem the tide within the Sound. Hence sampling occurred on two days of the neap or near neap tides and two days of spring tides and in each both flood and ebb tides were sampled (Table 1). Overall, these recording sessions generated 12 hrs 20 minutes of acoustic data which were later divided into 324 spatially independent 60 second samples for further analysis.

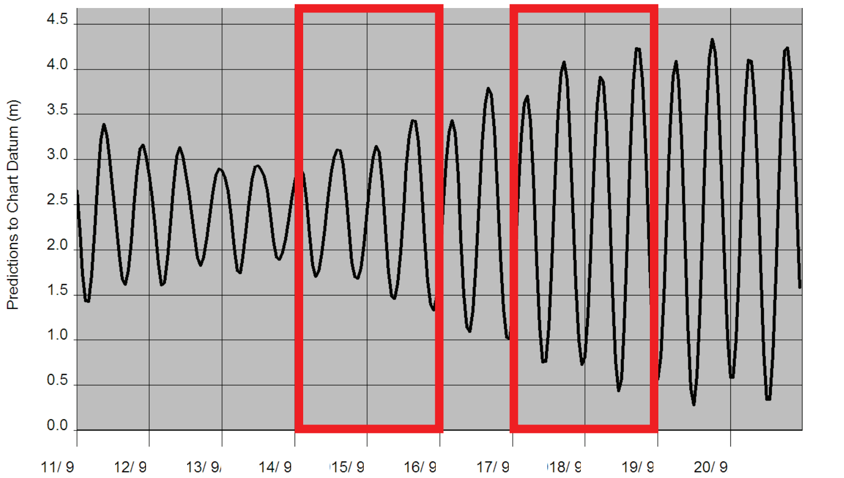


Figure 3. Boxes shows the days in the neap to spring cycle that were sampled during this study in 2009. Tidal heights are referenced to Oban.

Table 1. Temporal spread of tides sampled during this study

	14.09.09	15.09.09	16.09.09	17.09.09	18.09.09
Flood tide (north going)	-	2	-	1	1
Ebb tide (south going)	1	1	-	1	-

Initial inspection of the sound spectrum data showed that noise occurs over a broad range of frequencies within the Sound of Islay (see Figure 4). As in other marine areas, low frequencies tend to dominate and the general shape of the sound spectrum curve appeared similar throughout the study area.

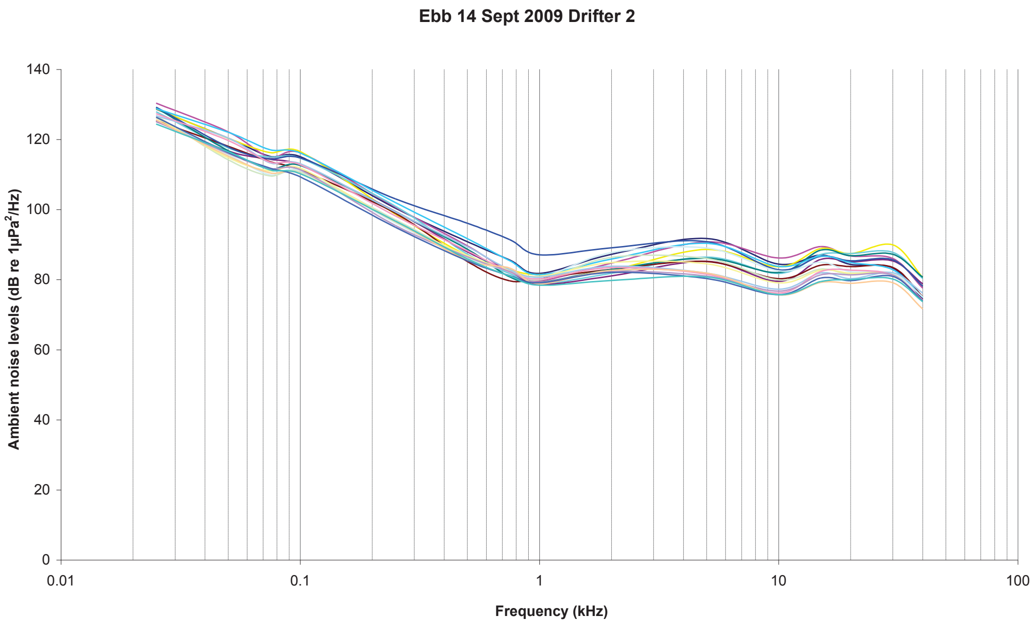


Figure 4. Example sound spectrum data from multiple sampling stations over the study area from a single drifter run on the ebb tide.

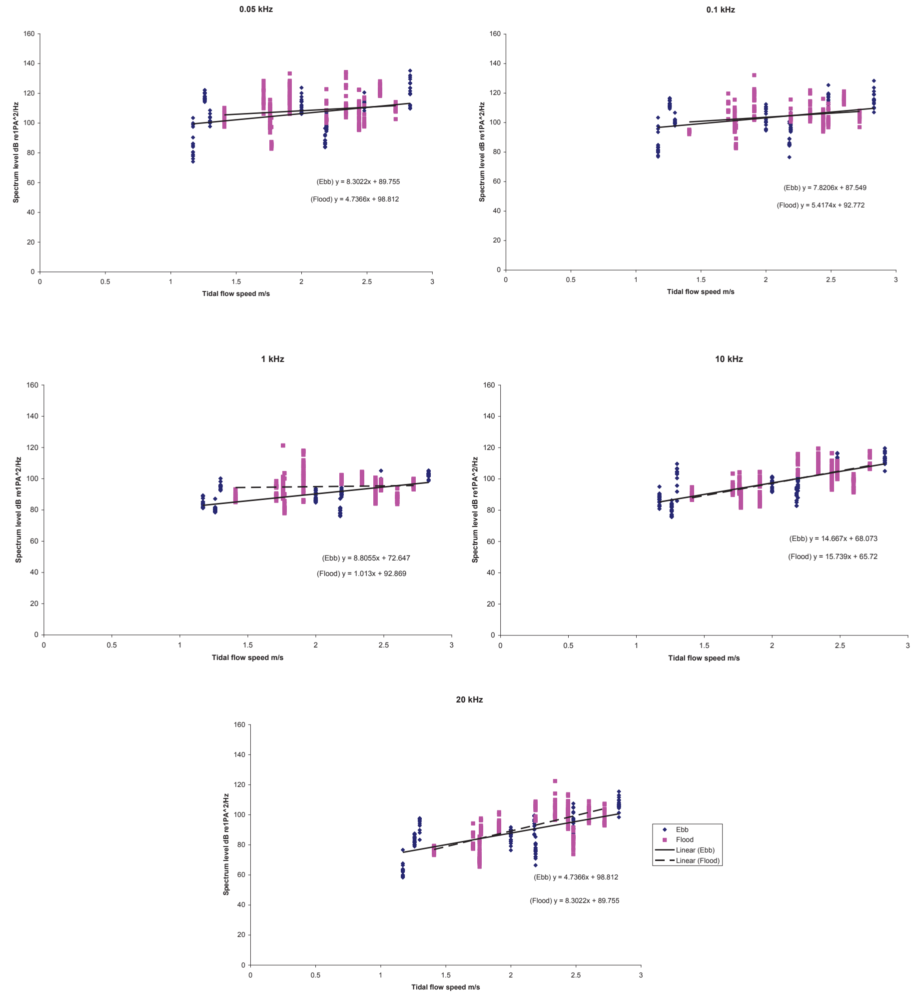


Figure 5a-e. Ambient sound level in each 60 s sample plotted against flow speed.

Initial comparisons of absolute acoustic values from flood versus neap tides proved inconclusive due to different points of each tide (early vs full flow etc) being sampled. So instead the relationship between ambient sound levels and the water flow (drifter progress) speed were compared (Figure 5a-e). These plots revealed a positive relationship between flow speed and noise levels regardless of it being spring or neap tides. In other words (and perhaps unsurprisingly), the faster the flow the louder the ambient noise that was recorded at any particular frequency. A separation value of $2 m.s^{-1}$ was therefore chosen as a threshold that divided the drift data approximately in half so that data from fast ($>2 m.s^{-1}$) and slow ($<2 m.s^{-1}$) drifts could be plotted separately and compared.

To investigate spatial structuring within the data, gridded sound levels were imported into ArcGIS and resulting soundscape maps plotted (Figures 6 to 9). When examined, these maps reveal several significant factors:

Firstly, that there is appreciable variation in sound levels across the area of study, both up and down the length of the channel and across it. These variations appear to be spatially clumped rather than spread across the survey area. In addition because the underlying data have been derived from multiple drifts at different times these variations are unlikely to be artefacts from temporally discrete noise events (distant boat revving engine etc).

Secondly, these heterogeneities in sound levels appear to be conserved both between fast and slow flow rates (compare Figures 6 vs 7, 8 vs 9) but also between flood and ebb tides (compare Figures 6 vs 8, 7 vs 9). Most noticeable is the area of particularly intense ambient noise at frequencies above 1 kHz (particularly 10 & 20 kHz) at approximately 55˚ 49' 40"N. This area of intense sound is most obvious in the *Flood Fast* maps but also appears in the *Flood Slow* and *Ebb Fast* maps. There are less data contributing to the *Ebb Slow* plot (on account of two of the four drifters failing to record data) but here again there is the suggestion of a similar pattern. Relative sound intensities appear more variable at the very northern extent of the study area across the different maps and are likely to be influenced by the operating status of the ferry.

Thirdly, there are many similarities in the general soundscape topography across different frequencies. Therefore areas of particularly high or low sound intensity at one frequency are also likely to be similarly intense at another frequency.

Figures 6 to 9. Contour plots of sound levels at a selection of frequencies (50, 100 Hz, 1, 2, 5, 10, 20 kHz) in the Sound of Islay. Colour scale is allowed to vary between graphs in order to emphasise spatial variability. Values are expressed in dB re 1 $\mu Pa^2/Hz$. Titles above each cluster of maps indicate the mode of tide with Flood tides running north and Ebb running south. To allow assimilation of multiple runs across the neap to spring cycle water flow speeds during the actual drifts are categorised as either Fast ($>2 m.s^{-1}$) or Slow ($<2 m.s^{-1}$). The actual acoustic sample stations are shown by red dots in the left hand panel of each figure.

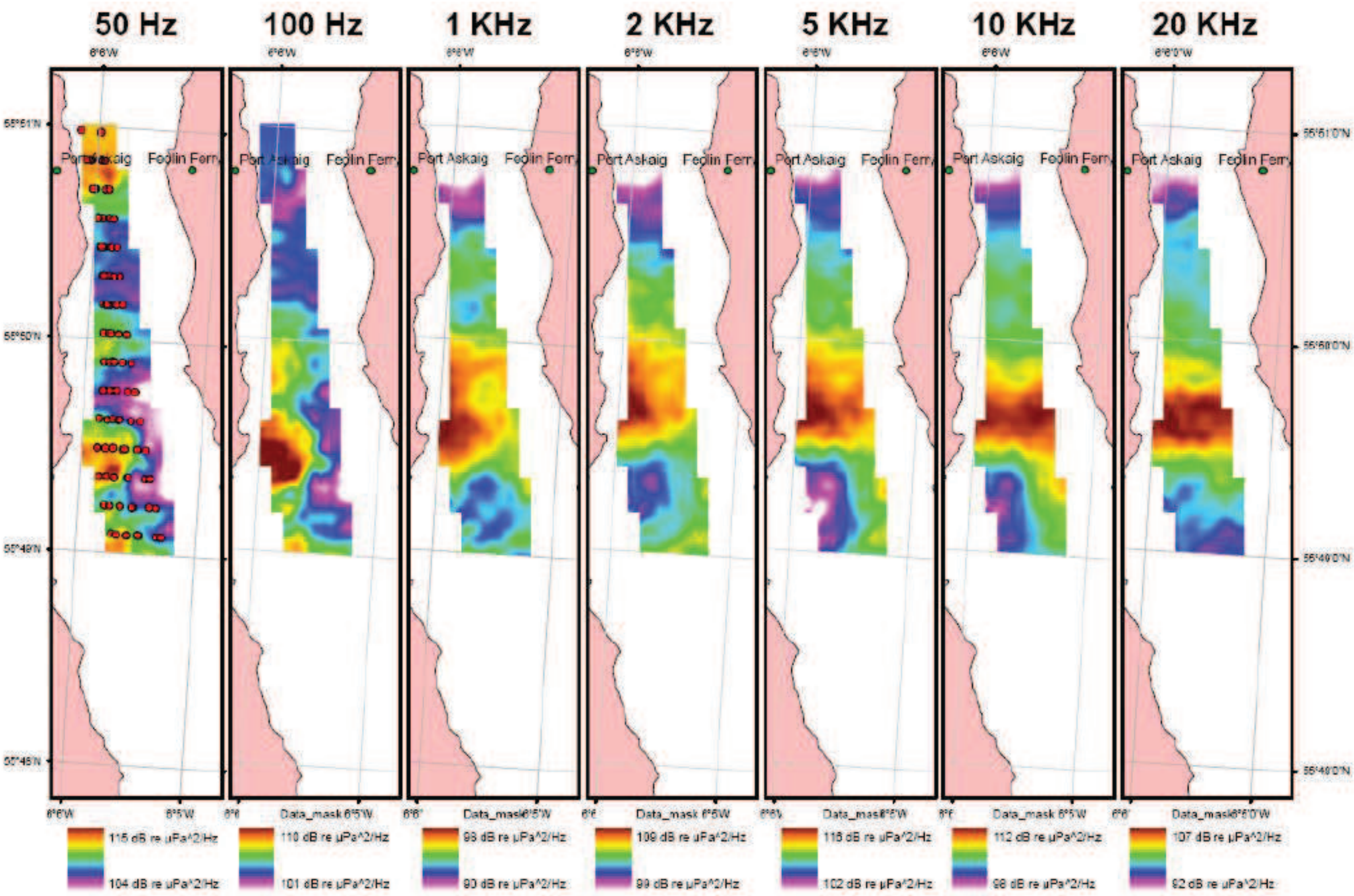


Figure 6. Flood Fast – Individually scaled per frequency

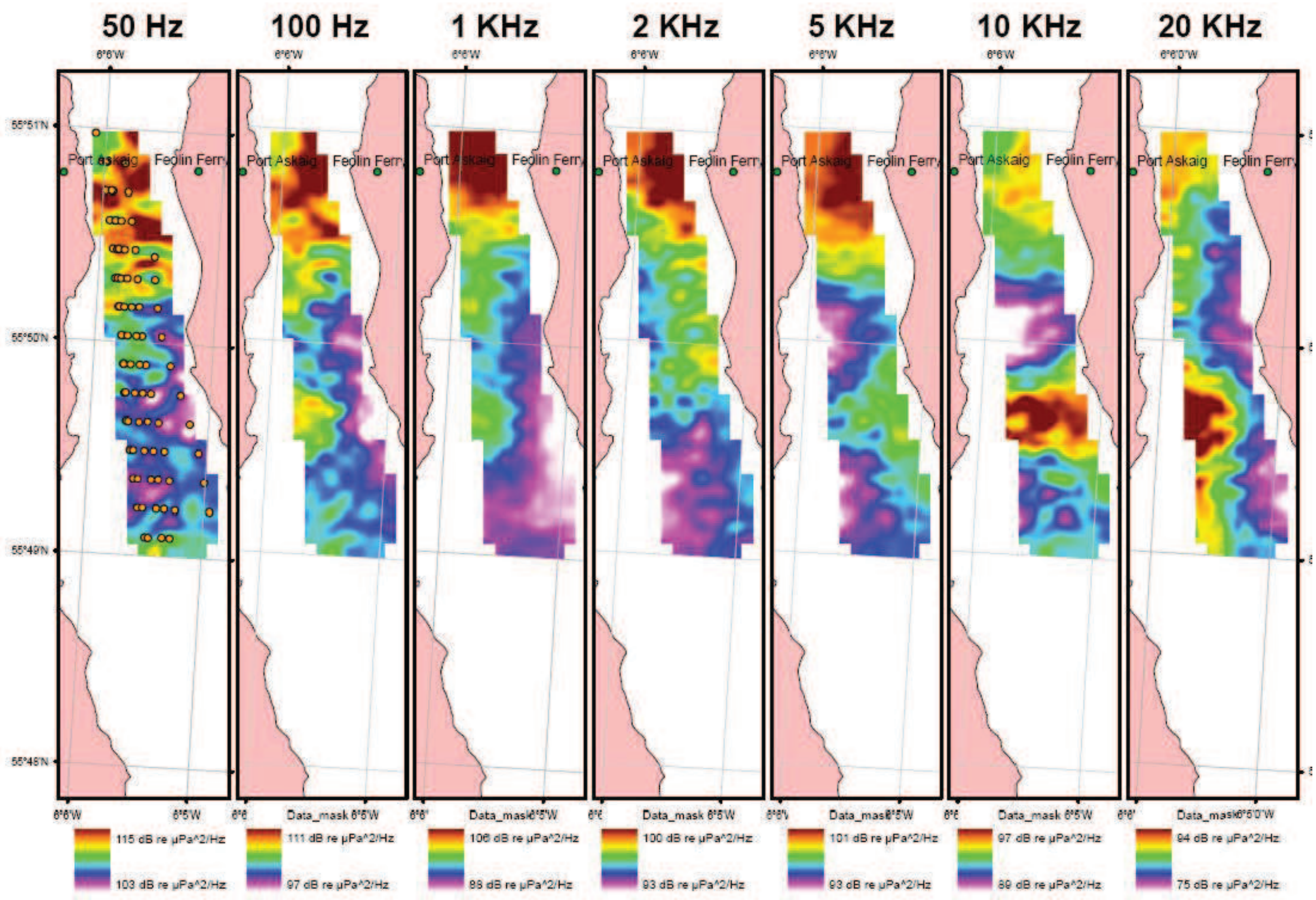


Figure 7. Flood Slow – Individually scaled per frequency

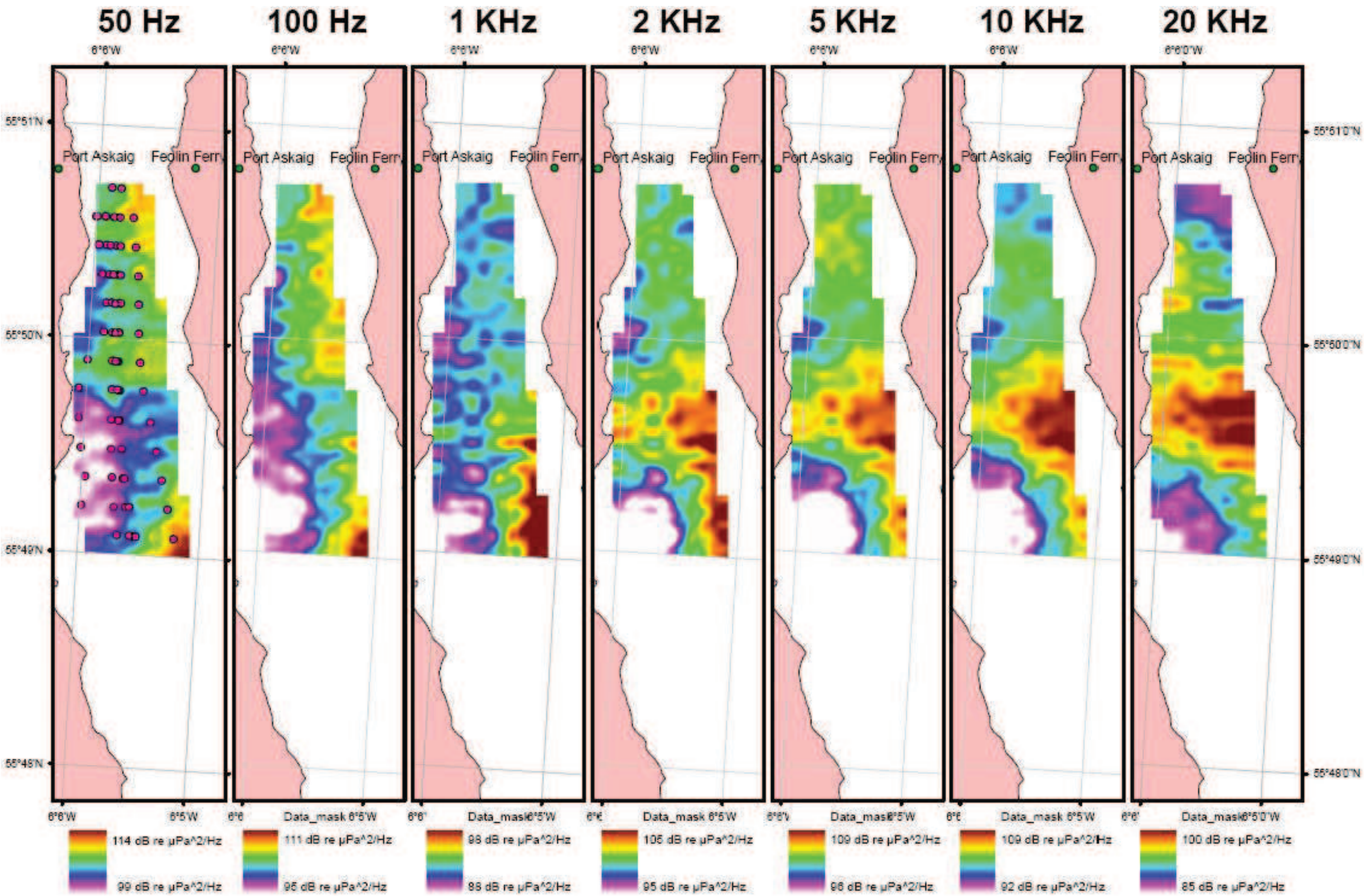


Figure 8. Ebb Fast – Individually scaled per frequency

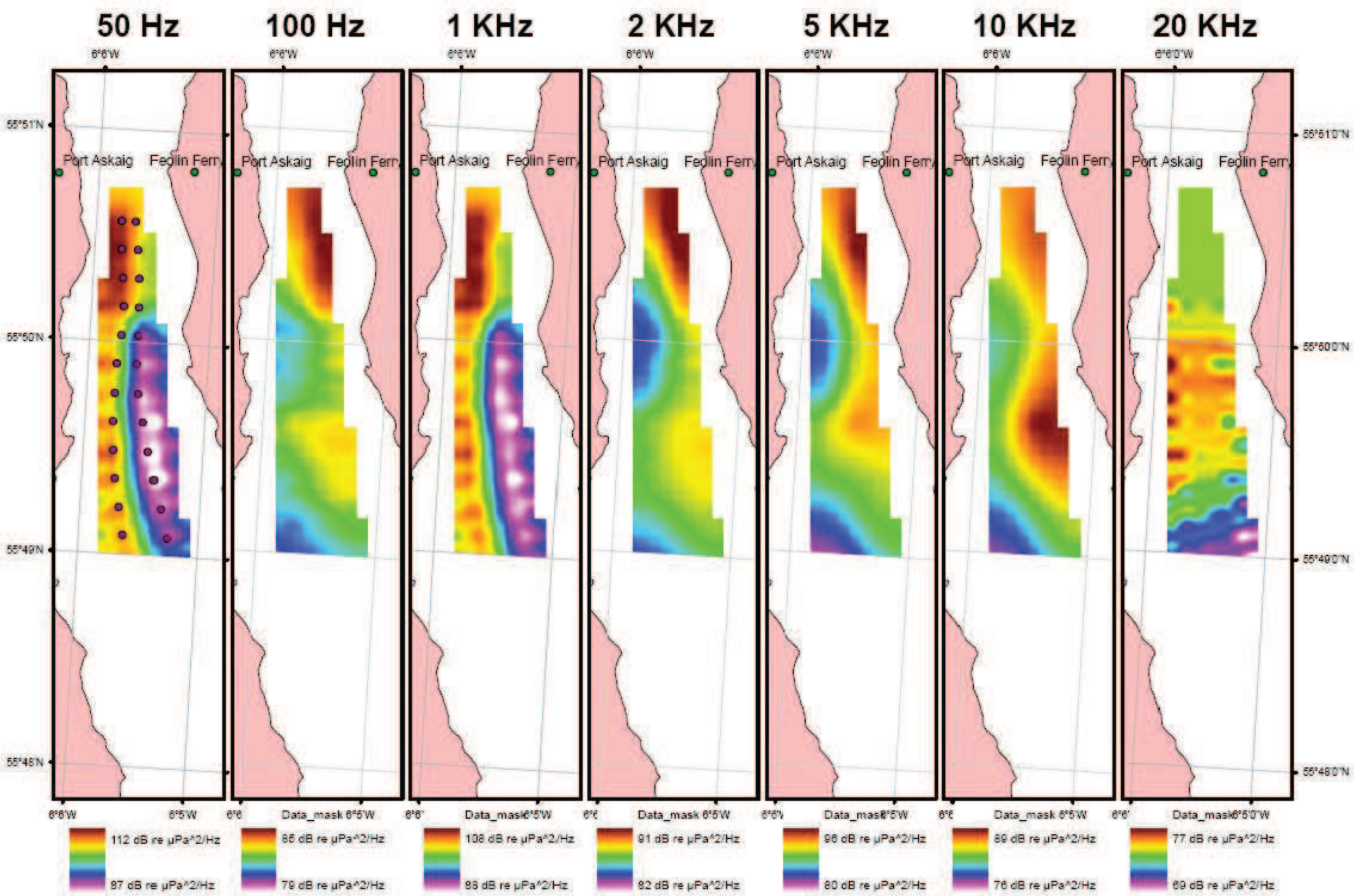


Figure 9. Ebb Slow – Individually scaled per frequency

Discussion:

Acoustic background sound sampling was carried out in the Sound of Islay in September 2009. Both flood and ebb tides were sampled (4 and 3 times respectively) across both spring and neap tides with water speeds during recordings ranging from approximately 1 to 3 meters per second. Ambient sound scaled strongly with flow speeds such that times of peak flow are expected to accord to highest levels of background noise. Accordingly underwater ambient noise levels are more likely to be associated with absolute flow speed at any point in time rather than whether the area is experiencing a period of spring or neap tides. Periods of slack tide were not sampled partly because (1) the method of sampling was not designed for still water but more importantly because (2) these periods in the Sound of Islay are brief and (3) the turbines are not physically or acoustically active at these times and so the risk of collision is low when neither water or turbines are moving. In this study, the tide turns were therefore used for servicing the recording equipment ready for further deployments.

The acoustic mapping revealed significant structuring in the spatial patterns of sound intensity over the area. Perhaps surprisingly areas of particularly intense sound occurred in similar areas in both flood and ebb tides. The factors that contribute to this soundscape are unclear. Our sampling regime attempted to minimize the influence of vessel traffic with recording sessions being terminated when boats passed through the sound and our drift regime being coordinated as much as possible to avoid the runs of the Port Askaig to Feolin ferry. However, vessel traffic could have influenced some of the recordings (particularly in the northern part of the survey area) but these influences would have been transitory and would thus contribute to inconsistencies between the different maps: therefore this can be discounted as a contributing factor. More interesting are the discrete patches of high and low intensity sound that appear across different maps. There is no obvious mechanism for these features to be an artefact of the sampling so they are likely to be real features of the Sound of Islay.

While making the recordings, the boat crew noted the presence of small streams and rivers reaching the shore line. Several of these had waterfalls and the sound of these was very noticeable in air particularly on the Islay side of the Sound at latitudes south of 55° 49’ 30”. However, there does not appear to be any noticeable correspondence between the stream locations and the high underwater sound intensity patches – if anything they correspond to particularly quiet patches (see Figure 8). Therefore, it is likely that the spatial variation in sound intensities is generated by features within the water column or sea bed at the locations of detection.

Besides anthropogenic and shore-based sources, there are many factors that can contribute to underwater noise. Breaking waves, entrained bubbles, rain, water column and surface turbulence, water flow over the bottom and gravel transport all contribute to sound (Kerman, 1988; Ma et al., 2005). In addition there are a range of biogenic sound sources. Most (marine mammal and fish calls for example) are transitory but the broad-band sounds produced by snapping shrimps (Au & Banks, 1998) tend to be more continuous because of the apparent superabundance of these crustaceans in appropriate habitats. The patches of high frequency sound observed in the Sound of Islay are most likely to have come from these organisms. The general increase in background sound with flow speed suggests that physical processes such as turbulence, water flow or gravel transport contribute to the observed soundscape. During this study, the presence of surface waves was variable and depended on the wind speed and direction relative to the water flow. Wind speeds during the survey were generally low so the contribution of waves to the soundscape is likely to be relatively slight. However, the similarity in high sound intensity locations whether the tide was flowing northwards or southwards suggests that the noise source(s) is tied somehow to the seabed itself. Though the source remains unknown, the most likely possibilities for the high sound intensity patches are: 1) areas of particularly high sediment transport, 2) areas of particular turbulence or eddies whether the tide is flowing north or south or 3) high density patches of snapping shrimp habitat.

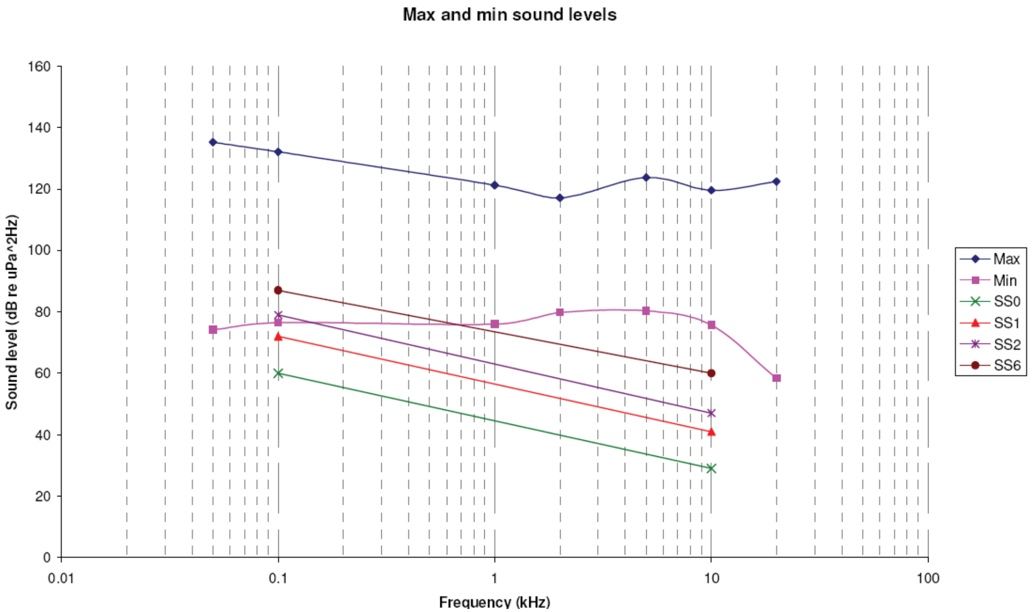


Figure 10. A comparison of sound levels from the open ocean (~200m depth) at Beaufort sea states ranging from 0 to 6 (straight lines) plotted against the minimum and maximum values observed in this study (curved lines). Oceanic values drawn from Richardson *et al*'s adaptation of the Knudsen curves.

Absolute sound levels recorded in the Sound of Islay were considerably greater than would be expected in the open sea. A basic comparison of the minimum-maximum sound levels recorded during this study with values derived from Knudsen’s curves (Richardson et al., 1995) for open ocean sound levels is shown in Figure 10. It can be seen that sound levels from the bulk of the Islay recordings substantially exceeded those from the open sea even to sea states up to Beaufort level 6. The greatest sea state we encountered was Beaufort level 3 with the majority of our survey effort taking place at sea states of 0 to 1. Thus ambient sound levels in this environment massively exceed those considered normal for open ocean environments.

Audibility of tidal turbines: The distance at which marine mammals can detect tidal turbines broadly depends on the interplay between five factors: 1) the acoustic output the operating turbines; 2) the likely propagation characteristics of the site; 3) the existing ambient noise in the site; 4) the hearing sensitivities of the receiving animals; and 5) the abilities of animals to pick out turbine sound relative to the ambient sound floor. Putting these threads of information together should give some guidance on the ranges at which animals may be impacted by the acoustic presence of the devices and what warning they might have in order to take appropriate action in order to avoid close encounters.

Operating turbine output of the type proposed for the Sound of Islay has been documented by Akvaplan-niva (2009). In that study, the bulk of the acoustic output was found to lie in the low frequencies (500 Hz and below) and in the order of 20 dB above ambient noise in the Norwegian site when measured 30 to 50 m from the turbine. If we use the described acoustic outputs (100 to 113 dB re 1μPa for frequencies less than 500 Hz) and compare these to the observed levels of background sound in the Sound of Islay in this study for the same frequencies (lowest 71.3 and highest 144.5 dB re 1 μPa spectrum level). For this study we assume that the received level is detectable when it matches the background noise level (provided it is within the hearing capabilities of the marine mammals) when the received level and background noise levels are given as third octave levels (Madsen et al., 2006). Thus converting the Sound of Islay data we obtain a minimum background noise level of 86.8 and a maximum of 159.8 dB re 1μPa.

Putting the Norwegian turbine output together with the Sound of Islay background noise levels we find that the device output will be well below the maximum background noise levels (113 vs 159.8 dB re 1μPa). In other words the highest levels of background noise we observed in the Sound of Islay will obscure the turbine noise even at close range. However, the lowest levels of background noise will not obscure the turbine noise and will therefore allow to be acoustically detectable to marine mammals out to some distance as explained below. Carter (2008) found that background noise levels in coastal areas generally exceed the hearing sensitivities of marine mammals such that their own audio sensitivities become unimportant relative to the interplay between device and ambient levels. Therefore, to calculate detection distances, device and ambient noise levels simply need to be combined with likely propagation values for this area. Like most other shallow coastal areas, precise measures of propagation is unknown for the Sound of Islay but conventional formulas that assume spherical or cylindrical spreading (Richardson et al., 1995) provide lower and upper bounds to assess the broad range of these likely distances.

Taking the peak turbine output and applying this to a spherical loss formula produces a distance of 20 m before the sound level drops below the minimum ambient level we recorded at the site. The more generous cylindrical spreading formula provides a value of 400 m. Given the depth of the sound of Islay, the actual propagation in the site is likely to be a combination of both spherical and cylindrical spreading and therefore true detection distances for turbines in quiet water (either due to a low intensity location or low flow speeds) are likely to lie between 20 and 400m.

If we assume that the turbine measured in Kvalsund is representative of those that are proposed to be placed in the Sound of Islay then it is clear that these devices are unlikely to add a significant underwater sound footprint to the area. Taking the maximum sound output, the minimum ambient noise and the best propagation scenario only leads to an audibility distance of 400m. All other combinations will have audibility distances that are less or much less than this. Given these measures, it is unlikely therefore that these devices will represent a significant source of sound pollution in the area. Even when considering an array of these devices with the potential that their acoustic outputs act in concert, the actual outputs relative to background are likely to be too low to produce substantial additive effects. This is because the sound from adjacent devices will have dropped below background before overlapping.

The data here suggests that these devices will not provide a significant sound footprint to the area. However, following on from this, the question arises as to whether they will be loud enough to be heard by approaching marine mammals and whether additional noises sources may need to be added to provide additional acoustic warning. The answer to this issue hinges around the degree of collision concern for these turbines tempered against the potential (and unknown) negative effects of added (potentially confusing) anthropogenic “warning” sound to the site.

Research on the behaviour of marine mammals in close proximity to active tidal turbines elsewhere is at too early a stage to infer both how (if) animals respond to operating turbines. Likewise responses to “warning” sounds in tidal narrows are also unknown. Therefore a precautionary approach would be to deploy and monitor the turbines alone for adverse impacts without adding an additional sound source(s) with addition risks of adverse behavioural impacts.

Summary: Marine mammals use sound for a variety of activities from navigation and obstacle avoidance to foraging, communication and threat avoidance. The hearing sensitivities of the pinniped and odontocete species likely to use the site are relatively well known, while the underwater hearing of otters and minke whales are very poorly understood. Of the better known species, their hearing is likely to be more sensitive than ambient sound level in coastal waters over a broad range of frequencies.

An investigation into the ambient sound characteristics of the Sound of Islay showed that ambient sound generally increases with flow speed and sound levels are substantially higher than would be encountered in open ocean environments for equivalent weather conditions. There was significant spatial variation in the general sound field of the area that was monitored. With what appeared to be quiet and loud patches that are conserved between flooding and ebbing tides and different flow speeds. While attempts were made to exclude the influence of vessel traffic, the factors (natural and anthropogenic) contributing to this ambient underwater sound field in the site remain unknown.

When comparing the reported acoustic output of the proposed tidal turbines with the ambient sound field, it became clear that if such devices are to be placed in the Sound of Islay, their acoustic footprints are likely to be small. If placed in areas of particular high acoustic intensity then their outputs will not exceed the ambient background sound. If placed in quieter regions then their sphere of acoustic impact will be in the order of tens to the low hundreds of meters.

References:

Akvanplan-niva 2009. Tidal turbine in Kvalsund, western Finnmark – underwater sound measurements. Akvaplan-niva AS Report:4302-04

Au and Banks 1998 The acoustics of the snapping shrimp *Synalpheus parneomeris* in Kaneohe Bay. J. Acoust. Soc. Am. 103: 41-47

Nolet, BA, Wansink, DEH and KruuK, H (1993) Diving of otters (Lutra lutra) in marine habitat: use of depths by a single-prey loader. J. Anim. Ecol. 62: 22-32.

Carter C 2008. Marine renewable energy devices: a collision risk for marine mammals? MSc thesis, University of Aberdeen.

Gunn, L.M. 1988. A behavioral audiogram of the north American river otter (Lutra canadensis). M.Sc. thesis. San Diego State University, San Diego, Calif. 40p.

Kerman B. 1988. Sea surface sound: natural mechanisms of surface generated noise in the ocean. North Atlantic Treaty Organization. Scientific Affairs Division

Ma, BB Nystuen, JA and Lien, RC 2005. Prediction of underwater sound levels from rain and wind. J. Acoust. Soc. Am. 117: 3555-3565

Madsen, Wahlberg, Tougaard, Lucke, Tyack 2006. Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. Marine Ecology Progress Series 309: 279-295.

Richardson, Greene, Malme and Thomson 1995. Marine mammals and noise. Academic Press.

SMRU Ltd (2010) Sound of Islay – marine mammal data for Environmental statement.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas and P.L. Tyack, 2007. Marine mammal noise exposure criteria. Aquatic Mammals 33 (4).

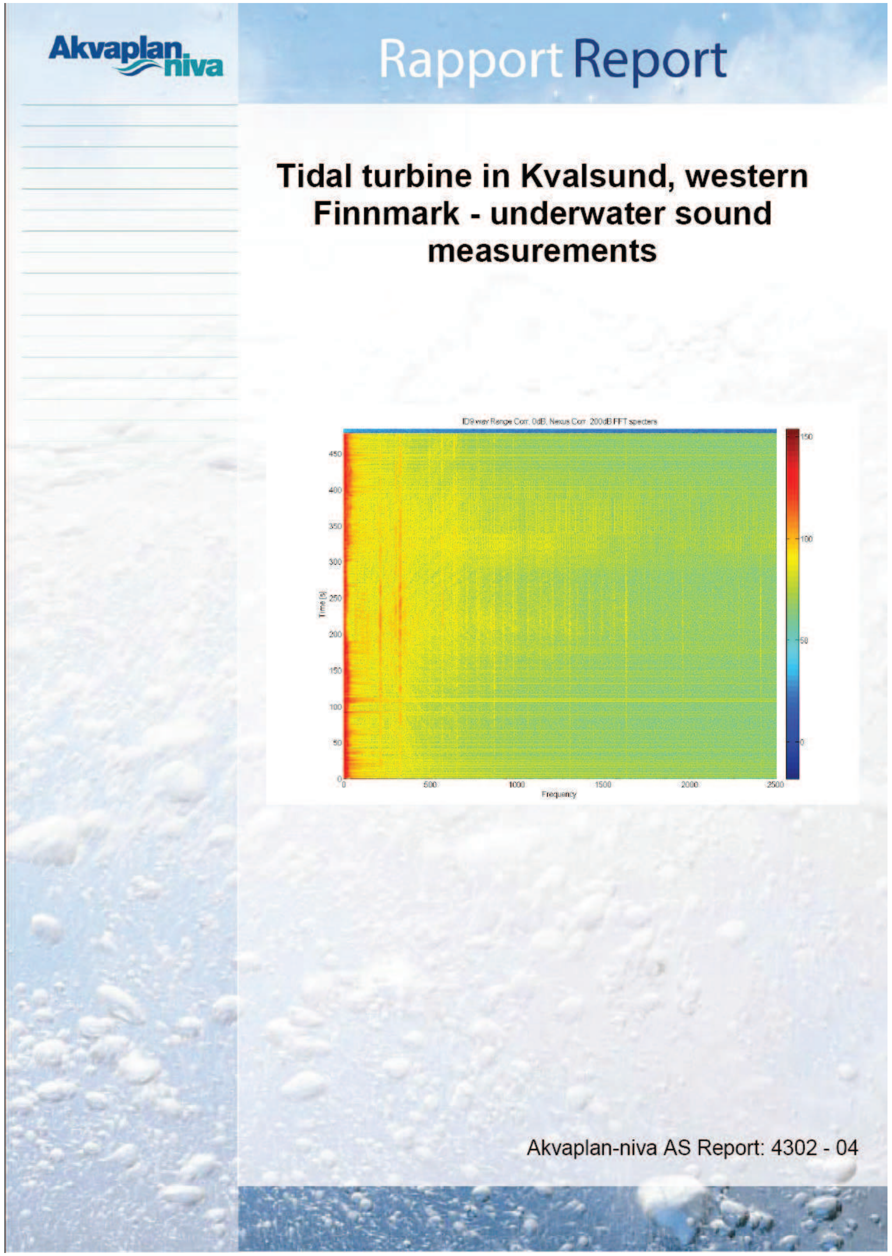
Wilson & Carter 2008. Acoustic monitoring of the European Marine Energy Centre Fall of Warness tidal-stream test site: The drifting ears project. SRSL report to EMEC

Recording the start time for a drifter immediately following its deployment, Sound of Islay September 2009.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 9 – Marine Mammals

Appendix 9.4: “Tidal turbine in Kvalsund, western Finnmark – Underwater sound measurements”



Front page illustration:

Front page picture shows a time/frequency plot of a narrowband analysis of ID9 (turbine on) . The plot is generated by means of an FFT (Fast Fourier Transform; with 75% overlap in time) and have a frequency resolution of 1.46 Hz, given by the ratio between the number of samples per FFT (32768) and the sampling rate fs =48 kHz

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Report title Tidal turbine in Kvalsund, western Finnmark - underwater sound measurements	
Author(s) Øyvind Leikvin Marianne Frantzen Harald Tholo Svein Mjølsnes	**Akvaplan-niva report no** 4302 - 04 **Date** 02.01.2010 **No. of pages** 43 **Distribution** Confidencial
Client Hammerfest Strøm AS	**Client's reference** Inger-Lise Mathisen

Summary
The noise frequency range of the tidal turbine in Kvalsund was 2 kHz and below, with peak frequency lines between 70-326 Hz. The intensity of the sound at these peak frequency lines reaches about 20 dB above the ambient noise level at CPA (Closest Point of Approach), 30 – 50 m away from the turbine.
Recent literature on hearing ability and avoidance to sound in fish and mammals indicate that the sound frequencies and intensities recorded in Kvalsund will pose no impact to the most common fish and mammal species in the area.

Project manager	**Quality controller**
Marianne Frantzen	Lars-Henrik Larsen
Marianne Frantzen	Lars-Henrik Larsen

Table of Contents

Preface

Akvaplan-niva AS has been given the task to measure and analyze the sound of the tidal turbine in Kvalsund in western Finnmark, Norway.

Several people have been involved in performing the task. We are especially grateful for the help from the local fisherman Peder Hansen from Kvalsund. His knowledge and skills concerning Kvalsund and at sea in general were just spectacular. Furthermore, we would like to thank Hammerfest Strøm AS for always being there to reply questions, handle the turbine and discover its behaviour. Finally, a huge gratitude is given to our sub-clients, Harald Tholo and Svein Mjølsnes, for their invaluable support in analyzing the sound measurement data and developing the software tool.

The present report describes the methods involved in performing the measurements and analysis, and states the results. Some main conclusions have been added.

These people have been involved in the sound analysis project:

Marianne Frantzen	Akvaplan-niva	Project leader, interpretation of results, reporting
Øyvind Leikvin	Akvaplan-niva	Field measurements, reporting
Lars-Henrik Larsen	Akvaplan-niva	Quality assurance
Peder Hansen	Local fisherman	Boat driver, local expert, field assistant
Inger-Lise Mathisen	Hammerfest Strøm	Coordinator, field assistant
Hans Olav Strømme	Hammerfest Strøm	Engineer, tidal turbine expert
Arne Størvik	Hammerfest Strøm	Tidal turbine pilot
Harald Tholo		Sound analysis, reporting
Svein Mjølsnes		Sound analysis

We would like to emphasize to Hammerfest Strøm AS our huge gratitude for this interesting project!

Øyvind Leikvin

Øyvind Leikvin

1 Introduction

As part of assessing the environmental impacts of an operating tidal turbine in Kvalsund, Western Finnmark, Norway, Akvaplan-niva AS has been given the task to measure the radiated underwater noise from the turbine. Also it is desirable to get indications on whether this sound has any potential effects on fish and marine mammals nearby. A summary of hearing ability and sensitivity to underwater noise of the most important local fish and mammal species is included.

The present report describes the methods involved in performing the measurements and analysis, and states the results. Furthermore, some discussions and conclusions on the sound analysis and the impact on fish and mammals are provided.

1.1 Area of study

The Kvalsund tidal turbine is located just east of the Kvalsund Bridge connecting Kvaløya from the mainland in Finnmark, far north in Norway (Figure 1). The coordinates of the location is about 70°30' N and just less than 24°E. Kvalsund is a nearly 4 km long and 0.6 km wide strait.

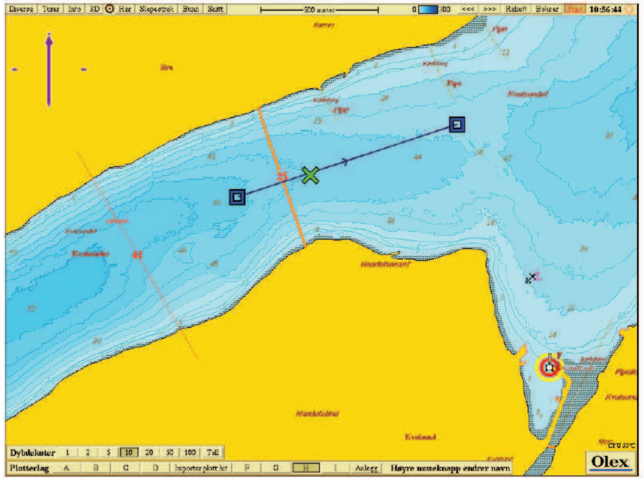


Figure 1 Map of the area of study, the location of the tidal turbine (green) and an approximate trajectory followed when drifting over the tidal turbine (blue line between squares, ID9). The map is drawn with the Olex software (www.olex.no).

1.2 Tidal Turbine

The tidal turbine is placed at about 50 m depth at the location given in Figure 1. The centre of the turbine is placed 20 m above the sea floor. The length of the turbine blades is about 10 m. An illustration of the turbine is given in Figure 2. This indicates that the distance between the upper range of the device in the water column, reaches up to about 20 m beneath the sea surface. The effect of the turbine is 300 kW.

The tidal turbine blades rotate with a typical and maximum speed of 7.2 rpm. In addition, there is a generator inside the nacelle behind the blades (see Figure 2), which has a maximum rotation speed of about 504 rpm.

The tidal turbine is only active and rotating when there is sufficiently strong ambient current speed. The threshold current is not known, but seems to be about 0.8 – 1.0 m/s. During the measurements, the typical duration of an active period (strong tidal currents), was about 4 hours, with a 2 hours break when the tidal current did change direction. The lengths of these periods change according to the tidal cycle (approximately one month), with opposite extremes at spring tide and neap tide (see also chapter 2.3.4).

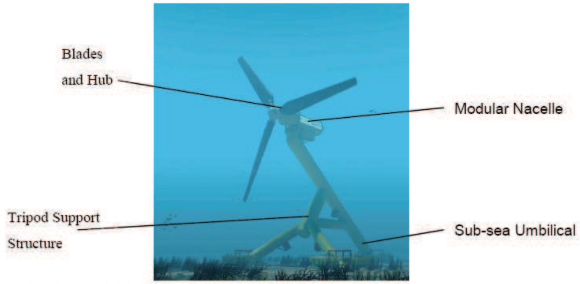


Figure 2 Illustration of the tidal turbine (Hammerfest Strøm).

2 Instruments, Methods & Environments

2.1 Instruments

The sound recorder which was operating was an analog DAT-recorder, Sony TCD-D100. This has a sampling frequency of 48 kHz and a flat frequency response in the bandwidth 20 Hz to 22 kHz.

The pre-amplifier utilized in the recordings, was a Nexus 2690 OS2 amplifier made by Brüel & Kjær. The amplifier was calibrated just in advance of the measurements (see Appendix B).

The hydrophone utilized was a Bruel & Kjær 8105. Calibration sheet with response curve is shown in Appendix A. The hydrophone has a measurement bandwidth between 0.1 Hz and 150 kHz. The recorded signal was connected to a *Native Instrument* 24bit AD converter. The analysis was performed with the help of Matlab software.

The different elements in the measurement chain can be visualized as shown in Figure 3.

Hydrophone sensitivity [C/Pa] → Nexus – Charge preamplifier [V/C] → DAT – recorder sensitivity [V/V] → AD Converter - Matlab sensitivity [V/V]

Figure 3 Elements in the measurement chain.

2.1.1 Calibration

2.1.1.1 Hydrophone – Nexus Calibration

The Nexus preamplifier is programmed to be a charge amplifier, preset with the corresponding charge sensitivity of the hydrophone. The Nexus preamplifier provides a low impedance voltage output that matches the high input impedance of the DAT recorder, without any drop in voltage. The gain settings with the corresponding dB correction values of the Nexus preamplifier are given in Table 1.

Table 1: Nexus sensitivity settings

Sensitivity	dBV re 1 µPa [V/µPa]
100 µV/Pa	-200
316 µV/Pa	-190
1 mV/Pa	-180
3.16 mV/Pa	-170

Depending on a correct setting for the hydrophone charge sensitivity, the Nexus sensitivity setting gives the total *hydrophone-preamplifier* sensitivity valid for the low frequency region, where the hydrophone frequency response is approximately constant. For the higher frequencies, one must correct for the frequency dependency of the sensitivity. The frequency responses for hydrophone 8105 is given in Appendix A. The DAT recorder used during these noise measurements has an adjustable gain knob, which was kept at a fixed position in order to assure a fixed tape recorder gain setting.

2.1.1.2 DAT recorder / AD converter Calibration

Signal generator 7.8 mV rms → DAT – recorder sensitivity [V/V] → AD Converter - Matlab sensitivity [V/V] → Matlab amplitude. 0.289 peak

Figure 4 Calibration of DAT recorder and AD converter

The DAT recorder and the AD converter were calibrated as one unit. A signal with known amplitude and frequency (7.8 mV rms @ 1kHz) was connected to the DAT tape recorder and recorded for a duration of 60 seconds. The recorded signal was connected to a *Native Instrument* 24bit AD converter, and the signal was stored to file and imported into Matlab. The corresponding amplitude reading in Matlab was 0.289.

The transfer function for the recorders can be found as:

$$TF_{dB} = 20 \cdot \log_{10}\left(\frac{\frac{0.289}{\sqrt{2}}}{7.8 \cdot 10^{-3}}\right) = 28.37\,dB$$

In addition, a frequency response calibration was performed. A signal containing white Gaussian noise was recorded on the DAT/AD Converter system and evaluated by means of FFT in Matlab. The frequency response of the system was evaluated and stored. The frequency response of the hydrophone and the recording system are compensated for in the Matlab evaluation program *sea_noise9*.

The software tool *sea_noise9* used for these measurements is developed with Matlab R2009. All user interactions are entered via a graphic user interface (GUI), see Figure 33, and exist in a compiled version. The program runs using a runtime version of Matlab, without the need for a separate Matlab license. The verification/ calibration of this software tool is given in Appendix C.

2.2 Methods

All field measurements were conducted in the period 22nd - 23rd of October 2009 by Akvaplan-niva AS, with assistance from a local fisherman. Sound recordings were conducted from a 14 feet open boat (Askeladden; Figure 5) by a handheld hydrophone. In addition, a 27 feet fishing boat holding a winch, were utilized for deployment/ recovery of measurement moorings. Both boats had engines turned off during all measurements. All recordings were made at about 18-22 m depth, which represents the depth of the uppermost part of the tidal turbine blades (see chapter 1.2 and Figure 2).

Sound measurements were conducted from fixed mooring positions in Kvalsund as well as by continuous recordings while drifting with the tidal current. The quality of all sound recordings were evaluated, and the recordings found to best represent the ambient noise and the turbine noise, respectively, were selected for further analysis:

For ambient noise measurements (turbine turned off), recordings were performed at a nearly fixed position about 60 m north-east of the turbine. The situation was during a time period when the tidal current was close to zero, representing a "minimum ambient noise level". The recordings were undertaken at 19 m depth on October 23rd about 2 am local time.

For turbine noise measurements (turbine turned on), the recordings from fixed mooring positions were difficult to accomplish because of the strong currents. Also the measurement equipment (rope, wire, hydrophone, weight etc) were exposed to massive vibrations and undulations due to the strong water flow passing by. Therefore, some of the continuous recordings performed while drifting over the turbine were selected as the most appropriate ones. These recordings were undertaken at 17-19 m depth during the night/ morning of 23rd of October 2009. Coincident with the sound recording, a handheld GPS plotted the hydrophone position every 30 seconds. An approximate drift trajectory is shown in Figure 1.

Figure 5 The boat (Askeladden 14 feet), from which measurements were carried out.

2.3 Abiotic Environment

2.3.1 Weather and waves during fieldwork

The weather during measuring was calm, with westerly winds of about 1-3 m/s, and no precipitation. The temperature was about 0°C during daytime and -2°C nighttime.

By manual inspection when performing the measurements, waves were in general very small or not present at all during the measuring period 22nd - 23rd of October 2003. Maximum 10 cm high waves were observed. An exception was in the final 60 seconds or so in the two final drift runs, ID16 and ID18. Here some countercurrent waves occurred. They were steep and increasing from around zero to about 0.7 m.

2.3.2 Bottom topography

The bottom topography in the vicinity of the tidal turbine is illustrated in Figure 6. The sea bed has a close to ideal U-shape in the strait. The width of the strait by the turbine is about 600 m, and the length of Kvalsund is about 4 km. The maximum depths close to the turbine is about 50 m, and this depth is increasing smoothly towards west to about 80-90 m depths.

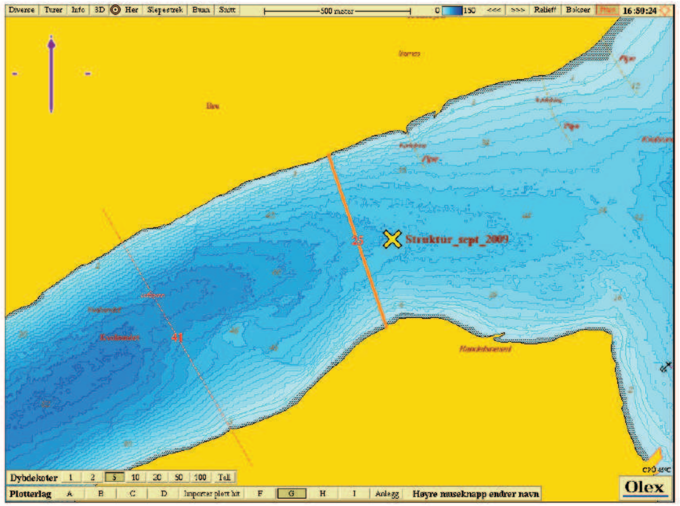


Figure 6 The bottom topography (equidistance 5 m) near the tidal turbine (marked with yellow cross) in Kvalsund. The map is drawn with the Olex software (www.olex.no).

2.3.3 Hydrography and currents

CTD-profiles taken from the area of study during the measurements, all illustrate (not shown) that the water masses were well mixed in Kvalsund, and no prominent stratification/ pycnoclines/ thermoclines were observed.

A SD6000 current meter with rotors was measuring the current during the initial phase of the field campaign. However, it lost its rotor after some time. When observing the data, it is evident that the current meter doesn't manage to measure when the current is at its strongest. Data from Hammerfest Strøm show a maximum current of about 2 m/s, which is consistent with measurements from 1997 performed by SINTEF (Trannum et al., 2002). These ADCP data collected by SINTEF in 1997 gave both current values and sea level values. By comparing these data with sea level observations at Hammerfest tidal gauge station, we could find a phase shift between Kvalsund and Hammerfest. These main results show that the maximum current towards east in Kvalsund leads high tide in Hammerfest with about 45-60 minutes, and that high tide in Hammerfest leads zero current in Kvalsund with approximately 2.5 hours. Furthermore, maximum current towards west in Kvalsund leads low tide in Hammerfest with 30-45 minutes. Still, there is a time lag between low tide in Hammerfest and zero current in Kvalsund, again with approximately 2.5 hours. These results above have been the foundation for the planning of the measurement schedules.

2.3.4 Tides

Based upon tidal charts from Sjøkartverket, we were able to find times for spring and neap tides at Hammerfest. With the help from the analysis of the ADCP data from 1997, (chapter 2.3.3) good estimates of the time schedules for zero current and maximum current in Kvalsund were possible to figure out. The spring tide was about 18th-19th of October 2009 (www.vannstand.statkart.no). This means that the tidal amplitudes were relatively high and the tidal currents strong, but not at its strongest at the time of measuring.

Thursday 22nd October 2009:

High tide:		**04:58**
Current ≈ zero:	07:30	
Maximum current (westbound):	10:40	
Low tide:		**11:12**
Current ≈ zero:	13:40	
Maximum current (eastbound):	16:55	
High tide:		**17:16**
Current ≈ zero:	19:40	
Maximum current (westbound):	23:10	
Low tide:		**23:39**

Friday 23rd October 2009:

Current ≈ zero:	02:10	
Maximum current (eastbound):	04:40	
High tide:		**05:40**
Current ≈ zero:	08:10	

Figure 7 Measuring from a fixed mooring position close to land (south). The Kvalsund Bridge is in the background. The tidal turbine is about 200 m behind the floating buoys. The floating buoys are attached to the mooring and to the boat. The picture is taken during strong currents towards east (rising tide) 22nd October 2009. The measuring boat is located in calm water, by the compensation current, and is right here drifting towards land.

3 Results from sound measurements

3.1 The final selection of sound measurements

The final selection of sound measurements after 3 days of testing and recording, is given in *Table 2* below. These are discussed into more detail in chapter 3.2 and chapter 3.3.

Table 2: List of IDs from tape nr. 5, 22nd - 23rd of October 2009, from sound measurements from the tidal turbine in Kvalsund. ID 14 (see chapter 3.1) and the drift IDs (chapter 3.3) are the ones utilized for the final sound analysis from the turbine. All these measurements are taken at about 19 m depth.

Start ID (tape)	Measuring/ station ID	State of ambient ocean current	Time of measuring
9	Drift_I	Westward, strong	23.10_00:19
10	Drift_II	Westward, weakening	23.10_00:38
14	Ambient noise	Calm	23.10_02:10
16	Drift_III	Eastward, strong	23.10_05:05
18	Drift_IV	Eastward, weakening	23.10_05:55

3.2 Ambient noise and recording noise evaluation

To identify the noise radiated from the turbine, it is necessary to know the contributions from the ambient noise in the area. ID14 is a measurement performed approximately 60 metres north-east of the turbine. At the time of recording, the tidal current was close to zero, and the turbine was not running. The hydrophone depth was 19 metres. Figure 8 gives the total noise in the measured frequency range. The fluctuations are noticeable, and may not be representative for the ambient noise in this area. The 1/3-octave spectra as a function of time (Figure 10) indicate that the dominant contributions are from the low frequency region. This is supported by Figure 9, showing the level after the frequencies below 20 Hz has been filtered out. One can observe that the ambient noise in the frequency range from 17.8 Hz up to 22.4 kHz has been reduced by 15 - 20 dB compared to the unfiltered data.

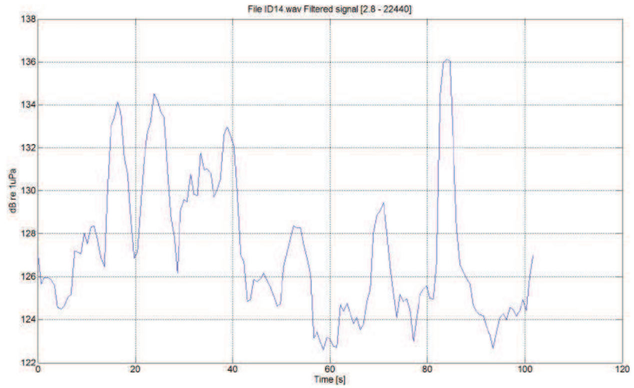


Figure 8 *ID 14 ambient noise in the frequency range from 2.8 Hz to 22440 Hz*

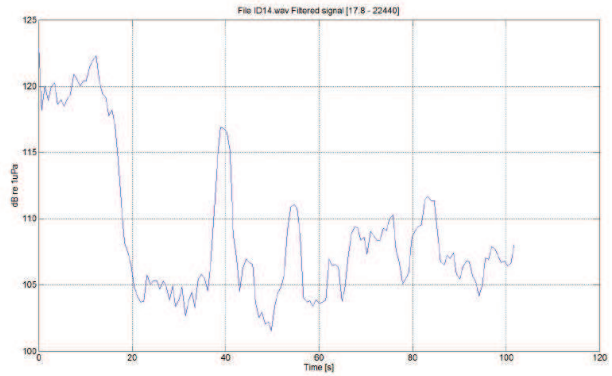


Figure 9 *ID 14 ambient noise in the frequency range from 17.8 Hz to 22440 Hz*

A possible cause of the observed low frequent noise could be turbulent flow, introducing mechanical vibrations in the hydrophone cable, which in turn are propagated to the hydrophone. In addition, other anthropogenic activities in the vicinity could of course also contribute to the measured ambient noise. This could for example be boat activity or road traffic across bridge. The method of measuring, with a handheld hydrophone from a small open boat, could well be responsible in producing low frequent noise. This could be, even if the waves were presumably negligible (see chapter 2.3.1) and the weather was calm.

The FFT plot in Figure 11 and Figure 12 indicates that no dominant frequency lines can be observed in ID14. This supports the hypothesis that detected frequency lines in the measurements with a running turbine are related to the turbine itself. By looking at the higher frequencies (f>5 kHz) in Figure 11, one can observe that the noise level do not decay with higher frequencies, as would be the case if the noise was ambient sea noise. This noise is probably a combination of electronic white noise generated in the preamplifiers and the quantization noise in the AD converter of the tape recorder. The tape recorder has a 16 bit AD converter which gives approximately 80 dB dynamic range.

The AD converter used to digitize the analogue signal from the tape recorder is a 24bit AD converter from and has a dynamic range of approximately 105dB. No quantization noise is expected due to this conversion.

The consequence of this high noise in the lower and higher frequency region is that frequency noise in this region will not be detected if these signatures are below this noise floor.

Another limitation of the upper frequency range will of course be the sampling frequency, which according to Nyquist will limit the maximum upper frequency to 24 kHz. Traces of the low pass filters used are visible in the frequency range from 22 kHz to 24 kHz (Figure 11 and Figure 13).

Figure 10 shows the distribution of spectral level versus time. Several transients (short time noise bursts) can be observed at random time intervals. These transients have a short duration, and they generate broadband noise with a frequency range up to several kHz. The effect of the transients can be illustrated by comparing a period of time with no transient to the complete measurement. This comparison is given in Figure 14.

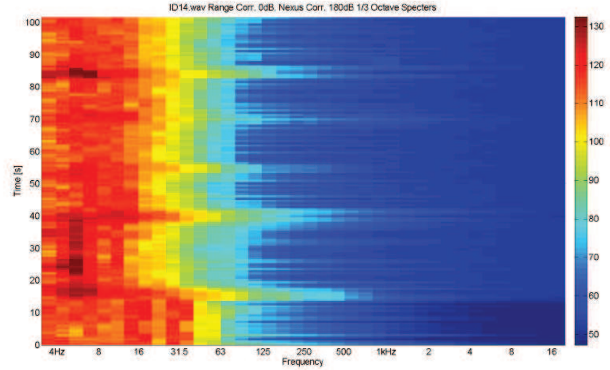


Figure 10 ID 14 – Ambient noise 1/3-octave levels versus time. The colors denote the sound intensity, dB re 1 μPa.

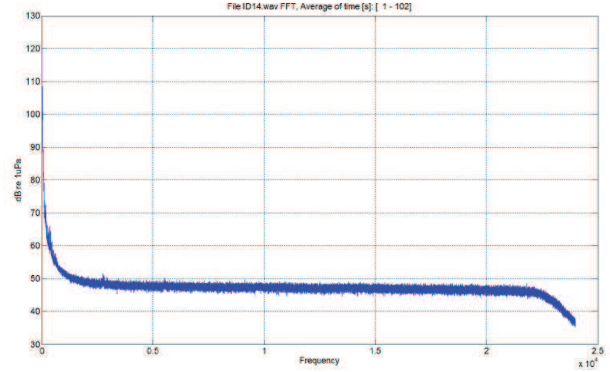


Figure 11 ID14 – Ambient noise, FFT analysis for frequencies up to 24 kHz.

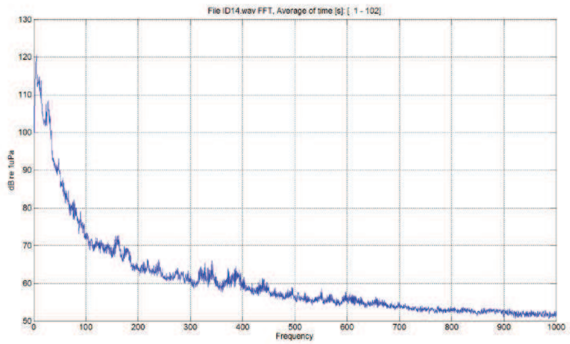


Figure 12 ID14 - Ambient noise, FFT analysis for frequencies up to 1000 Hz

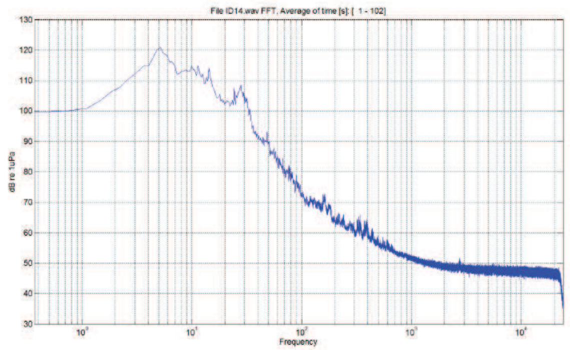


Figure 13 ID14 - Ambient noise, FFT analysis of frequencies up to 24000 Hz – log frequency scale.

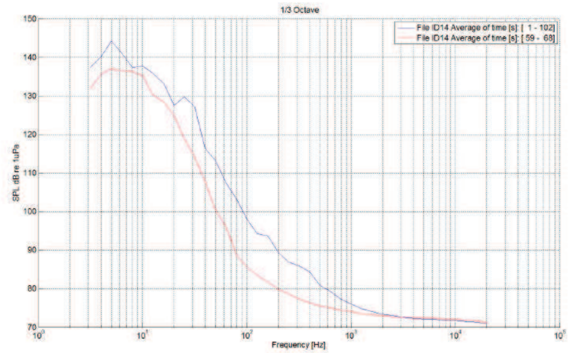


Figure 14 Ambient noise, 1/3-octave spectra - average of the complete recording compared to a "silent" period.

3.3 Turbine noise evaluation

In order to do measurements with a minimum of flow noise induced by the tidal current flow around the hydrophone, the best solution was to let the recording platform drift along with the current (see chapter 2.2). In addition, this setup also gave a continuum of measurements at different locations. A GPS receiver was used in order to track the position during the drifting runs. In total there were performed four different drifting runs. The results for the four different runs seem to agree fairly well (Figure 15a-d). Run ID16 and ID18 seem to be influenced by noise from other sound sources as well, as this signature do not vary in accordance with the distance to the turbine. The figures used in this report to support the discussions are mainly based on data from ID9. Table 3 shows the positions and distances to the turbine during the measurement for ID9 – Drift I.

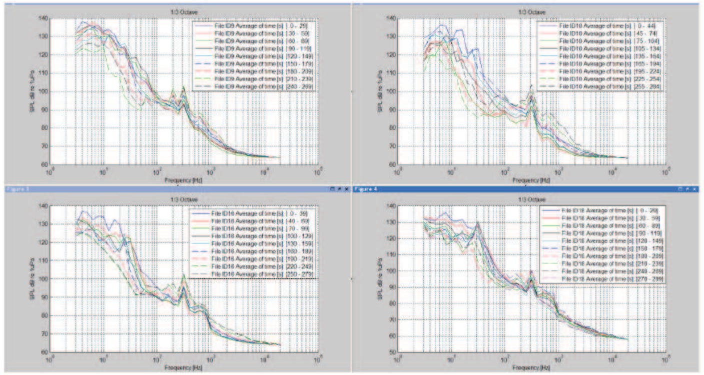


Figure 15a-d 1/3 Octave, spectral levels. Analysis of all 4 drifting runs. Average of selected 30s intervals.

Table 3 Positions during run "Drift I"

ID9 Drift I. Nexus gain setting 100µV – 200dB				**Spherical transmission loss**	**Cylindrical transmission loss**
Time [sec]	Lat	Lon	Dist from turbin [m]	20 log(r) Corrections [dB]	10 log(r) Corrections [dB]
30	70°30.800'	23°57.583'	202	46.1	23.1
60	70°30.795'	23°57.534'	171	44.7	22.3
90	70°30.789'	23°57.474'	133	42.5	21.2
120	70°30.785'	23°57.433'	107	40.6	20.3
150	70°30.780'	23°57.385'	77	37.8	18.9
180	70°30.776'	23°57.337'	51	34.1	17.0
210	70°30.772'	23°57.285'	32	30.2	15.1
240	70°30.768'	23°57.233'	42	32.4	16.2
270	70°30.764'	23°57.184'	66	36.5	18.2
300	70°30.759'	23°57.132'	96	39.7	19.8
330	70°30.754'	23°57.075'	131	42.4	21.2
360	70°30.750'	23°57.019'	166	44.4	22.2
390	70°30.743'	23°56.963'	202	46.1	23.1
420	70°30.737'	23°56.908'	237	47.5	23.8
450	70°30.731'	23°56.854'	272	48.7	24.4

The 1/3-octave spectrum shown in Figure 16 indicates that the main contribution to the radiated noise from the turbine can be observed in the frequency range from approximately 50 Hz to 3 kHz. For frequencies below 50 Hz, no change in the measured levels can be observed, even at the closest point of approach (CPA) to the turbine. When plotting the total sound pressure level (SPL), integrated over the entire frequency band from 3.15 Hz to 20 kHz, there are no indications of a clear relationship with the distance to the turbine (see Figure 17). The measured high energy low frequent noise can not be related to the turbine itself.

However, when the signal is band pass filtered to the range 70 Hz to 3 kHz, the integrated sound pressure level is clearly correlated to the distance to the turbine, as shown in Figure 18.

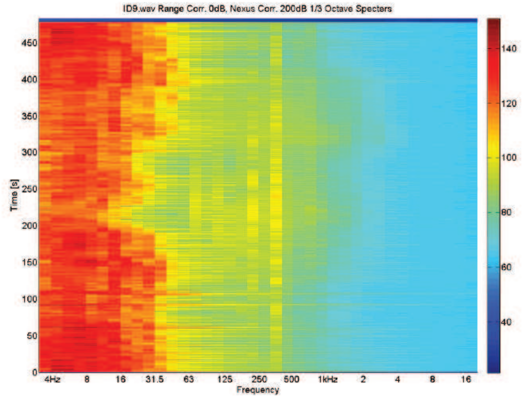


Figure 16 ID 9 – 1/3-octave spectra as function of time. The colors denote the sound intensity, dB re 1 µPa

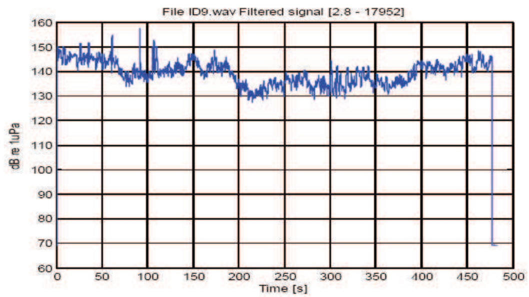


Figure 17 ID 9 – SPL as a function of time, integrated over all 1/3-octave filters.

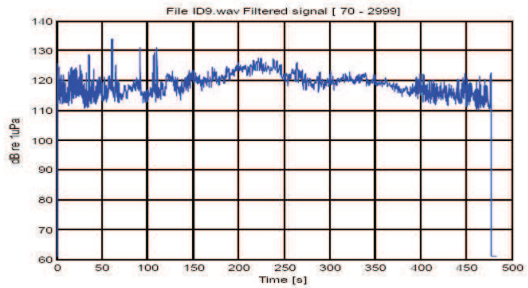


Figure 18 ID 9 – SPL as function of time, integration over frequency [70 Hz – 3 kHz].

The 1/3-octave representation of the signal also support the correlation between the range (time) and the SPL in the frequency area 70 Hz to 3 kHz. By looking at the 300 Hz frequency filter in Figure 19, the variations is approximately 10 dB from maximum value at time [180s – 239s] to the minimum value at time [420s -474s]. By comparing this dB reduction to the corresponding dB reductions in Table 3, one would assume that the transmission loss is closer to cylindrical spreading loss than spherical transmission loss.

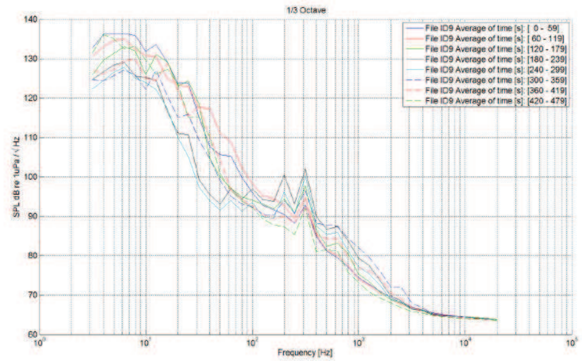


Figure 19: ID9 (Drift 1) - 1/3-octave spectra, averaged over 60 seconds for 8 different time intervals.

Figure 20 shows a time/frequency plot of a narrowband analysis of ID9. The plot is generated by means of a FFT (with 75% overlap in time) and have a frequency resolution of 1.46 Hz, given by the ratio between the number of samples per FFT (32768) and the sampling rate fs =48 kHz. Only the lower part of the frequency range (frequencies up to 2.5 kHz) are shown, as this frequency band contains most of the frequency lines of interest. The maximum levels is found at approximately 230 seconds after the start of record.

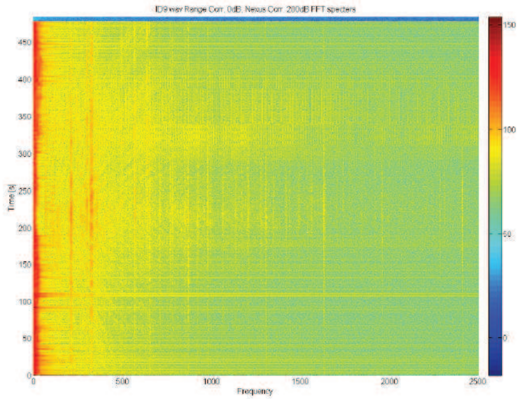


Figure 20 ID 9 – FFT spectra [0 -2500Hz] versus time, frequency resolution 1.46Hz. The colors denote the sound intensity, dB re 1 µPa

Looking at the narrow band spectrum, averaged over 60 seconds around CPA, given in Figure 21 and Figure 22, one can observe tonals (frequency lines) in the range 70 Hz to about 3 kHz. In Figure 22, there exist a large number of evenly spaced frequency lines in the range 150 Hz to 800 Hz. The frequency spacing is estimated to be 9.08 Hz, which corresponds to 545 rpm. This does not match the turbine rpm of approximately 500 rpm.

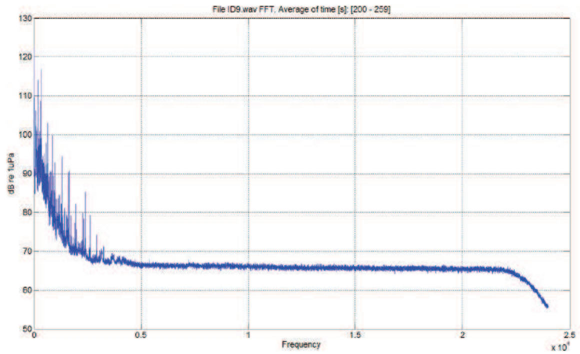


Figure 21 ID 9 – Time averaged narrow band spectrum (0 to 25 kHz)

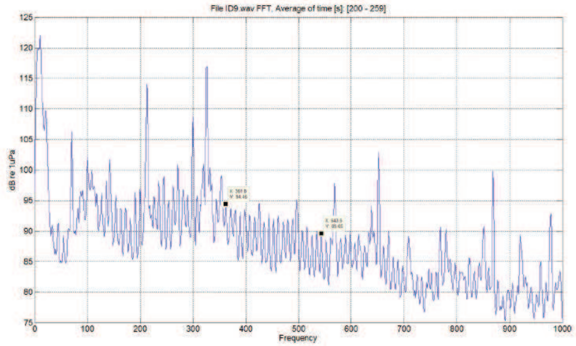


Figure 22 ID 9 – Time averaged narrow band spectrum (0 to 1000 Hz).

Figure 23 is based on the same information as Figure 20, but the time axis is limited to [140 s -320 s], and the frequency axis is limited to a maximum of 500 Hz. By looking at the frequency region 70Hz to 150 Hz, one can observe distinct broadband transients, occurring at regular intervals. Actually there are two sets of transients slightly differing in frequency contents. By filtering the signal in the frequency area (70 Hz to 150 Hz), the intervals between the transients can be estimated (Figure 24). By counting a certain number of transients and dividing by the corresponding elapsed time, the transient interval is estimated to be 8.40 seconds, which would correspond to 7.15 rpm. Multiplying this number by the gear ratio of 70.13 this would give a corresponding turbine speed of 501.1 rpm, which is very close to the measured turbine rpm, according to the turbine rpm log for this time interval.

As mentioned in chapter 3.2, the electronic measuring equipment makes considerable noise for frequencies above 5 kHz (about 66-67 dB re 1Pa SLP, when 30-50 m from CPA (Figure 21). However, if there would be sound pulses higher than this equipment noise, it would have showed up in the plot.

Furthermore , the DAT-player is constricting the upper frequency limit to 22-24 kHz, due to the sample frequency. According to a local tidal turbine engineer (Strømme, 2009), the only high frequency sources from the turbine would be normal computer-generated noise from some electronic equipment (no transmitting devices) and an ADCP current meter (about 600 kHz?).

If there would be strong signals at high frequencies at frequencies above 24 kHz, we would be likely to see some signals showing up between 5 kHz and 22 kHz (harmonics), above the white noise level.

Another issue is that high frequency signals lose its energy faster with the distance than low frequency signals, because there is more energy transferred to the surrounding water (medium) (Colwell, 2009).

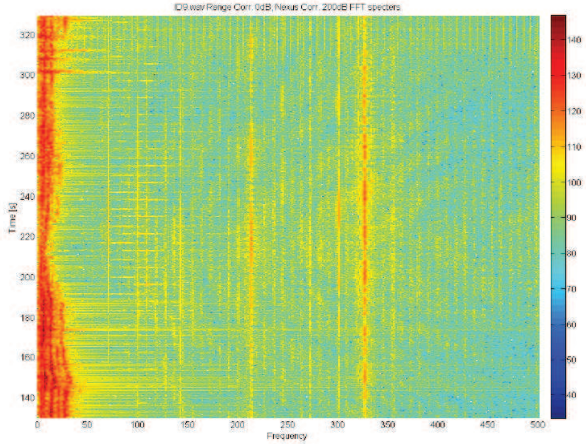


Figure 23 ID 9 - FFT spectra [0 -500 Hz] versus time, frequency resolution 1.46Hz. The colors denote the sound intensity, dB re 1 µPa.

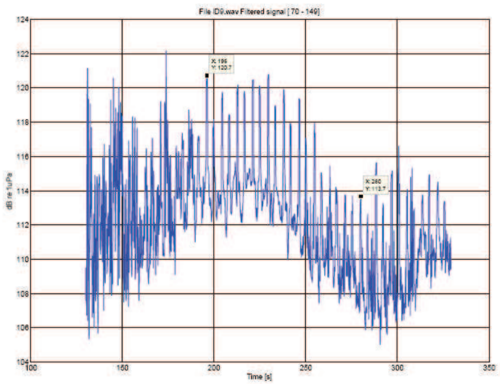


Figure 24 ID 9 – SPL as function of time, integrated over the frequency band 70 Hz – 3 kHz.

4 Identification of turbine frequency lines

The turbine gear box consists of a number of shafts and gear wheels. Potential gear box frequency lines are listed in Table 4. The gear box provides an input/output gear ratio of 70.13. The nominal turbine rpm is 500, which corresponds to a frequency of 8.33 Hz. Divided by the gear ratio, the corresponding propeller shaft rpm is 7.16 or 0.119 Hz. The turbine has three propeller blades, i.e. the propeller blades generate a fluctuating pressure field with a frequency of 0.358 Hz.

Each of the gear shafts with the corresponding gear wheel is a potential source of tonals (frequency lines). The fundamental frequency for each of the gear shafts and gear wheels are given in Table 4. In addition to the fundamental frequencies, also higher harmonics might be expected to occur at integer multiples of the fundamental frequencies.

Table 4: Turbine gear ratio and fundamental frequencies

	GearTeeth	rpm	Hz
Input shaft		7,156	0,119
Propeller blade rate		21,468	0,358
Gear wheel 1	76	200,368	3,339
Shaft 1, fixed		0,000	0,000
Gear wheel 2	28	200,368	3,339
Shaft 2		19,423	6,474
Gear wheel 3	20	200,368	3,339
Shaft 3 relative		27,193	0,453
Shaft 3		34,349	0,572
Gear wheel 4	124	4259,249	70,987
Shaft 4, fixed		0,000	0,000
Gear wheel 5	47	4259,249	70,987
Shaft 5		90,622	1,510
Gear wheel 6	29	4259,249	70,987
Shaft 6		181,219	3,020
Gear wheel 7	108	19571,698	326,195
Generator shaft		501,838	8,364
Gear wheel 8	39	7067,558	117,793
Oil pump shaft		1151,276	19,188
Total gear ratio	70,128382		

Even though all of the frequency lines have not been identified, they can be associated to the turbine. Figure 10 - Figure 12 from the ambient noise recording showed that no frequency lines were detected when the turbine was switched off. In addition, Figure 26 indicates that there seems to be a slight Doppler shift that is anti symmetric around CPA. From Figure 20 it is also evident that the measured levels for the frequency lines varies with range to the turbine.

The recordings contain information down to a few Hz, but the lower frequency region seems to be dominated ambient noise, even for the recordings done without tidal current and the turbine switched off. Thus there could be low frequency turbine related lines that are masked by the ambient noise levels.

Figure 25 gives an average of a number of FFT spectra around CPA for ID18. The frequency lines that match the frequencies in Table 4 are annotated accordingly. Figure 26 is a detailed time/ frequency plot for the frequency range in the neighborhood of the tooth rate for gear wheel 7 (326 Hz). CPA is located at approximately t=260 s. From this plot a number of frequency lines can be observed in the frequency range 317 Hz to 337 Hz.

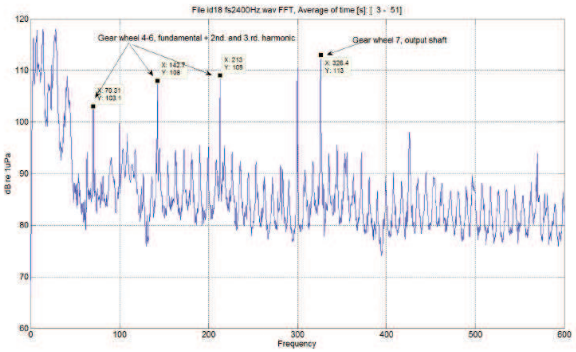


Figure 25 Turbine gear lines

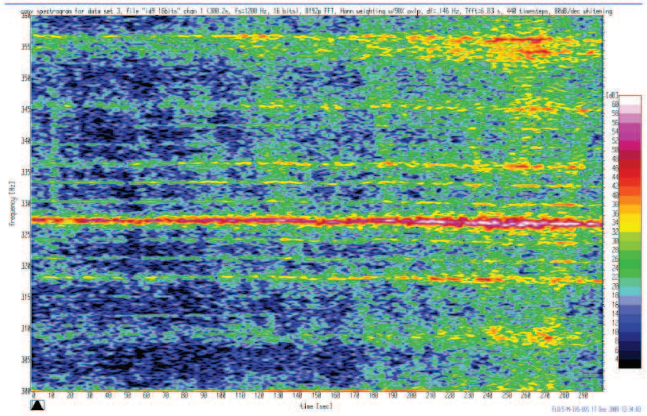


Figure 26 ID9 Frequency versus time. Frequency lines.

By utilizing the phase information in the FFT sequence, the frequencies of the spectral lines can be determined more accurately, as demonstrated in Figure 27. Based on data extracted from this plot the frequency spacing between these lines is calculated to be 3.0207 Hz at time 20 s (corresponding to 240 s before CPA). This frequency spacing matches the fundamental frequency for shaft 6.

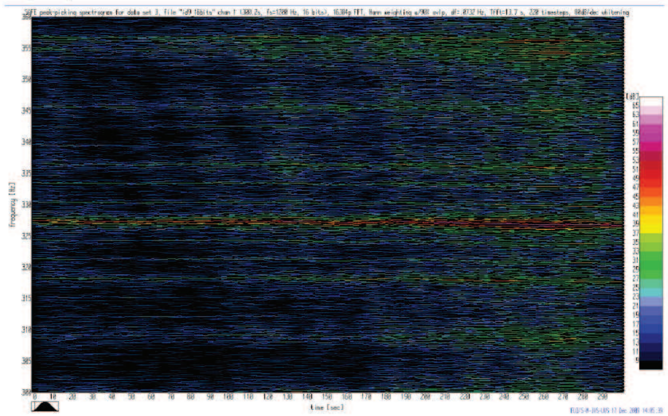


Figure 27 Frequency versus time, FFT phase corrected.

5 Conclusions on sound measurements

The recordings are somewhat limited by a high measured ambient noise at lower frequencies and by electronic noise at higher frequencies.

Within the frequency range where the turbine is detected, the main contribution of the radiated noise can be explained by the tonal energy (frequency lines). The tonals are anticipated to radiate from the turbine and its associated components. Some of the frequency lines have been matched to the frequencies from the turbine gear box.

The main bandwidth where the tidal turbine is giving its most obvious signature is from about 2 kHz and below. Peak frequency lines occur at 326 Hz, 300 Hz, 213 Hz, 142 Hz and 70 Hz.

The intensity of the sound at these peak frequency lines reaches about 20 dB above the ambient noise level at CPA (Closest Point of Approach), 30 – 50 m away from the turbine. Absolute values of SPL (Sound Pressure Level) measured in 315 Hz – 1/3 octave filter, has been estimated to just above 100 dB re 1µPa when reaching CPA.

6 Hearing abilities and noise sensitivity of fish and marine mammals recorded in the Kvalsund area

As part of the environmental assessment of the tidal turbine in Kvalsund, recordings of birds and mammals have been carried out in 2008 and 2009. General knowledge of the biology has been compiled from literature and local resource persons in the area. These reports provide the basis for the evaluations presented in the present chapter.

6.1 Fish

The most common marine fish species in Kvalsund are cod (*Gadus morhua*), saithe (*Pollachius virens*) and wolffish (*Anarhichas lupus*). Also the anadromous salmonids Atlantic salmon (*Salmo salar*), trout (*Salmo trutta*) and Arctic charr (*Salvelinus alpines*) can be found in Kvalsund (APN report 4302-02).

The majority of fish species detect sound from below 50 Hz up to 500-1500 Hz. A small number of species can detect sounds to over 3 kHz, while a very few species can detect sound to well over 100 kHz (Popper and Hastings 2009). Fishes with a narrow bandwidth of hearing are often referred to as "hearing generalists" whilst fishes with the broader hearing range are often referred to as "hearing specialists". The difference between hearing generalists and specialists is that the latter usually have specialized anatomical structures that enhance hearing sensitivity and bandwidth. The fish species common to the Kvalsund area as listed above, are all considered as hearing generalists.

The fish audiograms shown in Figure 28 indicate that cod is relatively sensitive to underwater sound in the frequency range 30-500 Hz, with a minimum hearing threshold of ~80 dB re 1 µPa at 100-200 Hz. There are data suggesting that cod are able to detect sound down to 0.1 Hz (Sand and Karlsen, 1986).

To the best of our knowledge, no audiogram is determined for saithe and wolffish.

Regarding the saithe, audiograms determined for other gadoid fish species (haddock (*Melanogrammus aeglefinus*; Figure 28), walleye pollock (*Theragra chalcogramma*; Mann et al., 2009)) indicates that other gadoid species in general detect underwater sound at about the same range of thresholds and bandwidth as the cod.

Fish species that are lacking a swim bladder (e.g. dab; Chapman and Sanders, 1974) are shown to be relatively insensitive to underwater sound (higher threshold level and narrower bandwidth (50-250 Hz) than i.e. cod). Also Wolffish is lacking a swim bladder and may therefore be assumed to be more insensitive to underwater sound as i.e. cod. However, extrapolation of hearing capabilities between taxonomically distant species has to be considered only as "qualified guessing".

Atlantic salmon is relative insensitive to underwater sound, hearing only low frequency tones (below 380 Hz) with minimum threshold level (maximum sensitivity) of ~100 dB re 1µPa at 100-200 Hz (Figure 28; Hawkins and Johnstone, 1978). There are data suggesting that salmonids (*S. salar* and related species) are able to detect sounds below about 35 Hz (*e.g.* Knudsen et al., 1992, 1994). No audiograms are to the best of our knowledge determined for trout and Arctic charr.

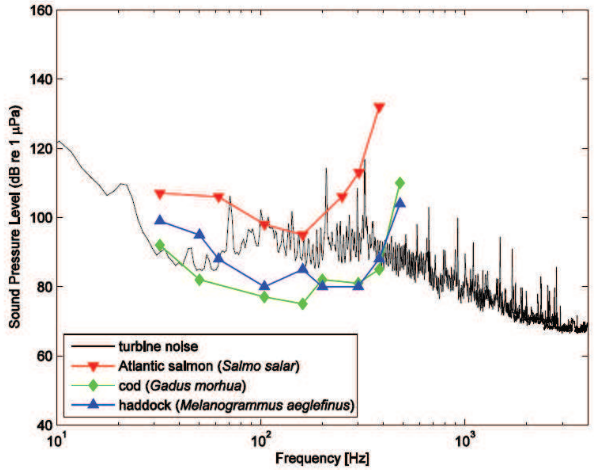


Figure 28 Hearing thresholds for a select group of fish species to illustrate fish hearing capabilities plotted together with the noise of the tidal turbine. These specific hearing thresholds are redrawn from Popper and Hastings (2009). The turbine noise is a time average corresponding to that of Figure 21 (but here with logarithmic scale on the x-axis) with the distance to the turbine varying from about 30-50 m.

6.2 Marine mammals

Harbor porpoise (*Phocoena phocoena*), grey seal (*Halichoerus grypus*), harbor seal (*Phoca vitulina*) and killer whale (*Orcinus orca*) are registered sporadic in the Kvalsund area (APN report 4302-02). Also white-beaked dolphin (*Lagenorhynchus albirostri*) and atlantic white-sided dolphin (*Lagenorhynchus acutus*) is occasionally observed along the coast of Finnmark, although not specifically reported for the Kvalsund area.

6.2.1 Cetaceans

In general, marine mammals are sensitive to a much broader bandwidth of sound than fish species. Harbor porpoise, killer whale and dolphins all belong to the odontocetes (toothed whales). The odontocetes are mid- and high frequency specialists, using principally frequencies of 1-150 kHz for vocalization (Richardson et al., 1995). High-frequency clicks are used to sense the environment and localize prey. Also, most odontocetes hear well between 1-150 kHz.

The harbor porpoise audiogram is U-shaped with the range of best hearing from 16 to 140 kHz (Figure 29). Maximum sensitivity (about 33 dB *re* 1 μPa) occurs between 100 and 140 kHz. The maximum sensitivity range corresponds with the peak frequency of echolocation pulses produced by harbor porpoises (120–130 kHz). Sensitivity falls about 10 dB per octave below 16 kHz and falls off sharply above 140 kHz (260 dB per octave). The harbor porpoise has the highest upper-frequency limit of all odontocetes investigated (Kastelein et al., 2002).

The most sensitive frequency in the killer whale audiogram is 20 kHz (36 dB *re* 1 μPa; Figure 29), matching the sensitivity level of harbor porpoise at this frequency. However, the killer whale has a reduced sensitivity to frequencies > 50 kHz compared to the harbor porpoise (Figure 29).

White-beaked dolphin shows the same sensitive high frequency hearing as the harbor porpoise although maximum sensitivity is of the order of 10 dB less sensitive compared to killer whale and harbor porpoise

As far as we have revealed, no audiogram is published for the Atlantic white-sided dolphin.

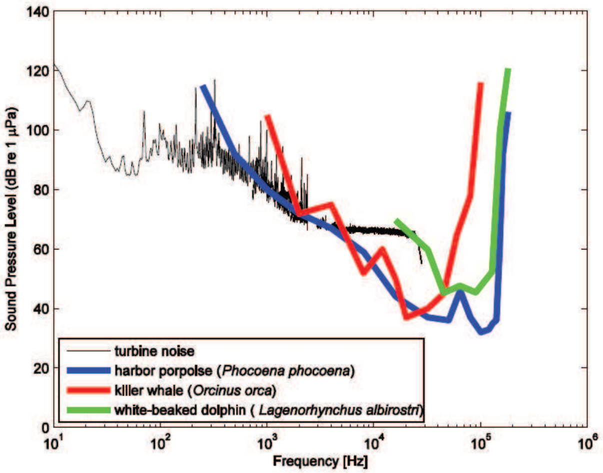


Figure 29 Audiograms for harbor porpoise (blue) (Kastelein et al., 2002), killer whale (red) (Szymanski et al., 1999) and white-beaked dolphin (green) (Nachtigall et al., 2008), displayed together with the noise of the tidal turbine. The noise is a time average corresponding to that of Figure 21, (but here with logarithmic scale on the x-axis) with the distance to the turbine varying from about 30-50 m. Note that the flat rightmost part of the turbine curve (>5 kHz) is likely to be generated by electronic white noise from the equipment (see chapter 3.2), and is therefore not representative for the turbine noise. The noise at frequencies >5 kHz is likely to have lower SLP, and definitely not higher, than the curve shown.

6.2.2 Seals

The harbor seal (and grey seal audiogram(s)) indicates that seals have better low and mid-frequency hearing than the odontocetes (Figure 30). Their hearing are however not as sensitive as the harbor porpoise and white-beaked dolphin at the very high frequencies.

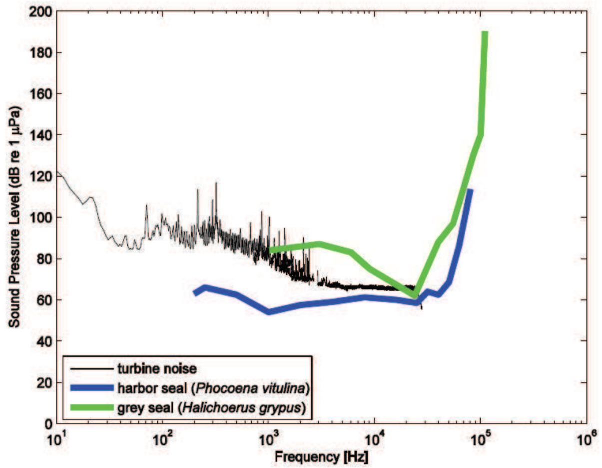


Figure 30 Audiograms for harbor seal (blue) (Kastelein et al., 2009) and grey seal (green) (Ridgeway and Joyce, 1975; redrawn from Nedwell and Brooker, 2008). displayed together with the noise of the tidal turbine. The noise is a time average corresponding to that of Figure 21, (but here with logarithmic scale on the x-axis) with the distance to the turbine varying from about 30-50 m. Note that the flat rightmost part of the turbine curve (>5 kHz) is likely to be generated by electronic white noise from the equipment (see chapter 3.2), and is therefore not representative for the turbine noise. The noise at frequencies >5 kHz is likely to have lower SLP, and definitely not higher, than the curve shown.

7 Impact of underwater noise/sound from the tidal turbine in Kvalsund on fish and marine mammals

7.1 Impact of underwater noise on fish and marine mammals

It has become increasingly evident over the last decades that anthropogenic noise may have an impact on marine animals (e.g. Popper and Hasting, 2009; Weilgart, 2007, Harwood and Wilson, 2001). High levels of underwater sound (generally taken to be in excess of 180 dB re 1 μPa) may cause fatality and injury in marine mammals and fish from activities such as pile driving, seismic operations and military sonar (Nedwell and Brooker, 2008).

To understand whether an anthropogenic sound affect hearing is whether it is within the hearing frequency range of the animal affected and loud enough to be detected above threshold. As a common framework for noise impact assessments in the marine environment Richardson et al. (1995) introduced the concept of four zones of marine animals behaviour and hearing:

- Zone of audibility; the area where an animal can hear the sound above the background noise
- Zone of responsiveness; reaction to the sound with altered behaviour (i.e. attraction, evasion, startle)
- Zone of masking; the area around a noise source where the noise reduces detection of other sounds that are important to the animal
- zone of hearing loss, discomfort and injury; usually a small zone close to very loud sound source where the sound pressures are sufficiently high to inflict temporary or permanent damage to the animal.

The zones of responsiveness, masking and hearing loss, discomfort, and injury may best assess potential short-term and long-term negative impacts on a particular species.

7.1.1 Impact of the turbine noise on fish species

The noise frequency range of the tidal turbine in Kvalsund was about 2 kHz and below, with peak frequency lines between 70-326 Hz. The intensity of the sound at these peak frequency lines reaches about 20 dB above the ambient noise level at CPA (Closest Point of Approach), 30 – 50 m away from the turbine. Absolute values of SLP (Sound Level Pressure) was estimated to just above 100 dB re 1μPa, when reaching CPA.

The turbine noise frequency range overlaps with the bandwidths that the fish species in Kvalsund area are able to detect (Figure 28). Regarding cod (and probably saithe) the sound level pressure was above the detection limit in the bandwidth 40-400 Hz, predicting that these species may hear the turbine noise well. Any behavior reactions to the sound (i.e. attraction, evasion, startle) or masking of other sounds relevant to individuals (co-specific communication, preys, predators), may not be ruled out. However, the background noise level in Kvalsund was also high for the relevant bandwidths and may have resulted in a masking of the noise from the turbine. Salmon seems to be nearly insensitive for the turbine noise regarding the bandwidths of peak frequency lines (70-326 Hz; Figure 28).

No conclusion can be given for frequencies below 20 Hz, both due to lack of research data on hearing thresholds and the fact that ambient noise is dominating the measurements at these low frequencies.

It is to mention that the turbine is working intermittently, with long breaks between the active periods. At the time of measuring, the period of impact was about 4 hours, and the "silent" or "calm" period lasted for about 2 hours (see chapter 1.2).

There have been very few studies on the effect of anthropogenic sound on the behavior of fish, and nothing at all is known about the long-term effects of exposure to sound on fish behavior. The concern for effects on behavior is how a fish will respond when it is in the wild and perhaps on its feeding site or at a breeding location (Popper and Hatings, 2009). However, the fact that a fish can detect a sound does not necessarily mean that it will react to it. In many species, a certain sound pressure level needs to be reached before the behavior is affected, and some fish species do not show startle response to sound no matter how loud they are. Thus, as well as on the spectrum and level of anthropogenic sound, the reactions of fish probably also depend on the context (e.g. location, temperature, physiological state, age, body size, and school size). (Kastelein et al., 2008).

The intensity of the sound generated by the turbine in Kvalsund is of no concern regarding possible physiological effects like hearing loss or injury of any kind to the fish species in the area (Popper and Hatings, 2009; Kastelein et al., 2008).

7.1.2 Impact of the turbine noise on marine mammals

According to Figure 29 the harbor porpoise may hear the noise of the turbine in the bandwidth 250 – 2000 Hz. The hearing threshold bandwidth of the killer whale overlaps with the noise from the turbine, and the species may hear noise in the bandwidth 1000 – 2000 Hz. Audiogram data for harbour porpoise, killer whale and white-beaked dolphin are measured for frequencies down to 250 Hz, 1000 Hz and 16000 Hz, respectively. No conclusions may be given for hearing thresholds for the species, below the respective minimum frequencies.

For higher frequencies in the bandwidth 5 - 22 kHz, the white noise from the measuring equipment is dominant to the hearing thresholds, and again it is difficult to determine whether the harbour porpoise or killer whale may hear the turbine.

According to Figure 30, the harbor seal is able to hear the turbine noise in the bandwidth 200 Hz and upwards. It is difficult to tell the upper limit, as white noise from the measuring equipment is masking the possible turbine noise at frequencies higher than about 5 kHz (see chapter 3.2). There is no audiogram data found for the harbor seal for frequencies below 200 Hz. Figure 30 also reveals that the grey seal is likely to be unaffected by the noise from the tidal turbine at frequencies above 1 kHz.
Tougaard and Damgaard Henriksen (2009) measured the underwater noise from three types of offshore wind turbines, and estimated the impact zones for harbor porpoise and harbor seal. The turbine noise frequency range and sound pressure levels, as well as the background noise levels, were in the same range as measured in this current study from Kvalsund. They estimated the zone of audibility for harbour seal and harbour porpoise to be <10 km and <80 meters, respectively. Further, regarding the zones of responsiveness, masking and hearing loss, discomfort, and injury, the authors estimated the impact of the noise generated by the turbines as insignificant due to the poor hearing capabilities of the animals within the turbine noise frequency range, lack of overlap between animal vocalisation frequencies and those of the turbine noise, and an overall low sound pressure level compared to what is known to induce hearing loss- or damage in marine mammals.

8 References

Chapman, C.J., Sand, O. 1974. Field studies of hearing in two species of flatfish, *Pleuronectes platessa* and *Limanda limanda*. Comparative Biochemistry and Physiology 47A, 371-385

Colwell, H.C., 2009. PhysicsLab online. http://dev.physicslab.org/Document.aspx?doctype=3&filename=WavesSound_IntroSound.xml

Harwood, J., Wilson, B. 2001.The implications of developments on the Atlantic Frontier for marine mammals. Continental Shelf Research 21, 1073–1093

Hawkins, A.D., Johnstone A.D.F. 1978. The hearing of the Atlantic Salmon, *Salmo salar*. Journal of Fish Biology 13, 655-673

Kastelein, R.A., Bunskoek, P., Hagedoorn, M., Au, W.W.L., de Haan, D. 2002. Audiogram of a harbor porpoise (*Phocoena phocoena*) measured with narrowband frequency-modulated signals. Journal of the Acoustical Society of America 112, 334–344

Kastelein, R.A., van der Heul S., Verboom, W.C. Jennings, N., van der Veen, J., de Haan, D. 2008. Startle response of captive North Sea fish species to underwater tones between 0.1 and 64 kHz. Marine Environmental Research 65, 369–377

Kastelein, R.A., Wensveen, P., Hoek, L. 2009. Underwater hearing sensitivity of harbor seals (*Phoca vitulina*) for narrow noise bands between 0.2 and 80 kHz. Journal of the Acoustical Society of America 126, 476-483

Knudsen, F.R., Enger, P.S., Sand, O. 1992. Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fish Biology 40, 523–534.

Knudsen, F.R., Enger, P.S., Sand, O. 1994. Avoidance responses to low frequency sound in downstream migrating Atlantic salmon smolt, *Salmo salar*. Journal of Fish Biology 45, 227–233.

Mann, D.A., Wilson, C.D., Song, J., Popper, A.N. 2009. Hearing Sensitivity of the Walleye Pollock. Transactions of the American Fisheries Society 138, 1000–1008

Nachtigall, P.E., Mooney, T.A., Taylor, K.A., Miller, L., A Rasmussen, M.H., Akamatsu, T., Teilmann, J., Linnenschmidt, M., Vikingsson, G.A. 2008. Shipboard measurements of the hearing of the white-beaked dolphin *Lagenorhynchus albirostris*. Journal of Experimental Biology 211(4), 642-647

Nedwell, J.R., Brooker, A.G. 2008. Measurement and assessment of background underwater noise and its comparison with noise from pin pile drilling operations during installation of the SeaGen tidal turbine device, Strangford Lough. Subacoustech Report No. 724R0120 to COWRIE Ltd. ISBN: 978-0-9557501-9-9

Popper, A.N., Hastings, M.C. 2009. The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology **75**, 455–489

Richardson, W.J., Greene, C.R., Jr., Malme, C.I., and Thomson, D.H. 1995. Marine mammals and noise. Academic Press, New York.

Sand, O., Karlsen, H.E. 1986. Detection of infrasound by Atlantic cod. Journal of Experimental Biology 125 (1), 197-204

Strømme, H.O. 2009. Personal comments.

Szymanski, M.D., Bain, D.E., Kiehl, K., Pennington, S., Wong, S., Henry, K.R. 1999. ‘‘Killer whale (*Orcinus orca*) hearing: Auditory brainstem response and behavioral audiograms’’. Journal of the Acoustical Society of America 84, 936–940

Tougaard, J., Henriksen, O.D. 2009 Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. Journal of the Acoustical Society of America 125 (6), 3766-3773

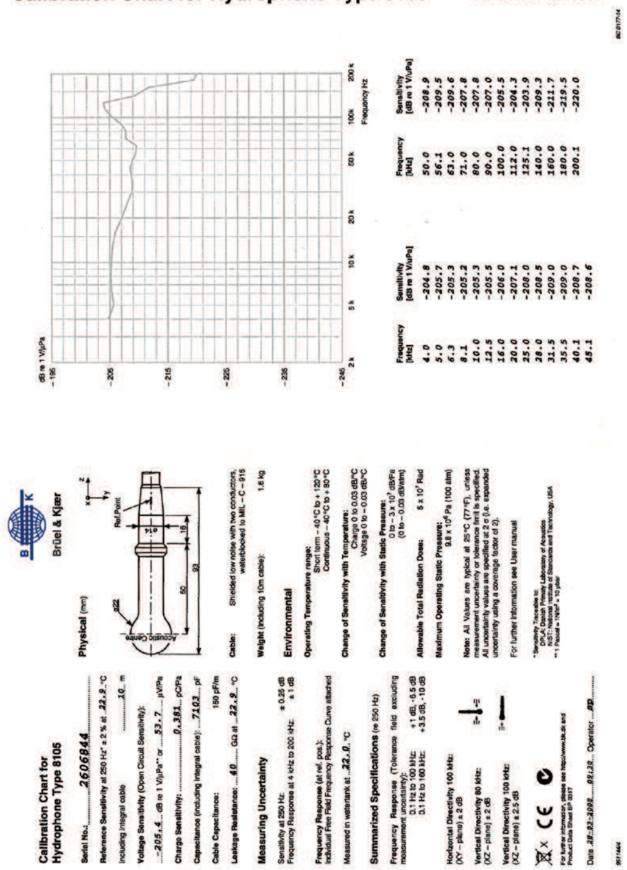
Trannum, H.C., Pedersen, G., Dahl-Hansen, G.A., Systad, G. 2002. Konsekvensvurdering av vannkraftanlegg i Kvalsundet. Delprosjekt 1. Miljøkonsekvenser av pilotanlegg. Akvaplan-niva rapport no. 2268.1. 29 sider.

Weilgart, L.S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85, 1091–1116.

Appendix

A. Calibration sheet, hydrophone 8105

Calibration Chart for Hydrophone Type 8105 **Serial No.:** *2606844*



B. Calibration certificate, pre-amplifier, Nexus 2690

Brüel & Kjær
The Calibration Laboratory
Skodsborgvej 307, DK-2850 Nærum, Denmark

DANAK CAL Reg nr. 307

CERTIFICATE OF CALIBRATION No.: C0908305 Page 1 of 7

CALIBRATION OF:

Conditioning Amplifier:	2690	No:	2192429
Identification:		Date of receipt:	2009-10-01

CUSTOMER:

Akvaplan-niva AS
Hjalmar Johansensgt. 14
9007 TROMSØ
Norway

CALIBRATION CONDITIONS:

Preconditioning:	4 hours at 23° C ± 3° C		
Environment conditions:	Air Temperature:	23° C	± 3° C
	Air Pressure:	101.3 kPa	± 5 kPa
	Relative Humidity:	50 % RH	± 25 % RH

PROCEDURE:

The instrument has been calibrated in accordance with the requirements as specified by vendor, using Calibration Procedure No. P_2690_A09.

RESULTS:

- [ ] Initial calibration
- [ ] Calibration prior to repair/adjustment
- [x] Calibration without repair/adjustment
- [ ] Calibration after repair/adjustment

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with EA-4/02. Measurements marked with an asterisk (*) are outside our range of accreditation.

Date of Calibration: 2009-10-06 Certificate issued: 2009-10-06

Are Fynn Nordeng
Calibration Technician

Morten Høngaard Hansen
Approved signatory

Reproduction of the complete certificate is allowed. Parts of the certificate may only be reproduced after written permission.

C. Software verification/calibration, Sea_noise9

In order to verify and calibrate the FFT and 1/3-octave evaluation program sea_noise9, two different synthetic test signal were generated. In the first test, random Gaussian noise was generated by Matlab and stored in a wav-file. The actual hydrophone response was replaced by a flat curve. The resulting 1/3-octave spectrum is shown in Figure 31. The fluctuations at lower frequencies can be explained as the result of a low time/bandwidth product.

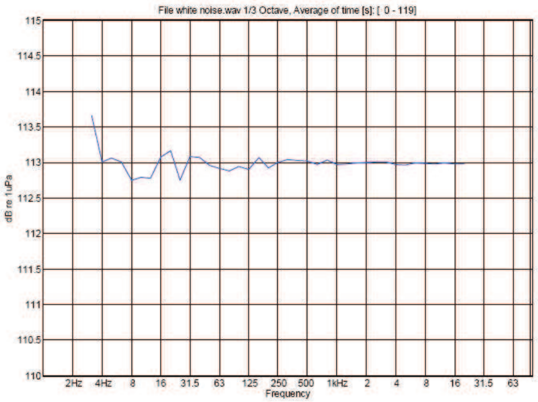


Figure 31: 1/3-octave test, Gaussian white noise

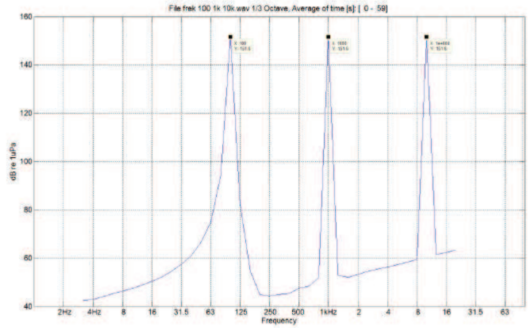


Figure 32: 1/3-octave analysis of a 100 Hz+1 kHz+10 kHz test signal

In Figure 32, a synthetic test signal consisting of three sine wave signal were generated by Matlab and stored in a wav file. The flat hydrophone response was used also in this test case. Each of the sine waves has an amplitude of 0.1V rms. The Nexus gain settings in the program was set to a value of 100µV, corresponding to a gain value of 200 dB.

The expected value from the 1/3 Octave analysis should be as follows.

$$SPL = Signal\ level - TF - Nexus\ gain$$

$$SPL = 20 * log\mathbf{10}(\mathbf{0.1}) - 28.37 - (-200) = 151.\mathbf{6}dB$$

The calculated value matches the computed values in Figure 32. Based on these two tests the evaluation program Sea_noise9 is considered calibrated.

D. Software evaluation tool description

The software tool *sea_noise9* used for this measurement is developed with Matlab R2009. All user interactions are entered via a graphic user interface (GUI), see Figure 33, and exist in a compiled version. The program runs using a runtime version of Matlab, without the need for a separate Matlab license. The normal sequences for operating the program are as follows. The hydrophone/system correction curve is loaded into the program. The digitized time data is loaded from file. Based on the time data, the program calculates two different matrices, one for FFT data and a second one for 1/3-octave spectra. Each matrix has frequency along the first axis, and time along second axis. The FFT frequency bin resolution is 1.46 Hz, and 75% time overlap between successive FFTs is used throughout.

Based on the information contained in these two matrixes, the operator can perform post processing in the form of averaging over different data sub-sets of interest. For the 1/3-octave spectra, the operator can select between spectral levels, i.e. dividing the measured SPL in each of the 1/3-octave filters by the corresponding bandwidth, or the SPL measured in each of the filter.

The centre frequencies (in Hz) for the 1/3-octave filters used can be expressed as:

$f_n = 10^{\frac{n}{10}}$, where n is the 1/3-octave frequency index, running from 5 to 43, corresponding to center frequencies from 3.15 Hz to 20 kHz.

The corresponding upper and lower frequency limits for each filter can be expressed as.

$$f_{n,lower} = f_n \cdot 10^{-\frac{1}{20}}$$

$$f_{n,upper} = f_n \cdot 10^{\frac{1}{20}}$$

In addition the program has a section for selecting the gain setting for the Nexus preamplifier and system gain TF. The program can also perform a range correction, based on spherical spreading: 20 log(r), or a user specified correction in dB.

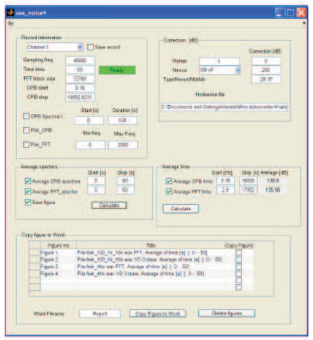


Figure 33: Sea_Noise9 GUI

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 12 – Anadromous Fish

Appendix 12.1: “Salmonid Habitat Survey”

Sound of Islay Demonstration Tidal Array
Salmonid Habitat Survey

ScottishPower Renewables

Technical Report
9T3474

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Document title	Sound of Islay Demonstration Tidal Array Salmonid Habitat Survey
Document short title	Sound of Islay Salmonid Habitat Survey
Status	Technical report
Date	24 February 2010
Project name	Sound of Islay Demonstration Tidal Array
Project number	9T3474
Client	ScottishPower Renewables
Reference	9T3474/R/303628/Edin

Drafted by	Joanna Girvan	
Checked by	Jen Trendall	
Date/initials check	....	....
Approved by		
Date/initials approval	....	....

SUMMARY

A salmonid habitat survey was carried out on five rivers and burns located on the Jura and Islay coasts of the Sound of Islay on the 19th and 20th of January 2010. The results of the survey showed that impassable barriers are likely to prevent the watercourses from being suitable for salmonid spawning. One river had a series of partial barriers through which some upstream penetration by large-bodied salmon may still be possible. However, the cumulative effect of the series of barriers along with the limited availability of spawning habitat suggests that utilisation of the river by salmonids is likely to be minimal.

The main finding of the survey is therefore:

- It is unlikely that any of the surveyed watercourses are accessible by salmonids. The largest river was the most penetrable, but a long series of partial barriers to migration is likely to discourage salmonid migration.

During the salmonid habitat survey, otter spraints and potential holts were also recorded. These have been discussed within this report.

CONTENTS

1 INTRODUCTION

ScottishPower Renewables commissioned Royal Haskoning UK Ltd to carry out salmonid habitat surveys at four river/burn sites on the west coast of Jura and one burn on the east coast of Islay within the vicinity of the Sound of Islay Demonstration Tidal Array. The five river sites are shown on Figure 1 and are listed below:

1. Abhainn an Daimh-sgeir;
2. Mucraidh Burn 2;
3. Mucraidh Brun 1;
4. Abhainn Mhor; and
5. Sruthan na Traighe Baine (at existing cable landfall site on Islay).

The main onshore study site associated with the project is outlined in red. Not all of the surveyed watercourses fall within the main boundary of the study site. The data generated by this survey will be used to contribute to the baseline information of the Environmental Impact Assessment for the proposed development. The information will also be used to establish opportunities for mitigation or enhancement that could arise as a consequence of the development.

1.1 Existing baseline

The coastline in the vicinity of the Sound of Islay Demonstration Tidal Array is generally very steep and is dominated by wet heath and marshy grassland. The five target watercourses are situated in steep sided ravines of varying sizes, with high gradients and heavily peat-stained water.

Salmonids have not been recorded in any of the five target rivers. The map of ‘The Distribution in Scottish Rivers of Atlantic salmon (*Salmo salar* L.)’ (Gardiner & Egglishaw, 1986) shows that the closest recorded salmon rivers are located approximately 3km to the north of the footprint on Jura and Islay. These are the Abhainn na Uainaire on Jura and the Abhainn Araig on Islay and they are the only recorded salmon rivers in the vicinity of the Sound of Islay. Brown trout are also present in the Jura river and the freshwater loch upstream [http://www.trout-salmon-fishing.com/] (Accessed 23rd March 2010).

2 SALMONID HABITAT SURVEY

Two rivers and two burns located on the west coast of Jura were included in the survey, along with one burn on the east coast of Islay (see Figure 1). On Jura, the two rivers were Abhainn an Daimh-sgeir (NR441667) and Abhainn Mhor (NR442680), and the 2 streams were at Mucraidh (NR450655). The Islay stream was Sruthan na Traighe Baine located at the current cable landfall site (NR429653).

2.1 Survey Methodology

The survey was conducted to assess potential habitats for salmonids (Atlantic salmon and sea or brown trout, *Salmo trutta*) in the five target rivers on the 19th and 20th of January 2010.

Habitats were assessed by a walkover survey to:

- Map salmon habitats, particularly areas suitable for juveniles and spawning;
- Quantify the availability of salmon habitats; and
- Identify the location and nature of any obstacles to upstream migration.

Each river was surveyed from the point of entry to the sea in an upstream direction until the extent of the onshore study area was reached, or an impassable barrier for migratory fish was encountered.

Salmonid habitats were assessed using Environment Agency Salmon Habitat Mapping Guidelines (Hendry & Cragg-Hine, 1997). The riverine habitat was divided into the following categories: fry; mixed juvenile; deep juvenile; pool / slow deep glide (adult salmonid habitat); spawning; glide; and bedrock. Descriptions of the habitat types are given in Table 1.

The habitat data was recorded directly onto 1:5000 scale waterproof maps in the field. In addition, a handheld GPS was used to record locations of barriers and extents of each habitat type.

The area of each unit of habitat was estimated from measurements taken in the field. The summary of this data is shown in Table 2.

Table 1 Habitat types and descriptions used during the survey (Adapted from Hendry and Cragg-Hine, 1997)

Habitat Type	Description
Fry	Water depth of around 20 cm or less with surface turbulence and substrate dominated by pebbles and cobbles
Mixed juvenile	Deeper than fry (20 - 45 cm) with a substrate of predominantly cobble and boulder. Suitable fry habitat may also be present at the stream edges
Deep juvenile	Water over 40 cm deep with pebble, cobble and boulder substrate
Pool / slow deep glide	Slow, deep flow, usually > 1 m depth.
Spawning	Optimally, stable gravel that isn't compacted with a lattice of grain sizes in the size range of 16 mm to 256 mm, but with the majority of particles < 150 mm and a mean size of approximately 80 mm. Substrates < 2 mm should not exceed 20%. Water depth at least 15 cm but not > 75cm. Water velocities should be in the range of 30 - 70 cm/s.
Glide	Smooth flow with little surface turbulence. Small substrates dominated by cobbles and fine materials
Bedrock	Habitat dominated by sheets of bare rock unsuited to juvenile fish

3 RESULTS

3.1 Target River 1 – Abhainn an Daimh-sgeir

Upstream of the study area, the Abhainn an Daimh-sgeir runs through flat, open heathland, and is heavily peatstained. Approximately 1km from the coast, the river enters a very steep sided ravine that is primarily vegetated and rocky in places. The channel is approximately 3-4m wide, with an average depth of around 20cm between pools (Plate 1). The substrate consists of clean (silt free) boulders, cobbles and gravels providing plenty of suitable habitat for juvenile salmonids, but only some very limited areas of suitable spawning gravels.

The river within the study area is punctuated regularly by some partially and some completely impassable falls (Plate 2). The survey revealed that many of the falls were high (>3m), however, often the gradient was not vertical (<70°) and breaks were present halfway up, offering potential resting pools (Plate 3). This means that some of the falls may be partially passable by adult salmon. The falls generally had deep pools at the foot, and the flow was sufficient to support potential ascent by salmon.

The cumulative effect of the series of partial barriers is likely to reduce the likelihood that salmon are able to penetrate upstream to any great distance. In addition, very limited habitat is available for spawning, reducing further the chances of attempted upstream migration.

Plate 1 Shallow depth and heavy peat staining

Plate 2 Series of falls of varying height and gradient, within steep sided ravine

Plate 3 Low gradient falls with 2 breaks containing small pools – partially impassable

3.2 Target River 2 - Mucraidh Burn 1

The southernmost burn at Mucraidh flows across open heathland, within a small gully (Plate 6). At the stream’s mouth, the substrate is composed of pebbles and cobbles and is generally free of silt and fines. It is therefore technically suitable for salmonid spawning, particularly sea trout due to the small size of the gravels, although is likely to be too close to the mouth to be used in practise (Plate 5). The burn is cut off from the sea by a substantial drop in level across the pebble beach (Plate 4). The depth of the burn here is not sufficient to allow salmon or sea trout to enter the stream except possibly during the highest of tides. At the mouth, the channel is 30-50cm wide and 5-15cm deep. The small size of the burn, and its isolation from the sea, mean that it is unlikely to attract salmon or sea trout. Within 100m from the shore, an impassable vertical barrier is present, ensuring that the burn is definitely not available to salmonids upstream of this point.

Plate 4 Mouth of the burn across pebble beach

Plate 5 Gravel substrates in shallow water

Plate 6 Small shallow burn leading to impassable barrier upstream

3.3 Target River 3 - Mucraidh Burn 2

The northern most burn at Mucraidh has essentially the same character as the southern burn i.e. narrow, cut off from the sea by the pebble beach, suitable substrate, and with an impassable barrier within 100m of the shore. It is therefore not accessible to or suitable for salmonids (Plate 7). At the time of survey, the stream disappeared beneath the surface of the substrate while crossing the beach (Plate 8).

Plate 7 Upstream from the mouth of the burn

Plate 8 Burn passing under pebbles across the beach

3.4 Target River 4 – Abhainn Mhor

This river is located to the north of Abhainn an Daimh-sgeir, and is suitable as a salmonid spawning river in the stretch approaching the shore (Plate 9) i.e. it is fast flowing and contains clean substrate, with some areas suitable for spawning. However, within 150m of the shore, where the river emerges from a steep sided ravine, there is an impassable barrier in the form of a waterfall of approximately 5m in height (Plates 9 and 10). This barrier ensures that the river upstream is not available to salmonids for spawning or juvenile habitat.

Plate 9 View upstream from the new road bridge

Plate 10 Impassable barrier 150m upstream from mouth

3.5 Target River 5 – Sruthan na Traighe Baine

The small stream, Sruthan na Traighe Baine, at the current cable landfall site on the east coast of Islay is similar in nature to the Mucraidh burns on Jura. The stream is very narrow (<50cms) (Plate 11), but there is a large amount of clean gravel substrate that would potentially be suitable for sea trout spawning. There is a steep drop in gradient across the beach (Plate 12), so that the stream is unlikely to be accessible to salmonids except perhaps at very high water. There is an impassable waterfall less than 50m upstream, ensuring that the burn is not available to salmonids after this point.

Plate 11 Clean gravel substrates in shallow water

Plate 12 Upstream from the beach, leading to impassable barrier

3.6 Habitat quantification

For each of the target-rivers, each salmonid habitat category was quantified from the downstream point as far upstream as the first impassable barrier. In the case of the three small burns, this distance was less than 100m. Figures 2-5 show the distribution of each habitat type within the target watercourses, as well as the position of partial and impassable barriers to migration. The quantitative results are shown in Table 2 overleaf.

Table 2. Distribution of salmon habitats within each river

Target River	Site Name	Downstream Grid ref.	Length (m)	Ave wetted Width (m)	Wetted area of habitat (m^2) below first impassable barrier							Total wetted area (m^2)
					Fry	Mixed juvenile	Deep juvenile	Glide	Pool	Bedrock	Spawning	
1	**Abhainn an Daimh-sgeir**	NR44190 67275	4,582	3.5	-	2069	-	84	221	277	109	**2760**
2	**Mucraidh Burn 1**	NR44920 65325	619	0.4	32	-	-	-	-	-	-	**32**
3	**Mucraidh Burn 2**	NR44815 65555	653	0.4	36	-	-	-	-	-	-	**36**
4	**Abhainn Mhor**	NR44210 68010	5,626	3	-	315	-	-	-	-	105	**420**
5	**Sruthan na Traighe Baine**	NR42980 65390	782	0.3	57	-	-	-	-	-	-	**57**

3.7 Discussion

Abhainn an Daimh-sgeir and Abhainn Mhor retain some characteristics of good quality salmonid spawning rivers, e.g. shallow fast-flowing water; clean, silt-free gravel and cobble substrate. Both rivers contain habitat suitable for juveniles and small areas of spawning habitat in the marginal areas and at the exits from pools and glides. However, the steep gradient of the rivers, and the presence of numerous partial and complete barriers to migration ensure that most of the rivers are not generally available to salmonids. Abhainn an Daimh-sgeir is the most penetrable river and as a result, provides the largest amount of suitable juvenile habitat as well as a larger diversity of habitat types compared to the other target rivers. However, the cumulative effect of the series of partial barriers, and the low availability of spawning habitat before the barriers, is likely to significantly limit the use of the river for salmonid spawning.

The Mucraidh burns and Sruthan na Traighe Baine also contain barriers impenetrable to salmonids within 100m of the shore. The lowest reaches that may be penetrable at high tides contain habitat suitable for fry.

3.8 Other protected species – otters

Many otter signs were located during the salmonid habitat survey. It is already known that otters inhabit the area, however, some potentially important information was gained. At Mucraidh Burn 2, a well used latrine was found at a distance of around 15m from the burn, and approximately 200m upstream of the coastline (Plate 13). Many more fresh spraints were found next to the burn upstream of this point.

Small burns such as the Mucraidh Burn are generally used by females and cubs rather than males. In addition, breeding females are likely to spraint away from a breeding holt to avoid advertising its presence to other otters, particularly males. In this case, the latrine was approximately 15m from the burn. The potential for holts along the Mucraidh Burn is high as the channel is very secluded and overhung by peat and vegetation, as well as being full of numerous hidden holes. Therefore, there is a very strong likelihood that there could be a breeding holt on Mucraidh Burn 2.

Plate 13 Otter spraints by Mucraidh Burn 2

4 CONCLUSIONS

None of the surveyed watercourses are likely to be used to any great extent by salmonids for spawning due to the steep gradient and presence of barriers to migration. It is therefore judged that there will be a negligible impact upon salmonids within these watercourses during construction or operation of the proposed scheme.

5 REFERENCES

Gardiner, W. R. & Egglishaw, H. J. (1986) A Map of the Distribution in Scottish Rivers of the Atlantic Salmon, *Salmo salar* L. Scottish Fisheries Publication, Department of Agriculture and Fisheries for Scotland.

Hendry, K. & Cragg-Hine, D (1997) Restoration of Riverine Salmon Habitats – A Guidance Manual. Fisheries Technical Manual 4, Environment Agency Bristol.

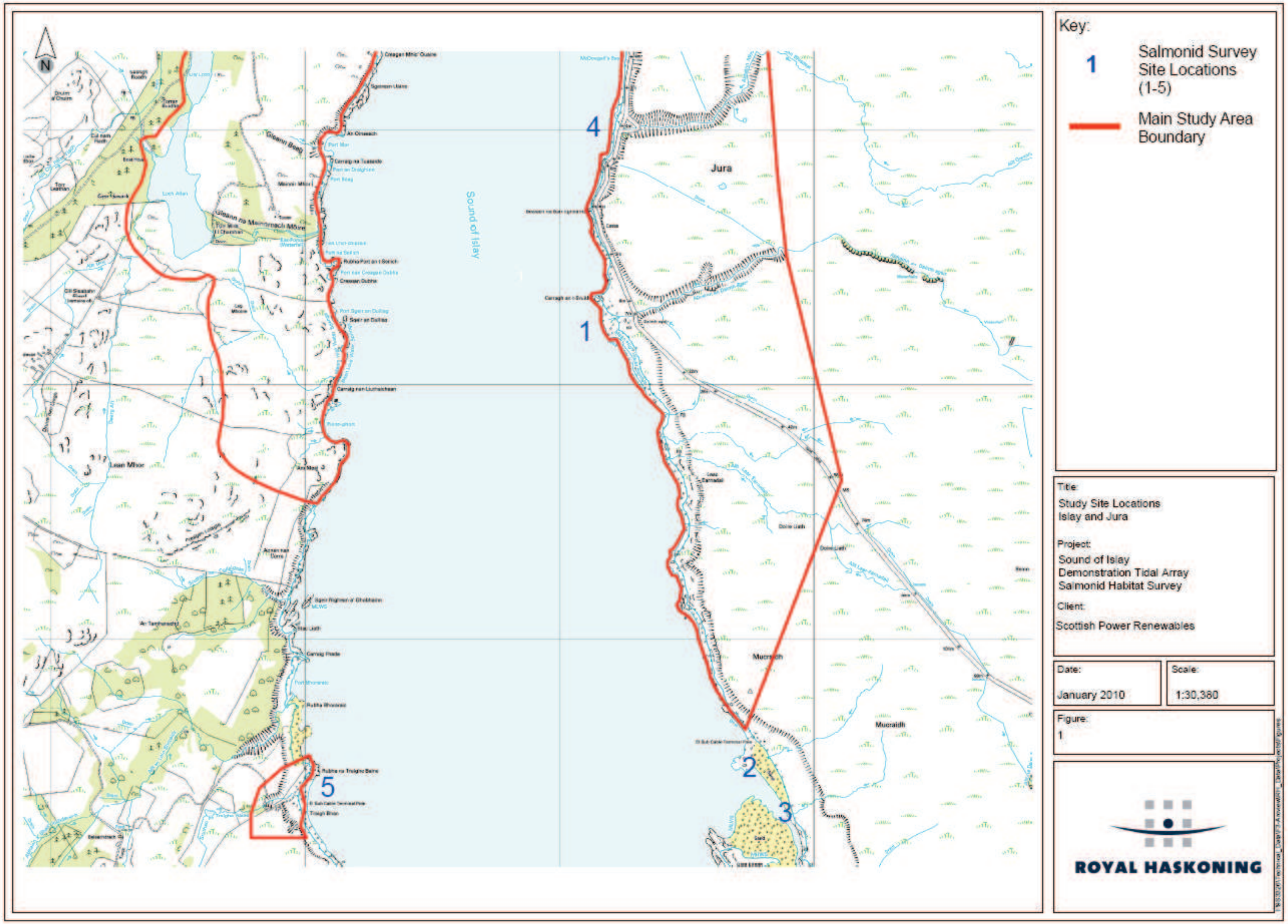
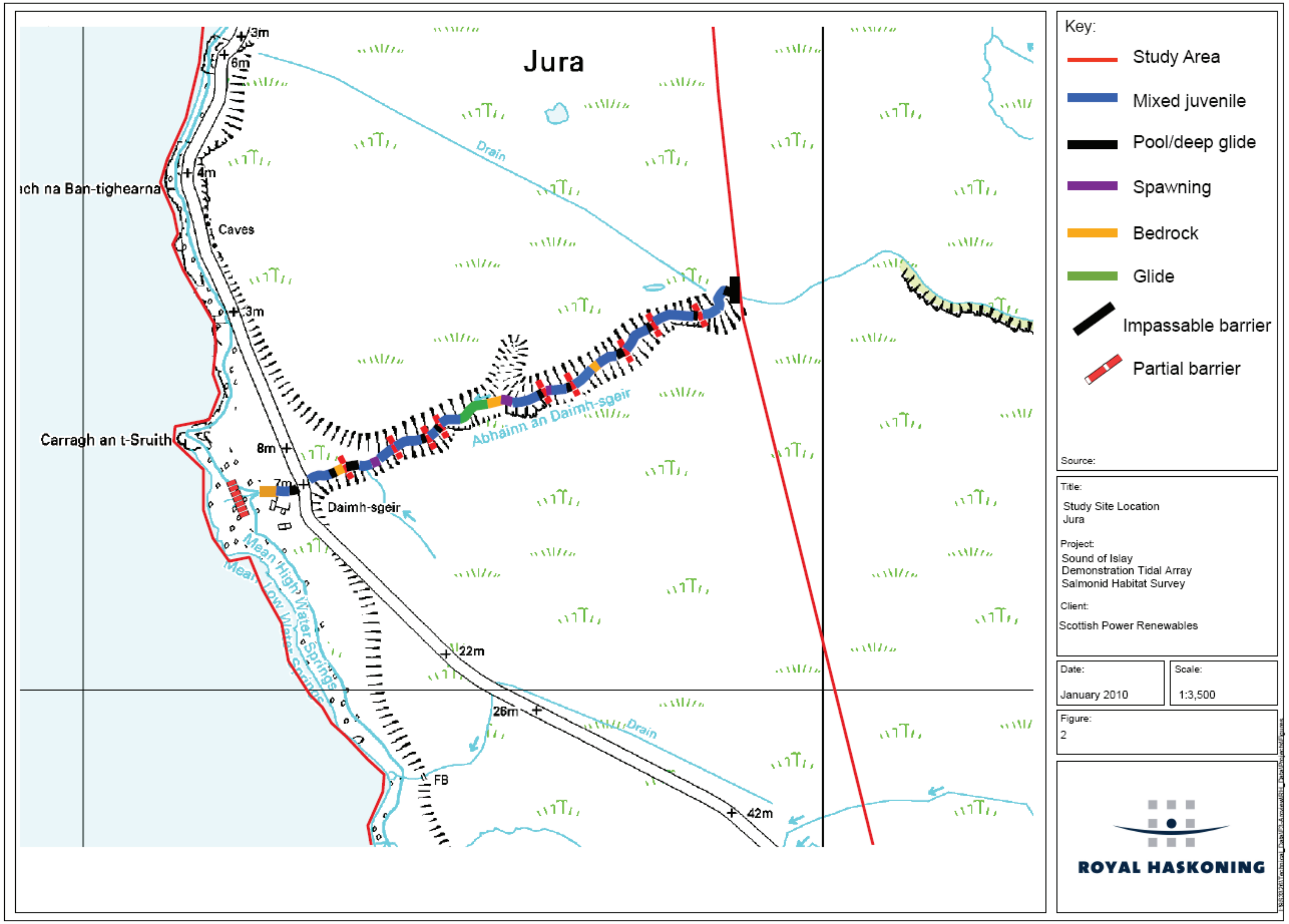
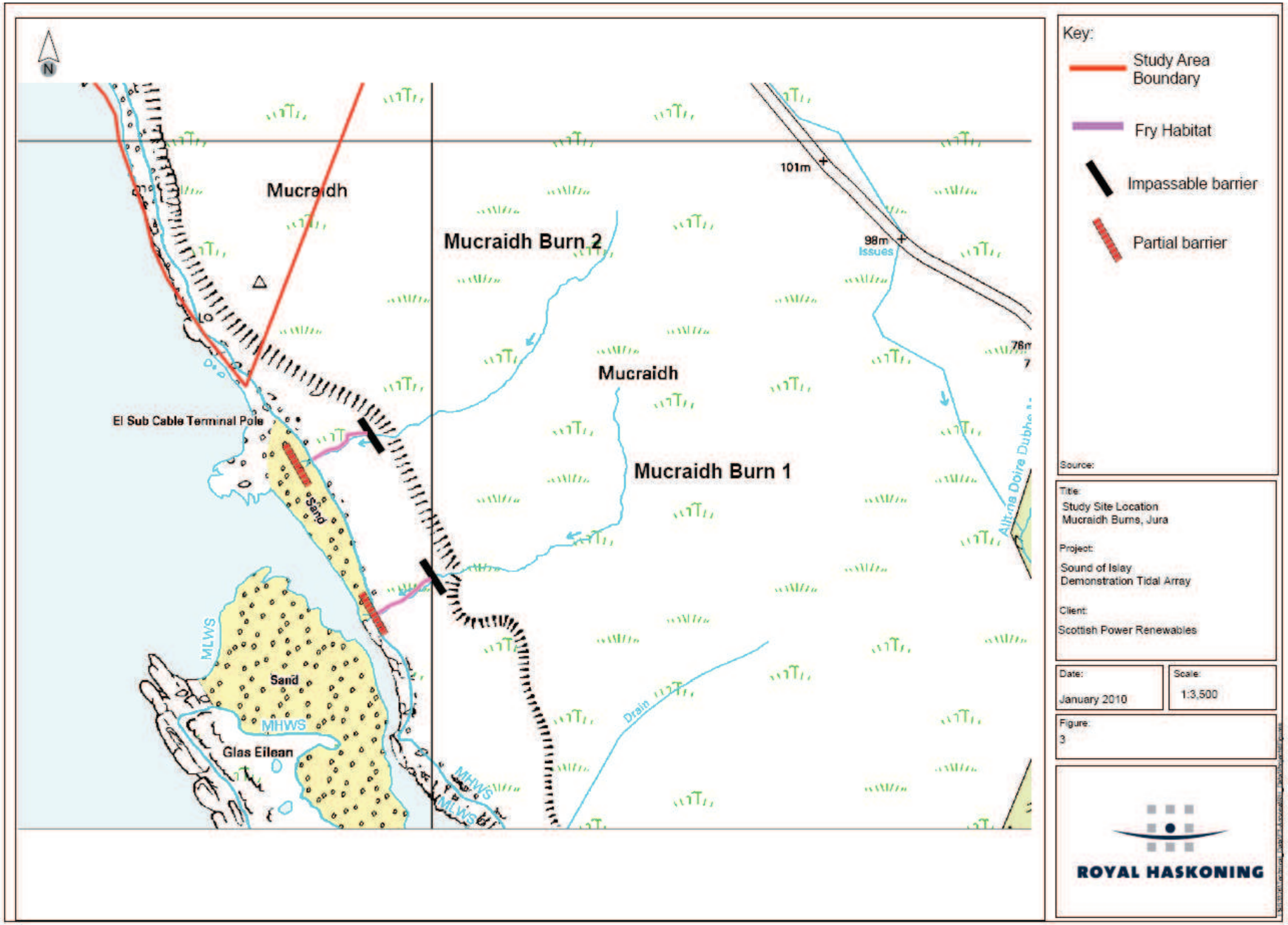


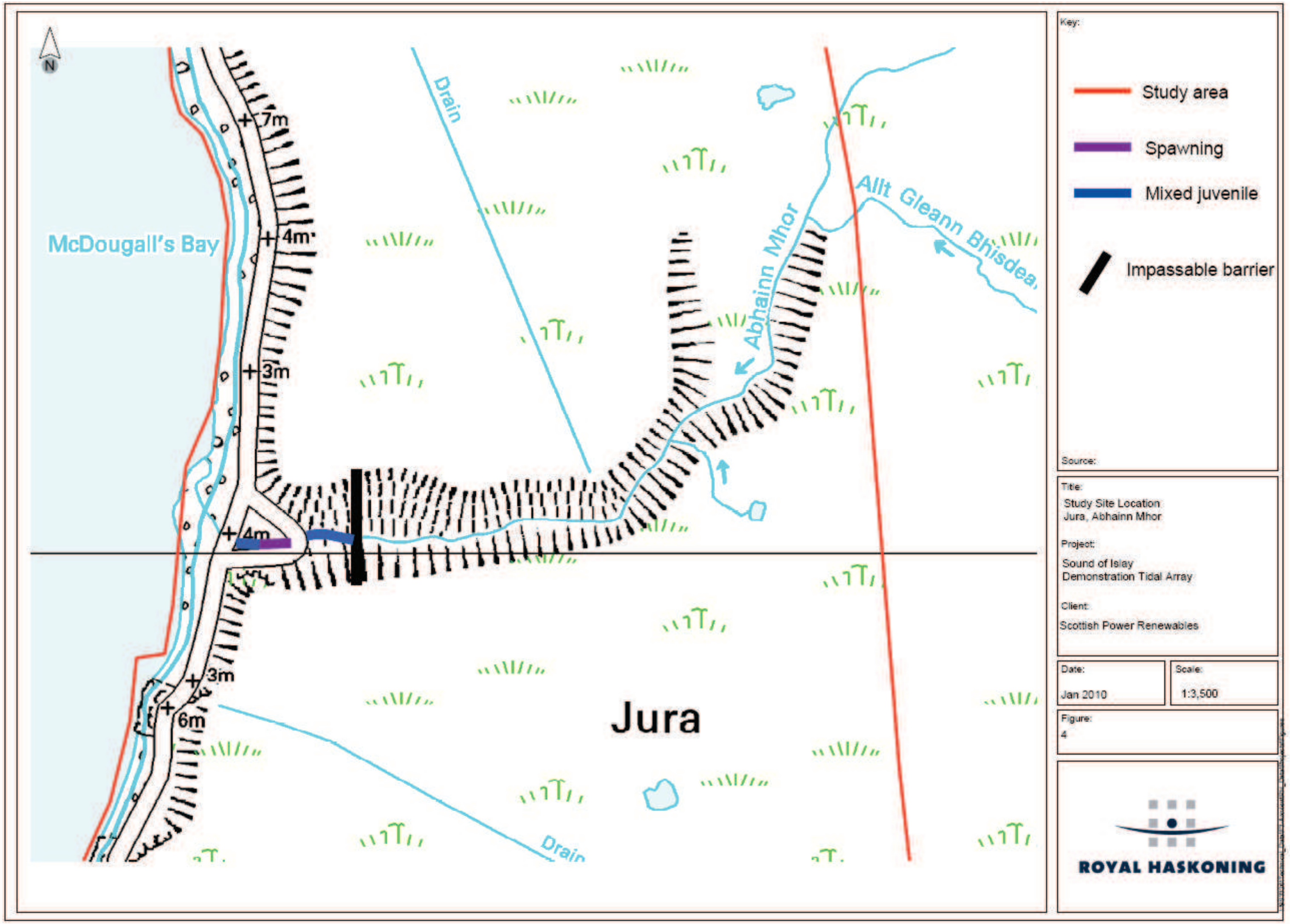
Figure 1 Locations of survey sites



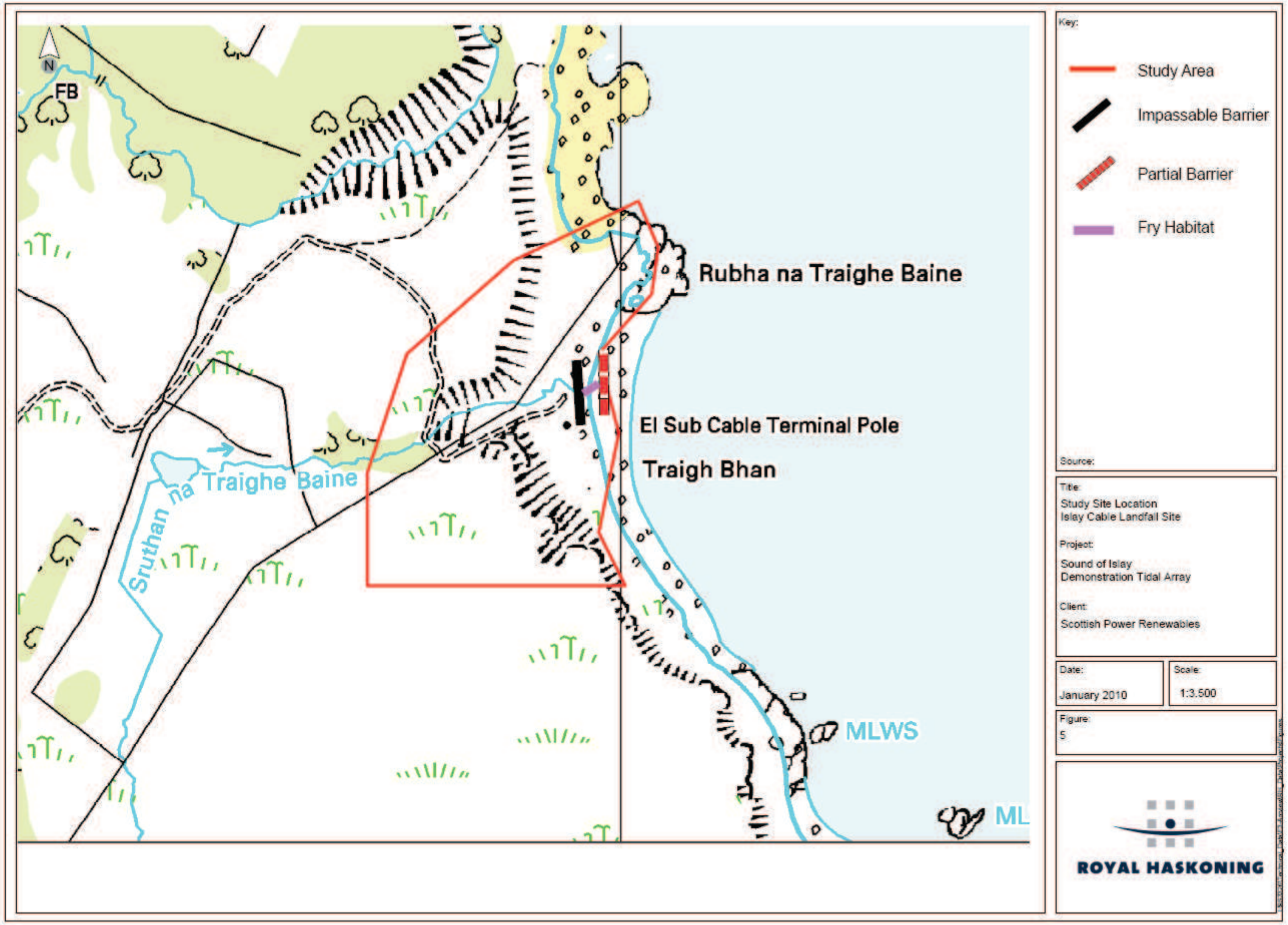
Figures 2 Distribution of habitat types within target watercourses



Figures 3 Distribution of habitat types within target watercourses



Figures 4 Distribution of habitat types within target watercourses



Figures 5 Distribution of habitat types within target watercourses

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 14 – Ornithology

Appendix 14.1: “Sound of Islay Bird Report: February 2010”

NATURAL RESEARCH PROJECTS LIMITED

SOUND OF ISLAY BIRD REPORT

February 2010

Digger Jackson
Simon Pinder

Photo credits: D.B. Jackson

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Sound of Islay Tidal Demonstration: Birds Technical Report

Introduction

1. This report presents the results of ornithological surveys undertaken by Natural Research Projects Ltd (NRP) during the 2009. The report provides a baseline resource for assessment of the potential effects of the proposed Sound of Islay Tidal Demonstration Site ("the Development") on birds.

2. The proposed demonstration site is located in the deepest part of the Sound of Islay, close to the ferry port of Port Askaig, and covers an area approximately 0.6 km^2 (Figures 1 and 2). The proposed development is for up to 20 submerged tidal stream-generating devices to be deployed on the site.

Overview of Habitats and Birds

3. The Sound of Islay is the ca. 20 km long, deep sea channel between the islands of Islay and Jura off the west coast of Scotland (Figure 1). The channel narrows to approximately 1 km wide for an eight km stretch in the inner, central part of the sound centred on Port Askaig. The proposed tidal demonstration site is in the southern part of the inner sound. The inner sound experiences strong tidal currents that create turbulence with upwellings and eddies. The strong tide flow has a major influence on the marine ecology resulting in conditions that are similar in many ways to highly exposed rocky coasts.

4. The marine benthic habitats, mostly tide swept rock and coarse sediment, provide habitat for a variety of fish, crustaceans and molluscs that are potential prey for diving seabirds, principally shag, eider and, auk and diver species. Other seabirds such as gulls, terns and gannet also feed in the sound targeting fish prey at or relatively close to the surface.

5. The coastlines of the sound comprise a mix of rocky shore, low cliffs and coarse shingle beaches (Photographs 1 to 4). There are also several small rivers entering the sea, particularly on the Jura side. The shorelines provide suitable foraging habitat for various waders and gulls, some of which breed in small numbers, and grey heron, mute swan and dabbling ducks. The sea cliffs are mostly on the Islay side north of Port Askaig and are up to 60m high. They provide nesting habitat for black guillemot, raven and peregrine, and roost sites for shag. On the Jura side, the habitat inland from the coast is almost entirely open blanket moorland and is used by a variety of moorland birds including eagle species, hen harrier and Arctic skua. On the Islay side there is a mix of marginal farmland, moorland, native woodland and conifer plantation. These provide suitable habitat for a range of woodland and farmland birds. The conifer woodland is also used by white-tailed eagles for roosting.

Consultations

6. Scottish Natural Heritage (SNH) and the Royal Society for the Protection of Birds (RSPB) were consulted by Scottish Power Renewables SPR with regard to their views on the Development and how it may affect birds.

7. In their Scoping Response to the Scottish Government (SNH 2008) Scottish Natural Heritage highlighted that some seabirds using the Sound of Islay, in particular by common guillemots, kittiwakes and razorbills, could originate from Special Protection Areas (SPA) breeding colonies. However they point out that the closest seabird SPA, North Colonsay and Western Cliffs SPA, is over 25 km away and is therefore unlikely to be regularly used by foraging seabirds from this colony.

8. In their Scoping Response to the Scottish Government (RSPB 2008) the Royal Society for the Protection of Birds identified black guillemot, common guillemot, razorbill, cormorant, shag, eider, common scoter, great northern diver and red-throated diver as species that use the Sound of Islay and that might be potentially affected at a local scale by the Development.

9. Dr. Beth Scott, an expert on tidal ecology, at Aberdeen University was consulted with regard to the study she undertook on the seabirds and marine mammals birds using the Sound of Islay in 2008. Dr. Scott provided information on the methods used and results from the 2008 study (Scott 2008), and helpful comments on the planned programme of field work.

10. Dr. Malcolm Ogilvie, a recognised expert on the ornithology of Islay, the director of the Islay Natural History Centre and a director of the Islay Energy Trust was consulted by NRP, with regard to previous bird survey data for the Sound of Islay. Dr. Ogilvie (email on 27 Jan 2009) explained that there were relatively few data available other than those obtained as part of the seabird 2000 surveys (Mitchell *et al* 2004). He made a copy of these data available to NRP. He also pointed out that the Sound of Islay was generally poor for shorebirds (waders and wildfowl) and that black guillemots were likely to be the most important seabird species likely to be affected by the proposed development.

11. No part of the development site lies within a site designated as a Special Protection Areas (SPA) or Site of Special Scientific Interest (SSSI). There are several SPAs and SSSIs designated for their bird populations on the islands of Islay, Jura, Colonsay and Oronsay (Table 1). In some cases individuals of the bird populations of interest at these sites may also use the Sound of Islay. Almost the whole of Jura, including the coast along the Sound of Islay, is a proposed SPA for golden eagles (Natura/SNH 2009). On Islay the closest SPAs are located at Bridgend Flats and Gruinart Flats, both are about 14 km away and are designated primarily for wintering geese. The closest seabird breeding colony designated as an SPA is the North Colonsay and Western Cliffs SPA on Colonsay. This is the nearest large seabird breeding colony to the Development and is approximately 30 km away, to the north. There is also a small seabird colony approximately 22 km to the west at Glac na Griche SSSI. This SSSI is contained within the Rinns of Islay SPA but the seabirds there do not form part of the qualifying interest of the SPA.

Scope of Studies

12. Survey work had two broad aims.
    - To determine baseline conditions required to assess the likely affects of the proposed development.
    - To establish baseline conditions against which any future changes can be compared.

13. Specific objectives were as follows:
    - Determine the year-round distribution and abundance of birds using the marine and shoreline habitats of the inner Sound of Islay
    - Determine the year-round distribution and abundance of seabirds using the outer Sound of Islay so far as this can be achieved by working from public ferries.
    - To determine which diving seabird species feed in the proposed development area and examine how their feeding behaviour is influenced by time of year, time of day and state of the tide.
    - To determine the presence and location of any breeding sites of scarce species of high conservation value.
    - To survey breeding black guillemots in the inner sound.

14. The field survey objectives and methods for marine mammals were developed in partnership with specialists at Sea Mammal Research Unit Ltd.

Survey Methods

15. Tidal turbine renewable energy developments are a novel technology. There is as yet no official guidance as to what ornithological survey work is required to inform the assessment of effects. Furthermore there are no previous commercial tidal turbine arrays in Scotland do draw experience or lessons from. For all these reasons the survey requirements and methods had to be developed largely from scratch. Where relevant, the survey guidance for windfarms, both onshore and offshore, was taken as a starting point (Camphuysen *et al* 2004).

16. Scarce birds were defined as species listed on Annex 1 of the EU Birds Directive and any species that are locally rare. Scarce birds included, eagle species, hen harrier, merlin, peregrine, diver species, tern species, chough and some geese species.

17. The field survey team comprised Digger Jackson, Simon Pinder and Fiona MacGillivray.

Pilot study

18. In February and April 2009 trials were undertaken to develop a suitable method to record the distribution and abundance of birds, marine mammals and sharks using the inner sound. The method needed to record to a high degree of spatial resolution as determining where animals were relative to the Development boundary and local bathymetry was important. The trials tested the use of sighting compass, laser rangefinder, clinometer and graduated compass

binoculars (i.e. fitted with a vertical graticule and a compass, Photos 5 and 6) as tools to aid determining the positions of animals. Of these, the graduated compass binoculars proved to be the best. Provided the exact position and height of the vantage point is known, an animal's position on the sea can be calculated with trigonometry using its bearing and angle of declination from the observer. The angle of declination was determined using the binoculars mounted dead level on a tripod with the aid of a 'levelling' video head (Photo 5). When set up in this way the eye-piece graticule effectively gives a measure of the angle of declination. This method of determining position was used for the VP surveys described below under VP watches. Having now gained over six months experience of using this positioning method it has proven to be practical way of recording to a high degree of resolution animals' positions.

VP watches

19. The survey work undertaken from VPs involved alternating short bouts of three survey activities:

    1. Snap-shot Scans
    2. Marine Mammal Watches
    3. Flying Bird Watches

20. These three activities were undertaken in a cycle that took approximately 50 minutes to complete. The cycle was: a 15-minute marine mammal watch, then a snap-shot scan (5-20 minutes), then a further 15-minute marine mammal watch and finally a 5-minute flying bird watch. Occasionally weather and daylight constraints caused some deviation from this regime. Prior to the review of survey methods in August 2009, a 35-minute cycle regime was used consisting of 15-minute marine mammal watch, a 15-minute snap-shot scan and a 5-minute flying bird watch.

21. The aim of the snap-shot scans was to provide a 'snap-shot' of the distribution and abundance of animals using the sea and shorelines. This involved methodically scanning the area of view with compass binoculars (either Bynolt Sea Ranger III or Bynolt Seabird) mounted level on a tripod and recording all birds, marine mammals (including otter) and basking sharks seen. Except for scarce species, flying birds seen during snapshot scans were ignored unless they were actively foraging. Snap-shot scans were not time limited, each scan took as long as necessary to make a complete 180° scan of the visible area and record the data. Normally a snap-shot scan took between 10 and 15 minutes to complete, the actual time depending on the number of animals present and the survey conditions. Care was taken to scan the visible area sufficiently slowly such that any birds that were actively diving were unlikely to be overlooked.

22. For each record, the species, number of individuals, age, plumage and behaviour were recorded using standard codes. If necessary, a x30 spotting scope was used to check species identification. Snap-shot scans were only conducted in conditions when birds were relatively easily visible. In practice this meant the surveys were not attempted before sunrise or after sunset, during heavy rain or if the sea surface over the majority of the visible area was greater than sea state 5. Up to several snap-shot scans were usually made from a VP on the same day with an interval of at least 45 minutes between scans. This was to allow time for animals to redistribute and promote independence between samples. During the

intervals between Snap-shot scans the surveyor undertook marine mammal watch and flying bird watch surveys

23. Marine mammal watches were timed 15-minute watches of the visible area for marine mammals and basking shark. Animals were recorded in the same way as for snap-shot scans. Any scarce bird species seen were also recorded but other birds were ignored. The marine mammal watches were designed to provide additional time to detect marine mammals and sharks (which are generally more easily overlooked than seabirds) and without the distraction of recording birds. Marine mammal watches were only conducted when conditions over most of the visible area were below sea state 4. Up to two 15-minute marine mammal watches were undertaken from a VP in an hour, separated by a short interval during which either snap-shot scan or flying bird watch surveys were usually undertaken.

24. Flying bird watches were timed 5-minute watches during which all flying birds passing a notional line across the sound, straight out from the VP, were recorded. The aim of the flying bird watches was to quantify the passage of birds flying through the sound and determine flight paths/timing of movements of locally breeding/wintering birds. The travel direction (usually north or south) and approximate distance from the VP (recorded as one of five distance bands) was recorded for each flight seen. Usually one 5-minute flying bird watch was completed in each hour of VP survey work.

25. Initially, (May 2009 to August 2009) the survey area was the whole of the inner sound, that is approximately from 2.5 km south of Port Askaig to approximately 3 km north, (Figure 2). This involved using seven VPs. Following a review of the methods in August 2009, the area regularly surveyed was reduced to the southern two thirds of this area, using 4 VPs. This allowed more frequent surveillance of the area where the development is proposed, something that SMRU Ltd advised was important for obtaining adequate measures of marine mammal occurrence. From September onwards, the distribution and abundance of birds in the northern half of the inner sound continued to be recorded three times per month to provide information on the number of birds typically present there.

26. A programme of VP watches was designed that aimed to give equal sampling effort with respect to tide series (neap *vs* spring), tidal cycle (6 periods per cycle) and day light hours. The sampling regime had to retain some flexibility to accommodate constraints caused by inclement weather and surveyor availability. After the August 2009 method review the aim was for each of the four southern VPs to receive a total of 12 hours of watch effort per month, equivalent to sixteen 45-minute survey cycles. The monthly survey effort was spread over 10-15 days each month. Prior to August 2009 the monthly effort per VP was lower as approximately similar effort was distributed across seven VPs.

27. The six tidal periods were equal portions (one sixth) of the tidal cycle (high tide to high tide). This meant that each period was of approximately two hours duration, the exact time depending on the actual length of the tidal cycle. Periods 1 to 3 covered the ebb part of the cycle, Period 1 commenced at high tide and Period 3 ended at low tide. Periods 4 to 6 covered the flow part of the cycle starting at low tide and ending at high tide. The start and end times of tidal periods was calculated from tide tables.

28. During VP watches the position of animals on the sea surface was recorded in terms of a compass direction and a binocular eye-piece graticule reading (to the nearest 0.1 unit) (Photo 6). The latter was later translated to an angle of

declination based on the angle subtended per graticule unit and landscape reference marks of known declination angle.

29. All ships and boats seen during the course VP survey work were recorded as requested by SPR. The type of vessel, the position in the channel, its activity and direction of travel were recorded. The vessel's name and registration code were also recorded if they were discernible.

Coastal walkover surveys

30. The coasts either side of the inner sound were walked periodically to check for the presence of scarce bird species and signs of breeding (Figure 2). Other land within 1 km of the Development site was also checked periodically, usually on the same occasions (Figure 2). Particular attention was paid to sections of cliff suitable for nesting raptors, and areas suitable for feeding shorebirds and geese. Otter signs were also recorded. Walkover visits were made in February, April, June, August and November 2009.

Black Guillemot Survey

31. On April 3rd and 4th 2009 early morning pre-breeding surveys were made of the coasts either side of the inner sound to count black guillemots as described in Mitchell *et al* (2004). In calm conditions at this time of year, breeding birds gather on the water below breeding sites early in the morning to display and are relatively easily counted. Counts were made with the aid of binoculars and spotting scope from suitable vantage points along the coast that between them gave complete coverage. All black guillemots seen on the land and on the sea within 300m of the shore were assumed to be breeding birds (Mitchell et al 2004).

Ferry Surveys

32. Surveys of seabirds, marine mammals and basking shark were conducted from the CalMac ferry routes using the European Seabirds at Sea (ESAS) survey method (Webb & Durinck 1992) modified slightly to improve the chances of seeing marine mammals. The modification involved the observer additionally scanning forward (beyond 300m) as used in the SCANS method (SCANS-II 2008). Surveys were conducted from the forward facing observation deck, about 11 m above sea level. Surveys were not conducted in persistent conditions above sea state 5.

33. The ferry route from West Loch Tarbert (Kennacraig ferry terminal) on the Scottish Mainland to Port Askaig was surveyed by a single ESAS accredited surveyor (S. Pinder) approximately twice monthly through the year. This route includes the whole of the southern parts of the Sound of Islay, including the Development site, and the southern end of the Sound of Jura (Figure 1).

34. The ferry route from Port Askaig to Colonsay was surveyed monthly from May to October (this service does not operate in the winter) by a single ESAS accredited surveyor (S Pinder). Surveys were conducted as a day-trip from Islay, surveying on the outward and return legs, day light and sea state permitting. This ferry route covers the whole of the northern part of the Sound of Islay and the approximately 10-km wide stretch of sea between Colonsay from Islay.

Results

35. At the time of writing this report (December 2009) the collection of field data has not continued for a whole year. Apart from some data obtained in trial surveys in February and the black guillemot survey in April, there are no survey data for the period December to April.

36. For seabirds, the regional breeding population is defined as all birds breeding in Argyll and Bute. Regional population sizes are taken from the Seabird 2000 census (Mitchell *et al* 2004). The units used to express seabird population sizes vary between species in accordance with Mitchell *et al* (2004). The units used include: pairs, individuals, apparently occupied nests (AONs), apparently occupied territories (AOTs) and apparently occupied sites (AOSs).

37. As explained in the Methods, the VP survey effort in the northern part of the inner sound was reduced following the review of survey work in August 2009. The summary information presented for each species primarily concerns the southern two-thirds of the inner sound, i.e. the area within approximately 1 km of the four southern VPs (Figure 2). This area extends from 1 km north of Port Askaig to 3 km south of Port Askaig. Information on birds using the more northerly part of the inner sound is presented only where it substantially adds to the account of a species.

38. A total 401 snap-shot scans were completed (Table 2). The snap-shot scan effort at each of the four southern VPs was similar (mean 89.2 Snap-shot scans each) and was approximately five times that at the three northerly VPs (Table 2).

39. Data on the numbers of birds seen during Snap-shot scans is summarised by season as follows, spring, May and June; summer, July and August; autumn, September and October; and winter, November and February (Table 3). The mean instantaneous density of seabirds seen on the sea in snap-shot scans each season was calculated to give an absolute measure of seabird average densities. In doing this records estimated (by trigonometry) to be more than 750 m from VPs were excluded. This was to prevent any bias caused by possible under recording of birds beyond 750 m away, something that surveyors considered likely, especially when survey conditions were sub-ideal. (When survey conditions were ideal even birds up to over 1 km away were easily seen and very unlikely to be overlooked).

40. The position of a birds seen on the water during snap-shot scans was calculated from the angle of declination and bearing from the VP. The accuracy that the distance to a bird can be estimated by this method declines with increasing distance from the VP because at longer distances even a small error in the angle of declination translates to a relatively large change in distance.

41. Maps are presented for the diving species that show the distribution of birds in the inner sound recorded during snap-shot scans. In preparing these maps no attempt has been made to correct for effort differences between the VPs. When examining the maps the bias in favour of the southern two-thirds of the inner sound needs to be borne in mind.

42. A total of 356 5-minute flying bird watches were completed. The mean number completed at the four southern was 77.8) and was approximately five times that at the three northerly VPs (Table 4).

43. The mean number of birds flying through the sound per hour during each month was calculated for data from the 5-minute flying bird watches (Table 5).

44. The numbers of birds that were recorded as flying either in a northerly or southerly direction was also examined to provide evidence of any net passage through the sound.

45. The results on marine mammals, otter, sharks and boat traffic are reported elsewhere (SMRU 2010).

Auks

46. Three species of auk were seen throughout the year, namely black guillemot, common guillemot and razorbill. A little auk was also seen in the sound during westerly gales in November.

47. Black guillemots (also known as tysties) breed in the inner sound in moderate numbers. The pre-breeding black guillemot survey undertaken on the 3rd and 4th of April 2009 found a total of 66 individuals present close to suitable nesting habitat. Five other individuals, one in winter plumage, were also seen during the survey, all flying approximately mid channel. It is not known if these were breeding individuals but it is likely that some were. Bearing in mind also that some individuals may have been overlooked, the survey results suggest that at least 35 pairs breed in the inner sound. All the black guillemots located in the pre-breeding survey were on the Islay side on stretches of steep rocky shore or sea cliffs (Figure 3).

48. The number of black guillemots breeding in the inner sound represent about 2.3% of the regional (Argyll and Bute) population of 3046 individuals (Mitchell et al 2004). Argyll and Bute support about 7% of the Great Britain and Ireland breeding population (Mitchell et al 2004).

49. Black Guillemots were detected during snap-shot scan surveys through out the year and from all VPs. The distribution of birds on the water shows that black guillemots were seen throughout the inner sound but not evenly so (Figure 4). They were less common in the shallow parts, e.g. Whitefarland and Dougall's Bay, and along the route of the Islay-Jura ferry. The average density of black guillemots seen on the water was 1.4 birds km^{-2} in spring, 1.6 km^{-2} in summer, 0.3 km^{-2} in autumn and 0.4 km^{-2} in winter (Table 3).

50. Razorbill and guillemot showed a similar pattern of seasonal occurrence. These two species are difficult to distinguish at distance and 21% of records were identified as being either guillemot or razorbill. For the analyses, these have been proportioned on the basis of the ratio of individuals identified to species level in each season.

51. Common guillemots were commonly recorded on the sea during snap-shot scans of the inner sound in the summer and, to a lesser extent, autumn months. The numbers present were always small with none recorded on the majority of summer and autumn survey dates. When present, there was typically 1-2 (maximum 3) birds in the spring months and 1-4 (maximum 14) in the autumn months. The average density of guillemots the southern inner sound seen during snap-shot scans (i.e. recorded within 750 m of the four southern VPs) was 0.5 km^{-2} in summer, <0.1 km^{-2} in the other seasons. Guillemots were very scarce in spring and winter (Table 3).

52. The distribution of common guillemots on the sea (Figure 5) indicates that birds occurred throughout the inner sound but had a tendency to avoid both the shallowest and deepest parts.

53. Few common guillemots were observed in the flying bird watches (Table 5). The only month when they were commonly seen was May, when there was an average of 5.7 birds hour $^{-1}$ passing through the sound, all but one of the individuals seen was flying south.

54. Razorbills were recorded on the sea during snap-shot scans much more frequently than common guillemots, especially in the summer months, when they were nearly six times more numerous. No razorbills were records in snap-shot scans in May to late July, or in October. From late July to the end of August they were recorded in moderate numbers on all survey dates. These late summer records mostly composed adults with attendant dependent young. Typically the numbers present in the inner sound in the late summer was 5-15 but there were at least 90 birds present on 18th August and at least 40 on the 30th August. Razorbills were recorded in low numbers through September when typically 1-4 birds were present in the inner sound.

55. The average density of razorbills seen on the water was 2.8 birds km^{-2} in summer, 0.2 km^{-2} in autumn and 0.5 km^{-2} in winter (Table 3). The numbers of razorbills recorded in the inner sound are small in comparison to the regional population of 9,056 individuals (Mitchell et al 2004).

56. The distribution of razorbill on the sea (Figure 5) indicates that birds occurred throughout the inner sound but had a tendency to avoid both the shallowest and deepest parts.

57. Razorbills were recorded in flying bird watches in all months from May to September. On average in these months 0.6 birds hour $^{-1}$ passed by, but in August and September the rate was greater at 0.9 birds hour $^{-1}$ (Table 5). Over three quarters of the birds seen on flying bird watches in August and September were flying south.

Divers

58. Red-throated divers were recorded in small numbers through out the year, especially in the spring and summer months. However, they were not seen on most survey dates suggesting that birds were not present in the inner sound most of the time. When they were present they occurred as singles or a pair, and the maximum number present was never more than three birds.

59. The birds present in the summer are local breeding birds that visit the sound to feed. These birds were seen flying from central Jura where it was presumed there was a lochan on which the birds were breeding I. The estimated population size for Argyll is about 80 pairs (Forrester and Andrews 2007). Red-throated diver is listed on Annex 1 of the EU Birds Directive.

60. The distribution of red-throated divers on the sea (Figure 6) indicates that birds occurred throughout the inner sound but had a tendency to avoid the deeper parts. The average density recorded in the summer months was 0.07 bird km^{2} and approximately 0.02 birds km^{2}, or less, in the other seasons (Table 3).

61. Red-throated divers were seen during flying bird watches in all months from May to September (Table 5) on average there were 0.5 birds hour $^{-1}$ passed by. It is likely that the most of these flights were by locally breeding birds visiting the sound to feed.

62. Great northern divers were recorded on the sea in small numbers in spring, autumn and winter. In the spring and autumn months they were recorded on only a few survey dates suggesting that these were passage birds making brief visits.

The maximum numbers present in the inner sound in these months was just one or two individuals. The few data available for the winter (February) indicate that approximately 2-4 birds over-winter in the inner sound. The numbers using the inner sound of Islay is small compared to the numbers over-wintering in West Scotland (approximately 2000-3000) (Forrester and Andrews 2007). Great northern diver is listed on Annex 1 of the EU Birds Directive.

63. The average density of great northern divers recorded in the spring months was 0.06 bird km^2 and 0.54 birds km^2 in winter (Table 3).

64. The distribution of great northern divers on the sea (Figure 6) indicates that birds tended to occur in the shallower areas, mainly on the Jura side of the sound.

65. No great northern divers were recorded in the flying bird watches undertaken from May – November. Nine singles were seen flying through the sound during the course of other fieldwork, in May (1 north), September (1 north), October (1 south) and November (5 south and 1 north).

Shag and cormorant

66. Shags were one of the commonest species recorded in the inner sound, being present in all months in moderate numbers.

67. Shags were recorded on almost all snap-shot scans. The average numbers of shags present in the southern inner sound based on the numbers seen on the water during scans from the four VPs was approximately 15-20 in spring and summer, 20-25 in autumn and 40 in winter.

68. The average density of shags on the water was similar in spring and summer at 1.9 and 2.3 birds km^{-2} respectively (Table 3). The average density increased to 3.2 birds km^{-2} in autumn and to 5.5 birds km^{-2} in winter. These densities do not include roosting birds on the land.

69. The numbers of shag using the inner sound are small in comparison to the regional breeding population of 3,341 (AONs). There is a small (<50 pairs) breeding colony on Jura at Rubha Bàrr nan Gobag, at the northern end of the inner sound. There are other small colonies in the southern part of the outer sound (Mitchell *et al* 2004).

70. Shags used all parts of the inner sound, certain parts were used disproportionately (Figure 7). There was a tendency to select areas of intermediate depths.

71. Shags roost on land, usually on a rock skerry or cliff. The numbers of shags counted on roost sites was generally similar to the number counted on the water at times when they were active. The largest roost recorded was 96 birds in mid November at Rubha Bàrr nan Gobag, the cliff used for breeding at the north end of the inner sound on the Jura side.

72. Shags made up 13% of birds seen on the flying bird watches. On average 11.4 birds hour^{-1} flew past (Table 5). The numbers of flights north and the number south were almost equal suggesting that the majority were local movements of birds re-distributing between feeding areas or moving between these and roost sites.

73. Cormorants were recorded in small numbers in all months. None were seen on most dates that snap-shot scans were undertaken. They were most commonly seen in summer and autumn, when up to three birds were present. The average

density of birds on the sea in these seasons was approximately 0.1 birds km^{-2} (Table 3).

74. Cormorants breed in small numbers in the region (231 AON) including a small colony in the southern part of the outer sound (Mitchell *et al* 2004).

75. A total of 12 cormorants were recorded during flying bird watches from June to November. On average 0.4 birds hour^{-1} passed by (Table 5). Approximately equal numbers were seen heading north as south.

Gulls

76. Common gulls were one of the most ubiquitous bird species in the inner sound though the total numbers present were relatively small. They were recorded during almost every snap-shot scan and flying bird watch during spring, summer and autumn and early winter, but none were recorded in February. The maximum total numbers of common gulls present in the inner sound was approximately 20 in the spring and summer months and 30 in the autumn months. The numbers of common gull recorded in the inner sound are very small in comparison to the regional breeding population of 2683 AONs (Mitchell et al 2004).

77. Common gulls were recorded all over the inner sound but they were most commonly observed within 100m of the shores, particularly in the vicinity of Port Askaig, Feolin and the Caol Ila distillery. Two pairs nested on the beach at Feolin Ferry House.

78. The average density of common gulls in the southern inner sound seen during snap-shot scans (i.e. recorded within 750 m of the four southern VPs) was 1.0 km^{-2} in spring, 0.8 km^{-2} in summer, 2.0 km^{-2} in autumn and 0.6 km^{-2} in winter (Table 3).

79. Common gull was one of the most frequently recorded species during flying bird watches, accounting for 20% of all flying birds recorded. On average there were 17.9 common gulls flights per hour from May to November (Table 5). In all months except July flights north and flights south were equally common suggesting there was no net passage. However, in July, almost twice as many flights were in a southerly direction as a northerly direction suggesting a net passage of birds southwards.

80. Herring gulls were commonly recorded in all seasons but in relatively small numbers. Typically they were less than 10 birds present in the inner sound. The maximum number recorded was a feeding flock of 20 in July. The numbers of herring gull recorded in the inner sound are very small in comparison to the regional breeding population of 15,370 AONs (Mitchell et al 2004). Herring gull is on the Birds of Conservation Concern Red-list.

81. The average density of herring gulls in the southern inner sound seen during snap-shot scans was 0.1 km^{-2} in spring, 0.4 km^{-2} in summer, 0.6 km^{-2} in autumn and winter (Table 3).

82. Herring gulls accounted for 8.6% of all flying birds recorded in the flying bird watches. On average there were 8 herring gull flights per hour (Table 5). There was no evidence of any real passage of birds from May to July, but from August-October twice as many flights were in a southerly direction as a northerly direction suggesting a net passage of birds southwards.

83. Lesser black-backed gulls were relatively uncommon. They were only recorded from May to August and none were seen on over half the survey dates in this

period. When they were present usually only a single bird was seen; the maximum number present was 3 in late June. The size of the regional breeding population is 3,235 AONs (Mitchell *et al* 2004).

84. Lesser black-backed gulls were recorded on four occasions in flying bird watches (maximum 2) (Table 5).

85. Great black-backed gulls were present in small numbers through the year but were approximately three time more abundant in autumn and winter than in the spring and summer months. The number present in the inner sound in spring and summer was usually two birds or fewer. In autumn and winter up to six birds were present. There was no evidence that they bred in the inner sound. The numbers of great black-backed gulls recorded in the inner sound are very small in comparison to the regional breeding population of 1,736 (AONs) (Mitchell *et al* 2004).

86. Great black-backed gulls accounted for 1.4% of all flying birds recorded in the flying bird watches (Table 5). On average there was 1.1 great black-backed gull flights hour $^{-1}$ and north bound flights were equally numerous as southbound.

87. Moderate numbers of kittiwakes were recorded in the inner sound in late July and August, when typically 5-20 birds were present. The largest single flock seen was 54 birds, in mid August. In spring and autumn kittiwakes were much scarcer with no birds recorded for most snap-shot scans and when they were present they occurred in only small flocks (maximum 12). The numbers of kittiwake recorded in the inner sound are small in comparison to the regional breeding population of 8,976 (AONs) (Mitchell *et al* 2004).

88. The average density of kittiwakes in the southern inner sound seen during snap-shot scans (i.e. recorded within 750 m of the four southern VPs) was 1.1 km^{-2} in July and August (Table 3).

89. Kittiwakes accounted for 25% of all flying birds recorded in the flying bird watches (Table 5). The numbers of kittiwakes recorded in flying bird watches averaged 29 birds hour $^{-1}$ in July and 115 birds hour $^{-1}$ in August, dropping to less than five birds hour $^{-1}$ in September and October. Through the summer and autumn approximately twice as many kittiwakes were recorded flying south as north. This suggests that overall there was a passage of kittiwakes south through the sound.

90. If the net rates of kittiwake passage detected in flying bird watches of approximately 10 birds hour $^{-1}$ in July and 40 birds hour $^{-1}$ in August are representative, this would mean that approximately 23,000 kittiwakes passed south through the sound in July and August. At this time large numbers (1000s) of kittiwake were noted feeding in the Sound of Jura during the surveys from ferries. The numbers kittiwake passing through the sound in the summer is potentially a significant proportion of the west of Scotland breeding population (approximately 108,000 breeding birds, Mitchell *et al* 2004).

91. Black-headed gulls were recorded on three occasions only, scattered throughout the year. All cases involved single birds. The size of the regional breeding population is 3,679 AONs (Mitchell *et al* 2004).

92. A single adult Iceland gull, an uncommon winter visitor from the arctic, was seen in February.

Terns

93. Small numbers (maximum 4) of arctic terns were seen on most survey days in May, June and July. The majority of the records were of birds flying south through the sound, most of the remainder were of feeding birds. Most of the birds seen were mid channel, away from the shores. It is likely that at least some of the birds seen were from local breeding colonies.

94. There was no evidence that arctic tern bred in the inner sound in 2009 however Glas Eilean island at the south end was not checked. There is a small arctic tern colony on the Jura coast of the outer sound (Mitchell *et al* 2004). The numbers of arctic tern using the inner sound represent a very small proportion of the regional population (1823 pairs) (Mitchell *et al* 2004). Arctic tern is listed on Annex 1 of the EU Birds Directive.

95. Four Sandwich terns were seen flying south on the 16th May. This species does not breed in western Scotland and is an uncommon visitor to the region. Sandwich tern is listed on Annex 1 of the EU Birds Directive.

Other seabirds

96. Gannets were recorded in all survey months and showed a strong seasonal pattern of occurrence. They were commonest in summer, when they were recorded on almost all survey dates, and scarcest in winter (one record only). In summer there were typically 5-10 birds present in the inner sound, but there were at least 22 present on one day. They were seen on most survey dates in the spring and autumn months, when typically 1-4 birds were present (maximum 8).

97. Although none of the twelve Scottish gannet breeding colonies are located in the region, the total numbers of this wide-ranging seabird present in western Scotland are large, for example, there are approximately 36,000 pairs on Ailsa Craig and 61,000 pairs on St Kilda. The numbers using the Sound of Islay represent a very small proportion the numbers that use the region.

98. The average density of gannets on the water/hunting was 0.5 birds km^{-2} in the summer and approximately 0.1 birds km^{-2} the spring and summer (Table 3).

99. The records of gannets on the sea and actively hunting are evenly spread over the inner sound (Fig. 8).

100. Gannets accounted for 13% of birds seen during flying bird watches. The numbers of gannets flying through the sound was high in August (44 birds hour-1), moderate in July and September (14 birds hour^{-1}), and lowest in May, June and October (4 birds hour-1) (Table 5). In the spring and summer months nearly twice as many gannets were flying south as north. In the autumn months the balance was almost even.

101. Manx shearwaters on the sea were recorded during snap-shots on only three occasions, all in late August. A flock estimated at 200 were dip-feeding and resting on the sea, mid channel, on the 17th August.

102. Manx shearwaters were commonly recorded in flying bird watches only in the second half of August, when a total of 63 birds were seen spread over several dates. The average number flying past per hour in August was 2.5 hour^{-1} (Table 5). No Manx shearwaters were recorded in flying bird watches earlier in the year or in October. Three were seen in September. Two thirds of the birds recorded in August and all those in September were flying south, suggesting there is a net southerly passage of Manx shearwaters through the sound in the late summer.

103. The numbers of Manx shearwater recorded in the inner sound are small in comparison to the numbers in west Scotland. Moderate numbers breed in the region (ca. 1500 AOSs) (Mitchell *et al* 2004). Manx shearwater range very widely, both within and outside the breeding season, and before they attain breeding

age. Therefore, the birds seen in the Sound of Islay are probably just a likely to originate from the larger colonies elsewhere in western Scotland, in particular Rhum (120,000 AOSs, Mitchell *et al* 2004).

104. Arctic skua were recorded in snap-shot scans on four occasions, once in late June and on three dates in August. The records were of singles or pairs. On one occasion a bird was seen kleptoparisiting a kittiwake. Arctic skuas breed in small numbers (21 AOTs) in the region, including a few pairs that nest on Jura (Mitchell *et al* 2004). It is likely that the birds seen in the inner sound in the summer were breeding birds from Jura. Arctic skua is on the Birds of Conservation Concern Red-list.

105. Arctic skua was recorded during flying bird watches only during August (Table 5). Single birds were seen on two occasions, one heading north and the other south.

106. Great skua was recorded only once; a single bird flying south in early July seen during a snap-shot scan.

Geese and swans

107. Mute swans were recorded in all survey months and it appeared that approximately 10 adults were resident in the inner sound. Usually there were two pairs in the northern half and three in the southern. They favoured the shallow bays, small estuaries and distillery quays. From late August onwards the pair that was based near VP I4 had three juveniles in attendance. It is not known where this pair nested, but Loch Allan is only 400 m from where the juveniles were commonly seen.

108. Five species of geese were seen in the inner sound, though no species was regularly present.

109. In February 350 barnacle geese were seen feeding on Glas Eilean, a low grassy island at the southern end of the inner sound on the Jura side. Three small flocks of barnacle geese, numbering 20, 9 and 15 birds, were seen flying over the sound in October. Apart from Glas Eilean the habitat adjacent to the inner sound is unlikely to be attractive to feeding barnacle geese. Barnacle goose is listed on Annex 1 of the EU Birds Directive.

110. Flocks of Greenland white-fronted geese numbering 150 (February) and 90 (November) birds were seen flying south-west over the sound from the vicinity of Loch a' Chrnuic Bhric on Jura (ca 5 km north of the Feolin ferry) towards Ballygrant on Islay. Apart from these flying birds, no Greenland white-fronted geese were recorded in the vicinity of the inner sound. Greenland white-fronted goose is listed on Annex 1 of the EU Birds Directive.

111. Small numbers of other geese were also noted migrating through the sound. Greylag geese were recorded on two occasions only, two flying north in May and eight flying south in October. Twenty five pink-footed geese flew south in September. Three flocks of brent geese, totalling 92 birds, were seen flying south on 29 September. Two pale-bellied brent geese were also seen flying south on 4th June.

Ducks

112. Eiders were the commonest duck species recorded. There were moderate numbers throughout the year except during the breeding season. Indeed, apart from a few records of individual males flying through there were no records in

May or June, suggesting that eider do not breed in the inner sound. Small numbers (maximum 5) were seen in July and August. Numbers increased in September (maximum 22) and peaked in October (maximum 156). A maximum of 11 birds were seen in February. The numbers using the inner sound are of regional importance representing approximately 3% of the wintering population in Argyll (Forrester and Andrews 2007). Eider is on the Birds of Conservation Concern Red-list.

113. The average instantaneous density of eider (within 750 m of the 4 VPs) in the southern sound was <0.1 bird per km^2 in the spring and summer months and 3.2 birds per km^2 in the autumn and winter months (Table 3).

114. The records of eider were not evenly distributed across the inner sound, they showed a strong preference for the shallower areas and almost completely avoided the deep waters of the Development site. Eider feed by diving to the seabed to catch mainly bivalve molluscs. (Fig. 9).

115. Small numbers (1-11) of eider were seen flying through the sound during the flying bird watches, mainly in October and November (Table 5). The total number recorded in autumn flying north was similar to the number flying south, suggesting these were mainly local movements rather than a distinct migration passage.

116. Common scoters were only rarely recorded. A single bird was seen in September and 7 females in November, all in the northern half of the inner sound. No feeding activity was observed. Three females were also noted flying south through the sound in November. Common scoters require soft bottom sediments at less than approximately 25 metres depth for feeding. Therefore, the habitats of the inner sound are largely unsuitable for this species. Small numbers (<100) regularly occur outside the breeding season in Loch Indaal on Islay. Tens of thousands of common scoter visit Britain from the arctic to winter (Forrester and Andrews 2007).

117. It is unlikely that the common scoter seen in the inner sound are part of the small Scottish breeding population. In recent years one or two pairs of common scoter have bred each year at Loch Gorm on Islay (part of the Rhinns of Islay SPA). These birds are believed to feed in Loch Indaal and there is no evidence or expectation that they use the Sound of Islay (M. Ogilvie email communication to NRP, January 2010). Common scoter is listed on Annex 1 of the EU Birds Directive.

118. Four individual red-breasted mergansers were present in the northern part of the inner sound in February. Small numbers were also seen flying through the sound in summer and, especially, in the autumn, though the species was recorded only once during the flying bird watches (Table 5). The seven autumn records totalled 21 birds and all were flying south, suggesting that there was a small southerly passage of this species. Red-breasted mergansers are relatively common in the region, the numbers seen in the Sound of Islay are not important in a regional context.

119. Small numbers of wigeon were seen in the autumn (maximum 13) and winter months (maximum 24). All birds seen were on the Jura side close to or on the shore, mainly in Whitefarland Bay and Dougall's Bay. Mallard (maximum 20) and teal (maximum 2) were also present in small numbers in the autumn and winter, mostly in Whitefarland Bay. Ten shelduck were seen on Glas Eilean in February and two near VP I4 in April.

Waders

120. Eight species of common waders were recorded during survey work, namely oystercatcher, dunlin, sanderling, common sandpiper, knot, curlew, ringed plover and turnstone. In all cases the numbers seen were small, a reflection of the scarcity of preferred habitat. The most important areas for waders were on the Jura side where there are two small estuaries and some small areas of inter-tidal substrate, e.g. at Whitefarland Bay and Dougall's Bay.

121. Waders were seen roosting at high tide close to feeding areas, particularly on the rocks at the north end of Whitefarland Bay. There are extensive potential wader roost sites on both sides of the inner sound.

122. A few pairs of oystercatcher, ringed plover and common sandpiper were suspected of breeding on the shores of the Jura side of the inner sound. One pair of oystercatcher possibly bred on the Islay coast about 1 km south of Port Askaig. The numbers of breeding pairs of these species are a very small proportion of the regional populations; all these species are common breeding species on coastal habitats in the region.

123. Small numbers of curlew (maximum 2), oystercatcher (maximum 11), ringed plover (maximum 3) and turnstone (maximum 25) were consistently present outside the breeding season. The numbers seen are small compared to numbers total numbers wintering in the region.

124. Dunlin (maximum 38), sanderling (maximum 1) and knot (maximum 18) were only seen during autumn passage. In all cases the numbers recorded were small compared to numbers recorded elsewhere in the region.

Herons

125. Grey herons were recorded throughout the year feeding and roosting along the shores. The numbers seen in the summer were small and no breeding sites were found. Greater numbers were present in autumn and winter (when Scandinavian migrants swell the population size), when feeding birds spread out along the rocky shorelines, with one every few hundred metres. At high tide herons often gather to roost communally. A roost of 19 individuals recorded in November at the north end of Whitefarland Bay probably included most of the birds using the inner sound.

126. A single great white egret, a scarce visitor from southern/eastern Europe, was seen flying south down the sound in October.

Raptors

127. Single hen harriers were noted on six occasions hunting over the coastal moorland of Jura. On one occasion the bird flew over the sound. The records involved both males and females and occurred in all seasons. Hen harriers breed in small numbers on both Islay and Jura. There was no evidence that the birds seen during the breeding season were breeding within 1 km of the Development site but it is likely that they bred locally on the Jura moors. Hen harrier is listed on Annex 1 of the EU Birds Directive. Hen harrier is also on the Birds of Conservation Concern Red-list.

128. The only record of merlin was two birds that flew past one of the Jura VPs on the 30th September 2009. Merlin can make large movements after the breeding season so it is uncertain if these birds were part of the local breeding population,

passage birds or winter visitors. Merlin is listed on Annex 1 of the EU Birds Directive.

129. Buzzard and kestrel were seen in small numbers through the year.

130. Peregrine and white-tailed eagle were both regularly recorded during survey work. In keeping with normal procedure for reporting locations used by sensitive species, the survey results for these two species are presented in a confidential annexe (Annexe 1).

131. No golden eagles were seen during fieldwork up to the end of November 2009.

Other land birds

132. A single twite was seen flying over the sound in late July. A small flock of up to 10 twite was regularly seen in the summer and autumn around Feolin Ferry House (Jura) and it is likely these were of local breeding origin. Twite is on the Birds of Conservation Concern Red-list.

133. Hooded crow, jackdaw, rook and raven were recorded regularly in small numbers. Ravens nested on a cliff close to the Caol Ila distillery and regularly made flights across the sound. No choughs were seen.

Ferry surveys of the outer Sound of Islay

134. Seabird (and marine mammal) surveys were undertaken from the CalMac ferry between West Loch Tarbert (Kennacraig terminal) on the Scottish mainland and Port Askaig in all months from May to November (Table 6). This route was surveyed a total of 16 times. Usually two or three survey visits were completed each month. In November one survey was ended part way through due to the onset of nightfall.

135. Surveys were also undertaken from the CalMac ferry operating between Port Askaig and Colonsay in all months from May to October, except August when the ferry was inoperative on the intended survey date (Table 6). A plan to fill this data gap by doing an extra survey trip on this route in September was cancelled due to unsuitable weather.

136. No attempt has so far been made to analyses the ferry survey data. This will require the use of Distance Sampling software. The results of these surveys are intended to provide baseline information on seabird abundance and distribution, particularly in the outer Sound of Islay, that can be later used for monitoring purposes should the Sound of Islay Tidal Demonstration Project be built.

137. A preliminary examination of the data indicates that the numbers of seabirds using the outer sound were generally small. The range of seabird species recorded was almost identical to that recorded in the inner sound, but with the addition of fulmar, puffin and storm petrel, species that are typically found further from land.

References

Camphuysen, C.J., Fox, T., Leopold, M.F. & Petersen, I.K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK. A report for COWRIE.

Forrester, R. and Andrews, I. et al. (eds) 2007. The Birds of Scotland. Scottish Ornithologists's Club. Aberlady.

Mitchell, P.I., Newton S.F., Ratcliffe, N. and Dunnn, T.E. 2004. Seabird populations of Britain and Ireland. Christopher Helm, London.

Natura/SNH 2009. Jura, Scarba and the Garvellachs: the Scientific Case. Report on SNH website, December 2009

RSPB 2008. RSPB Scoping Opinion concerning Sound of Islay Tidal Device, letter to Scottish Government , 8 September 2008.

SNH 2008. SNH Scoping Opinion concerning Sound of Islay Tidal Device, letter to Scottish Government , 22 October 2008.

SNH 2009. Jura, Scarba and the Garvellachs: The Scientific Case. Natura Scottish Natural Heritage. Report on SNH website, December 2009.

SCANS-II 2008. Small Cetaceans in the European Atlantic and North Sea. Final Report to the European Commission under project LIFE04NAT/GB/000245. Available from Sea Mammal Research Unit, University of St. Andrews, 54pp. plus appendices.

Scott, B, 2008. Preliminary Report on Seabird and Mammal Surveys in Islay Sound June 2008. Unpublished preliminary report. University of Aberdeen.

SMRU 2010. Marine Mammals and Basking Shark Sound of Islay Technical Report. Unpublished report to Scottish Power Renewables. SMRU Ltd. GUESSED Title

Webb, A. & Durinck J. 1992. Counting birds from ships. In: Manual for aeroplane and ship surveys of waterfowl and seabirds, eds,. J. Komdeur, J. Bertelsen & G. Cracknell, 24-37. Slimbridge, IWRB Special Publication No. 19.

Sound of Islay Tidal Demonstration: Birds Technical Report

Table 1. SPAs and SSSIs designated for birds on Islay, Jura and Colonsay.

Site name	Desigation	Principal Interests
Jura, Scarba and Garvellachs	Proposed SPA	Breeding golden eagles.
Gruinart Flats, Islay	SPA, SSSI	Wintering barnacle and Greenland white-fronted geese.
Bridgend Flats, Islay	SPA, SSSI	Wintering barnacle geese.
Laggan Peninsula and Bay, Islay	SPA, SSSI	Wintering barnacle and Greenland white-fronted geese.
Rinns of Islay	SPA, SSSI	Wintering Greenland white-fronted geese and whooper swan. Breeding chough, corncrake and hen harrier.
Glac na Crishe	SSSI, (contained within Rinns SPA)	Breeding seabirds and chough
Eilean na Muice Duibhe, Islay	SPA, SSSI	Wintering Greenland white-fronted geese.
The Oa	SPA, SSSI	Breeding chough.
North Colonsay and Western Cliffs	SPA, SSSI	Breeding chough. Breeding seabird assemblage esp. guillemot and kittiwake
Oronsay and South Colonsay	SPA, SSSI	Breeding chough and corncrake

Table 2. The number of snap-shot scans undertaken in 2009 broken down by month, VP and tide period.

Month	Tide Period	VP I1	VP I2	VP I3	VP I4	VP J1	VP J2	VP J3	All VPs
May	T1	0	4	0	2	0	1	3	10
	T2	0	0	0	0	0	2	0	2
	T3	0	0	3	0	3	0	0	6
	T4	1	0	0	0	0	0	0	1
	T5	2	0	0	0	0	0	0	2
	T6	0	2	0	0	0	0	0	2
	Sub-total	**3**	**0**	**3**	**2**	**3**	**3**	**3**	**17**
June	T1	0	1	1	3	1	0	2	8
	T2	0	0	0	0	2	0	2	4
	T3	0	0	0	0	0	2	2	4
	T4	1	0	3	0	0	4	1	9
	T5	4	3	0	0	3	0	2	12
	T6	2	2	2	4	0	0	0	10
	Sub-total	**7**	**6**	**6**	**7**	**6**	**6**	**9**	**47**
July	T1	0	3	2	2	0	2	0	9
	T2	0	0	2	3	1	1	2	9
	T3	0	0	0	2	2	4	0	8
	T4	2	0	2	1	0	2	3	10
	T5	0	0	4	2	0	3	3	12
	T6	0	0	3	3	0	1	3	10
	Sub-total	**2**	**3**	**13**	**13**	**3**	**13**	**11**	**58**
August	T1	0	0	2	5	0	4	6	17
	T2	0	0	5	3	0	5	2	15
	T3	0	2	2	7	0	3	2	16
	T4	0	0	3	4	0	7	3	17
	T5	0	0	4	5	0	2	7	18
	T6	0	0	5	3	0	4	1	13
	Sub-total	**0**	**2**	**21**	**27**	**0**	**25**	**21**	**96**
September	T1	0	0	4	2	0	2	2	10
	T2	0	0	1	3	0	2	2	8
	T3	0	0	4	2	0	2	0	8
	T4	0	0	2	2	0	1	1	6
	T5	0	1	2	2	0	3	2	10
	T6	0	0	1	4	1	5	4	15
	Sub-total	**0**	**1**	**14**	**15**	**1**	**15**	**11**	**57**
October	T1	0	1	3	2	0	4	3	13
	T2	0	0	2	3	0	2	1	8
	T3	0	2	2	3	0	1	3	11
	T4	0	0	4	3	0	2	2	11
	T5	0	0	3	2	0	4	2	11
	T6	0	1	1	4	0	1	2	9
	Sub-total	**0**	**4**	**15**	**17**	**0**	**14**	**13**	**63**
November	T1	0	0	0	2	1	3	3	9
	T2	0	0	2	0	0	2	3	7
	T3	0	0	2	2	0	0	2	6
	T4	0	1	5	4	0	1	2	13
	T5	0	0	5	4	0	4	3	16
	T6	0	1	2	4	0	4	1	12
	Sub-total	**0**	**2**	**16**	**16**	**1**	**14**	**14**	**63**
All months		**12**	**18**	**88**	**97**	**14**	**90**	**82**	**401**

Table 3. The mean estimated density of seabirds (birds km^{-2}) within 750m of the four southern VPs during snap-shot scans overlooking the inner Sound of Islay in 2009. Density was calculated on the basis of a visible area equating to a semi-circle of 0.75 km radius.

Species	Spring (May & June)	Summer (July & Aug.)	Autumn (Sept. & Oct.)	Winter (Nov. & Feb.)
Great northern diver	0.06	0	0.01	0.54
Red-throated diver	0	0.07	0.02	0.02
Gannet	0.14	0	0.50	0.28
Cormorant	0	0.07	0.10	0.06
Shag	1.92	2.33	3.19	5.46
Manx shearwater	0	0.08	0.03	0
Eider	0.08	0.04	2.57	3.74
Kittiwake	0	1.11	0.27	0.06
Common gull	1.02	0.80	2.01	0.59
Herring gull	0.14	0.36	0.59	0.62
Great black-backed gull	0.08	0.11	0.29	0.44
Common guillemot	0.06	0.47	0.05	0.07
Razorbill	0	2.76	0.16	0.47
Black guillemot	1.35	1.55	0.34	0.42
No. of snap-shot scans	40	144	114	60

Table 4. The number of five-minute Flying Bird Watches undertaken in 2009 broken down by month, VP and tide period.

Month	Tide Period	VP I1	VP I2	VP I3	VP I4	VP J1	VP J2	VP J3	All VPs
May	T1	0	4	0	2	0	0	3	9
	T2	0	0	0	0	0	3	0	3
	T3	0	0	3	0	2	0	0	5
	T4	0	0	0	0	1	0	0	1
	T5	0	0	0	0	0	0	0	0
	T6	0	2	0	1	0	0	0	3
	Sub-total	**0**	**6**	**3**	**3**	**3**	**3**	**3**	**21**
June	T1	0	1	0	3	0	0	2	6
	T2	0	0	0	0	3	0	2	5
	T3	0	0	0	0	0	1	2	3
	T4	1	0	2	0	0	5	1	9
	T5	4	2	1	0	3	0	3	13
	T6	2	4	1	4	0	0	0	11
	Sub-total	**7**	**7**	**4**	**7**	**6**	**6**	**10**	**47**
July	T1	0	3	2	1	0	2	1	9
	T2	0	0	3	3	1	1	2	10
	T3	0	0	0	3	2	4	0	9
	T4	2	0	2	1	0	2	3	10
	T5	0	0	4	1	0	3	2	10
	T6	0	0	2	4	0	1	3	10
	Sub-total	**2**	**3**	**13**	**13**	**3**	**13**	**11**	**58**
August	T1	0	0	2	2	0	1	4	9
	T2	0	0	1	3	0	2	2	8
	T3	0	2	2	3	0	2	1	10
	T4	0	0	2	2	0	4	2	10
	T5	0	0	1	3	0	1	3	8
	T6	0	0	2	2	0	3	0	7
	Sub-total	**0**	**2**	**10**	**15**	**0**	**13**	**12**	**52**
September	T1	0	0	4	3	0	2	2	11
	T2	0	0	1	2	0	2	2	7
	T3	0	0	4	3	0	2	0	9
	T4	0	0	2	2	0	0	1	5
	T5	0	1	2	2	0	4	2	11
	T6	0	0	1	1	0	4	4	10
	Sub-total	**0**	**1**	**14**	**13**	**0**	**14**	**11**	**53**
October	T1	0	1	3	2	0	4	2	12
	T2	0	0	2	2	0	2	2	8
	T3	0	2	2	4	0	1	2	11
	T4	0	0	3	2	0	2	3	10
	T5	0	0	3	3	0	3	2	11
	T6	0	1	1	4	0	2	2	10
	Sub-total	**0**	**4**	**14**	**17**	**0**	**14**	**13**	**62**
November	T1	0	0	1	2	0	4	3	10
	T2	0	0	2	0	0	2	3	7
	T3	0	0	2	2	0	0	2	6
	T4	0	0	5	4	0	0	3	12
	T5	0	1	4	4	0	4	1	14
	T6	0	0	3	4	0	6	1	14
	Sub-total	**0**	**1**	**17**	**16**	**0**	**16**	**13**	**63**
All months		**9**	**24**	**75**	**84**	**12**	**79**	**73**	**356**

Table 5. The estimated mean number of flying birds per hour in the inner Sound of Islay each month. Estimates are calculated from 5-minute flying bird watch data. N = the total number of birds seen during watches.

Species	N	May	June	July	Aug.	Sept.	Oct.	Nov.	Mean
Red-throated diver	11	1.1	0.3	0.8	0.7	0.2	0.0	0.0	0.4
Manx shearwater	66	0.0	0.0	0.0	14.5	0.7	0.0	0.0	2.2
Gannet	360	4.6	2.0	14.1	43.8	14.5	4.3	0.0	11.9
Cormorant	13	0.0	0.5	0.2	0.9	0.2	0.8	0.2	0.4
Shag	355	7.4	12.5	6.8	7.2	14.0	17.0	15.0	11.4
Grey heron	24	0.0	0.3	0.4	0.5	0.9	1.5	1.3	0.7
Greylag goose	2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Brent goose	53	0.0	0.0	0.0	0.0	12.0	0.0	0.0	1.7
Eider	25	0.0	0.0	1.0	0.0	0.7	2.3	1.0	0.7
Red-breast. merganser	1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Hen harrier	1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Buzzard	2	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.1
Oystercatcher	25	0.6	1.0	0.8	3.5	0.0	0.0	0.2	0.9
Dunlin	27	0.6	0.0	1.2	0.0	0.0	3.9	0.0	0.8
Curlew	1	0.0	0.0	0.2	0.0	0.0	0.0	0.4	0.1
Turnstone	20	0.0	0.0	0.0	0.0	0.0	3.9	4.6	1.2
Arctic skua	2	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1
Common gull	535	17.1	20.2	27.7	17.3	5.9	22.8	13.9	17.9
Lesser black-backed gull	11	0.6	0.8	0.6	0.9	0.0	0.0	0.0	0.4
Herring gull	234	9.7	3.6	9.7	5.8	11.8	6.8	8.4	8.0
Great black-backed gull	38	0.0	0.5	1.2	0.9	1.6	2.3	1.3	1.1
Kittiwake	689	0.0	0.3	29.4	115.4	3.2	4.3	1.9	22.1
Sandwich tern	2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Arctic tern	11	1.1	0.5	1.4	0.0	0.0	0.0	0.0	0.4
Guillemot	13	5.7	0.0	0.6	0.0	0.0	0.0	2.5	1.3
Razorbill	12	0.6	0.3	0.2	0.92	0.91	0.0	0.2	0.4
Black guillemot	63	4.0	2.3	5.4	0.9	0.7	1.7	1.0	2.3
No. of 5-minute watches		21	47	58	52	53	62	63	

Table 6. CalMac ferry sailings used for seabird and marine mammal surveys in 2009. Note, the 13th November survey was stopped part way through due to onset of nightfall.

Ferry Route	Date	Sea state	Time
West Loch Tarbert - Port Askaig			
WLT > PA	12/05/2009	4 > 2	13:02 - 14:47
PA > WLT	17/05/2009	2 (occ. 3)	15:24 - 17:14
WLT > PA	02/06/2009	2 (occ. 1)	12:58 - 14:55
PA > WLT	07/06/2009	2 > 1	15:24 - 17:23
WLT > PA	30/06/2009	1 >2	12:59 - 14:52
PA > WLT	04/07/2009	2 (occ. 1)	06:55 - 08:40
WLT > PA	28/07/2009	2 - 4	13:03 - 14:52
PA > WLT	30/07/2009	2 - 3	15:38 - 17:27
WLT > PA	17/08/2009	2 (occ. 3)	12:58 - 14:59
PA > WLT	21/08/2009	2 - 3	15:28 - 17:27
WLT > PA	08/09/2009	5 > 2	13:01 - 14:50
PA > WLT	11/09/2009	0 -1 (occ. 2)	15:32 - 17:21
WLT > PA	13/10/2009	1 - 3	12:59 - 14:53
PA > (WLT)	13/11/2009	1 - 2	15:32 - 16:15
Port Askaig - Colonsay			
PA > COL	13/05/2009	5 > 2	10:18 - 11:29
COL > PA	13/05/2009	5 > 2	18:19 - 19:26
PA > COL	03/06/2009	0-1 > 2	10:12 - 11:10
COL > PA	03/06/2009	2	18:16 - 19:13
PA > COL	01/07/2009	0 - 1 (occ. 2)	10:12 - 11:05
COL > PA	01/07/2009	2 (occ. 3)	18:18 - 19:22
PA > COL	09/09/2009	1 - 3	10:24 - 11:34
COL > PA	09/09/2009	1 - 3	18:26 - 19:30
PA > COL	14/10/2009	0 - 1	10:12 - 11:07

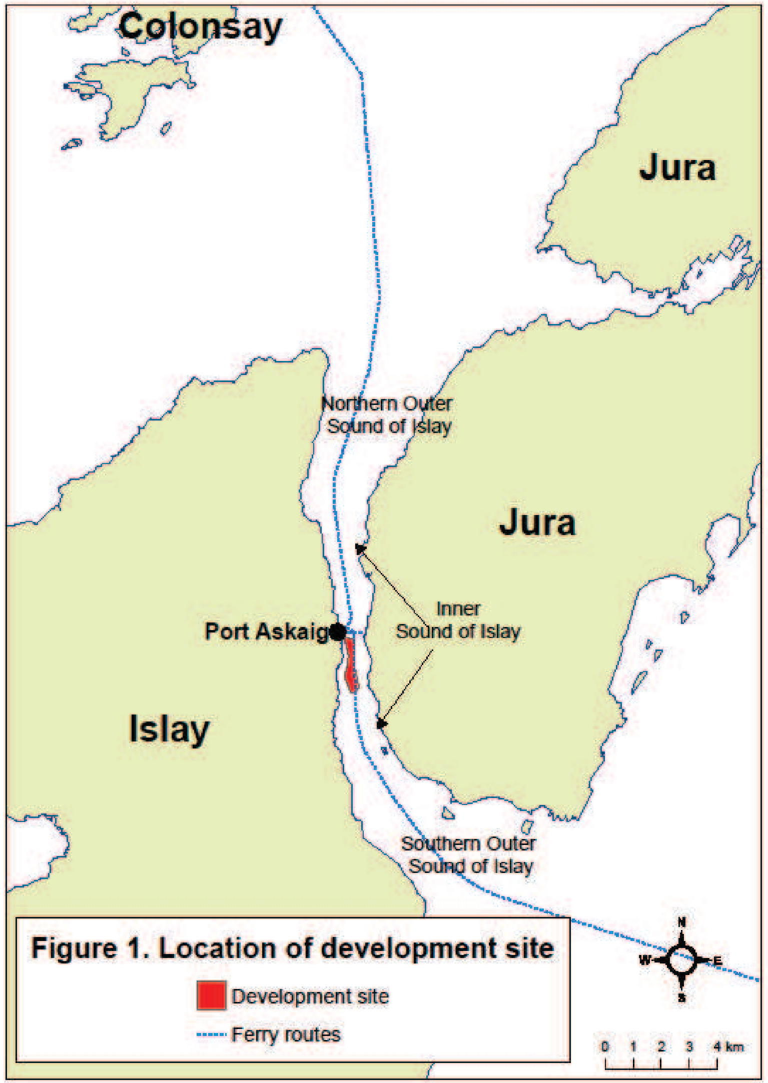


Figure 1. Location of development site

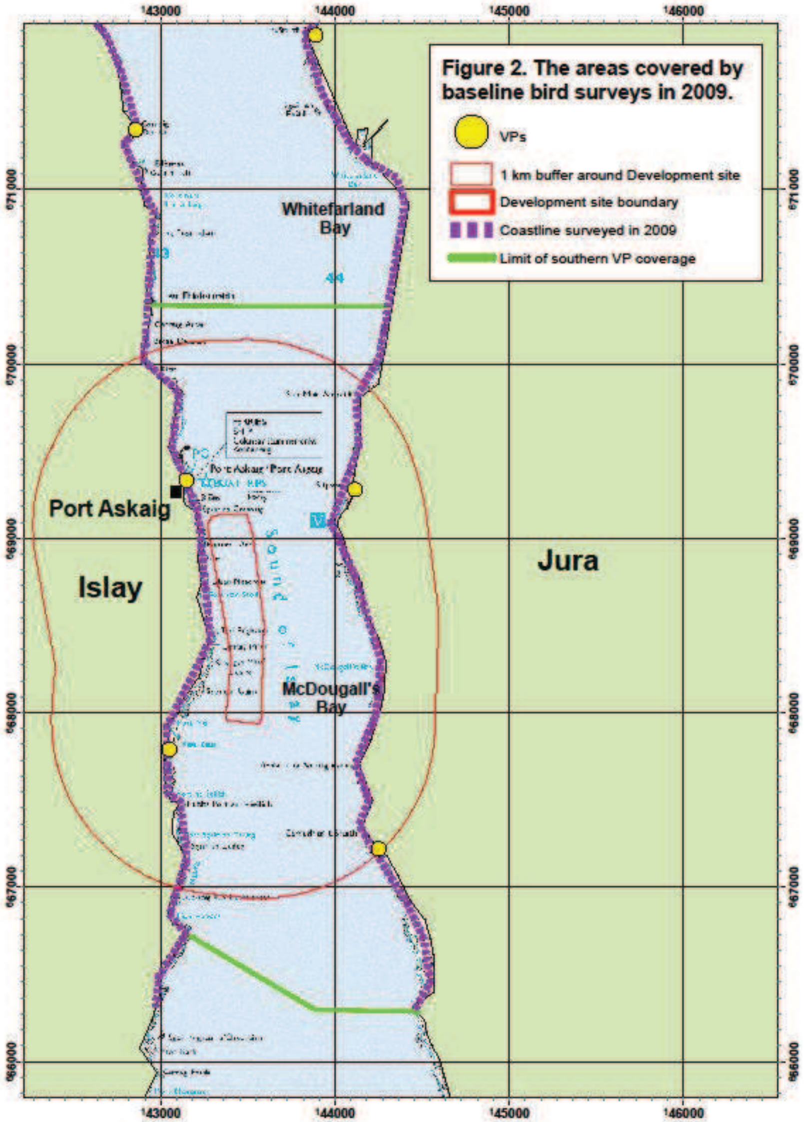


Figure 2. The areas covered by baseline bird surveys in 2009.
VPs
1 km buffer around Development site
Development site boundary
Coastline surveyed in 2009
Limit of southern VP coverage
Whitefarland Bay
Port Askaig
Islay
Jura
McDougall's Bay
143000
144000
145000
146000

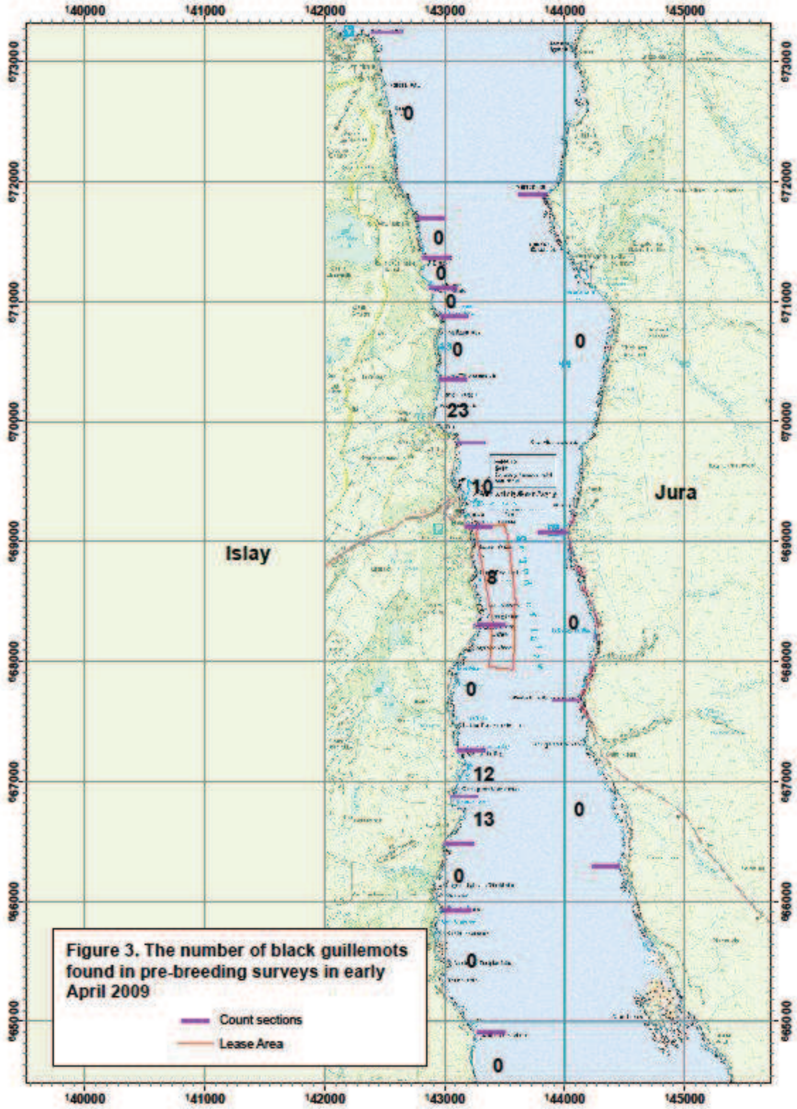


Figure 3. The number of black guillemots found in pre-breeding surveys in early April 2009
Count sections
Lease Area
Islay
Jura
140000
141000
142000
143000
144000
145000

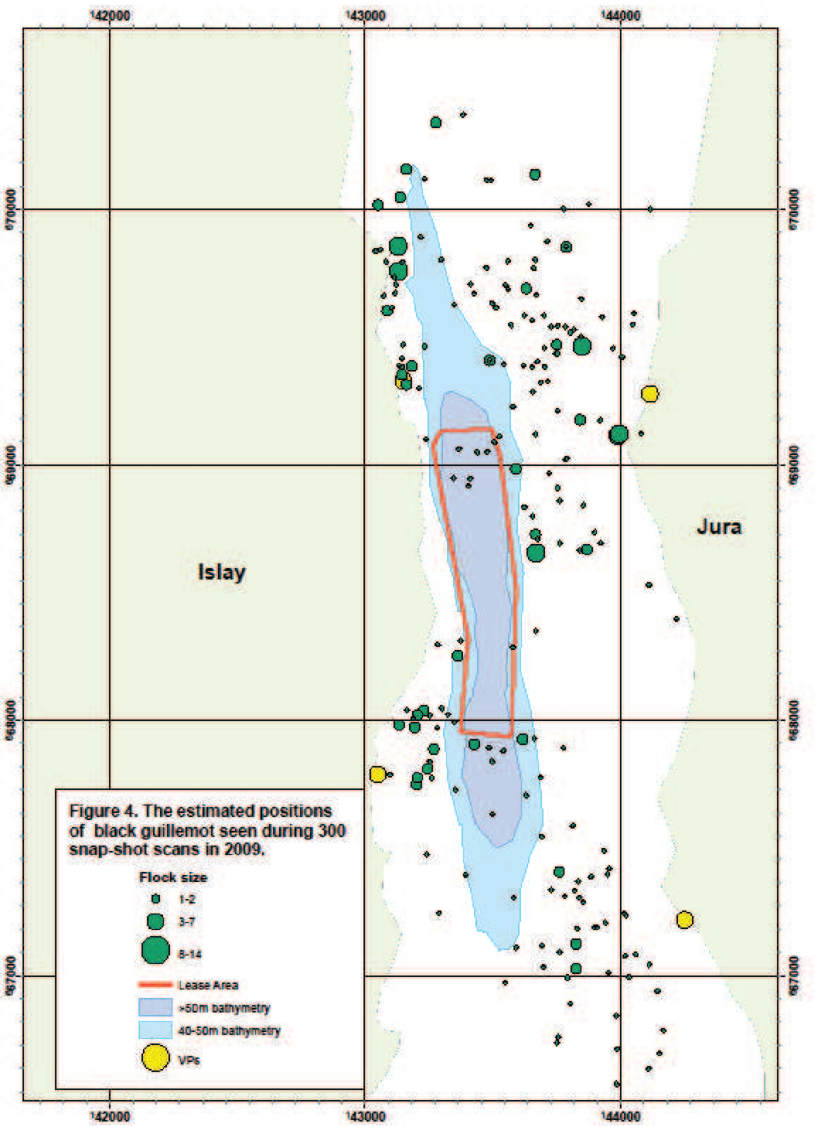


Figure 4. The estimated positions of black guillemot seen during 300 snap-shot scans in 2009.

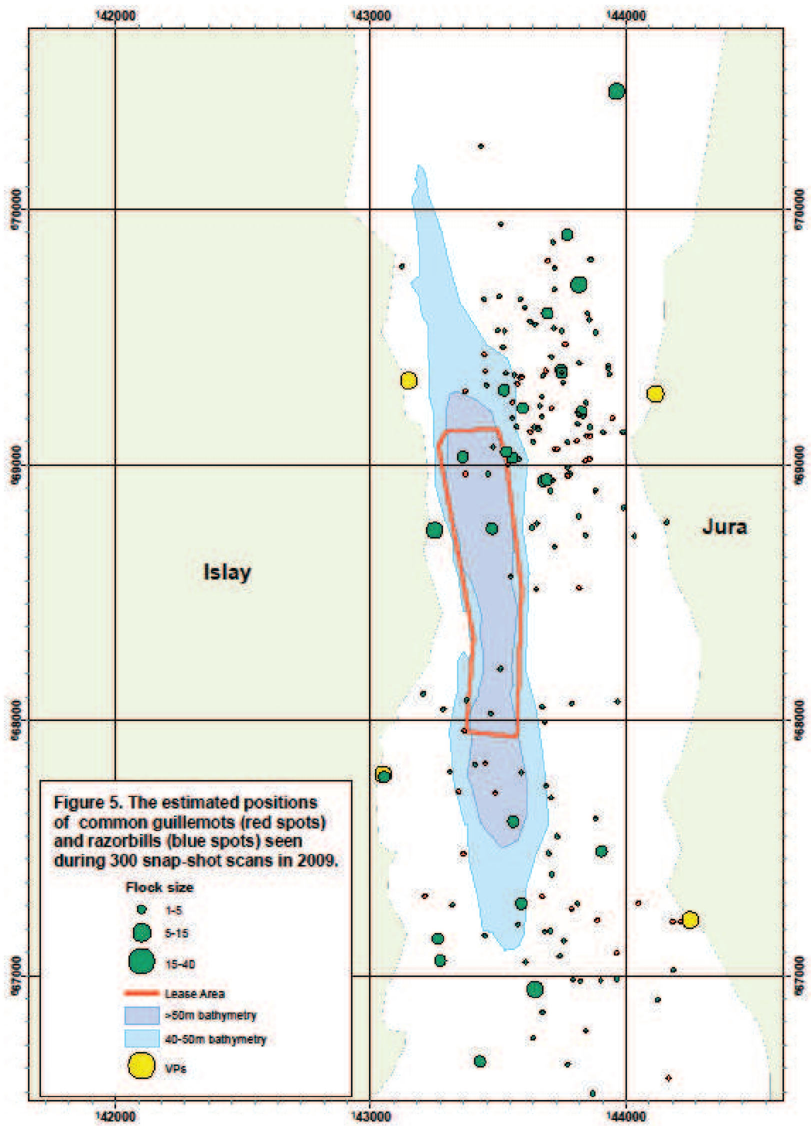


Figure 5. The estimated positions of common guillemots (red spots) and razorbills (blue spots) seen during 300 snap-shot scans in 2009.

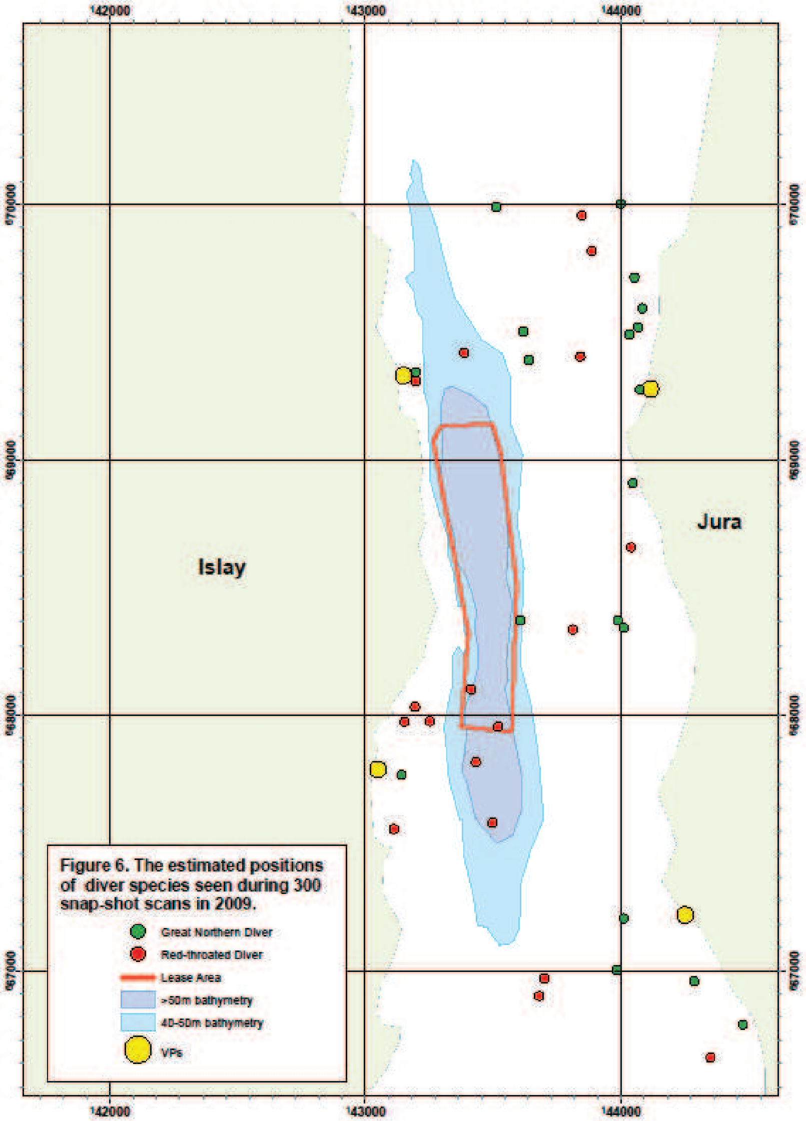


Figure 6. The estimated positions of diver species seen during 300 snap-shot scans in 2009.

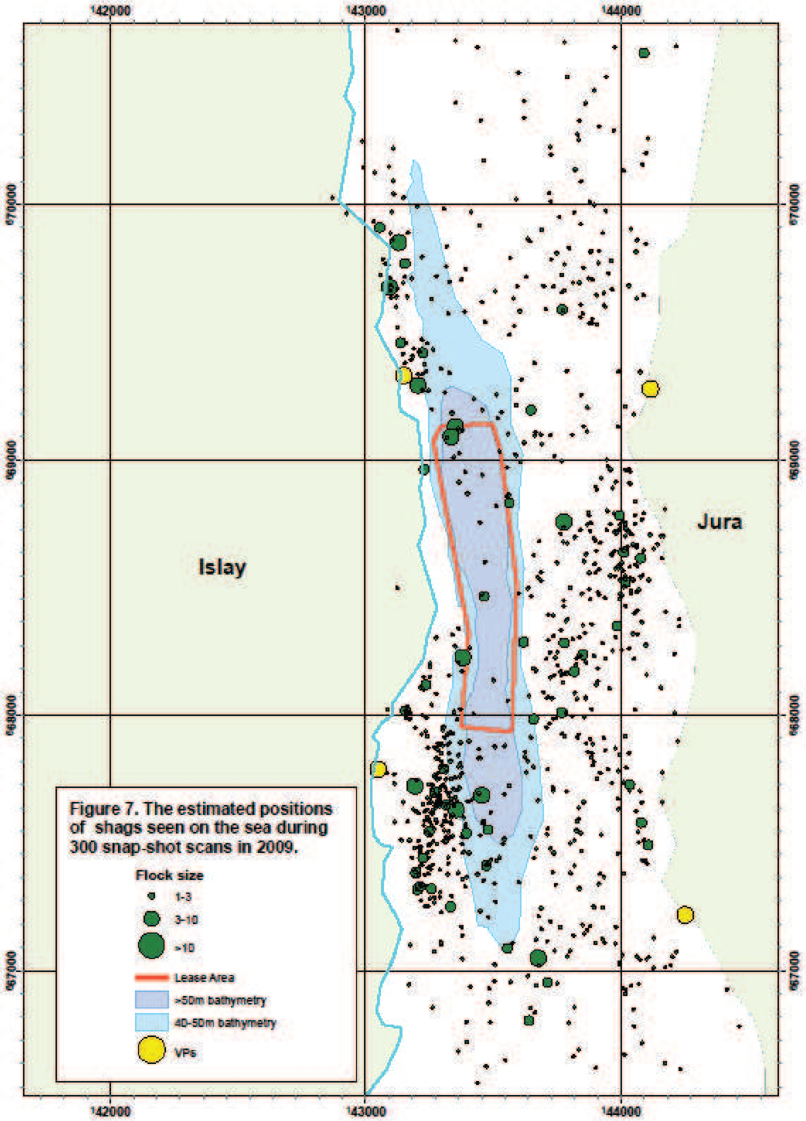


Figure 7. The estimated positions of shags seen on the sea during 300 snap-shot scans in 2009.

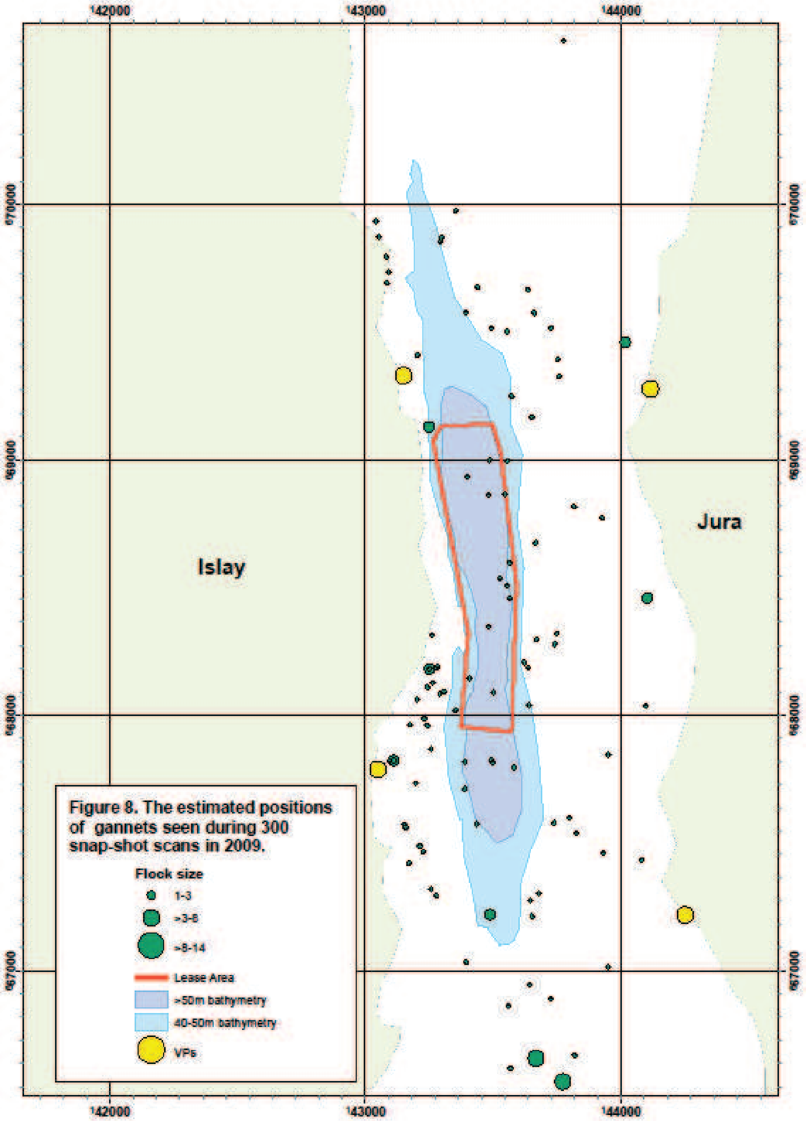


Figure 8. The estimated positions of gannets seen during 300 snap-shot scans in 2009.

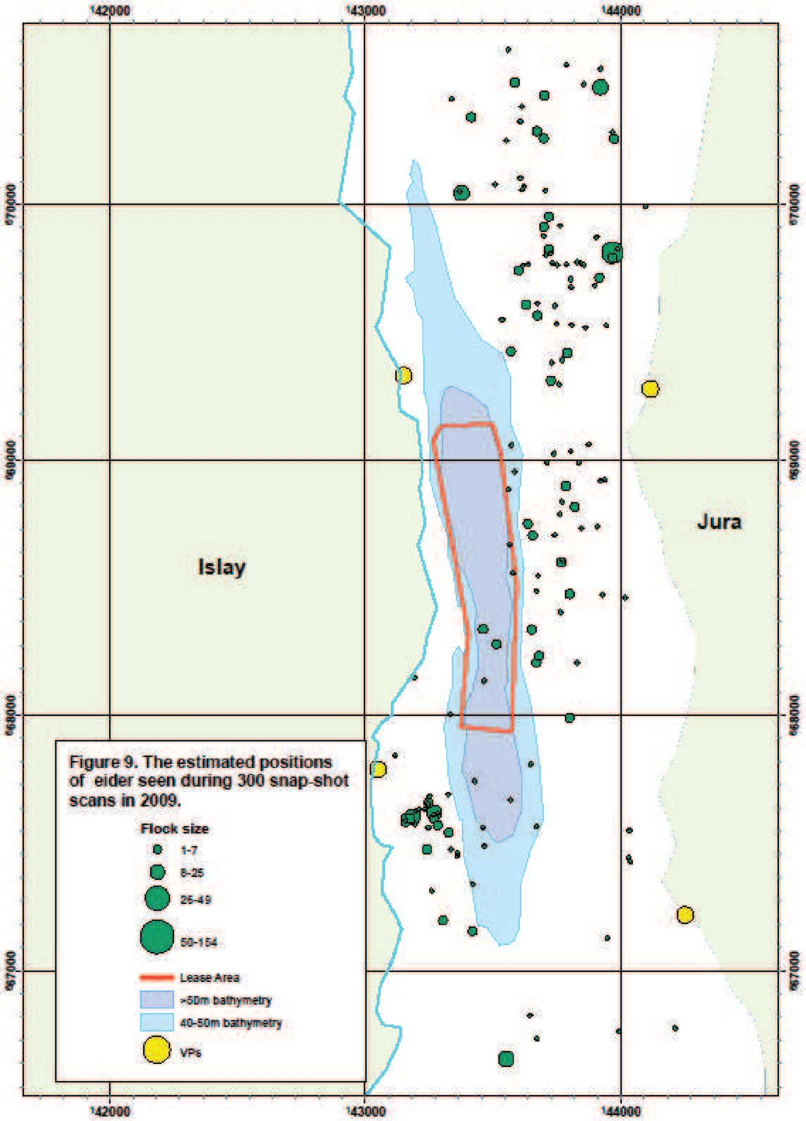


Figure 9. The estimated positions of eider seen during 300 snap-shot scans in 2009.

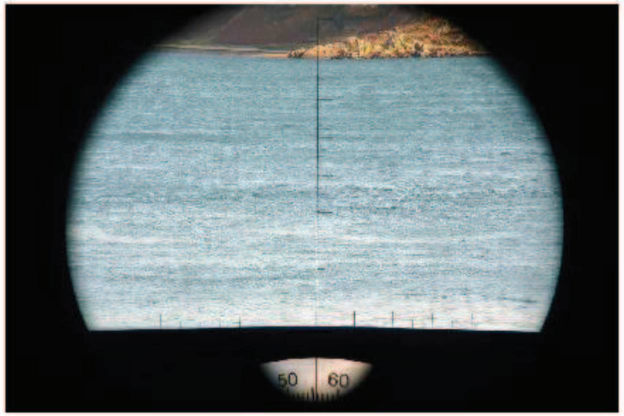
Photograph 1. Southern inner Sound of Islay looking south-east from Dunlossit (close to VP I4), Islay, and showing CalMac ferry.

Photograph 2. Central inner Sound of Islay looking north-east from Dunlossit, Islay, (close to VP I4) across the development site towards Feolin.

Photograph 3. Northern inner Sound of Islay, looking east from Islay.

Photograph 4. Northern inner Sound of Islay and Whitefarland Bay, looking north from Feolin, Jura (close to VP J2)

Photograph 5. Compass binoculars mounted level on a tripod. Looking east from cliffs above Port Askaig (at VP I3).



Photograph 6. View through compass binoculars showing compass bearing and vertical graticule.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 15 – Commercial Fisheries

Appendix 15.1: Additional Statistics

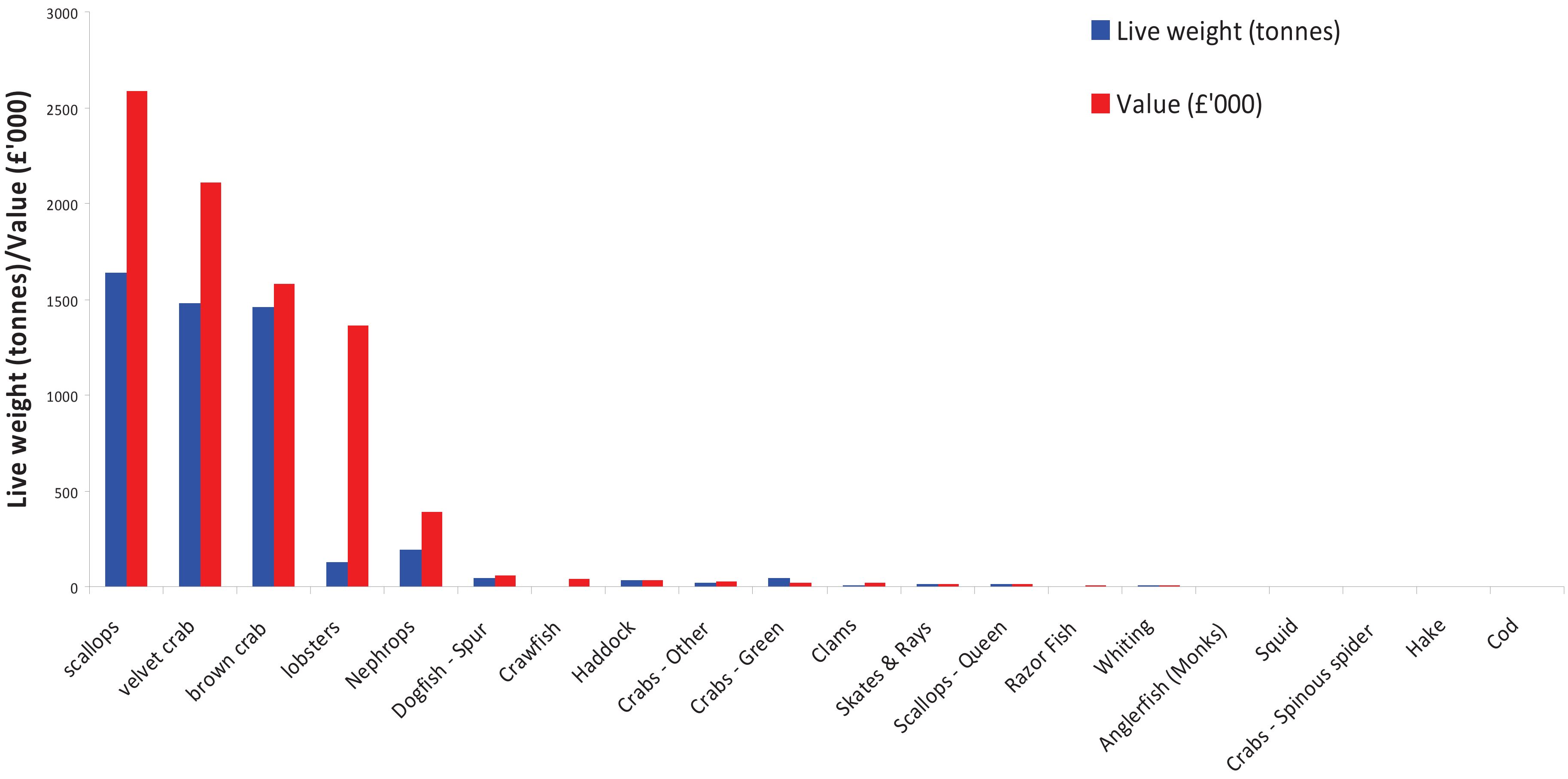
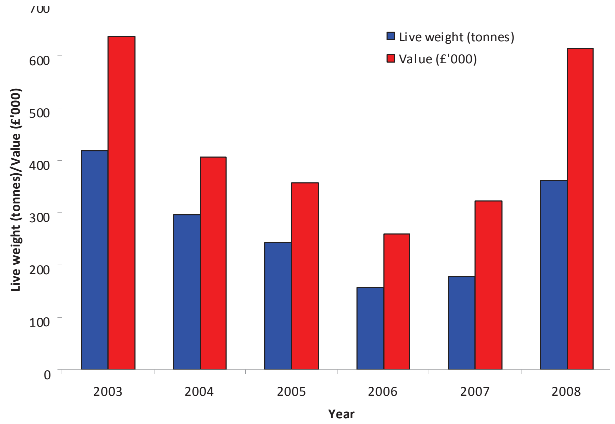
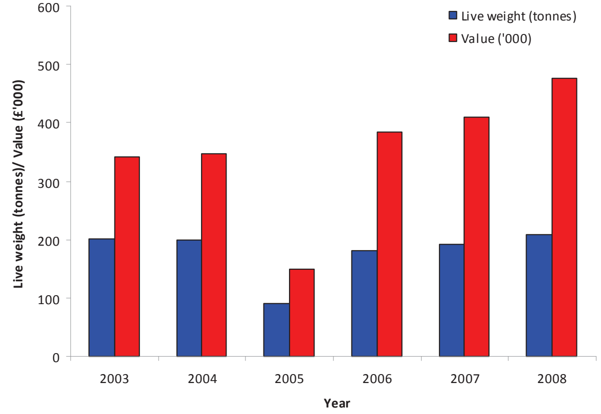


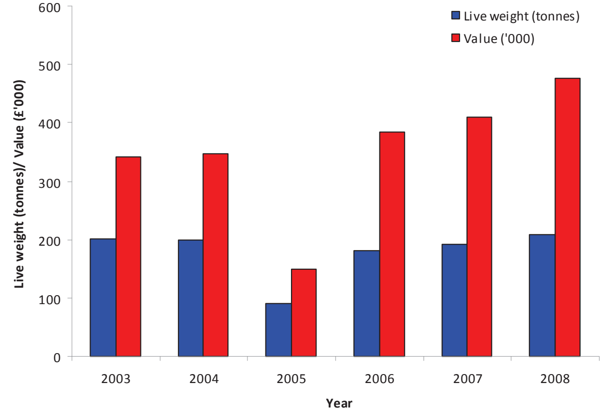
Figure. 1: Live weight and value of the landings from ICES rectangle 40E3 for each species for the period 2003 and 2008 (inclusive) showing the top 20 species by value.



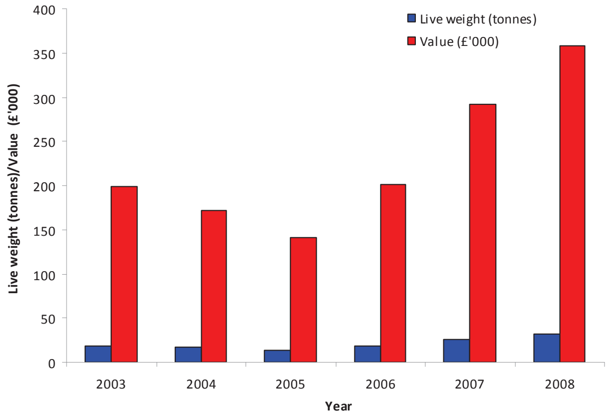
(a) Great Scallop



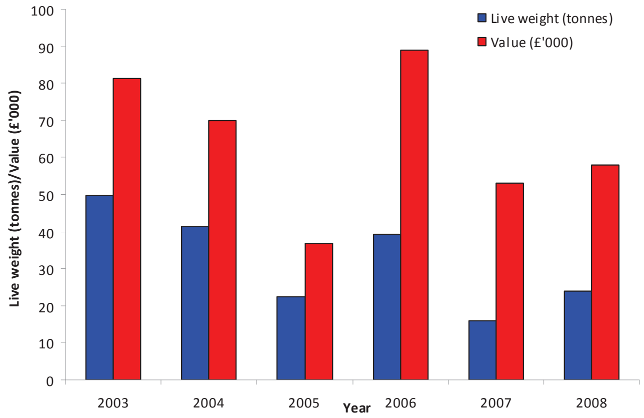
(b) Velvet Swimming Crab



(c) Brown Crab



(d) Lobster



(e) Nephrops

Figure 2: Landings weight (in blue) and Value (in red) for individual species landed from ICES rectangle 40E3 by year from 2003-2008. (a) Great scallop (b) velvet swimming crab (c) brown crab (d) lobster (e) *Nephrops*

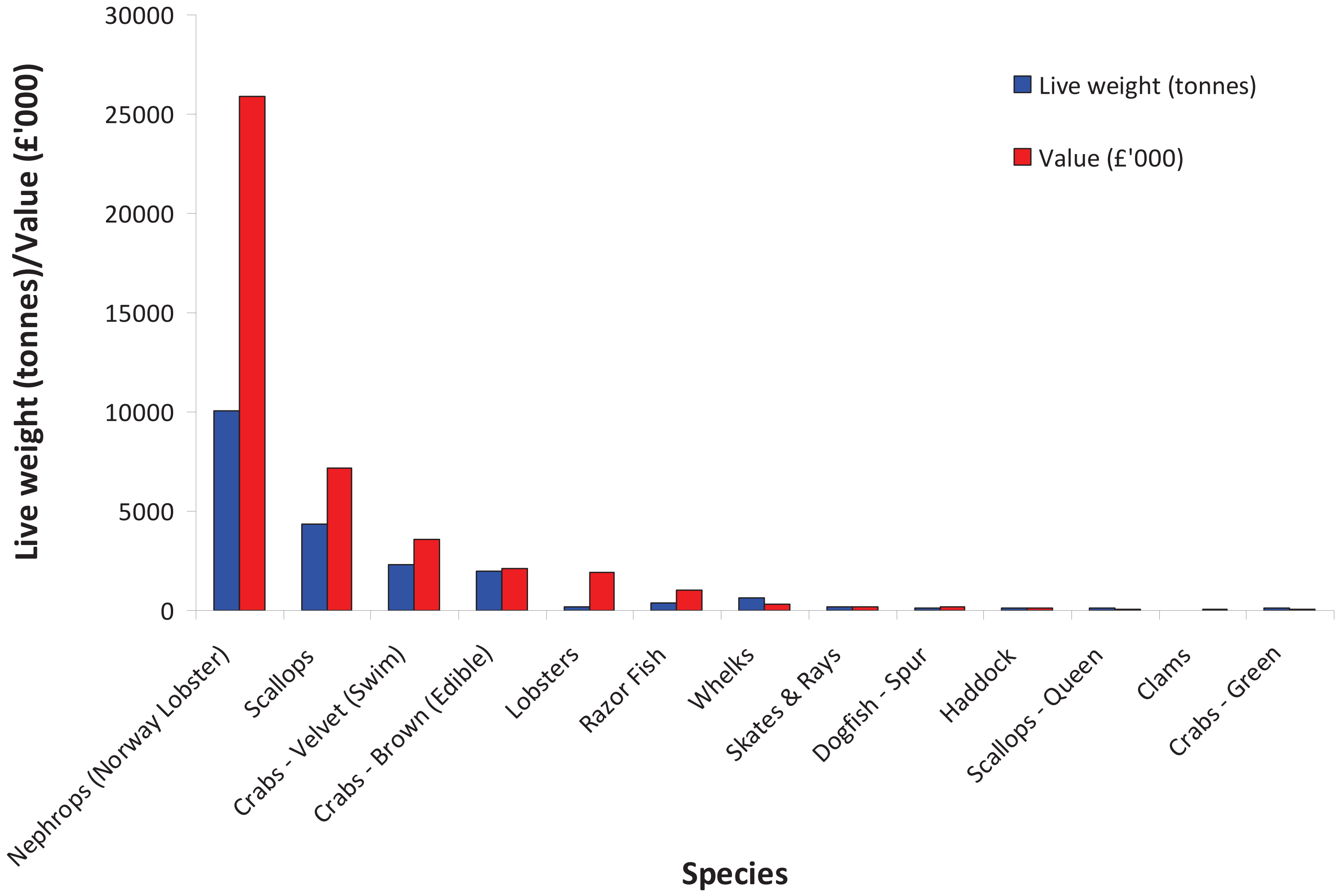


Figure 3: Live weight and value of the landings from ICES rectangle 40E3 and 40E4 combined by species for the period 2003 and 2008 (inclusive) showing the top 20 species by value.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 15 – Commercial Fisheries

Appendix 15.2: “Fishermen Interviews”

Appendix 15.3 Fishermen Interviews – 25th May 2009

In order to gain a better understanding of the commercial fishing activity in Islay, the Fishing Liaison Officer, Andrew Macdonald, and SPR's Fisheries consultant, Stephen Appleby, carried out informal interviews with four local fishermen on the 25th May 2009.

Of the fishermen interviewed, two were full-time creel fishermen based out of Port Askaig, one was a full-time creel fisherman based in Port Ellen and the other was a part-time creel fisherman based in Craighouse on Jura.

These interviews provided a background for further more detailed research including a fishing trip in September, the NSRA meeting in November 2009 and a commercial fisheries questionnaire.

General Information regarding fishing in the Sound of Islay

- Number of vessels operating within Sound of Islay
  - There are approximately nine fisherman who work in the Sound. Most of these will fish outside of the Sound during summer but will return to the Sound from September to March.
- Number operating specifically within area of interest
  - Exact areas of fishing varied for each fisherman with little regular fishing in the deep areas of interest. However, some lobster pots are probably set in the deeper waters on occasions.
- Gear type
  - Creels are generally relatively small but some larger purpose built lobster pots are used.
- Size of vessels
  - Between 6 and 12 metres
- Home port(s) of these vessels
  - The majority of boats fishing the Sound use Port Askaig. Some also use Port Ellen.
- Steaming time from home port
  - The smaller boats may steam for up to two hours. The larger boats heading west from Port Ellen may steam for four to six hours.
- Proportion of time fishing time spent within Sound of Islay
  - Depends on individuals but generally, the Sound is used for six months from September to February.
- Depth normally deploy gear
  - 10m to 30m but deeper for lobsters.
- Tidal state / time gears normally deployed
  - Fishing times are predominantly dependent on daylight rather than tides.
- Number of pots set within area of interest
  - Each fisherman is working between 400 and 1500 pots (though not all will be hauled daily)
- Extent of drag due to current
  - One fisherman reported drag while untangling gear of up to two miles.
- Species caught
  - Brown crab, Velvet crab, lobster, nephrops
  - Occasional diving for scallops
- Scallop dredging
  - Only occasionally at very north and very south of Sound of Islay.
- Extent of alternative fishing opportunities
  - Fishing takes place outside the Sound but is restricted in winter due to weather. The current pattern of fishing in winter in the Sound and summer out of the Sound is also likely to maintain stocks. It was reported that by February the Sound is 'fished out'
- Potential impact due to disturbance during installation
  - If installation is during summer then this will have less impact.
- Impact of long term displacement due to safety zones or marker buoys
  - Increased travel time (reduced fishing hours, increased fuel costs)
  - Increased pressure on stocks due to change in fishing pattern
  - Potential for gear conflict due to increased pressure on alternative grounds
  - Depends on size of safety zone but there is a possibility that this would result in more fishermen in smaller area.
- Impact of loss or damage of gear – related to number of pots currently lost and drag due to current
  - Pots may have to be cut free as a safety measure if drifting towards tidal array.
- Prices
  - Velvet Crabs £1.80 to £2.30 per kilo
  - Brown Crabs £1.10 per kilo
  - Spider Crabs £1.00 per kilo
  - Lobsters £14.00 to £18.00 per kilo
  - Squat Lobsters £12.00 per kilo
- Buyers
  - Tarbert Shellfish
  - Local Hotels

Specific Notes from Interviews

Fisherman A

Target Catch	Velvet Crab, Brown Crab, Lobster. In general, doesn't fish for Nephrops as areas where this is possible are also fished by trawlers. Other species seen but not caught include Cod, Ling, Conger Eel, Spotted Dog Fish.
Method	Total 500 Pots (20 fleets of 25 pots per fleet) Creels are relatively small lightweight with 25kg weights at ends of fleet. Hauls all 500 pots per day. Fishing hours are generally determined by daylight. In summer, he sets out at 6am. Fishing takes place in all tide states.
Fishing Grounds	In winter months (August to February) he fishes in the Sound of Islay as weather prevents much fishing in other areas. Approximately 30 minutes steaming time to fishing grounds in Sound. In summer months (March to July) - North of Sound – around coast to west and north towards Colonsay. Approximately 2 hours steaming time to fishing grounds out of Sound.
Opinion	Opposed to any development that would restrict fishing or create hazards. Concerned that boat and gear can drift up to two miles in the Sound when tangled during hauling. Fishing is sole source of income.

Fisherman B

Target Catch	Brown Crab, Velvet Crab, Lobster
Method	750 Pots, planning to increase to 1400 Works with himself and one crew member. Targeting Brown Crab and Lobsters to the west of Islay.
Fishing Grounds	Plans to fish to west of Islay and not planning to fish in the Sound.
Opinion	Stated that the tidal development would not affect him in any way as he and other Port Ellen boats do not fish in the Sound. Stated that it would be impossible to dredge for scallops in the Sound. More concerned about the plans for offshore wind farms as this was the main fishing ground for him.

Fisherman C

Target Catch	Velvet Crab, Brown Crab, Lobster

Method	Small number of pots. Works on his own part-time
Fishing Grounds	Fishes near to Craighouse and not in Sound
Opinion	Not concerned by Tidal Project as it does not affect the area that he fishes.

Fisherman D

Target Catch	Velvet Crab, Brown Crab, Lobster
Method	Total of 800 creels. Hauls about 500 in one day. Mixture of light and heavy creels. Different combination of fleet length – either 25 or 50 creels per fleet. Also fishes on a less frequent basis with large purpose built lobster pots in deeper parts of the Sound
Fishing Grounds	In winter months he fishes in the Sound of Islay. Approximately 30 minutes steaming time to fishing grounds in Sound. In summer months (March to July) - North of Sound – mostly to the east to Loch Tarbert. Approximately 2 hours steaming time to fishing grounds out of Sound.
Opinion	Objects to the tidal project as he believes it will reduce fishing grounds and presents safety risk. Fishing is sole source of income.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 15 – Commercial Fisheries

Appendix 15.3: “Commercial Fishing Questionnaire”

Appendix 15.4 Commercial Fishing Questionnaire

The following questionnaire was sent out to as many fishermen as possible on Islay. A total of 21 questionnaires were sent out in December 2009 and 6 were returned.

Sound of Islay Demonstration Tidal Array
Commercial Fishing Interests

SCOTTISHPOWER RENEWABLES

Position within the fishing industry

Owner/ Skipper	Crew member

FT	PT	Seasonal

Type/size of vessel

Under 10m	10-12m	Over 12m

Where is your home port?

Port Askaig	Port Ellen	Other, specify

On average how many days do you spend at sea PER MONTH? (Please indicate if seasonal variation)

J	F	M	A	M	J	J	A	S	O	N	D

Do you fish within the Sound of Islay?

Yes	No

If yes, when seasonally do you fish within the Sound of Islay?

J	F	M	A	M	J	J	A	S	O	N	D

What gear do you operate within the Sound of Islay?

Pots	Static nets	Otter trawl	Scallop dredge	Nephrops trawl	Rod & line

Which species do you target within the Sound of Islay?

Lobster	Edible crab	Velvet crab	Nephrops	Demersal fish	Pelagic fish

What gear do you operate OUTSIDE the Sound of Islay?

Pots	Static nets	Otter trawl	Scallop dredge	Nephrops trawl	Rod & line

Which species do you target OUTSIDE the Sound of Islay?

Lobster	Edible crab	Velvet crab	Nephrops	Demersal fish	Pelagic fish

If you are primarily a potter, how many pots do you normally work?

<200	<500	<750	<1000	<1250	<1500	>1500

Please indicate the proportion of time spent fishing within the area of interest for tidal development in the Sound of Islay?

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Are you concerned about the demonstration tidal array project?

Yes	No

If yes, what are your concerns? (continue overleaf if required)

Please return to Andrew Macdonald Custom House, Main Street, Bowmore, Islay, PA43 7JJ
01496 810 873 andrew.macdonald@islayenergytrust.org.uk

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 15 – Commercial Fisheries

Appendix 15.4: “Summary of Fishermen Questionnaire Responses”

The following is a summary of the six returned questionnaires from December 2009. All are from fishermen based at Port Askaig and this represents approximartely 60% of the regular fishing vessels in the Sound.

	<10m	>10m and <12m	>12m	Actual (average) m
Vessel Sizes	5	1	-	7

	1	2	3	4
Crew Number (including skipper)	4	2	-	-

	Full-Time	Part-Time
Full-time/Part-time vessels	6	-

On average how many days do you spend at sea PER MONTH? **Table shows average per vessel**	J	F	M	A	M	J	J	A	S	O	N	D	Total
	14	16	14	17	16	17	17	18	18	15	16	19	196

Do you fish within the Sound of Islay? **Table shows number of vessels**	Yes	No
	6	

If yes, when seasonally do you fish within the Sound of Islay? **Table shows vessels per month**.	J	F	M	A	M	J	J	A	S	O	N	D	Total
	6	5	2	1	-	-	-	4	5	5	5	6	39

What gear do you operate within the Sound of Islay?	Pots	Static nets	Otter trawl	Scallop dredge	Nephrops trawl	Rod & line
	6	1	-	-	-	1

Which species do you target within the Sound of Islay?

Lobster	Edible crab	Velvet crab	Nephrops	Demersal fish	Pelagic fish
5	5	6	2	2	-

What gear do you operate OUTSIDE the Sound of Islay?

Pots	Static nets	Otter trawl	Scallop dredge	Nephrops trawl	Rod & line
6	1	-	-	-	1

Which species do you target OUTSIDE the Sound of Islay?

Lobster	Edible crab	Velvet crab	Nephrops	Demersal fish	Pelagic fish
6	6	6	3	2	-

If you are primarily a potter, how many pots do you normally work?

<200	<500	<750	<1000	<1250	<1500	>1500	Actual (average)
1	-	3	1	1	-	-	683

Please indicate the proportion of time spent in the Sound of Islay that is within the area of interest for tidal development in the Sound of Islay?

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
6	-	-	-	-	-	-	-	-	-

Days in tidal development area **Table shows average per vessel**	
	8

Are you concerned about the demonstration tidal array project?

Yes	No
3	3

Comments from the questionnaires:

Are you concerned about the demonstration tidal array? 3 fishermen replied ‘yes’ and 3 fishermen replied ‘no’

If yes, what are you concerns? One fisherman responded “Loss of income” and one responded “Restricted access to fishing grounds and loss of income”

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 16 – Terrestrial and Intertidal Ecology

Appendix 16.1: “Islay Phase 1 Habitat Report”

Sound of Islay Demonstration Tidal Array
Phase 1 Habitat survey of potential cable routes

Scottish Power Renewables

31st August 2009
Final Report
9T3474

A COMPANY OF
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Document title	Sound of Islay Demonstration Tidal Array Phase 1 Habitat survey of potential cable routes
Document short title	
Status	Final Report
Date	31 August 2009
Project name	Sound of Islay Tidal Turbines
Project number	9T3474
Client	Scottish Power Renewables
Reference	9T3474/R/303352/Edin

Drafted by	Jen Trendall and Jo Girvan	
Checked by	Amy Clark and Fiona Nimmo	
Date/initials check	…………………	29/08/09……….
Approved by	Frank Fortune	
Date/initials approval	…………………	31/08/09……….

CONTENTS

1 INTRODUCTION

Scottish Power Renewables (SPR) has commissioned Haskoning UK Ltd to assist in applications for consent to install a demonstration tidal turbine array within the Sound of Islay, Scotland. The proposed area of interest lies within the central channel of the Sound of Islay. The demonstration tidal array of ten devices would be deployed within this area and is anticipated to have a footprint of approximately 0.4 km^2. The turbines would generate up to 10MW of power and will be linked via underwater cabling to onshore infrastructure on Islay. SPR are currently investigating six potential landing sites on Islay for cable routing onshore to a substation that is currently proposed to be located in Keills.

To inform the Environmental Impact Assessment a Phase 1 Habitat Survey was undertaken across an area shown in Figure 1. Potential landing sites are labeled A-F, with the survey boundary depicted by the red border.

The varied geology of Islay supports a range of natural environments, ranging from heather moorland, peat bogs, wetlands and saltmarsh to deciduous and coniferous woodlands, rich grassland and scrub forest. The footprint of the Phase 1 habitat survey is concentrated on the west coast of the Sound of Islay, encompassing the Caol Ila distillery and land south of this point for approximately 3.5km to Fionn-phort, and westward inland for approximately 0.5km. In addition, a small pocket of land is included in the footprint approximately 1.5km south of Fionn-phort, at Traigh Bhan.

1.1 Objectives

The objectives of the survey were to:

a) Identify the habitat of each parcel of land within the proposed footprint by foot;
b) Digitally map all habitats as per standard Phase 1 habitat symbols and colours (JNCC, 1993); and
c) 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 five bays potentially suitable for the landing of cables associated with the development (Royal Haskoning, 2009).

1.2 Conditions of survey

The survey was completed by two experienced Royal Haskoning ecologists from the 3rd to 7th of August 2009. Weather conditions for the majority of the survey were fair, however low cloud restricted visibility on the morning of the 4th August. Access was good throughout the site; however restrictions were located around the residential buildings of the Dunlossit Estate.

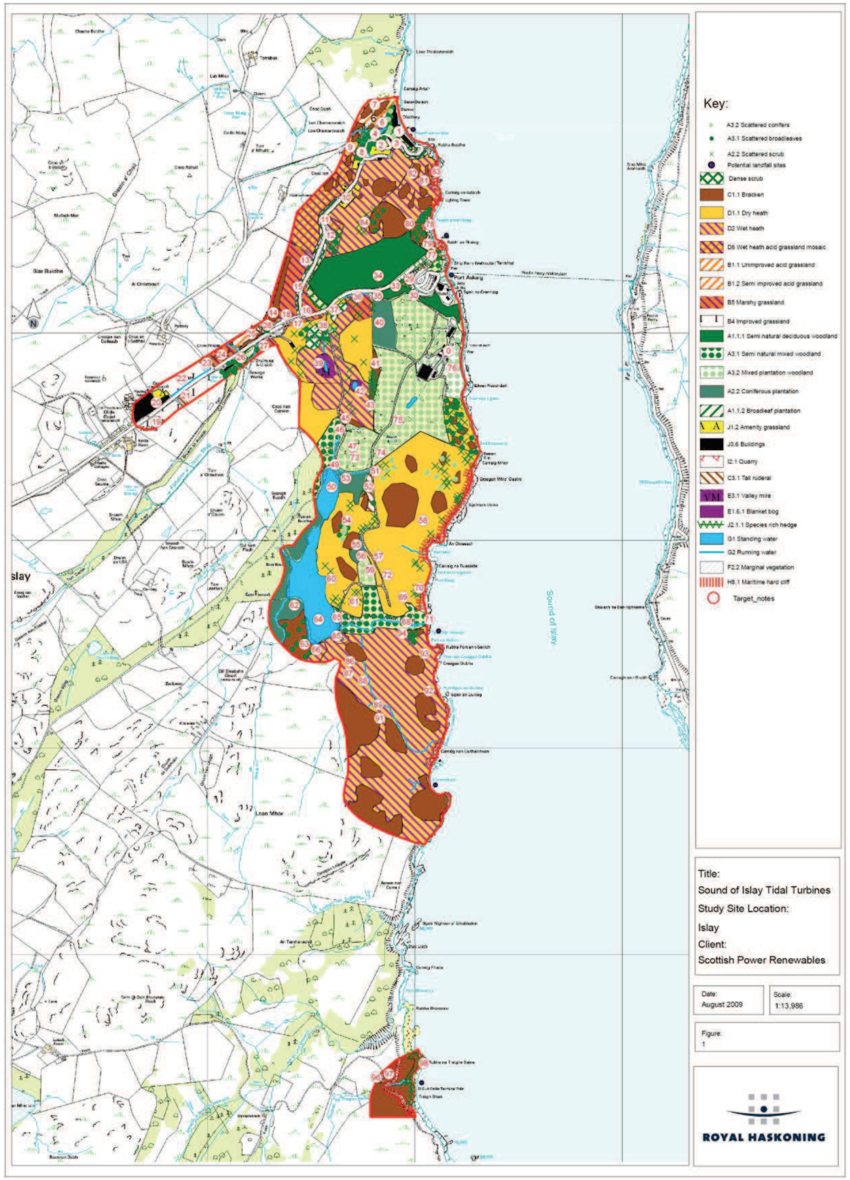

Figure 1 Footprint boundary (red line), potential cable access points (A-F) and habitat codes.

2 METHODS

2.1.1 Phase 1 Habitat Survey

Standard methods were used as described in Joint Nature Conservation Committee (JNCC) Phase 1 Handbook for Habitat Survey (1993).

Every parcel of land throughout the entire survey area was systematically visited by trained surveyors and the vegetation was mapped on to an Ordnance Survey map at a scale of 1:10,000 by hand in the field and then digitised. The final habitat map was electronically colour coded in GIS with standard symbols and colours with regards to the dominant species codes, 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 the colour, the greater the value. Species were identified using standard references books, including FSC (1998), Rose (1991) Sterry (1997) and Fitter (1995).

3 RESULTS

A map identifying the habitat of each parcel of land is presented in Figure 1. A description of each parcel is provided below in the form of target notes. Detailed maps of sections of the footprint are presented in Figures 2 to 6.

3.1 Main findings

Two roads intersect the footprint in the northern sector, one leading to Caol Ila Distillery and leading to Port Askaig ferry terminal, linking the islands of Islay and Jura together (Figure 2). North of Caol Ila, the habitat consists of a matrix of semi-improved acid grassland with dense bracken habitat leading up a steep sloping hillside. West of the Caol Ila road, the habitat leads south into species rich wet heath and acid grassland mosaic, leading to marshy grassland to the road junction. West along the road to the settlement of Kellis (Figure 3), the habitat changes to improved grasslands and farmland. Between the distillery and Port Askaig, the hillside is dominated by wet dwarf shrub heath with outcrops of bracken on raised ground, leading south to semi natural broadleaved woodland. Landing sites E, F and B, closest to current areas of high level anthropogenic activity, were found to have the least amount of high quality or species rich habitat.

Directly south of Port Askaig, the Dunlossit Estate the habitat is dominated by semi-natural broadleaves woodland to the east, with acid dry heath to the east on high ground with valley mire and wet heath habitat in hollows (Figure 4). Scrub and trees including silver birch and rowan are scattered throughout the heath. The south of the woodland is fenced, separating the wooded area from a large expanse of dry heath and bracken complex, with vegetated coastal cliffs to the east and two freshwater lochs to the south. The southern loch is dammed with an inactive hydroelectric power scheme connected. The river from the south east of the loch flows east to the coast, through a semi natural broadleaved woodland with species rich ground flora and moss and lichen. A large waterfall is also present on this river. Otter signs were recorded up the coastline, however this particular location (at landing Site C) provides good freshwater resources for otters to clean their fur along a cliff dominated coastline.

A boundary wall is present south of the river, defining the edge of the broadleaved woodland. South of this point the habitat is dominated by wet dwarf shrub heath on remote hilly ground with bare rock outcrops (Figure 5). Again, a matrix of bracken was present across the site, restricted to the drained steep slopes of the hummocks. Several small streams networked the wet heath, with wet sphagnum rich bog habitats present on the extreme hollows. No path access to this southern section of the main footprint was present, and therefore considerable engineering would be required to provide an access track to Site D compared to the other, more easily accessed, potential landing sites.

The small additional footprint at landing site A was accessed through farmland including improved grassland with heavily poached ground and cattle grazing. The actual footprint was dominated by bracken habitat with vegetated cliffs, with a small stream bisecting the footprint (Figure 6). Access tracks were present to the coast. This bay contains the existing energy cable between the Isles of Jura and Islay.

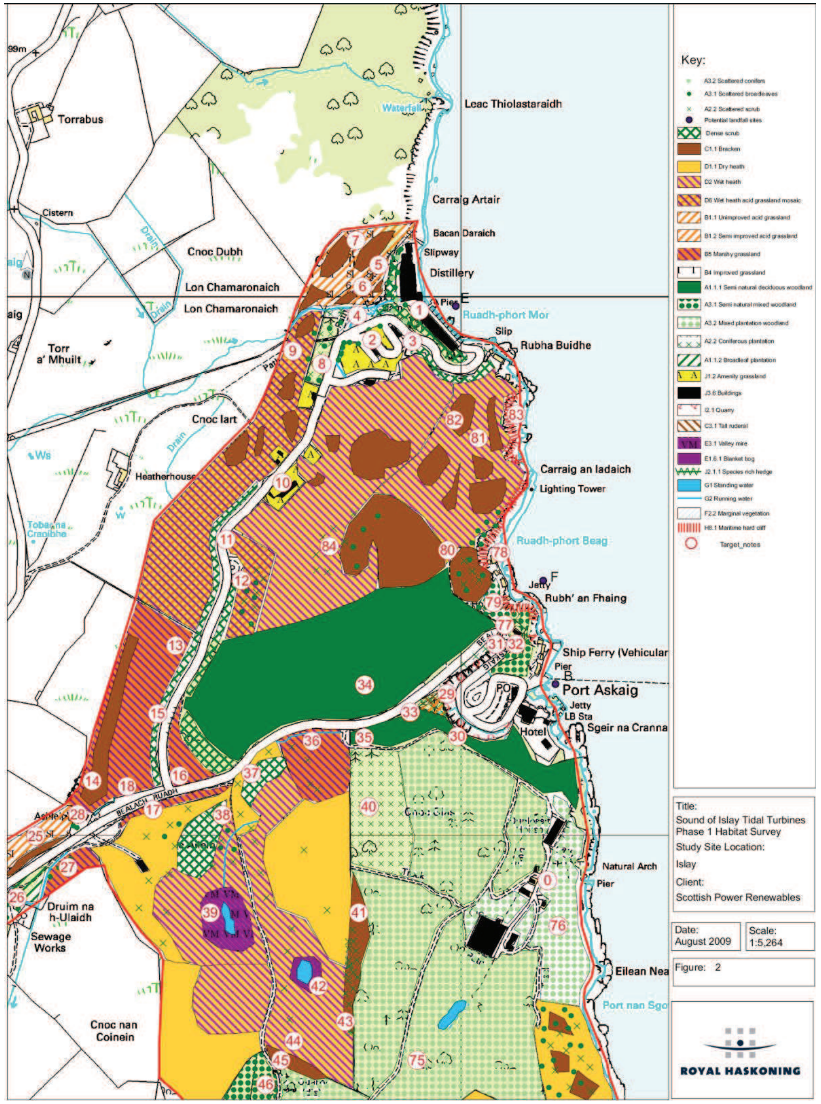

Figure 2 Habitats in the north of the footprint (Sites E, F and B)

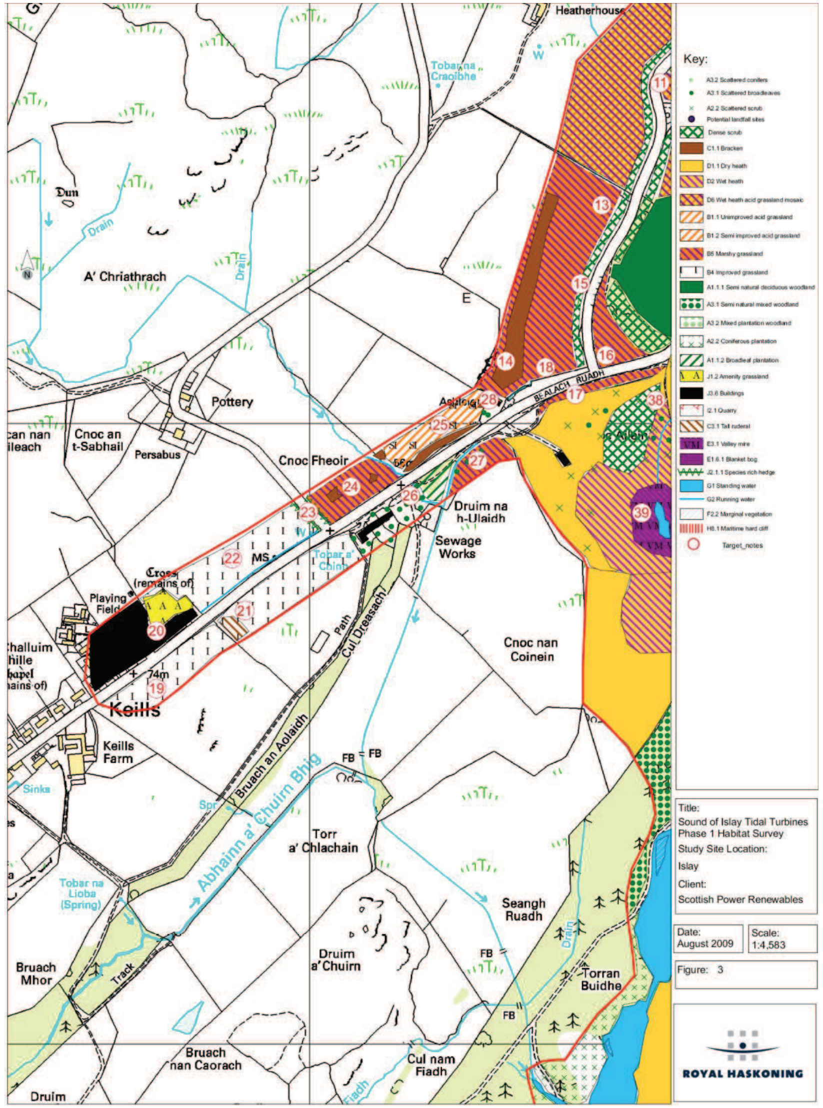

Figure 3 Habitats along route to Keills

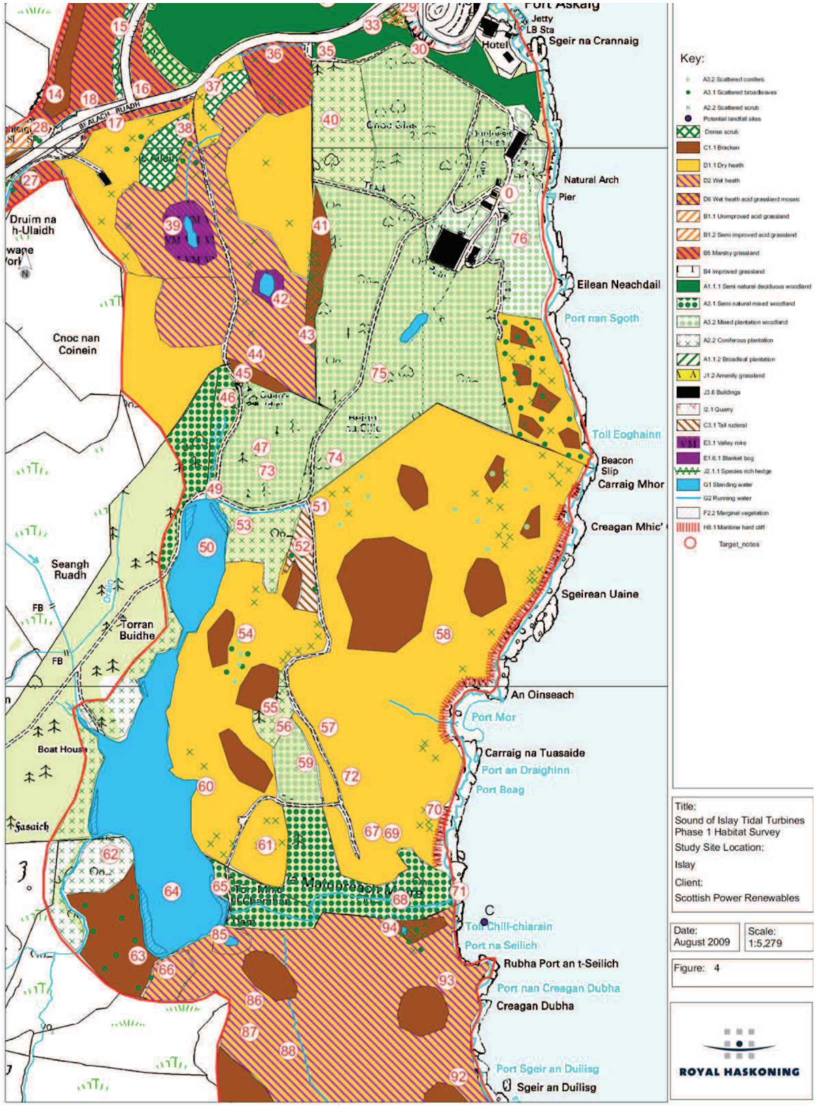

Figure 4 Habitats in the middle of the main footprint (Site C)

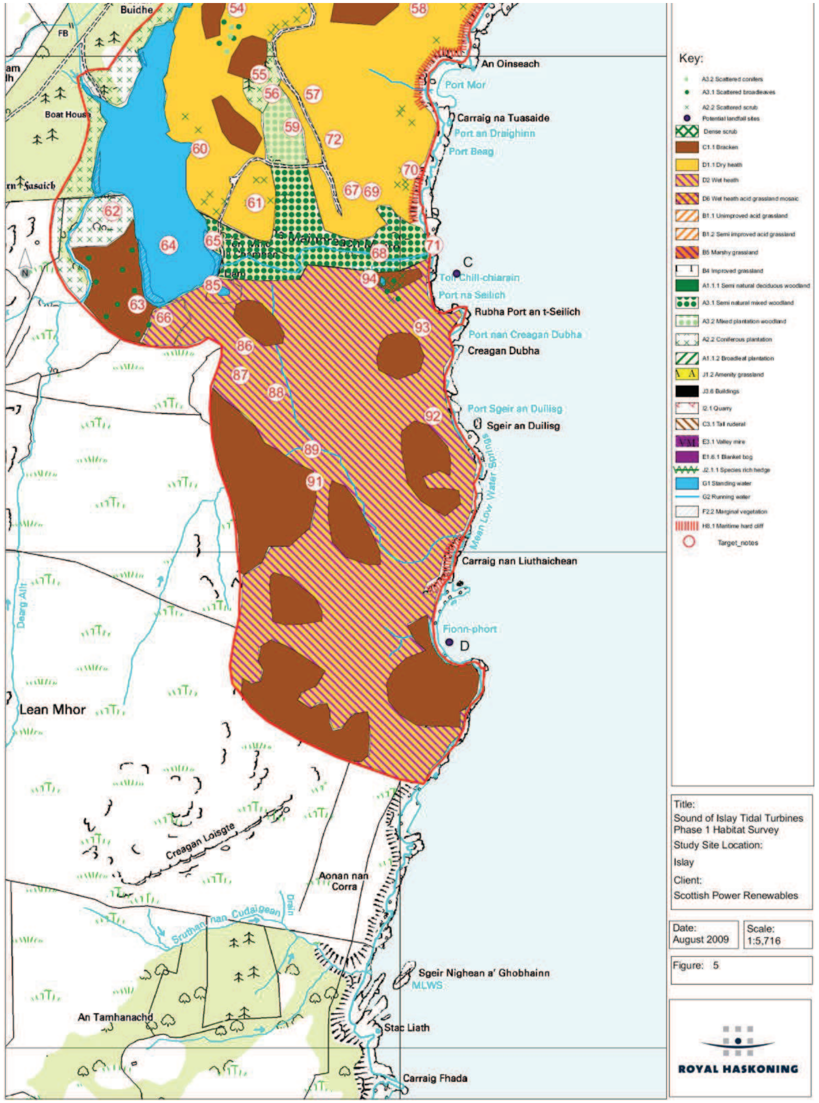

Figure 5 habitats in the south of the main footprint (Sites C and D)

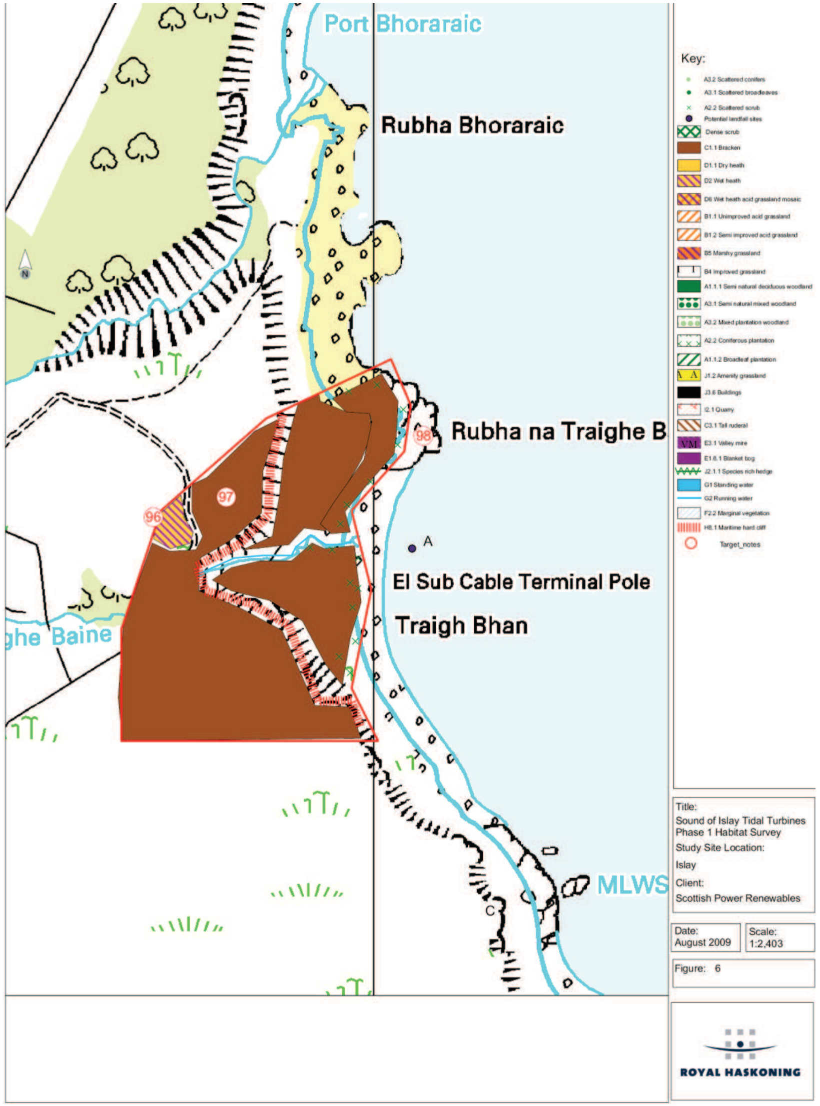

Figure 6 Habitats south of the main footprint (Site A)

3.2 Target notes

Target Note 1: NR 42922 69975
Area immediately surrounding Caol Ila Whisky Distillery. Steep hillside of maintained scrub and young trees, predominantly broadleaved, including rhododendron (*Rhodendron ponticum*), sycamore (*Acer pseudoplatanus*), rowan (*Sorbus aucuparia*), buddleia (*Budleja spp.*), ash (*Fraxinus excelsior*), fuchsia (*Fuchsia spp.*) and holly (*Ilex aquifolium*), with an understory of bramble (*Rubus fructicosus*), ling (*Calluna vulgaris*) and bracken (*Pteridium aquilinum*). Scots pine (*Pinus sylvestris*) was also scattered throughout the vegetation. (Plate 3.1)

Plate 3.1 Caol Ila distillery grounds

Plate 3.2 Amenity grassland and gardens

Target Note 2: NR 42835 69920
Amenity grass and gardens surrounding residential houses and terraces. Amenity grass includes ribwort plantain (*Plantago lanceolata*), white clover (*Trifolium repens*), daisy (*Bellis perennis*), dandelion (*Taraxacum officinale*), red fescue (*Festuca rubra*), perennial ryegrass (*Lolium perenne*) and birds foot trefoil (Lotus corniculatus), with rowan and silver birch (*Betula pendula*) trees lining the road (Plate 3.2).

Target Note 3: NR 42910 69917
Gardens and amenity grassland, leading to scrub.

Target Note 4: NR 42807 69965
Coniferous plantation adjacent to road, consisting of large Cyprus tree (indet.) and Douglas fir (*Pseudotsuga menziesii)*, with occasionally scattered deciduous trees including birch and rowan. The understory consisted of wood horse tail (*Equisetum sylvaticaum)*, ling, bracken, Devil's-bit scabious (*Succisa pratensis*), cocksfoot (*Dactylis glomerata*), tormentil (*Potentilla erecta*), foxglove (*Digitata purpurea*), woodrush (*Luzula sylvatica*), soft rush (*Juncus effusus*), bell heather (*Erica cinerea*) and Yorkshire fog (*Holcus lanatus*). In addition, thistle *Cirsium dissectum*), meadow vetchling (*Lathyrus pratensis*), perennial ryegrass, false oat grass (*Arrhenatherum elatius*), common sorrel (*Rumex acetosa*), buttercup (*Ranunculus repens*), ragwort (*Senecio jacobaea*), cow parsley (*Anthriscus sylvestris*), pineappleweed (*Matricaria matricarioides*), nettle (*Urtica dioica*), dock (*Rumex obtusifolious*) and sharpflowered rush (*Juncus acutiflorus*) were located back from the road, with fuchsia and rhododendron lining a small stream flowing through the wooded area. (Plate 3.3)

Plate 3.3 Small stream in woodland

Plate 3.4 Grassland and bracken matrix

Target Note 5: NR 42846 70059
Culverted small burn on both sides of road, with dock, ragwort, nettles, bracken, white clover, bramble and ribwort plantain.

Target Note 6: NR 42817 70018
Bracken habitat with scattered scrub of rowan, grey willow (*Salix cinerea*) and rhododendron. Understory included Yorkshire fog, common bent (*Agrostis capillaris*), soft rush, nettle and dock.

Target Note 7: NR 42804 70104
Matrix of bracken habitat and semi improved acid grassland (Plate 3.4)

Target Note 8: NR 42741 69875
Cyprus and Douglas fir plantation, with woodrush, rowan, bracken, dock, rhododendron, wood sorrel, grey willow, Yorkshire fog, foxglove.

Target Note 9: NR 42688 69899
Bracken habitat leading to acid peaty heath. Species include ling, bell heather, eyebright (*Euphrasia nemorosa*), young rowan, tormentil, heath spotted orchid (*Dactylorhiza maculata*), deer grass (*Scirpus cespitosus)*, purple moor grass (*Molinia caerulea*), sphagnum moss (*Sphagnum recurvum*), heath milkwort (*Polygala serpyllifolia*), bog asphodel(*Narthecium ossifragum*), bog myrtle (*Myrica gale*), grey willow carr, starry moss (*Polytricum commune*), soft rush and Devil's-bit scabious. Cladonia impexa present amongst heathers (Plate 3.5 and 3.6)

Plate 3.5 Grassland and bracken matrix

Plate 3.6 Bog asphodel and heathers

Target Note 10: NR 42668 69654
Amenity grassland and gardens surrounding houses, immediately surrounded by moorland and bracken.

Target Note 11: NR 42564 69549
Verges with soft rush, ragwort, buttercup, hogweed (*Heracleum spondylium*), dock, red clover, woodrush, cocks foot, sharp flowered rush, gorse (*Ulex europaeus*), ling, bell heather, silverweed (*Potentilla anserina*), white clover, nettle, meadow vetchling, bracken, bramble and yellow loosestrife (*Lysimachia vulgaris*).

Target Note 12: NR 42592 69473
Scattered trees of rowan, silver birch and gorse scrub, leading to a small wooded area of beech (*Fagus sylvatica*), rowan and silver birch. Understory includes sharp flowered rush, purple moor grass, wild angelica (*Angelica sylvestris*), false oat grass, horsetail, thistle, silverweed, bramble, softrush, ragwort, herb robert (*Geranium robertianum*), ragged robin (*Lychnis flos-cuculi*), bog myrtle and common bent. A hollow of ground included standing water and sphagnum mosses. A common hawker dragonfly (*Aeshna juncea*)was observe at this location.

Target Note 13: NR 42470 69352
Marshy grassland, dominated by soft rush, and including gorse, foxglove, bramble, thistle, willow, gorse, bracken, ragwort, silverweed, horsetail, ribwort plantain and meadowsweet.

Target Note 14: NR 42315 69100
Bracken habitat.

Target Note 15: NR 42436 69226
Gorse scrub.

Target Note 16: NR 42477 69110
Bell heather, meadowsweet, soft rush and wild raspberry (*Rubus idaeus*), rising uphill to bell heather and gorse scrub.

Target Note 17: NR 42428 69047
Soft rush, meadowsweet, ragwort, cow parsley, nettle, meadow vetchling, silverweed, dock, bramble, dandelion, cocksfoot, ragged robin, Yorkshire fog, tufted vetch (*Vicia cracca*), horsetail, white clover, wild raspberry, gorse, Devil's-bit scabious, eyebright, scentless mayweed (*Tripleurospermum maritimum*) and pignut (*Conopdium majus*) (Plate 3.7).

Plate 3. 7 Raspberry and scrub

Plate 3.8 Meadowsweet soft rush and heather

Target Note 18: NR 42380 69091
Horsetail, meadowsweet, soft rush, ragwort, dock and red clover. (Plate 3.8)

Target Note19: NR 41753 68573
Tall ruderals including nettle, dock, cow parsley and fuschia in filed margins surrounding substantially improved grassland. Grassland species include silverweed, thistle, annual meadow grass (*Poa annua*), perennial rye grass, dandelion, broadleaved dock, buttercup, daisy and red and white clovers. Maidenhair spleenwort (*Asplenium trichomanes*) was also recorded in the wall adjacent to the field. (Plate 3.9)

Target Note 20: NR 41753 68666
Amenity grassland, including red and white clovers, ribwort plantain, cocks foot, Yorkshire fog, nettle, bordered by a dogrose (*Rosa canina agg*) hedge.

Target Note 21: NR 41895 68698
Tall ruderal and improved grassland matrix, consisting of silverweed, black knapweed (*Centaurea nigra*), meadowsweet, nettle, red and white clovers, meadow vetchling, ribwort plantain, dandelion, scentless mayweed, thistle, cocksfoot, perennial rye grass, Yorkshire fog, false oat grass, bramble and ragwort.

Target Note 22: NR 41875 68783
Improved grassland, including large areas of mown grass. Species include buttercup, thistle, white clover, nettle, horsetail, Yorkshire fog, cow parsley, silverweed. A drystone wall and fence run along both sides of the road, outside ditches with running water. Gorse, bracken, ragwort and bramble are present immediately adjacent to the road.

Target Note 23: NR 41997 68857
Hedge alongside road, continuous and consisting of hawthorn and osier. Verges include silverweed, lolium and meadow vetchling.

Target Note 24: NR 42066 68898
Marshy grassland with patches of bracken. Species include meadowsweet, thistle, cow parsley, ragwort, eyebright, meadow vetchling, buttercup, clover, horsetail cocksfoot, black knapweed, ribwort plantain, tufted vetch, bindweed (*Convolvulus arvensis*), cocksfoot, timothy (*Phleum pratense*), lady's bedstraw (Galium verum) and sneezewort (*Achillea ptarmica*). (Plate 3.10)

Plate 3. 9 Improved grassland with ruderal border

Plate 3.10 Marshy grassland with patches of bracken on raised ground

Target Note 25: NR 42210 68998
This parcel was species rich more drained than TN24, and included thistle, dock, silverweed, cow parsley, ragwort, black knapweed, false oat grass, gorse, annual meadow grass, cocksfoot, bracken, buttercup, white clover, meadow vetchling and ling.

Target Note 26: NR 42162 68884
Stream passing under road. In the riparian habitat, elm (*Ulmus procera*), giant rhubarb , (Gunnera spp) ragwort, bracken, bramble, cocksfoot, Yorkshire Fog, horsetail, sycamore, nettle, leading to a small deciduous woodland of sycamore trees.

Target Note 27: NR 42270 68940
Marshy grassland, consisting of soft rush, broadleaved dock, bracken, ragwort, cow parsley, broad buckler fern (*Dryopteris dilatata*), Yorkshire fog, cocksfoot, meadowsweet, meadow vetchling, raspberry, ribwort plantain, nettle and scattered sycamore trees.

Target Note 28: NR 42288 69039
Scattered sycamore trees amongst bracken, bramble, alder (*Alnus glutinosa*) and field bindweed.

Target Note 29: NR 42973 69262
Unimproved grassland and tall ruderal matrix to the south of here, with scattered scrub to the north. Species include rosebay willowherb (*Chamaenerion angustifolium*), ragwort, broadleaved dock, bramble, tufted vetch, cocksfoot, fuchsia, scattered gorse scrub. Mosses were present on excavated rock.

Target Note 30: NR 42993 69183
Broadleaf woodland, predominantly silver birch, with Scots pine present at <10%.

Target Note 31: NR 43064 69355
Scattered gorse scrub, with ragwort, bramble, buddleia, white clover, silverweed, dandelion, cocksfoot and Yorkshire fog, along with garden escapees.

Target Note 32: NR 43101 69355
Exposed rock with scattered gorse, ragwort, ling, buddleia, cow parsley and bramble.

Target Note 33: NR 42906 69228
Purple loosestrife (*Lythrum salicaria*), bramble, gorse, cocksfoot, ragwort, white clover, dock and thistle.

Target Note 34: NR 42821 69279
Deciduous semi natural woodland of silver birch, sycamore, alder and gorse, with scattered Scots pine.

Target note 35: NR 42820 69181
Target note removed

Target Note 36: NR 42723 69175
Open water, with burn on south side of road, surrounded by marshy grassland including soft rush, cocksfoot and timothy.

Target Note 37: NR 42610 69114
Ling, bell heather, soft rush, foxglove, bramble, bracken, ragwort, thistle, tormentil, red clover, Yorkshire fog, bog myrtle, purple moor grass, bilberry (*Vaccinium myrtillus*), sheeps sorrel (*Rumex acetosella*), cow parsley, velvet bent (*Agrostis canina*), bog asphodel and rhododendron, with scattered rowan trees and gorse and small rock outcrops. Locally abundant patches of sphagnum moss and starry moss were also present. Where the land undulates, the habitat is wetter with more mosses in the hollows

Target Note 38: NR 42557 69037
Bracken, gorse and scrub mosaic with stone outcrops (Plate 3.11)

Target Note 39: NR 42534 68856
Wet bog, with soft rush, gorse and grey willow carr scrub, with standing water present. (Plate 3.12)

Plate 3. 11 Bracken. scrub and gorse mosaic

Plate 3.12 Standing water and marsh/bog habitat

Target Note 40: NR 42828 69053
Conifer plantation behind a stone wall

Target Note 41: NR 42810 68856
Scattered gorse and scrub between deer fence and coniferous plantation, of silver birch, sycamore, rhododendron, foxglove and bracken.

Target Note 42: NR 42735 68719
Standing water on sphagnum moss, with bell heather, deer grass, ling and common sorrel

Target Note 43: NR 42785 68653
Bracken and gorse scrub matrix

Target Note 44: NR 42689 68608
Dense sharp flowered rush in hollow, with rhododendron, bell heather, ling, tormentil, thistle, bracken, gorse, soft rush, starry moss, woolly hair moss. To the west of this point is scattered bracken and gorse.

Target Note 45: NR 42665 68582
Rowan, silver birch, hawthorn (*Crataegus monogyna*) and sycamore woodland with scattered Scots pine, with an understory of hard fern (*Blechnum spicant)*, bracken, bramble and foxglove.

Target Note 46: NR 42637 68537
Deciduous woodland with holly, sycamore, silver birch, elm and rowan, with an understory of bramble and bracken, with ragwort, fuschia, creeping buttercup, foxglove and wild angelica. (Plate 3.13)


Plate 3. 13 deciduous woodland with bracken understory


Plate 3.14 Caterpillars of The Cinnabar moth on ragwort

Target Note 47: NR 42699 68444
Stone outcrops in open woodland, consisting of Scots pine, gorse, silver birch, sycamore, elm, hawthorn, bramble, bell heather, foxglove, angelica, tormentil, ribwort plantain, honeysuckle (*Lonicera periclymenun*), hard fern, rowan and woodrush.

Target Note 48:
Target note removed.

Target Note 49: NR 42613 68367
Woodland on both sides of path becomes denser. To the east, the woodland is predominantly coniferous pines with occasional silver birch and sycamore, with a light understory including hard fern, broad buckler fern and foxglove. To the west of the path, the species complex is dominated by rowan, ash, white willow (*Salix alba*) and sycamore, with occasional pine, with an understory of broad buckler fern and bramble. In addition, caterpillars of The Cinnaber moth (*Tyria jacobaeae*) were recorded feeding on ragwort by the woodland path (Plate 3.14).

Target Note 50: NR 42598 68258
Lily Loch, containing lily pads (*Nymphaeaceae* indet), hard rush (*Juncus inflexus*) and broadleaved pondweed (*Potamogeton natans*) (Plate 3.15). Open moorland is present to the southeast, with predominantly coniferous woodland surrounding the other sides of the loch. At the loch margins, silverweed, angelica, ribwort plantain, water parsnip (*Berula erecta*), alder, willow and sheep sorrel are present.

Target Note 51: NR 42809 68334
Bracken and heath complex, including ling, bell heather, silver birch, willow, ragwort, with scattered self seeded conifers.

Target Note 52: NR 42776 68260
Bramble, bracken, thistle, birch, willow, wild angelica, ragwort, soft rush, bent indet. (*Agrostis* spp.), hard rush, meadow vetchling, thistle, rosebay willowherb. (Plate 3.16)


Plate 3. 15 Lily Loch


Plate 3.16 Bracken and heath

Target Note 53: NR 42667 68299
Open plantation including Scots pine and bracken, with scattered silver birch.

Target Note 54: NR 42671 68098
Scattered self seeded coniferous and silver birch trees, with bracken and marshy rush/ tufted hair grass (*Deschampsia caespitosa*) complex. Grey willow was present adjacent to the path.

Target Note 55: NR 42716 67960
Mature conifers, predominantly self seeded Douglas firs, with scrubby grey willow, silver birch, bracken, wild angelica, soft rush, tufted hair grass, rowan.

Target Note 56: NR 42741 67925
Mature Scots pine.

Target Note 57: NR 42824 67924
Bracken, with Norway spruce (*Picea abies*), rowan, scattered scrub, foxglove with heath patches in a matrix, heath including bell heather, ling, bog asphodel, tormentil and soft rush.

Target Note 58: NR 43038 68097

Moorland heath including bell heather, ling, bog asphodel, tormentil ladies bedstraw, wavy hair grass and soft rush, with young rhododendron plants and scattered Douglas firs and bracken.

Target Note 59: NR 42782 67858
Dense woodland plantation, including silver birch, rowan, Douglas fir, alder, bay willow (*Salix pentandra*) and Norway spruce, with an understory of gorse, bramble, ragwort, foxglove, cleavers (*Galium aparine*), soft rush, thistle, ling and bell heather.

Target Note 60: NR 42596 67814
Heath and bracken complex, including scattered self seeded Norway spruce, grey willow, silver birch, rhododendron, bell heather, ling, bracken and soft rush.

Target Note 61: NR 42707 67705
Self seeded Norway Spruce, amongst dense bracken and heath, with bell heather, ling, rowan, silver birch, rhododendron, angelica and occasional Scots pine.

Target Note 62: NR 42419 67688
Coniferous plantation

Target Note 63: NR 42470 67499
Bracken habitat with scattered deciduous trees, predominantly willow and birch.

Target Note 64: NR 42533 67619
Loch with hard rush in emergent areas, with field horsetail and water lily

Target Note 65: NR 42623 67629
Gorse, birch, Scots pine, bramble, willow, ragwort, daisy, thistle, Yorkshire fog, foxglove, alder.

Target Note 66: NR 42523 67473
Marshy heath, with ling, bell heather and soft rush.

Target Note 67: NR 42917 67730
Bracken habitat.

Target Note 68: NR 42958 67603
Semi-natural beech/ash woodland, with sycamore, Scots pine, with a deep gorge and waterfall (Plate 3.17) leading to coast (Plate 3.18). Rocky outcrops are present in the woodland. Ground flora include woodrush, bracken, rhododendron, ground ivy, holly and wood sorrel (*Oxalis acetosella*). Otter spraints found along river and on prominent coastal rocks.


Plate 3. 17 Gorge and waterfall


Plate 3.18 Downstream of waterfall

Target Note 69: NR 42942 67727
Scrub behind bracken, predominantly grey willow, silver birch and rowan.

Target Note 70: NR 43021 67771
Coastal margin, predominantly bracken and scrub/small trees of gorse, grey willow, self seeded Norway spruce and rhododendron. Vegetated seacliffs lead to rocky shore of bedrock, cobbles, boulders and pebbles. Rocky outcrops are present in the cliff edge, with dense high vegetation.

Target Note 71: NR 43067 67619
Common seals hauled out on rocks to the south, with a path leading to the substation by the river. Sycamores, bracken, foxglove, bramble, ling, bell heather and lichens on stone outcrops are present, with sheep sorrel (*Rumex acetosella)*, silverweed, cow parsley grey willow, thrift (*Armeria maritima)*, sea plantain (*Plantago maritima*), yellow scales (*Xanthoria parietina*) and sea ivory (*Ramalina siliquosa*) lichens on rocks, eyebright, birds foot trefoil, black knapweed, lady's bedstraw, tufted vetch and hard fern. Dense bracken and scrub were present to the south on the coastal margin, and evidence of pigs (digging marks and faeces) was present on the beach.

Target Note 72: NR 42866 67832
Marshy moorland, with bell heather, ling, bog asphodel, tormentil ladies bedstraw, wavy hair grass and soft rush and sphagnum moss and starry moss.

Target Note 73: NR 42710 68400
Mixed woodland of Scots pine, sycamore, birch, willow, beech, rowan and elm with an understory of foxglove, meadow thistle, meadowsweet, rosebay willowherb, bracken, bramble and bell heather.

Target Note 74: NR 42837 68424
Mixed woodland of horse chestnut (*Aesculus hippocastanum)*, beach, grey willow, sycamore, Scots pine, with an understory of cocksfoot, Yorkshire fog, meadowsweet, woodrush, foxglove, thistle, ragwort, bell heather, broad buckler fern and ribwort plantain.

Target Note 75: NR 42918 68582
Track of rough scrubby heath through woodland, used by quadbikes and containing ling, bell heather, soft rush, purple moor grass, rowan, woodrush, sphagnum moss, tormentil, starry moss, and cotton grass (*Eriophorum angustifolium*). The wooded areas on both sides of the track contain birch, Norway spruce and rowan, with a thick bracken understory.

Target Note 76: NR 43180 68832
Mixed woodland with woodrush, wood sorrel, foxglove, Scots pine, rowan, silver birch, rhododendron, with small patches of dense bracken and bramble.

Target Note 77: NR 43081 69390
Mixed woodland with scrubby bracken, including ragwort, scentless mayweed, silverweed, Scots pine, meadowsweet, wild angelica, sycamore, red clover, white clover, thistle, gorse, rosebay willowherb, bracken, cow parsley, bramble, cocksfoot, Yorkshire fog, broadleaved dock (*Rumex obtusifolius*), beach, foxglove.

Target Note 78: NR 43073 69525
Vegetated steep cliffs to bouldery shore, with ling, bell heather, mature silver birch trees and bracken.

Target Note 79: NR 43060 69432
Scrubby bracken matrix with scattered trees, including woodrush, tormentil, wavy St John’s wort (*hypericum triquetrifolium*), bracken, rowan, gorse, bramble, soft rush, foxglove, silver birch, grey willow, ash, rhododendron, sharp flower rush, sphagnum moss starry moss.

Target Note 80: NR 42974 69529
Bracken with patches of scattered birch and foxglove up on the hillside.

Target Note 81: NR 43032 69737
Predominantly bracken with heath matrix of ling, bell heather, rowan, foxglove, silver birch, heath spotted orchid, soft rush, bilberry and purple moor grass.

Target Note 82: NR 42987 69771
Bracken habitat with heath patches and small outcrops of rock.

Target Note 83: NR 43102 69781
Coastal margin of vegetated seacliffs and broadleaved woodland to rocky boulders tubular water dropwort (*Oenanthe fistulosa*).

Target Note 84: NR 42755 69536
Heath with scattered scrub and bracken patches, and scattered Scots pine and silver birch. The ground consisted of large hummocks, small hills, dry on top and wet in the hollows. Species include cotton grass, sharp flower rush, heath spotted orchid, ling, bell heather, tormentil, soft rush, bilberry and rhododendron.

Target Note 85: NR 42622 67539
Dry heath, wet hollows, with bog asphodel, ling, bell heather, purple moor grass, bog myrtle, soft rush, sneezewort, thistle, rhododendron, sharp flower rush, tormentil and hard fern. Common butterwort (*Pinguicula vulgaris*) was located in a wet hollow, but not recorded anywhere else on the site. (Plate 3.19)

Target Note 86: NR 42686 67416
Scattered scrub of willow carr and silver birch on a bracken/heath matrix.

Target Note 87: NR 42678 67357
Wet heath, with abundant sphagnum moss and cotton grass.

Target Note 88: NR 42749 67322
Broad-leaved pondweed and bogbean (*Menyanthes trifoliata*) in a small area of standing water with scattered grey willow bushes in wet heath. (Plate 3.20)

Plate 3.19 Dry heath with wet hollows

Plate 3. 20 Broad leaved pondweed and bogbean

Target Note 89: NR 42821 67207
Small burn with running water through the wet heath.

Target Note 90: NR 42806 67200
Small round hill with rocky outcrops. Heath habitat consists of ling, bell heather, purple moor grass, bilberry (pink 104 105 view south).
To the south of this point, the ground was hummocky

Target Note 91: NR 42828 67142
Stream in heath, leading to coastal margin of a rocky bedrock shore. Steep vegetated cliffs to sea. Scattered scrub, including grey willow, rowan and bracken in the re-entrant. Patches of bog myrtle. Otter (*Lutra lutra*) was observed foraging along the coastal margin from this vantage point.

Target Note 92: NR 43066 67274
Flowing stream in heath and bracken habitat, with re-entrant containing grey alder and rowan.

Target Note 93: NR 43044 67453
Bay D. Steep vegetated cliffs to the north, with a gentle gradient to the south (Plate 3.20). Common seal (*Phoca vitulina*) hauled out. Dense bracken habitat up coastal margin, with bracken, ling, bell heather and birch on the cliffs.

Target Note 94: NR 42938 67551
Dense bracken with willow carr and a small pond present. Rowan and birch trees by a stone wall south of a waterfall.

Target Note 95: NR 43187 68828
Small scatterings of Japanese knotweed, 4 plants on either side of the path.

Target Note 96: NR 42812 65407

Bracken and scattered willow carr surrounding track, dense habitat with small patch of heath contained within. Heath species include purple moor grass, tormentil, bog myrtle, cotton grass, bell heather, ling, bog asphodel, sphagnum moss, starry moss, bilberry, creeping bent and Yorkshire fog. (Plate 3.22)

	
Plate 3.20 vegetated sea cliffs	Plate 3. 22 Pocket of dry heath with bog asphodel

Target Note 97: NR 42874 65424
Riparian, dense and shady habitat – birch, bracken, sphagnum moss, water forget me not (*Myosotis scorpioides)*, Yorkshire fog, thistle, bramble, grey willow carr, white clover, red clover, daisy, herb Robert, broad leaved willowherb (*Epilobium montanum*).

Target Note 98: NR 43042 65476
Scattered trees amongst bracken habitat, including birch, young Scots pine and rowan. Small patches of heath grassland complex within the bracken, including soft rush, nettle, eyebright, dandelion, tormentil, sheep sorrel, white clover, meadowsweet, Yorkshire fog, common bent, devil's bit scabious, black knapweed, selfheal (*Prunella vulgaris*), ling, ribwort plantain, bramble, bell heather, purple moor grass. A female adder was observed basking on the track, and disappeared into the bracken habitat on disturbance.

From this location, the coastal margin away from the bay was observed to be steep vegetated sea cliffs leading to gentle angled hills back from the coast. Power cables are present, as part of the Islay-Jura connection.

4 CONCLUSIONS

4.1 Habitats

The footprint of the proposed scheme contains a complex habitat matrix incorporating wet and dry heath, bracken, woodland and water bodies. The topography of the land is characteristically hilly, particularly in the north and south of the survey area, where the wet heath habitat is of high species richness and high quality. Bracken habitat dominates areas of dry raised ground, with valley mire and wet boggy habitat dominating the hollows of ground. Broad leaved and mixed semi natural woodlands are present in much of the middle of the footprint. Two large interlinked freshwater lochs are present on the western margin of the footprint, with smaller lochans and stream and river systems networking the footprint. The coastal margin is predominantly vegetated sea cliff, with small sheltered bedrock, shingle or sandy embayments distributed up the coastline. To the west of the site, habitat is of lowest quality, consisting of farmed improved grasslands, with buildings and amenity grassland.

4.2 Protected habitats

There are no Special Areas of Conservation (SAC), Sites of Special Scientific Interest (SSSI) or National or Local Natures Reserves (NNR and LNR respectively) in or adjacent to the proposed footprint.

Three terrestrial habitats listed under Annex I of the EU Habitats Directive are abundantly present on Islay. These are as follows:

- North Atlantic wet heath;
- Blanket bog;
- European dry heath

Both wet and dry heaths were dominating habitats across much of the footprint, with bog features present in hollows within the topography of the study area.

Argyll and Bute have several habitats for which Biodiversity Action Plans have been developed which were found within the footprint of the proposed scheme. They are as follows:

Broad habitats

- Coniferous woodland;
- Improved grassland;
- Rivers and streams; and
- Standing open water and canals.

Local habitats

- Open hill ground;
- Peatlands;
- Species Rich Grassland; and
- Unimproved/semi-improved grassland.

Priority Habitats

- Coastal vegetated shingle; and
- Maritime cliff and slopes.

4.3 Protected species

Although a protected species survey was not being completed alongside the Phase 1 Habitat survey, several protected species were encountered which have been recorded below.

Otter
Otters are protected by the EC Habitats Directive, which is transposed into domestic law through the Conservation (Natural Habitats, &c.) Regulations 1994. The latter are hereafter referred to as 'the Habitats Regulations'. Under the Habitats Regulations, otters are classed as "European Protected Species" and therefore given the highest level of species protection.

The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007 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[1] or harass an otter
- damage, destroy or obstruct access to a breeding site or resting place of an otter (i.e an otter shelter)

Thus, otter shelters are legally protected whether or not an otter is present.

Evidence of otter (*Lutra lutra*) was found throughout the coastal margin of the proposed footprint, and it is therefore presumed the Sound of Islay is included in the habitat range of several species.

The majority of otter signs and activity were found in the southern half of the coastal footprints, with an otter observed foraging just north of Site D, and otter spraints and crustacean remains found at Sites C, D and A, however a footprint was also found at Caol Ila (Site E) (Royal Haskoning, 2009). A targeted otter survey would be recommended in advance of any construction.

A dedicated otter survey will be required for the cable development at all locations, and advice will be required to be sought from Scottish Natural Heritage (SNH) to establish mitigation measures to reduce impacts[*].

Adder
The adder (*Vipera berus)* is one of four British reptiles found in Scotland and is listed on Schedule 5 (Protected animals) of the LUK2 - Wildlife and Countryside Act 1981 of the United Kingdom. (W5.Oct01) (Sections 9(1) "killing & injuring" and 9(5) "sale" only).This species is listed on the Dangerous Wild Animals Act 1976 (as amended by The Dangerous Wild Animals Act 1976 (Modification) Order 1984).

A female adder was discovered basking on the track at Site A, approximately 50m up from the coast. On disturbance it disappeared into the dense bracken habitat. A female adder was also identified at the same site just above the intertidal zone during the cabling study walkover (August 2009). It is therefore assumed that adders are defiantly located in habitat at Site A, with potential to be located at Sites C and D due to the remoteness of these sites and the presence of suitable habitat (i.e. moorland, heath, bogs, open woodland). Sites B, E and F are subject to higher levels of disturbance and development than the southern sites, however adders may still be present at these locations too. Further surveys may be required (NB hibernation occurs October to February) and consultation should be sought with SNH regarding the potential impact to this species.

Golden Eagle
The golden eagle (*Aquila chrysaetos)* is afforded protection under the Schedule 1 of the Wildlife and Countryside Act 1981. It is an offence to intentionally take, injure or kill a golden eagle or to take, damage or destroy its nest, eggs or young. It is also an offence to intentionally or recklessly disturb the birds close to their nest during the breeding season. The Nature Conservation (Scotland) Act 2004 widens this protection and provides additional protection for the golden eagle in Scotland.

Records of a golden eagle around Site A were mentioned to the surveyors by Islay Energy Trust, and a golden eagle was sighted carrying food whilst the surveyors were walking out of the site, halfway from the coast to the Lossit Farm buildings.

Marine mammals
All cetaceans found within Scottish waters are protected by a range of national and international obligations:

- Council Directive 92/43/EC on the Conservation of Natural Habitats and of Wild Fauna and Flora, Annex IV (the 'Habitats Directive'). The bottlenose dolphin and harbour porpoise are also listed as Annex II species;
- The harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncates and* Minke whale *Blaenoptera acutorostrata* are protected under Schedule 2, Regulation 38 of The Conservation (Natural Habitats, & c.) Regulations 1994;
- Convention on the Conservation of Migratory Species (The Bonn Convention);
- Wildlife and Countryside Act 1981;
- Nature Conservation (Scotland) Act 2004; and
- The harbour porpoise is afforded further protection under OSPAR's list
- of threatened and declining species (Annex V).

During the survey, common seals were recorded hauled out at Sites A, D and C, and a male orca whale was observed milling approximately 200m off the coast from Site C. These sightings should be considered within the marine mammal assessment work as part of this project.

4.4 Invasive species

The footprint of the proposed scheme was assessed for terrestrial invasive species during the Phase 1 Habitat survey. No assessment was made of aquatic invasive species.

The species found are as follows:

Giant hogweed
Giant hogweed (*Heracleum mantegazzianum*) is listed under the Wildlife and Countryside Act 1981.

No giant hogweed was present in the survey footprint, and no further survey is required for this species.

Japanese knotweed
Japanese Knotweed originated in Japan and Northern China, and is a tall, perennial plant with vigorous growth which has been widely disturbed throughout Europe. As this species has been

[*] Guidance is available from www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

removed from the natural enemies that control its growth in its native range in Japan, it out competes native plants and animals in this country (Environment Agency 2005).

The Wildlife and Countryside Act 1981, provides the primary controls on release of non native species into the wild in the UK. Listed below is the legislation which covers the handling and disposal of Japanese knotweed. These have consequences for a wide range of people, including developers, local authorities and land owners.

- Wildlife and Countryside Act 1981;
- Environmental Protection Act 1990;
- Waste Management Licensing Regulations 1994; and
- Hazardous Waste Regulations 2005.

Japanese knotweed (*Fallopia japonica*) was recorded at NR43187 68828, east of the Dunlossit Estate buildings, where four small plants were present both east and west of the footpath. The area close to the buildings was not surveyed so as not to disturb occupants.

If the cable route is proposed to include the area of Dunlossit Estate where Japanese knotweed was found, further invasive species mapping will be required in this area, in consultation with the landowners. No further surveys are required in the rest of the footprint of the scheme.

Rhododendron

Rhododendron can be difficult to control and forms dense impenetrable thickets that are difficult to treat, and is a threat to biodiversity, out-competing native species and monopolising local environments; Rhododendron also exudes toxic chemicals into the soil around them to suppress competing vegetation.

Rhododendron is not required by legislation to be removed. No further work is therefore required for this species by law however best practice should ensure minimisation of spread across the site..

Rhododendron (*Rhodendron ponticum*) was present through the survey footprint, as has been recorded within the target notes. The species was generally found as large bushes close to roads, woodlands and development, and as small sprigs within the acidic heath and moorland complexes.

Himalayan balsam

No Himalayan balsam (*Impatiens glandulifera*) was recorded within the study area and no further survey is required for this species.

4.5 Ecological assessment of landfall sites

From an environmental perspective, some of the potential landfall sites are preferable to others (Figure 1). Landfall Sites E (Caol Ila distillery) and B and F (Port Askaig) are considered to be ideal as these areas are already developed and do not contain the higher quality habitats found elsewhere in the footprint. In addition, while landfall point A to the south of the footprint constituted a beautiful landscape with good quality intertidal habitat, there are already cables present at the site, as well as access and infrastructure. The presence of these attributes does not appear to have had a negative impact on the landscape or the quality of the habitat. Indeed, the cables seem to have provided an artificial reef providing substrate for a diversity of sea weeds (Royal Haskoning, 2009).

Potential landfall Sites C and D however, may be better avoided. Site C is at the site of the mouth of the Eas Forsa River. This source of freshwater may be important for otters to maintain the waterproof properties of their fur. Indeed, several spraints were found on rocks in this river indicting that it is used by otters. Freshwater as easily accessible yet undisturbed as this river mouth may be scarce along the coastline, so if disturbance to the area can be avoided then that is to be recommended. However, this does not mean that works are totally precluded in this area, but a targeted otter survey would be recommended in advance of any construction.

At potential landfall Site D, the area comprises a remote stretch of coastline surrounded by high quality wet heath habitat. There is no access to the area and the disturbance that would be required to bring machinery and plant into the area would be high. It is therefore recommended that this area should not be developed. Again, however, works are not precluded here, but the environmental impact would be high compared to Sites E, B and A.

5 RECOMMENDATIONS

Following the Phase 1 Habitat survey, several recommendations are made and are as follows:

1) Sites E, F and B are ecologically preferred options for cable landings regarding minimising the impacts on quality habitats and protected species.

2) A thorough Phase 1 Habitat survey was completed across the site with no survey restrictions and at an optimum time of year. It is therefore recommended that consultation occurs with SNH following the decision as to which landing site is the preferred choice (following consideration of all factors including engineering, land ownership, feasibility, cost etc).

3) An otter survey is required for all landing sites.

4) A terrestrial invasive species survey is not required unless cable development is to occur near the Dunlossit Estate buildings.

5) An aquatic invasive species survey was not completed during the Phase 1 habitat survey, and advice should be sought from SNH as to whether one is required.

6) Advice should be sought from SNH regarding reptile mitigation.

7) The sightings of common seal and orca whale should be added to the marine mammal baseline.

8) The sighting of golden eagle should be added to the ornithology baseline.

6 SPECIES LIST

Latin name	Common name
Grasses, ferns, rushes, lichens, pondweeds	
Agrostis canina	Velvet bent
Agrostis capillaris),	Common bent
Agrostis spp.	Bent indet
Agrostis stolonifera	Creeping bent
Arrhenatherum elatius	False oat grass
Asplenium trichomanes	Maidenhair spleenwort
Blechnum spicant	Hard fern
Cladonia impexa	A lichen
Dactylis glomerata	Cocksfoot
Deschampsia caespitosa	Tufted hair grass
Dryopteris dilatata	Broad buckler fern
Equisetum sylvaticaum	Wood horse tail
Eriophorum angustifolium	Cotton grass
Festuca rubra	Red fescue
Holcus lanatus	Yorkshire fog
Juncus acutiflorus	Sharpflowered rush
Juncus effusus	Soft rush
Juncus inflexus	Hard rush
Lolium perenne	Perennial ryegrass
Luzula sylvatica	Woodrush
Molinia caerulea	Purple moor grass
Phleum pratense	Timothy
Poa annua	Annual meadow grass
Polytricum commune	Starry moss
Potamogeton natans	Broadleaved pondweed
Pteridium aquilinum	Bracken
Ramalina siliquosa	Sea ivory
Rumex obtusifolius	Broadleaved dock
Scirpus cespitosus	Deer grass
Sphagnum recurvum	Sphagnum moss
Xanthoria parietina	Yellow scales
Herbs and flowers	
Achillea ptarmica	Sneezewort
Angelica sylvestris	Wild angelica
Anthriscus sylvestris	Cow parsley
Armeria maritima	Thrift
Bellis perennis	Daisy
Berula erecta	Water parsnip
Centaurea nigra	Knapweed
Chamaenerion angustifolium	Rosebay willowherb
Cirsium dissectum	Thistle
Conopdium majus	Pignut
Convolvulus arvensis	Field bindweed
Dactylorhiza maculata	Heath spotted orchid
Digitata purpurea	Foxglove
Epilobium montanum	broad leaved willowherb
Euphrasia nemorosa	Eyebright
Filipendula ulmaria	Meadowsweet
Galium aparine	Cleavers
Galium verum	Lady's bedstraw
Geranium robertianum	Herb Robert
Heracleum spondylium	Hogweed
hypericum triquetrifolium	Wavy St John's wort
Lathyrus pratensis	Meadow vetchling
Lonicera periclymenun	Honeysuckle
Lotus corniculatus	Birds foot trefoil
Lychnis flos-cuculi	Ragged robin
Lysimachia vulgaris	Yellow loosestrife
Lythrum salicaria	Purple loosestrife
Matricaria matricarioides	Pineappleweed
Menyanthes trifoliata	Bogbean
Myosotis scorpioides	Water forget-me-not
Narthecium ossifragum	Bog asphodel
Nymphaeaceae indet	Lily pads
Oenanthe fistulosa	Tubular water dropwort
Oxalis acetosella	Wood sorrel
Pinguicula vulgaris	Common butterwort
Plantago lanceolata	Ribwort plantain
Plantago maritima	Sea plantain
Polygala serpyllifolia	Heath milkwort
Potentilla anserina	Silverweed
Potentilla erecta	Tormentil
Prunella vulgaris	Selfheal
Ranunculus repens	Buttercup
Rumex acetosa	Common sorrel
Rumex acetosella	Sheep sorrel
Rumex obtusifolious	Dock
Senecio jacobaea	Ragwort
Succisa pratensis	Devil's-bit scabious
Taraxacum officinale	Dandelion
Trifolium repens	White clover
Tripleurospermum maritimum	Scentless mayweed
Urtica dioica	Nettle
Vicia cracca	Tufted vetch
Trees, shrubs, scrubs and heathers	
Acer pseudoplatanus	Sycamore
Aesculus hippocastanum	Horse chestnut

Alnus glutinosa	Black Alder
Alnus incana	Grey alder
Betula pendula	Silver birch
Budleja spp	Buddleia
Calluna vulgaris	Ling
Crataegus monogyna	Hawthorn
Cupressus Indet.	Cypress tree (indet.)
Erica cinerea	Bell heather
Fagus sylvatica	Beech
Fraxinus excelsior	Ash
Fuchsia spp	Fuchsia
Gunnera spp	Giant rhubarb
Ilex aquifolium	Holly
Myrica gale	Bog myrtle
Picea abies	Norway spruce
Pinus sylvestris	Scots pine
Pseudotsuga menziesii	Douglas fir
Rhodendron ponticum	Rhododendron
Rosa canina agg	Dogrose
Rubus fructicosus	Bramble
Rubus idaeus	Wild raspberry
Salix alba	White willow
Salix cinerea	Grey willow
Salix pentandra	Bay willow
Sorbus aucuparia	Rowan
Ulex europaeus	Gorse
Ulmus procera	Elm
Vaccinium myrtillus	Bilberry

Fauna

Aeshna juncea	Common hawker dragonfly
Aquila chrysaetos	Golden Eagle
Lutra lutra	Otter
Orcinus orca	Orca whale (male)
Phoca vitulina	Common seal
Tyria jacobaeae	The Cinnaber moth (caterpillar)
Vipera berus	Adder (female)

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7 REFERENCES

Environment Agency (2005). Managing Japanese Knotweed on development Sites, The Knotweed Code of Practice

Fitter, r. (1995) Collins Pocket Guide to the Grasses, Sedges, Rushes & Ferns of Britain & N Europe. Harper Collins

FSC (1998) Grasses Identification Chart

JNCC (2003) Handbook for Phase 1 Habitat Survey, a technique for environmental audit.

Rose, F(1991) The Wild Flower Key, Britsh Isles – N.W. Europe. The Penguin Group

Royal Haskoning (2009) Sound of Islay Tidal Turbines: Intertidal survey of potential cable routes

Sterry, P (1997) Collins Complete British Wildlife Photoguide. Harper-Collins Publishers Ltd.

www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 16 – Terrestrial and Intertidal Ecology.

Appendix 16-2: “Islay Inter-tidal Report”

Sound Of Islay Demonstration Tidal Array

Inter-tidal survey of potential cable routes

Scottish Power Renewables

31st August 2009
Final Report
9T3474

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Project name	
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Drafted by	Jen Trendall	
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Date/initials check	…………………	29/08/09……….
Approved by	Frank Fortune	
Date/initials approval	…………………	29/08/09……….

CONTENTS

1 INTRODUCTION

1.1 Scheme description

Scottish Power Renewables (SPR) has commissioned Haskoning UK Ltd to assist in applications for consent to install a demonstration tidal turbine array within the Sound of Islay, Scotland. The proposed area of interest lies within the central channel of the Sound of Islay. The demonstration tidal array of ten devices would be deployed within this area and is anticipated to have a footprint of approximately 0.4 km^2. The turbines would generate up to 10MW of power and will be linked via underwater cabling to onshore infrastructure on Islay. SPR are currently investigating six potential landing sites on Islay for cable routing onshore to a substation that is currently proposed to be located in Keills.

To inform the Environmental Impact Assessment an intertidal survey was undertaken across an area shown in Figure 1.1. The intertidal survey was completed in conjunction with the Phase 1 habitat survey of potential cable routes.

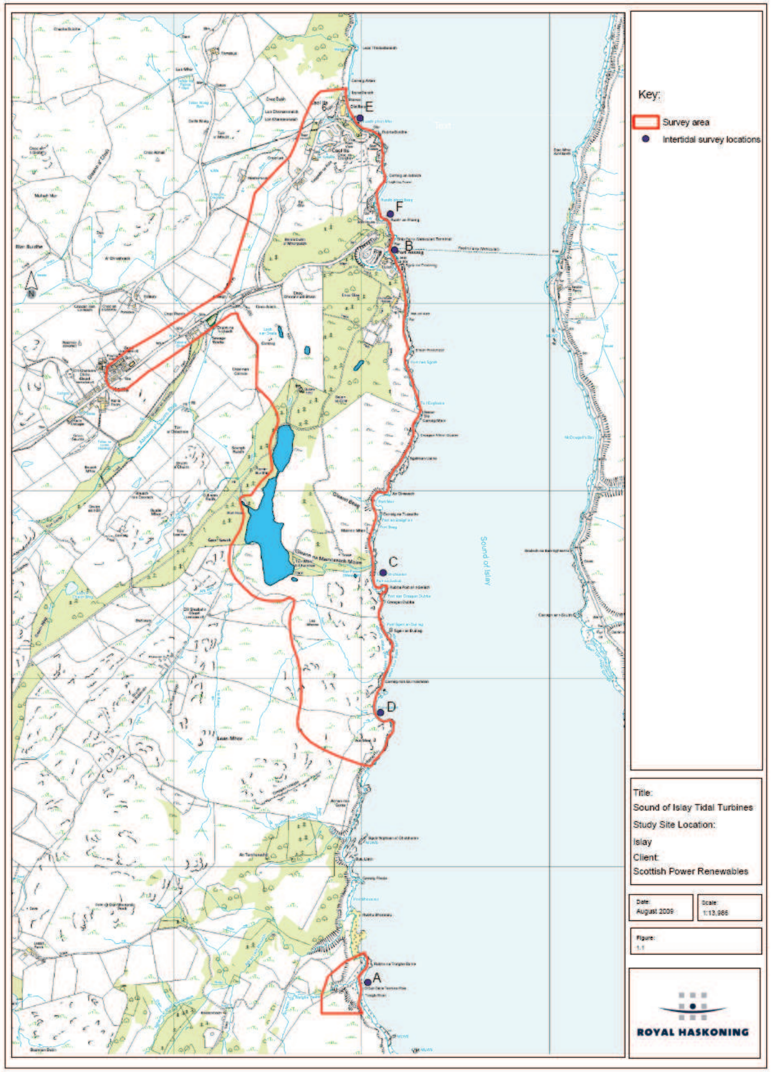

Figure 1.1 Locations of intertidal survey sites A – F.

1.2 Aims and Objectives

The intertidal survey aimed to identify the zonation of biotopes at six locations within bays along the Sound of Islay, each of which has been identified by Scottish Power as potential cable routes for the tidal array.

The main objectives were to:

a) Complete at minimum 1 re-locatable transect at each of the six locations;
b) Identify species present at each bay, noting rare, protected or non-native species;
c) Provide photographic records of each bay; and
d) Identify the biotopes present at each bay.

2 METHODOLOGY

Four bays were surveyed at low spring tide on the 6th and 7th of August, 2009 (Figure 1.1). Weather conditions were fair throughout the survey, with little wind and good visibility. The surveys were completed by foot by two experienced ecologists.
A number of methods and techniques were used, including 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).

A hand held Garmin Global Positioning System (GPS) was used to provide positioning data for each transect and throughout the survey. Transects were predominantly placed at a location most suited for cables to be brought ashore, i.e. avoiding large areas of bedrock and rough boulders. Where a matrix of substrates were present, an additional transect was completed to inform on all potential biotopes present at each bay.

Each bay was surveyed from the top of the shore to the low shore, with the aim of recording all typical biotopes within the study area and recording details in field notes. A 100m tape measure transect was surveyed down the shore and was assessed and photographed. Where features (biological or physical) were encountered of interest outside of the transects (and in geographically discrete areas) target notes recorded the detail of those features. Biotopes within each transect and quadrat were assigned codes under the 2004 JNCC Biotope classification (Connor, *et al*, 2004). A species list is provided in Section 5.1 with a description of each biotope provided in Section 5.2.

A 100m tape measure was used to mark out the length of each transect, and the mark (in cm) where distinct biotope zones changed on the shore were noted. Field notes were completed for each distinct section of the shore. Target notes were completed for features or biotopes of notable value, quality or uniqueness.

A drawing was made of each bay on site, recording the substrates and main biotopes encountered and identifying the location of each transect and other features of interest.

Notes were additionally taken of marine mammals observed, including tracks or signs, during the intertidal survey.

3 RESULTS

3.1 Site A – Traigh Bhan

Site A was the most southern site, and was accessed via farm tracks from Lossit Farm. The site was surveyed on the 5th August at 1pm.

The site consisted of a large sandy bay with cobbles and pebbles in the upper shore and rocky outcrops with rockpools to the north and south. An existing cable to the mainland is present in the sandy substrate, and is colonised by seaweeds, providing an artificial reef habitat. A small stream runs into the sea just north of the cable, with abundant *Ulva intestinalis* and *Fucus spiralis* present on the cobbles. *Arenicola marina* was present in the sands around and north of the existing cable, however no dig was taken to confirm the other infauna present and therefore the exact biotope of the sandy substrate is unknown.

Plate 3.1 Transect A1 location along existing cable, viewed from the south west

Plate 3.2 Transect A2 location at rocky outcrop, viewed from the south

Two transects were surveyed at this site (Figure 3.1) – the first (A1: NR 42951 65348, Plate 3.1) took the line of the existing cable to determine the species which had established on the artificial reef created by the cable armouring. Biotopes for this transect are described in Table 3.1 and Plates 3.3 and 3.4. The second transect (A2: NR 43047 65472, Plate 3.2) assessed the bedrock/rock pool outcrop to the north of the cable. Biotopes for this transect are described in Table 3.2 and Plates 3.5 to 3.8

During the surveys two common (harbour) seals (*Phoca vitulina*) were observed milling close to the shore at the beginning of the survey, with a common seal hauled out at the north end of the bay at the end of the survey. Otter (*Lutra lutra*) spraints and anal jelly were found on bedrock outcrops near Transect A2, along with crustacean remains.

Table 3.1 Transect biotopes at Site A1

Location on tape measure (m)	Description	Biotope
0 - 11.30	Silverweed (*Potentilla anserina*), nettle (*Urtica dioca*) and red dead nettle (*Lamium purpureum*) on cobbles, with tormentil (*Potentilla erecta*) and bracken (*Pteridium aquilinum*) on shingle	LS.LCS.Sh
11.30 – 14.00	Cobble and pebble shingle	LS.LCS.Sh
14.00	Strandline on cobble and pebble shingle.	LS.LSa.St
14.00 – 19.90	Cobble and pebble shingle, with *Ulva intestinalis*	LR.FLR.Eph.Ent
19.90	End of cable armouring, with *Ulva intestinalis* on cable end and on scattered cobbles. Clean fine sand sediments.	LR.FLR.Eph.Ent
19.90 – 22.20	Upper cable with *Ulva intestinalis*	LR.FLR.Eph.Ent
22.20 – 24.10	Cable dominated by *Ulva intestinalis* with occasional *Fucus spiralis*	LR.FLR.Eph.Ent
24.10 – 27.70	*Fucus serratus* and *Fucus vesiculosis,* with *Ulva intestinalis, Littorina obtusata* and *Cladophora rupestris.* Algae cover is less dense than in lower down the shore and *no Arenicola marina* is present in the clean fine sand sediments	LR.LLR.F.Fserr.FS
27.70 – 43.50	*Fucus serratus* dominating cable armouring, with *Ulva intestinalis, Actinia equina, Littorina obtusata, Spirorbis spirorbis, Semibalanus balanoides, Sagartia elegans, Cladophora rupestris, Colpomenia peregrina, Polyides rotundus* and *Carcinus maenas,* with *Arenicola marina* on clean fine sand sediments 40/m^2	LR.LLR.F.Fserr.FS and LS.LSa.FiSa.Po
27.70 – 43.50	Cable armouring dominated by *Fucus serratus supporting Spirorbis spirorbis,* rare *Laminaria digitata* on scattered boulders. Cable armouring is on on clean fine sand sediments supporting *Arenicola marina* casts 5/m^2.	LR.LLR.F.Fserr.FS and LS.LSa.FiSa.Po
Below 43.50	*Laminaria digitata, Laminaria saccharina* and *Himanthalia elongata* on scattered half buried boulders, with *Fucus serratus* dominating the cable.	IR.MIR.KR.Ldig.Bo

Plate 3.3 Transect A1 lower shore facing west, view along cable armouring

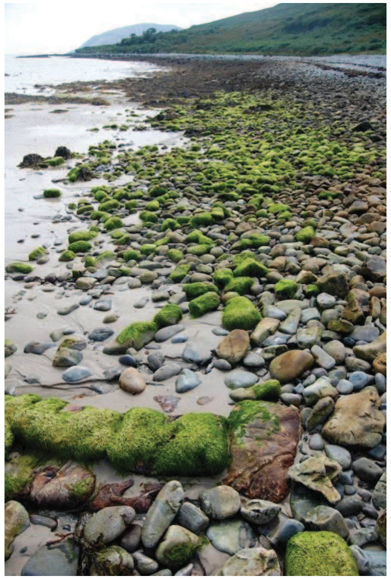

Plate 3.4 Transect A1 top of existing cable facing south

Table 3.2 Transect biotopes at Site A2

Location on tape measure (m)	Description	Biotope
0-18.40	Bare cobble and shingle, with patches of red dead nettle (*Lamium purpureum*)	
18.40	Strandline on cobble and shingle	
31.00 – 18.40	*Xanthoria parietina, Ramalina siliquosa, Armeria maritima* and rockpools containing *Ulva intestinalis*.	LR.FLR.Lic.YG
32.30 – 31.80	*Verrucaria maura* on steep rock	LR.FLR.Lic.Ver.Ver
31.80 - 36.50	*Pelvetia canaliculata, Hildenbrandia rubra, Fucus spiralis, Patella vulgata* on bedrock	*LR.MLR.BF.PelB*
36.50 - 37.50	*Fucus spiralis, Patella vulgata, Hildenbrandia rubra, Semibalanus balanoides, Littorina obtusata, Actinia equina, Ascophyllum nodosum, Polysiphonia lanosa* on bedrock.	LR.LLR.F.Fspi.FS
37.50 - 49.00	*Ascophyllum nodosum, Chondrus crispus, Polysiphonia lanosa, Halichondria panicea, Littorina obtusata, Patella vulgata, Lomentaria articulata, Spirorbis spirorbis, Nucella lapillus, Semibalanus balanoides, Actinia equina, Ulva intestinalis, Ulva lactuca, Cladophora rupestris, Corallina officinalis Lithophyllum incrustans,* orange encrusting sponge indet. (possibly *Myxilla sp.)* and *Dilsea carnosa* on bedrock and rockpools. Rare *Laminaria digitata* was present in rockpools	LR.HLR.FT.AscT
Below 49.00	*Laminaria digitata, Fucus serratus, Chondrus crispus, Corallina officinalis, Patella vulgata, Lithophyllum incrustans, Himanthalia elongata, Semibalanus balanoides, Nucella lapillus, Littorina obtusata, Halichondria panicea, Sagartia elegans* on steep bedrock	IR.MIR.KR.Ldig.Ldig

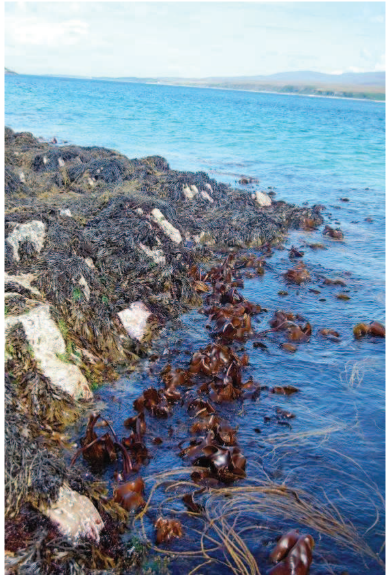

Plate 3.5 Transect A2 lower shore with bedrock supporting *Laminaria hyperborea* and *Himanthalia elongata*

Plate 3.6 Transect A2 view down shore from upper shore. Upper shore bedrock supporting yellow and grey lichens

Plate 3.7 *Dilsea carnosa* and *Corallina officinalis* in rockpools

Plate 3.8 *Halichondria panicea* and orange sponge indet. (possibly *Myxilla* sp.)

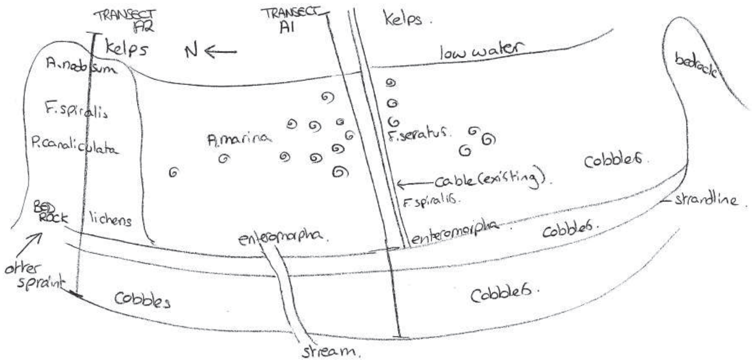

Figure 3.1 Map of Site A

3.2 Site B – Port Askaig

Site B was surveyed on the 7th August 2009 at 1.50pm. The area to focus on as a potential cable route at Site B was identified by staff from the Islay Energy Trust just south of the lifeboat station, adjacent to the stone wall running down the intertidal zone from upper to lower shore, between land owned by the Port Askaig Hotel and the Dunlossit Estate. A transect was completed down the north side of the wall, with an assessment completed to the south and across the bay. No additional biotopes were recorded outside the transect.

Zonation occurred vertically up the wall, as well as horizontally up the shore. Zonation was similar on both sides of the wall, with no new species on the south side. Biotopes are described in Table 3.3 and Plates 3.9 – 3.12, while Figure 3.2 provides a map of the bay.

The substrate was characterised by a complex matrix of bedrock encompassing natural steps, with a natural slipway through the bedrock of pebbles and shingles. Shingle and cobbles were present in the upper shore.

Table 3.3 Biotopes at Transect B

Location on tape measure (m)	Description	Biotope
0 – 6.90	*Xanthoria parietina, Ramalina siliquosa, Armeria maritima* on bedrock and shingle	LR.FLR.Lic.YG
6.90 – 8.70	*Pelvetia canaliculata* with *Xanthoria parietina, Ramalina siliquosa, Armeria maritima* on taller bedrock	LR.FLR.Lic.YG
8.70 - 13.40	Common *Pelvetia canaliculata*, with *Spirorbis spirorbis* and *Ulva intestinalis*	LR.MLR.BF.PelB
13.40 – 13.90	*Fucus spiralis*, with *Cladophora rupestris*, *Actinia equina, Patella vulgata, Semibalanus balanoides and Ascophyllum nodosum*, with *Pelvetia canaliculata* present on taller bedrock. Rockpools also present, containing additionally *Codium tomentosa, Lithophyllum incrustans, Sagartia elegans* and *Carcinus maenas* on stepped bedrock	LR.LLR.F.Fspi.FS and LR.FLR.Rkp
Below 13.90	*Steep drop to Laminaria digitata, with Ascophyllum nodosum, Fucus serratus, Polysiphonia lanosa, Chondrus crispus, Actinia equina, Sagartia elegans, Patella vulgata, Lomentaria articulata, Nucella lapillus, Semibalanus balanoides, Electra pilosa, Halichondria panicea and Calliostoma zizyphinum* on stepped bedrock	IR.MIR.KR.Ldig.Ldig

Plate 3.9 Transect B facing down the shore

Plate 3.10 Transect B facing up the shore

Plate 3.11 *Calliostoma zizyphinum*

Plate 3.12 view north from the wall

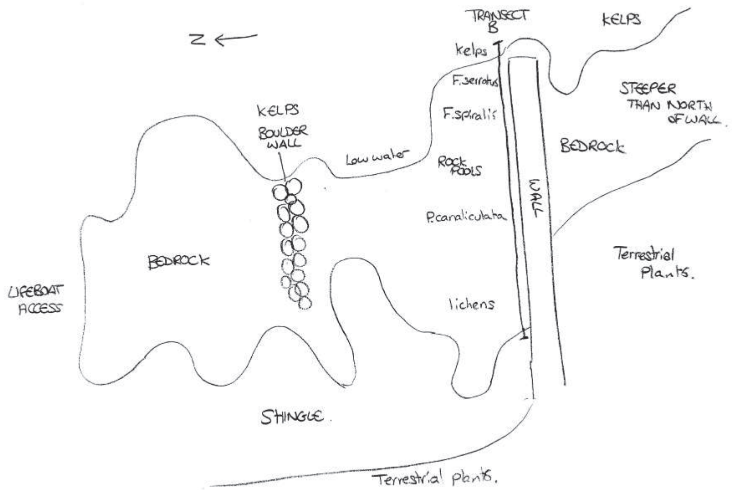

Figure 3.2 Map of Site B

3.3 Site C – Toll Chili-chiarain

Site C was a small embayment of cobbles, boulders and bedrock, accessed via tracks through the Dunlossit Estate, which lead to a small hydro-electric substation hut close to the shore. The site was surveyed on the 5th August 2009 at 12.30pm. To the south of the bay, a boundary wall continued from the terrestrial down shore to a small steep rocky headland. Inshore of the bay a deciduous woodland habitat is present, with a river running down the south side containing several large waterfalls. A small area of saltmarsh was present between the river and the wall, and the mouth of the river was dominated by *Fucus ceranoides*.

A transect was surveyed north of the river (NR 43070 67629) to provide an assessment of the intertidal zones without freshwater influence. Due to the rocky nature of the substrate, zonation often occurred vertically up boulders in addition to horizontally up the shore, and therefore several biotopes may occur at any location.

Biotopes found within the transect are described in Table 3.4, with additional biotopes recorded at the site shown in Table 3.5. Plates 3.13 to 3.16 describe the site, and a map is provided in Figure 3.3.

South of the wall, 14 common seals (*Phoca vitulina*) were observed hauled out on bedrock and milling in the sea immediately offshore on the 4th and 5th August at low tide. Otter spraints were found on the rocky headline at the end of the wall, and up to the river as far as the waterfall. Following the survey a male Orca whale (*Orcinus orca*) was observed milling in the Sound of Islay approximately 200m offshore.

Table 3.4 Transect biotopes at Site C

Location on tape measure (m)	Description	Biotope
0 – 5.90	*Xanthoria parietina*, *Ramalina siliquosa* and *Verrucaria maura* on boulders	LR.FLR.Lic.YG and LR.FLR.Lic.Ver.Ver
5.90 – 10.70	Frequent *Pelvetia canaliculata* with *Xanthoria parietina, Ramalina siliquosa* and *Verrucaria maura* on boulders	LR.MLR.BF.PelB
10.70 – 21.60	Common *Fucus spiralis* with occasional *Ascophyllum nodosum* and *Pelvetia canaliculata* on taller rocks. *Nucella lapillus, Actinia equina, Patella vulgata, Littorina littorea, Littorina obtusata* and *Hildenbrandia rubra* also present.	LR.LLR.F.Fspi.FS
21.60 – 22.80	Abundant *Ascophyllum nodosum* with *Fucus vesiculosis, Fucus serratus, Chondrus crispus, Halichondria panicea, Semibalanus balanoides, Actinia equina, Ulva intestinalis, Corallina officinalis, patella vulgata, Sagartia elegans, Polysiphonia lanosa, Spirorbis spirorbis, Gelidium sp. Hypoglossum woodwardii, Ceramium sp., Lithophyllum* incrustans on bedrock and boulders. Additionally, *Codium tomentosum*, was recorded in a small rockpool *and* mollusc egg mass on large boulder (potentially Nudibranchia)	LR.HLR.FT.AscT
22.80 and below	*Laminaria digitata* and *Fucus serratus,* with *Ascophyllum nodosum Ulva intestinalis, Polysiphonia lanosa, Spirorbis spirorbis, Gelidium sp (potentially spinosum), Hypoglossum woodwardii, Lithophyllum incrustans, Chondrus crispus, Lomentaria articulata, Halichondria panacea, Nucella lapillus, Patella vulgata, Actinia equina, Littorina obtusata, Electra pilosa,,Ulva lactuca, and Semibalanus balanoides* on bedrock and boulders.	IR.MIR.KR.Ldig.Ldig

Table 3.5 Additional biotopes at Site C

Location	Description	Biotope
River mouth	*Fucus ceranoides*	LR.LLR.FVS.Fcer
Between river and wall	Sea sandwort *(Honkenya peploides)*, sea plantain *(Plantago maritima)*, small red goosefoot *(Chenopodium rubrum)*	LS.LMp.Sm


Plate 3.13 Site C transect up the shore


Plate 3.14 Lower shore


Plate 3.15 Codium tomentosa


Plate 3.16 Mollusc egg mass

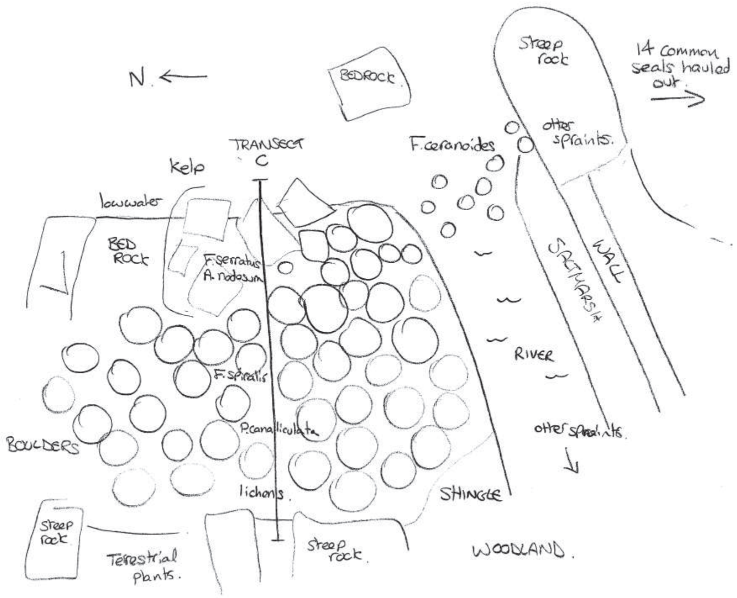

Figure 3.3 Map of Site C

3.4 Site D – Fionn Point

Site D was a wide west facing bay and predominantly consisted of a gentle gradient pebble-cobble beach leading down the shore into the subtidal zone. The site was surveyed on 5th August at 11.30am. Viewing this bay from the cliff top at low tide, it was apparent no species were present in the intertidal where cables were likely to be brought ashore due to the mobile nature of the beach substrate, and so a transect was not completed at this bay (Plates 3.17 and 3.18). From the vantage point, dense *Himanthalia elongata* was observed in the subtidal waters.

Steep seacliffs were present to the north of the bay, supporting bracken (*Pteridium aquilinum*), bell heather (*Erica cinerea*), silver birch (*Betula pubescens*) and grey willow (*Salix cinerea*). To the south of the bay, a gentle slope of dense bracken led away from the shore.

Access to this site was across rough hilly moorland and marshy ground, with no current access track to the bay.

Plate 3.17 North end of Site D

Plate 3.18 South end of Site D

A common seal (*Phoca vitulina*) was observed hauled out on the rocks to the south of the bay, and an otter (*Lutra lutra*) was observed foraging, fishing and eating approximately 200m north of the bay.

3.5 Site E – Caol Ila Distillery

Site E was a west facing sheltered bay and was surveyed on the 7th August 2009 at 11:30am. This site was industrialised compared to other potential cable route sites. The road to the distillery runs adjacent with the shore, with the intertidal substrate dominated by steep rock armour and vertical artificial seawall. A large pier was present in the middle of the bay.

A transect was completed at the south of the bay (NR 43019 65471) close to the road where it was presumed best access for a cable route. The rest of the bay was walked over, with additional species recorded.

Table 3.6 describes the biotopes present in the transect, with Table 3.7 describing the additional biotopes located at Site E. Plates 3.19 to 3.23 describe the shore and the bay is mapped in Figure 3.4.

Otter prints and crustacean remains were found in the dirt on the road margin on the coastal front of the distillery buildings.

Table 3.6 Transect biotopes at Site E

Location on tape measure (m)	Description	Biotope
0 – 1.10	Lichens on rock armour, appear to be historically terrestrial prior to rock armour being placed, occasional *Xanthoria parietina*	LR.FLR.Lic.YG
1.10 – 2.00	Occasional *Pelvetia canaliculata*, with *Littorina littorea, Semibalanus balanoides* and mayfly larvae indet. on rock armour	LR.MLR.BF.PelB
2.00 – 3.60	*Fucus spiralis*, with *Littorina obtusata, Patella vulgata, Semibalanus balanoides*, and *Littorina littorea* on rock armour	LR.LLR.F.Fspi.FS
3.60 – 7.30	Abundant *Fucus vesiculosis, with Ulva intestinalis, Fucus serratus, Ulva lactuca, Littorina obtusata* and *Lithophyllum incrustans* on rough jagged pebbles and cobbles.	LR.LLR.F.Fves.X
7.30 – 9.20	*Fucus serratus, Fucus vesiculosis, Ascophyllum nodosum, Spirorbis spirorbis, Littorina obtusata, Ceramium sp., Polysiphonia lanosa, Calliostoma zizyphinum, Lithophyllum incrustans, Ulva lactuca, Electra pilosa, Anemonia viridis* and *Dilsea carnosa* on rough jagged pebbles and cobbles	LR.LLR.F.Fserr.X
Below 9.20	*Occasional Laminaria digitata with Fucus serratus* on rough jagged pebbles and cobbles and boulders	IR.MIR.KR.Ldig.Bo

Table 3.7 Additional biotopes at Site E

Location	Description	Biotope
Slipway north of pier	*Actinia equina, Asterias rubens, Botryllus schlosseri, Pomatoceros triqueter* and *Nucella lapillus in Fucus serratus zone*	LR.MLR.BF.Fser.Bo

Plate 3.19 Site E transect up the shore

Plate 3.20 south of transect

Plate 3.21 Site E north of transect

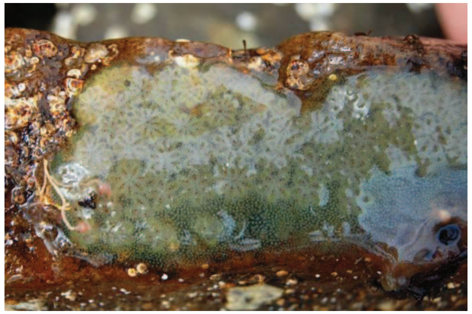

Plate 3.22 *Botryllus schlosseri*

Plate 3.23 *Anemonia viridis*

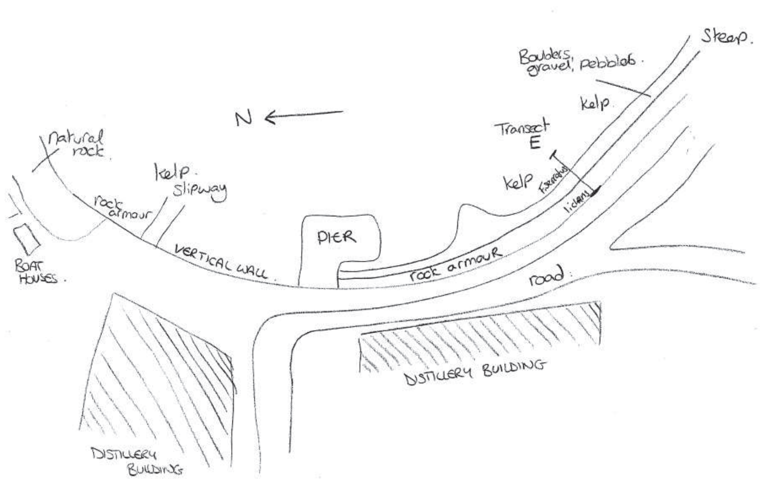

Figure 3.4 Map of Site E

3.6 Site F - Ruadh phort Beag

The area to focus on as a potential cable route at Site F was identified by staff from the Islay Energy Trust as a small sheltered west facing bay set back from the cliffs, located between Port Askaig ferry terminal and Caol Ila Distillery. The survey was completed on 7th August 2009 at 12:50pm.

The transect (NR 43116 69433) was completed just north of a stone jetty where a pebble gravel substrate natural slipway was present leading up to a boathouse. Large boulders and bedrock existed across the rest of the shore. Several small boats were anchored in the embayment, and holiday cottages and a small boat house are present just above the shore. A small jetty was present in the rock in the south of the bay. North of the jetty the lichens *Ramalina siliquosa* and *Xanthoria parietina* were present above the high-tide mark with thrift (*Armeria maritima*). No other biotopes were observed on the site.

Table 3.8 describes the biotopes present in the transect, with Table 3.9 describing the additional biotopes present at Site F. The site is shown in Plates 3.24 and 3.25, and mapped in Figure 3.5.

The non-native algae *Sargassum muticum* was identified within the transact at NR 43116 69433. This alga can cause displacement of native species and the sighting has been reported to SNH, who are currently monitoring the spread of *S. muticum* around the Scottish coastline.

Table 3.8 Transect biotopes at Site F

Location on tape measure (m)	Description	Biotope
0-1.40	Above strandline, gravel and pebbles leading to coastal grassland habitat	LS.LCS.Sh
1.40	strandline	LS.LSa.St
1.40-7.20	Below strandline, gravel and pebbles	LS.LCS.Sh
7.20 – 10.60	Occasional *Fucus spiralis* and *Fucus vesiculosus* on gravel and pebbles	LR.LLR.F.Fspi.X
10.60 – 12.40	*Fucus serratus and Fucus vesiculosis, Ulva intestinalis, Fucus spiralis, Ceramium sp., Ascophyllum nodosum*, *Pomatoceros triqueter, Actinia equina, Patella vulgata, Littorina obtusata* on pebbles and cobbles	LR.LLR.F.Fserr.X
12.40 – 16.60	*Fucus serratus* and *Himanthalia elongata*, with *Sargassum muticum*, *Pomatoceros triqueter, Littorina obtusata, Actinia equina,* and *Lithophyllum incrustans* on rocky cobbles	LR.LLR.F.Fserr.X
Below 16.60	*Laminaria digitata, Ulva lactuca, Spirorbis spirorbis* and *Chondrus crispus* on rocky cobble substrate	IR.MIR.KR.Ldig.Bo

Table 3.9 Additional biotopes at Site F

Location	Description	Biotope
Above high tide south of jetty	*Ramalina siliquosa* and *Xanthoria parietina*, and *Armeria maritima* on rocks and bedrock.	LR.FLR.Lic.YG

Plate 3.24 Site F transect down the shore

Plate 3.25 Site F transect up the shore

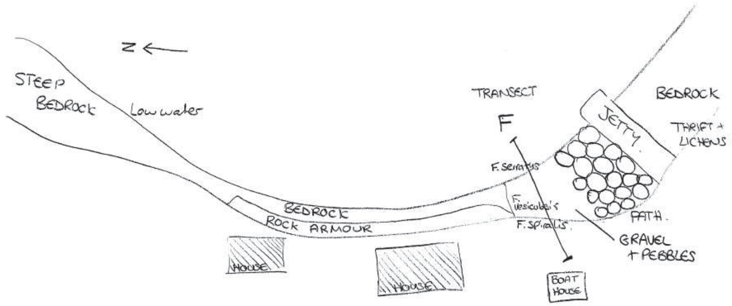

Figure 3.5 Map of Site F

4 CONCLUSIONS

4.1 Rare and protected species and biotopes

No rare or protected biotopes were found within the proposed footprint of the scheme during the intertidal survey, and the zonation of biotopes identified (lichens through to fucoids to kelp) were typical of the area.

The following species of note were recorded:

- *Sargassum muticum* – Non native fucoid recorded at Site F, sighting recorded to Scottish Natural Heritage.
- Otter (*Lutra lutra*) – European Protected Species listed in Appendix 74 of the CRoW Act 2000 and protected under Section 5 of the Wildlife and Countryside Act 1981 (as amended). In addition, otters are also protected under the Conservation (Natural Habitats &c.) Regulations 1994. Signs of otters were recorded throughout the study area.
- Orca whale (*Orcinus orca*) - All cetaceans found within Scottish waters are protected by a range of national and international obligations: Council Directive 92/43/EC on the Conservation of Natural Habitats and of Wild Fauna and Flora, Annex IV (the 'Habitats Directive'); Convention on the Conservation of Migratory Species (The Bonn Convention); Wildlife and Countryside Act 1981; and Nature Conservation (Scotland) Act 2004. A male orca whale was observed milling at low water slack approximately 200m off shore from Site C.
- Common seal (*Phoca vitulina*) Classified as Least Concern (LC) on the IUCN Red List. Protected in Britain under the Conservation of Seals Act 1970 (closed season from 1 September until 31st December) and schedule 3 of the Conservation Regulations (1994). Listed as a protected species under Annex II and Annex V of the European Community's Habitats Directive. Common seal was recorded hauled out or close to the shore at sites C, D and E.

4.2 Recommendations

From an environmental perspective, some of the potential landfall sites are preferable to others. Landfall Sites E (Caol Ila distillery) and B and F (Port Askaig respectively) are considered to be ideal as these areas are already developed with high anthropogenic influence relative to the other sites. In addition the surrounding terrestrial habitats for sites E, B and F do not contain the higher quality habitats or species richness found elsewhere in the footprint (Royal Haskoning, 2009). In addition, while landfall point A to the south of the footprint constituted a beautiful landscape with good quality intertidal habitat, there are already cables present at the site, as well as access and infrastructure. The presence of these attributes does not appear to have had a negative impact on the landscape or the quality of the habitat. Indeed, the cables seem to have created artificial reefs providing substrate for a diversity of sea weeds.

Potential landfall Sites C and D however, may be better avoided. Site C is at the site of a river mouth. This source of freshwater may be important for otters to maintain the waterproof properties of their fur. Indeed, several spraints were found on rocks in this river indicting that it is used by otters. Freshwater as easily accessible yet undisturbed as this river mouth may be scarce along the coastline, so if disturbance to the area can be avoided then that is to be recommended. This does not mean that works are totally precluded in this area, but a targeted otter survey would be recommended in advance of any construction.

At potential landfall Site D, the area comprises a remote stretch of coastline surrounded by high quality wet heath habitat (Royal Haskoning, 2009). There is no access to the area and the disturbance that would be required to bring machinery and plant into the area would be high. It is therefore recommended that this area should not be developed. Works are not precluded here, and the environmental impact would be high compared to Sites E, B and A.

5 SPECIES AND BIOTOPE LIST

5.1 Species

Algae
Ascophyllum nodosum
Ceramium sp
Chondrus crispus
Cladophora rupestris
Codium tomentosa
Colpomenia peregrina
Corallina officinalis
Dilsea carnosa
Fucus ceranoides
Fucus serratus
Fucus spiralis
Fucus vesiculosis
Gelidium sp
Hildenbrandia rubra
Himanthalia elongata
Hypoglossum woodwardii
Laminaria digitata
Laminaria saccharina
Lithophyllum incrustans
Lomentaria articulata
Pelvetia canaliculata
Polyides rotundus
Polysiphonia lanosa
Sargassum muticum
Ulva intestinalis
Ulva lactuca
Marine Invertebrates
Actinia equina
Anemonia sulcata
Arenicola marina
Botryllus schlosseri
Calliostoma zizyphinum
Carcinus maenas
Electra pilosa
Halichondria panicea
Littorina littorea
Littorina obtusata
Nucella lapillus
Orange encrusting sponge indet. (*Myxilla sp.)*
Patella vulgata
Pomatoceros triqueter
Sagartia elegans
Semibalanus balanoides
Spirorbis spirorbis
Lichens
Ramalina siliquosa
Verrucaria maura
Xanthoria parietina
Terrestrial plants
Armeria maritima
Betula pubescens
Chenopodium rubrum
Erica cinerea
Honkenya peploides
Lamium purpureum
Plantago maritima
Potentilla anserina
Potentilla erecta
Pteridium aquilinum
Salix cinerea
Urtica dioica
Mammals
Lutra lutra
Orcinus orca
Phoca vitulina

5.2 Biotopes

IR.MIR.KR.Ldig.Bo *Laminaria digitata* and under boulder fauna on sublittoral fringe boulders
IR.MIR.KR.Ldig.Ldig *Laminaria digitata* on moderately exposed sublittoral fringe rock
LR.FLR.Eph.Ent *Enteromorpha* spp. on freshwater-influenced and/or unstable upper
LR.FLR.Lic.Ver.Ver *Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock
LR.FLR.Lic.YG Yellow and grey lichens on supralittoral rock
LR.FLR.Rkp Rockpools
LR.HLR.FT.AscT *Ascophyllum nodosum*, sponges and ascidians on tide-swept mid eulittoral rock
LR.LLR.F.Asc.FS *Ascophyllum nodosum* on full salinity mid eulittoral rock
LR.LLR.F.Asc.FS *Ascophyllum nodosum* on full salinity mid eulittoral rock
LR.LLR.F.Fserr.FS Dense *Fucus serratus* on moderately exposed to very sheltered full salinity lower eulittoral rock
LR.LLR.F.Fserr.X *Fucus serratus* on full salinity lower eulittoral mixed substrata
LR.LLR.F.Fspi.FS *Fucus spiralis* on full salinity moderately exposed to very sheltered upper eulittoral rock
LR.LLR.F.Fspi.X *Fucus spiralis* on full salinity upper eulittoral mixed substrata

LR.LLR.F.Fves.X *Fucus vesiculosus* on mid eulittoral mixed substrata
LR.LLR.FVS.Fcer *Fucus ceranoides* on reduced salinity eulittoral rock
LR.MLR.BF.Fser.Bo *Fucus serratus* and under-boulder fauna on lower eulittoral
LR.MLR.BF.PelB *Pelvetia canaliculata* and barnacles on moderately exposed littoral
LS.LCS.Sh Shingle (pebble) and gravel shores
LS.LMp.Sm Saltmarsh
LS.LSa.FiSa.Po Polychaetes in littoral fine sand
LS.LSa.St Strandline

6 REFERENCES

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, 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

Hiscock, K (ed.) (1996) *Marine Nature Conservation Review: rational and methods*. Coasts and seas of the United Kingdom. MNCR Series. Joint Nature Conservation Committee, Peterborough.

Royal Haskoning (2009) Sound of Islay Tidal Turbines: Phase 1 habitat survey of potential cable routes.

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

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Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 16 – Terrestrial and Intertidal Ecology

Appendix 16.3: “Phase 1 Habitat survey of the Isle of Jura”

Sound Of Islay Demonstration Tidal Array

Phase 1 Habitat survey of the Isle of Jura

Scottish Power Renewables

23rd February 2010

Final Report

9T3474

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CONTENTS

1 INTRODUCTION

ScottishPower Renewables UK Ltd. (hereafter known as SPR) has commissioned Haskoning UK Ltd to assist in applications for consent to install a demonstration tidal turbine array within the Sound of Islay, Scotland. The proposed area of interest lies within the central channel of the Sound of Islay. The demonstration tidal array of ten devices would be deployed within this area and is anticipated to have a footprint of approximately 0.4 km^2. The turbines would generate up to 10MW of power and would be linked via underwater cabling to onshore infrastructure on Islay or Jura. SPR are currently investigating four potential landing sites on the west coast of the Isle of Jura, after carrying out a comparable survey on the east coast of the Isle of Islay. In August 2009, a Phase 1 Habitat Survey was completed for six potential landing sites on Islay.

To inform the Environmental Impact Assessment a Phase 1 Habitat Survey was undertaken across an area on the Isle of Jura adjacent to the Sound of Islay, shown in Figure 1. Potential cable landing sites are labeled A-D, with the survey boundary depicted by the red border.

Much of the Isle of Jura is dominated by wet heath and marshy grassland habitat. The island is sparsely populated compared to neighbouring Islay, and a population of approximately 6000 red deer roam the island. The footprint assessed within the Phase 1 Habitat survey followed the coastline and approximately 1.5km inland from the Feolin Ferry slipway south to the existing cable route for the Islay – Jura power connection, and was freely grazed by deer.

1.1 Objectives

The objectives of the survey were to:

a) Identify the habitat of each parcel of land within the proposed footprint by foot;
b) Digitally map all habitats as per standard Phase 1 habitat symbols and colours (JNCC, 1993); and
c) 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 five bays potentially suitable for the landing of cables associated with the development (Royal Haskoning, 2009a).

1.2 Conditions of survey

The survey was completed by two experienced Royal Haskoning ecologists from the 16th to 19th of November 2009. Inclement weather persisted throughout the survey, with winds and rain predominantly from the south-west, however this was not deemed to have hindered the survey. Access was unrestricted throughout the survey.

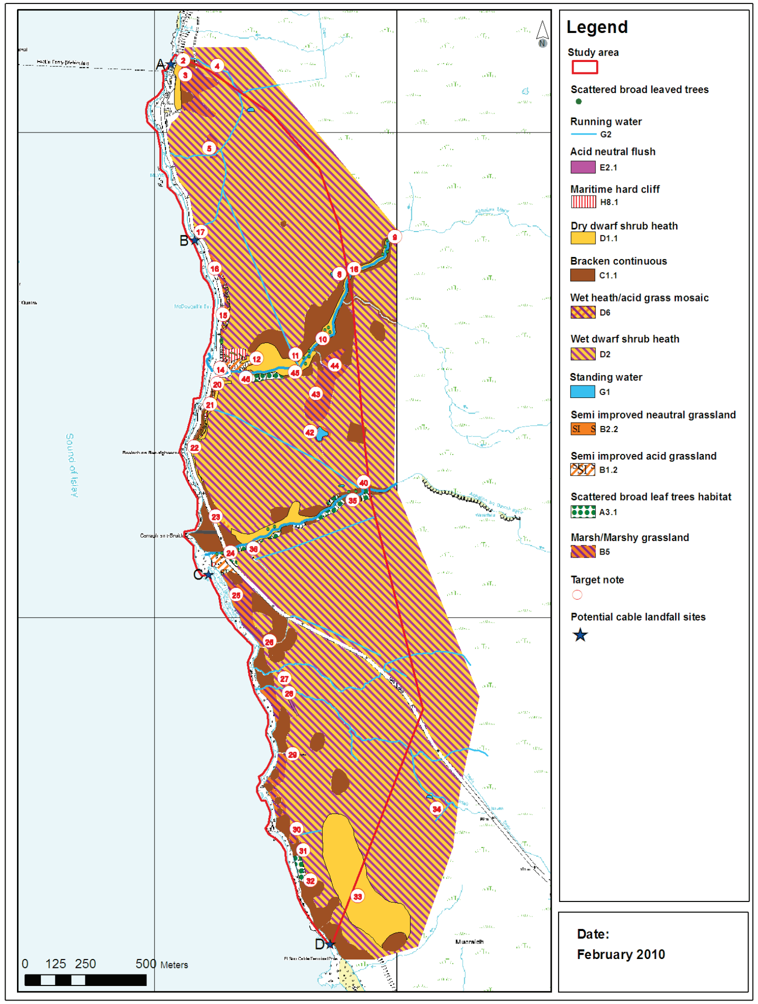

Figure 1 Study Area (red line), potential cable access points (A-D) and habitat codes. Feolin Ferry slip is at Site A, in the north of the footprint

2 METHODS

2.1.1 Phase 1 Habitat Survey

Standard methods were used as described in Joint Nature Conservation Committee (JNCC) Phase 1 Handbook for Habitat Survey (1993).

Every parcel of land throughout the entire survey area was systematically visited by trained surveyors and the vegetation was mapped on to an Ordnance Survey map at a scale of 1:10,000 by hand in the field and then digitised. The final habitat map was electronically colour coded in GIS with standard symbols and colours with regards to the dominant species codes, 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 / 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) Sterry (1997) and Fitter (1995).

When previous summer surveys were completed on Islay (Royal Haskoning, 2009b) it was not considered an option to land the cables directly on the Isle of Jura. As this option became viable later in the year, consequent surveys have been completed in a non-optimum season. 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, such as Orchaidaceae, to have already died back and no longer be apparent. The optimum survey period would be mid-summer.

3 RESULTS

A map identifying the habitat of each parcel of land is presented in Figure 1. A description of each parcel is provided below in the form of target notes. Detailed maps of sections of the footprint are presented in Figures 2 to 4.

3.1 Main findings

The majority of the survey site was dominated by wet heath habitat, with areas of *Sphagnum* bog, flushes, bracken and marshy grassland/neutral grassland complexes form a matrix throughout the habitat, which extends east of the study area towards inland Jura and the Paps of Jura. Several small oligotrophic lochans were also present. In flatter areas the ground was very waterlogged and boggy, with drier heath habitat characteristically on sloping ground. Two major streams cut through the study area, flowing from east to west into the Sound of Islay, and these have formed deep ravines (or re-entrants) lined by bracken, riparian trees and exposed inland cliff habitats. The ferry slip for the Islay-Jura ferry is located in the northwest corner of the study area at Feolin, where a couple of small buildings are also present. The existing Islay- Jura cable connection lies in the south west of the study area, where the undersea cable connects to small overhead power line pylons. The Isle of Jura itself is accessed by a single track road along the south east coastline, with intermittent passing places. In the northern half of the study area, the western seaward margin is depicted by the single track road, immediately east of which is a steep cliff up to 10m high in places. Approximately halfway down the proposed study area, the coastal road cuts inland and uphill. The only other evidence found of anthropogenic management or influence was areas of peat cutting, which have been target noted.

The habitat throughout the study area is broadly similar to that of the southern half of the Islay footprint, of complicated terrestrial terrain of wet heath and bog mosaic, along with important and fragile habitat

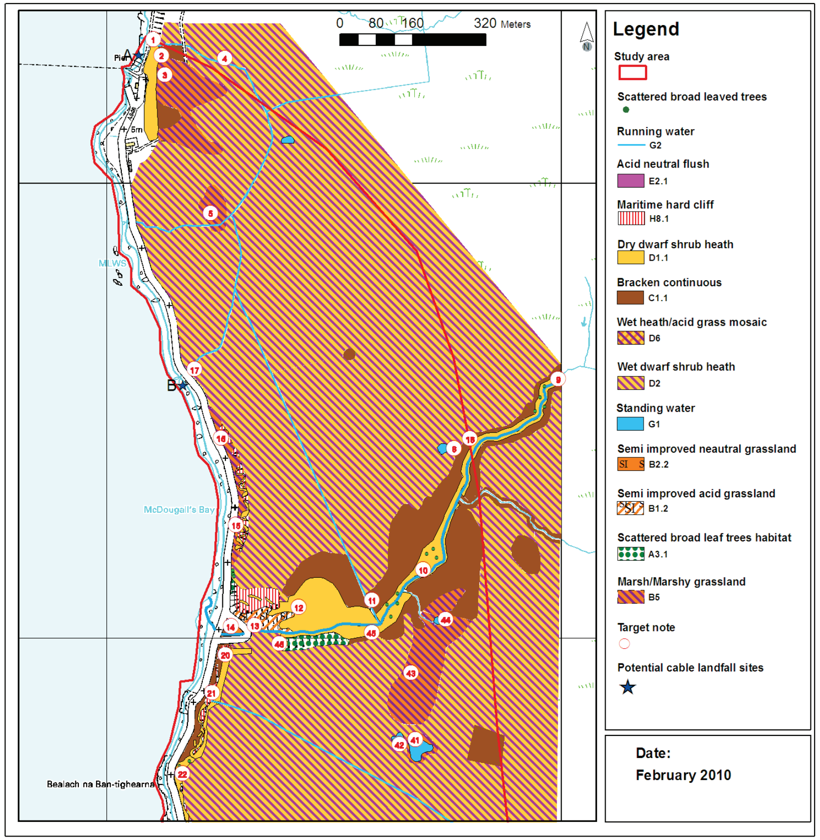

Figure 2: Northern section of study area

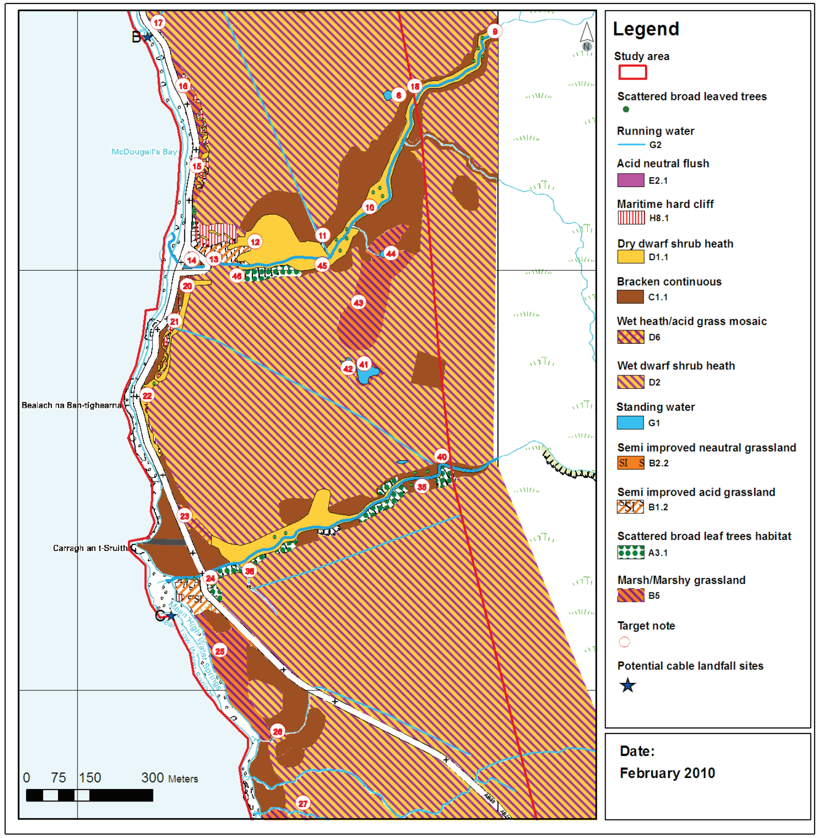

Figure 3: Central section of study area

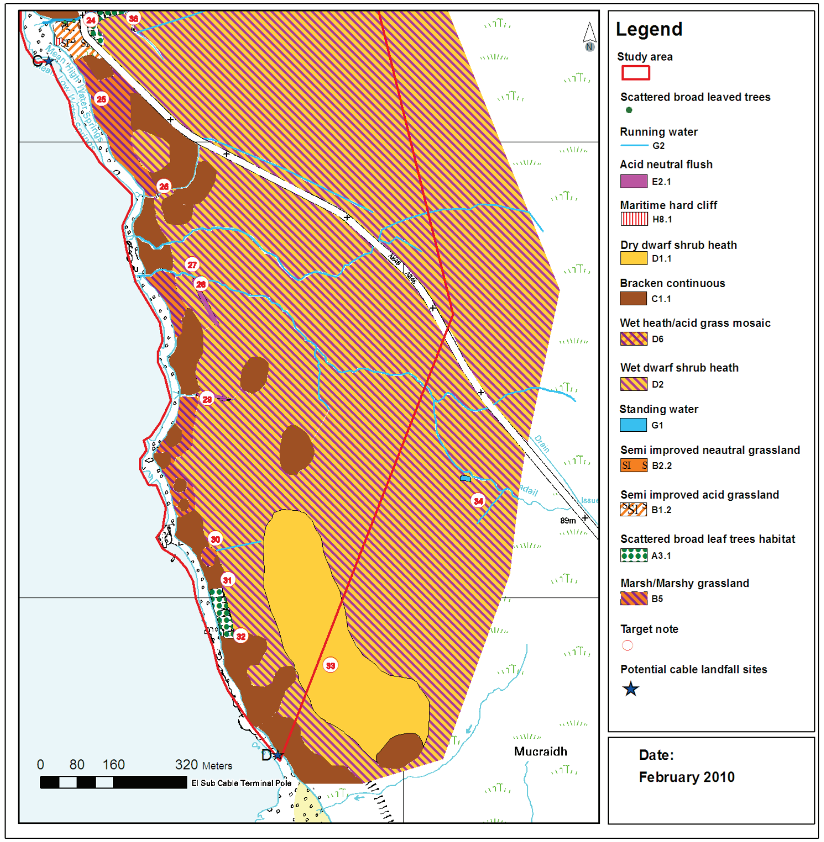

Figure 4: Southern section of the study area

3.2 Target notes

Target notes referred to in Figures 1 to 4 are discussed below:

Target Note 1
G2 Running water / D1 dry dwarf shrub heath
NR 4410 6931:
Sheer waterfall approximately three metres high located 10m inshore form the strand line. The shore was composed of a mixture of bedrock boulders and shingle. The bank over which the water flowed was composed of highly vegetated rocky outcrops on which were found: small rhododendron (*Rhododendron ponticum*) shrubs, great woodrush (*Luzula sylvatica*), scattered sharp flowered rush (*Juncus acutiflorus*), small bilberry (*Vaccinium myrtillus*) bushes, sphagnum moss, deer grass (*Trichophorum cespitosum*), reindeer moss, cross leaf heather (*Erica tetralix*) and bell heather (*Erica cinerea*), bog asphodel (*Narthecium ossifragum*) *Polytricum commune*, bramble (*Rubus fructicosus*), hard fern (*Blechnum spicant*), devils-bit scabious (*Succisa pratense*), wood sorrel (*Oxalis acetosella*) tormentil (*Potentilla erecta*), foxglove (*Digitatum purpurea*) and willow (*Salix indet.*).

Target Note 2
C1 Bracken
NR4412 6928:
Bracken (*Pteridium aquilinum*) biotope, with bramble, wood sorrel, sheep sorrel (*Rumex acetosella*), mosses, Yorkshire fog (*Holcus lanatus*), heath bedstraw (*Gallium saxatile*), and tormentil.

Target Note 3
B5 Marsh/marshy grassland
NR 4413 6924:
Wet marshy habitat including abundant soft rush (*Juncus effusus*).

Target Note 4
D2 wet dwarf shrub heath
NR 4426 6924
Wet heath biotope with grasses (Plate 1). Undulating ground with dryer upper ground and sphagnum rich wet hollows and small areas of standing water (Plate 1). Other species present include cotton grass (*Eriophorum angustifolium*), lousewort (*Pedicularis sylvatica*), some soft rush, ling (*Calluna vulgaris*), tormentil, *Cladonia floerkeana*, *Cladonia portentosa*, mosses, *Polytricum commune*, bilberry bushes, small amounts of bracken, cross leaf heather, bog myrtle (*Myrica gale*), and devils bit scabious.

Also recorded within this biotope were a large herd of deer; areas where peat has been cut (Plate 2).

Plate 1 wet heath, facing north west across the Sound of Islay (NR44367 69138)

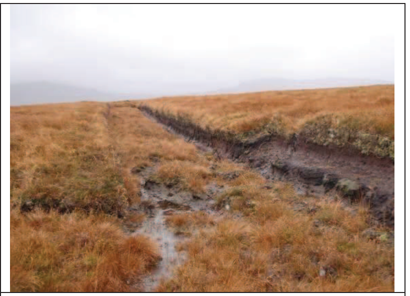

Plate 2 historic peat cutting

Target Note 5
B5 Marsh / marshy grassland
NR 4423 6894:
Soft rush dominated habitat with tufted hair grass (*Deschampsia cespitosa*), purple moor grass (*Molina caerulea*), sphagnum mosses and tormentil.

Target Note 6
C1 Bracken
NR445 6835:
Small patches of bracken, in an otherwise wet heath habitat.

Target Note 7
C1 Bracken
NR4452 6819:
Dense bracken in a hollow, approximately 30m in diameter (Plate 3).

Target Note 8
G1 Standing water
NR 4476 5842:
Small lochan near the large re-entrant (Plate 4) soft rush present on edge and on tufts in the lochan, with heath rush (*Juncus squarrosus*), spring quillwort (*Isoetes echinosporo*) and whorl leaved water milfoil (*Myriophyllum verticillatum*) found in lochan. Species that surround the lochan are the same as found in the previous samples that are indicative of the wet heathland covering much of the area.

Plate 3 wet heath, bracken dominated a hollow

Plate 4 small lochan

Plate 5 riparian habitat within the re-entrant

Plate 6 heath and bracken, facing west, to the mouth of the re-entrant

Target Note 9
D1 dry dwarf shrub heath / A3 scattered trees
NR 4499 6857
Bottom of re-entrant: (Plate 5). Species present: Wood rush, hard fern, pedunculate oak trees (*Quercus robur*), Alder (*Alnus glutinosa*), ling and bell heathers, rowan trees (*Sorbus aucuparia*), bramble, holly (*Ilex aquilinum*), lichen well established on old oak trees, soft rush and *Sphagnum* mosses are also present.

Target Note 10
D1 dry dwarf shrub heath / A3 scattered trees
NR4470 6815
Banks steepen rapidly in a sharp ‘V’ shaped valley from this point down, and the re-entrant gets deeper and areas of exposed rock can be seen. Species include pedunculate oak, bog asphodel, foxglove, bilberry, hard fern, cross leaf heather, bracken, woodrush and *Polytricum commune*.

Target Note 11
C1 Bracken / A3 scattered trees
NR 4458 6808
Top of the re- entrant bank, with sheep sorrel, wood sorrel, bracken and foxglove. Oaks and alders are now fairly dense in the re-entrant, which is 30m deep and v-shaped, and includes rocky outcrops and broad buckler ferns (*Dryopteris dilitata*).

Target Note 12
D1 dry dwarf shrub heath
NR 4442 6807
Habitat: consists of grassy heath land with deer grass, cross-leaf and ling heather, and mosses. The heath is well drained and is much dryer here than in other areas. Plate 6 shows where the stream entered the Sound of Islay.

Plate 7 wet heath, facing west, on right hand bank of re-entrant

Plate 8 coastal cliffs immediately south of the re-entrant

Target Note 13
B1 semi improved neutral grassland
NR 4432 6808
Grassland with: Dandelion (*Taraxacum officinalis*), daisy (*Bellis perennis*), soft rush, grass area next to stream, bracken (small patches) ribwort plantain (*Plantago lanceolata*), bramble, thistle (*Cirsium* spp.), nettle (*Urtica dioica*), and small patches of gorse (*Ulex europaea*)

Target Note 14
B2 semi improved neutral grassland
NR 4427 6803:
Neutral grassland in between the old and new bridges, including crested dog tail (*Cynosurus cristatus*) and soft rush.

Target Note 15
H8.1 Maritime hard cliff / D1 dry dwarf shrub heath / A3 scattered trees
NR 4428 6825:
Exposed rock on the inland side of road with heath ledges, many silver birch (*Betula pendula*) and bracken, with several pedunculate oaks.

Target Note 16
H8.1 Maritime hard cliff / B5 Marsh / marshy grassland
NR 4428 6844:
The cliffs are punctuated by a series of small heath/ grass and soft rush matrix vegetated embayments approximately every 50 metres, with rocky outcrops on the small headlands.

Target Note 17
C1 Bracken / D2 wet dwarf shrub heath
NR 4419 6859:
Matrix of soft rush, wet heath habitat and bracken.

Target Note 18
C1 Bracken
NR 4479 6844
At the eastern boundary of the footprint at the northern large re-entrant (Plate 7). From a vantage point on the bend in the re-entrant it was noted that the re-entrant at this point and further east was lined with dense bracken with the occasional deciduous tree. Outwith the re-entrant the habitat is dominated by wet heath. The re-entrant at this point was about 10m deep with shallow sloping sides roughly forming the following shape:

Target note 19
Removed.

Target note 20
G2 Running water / D1 dry dwarf shrub heath / H8.1 Maritime hard cliff
NR 4426 6796:
Left hand bank of the big re-entrant. Species present: Bell and ling heather, bilberry, hard fern and grasses (indet.). Also present were *Sphagnum* mosses and the lichen *Cladonia portentosa* incorporated within the heathers. Small rocky outcrops perforate the bank. Plate 8 shows the view looking south down the road from big re-entrant.
Approximately 30 metres south along the road, an outcrop of rowan trees is present on the steer bank.

Target note 21
G2 Running water / D1 dry dwarf shrub heath
NR 4423 6788:
1st Small stream tumbling over cliff of exposed bedrock. Species present: Bell and ling heather, bilberry, hard fern, foxglove, *Sphagnum* mosses and bracken outcrop at base of cliff (Plate 9).

Here the shore is composed mainly of exposed bedrock with a small headland then another bay further south that is composed of shingle.

Plate 9 waterfall over cliff, adjacent to the road.

Plate 10 stream down steep vegetated bank

Target note 22
G2 Running water / D1 dry dwarf shrub heath
NR 4416 6770:
2nd small stream. The bank/cliff at this point does not contain the exposed bedrock seen previously or seen further south. A steep water fall cuts down through the bracken-heath-grassland matrix (Plate 10). An otter was sighted again to the south of this point approximately 20m offshore. Lichen covered trees (indet.) are present on the cliffs to the south of this point. Rock outcrops dominate the cliffs to the south, with large patches of bracken present close to the road (Plate 11).

As progress was made in a southerly direction species on the eastern side of the road remained constant but on the shore became more rocky NR 44146 67679 (Plate 12). South of this point was a pebbly beach with bedrock sections.

Plate 11 shoreline

Plate 12 shoreline

Target note 23
D6 wet heath / acid grassland matrix / C1 Bracken
NR 4425 6741:
End of the Bank/ cliff. The cliff diminishes and the road heads inland. To the east of the road at this point is a habitat composed of a heath-grassland-bracken matrix with the following species: Bracken, soft rush, sharp flowered rush, *Sphagnum* mosses, velvet bent (*Agrostis canina*), tormentil, bog asphodel, sheep’s fescue (*Festuca ovina*) and lousewort. This habitat continues west of the road, to a small peninsular jutting into the Sound of Islay (Plate 13).


Plate 13 bracken leading to grassy peninsular into Sound of Islay


Plate 14 stream habitat

Target note 24
A3 scattered trees / G2 Running water
NR 4431 6727:
At this location the stream emerges from the small southern re-entrant (plate 14), under a stone road bridge and enters the Sound of Islay (Plate 15). Species present: maidenhair spleenwort (*Asplenium trichomanes*) on bridge, holly, white willow (*Salix alba*), common alder (*Alnus glutinosa*), grey alder (*Alnus incana*), bramble, crack willow (*Salix fragilis*), and many silver birch.


Plate 15 mouth of stream


Plate 16 wet heath

Target note 25
B5 marsh / marshy grassland
NR 4438 6709:
Grassy marshy lower level in a matrix with wet heathland with the following species: soft rush, velvet bent, small patches of bracken, sheep's sorrel, wood sorrel, ling and bell heathers, bog asphodel, bog myrtle, deer grass. Steep slopes are dominated by bracken.

Target note 26
G2 Running water / D2 wet dwarf shrub heath
NR 4447 6690:
Small gulley created by stream with a footbridge (marked in map) small rhododendron bush, bell heather, hard fern, *Cladonia portentosa*, bog myrtle *Sphagnum* mosses, *Polytricum commune* and bilberry.

Target note 27
D2 wet dwarf shrub heath / C1 bracken
NR 4453 6673:
Boundary of bracken and wet heath biotopes. In the heath the following species were identified: deer grass, *Sphagnum* mosses, ling and bell heather, bog myrtle bog asphodel, soft rush, tormentil, *Polytricum commune*, sharp flowered rush (Plate 16).

Target note 28
E2.1 Acid / neutral flush
NR 4455 6668:
First wet flush, species identified include soft rush, abundant *Sphagnum* mosses, bell heather, heath rush (*Juncus squarrosus*) tormentil, *Polytricum commune* and lousewort. In the surrounding wet heathland the same species were found as in Target note 27.

Target note 29
E2.1 Acid / neutral flush
NR 4457 6643:
Second wet flush, in which were found the following species: wood rush and abundant *Sphagnum* mosses and soft rush, also recorded in the surrounding wet heathland biotope. The Cotton grass *Eriophorum angustifolium* is also present on the wet heath habitat.

B5 marsh / marshy grassland / C1 bracken
The lower level of ground still composed of bracken and marshy grass land matrix with marshy grassland on the steep parts of the bank

Target note 30
G2 Running water
NR 4458 6612
Small stream with abundant *Sphagnum* mosses,

Target note 31
A3 scattered trees
NR4461 6603
Clump of birch trees on steep bank facing the sound, located amongst bracken habitat (Plate 17).

Plate 17 birch trees

Plate 18 existing cable connection site

Target note 32

C1 bracken

NR 4464 6591:

Large patch of bracken close to the cliff edge. Moving further inland from the bracken the bank steepened sloping up to a rounded hill top. Approximately 20 deer were noted on the hillside.

Target note 33

D1 dry dwarf shrub heath

NR 4484 6585:

looking down toward cable landfall of the cable that runs to Islay. Dry heath with small patches of bracken, some *Sphagnum* mosses. Dominated by heathers and deer grass (*Scirpus cespitosus*), with some purple moor grass (*Molina caerulea*) and bog asphodel. Dry under foot. Plate 18 looks south west from the target note to where the existing cable connects Jura to Islay.

Target note 34

D2 wet dwarf shrub heath

NR 4516 6621:

Wet heath plateau, slightly lower in altitude than surrounding areas to the north east and west. Whorl leaved water milfoil and *Sphagnum* mosses are abundant in straight manmade drainage ditches. Tormentil also present, along with the round leaved sundew (*Drosera reotundifolia*).

Target note 35

D2 wet dwarf shrub heath / C1 bracken / A3 scattered trees

NR 4481 6784:

Point at which the eastern boundary of the footprint meets the southerly (smaller) re-entrant (Plates 19 and 20). Bracken and heath (dry on the well drained areas on top of re-entrant banks) matrix. Silver birch present on the left bank of the re-entrant. Bell, ling and cross leafed heather (*Erica tetralix*) found at the top of banks with tormentil and biliberry. Well established lichen on many of the older trees, which include pedunculate oak, however very steep sided banks prevents access to identify species. A stag was recorded in the in the stream feeding on ferns. Hard and broad buckler ferns were identified lower in the gully most abundant on the left hand bank.

Plate 19 re-entrant downstream (viewed looking west)

Plate 20 re-entrant upstream (viewed looking east)

Target note 36

D2 wet dwarf shrub heath / A3 scattered trees

NR 4440 6728:

Daimh-sgeir. Rhododendron and silver birch in wet heath above the re-entrant. Species identified in the wet heath include heath rush, purple moor grass, mat grass (*Nardus stricta*), velvet bent, crowberry and marsh gentian (*Gentiana pneumonanthe*).

Target notes 37, 38 and 39

Removed.

Target note 40

D2 wet dwarf shrub heath / C1 Bracken / D1 dry dwarf shrub heath

NR 4487 6756:

Point at which the footprint boundary crosses re-entrant. East of this point the wet heath continues with the banks of the re-entrant lined with bracken and dry heath matrix as has occurred up to this point. Ground is generally sloping uphill to the east and is gently undulating (Plate 21).

Plate 21 wet heath, facing west towards the Sound of Islay

Plate 22 wet heath adjacent to small lochan

Target note 41

B5 Marsh / marshy grassland / G1 Standing water

NR 4467 6777

Area south east of the small lochan (possibly flooding) located approximately mid way between re-entrants (on map). Very shallow water was present at the time of survey, with numerous tussocks emerging from the water (Plate 22). Whorl leaved water milfoil was identified in the lochan and the area was dominated by mosses.

Target note 42

G1 Standing water
NR 4464 6776:
Small oligotrophic lochan, with soft rush, heath rush, *Sphagnum* mosses, *Polytricum commune* and hard fern. In the wet heath surrounding the pond crowberry and marsh gentian were recorded, along with ling and bell heathers and bog asphodel.

Target note 43

B5 Marsh / marshy grassland
NR 4466 6792:
Neutral grassland, tussocky and very wet between tussocks of purple moor grass. Also present were deer grass, mat grass, tormentil, *Sphagnum* mosses and bog asphodel. No heather was present at this location.

Target note 44

G1 Standing water
NR 4474 6803:
Small lochan draining into the northern re-entrant. Whorl leaved water milfoil, soft rush and Sphagnum mosses recorded, surrounded by bracken to the north and grassland (TN43) to the south.

Target note 45

C1 Bracken / D2 wet dwarf shrub heath
NR 4458 6800:
Bracken and heath matrix on the left bank of the re-entrant. Up stream along northern re-entrant, wood rush sheep’s & and wood sorrel, *Cladonia portentosa*, and sharp flowered rush. Patches of trees are present on the bank, including silver birch, downy birch, holly, bay willow (*Salix pentandra*) and alder.

Target note 46

NR 4437 6798:
Search for otter signs at the southern most possible cable landfall site. No spraint found but bits of crab were found possibly as remnant of an otters meal.

4 CONCLUSIONS

4.1 Habitats

The study area of the proposed scheme contains a complex habitat matrix incorporating wet and dry heath, bracken, oligotrophic lochans, with occasional scattered deciduous trees on sloping ground. Two streams cut across the study area from east to west, forming deep gorges and entering the Sound of Islay. The topography of the land is characteristically hilly, with the wet heath habitat of high species richness and high quality. Bracken and dry heath habitat dominates areas of dry raised ground, with valley mire and wet boggy habitat dominating the hollows of ground. The coastal margin is predominantly vegetated sea cliff in the north of the footprint, separated from the shoreline by the single track road servicing the Isle of Jura, with small sheltered bedrock outcrops, shingle and gravel embayments distributed up the coastline.

4.2 Protected habitats

There are no Special Areas of Conservation (SAC), Sites of Special Scientific Interest (SSSI) or National or Local Natures Reserves (NNR and LNR respectively) in or adjacent to the proposed footprint.

Three terrestrial habitats listed under Annex I of the EU Habitats Directive are abundantly present on the Isle of Jura. These are as follows:

- North Atlantic wet heath;
- Blanket bog;
- European dry heath

Both wet and dry heaths were dominating habitats across much of the study area, with bog features present in hollows and flushes within the topography of the study area.

Argyll and Bute have several habitats for which Biodiversity Action Plans have been developed which were found within the footprint of the proposed scheme. They are as follows:

Broad habitats

- Improved grassland;
- Rivers and streams; and
- Standing open water and canals.

Local habitats

- Open hill ground;
- Peatlands; and
- Species Rich Grassland.

Priority Habitats

- Coastal vegetated shingle; and
- Maritime cliff and slopes.

4.3 Protected species

Although a protected species survey was not being completed alongside the Phase 1 Habitat survey, several protected species were encountered which have been recorded below.

Otter

Otters are protected by the EC Habitats Directive, which is transposed into domestic law through the Conservation (Natural Habitats, &c.) Regulations 1994. The latter are hereafter referred to as 'the Habitats Regulations'. Under the Habitats Regulations, otters are classed as "European Protected Species" and therefore given the highest level of species protection.

The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007 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[1] or harass an otter
- damage, destroy or obstruct access to a breeding site or resting place of an otter (i.e an otter shelter)

Thus, otter shelters are legally protected whether or not an otter is present.

Otters were recorded at several locations throughout the study area and given the relatively undisturbed environment on Jura, it was presumed the whole study area encompasses territory for otters, with the regular sightings around the mouths of the two streams in the middle of the study area suggest these freshwater sources are important to local otters for washing fur, and provision of other habitat requirements. Signs of otters (footprints, spraints and remains of feeding activity) were recorded on Islay during surveys in of potential cable landing sites during summer 2009 (Royal Haskoning, 2009b), and otters were recorded just north of the proposed footprint during surveys for the proposed Inver Estate Hydro scheme (MacGillivray, 2009).

Of particular note, otters were recorded at the following locations:

- During the intertidal survey of site B a large otter (*Lutra lutra*) was spotted approximately 30m offshore at 13:40 (on the incoming tide), from there it moved south along the shore whilst fishing. The otter came ashore at the site where the Abhain Mhor (stream) enters the Sound of Islay and emerged from the water with a prey item (likely a fish). The otter then swam up the stream to just below the bridge where it dived and surveyors lost sight of it. No signs of otters (tracks or spraints) were found on the shore at this site. Rock armouring is present around a small road bridge over the stream. It is possible that the otter may have retreated to a lie-up within the rock armouring.

- During the survey at site C a large otter was sighted approaching rocks at the northern end of the bay. The otter approached from the north at 10.55am (around slack water low tide) then spent 20 minutes on and around the rocks uncovered by the low tide before swimming west into the Sound of Islay. No other signs (tracks, spraints, or feeding remnants) of otter were found at this location.

A dedicated otter survey is planned for the cable development at all locations, and advice will be required to be sought from Scottish Natural Heritage (SNH) to establish mitigation measures to reduce impacts*. Otter surveys are not seasonally dependant, and can be accurately completed at any time of the year.

Adder
The adder (*Vipera berus)* is one of four British reptiles found in Scotland and is listed on Schedule 5 (Protected animals) of the Wildlife and Countryside Act 1981 of the United Kingdom (W5.Oct01) (Sections 9(1) "killing & injuring" and 9(5) "sale" only). This species is listed on the Dangerous Wild Animals Act 1976 (as amended by The Dangerous Wild Animals Act 1976 (Modification) Order 1984).

Adders are likely to have been hibernating at the time of survey (NB hibernation occurs October to February), however suitable adder habitat (i.e. moorland, heath and bogs) was present throughout the study area on Jura. As concluded in the survey reports for Islay landing sites, further surveys may be required and consultation should be sought with SNH regarding the potential impact to this species.

Golden Eagle
The golden eagle (*Aquila chrysaetos)* is afforded protection under the Schedule 1 of the Wildlife and Countryside Act 1981. It is an offence to intentionally take, injure or kill a golden eagle or to take, damage or destroy its nest, eggs or young. It is also an offence to intentionally or recklessly disturb the birds close to their nest during the breeding season. The Nature Conservation (Scotland) Act 2004 widens this protection and provides additional protection for the golden eagle in Scotland.

A juvenile golden eagle was observed hovering low above surveyors at Site D during the low tide. This observation should be added to the ornithology survey work.

Sea Eagle
The sea eagle, or white tailed eagle (*Haliaeetus albicilla*), is afforded protection under the Schedule 1 of the Wildlife and Countryside Act 1981. It is an offence to intentionally take, injure or kill a golden eagle or to take, damage or destroy its nest, eggs or young. It is also an offence to intentionally or recklessly disturb the birds close to their nest during the breeding season. The Nature Conservation (Scotland) Act 2004 widens this protection and provides additional protection for the sea eagle in Scotland

An adult sea eagle was observed circling above surveyors at Site D before settling on top of the vegetated seacliff. This observation should be added to the ornithology survey work.

Pinnipeds
Pinnipeds found within Scottish waters are protected by a range of national and international obligations. In Great Britain, legislation, which extends to territorial waters, prohibits certain methods of killing seals, which include using poison or firearms other than a rifle. There is currently a total prohibition on the killing, injuring and taking of common seals in Scotland and a more limited geographical restriction concerning grey seals.

* Grey seals (and 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'). The 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.
* Specific legislation for seals is also provided in the Conservation of Seals Act 1970. The close season for seals in (some areas of) Scotland was extended by the Conservation of Seals (Scotland) Order 2002.

During the survey, a grey seal was observed milling close to the shore at Feolin ferry slip at slack low water. This sighting should be considered within the marine mammal assessment work as part of this project.

4.4 Invasive species

The study area was assessed for terrestrial invasive species during the Phase 1 Habitat survey. No assessment was made of aquatic invasive species.

The terrestrial invasive species included in the survey are as follows:

Giant hogweed
Giant hogweed (*Heracleum mantegazzianum*) is listed under the Wildlife and Countryside Act 1981.

No giant hogweed was present in the study area, and no further survey is required for this species.

Japanese knotweed
Japanese Knotweed originated in Japan and Northern China, and is a tall, perennial plant with vigorous growth which has been widely disturbed throughout Europe. As this species has been removed from the natural enemies that control its growth in its native range in Japan, it out competes native plants and animals in this country (Environment Agency 2005).

The Wildlife and Countryside Act 1981, provides the primary controls on release of non native species into the wild in the UK. Listed below is the legislation which covers the handling and disposal of Japanese knotweed. These have consequences for a wide range of people, including developers, local authorities and land owners.

* Wildlife and Countryside Act 1981;
* Environmental Protection Act 1990;
* Waste Management Licensing Regulations 1994; and
* Hazardous Waste Regulations 2005.

No Japanese knotweed was present in the study area, and no further survey is required for this species.

Rhododendron
Rhododendron can be difficult to control and forms dense impenetrable thickets that are difficult to treat, and is a threat to biodiversity, out-competing native species and monopolising local

* Guidance is available from www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

environments; Rhododendron also exudes toxic chemicals into the soil around them to suppress competing vegetation.

Rhododendron is not required by legislation to be removed. No further work is therefore required for this species by law however best practice should ensure minimisation of spread across the site.

Rhododendron (*Rhodendron ponticum*) was rare through the study area, and has been recorded within the target notes. The species was generally found as and as small sprigs within the acidic heath and moorland complexes.

Himalayan balsam
No Himalayan balsam (*Impatiens glandulifera*) was recorded within the study area and no further survey is required for this species.

4.5 Ecological assessment of landfall sites

From an environmental perspective, some of the potential landfall sites are preferable to others. Landfall Sites A (Feolin Ferry Terminal) and D (Site of existing cable landfall) have already been altered due to anthropogenic activities and therefore would only suffer an additional disturbance whereas Sites B and C have are in a relatively undisturbed state and otters using these sites for holts, washing or feeding activities would therefore be more sensitive to construction works. If the terrestrial cable could be installed sympathetically alongside the A846 the impacts would be minimised, however cliffs are present along the eastern boundary of the road, with the shore closely positioned along the western boundary. It is presumed cabling would be required to run adjacent to the road due to the hard constraints on either side. It is not known whether the available space alongside the road would be sufficient, and as the linear single track road is the only road on Jura, forming a lifeline connection with the ferry to Islay, consideration must be taken during construction to not obstruct this access route to vehicles. Crossings by the existing road bridges would also be required to cross the two rivers which cut across the study area. Both rivers are likely to be suitable habitat for otters and salmonids, both species protected under European law. Should it be decided that cable routing will make landfall on Jura an otter survey and salmonid habitat assessment will be conducted to confirm if this is correct.

If it is not possible to run the cabling along the road and therefore the cable route needed to be inland of the A846, two large steepsided gullies would have to be negotiated (with potential implications to otter and/or salmonid habitats as discussed above) and access roads would need to built which are likely to cause a greater environmental impact, particularly with regards to the northern potential landing sites which have a longer terrestrial landfall and will therefore impact on a wider area than the southern sites.

Aside from the ecological implications of cable routing on land, the impact to the visual landscape must be considered, if this option was chosen. Jura is designated as a National Scenic Area and currently exists as a rugged island with little development, with much of the land owned by estates and roamed by red deer. The cabling would therefore have to be incorporated sympathetically into the landscape to be in-keeping with the current environment and its designations.

Site A has been subjected to highest levels of anthropogenic activity, which is mainly infrastructure associated with the ferry terminal. It is also located close to the proposed scheme. Due to the current levels of disturbance at this area, Site A is a preferable location in terms of intertidal habitat and protected species, however if cable landfall were to occur at Site A the cable would need to be installed across the longest distance of complicated terrestrial terrain of wet heath and bog mosaic, and important and fragile habitat, making the location unpreferable for terrestrial habitats.

Sites B and C, in the middle of the footprint coastline, are situated close to river mouths, which both have potential to provide an important habitat resource for local otters. Indeed an otter was sighted in the vicinity of both the river mouths during the intertidal survey of these sites. Fresh water is important for otters to maintain the waterproof properties of their fur (Twelves, undated; Roper, in draft). Freshwater as easily accessible yet undisturbed as this river mouth is scarce along the coastline, with these two rivers being the most suitable for otters in the 3.5km stretch of coastline in the habitat footprint. Although the single track road lies close to these two sites, subjecting them to limited disturbance, the potential adverse impact to local otter populations will be greatest at these locations. This does not mean that works are precluded in this area, but a targeted otter survey would be recommended in advance of any construction, and works which minimise disturbance to the rivers are likely to be preferable.

Site D is a preferable location for cable landfall on Jura as it has an existing cable landfall, as has been subjected to anthropogenic disturbance with limited residual impact. Terrestrial cable routing from this point will not encounter the problems associated with Sites A, B or C (as discussed above) as it is located to the south of the A846 and would therefore not create such a large visual impact. Approximately 200m south of the existing cable landfall is a small stream which may provide potential habitat for otters. A walkover was completed of the area surrounding the cable routing and no signs of otters were located however this does not conclude that otters do not use this site. The existing cable and associated hard casing has created an artificial reef which supports a greater diversity of species than the surrounding area, which was characterised by sandy substrates with scattered boulders. It can therefore be assumed that within a few years natural succession would occur on the new cable and hard casing leading to greater species richness and diversity on the artificial reef.

Overall, as otters are regularly observed from Jura and were recorded on three days on surveying, it is recommended that when decisions are made as to the whereabouts of the cable landfall (i.e. Islay or Jura), further detailed and targeted otter surveys will be required to assess for the presence of holts, lie-ups, couches etc in the proposed footprint to inform detailed design.

5 RECOMMENDATIONS

Following the Phase 1 Habitat survey, several recommendations are made and are as follows:

1) Site D and south of the river at Site C are ecologically preferred options for cable landings regarding minimising the impacts on quality habitats and protected species, however no site is deemed unsuitable on ecological grounds.

2) A thorough Phase 1 Habitat survey was completed across the whole site, however was completed outwith the optimum season. It is therefore recommended that consultation occurs with SNH following the decision as to which landing site is the preferred choice (following consideration of all factors including engineering, land ownership, feasibility, cost etc).

3) An otter survey is required for all proposed landing sites. These surveys are currently being planned.

4) A terrestrial invasive species survey is not required for the Isle of Jura.

5) An aquatic invasive species survey was not completed during the Phase 1 Habitat Survey, and advice should be sought from SNH as to whether one is required.

6) Advice should be sought from SNH regarding reptile mitigation.

7) The sightings of grey seal should be added to the marine mammal baseline.

8) The sighting of golden eagle and sea eagle should be added to the ornithology baseline.

6 SPECIES LIST

Latin Name	Common Name
Moses and Lichens	
	Mosses (indet.)
Cladonia floerkeana	A lichen
Cladonia portentosa	A Lichen
Polytricum commune	A moss
Sphagnum spp.	*Sphagnum* mosses
Grasses, rushes and ferns	
Agrostis canina	velvet bent
Asplenium trichomanes	maidenhair spleenwort
Blechnum spicant	hard fern
Cynosurus cristatus	crested dog tail
Deschampsia caespitosa	tufted hair grass
Dryopteris dilitata	broad buckler fern
Eriophorum angustifolium	cotton grass
Festuca ovina	sheep's fescue
Holcus lanatus	Yorkshire fog
Juncus acutiflorus	sharp flowered rush
Juncus effusus	soft rush
Juncus squarrosus	heath rush
Luzula sylvatica	great woodrush
Molina caerulea	purple moor grass
Nardus stricta	mat grass
Pteridium aquilinum	Bracken
Trichophorum cespitosum	deer grass
Trees and shrubs	
Alnus glutinosa	common alder
Alnus incana	grey alder
Betula pendula	silver birch
Betula pubescens	downy birch
Ilex aquilinum	holly
Quercus robur	pedunculate oak
Rhododendron ponticum	rhododendron
Salix alba	white willow
Salix fragilis	crack willow
Salix indet.	A willow
Salix pentandra	bay willow
Sorbus aucuparia	rowan
Ulex europaea	gorse
Herbs, flowers and ericoids	
Bellis perennis	daisy

Calluna vulgaris	ling
Cirsium spp.	A thistle
Digitatum purpurea	foxglove
Drosera rotundifolia	round leaved sundew
Empetrum nigrum	crowberry
Erica cinerea	bell heather
Erica tetralix	cross leaf heather
Gallium saxatile	heath bedstraw
Gentiana pneumonanthe	marsh gentian
Isoetes echinosporo	spring quillwort
Myrica gale	bog myrtle
myriophyllum verticillatum	whorl leaved water milfoil
Narthecium ossifragum	bog asphodel
Oxalis acetosella	wood sorrel
Pedicularis sylvatica	lousewort
Plantago lanceolata	ribwort plantain
Potentilla erecta	tormentil
Rubus fructicosus	bramble
Rumex acetosella	sheep sorrel
Succisa pratense	devils-bit scabious
Taraxacum officinalis	dandelion
Urtica dioica	nettle
Vaccinium myrtillus	bilberry

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7 REFERENCES

Environment Agency (2005). Managing Japanese Knotweed on development Sites, The Knotweed Code of Practice

Fitter, R. (1995) Collins Pocket Guide to the Grasses, Sedges, Rushes & Ferns of Britain & N Europe. Harper Collins

Field Studies Council (1998) Grasses Identification Chart

JNCC (2003) Handbook for Phase 1 Habitat Survey, a technique for environmental audit.

Rose, F(1991) The Wild Flower Key, British Isles – N.W. Europe. The Penguin Group

Royal Haskoning (2009a) Sound of Islay Tidal Turbines: Intertidal survey of potential cable routes on the Isle of Jura

Royal Haskoning (2009b) Sound of Islay Tidal Turbines: Phase 1 Habitat survey of potential cable routes

Sterry, P (1997) Collins Complete British Wildlife Photo guide. Harper-Collins Publishers Ltd.

www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

MacGillivray, F (2009) Otter *S*urvey Inver Estate Autumn 2008 Area of Proposed Hydro Scheme and other key locations :Survey September – November 2008 Report

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 16 – Terrestrial and Intertidal Ecology

Appendix 16.4: “Inter-tidal survey of potential cable routes on the Isle of Jura”

Sound Of Islay Demonstration Tidal Array

Inter-tidal survey of potential cable routes on the Isle of Jura

Scottish Power Renewables

14th December 2009

Final Report

9T3474

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Approved by	Frank Fortune
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CONTENTS

1 INTRODUCTION

1.1 Scheme description

Scottish Power Renewables (SPR) has commissioned Haskoning UK Ltd to assist in applications for consent to install a demonstration tidal turbine array within the Sound of Islay, Scotland. The proposed area of interest lies within the central channel of the Sound of Islay. The demonstration tidal array of ten devices would be deployed within this area and is anticipated to have a footprint of approximately 0.4 km^2. The turbines would generate up to 10MW of power and will be linked via underwater cabling to onshore infrastructure on either Islay or Jura. SPR are currently investigating four potential landing sites on Jura for cable routing onshore to a potential substation the location of which is yet to be determined.

To inform the Environmental Impact Assessment an intertidal survey was undertaken on the 17th 18th and 19th November to assess each of the four locations presented in Figure 1.1. The intertidal survey was completed in conjunction with the Phase 1 habitat survey of potential cable routes (Royal Haskoning 2009a). The survey was completed late in the season, and there is potential some smaller/more fragile species of alga may have died back at the time of survey.

An intertidal survey was completed August 2009 on Islay (Royal Haskoning 2009b), to assess six potential cable landfall sites directly opposite the potential Jura footprint, which is discussed in this report. This survey used identical techniques to the present survey but was conducted during the summer when a greater number of species are generally present.

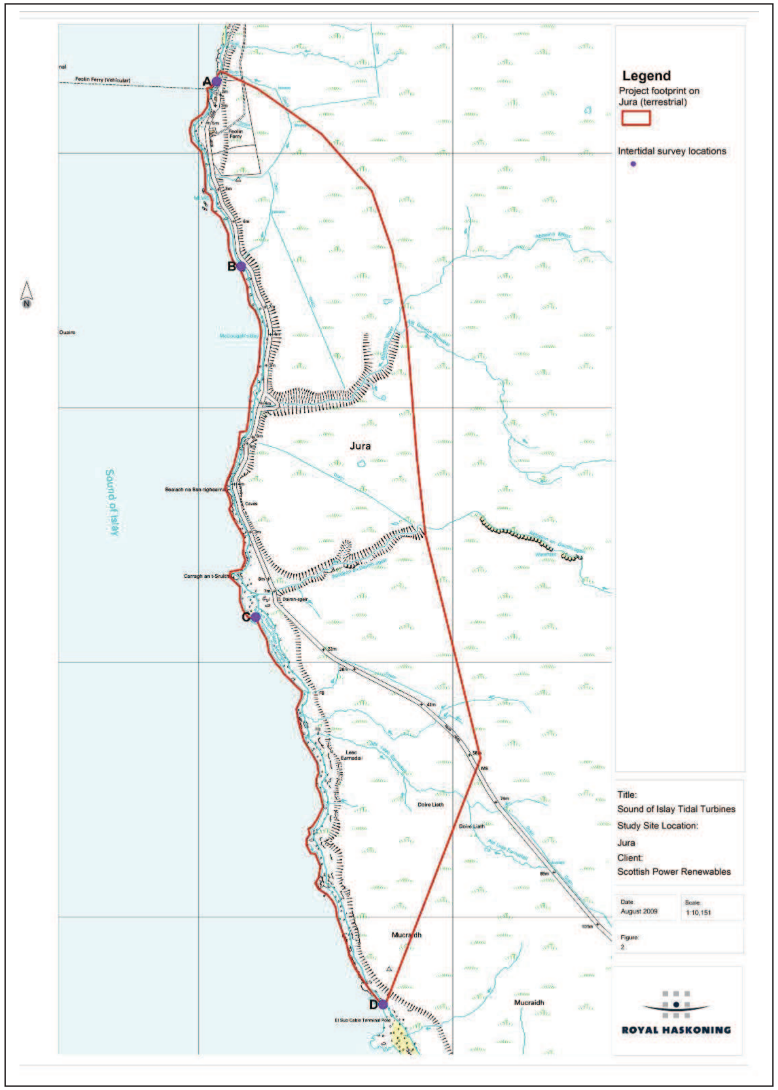

Figure 1.1. Locations of intertidal survey sites A – D.

1.2 Aims and Objectives

The intertidal survey aimed to identify the biotopes and their zonation and distribution at four locations along Jura coastline, bordering the Sound of Islay. Each location has been identified by Scottish Power as a potential cable route landing area for the proposed tidal turbine array.

The main objectives were to:

a) Complete at minimum 1 re-locatable transect at each of the four locations;
b) Identify species present at each of the locations, noting rare, protected or non-native species;
c) Provide photographic records of each location; and
d) Identify the biotopes present at each location and determine their distribution.

2 METHODOLOGY

Four sites were surveyed at low spring tide during the 17th 18th and 19th of November, 2009 (Figure 1.1). Weather conditions varied throughout the survey as follows: The 17th was clear with a gentle breeze from the southwest; the 18th was overcast with slight rainfall occurring toward the end of the day's survey, and during the 19th heavy rain persisted throughout the day with moderate to strong south-westerly wind. Visibility ranged from good to moderate throughout the survey. The survey was completed by two experienced ecologists operating on foot, using a number of methods and techniques, including 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).

A hand held Garmin Global Positioning System (GPS) was used to provide positioning data for each transect and throughout the survey. Transects were predominantly placed at a location most suited for cables to be brought ashore, i.e. avoiding large areas of bedrock and large boulders. Where a matrix of substrates were present, an additional transect was completed to inform on all potential biotopes present at each site especially when the probable cable sighting transect was atypical of the shore at that location.

Each transect was surveyed from the top of the shore to the low shore, with the aim of recording all typical biotopes within the study area. A 100m tape measure was used to mark the position of the transect, and to determine the extent in meters of each biotope within the context of the shore. Each zone or biotope was assessed for the species present and was photographed. Where features (biological or physical) were encountered of interest outside the transects (and in geographically discrete areas) target notes were used to record and sketch maps were drawn of the feature. Biotopes within each transect were assigned codes under the 2004 JNCC Biotope classification (Connor, *et al*, 2004). A species list is provided in Section 5.1 with a description of each biotope provided in Section 5.2.

Additional data was recorded during the intertidal survey to include positive sightings of, tracks or signs of marine mammals.

3 RESULTS

3.1 Site A – Feolin Ferry Terminal

Site A, the most northern site, was located just north of the ferry terminal (Figure 1.1) and was accessed via the ferry waiting area car park. The site was surveyed using two transects (A1 and A2) on the 19th November at 12:35am.

The site consisted of a wide bay bordered by the Ferry terminal seawall to the south and a protruding rocky outcrop to the north (Figure 3.1). Much of the bay consisted of shingle (mostly pebble and cobbles) with occasional patches of sand and boulders (which were mainly at the top of the shore). Areas of exposed bedrock and large boulders made up much of the northern part of site A, with the bedrock extended down from a small but steep rocky headland and continuing to the north (Figure 3.1). Two small streams entered the Sound of Islay at site A, the first dispersed through the shingle in the southern part of the bay whilst the second formed a more obvious channel just north of the exposed rock (Figure 3.1). Fucoids and *Ascophyllum nodosum* dominated the lower shore of much of the area particularly in the north whilst the upper shore supported few species.

Two transects were surveyed at this site (Figure 3.1) – the first (A1: NR 44083 69275, bearing: 295^o, Plate 3.1 & 3.2) took the line of least resistance up the shore and was therefore considered probably the most suitable line for the installation of a cable. Biotopes for this transect are described in Table 3.1 and shown in Plates 3.3 and 3.4. Transect A1 was not deemed typical of the shore at this predominantly rocky site so a second transect (A2: NR 44104 69359, Bearing 281^o, Plate 3.2) was surveyed to assess the exposed bedrock and rock pool habitats of the northern part of the bay. Biotopes for this transect are described in Table 3.2 and Plates 3.5 to 3.8.

Plate 3.1. Transect A1: View up transect from water level

Plate 3.2. Transect A2: view up transect from lower shore

Weather conditions during the survey were less then optimum with heavy rain and moderate winds from the south west. Sea state remained fairly calm throughout the survey and did not inhibit work on the lower shore.

Table 3.1. Transect biotopes at Site A1

Location on tape measure (m)	Description	Biotope
0.00 – 2.30	Shingle composed mainly of pebbles	LS.LCS.Sh
2.30 - 2.80	Strand line on boulders and pebble shingle.	LS.LSa.St
2.80 - 13.80	*Fucus spiralis*, on loose cobles, pebbles and some small boulders	LS.LCS.Sh
13.80 - 15.00 (water line) and below	*Fucus vesiculosus*, in small clumps on gravel and pebble substrate	LS.LCS.Sh and LR.LLR.F.Fves.X

Plate 3.3. Transect A1: view from upper shore down transect showing biotopes encountered.

Plate 3.4. Transect A1: looking north from the transect location, providing a view of the shoreline in profile.

Table 3.2. Transect biotopes at Site A.2

Location on tape measure (m)	Description	Biotope
0.00 - 4.50	Large boulders and rocks. A scattered strandline (approximately 3m wide) within this zone, location and extent not clearly defined. Larger boulders and rock support *Verrucaria maura.*	LS.LSa.St and LR.FLR.Lic.Ver.Ver
4.50 - 9.00	*Ramalina siliquosa*, *Xanthoria sp*. and *Verrucaria maura* on boulders and exposed bedrock	LR.FLR.Lic.Ver.Ver
9.0 – 10.60	Abundant *Pelvetia canaliculata***,** occasional and small clumps of *Fucus spiralis*. *Verrucaria maura*, and *Ulva enteromorpha* are both present, on a substrate of mainly pebbles and large cobbles	LR.MLR.BF.PelB
10.60 - 17.30	A low lying partly enclosed rock pool on lower ground containing many of the species found below 24.7m (see below) with the addition of: *Ulva lactuca* and *Polyides rotundus*. The substrate was composed of Bedrock and boulders	LR.FLR.Rkp
17.30 - 24.70	*Fucus spiralis* on higher ground and, *Ascophyllum nodosum*, on lower ground with *Cladophora*, *Hildenbrandia rubra*, *Nucella lapillus and Patella sp* on substrate composed of mainly bedrock with some boulders, *Chthamalus montagui*, *Semibalanus balanoides* found on exposed rock.	LR.LLR.F.Asc.FS
24.70 (water line) and below	Abundant *Ascophyllum nodosum*, with *Polysiphonia lanosa*, *Fucus vesiculosus*, *Fucus serratus*. *Fucus spiralis* present on the higher rock, *Chthamalus stellatus*, *Semibalanus balanoides, Patella sp.*, *Littorina obtusata*, *Cladophora*, *Chondrus crispus*, *Plocamium cartilagineum*, Porifera indet. (orange), green algae indet. (hard crustose), *Hildenbrandia rubra* all present. Substrate composed of undulating bedrock and boulders.	LR.LLR.F.Asc.FS

Plate 3.5. Transect A2: lower shore with bedrock and boulders supporting *Ascophyllum nodosum* and Fucoids

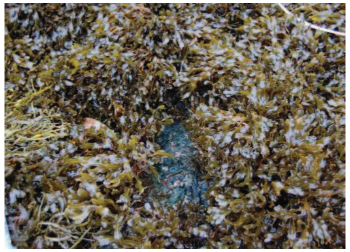

Plate 3.6. Transect A2: Mid shore dominated by *Fucus spiralis*, especially on the higher ground

Plate 3.7. Transect A2: Rock pool

Plate 3.8. Transect A2: Above the rock pool showing the Fucus spiralis zone and Pelvetia canaliculata zone boundary

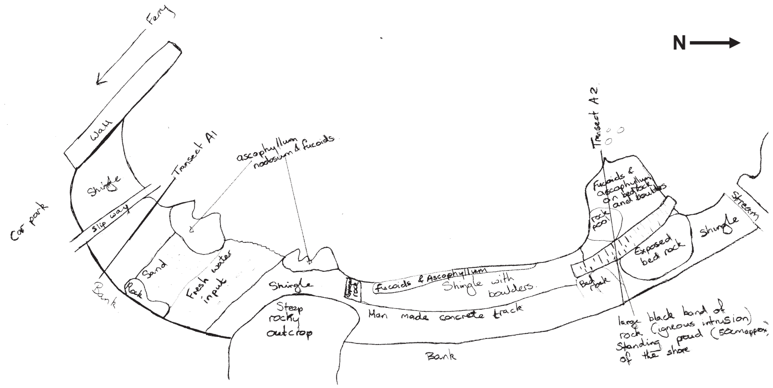

Figure 3.1. Sketch Map of Site A - showing target notes and distribution of species and habitats

No signs of the presence of marine mammals (spraints, tracks, food remnants) were recorded at this site during the intertidal survey. However a grey seal (*Halichoerus grypus*) was sighted on 16th November milling near the ferry port wall.

3.2 Site B – McDougal’s Bay

Site B was located approximately 500m south of site A at the northern end of McDougal’s Bay. This site was accessed via the A486 which had adequate roadside parking. The site was surveyed using a single transect (B) on the 19th November at 13:35pm.

The site consisted of relatively straight uniform coastline roughly forming a wide bay (Figures 1.1 and 3.2). The shore which sloped steeply down to the waters edge consisted of cobble and pebble shingle with occasional boulders which were mainly on the mid to lower shore (Figure 3.2). The top of the shore was bordered by a steep bank approximately 1.5 meters high on which a bracken and grassy matrix was present.

The transect surveyed at this site ran from the point at which the shingle met the bank (at NR 44083 69275, Figure 3.2, plates 3.9 & 3.10) down the shore on a bearing of 246^{o} to well below the water line. Biotopes for this transect are described in Table 3.3 and Plates 3.11 to 3.12.

Table 3.3. Biotopes at Transect B

Location on tape measure (m)	Description	Biotope
0 - 1.40	Above the strand line. Mainly pebbles with some cobbles	LS.LCS.Sh
1.4 – 3.00	The strand line on pebbles cobbles and boulders (plate 3.11).	LS.LSa.St
3.00 - 13.10	The substrate is mainly cobbles pebbles and boulders with some gravel. Larger boulders support small amounts of *Pelvetia canaliculata*, *Patella sp*. and *Fucus spiralis*. *Verrucaria maura* and yellow and grey lichens were found on larger boulders (Plate 3.12).	LS.LCS.Sh and LR.FLR.Lic.Ver.Ver
13.10 – 15.00	Rare scattered *Fucus spiralis* on cobbles.	LS.LCS.Sh
15- and below	*Ascophyllum nodosum*, *Fucus serratus, Fucus vesiculosus* are all present but are not covering much area. The substrate is composed of cobbles and small boulders.	LS.LCS.Sh and LR.MLR.BF

Plate 3.9. Transect B: Taken from water looking up the transect

Plate 3.10. Transect B: Taken from the transect facing North

Weather conditions during this part of the survey were less then optimum with heavy rain and moderate winds from the south west. Sea state remained fairly calm throughout the survey and did not inhibit work on the lower shore.

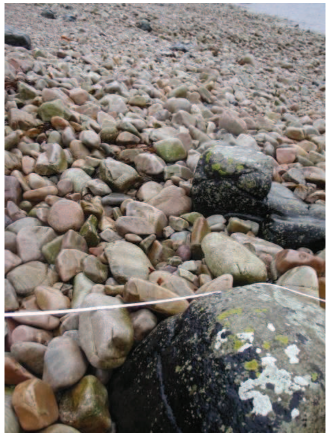

Plate 3.11. Transect B: Boulders with supporting lichens on a shingle dominated shore

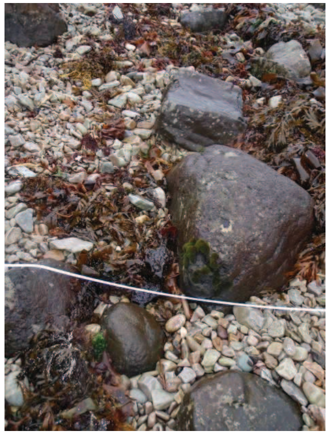

Plate 3.12. Transect B: The strand line on cobbles and boulders

During the intertidal survey of site B a large otter (*Lutra lutra*) was spotted approximately 30m offshore at 13:40pm (on the incoming tide), from there it moved south along the shore whilst fishing. The otter came ashore at the site where the Abhain Mhor (stream) enters the Sound of Islay and emerged from the water with a prey item (probably a fish Plate 4,1), which it proceeded to eat in the intertidal. The otter then swam up the stream to just below the bridge where it dived and surveyors lost sight of it. No signs of otters (tracks or spraints) were found on the shore at this site although this is likely to be because the river was in spate and therefore has washed away any signs. Rock armouring is present around a small road bridge over the stream. It is possible that the otter may have retreated to a lie-up within the rock armouring.

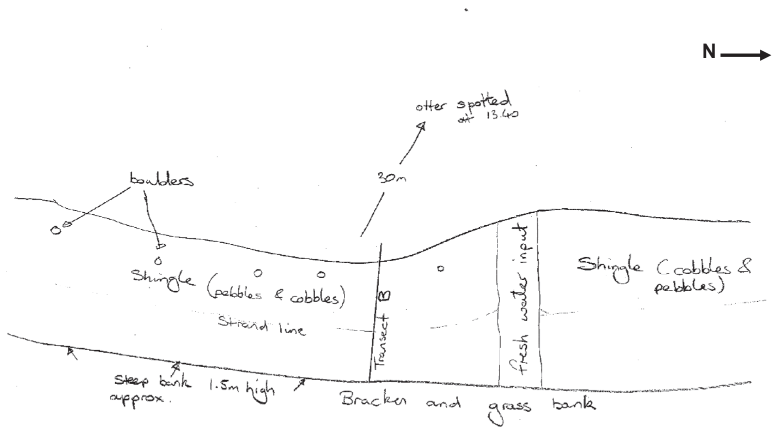

Figure 3.2. Sketch Map of Site B- showing target notes and distribution of species and habitats

3.3 Site C – South of the mouth of Abhainn an Daimh-sgeir

Site C was located just to the south of the mouth of the Abhainn an Daimh-sgeir (stream) (Figure 1.1) and was accessed via the A486 which had adequate roadside parking. The site was surveyed using two transects (C.1 and C.2) on the 17th November at 11:00am.

The site consisted of a small embayment bordered on the north by a small rocky headland that in turn forms the southern bank of the Abhainn an Daimh-sgeir (a small stream that flows down a steep sided gorge and into the Sound of Islay). Exposed bedrock continues down from the rocky headland and into the Sound to form the northern shore of the bay. The shore in the middle and southern sections of the bay was composed of shingle with occasional patches of bedrock (Figure 3.3). Two small unnamed and unmapped streams were present on the shore at the time of the survey the first which was located in the south and flowed across the shore in a diffuse nature, while the second, which was very small, flowed down the shore in a more obvious channel (Figure 3.3).

The lower shore across much of the bay was dominated by fucoids and *Ascophyllum nodosum*, whilst the upper shore supported few species. The upper shore was bordered by a bank upon which a matrix of marshland and grassland habitat existed. The bank was less than 1m high at its southern end and was steeper and higher in the north.

Two transects were surveyed at this site (Figure 3.3) – the first (C1: NR:44241 67190 plate 3.13) took a line from the headline down through the edge of the border between bedrock and shingle (Figure 3.3) and was positioned to capture as many different habitats as possible. The second transect (C2: NR: 44267 67167, Plate 3.14) assessed the middle of the bay along a line with few features to gather information which was more typical of the bay and also a more appropriate line for cable landfall (Figure 3.3).

Plate 3.13. Transect C1: View down transect from the foot of the rocky headland.

Plate 3.14. Transect C2: View up transect from the water line

Details of the biotopes found in transect C1 are displayed in Table 3.4 and Plates 3.15 and 3.16 and details of C2 are displayed in Table 3.5 and plates 3.17 and 3.18.

Table 3.4. Transect biotopes at Site C1

Location on tape measure (m)	Description	Biotope
0 - 4.9 (NR44248 67202)	*Ramalina siliquosa* and *Xanthoria sp.* on bedrock and boulders.	LR.FLR.Lic.YG
4.9 - 6.60	*Verrucaria maura*, yellow and grey lichens	LR.FLR.LIc.YG
6.60 – 7.20	*Pelvetia canaliculata*, *Verrucaria maura*, yellow land grey lichens on cobbles, boulders, and bedrock.	LR.FLR.Lic.Ver.B
7.20 - 8.80	*Fucus spiralis* with *Pelvetia canaliculata* on higher ground, *Littorina littorea* and *Littorina obtusata*, *Cladophora sp*, *Ulva enteromorpha*, *Hildenbrandia rubra*, *Patella sp* all present (Plate 3.15). Bedrock at sides of transect and cobles and pebbles in gully.	LR.LLR.F.Fspi.X and LR.MLR.BF.PelB
8.80 – 11.80	Scattered *Ascophyllum nodosum* with *Spirobis spirobis*, 5% cover of seaweeds. The transect runs through a gully and on the rocks either side of this are *Pelvetia canaliculata*, *Patella sp.*, *Verrucaria maura* and *Chthamalus montagui* are all present on bedrock.	LR.LLR.F.Asc.FS and LR.MLR.BF.PelB
11.80 – 15.30 (waters edge at 12.80)	*Fucus serratus* with *Spirobis spirobis*, *Ascophyllum nodosum*, *Polysiphonia lanosa*, *Cladophora*, pink encrusting algae (possibly *Lithothamnion*) *Patella sp.* and *Chondrus crispus* are all present (plate 3.16). Algal cover is approximately 80%. *Nucella lapillus*, *Halichondria panacea*, *Carcinus maenas* and amphipods are also present	LR.LLR.F.Asc.FS
15.30 – and below (NR 44241 67190)	*Himanthalia elongate* with *Ceramium sp.* attached, *Fucus serratus* with *Spirobis spirobis* attached. *Littorina obtusata* are all present. *Laminaria digitata* was also seen to be approximately 10m out from lowest point that surveyors could safely reach. Visibility through water was poor due to its dark brown colour (presumably as a result of surface run off as a result of recent rain).	LR.LLR.F.Fserr.X

Weather conditions throughout the survey of site C were favourable, clear skies gave good visibility and a light south-westerly breeze had little or no effect on the sea state which was calm.

Plate 3.15. Transect C.1: Mid section of the transect

Plate 3.16. Transect C.1: looking north from the transect toward the rocky headland

Table 3.4. Transect biotopes at Site C.2

Location on tape measure (m)	Description	Biotope
0.7 - 0	Yellow and white lichens on exposed rock.	LR.FLR.Lic.YG
3.10 – 0.7	Strandline on cobbles	LS.LSa.St
3.10 – 11.90	Cobbles and pebbles with no algae.	LS.LCS.Sh
11.90 - 14.1 (12.80 is the water line)	*Ascophyllum nodosum* (not as much as in next zone), *Fucus spiralis*, *Ulva enteromorpha*, brown (filamentous feathery) algae indet., (possibly *Spongonema tomentosum*, or an *Ectocarpus sp*.) and *Porphyra umbilicalis* on mainly cobbles and occasional boulders (plate 3.17)	LR.LLR.F.Asc.FS and LS.LCS.Sh
14.10- below	*Ascophyllum nodosum*, *Fucus serratus*, *Cladophora*, *Chondrus crispus*, *Spirobis spirobis*, *Littorina obtusata*, *Fucus vesiculosus*, all present on cobbles and the occasional boulder. Further offshore *Laminaria digitata*. and *Himanthalia elongata* could be seen semi submerged (see bottom of shore plate 3.18) but were not surveyed.	LR.LLR.F.Asc.FS

Plate 3.17. Transect C.2: *Ascophyllum nodosum* and fucoid dominated lower shore

Plate 3.18. Transect C.2: Strandline on cobbles and cobbles with no algae. Small diffuse stream on left of picture

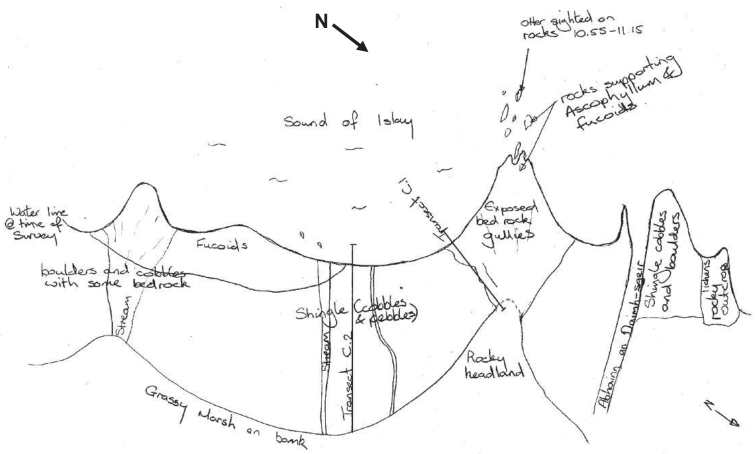

Figure 3.3. Sketch Map of Site C- showing target notes and distribution of species and habitats

During the survey at site C a large otter was sighted approaching rocks at the northern end of the bay. The otter approached from the north at 10.55am (around slack water low tide) then spent 20 minutes on and around the rocks uncovered by the low tide (Figure 4.3) before swimming west into the Sound of Islay. No other signs (tracks, spraints, or feeding remnants) of otter activity were found at this location.

3.4 Site D – Site of existing cable landfall

Site D was the southern most location considered by SPR for potential cable landfall and is currently the location of an existing cable landfall. The site was accessed by parking in a lay-by on the A486 near to where the Alit Leac Earnadail (stream) passes under the road; from here the approach was made by walking in a south westerly direction until the site was reached. A single transect (D) was used to survey this site on the 18th November at 12:15. The transect ran perpendicular to the shore starting on the upper shore at NR 44778 65621 and continuing down the shore on a bearing of 254°. At the point where the transect met the water line it changed direction slightly to follow the existing cable with its concrete armouring in a north-westerly direction (Figure 3.4)

The site consisted of a wide bay bordered to the north by small patches of exposed rock and two rock pillars (which can be seen in Plate 3.19). To the south the bay curved gently toward a channel that exists between Glas Eilean (island) and mainland Jura (which can be seen in Plate 3.20). The hinterland consisted of a grass and bracken matrix sloping up steeply from the shore in the north (with areas of exposed cliff) and sloping up gently from the middle and southern parts of the shore.

The substrate across much of the upper and mid shore consisted of shingle, which was composed mainly of cobbles with some pebbles, and boulders. The lower shore, much of which was below the water line, was composed of rippled sand on which occasional boulder was found.

Plate 3.19. looking to the northern part of Site D

Plate 3.20. looking to the southern end of Site D

Details of the biotopes found on transect D and their extents are presented in Table 3.4 and plates 3.19 and 3.20.

Table 3.4. Transect biotopes at Site C.2

Location on tape measure (m)	Description	Biotope
10.20-0	Pebbles and cobbles arranged in steps.	LS.LCS.Sh
11.30-10.20	Strandline on cobbles and pebbles (plate 3.19)	LS.LSa.St
18.90-11.30	Small patches of *Fucus spiralis* on pebbles, cobbles and boulders.	LS.LCS.Sh and LR.LLR.F.Fspi.X
21.10-18.90	Abundant *Fucus spiralis*, *Littorina littorea*, *Littorina obtusata*, *Chthamalus montagui*, *Semibalanus balanoides*, *Actinia equina*. Shore composed of cobbles and boulders.	LR.LLR.F.Fspi.X
24.8- 21.10	On cable armouring and on occasional boulders either side of it were: *Ascophyllum nodosum*, *Fucus serratus*, *Electra pilosa*, *Cladophora*, *Fucus vesiculosus*, *Actinia equina*, *Chondrus crispus*, *Patella sp.*, *Chthamalus montagui*, *Hildenbrandia rubra, Semibalanus balanoides*, and *Littorina obtusata*.	LR.LLR.F.Asc.FS
40.9-24.80	On cable armouring were: *Fucus serratus* with *spirobis*, and an abundant covering of *Cladophora* Sp. Either side of the cable armouring was rippled sand with occasional boulders supporting *Fucus serratus*. Remaining substrate composed of rippled sand.	LR.LLR.F.Fserr.X
45.1- 40.9m	*Laminaria digitata*, *Ulva lactuca*, *Himanthalia elongata* with *Ceranium sp.*, *Fucus vesiculosus, Halichondria panicea* (breadcrumb sponge) C*hondrus crispus* and *Cladophora sp.* were all present on the cable armouring. Surrounding substrate was composed of plain rippled sand with *Arenicola marina* (approximately 3m^2).	IR.MIR.KR.Ldig and LS.LSa.FiSa.Po

Weather conditions during the survey at site D were generally good with slight south westerly winds and overcast skies, light rain began falling toward the end of the survey, but conditions did not affect the survey in any way.

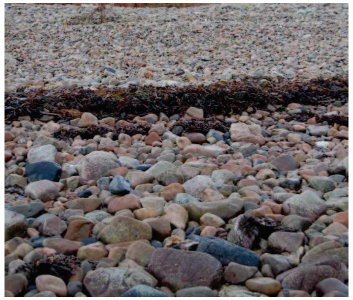

Plate 3.19. Transect D: The strandline

Plate 3.20. Transect D: *Fucus serratus* on armouring that protects existing cable

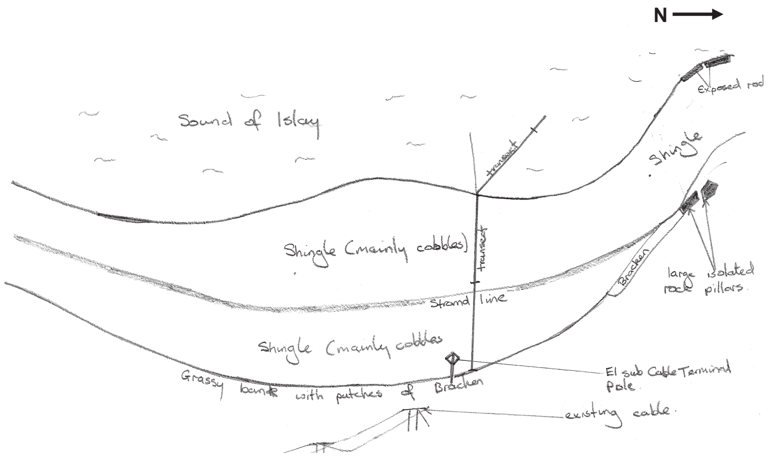

Figure 3.4 Sketch map of site D- showing target notes and distribution of species and habitats

Possible remnants of otter feeding were found on exposed rocks in the northern part of this site. These included shards of the carapace and chelae (claws) of an edible crab (*cancer pagurus*). No other signs (spraints, tracks ect) were found. Several prominent rocks in the area supported shags (*Phalacrocorax aristotelis*).

4 CONCLUSIONS

4.1 Comparison with Islay survey

Although similar biotopes were recorded in the Islay and Jura intertidal surveys there was a notable difference in the biodiversity. Fewer species were recorded on Jura than on Islay (see Haskoning 2009b) this may be due an actual difference in biodiversity or it may be due to seasonality as the Islay survey was conducted during the summer when more species may be present.

4.2 Rare and protected species and biotopes

No rare or protected biotopes were found within the proposed footprint of the scheme during the intertidal survey, and the zonation of biotopes identified (lichens through to fucoids to kelp) were typical of the area. Fewer species were recorded during the Jura survey (the present survey) than were recorded during the Islay survey (Royal Haskoning 2009b) which took place on the Islay shoreline of the Sound. This may be due to the change in season that occurred between the two surveys, or may be due to increased exposure on the Jura coastline compared to on the Islay coastline.

The following species of note were recorded:

- Otter (*Lutra lutra*, plate 4.1) – European Protected Species listed in Appendix 74 of the CRoW Act 2000 and protected under Section 5 of the Wildlife and Countryside Act 1981 (as amended). In addition, otters are also protected under the Conservation (Natural Habitats &c.) Regulations 1994. Otters were recorded at several locations throughout the study area and given the relatively undisturbed environment on Jura it was presumed the whole footprint encompasses territory for otters. Regular sightings around the mouths of the two streams in the middle of the footprint suggest that these freshwater sources are important to local otters for washing fur, and provision of other habitat requirements. It is likely that the footprint assessed during the current survey is part of a much larger area of coastline that is used by otters. Evidence to support this comes from an Otter survey which was conducted in November 2008 in connection with a proposed hydro scheme which would be located to the north of the current study area. During this survey Otters were sighted fishing in the Sound just off shore at Feolin Ferry House and just south of Stac nan Sgarbh (MacGillivray, 2009).
- Grey seal (*Halichoerus grypus*) grey seals are protected by law in the U.K. under the Wildlife and Countryside Act 1981 and the Conservation of Seals Act. A grey seal was recorded close to the shore at site A on the 16th of November prior the phase 1 habitat survey commencing (see phase 1 habitat survey report for details).

Plate 4.1. Otter (*Lutra lutra*) Photographed at the mouth of the Abhain Mhor (stream) shortly after the survey at site B.

Plate 4.2 Rock armouring around the road bridge (all four sides) over Abhain Mhor – potential otter lie-up site (Survey Site B).

Plate 4.3 Otter post feeding on small rocky outcrops uncovered at low tide (Survey Site C).

4.3 Recommendations

From an environmental perspective, some of the potential landfall sites are preferable to others. Landfall Sites A (Feolin Ferry Terminal) and D (Site of existing cable landfall) have already been altered due to anthropogenic activities and therefore would only suffer an additional disturbance whereas sites B and C have are in a relatively natural state and therefore cable landfall at these sites would alter this status considerably.

Site A has been subjected to highest levels of anthropogenic activity, which is mainly infrastructure associated with the ferry terminal. It is also located close to the proposed scheme. Due to the current levels of disturbance at this area, Site A is a preferable location in terms of intertidal habitat and protected species, including otters, however if cable landfall were to occur at site A, cable would then need to be installed across the longest distance of complicated terrestrial terrain of wet heath and bog mosaic, and important and fragile habitat (as identified in Royal Haskoning 2009a). If the terrestrial cable could be installed sympathetically alongside the A846, impacts would be minimised, however cliffs are present along the eastern boundary of the road, with the shore closely positioned along the western boundary, which could make this problematic. It is presumed cabling would be required to run adjacent to the road due to the hard constraints on either side. It is not known whether the available space alongside the road would be sufficient, and as the linear single track road is the only road on Jura, forming a lifeline connection with the ferry to Islay, consideration must be given during construction to not obstructing this access route to vehicles.

If it is not possible to run the cabling along the road and therefore the cable route needed to be inland of the A846, two large steepsided gullies would have to be negotiated and access roads would need to built, with considerable potential for environmental inpact. Both gullies contain rivers which are likely to be suitable habitat for otters (Should it be decided that cable routing will make landfall on Jura an otter survey will be conduceted to confirm if this is correct), a species protected under europen law.

In addition to the ecological implications of cable routing on land, the impact to the visual landscape must also be considered, if this option is chosen. Jura is designated as a National Scenic Area (NSA) and currently exists as a rugged island with little development, with much of the land owned by estates and roamed by red deer. The cabling would therefore have to be incorporated sympathetically into the landscape to be in-keeping with the current environment and its designations.

Sites B and C, in the middle of the footprint coastline, are situated close to river mouths, which both have potential to provide an important habitat resource for local otters. Indeed an otter was sighted in the vicinity of both the river mouths during the intertidal survey of these sites. Fresh water is important for otters to maintain the waterproof properties of their fur (Twelves, undated; Roper, in draft). Freshwater as easily accessible yet undisturbed as this river mouth is scarce along the surveyed coastline, with these two rivers being the most suitable for otters in the 3.5km stretch of coastline in the habitat footprint. Although the single track road lies close to them, these two sites are subjected to limited disturbance, and although there are no intertidal species and biotopes of significant ecological importance, the potential adverse impact on local otter populations will be greatest at these locations. This would not mean that works are totally precluded in this area, but a targeted otter survey would be recommended in advance of any construction.

Alongside Site A, Site D is a preferable location for cable landfall on Jura as it has an existing cable landfall, as has been subjected to anthropogenic disturbance with limited residual impact. Terrestrial cable routing from this point will not encounter the problems associated with sites A, B or C (as discussed above) as it is located to the south of the A846 and would therefore not create such a large visual impact. Approximately 200m south of the existing cable landfall is a small stream which may provide potential habitat for otters. A walkover was down of the area surrounding the cable routing and no signs of otters were located. The existing cable and associated hard casing has created an artificial reef which supports a greater diversity of species than the surrounding area, which was characterised by sandy substrates with scattered boulders. It can therefore be assumed that within a few years natural succession would occur on the new cable and hard casing leading to greater species richness and diversity on the new ‘artificial reef’.

Overall, as otters are regularly observed from Jura and were recorded on three days on surveying, it is recommended that when decisions are made as to the whereabouts of the cable landfall (i.e. Islay or Jura), further detailed and targeted otter surveys will be required to assess for the presence of holts, lie-ups, couches etc in the footprint for inform detailed design.

5 SPECIES AND BIOTOPE LIST

5.1 Species

Algae
Ascophyllum nodosum
Ceramium sp
Chondrus crispus
Cladophora rupestris
Fucus serratus
Fucus spiralis
Fucus vesiculosis
Hildenbrandia rubra
Himanthalia elongata
Laminaria digitata
Pelvetia canaliculata
Polyides rotundus
Polysiphonia lanosa
Ulva intestinalis
Ulva lactuca

Marine Invertebrates
Actinia equina
Arenicola marina
Carcinus maenas
Electra pilosa
Halichondria panicea
Littorina littorea
Littorina obtusata
Nucella lapillus
Patella
Spirobis spirobis
Semibalanus balanoides
Chthamalus montagui

Lichens
Ramalina siliquosa
Verrucaria maura
Xanthoria parietina

Mammals (not within transect)
Lutra lutra
Halichoerus grypus

5.2 Biotopes

IR.MIR.KR.Ldig *Laminaria digitata* on moderately exposed sublittoral fringe rock
LR.FLR.Lic.YG Yellow and grey lichens on supralittoral rock
LR.LLR.F.Asc.FS Strandline
LR.LLR.F.Fspi.X *Fucus spiralis* on full salinity upper eulittoral mixed substrata
LR.LLR.F.Asc.FS *Ascophyllum nodosum* on full salinity mid eulittoral rock
LR.LLR.F.Fserr.X *Fucus serratus* on full salinity lower eulittoral mixed substrata
LR.LLR.F.Fves.X *Fucus vesiculosus* on mid eulittoral mixed substrata
LR.FLR.Lic.Ver.B *Verrucaria maura* and sparse barnacles on exposed littoral fringe rock
LR.FLR.Lic.Ver.Ver *Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock
LR.MLR.BF.PelB *Pelvetia canaliculata* and barnacles on moderately exposed littoral
LR.FLR.Rkp Rockpools
LR.LLR.F.Fspi.X *Fucus spiralis* on full salinity upper eulittoral mixed substrata
LR.LLR.F.Asc.FS *Ascophyllum nodosum* on full salinity mid eulittoral rock
LS.LCS.Sh Shingle (pebble) and gravel shores
LS.LSa.St Strandline
LS.LSa.FiSa.Po Polychaetes in littoral fine sand

6 REFERENCES

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, 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

Hiscock, K (ed.) (1996) *Marine Nature Conservation Review: rational and methods*. Coasts and seas of the United Kingdom. MNCR Series. Joint Nature Conservation Committee, Peterborough.

MacGillivray, F. (2008) Otter *S*urvey Inver Estate Autumn 2008: Area of Proposed Hydro Scheme and other key locations.

Roper. E. (in draft) An otter surveyors Handbook

Royal Haskoning (2009a) Sound of Islay Tidal Turbines: Phase 1 habitat survey of potential cable routes on Jura.

Royal Haskoning (2009b) **Error! Reference source not found. Error! Reference source not found.**

Twelves. J. (undated) The Otters of Berneray: Illustrated natural history guide with map. Published by Berneray Development Group, The Nurses’ Cottage, Isle of Berneray. Accessed at http://www.isleofberneray.com/exploring/otter1.pdf

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.

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Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 18 – Cultural Heritage

Appendix 18.1: “Gazetteer and Concordance”

HA NO	NAME	TYPE	DESCRIPTION	STATUS	REFERENCE NOS	NGR
1	Torabus	Farmstead	A steading of this name is shown on McDougall's 1749-51 map of Islay and Jura. Due to the scale of the map (740' :1") the exact location and preservation of this site is unknown at present. Its co-ordinates here are based on the location of a modern settlement of the same name, which may or may not be derived from that shown on McDougall's map.	-	-	142211, 670322
2	Caol Ila	Lead Smelter	There are no identifiable remains of the lead-smelting furnace that was in operation at the date of Pennant's visit in 1772; it was situated 'near Freeport', an unidentified site near Port Askaig, probably at, or close to the site of the later distillery	-	NMRS NR47SW 9, WoSAS 2759	142800, 670000
3	Caol Ila Distillery	Distillery	Caol Ila Distillery, founded 1846. It has been extensively modernised but retains a handsome late 19th to early 20th century 3-storey and attic 20-bay range of bonded warehouses, which are brick-built, with bays separated by pilasters. There is a small wood piled pier.	-	NMRS NR46NW 21, WoSAS 2709	142950, 669950
4	Heatherhouse	Cottage	Heatherhouse lies about a kilometre west of Port Askaig, and is a row of four single-storeyed cottages probably dating from the late 18th or early 19th century. All four cottages are rubble-built and limewashed. The two outer cottages still retain the heather-thatched roofs which gave the cottages their name, while the roofs of the centre two have been replaced with slates.	B-Listed Building	HB Num 12161, NMRS NR46NW 26, WoSAS 2714	142360, 669650
5	Persebollis	Farmstead	A steading of this name is shown on McDougall's 1749-51 map of Islay and Jura. Due to the scale of the map, which shows both islands, the exact location and preservation of this site is unknown at present, although in the opinion of the author it is likely to be within roughly 500 metres of the co-ordinates given here. There are no settlements of this name which appear on the modern OS 1:10, 000 maps.	-	-	142675, 669359
6	D. MacBranes	Store House	An earlier 19th century traditional structure which is harled with a pended roof.	C (S) Listed Building	HB Num 12166, NMRS NR46SW 85	143154, 669350
7	Piermasters Shipping Office	Office	An earlier 19th century two storey traditional structure which is harled with a pended roof.	C (S) Listed Building	HB Num 12165, NMRS NR46SW 88	143147, 669318
8	Port Askaig	Village	General entry for Port Askaig Village	-	NMRS NR46NW 30,	143124, 669283
9	Port Askaig Jetty	Jetty	Earlier 19th century. Small. Large stones, built open jointed with slip at north side.	C (S) Listed Building	HB Num 12164, NMRS NR46NW 84,	143159, 669276
10	Port Askaig (Shop)	House, Post Office, Shop	This entry comprises of two houses, which are thinly rendered, gabled buildings with slate roofs. The south house dates to the earlier 19th century. It is a traditional building of two storeys, with skews and a lean-to porch. One storey gabled addition at the south end. The north house is a later 19th century Victorian one storey structure and attic. Gabled additions. There is a large display window.	C (S) Listed Building	HB Num 12163, NMRS NR46NW 87	143101, 669263
11	Dunlossit House	Gate lodge	The gate lodge of Dunlossit House	-	NMRS NR46NW 82.01, WoSAS 44044	143040, 669250
12	Feolin Ferry Jetty	Jetty/Slipway	Built around 1810 by the Parliamentary Commissioners for Highland Roads. Both piers were intended primarily for drove-road traffic. The jetty is constructed of large blocks of local rubble and is of simple, round-ended plan, having a slipway on each side.	B-Listed Building	HB Num 11628, NMRS NR46NW 24, WoSAS 2712	144044, 669248
13	Port Askaig Hotel	Hotel	This entry comprises of two earlier 19th century traditional houses. They are both two storeys, harled and gabled with slate roofs and skews. The window- openings have been altered. They are linked by a Victorian gable to the front with some other additions.	C (S) Listed Building	HB Num 12162, NMRS NR46NW 86	143118, 669236
14	Dunlossit House Cross	Commemorative monument	Carved stone memorial Celtic cross (shaft remains) to Gilmour family, dating to around 1900 and sited at the western end of a track to the west of Port Askaig and NW of Dunlossit House.	C (S) Listed Building	HB Num 47367, NMRS NR46NW 82.04	142906, 669193
15	Feolin Ferry House	Cottage	Earlier 19th century. Traditional one-storey cottage with attic. Harled with a slate roof and two gabled dormers. Gabled porch. Plain interior. L-shaped wing at rear. Lean-to addition in angle with house.	C (S) Listed Building	HB Num 11627, NMRS NR46NW20	144056, 669085
16	Dunlossit House	Country House	Dated 1865. Scots Baronial. Small 'keep' with 1 and 2 storey Wings - Coursed Rubble. Gabled. Slate roof. Crow-steps. Angle turrets; conical roofs. Downpipes with date.	C (S) Listed Building	HB Num 12160, NMRS NR46NW 82.00	143179, 669031
17	Feolin	Steading	A ruined byre of 3 bays, rubble built. The remains are similar to those identified at Daimh-sgeir.	-	-	144054, 669030

HA NO	NAME	TYPE	DESCRIPTION	STATUS	REFERENCE NOS	NGR
18	Loch nan Deala	Crannog	This low grass-covered island is situated close to the former sw shore of the partly-drained Loch nan Deala. It is roughly circular, varying between 23m and 26m in diameter, and there are traces of a rubble causeway 25m in length and 2m wide linking the island to the original shoreline. The North half of the island is occupied by the remains of two conjoined drystone buildings which together form an overall L-plan bicameral structure, and there is a smaller detached structure in the SE sector.	-	NMRS NR46NW 5, WoSAS 2717	142530, 668810
19	*Glen Holme*	Steamship	A steamship, formerly named the Margaret Banks. The ship was carrying a cargo of sleepers in the Sound of Islay on the 28th May 1893 when it was in a collision with the Danish steamship the C. P. A. Koch and ran aground opposite Port Askaig. Its location is cited in Seazone data derived from the UK Hydrographic Office.	-	NMRS NR46NW 8004	143478, 666541
20	Killkolumkill	Farmstead	A steading of this name is shown on McDougall's 1749-51 map of Islay and Jura. Due to the scale of the map, which shows both islands, the exact location and preservation of this site is unknown at present. There appears to be a structure shown in the eastern part of 'Killkolumkill' which could place it within the study area. However it is equally possible that the structure is inaccurately mapped.	-	-	142702, 668642
21	Keills Mine	Lead Mine	Site of a former lead mine. No further information relating to this site is included in the SMRs although it is included in the RCAHMS and WOSAS databases. The accuracy of the location of this site appears to be poor.	-	NMRS NR46NW 27, WoSAS 13520	142300, 668500
22	Carragh Mhor	Beacon	Cast-iron beacon, still in operation in October 1999	-	NMRS NR46NW 81	143300, 668410
23	McDougall's Bay Bridge	Bridge	A single arched stone bridge which appears in the same location as a bridge shown on the 1st edition Ordnance Survey map (1882).	-	WoSAS 45710	142530, 668810
24	*Kay D*	Vessel	A modern vessel which sank in 1982 after taking on water. It's location is cited in Seazone data derived from the UK Hydrographic Office and appears to be based on the recorded position of its loss.	-	-	144066, 668667
25	Carragh an t-Sruith	Landing Point	Old landing point for lorries	-	-	144198, 667355
26	Carragh an t-Sruith	Stones	Spread of stone, approximately 3m by 1m	-	-	144223, 667307
27	Carragh an t-Sruith	Area of reinforced concrete	Area of reinforced concrete	-	-	144201, 667301
28	Daimh-sgeir	Steading	Site of two houses which are 19th century or earlier. The first recorded reference to the site name is from 1757. No baptisms were recorded for the site during the eighteenth century but two cottages are mentioned on all the 19th century censuses. The last known reference to the settlement was in 1923 when a death was recorded. The cottages are now ruined although there are some remains as well as traces of enclosing walls. Also shown on the 1st edition Ordnance Survey map is a small gravel pit to the east of the house on the far side of the road.	-	-	144267, 667235
29	_	Sonar Contact	A possible wreck site identified through an examination of data gathered from a sonar survey of the offshore area of the Sound of Islay carried out in 2009 (See also Oakley D, 2009)	-	-	143305, 667606
30	An Tamhanachd	Building	One unroofed building is depicted on the OS 1st edition 6-inch map (Argyllshire 1867, sheet CXCVIII) and on the current edition of the OS 1:10000 map (1981).	-	NMRS NR46NW 75, WoSAS 45860	142460, 665970
31	Rubha Boraraich	Rock Shelter	A rock shelter identified during fieldwork carried out in preparation for this report.	-	-	142886, 665754
32	Rubha Boraraich	Rock Shelter	A rock shelter identified during fieldwork carried out in preparation for this report.	-	-	142933, 665533
33	Baleachdrach	Farmstead, Corn Drying Kiln, Lime Kiln	One unroofed building with an attached enclosure and a lime kiln are depicted on the OS 1st edition 6-inch map (Argyllshire 1867, sheet CXCVIII). Was still present though unroofed in 1981. A steading of this name is shown on the McDougall map of 1749-51; this may represent an earlier structure but if it was a separate structure it is likely to have been close to the present site.	-	NMRS NR46NW 63, WoSAS 19407	142250, 665150
34	Beinn Dubh	Cave	This site was recorded during the 2002 fieldwork season of the Islay Caves Project.	-	NMRS NR46SW 37, WoSAS 50724	143120, 664930
35	Earachan	Rock Shelter	These sites were recorded during the 2002 fieldwork season of the Islay Caves Project. This shelter contains deposits and is described as 'recently inhabited'.	-	NMRS NR46SW 35, WoSAS 50722	143250, 664410

Sound of Islay Demonstration Tidal Array

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<u>Appendix 18.2: “Sources consulted”</u>

(See also references section 18.40 in main chapter)

Monuments records

National Monuments Record, dated 14th September 2009.

WoSAS Sites and Monuments Record dated 07th September 2009.

Scheduled Ancient Monuments & Designated Wreck Sites (Historic Scotland) dated 3rd September 2009.

Listed buildings (Historic Scotland) dated 3rd September 2009.

Gardens and Designed Landscapes (Historic Scotland) dated 3rd September 2009.

Properties in Care (Historic Scotland) dated 3rd September 2009.

Sound of Islay Demonstration Tidal Array

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Appendix 18.3: “Shipwrecks recorded in the Sound of Islay derived from Moore and Wilson 2003, 493-500 with UK grid references appended”

Appendix 18.3 “Shipwrecks recorded in the Sound of Islay derived from Moore and Wilson 2003, 493-500 with UK grid references appended”

Name	Type	Location	Event Date	Latitude Longitude	UKNGR	NMRS NO.	Source
A. G. Mackintosh	Lugger	Islay, Sound of Islay, Port Askaig	17.11.1893	55.50.30N 06.06.45W	142642 E 668585 N	NR46NW 8007	Larn, B & Larn R 1998
A/C	aircraft	Near Port Askaig.	25.10 1945	55 51.00N 06.00.00W	143479 E 669465 N		Whittaker I G 1998
Adventure	Full-rigged ship	Islay	09.03.1810	55.45.00N 06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Alert	Unknown	Islay	07.12.1863	55 50.00N 06.20.00W	128768 E 668503N		Whittaker I G 1998
Amity	Sailing vessel	Islay	15.11.1799	55.45.00N 06.10.00W	138639 E658596 N	NR46NW 8005	Larn, B & Larn R 1998
Ann & Francis	Brigantine	Islay	12.1792	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Ann Falcon	Unknown	Islay	1847	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Ardchatten	Ship	Islay Steam	23.04.1949	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Augustus	Sailing vessel	Islay	08.11.1817	55.45.00N 06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Bell & Ann	Sloop	'Lost at Islay'	10.1818	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Bridesmaid	Trawler	Islay Steam	31.12.1948	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Bull Dog	Steam Tug	Stranded on Black Rock, Sound of Islay	14.09.1869	55.47.75N 06.04.00W	145210 E 663319 N	NR46SE 8001	Whittaker I G 1998
Carl Angell	Barque	Islay	26.05.1886	55.35.00N 06.25.00W	121781 E 641040 N		Larn, B & Larn R 1998
Catherines	Unknown	Islay	12.12.1836	55 50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Cerealia	trawler	Islay, sound of Islay Fishing	25.11.1920	55.47.45N 06.03.30W	145732 E 663289 N		Larn, B & Larn R 1998
Christian	Unknown	Islay	1741	55 50.00N 0620.00W	128768 E 668503 N		Whittaker I G 1998
Clyde	Sloop	Islay	30.12.1803	55.45.00N 06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Commerce	Sailing vessel	Islay, in the sound	16.05.1827	55.48.00N 06.04.00W	145237 E 663783 N		Larn, B & Larn R 1998
Constance	Schooner	Islay, Sound of Islay	01.05.1902	55.52.00N 06.40.00W	108164 E 673566 N	NR47SW 8002	Larn, B & Larn R 1998
Criscilla	trawler	Islay, E side, Sound of Islay, Black Rock Fishing	03.11.1931	55.47.37N 06.03.48W	145404 E 663060 N	NR46SE 8008	Larn, B & Larn R 1998
Daylight	Steamship	Islay, Sound of Islay, Carnstack	07.02.1881	55.43.00N 06.01.30W	147308 E 654364 N	NR46SE 8004	Larn, B & Larn R 1998
Earl Lennox	Trawler	Islay, Sound of Islay Fishing	23.10.1917	55.45.00N 06.00.00W	149091 E 657979 N	NR47SW 8003	Larn, B & Larn R 1998
Edith Morgan	Schooner	Islay, Sound of Islay, Black Rocks	16.01.1881	55.48.00N 06.04.00W	145237 E 663783 N	NR46SE 8003	Larn, B & Larn R 1998
	Schooner	Stranded on Black Rock, Sound of Islay	16.01.1881	55.47.75N 06.03.83W	145387 E 663309 N		Whittaker I G 1998
Edmiston	Brigantine	Wrecked on Black Rock, Sound of Islay	06.03.1863	55.47.75N 06.04.00W	145210 E 663319 N	NR46SE 8013	Whittaker I G 1998
Eenar Tumeersheelver	Sailing vessel	Islay	17.12.1811	55.45.00N 06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Eienr Tamper Skielver	Ship	Islay	11.1811	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Elizabeth & Janet	Unknown	Islay	1.1758	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Elizabeth	Unknown	Islay	1.1811	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Elizabeth	Schooner	Islay, Sound of Islay	28.10.1874	55.50.00N 06.06.00W	143369 E 667612 N		Larn, B & Larn R 1998
Ella Glensdale	Unknown	Islay	1875	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Faenar	Unknown	Islay	20.05.1950	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Falkenborg	'MFV'	Stranded in the Sound of Islay	29.06.1994	55.47.47N 06.03.87W	145345 E 663311 N		Whittaker I G 1998
Florence Muspratt	Unknown	Islay	1877	55.50.00N 06.20.00W	128768 E 668503 N		Whittaker I G 1998
Francis Alexander	Sloop	Wrecked on Black Rock, Sound of Islay	02.01.1800	55.47.75N 06.04.00W	145210 E 663319 N		Whittaker I G 1998
Glen Holme	Steamship	Islay, E side	28.05.1893	55.50.36N 06.05.20W	144130 E 668683 N	NR46NW 8004	Larn, B & Larn R 1998
Globe	Sailing vessel	Islay	12.01.1808	55.45.00N 06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Gratitude	Sloop	Islay: Sound of Islay	07.07.1833	55.50.00N 06.06.00W	143369 E 667612 N	NR46SE 8015	Whittaker I G 1998
Harmony	Sailing vessel	Islay	25.02.1810	55.45.00N 06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998

Name	Type	Location	Event Date	Latitude	Longitude	UKNGR	NMRS NO.	Source
Henrietta	Sailing vessel	Islay, sound of	6.12.1757	55.50.00N	06.06.30W	143369 E 667612 N		Larn, B & Larn R 1998
Henry	Unknown	Islay	03.12.1812	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Hiddenite	Trawler	Islay: Sound of Islay	15.07.1928	55.50.00N	06.06.00W	143369 E 667612 N		Whittaker I G 1998
Independant	Smack	Islay	10.1893	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Isa	Lugsail	Islay	1.1894	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Isabella Helen	Unknown	Islay	1820	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
James Hamilton	Sailing vessel	Islay	03.02.1818	55.45.00N	06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Janet	Lugger	Islay, Sound of Islay, Caolila Bay	17.11.1893	56.47.30N	06.02.30W	153285 E 773961 N	NR47SW 8019	Larn, B & Larn R 1998
Jean	Ship	Islay	c.1785	55.50.00N	0620.00W	128768 E 668503 N		Whittaker I G 1998
Jenny	Sailing vessel	Islay, sound of	25.01.1794	55.50.00N	06.06.30W	142848 E 667643 N		Larn, B & Larn R 1998
John	Unknown	Islay	12.12.1836	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Johns	Sloop	Wrecked on Islay	1797	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Juno	Sloop	Islay	18.01.1821	55.35.00N	06.25.00W	121781 E 641040 N		Larn, B & Larn R 1998
Kay D	Unknown	Near Black Rock Buoy, Sound of Islay	03.04.1982	55.47.75N	06.04.00W	145210 E 663319 N		Whittaker I G 1998
Ketty & Mary	Sloop	Islay	7.1835	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Kilkerran	Unknown	Islay, Sound of Islay, Caolila Bay	17.11.1893	55.47.30N	06.02.30W	146749 E 662764 N	NR47SW 8018	Larn, B & Larn R 1998
Lancer	Lugger	Islay Unknown	Unknown	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Little Betsy	Sailing vessel	Islay, sound of	24.12.1790	55.50.00N	06.06.30W	143317 E 667615 N		Larn, B & Larn R 1998
	Unknown	Little Betsy Islay: Sound of Islay	03.12.1790	55.50.00N	06.06.00W	143369 E 667612 N		Whittaker I G 1998
Lord Wellington	Sailing vessel	Islay	18.03.1817	53.30.00N	06.22.00W	110525 E 409245 N		Larn, B & Larn R 1998
Lucretia	Sailing vessel	Islay	18.12.1798	55.45.00N	06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Maggies Ann	Lugger	Islay, Sound of Islay, Caolila Bay	18.11.1893	55.56.30N	06.06.45W	143304 E 679704 N	NR47SW 8020	Larn, B & Larn R 1998
Maree	Unknown	Islay	1880	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Margaret	Sailing vessel	Islay.	1833	55.35.00N	06.25.00W	121781 E 641040 N		Larn, B & Larn R 1998
Martin	Sailing vessel	Islay	24.08.1835	55.45.00N	06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Martin Islay	Sloop	: Sound of Islay	24.08.1835	55.50.00N	06.06.00W	143369 E 667612 N		Whittaker I G 1998
Mary Ann	Sailing vessel	Islay, sound of Islay	19.03.1817	55.50.00N	06.06.00W	143369 E 667612 N		Larn, B & Larn R 1998
Mary Ann Mcleod	Sound of Islay	Islay: Sloop	28.09.1868	55.50.00N	06.06.00W	143369 E 667612 N	NR46SE 8010	Whittaker I G 1998
Mary Ellen	Schooner	Stranded 200yds off, 3.5M S of Port Askaig	21.09.1879	55.48.00N	06.05.50W	143671 E 663875 N	NR46SW 8001	Whittaker I G 1998
Merisia	Trawler	Islay	26.01.1940	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Miller	Smack	Islay	3.1846	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Moor Cock	Unknown	Islay	26.11.1948	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Mount Park	Steamship	Islay, sound of	13.06.1887	55.50.00N	06.06.30W	142848 E 667643 N	NR47SW 8005	Larn, B & Larn R 1998
Nancy B	'MFV'	Near Black Rock Buoy, Sound of Islay	27.10.1959	55.47.75N	06.04.00W	145210 E 663319 N	NR46SE 8009	Whittaker I G 1998
Narwhal	Steamship	Islay, Ruer Voer	18.01.1897	55.45.00N	06.10.00W	138639 E 658596 N		Larn, B & Larn R 1998
Nellies	Lugsail	Islay Aux.	15.09.1948	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
North Briton	Unknown	Wreckage on Islay	4.1832	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Orlay	Unknown	Islay	17.02.1776	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Peggy	Unknown	Islay	12.1779	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Peggy	Sloop	Islay	07.01.1812	56.30.00N	06.25.00W	128310 E 742950 N		Larn, B & Larn R 1998
Phoenix	Steam Tug	Islay: Sound of Islay	10.01.1866	55.50.00N	06.06.00W	143369 E 667612 N		Whittaker I G 1998
Progress	Unknown	Islay	1881	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Providence	Unknown	Islay	1877	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Roseneath Castle	Sloop	Islay	27.02.1825	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998
Royal Recovery	Sailing vessel	Islay, sound of	04.10.1798	55.50.00N	06.06.00W	143369 E 667612 N		Larn, B & Larn R 1998
Selina	Unknown	Islay	22.10.1849	55.50.00N	06.20.00W	128768 E 668503 N		Whittaker I G 1998

Appendix 18.3 "Shipwrecks recorded in the Sound of Islay derived from Moore and Wilson 2003, 493-500 with UK grid references appended"

Name	Type	Location	Event Date	Latitude Longitude	UKNGR	NMRS NO.	Source
Sethon	**Unknown**	**Islay**	**02.03.1957**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Sir Joseph Banks	**Schooner**	**Islay: Sound of Islay, entrance**	**15.12.1847**	**55.50.00N 06.06.00W**	**143369 E 667612 N**		**Whittaker I G 1998**
Soprano	**Unknown**	**Islay**	**Unknown**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
St. Lawrence	**Sailing vessel**	**Islay**	**19.01.1819**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
Sturdy Beggar	**Privateer**	**Islay, Near**	**14.05.1779**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
Surprise	**Steamship**	**Islay, SE corner, Eilean Bhride**	**16.12.1906**	**55.39.18N 06.02.52W**	**145477 E 647590 N**		**Larn, B & Larn R 1998**
Susannah	**Unknown**	**Islay**	**24.12.1821**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Telegraph	**Sailing vessel**	**Islay.**	**1834**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
Three Brothers	**Sailing Vessel**	**Islay**	**19.04.1785**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
Trio	**Sailing vessel**	**Islay**	**17.02.1803**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
Triton	**Full-rigged ship**	**Islay**	**01.02.1811**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
Undaunted	**Lugsail**	**Islay**	**1893**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Unidentified	**Sailing vessel**	**Islay**	**24.02.1810**	**55.35.00N 06.25.00W**	**121781 E 641040 N**		**Larn, B & Larn R 1998**
Unidentified	**Lobster Boat**	**Islay**	**04.07.1983**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Unidentified	**Sloop**	**Islay**	**2.1761**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Unidentified	**Unknown**	**Islay**	**24.02.1810**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Unidentified	**Unknown**	**Islay**	**29.03.1842**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Unidentified	**Unknown**	**Islay: Sound of Islay**	**1856**	**55.50.00N 06.06.00W**	**143369 E 667612 N**		**Whittaker I G 1998**
Unidentified	**Unknown**	**Sound of Islay**	**1867**	**55.43.00N 06.00.00W**	**148877 E 654273 N**		**Whittaker I G 1998**
Unidentified	**wreckage**	**Mull of Kinahoe (near Ardnahoe)**	**22.03.1859**	**55.53.00N 05.55.00W**	**155157 E 672507 N**		**Whittaker I G 1998**
Unknown	**Steamship**	**Stranded near Port Askaig**	**22.11.1942**	**55.51.00N 06.06.50W**	**142958 E 669496 N**		**Whittaker I G 1998**
Venus	**Sailing vessel**	**Islay**	**16.03.1810**	**55.35.00N 06.25.00W**	**121781 E 641040 N**	**NR47SW 8009**	**Larn, B & Larn R 1998**
Victoria	**Schooner**	**Islay**	**25.02.1874**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Vine	**Sailing vessel**	**Islay, south part of the island**	**15.02.1820**	**55.34.30N 06.16.30W**	**130645 E 639554 N**		**Larn, B & Larn R 1998**
Vivid	**Unknown**	**Islay: Sound of Islay**	**1920**	**55.50.00N 06.06.00W**	**143369 E 667612 N**	**NR39SE 8002**	**Whittaker I G 1998**
Wellington	**Unknown**	**Islay**	**17.12.1832**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
William	**Unknown**	**Islay**	**1.1811**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Wortley	**Sailing vessel**	**Islay**	**17.12.1833**	**55.45.00N 06.10.00W**	**138639 E 658596 N**		**Larn, B & Larn R 1998**
	snow	**Wortley Islay**	**17.12.1833**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**
Zapota	**Unknown**	**Islay**	**Unknown**	**55.50.00N 06.20.00W**	**128768 E 668503 N**		**Whittaker I G 1998**

Sound of Islay Demonstration Tidal Array

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Appendix 18.4: “Ship losses recorded in the vicinity of the Sound of Islay by the Royal Commission of Ancient and Historic Monuments”

Data acquired 14th September 2009 (does not include wrecks which can be matched to entries in Appendix 18.3)

NMRS NO.	***NAME***	***TYPE***	***NGR***
NR46SE 8006	JOHN DUNKIN: BLACK ROCK	STEAM TRAWLER (20TH CENTURY)	145300, 663300
NR47SW 8023	CONQUEST: ARDNAHOE	CRAFT (19TH CENTURY)	142000, 671000
NR46NW 8011	UNKNOWN: PORT ASKAIG	CRAFT (19TH CENTURY)	143000, 669000
NR47SW 8039	UNKNOWN: CAOL ILA	BRIG (19TH CENTURY)	143000, 670000
NR46NW 8013	UNKNOWN: PORT ASKAIG	CRAFT (19TH CENTURY)	143000, 669000
NR46SE 8007	SCOTLAND: BLACK ROCK	STEAMSHIP (20TH CENTURY)	145300, 663300
NR46NW 8008	PEEP O' DAY: PORT ASKAIG	LUGGER (19TH CENTURY)	143100, 669300
NR46NW 8010	UNDINE: PORT ASKAIG	CRAFT (19TH CENTURY)	143000, 669000
NR46SW 8002	NEPTUNE: MCARTHUR'S HEAD	STEAMSHIP (19TH CENTURY)	146200, 659070
NR46NW 8006	ROCK: PORT ASKAIG	CRAFT (19TH CENTURY)	143000, 669000
NR46SE 8016	RANKIN: BLACK ROCK	BRIG (19TH CENTURY)	145300, 663300
NR37NE 8007	CHIEFTAIN: BOLSA	BARQUE (19TH CENTURY)	138000, 678000
NR47NE 8001	UNKNOWN: SGEIR TRAIGHE, JURA	TRAWLER (20TH CENTURY)	145920, 676750
NR47SW 8011	LILY MELLING: CARRAGH AN T-SRUITH, JURA	STEAM TRAWLER (20TH CENTURY)	143800, 671900
NR46SE 8014	VULCAN: BLACK ROCK	CRAFT (19TH CENTURY)	145300, 663300
NR47SW 8035	UNKNOWN: ARDNAHOE	CRAFT (19TH CENTURY)	142000, 671000
NR46NW 8002	PASAGES: GLAS EILEAN, JURA	STEAM TRAWLER (20TH CENTURY)	144700, 665000
NR46SE 8012	ENTERPRIZE: BLACK ROCK	CRAFT (19TH CENTURY)	145300, 663300
NR46SE 8017	PARAMOUNT: BLACK ROCKS	CRAFT (19TH CENTURY)	145300, 663300
NR37NE 8001	UNKNOWN: RUBHA BHOLSA	CRAFT (20TH CENTURY)	137900, 678500
NR46SE 8002	ISABELLA: ARDFIN, JURA	STEAMSHIP (19TH CENTURY)	148000, 663000
NR56NW 8001	STORMLIGHT: EILEAN NAM GABHAR, SMALL ISLES, SOUND OF JURA	MOTOR VESSEL (20TH CENTURY)	153500, 667100
NR47SW 8032	SWALLOW: ARDNAHOE	CRAFT (19TH CENTURY)	142000, 671000
NR46NW 8003	SEPHON: GLAS EILEAN, JURA	TRAWLER (20TH CENTURY)	144700, 665000
NR47SW 8001	WYRE MAJESTIC: RUBHA A' MHILL	MOTOR TRAWLER (20TH CENTURY)	143330, 673240
NR46SE 8013	EDMISTON: BLACK ROCK	BRIGANTINE (19TH CENTURY)	145300, 663300
NR46NW 8009	BRITISH QUEEN, ATLANTIC	CRAFT (19TH CENTURY)	143000, 669000

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 18 – Cultural Heritage.

Appendix 18.5: “Vertical aerial photographs consulted in the Royal Commission of Ancient and Historic Monuments search room”

Appendix 18.5 “Vertical aerial photographs consulted in the Royal Commission of Ancient and Historic Monuments search room”

SORTIE	***FRAMES***	***DATE***
CPE/UK/0263	3339, 3340, 3341, 3342, 3351, 3353, 4341, 4342, 4351, 4353, 4458	1947
ASS/612/88	156, 185, 259	1988

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 19 – Traffic and Transport

Appendix 19.1: “Navigational Safety Risk Assessment for ScottishPower Renewables (UK) Limited: Proposed Demonstration Tidal Array, Sound of Islay”

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Navigational Safety Risk Assessment for ScottishPower Renewables (UK) Limited
Proposed Demonstration Tidal Array

Sound of Islay

Prepared for: Dr Douglas Watson
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Report No: ARC-266-004-R1

Revision: 2

Date: July 2010

Abbott Risk Consulting Ltd

APPROVAL AND REVISION RECORD

Rev No.	Date	Prepared	Reviewed	Approval	Revision Notes
Draft A	Mar 10	D Cantello	T Lambert	J Abbott	Internal Review
0	April 10	D Cantello	T Lambert	J Abbott	Issue for Client comment
1	June 10	D Cantello	T Lambert	J Abbott	Including Client comments and report update to reflect finalisation of installation methodology (DP Vessel) and rotor diameter.
2	July 10	D Cantello	T Lambert	J Abbott	Including additional client comment.

Contents

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Annexes

Glossary

ADCP	Acoustic Doppler Current Profiler
AHT	Anchor Handling Tug
AIS	Automatic Identification System. A (usually) vessel mounted transponder system whereby identification information is transmitted to other vessels or shore-based interrogation systems. Can be fitted to fixed objects e.g. platforms or devices to provide information of use to the mariner
ATBA	Area To Be Avoided. An area so designated is marked on charts along with details of the area and vessels to which it applies
AtN	Aids to Navigation. Those aids, including visual marks, lights, buoyage, electronic devices etc provided for the mariner to assist in the safe navigation of the vessel
Cable (as a measurement of distance)	1/10th of a nautical mile (approx 185 metres) and a standard measure of distance at sea
CHA	Competent Harbour Authority. A statutory authority responsible for a defined area of water in and around a port or harbour
Chart Datum	By international agreement, Chart Datum is a level so low that the tide will not frequently fall below it. In the UK, this is normally approximately the level of LAT
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
DBERR	Department for Business, Enterprise and Regulatory Reform
DECC	Department for Energy & Climate Control
DNV	Det Norske Veritas
DP	Dynamic Positioning
DTI	Department of Trade and Industry
EMEC	European Marine Energy Centre
EMI	Electromagnetic Interference
ENC	Electronic Navigation Chart
EPR	Ethylene Propylene Rubber
GLA	General Lighthouse Authority. The general name given to those authorities with responsibilities for Aids to Navigation in specific geographical areas. In the waters around the UK and Republic of Ireland, these authorities are: Trinity House, Northern Lighthouse Board and the Commissioners for Irish Lights
GT	Gross Tonnage. The total volume of a vessel, expressed in units of 100 cubic feet (gross ton), with certain open structures, deckhouses, tanks, etc., exempted. Also called Gross Registered Tonnage
HAT	Highest Astronomical Tide. HAT is the highest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. HAT is not the extreme level as storm surges may cause higher levels to occur. Determined by inspection over a period of years
HIRA	Hazard Identification and Risk Assessment
HSE	Health and Safety Executive
HSUK	Hammerfest Strøm (UK)
IMM	International Maritime Mobile (Radio channels)
IMO	International Maritime Organisation
kn	Knot (1 nautical mile per hour)
kV	Kilovolt
LAT	Lowest Astronomical Tide. LAT is the lowest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. LAT is not the extreme level as storm surges may cause lower

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	levels to occur. Determined by inspection over a period of years
LOA	Length Overall.(of a vessel)
m	metre
MCA	Maritime and Coastguard Agency
MGN	Marine General Notice
MHWN	Mean High Water Neaps. The height on MHWN is the average, throughout a year, of two successive high waters during those periods of 24hrs (approx. once per fortnight) when the range is the least
MHWS	Mean High Water Springs. The height on MHWS is the average, throughout a year, of two successive high waters during those periods of 24hrs (approx. once per fortnight) when the range is the greatest.
MLWN	Mean Low Water Neaps. The height on MLWN is the average, throughout a year, of two successive low waters during those periods of 24hrs (approx. once per fortnight) when the range is the least
MLWS	Mean Low Water Springs. The height on MLWS is the average, throughout a year, of two successive low waters during those periods of 24hrs (approx. once per fortnight) when the range is the greatest
MSL	Mean Sea Level. The average level of the sea surface over a period (normally 18.6 years)
MSI	Maritime Safety Information
MV	Motor Vessel
MW	Megawatt
NavWarns	Navigation Warnings
NLB	Northern Lighthouse Board
NM	Notice to Mariners. A NM is an update or alteration to a chart. Issued to allow the mariner to update their charts to the latest safety-critical information. NMs are issued in paper format on a weekly basis (also available online at www.ukho.gov.uk), or via the online searchable NMs database at www.nmwebsearch.com. They are also reproduced in the magazines 'Practical Boat Owner' and 'Motor Boats Monthly'
nm	(International) Nautical Mile. (1,852 metres)
OREI	Offshore Renewable Energy Installation
RACON	Radar Beacon. A transponder system which shows up on a vessel's radar as a coded mark adjacent to the contact
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
SCADA	Supervisory, Control And Data Acquisition
SFF	Scottish Fishermen's Federation
SFPA	Scottish Fisheries Protection Agency
SNC	Standard Navigational Chart (i.e. paper chart)
ShipRoutes	ShipRoutes is a UK shipping route database administered by Anatec Ltd which brings together data from a variety of sources to provide a representation of shipping routes and traffic densities by vessel type in UK waters. It is used to assist in identifying shipping passing in proximity to proposed offshore developments
TEU/teu	Twenty foot Equivalent Unit. A twenty-foot equivalent unit is a measure of containerized cargo equal to one standard 20 ft (length) × 8 ft (width) × 8.5 ft (height) container (approximately 39 m^3).
Tidal Stream	A distinction is drawn between tidal streams, which are astronomical in origin, and currents, which are independent of astronomical conditions and which, in the waters around the British Isles, are mainly of meteorological origin
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency (Radio)
VTS	Vessel Traffic Services

1.0 Introduction

1.1 Background

ScottishPower Renewables (hereafter "SPR") is wholly owned by Iberdrola Renovables SA and is responsible for Iberdrola Renovables' UK renewables project portfolio. It is the leading UK onshore windfarm operator, managing operational windfarms in Britain with a capacity at the end of 2009 of over 800 MW.

Under the Renewables Obligation, SPR is implementing a development programme in renewable energy and has recently undertaken a tidal device review and site selection exercise. An outcome of this process is SPR involvement in the development of a candidate demonstration tidal stream generating device, of approximately 1MW. Once testing of the candidate demonstration tidal device is complete, which will be undertaken at another location, it is proposed that approximately 10 such devices will be deployed in the Sound of Islay subject to the appropriate consents and licences being granted. As such, the development is considered a 'Demonstration Tidal Array' for which SPR will require consent from Marine Scotland under Section 36 of the Electricity Act 1989 to construct and operate.

As part of the consents process there is a requirement to undertake an assessment of the navigational safety issues arising from the establishment of an Offshore Renewable Energy Installation (OREI). This is required to be conducted in accordance with the Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371(M+F) - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues (Reference 1). The methodology for this assessment follows that for assessing the Marine Navigational Safety Risks of Offshore Wind Farms contained in the DTI/DECC publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2).

The assessment will be taken into account in the preparation of the Environmental Impact Assessment (EIA) study report and the resulting Environmental Statement (ES).

The Navigational Safety Risk Assessment (NSRA) methodology requires, in accordance with the DTI/DECC guidance, a Preliminary Hazard Analysis (PHA) to be undertaken prior to the NSRA. That analysis is required to investigate the hazards and propose the methodology and tools to be used in the risk assessment and is required to be submitted to the MCA for agreement in order to ensure that the risk assessment phase is appropriate to the nature and scale of the development and employs suitable tools and techniques and methodology. The PHA and accompanying recommendations were contained in ARC report ARC-266-002-R1 dated March 2009 (Reference 3).

The MCA responded to the PHA 6th May 2009 and stated that *"We are content that the Preliminary Hazard Analysis and proposed methodology for Navigation Safety Risk Assessment meets the requirements for a "Low risk of small scale development" outlined in Section 3 of the DTI/DfT/MCA Guidance on the*

Assessment of the impact of Offshore Wind farms - Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms.

Particular attention should be made in the Hazard Log to the structures and mooring arrangements which will require Third Party Validation, and controlling depths to ensure safe underkeel clearance (UKC) is ensured for any vessels operating in the area."[1] (Reference 4)

This report constitutes the NSRA undertaken for the proposed development using the methodology and tools agreed with the MCA as being appropriate for the development.

1.2 Aim

The aim of this report is to demonstrate that a suitable and sufficient assessment of the risks presented to mariners and the emergency services by the installation and operation of the SPR demonstration array in the Sound of Islay has been undertaken. Where appropriate, this report proposes suitable measures to ensure that any remaining risks are either tolerable or can be made tolerable by the application of suitable, agreed controls.

1.3 Scope

The scope of the NSRA covers the risks to navigation during the construction, operation and decommissioning phases of a demonstration array of 10 tidal turbines to be located at a site adjacent to Port Askaig in the Sound of Islay as shown in Figure 1.

1.4 Stakeholders

The views of all organisations and individuals whose marine activities in the area could be affected by the establishment of the demonstration tidal array have been sought and have been given the opportunity to contribute to the Hazard Identification and Risk Assessment (HIRA) process. A list of marine stakeholders involved is at Annex A.

[1] *Capt P Townsend, MCA email 6th May 2009(Reference 4)*

2.0 Risk Claim

2.1 Navigational Safety Claim

The navigational risks from the proposed demonstration array arise mainly from the installation and decommissioning phases. The risk, however, from using a Dynamic Position (DP) system fitted vessel for the installation are considered "Tolerable with Monitoring"[2] as a result of the relatively short duration "time on task" for each installation activity and that the vessel can move out of the navigable channel between each activity. The risks from the decommissioning would be similar to those involved in installation subject to the type of vessel used.

The risks to navigation from the operational phase are considered "Tolerable with Monitoring" as the least depth over the array is such that, in all conceivable circumstances, the devices do not present a hazard to surface navigation. There does, however, remain a risk to vessels engaged in creeling activities in the sound where, in circumstances involving a fishing vessel stopped in the water to recover a fleet of creels which have become entangled or snagged, that the vessel may drift with the tide over the devices in the array causing the gear to become entangled and, potentially, lead to vessel capsize. This represents the worst case scenario. There is also a risk to recreational divers if they were to undertake one of the dives identified in diving guide for the area. This involved the use of the area where the devices are to be sited to conduct a "deep" dive. However, with the application of the controls identified in this report, the risk is considered to be "Tolerable with Monitoring".

Risk controls necessary to achieve the acceptable level of risk for the demonstration array are identified in this report and are required to be implemented prior to installation and operation and will require to be checked periodically. The impact of the siting of the array will be monitored throughout its deployment.

2.2 Supporting Reasoned Argument & Evidence

The supporting arguments for the above assessments are contained in this report. They are derived from qualitative analysis based on a number of sources of data including expert opinion (both written and oral) of the marine users of the area and quantitative data regarding vessel movements.

2.3 Tools/Techniques

In order to identify the hazards presented by the proposed installation and make an assessment of the level of risk and, from there, propose appropriate controls to reduce such risks to tolerable level, the following data gathering methodology was used:

[2] Risk Tolerability definitions throughout this report are taken from DTI/DECC publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2) Table C.4.4. These are also contained at Annex D.

- Stakeholders and representative organisations were sent a letter describing the proposed development (including device positions and siting depths) requesting their views and issues with regard to navigational safety.
- A range of the key stakeholders were interviewed and a structured examination conducted of all phases of the proposal to ensure that all appropriate relevant issues were identified.
- A HIRA process was conducted based on the responses and interviews in order to develop the Hazard and Controls Log (See Annex D).

The structured examination involved reviewing the various physical elements and phases of the demonstration array lifecycle in order to identify potential hazards to personnel and the maritime environment and estimating, using standard techniques recommended by Reference 2.

In particular, it identified and examined the potential hazards presented to marine safety by the array, made an estimate of the resultant risk and determined what controls were appropriate to prevent such occurrences and what operational and emergency procedures were appropriate in the case of an event occurring. The intent of the controls is to ensure that all identified risks are reduced to a tolerable level. This information was then used to develop the hazard and control log at Annex D.

3.0 Description of the Marine Environment

3.1 Current Marine Environment

3.1.1 General

The source of much of the data in the following section is derived from:

- Admiralty Sailing Directions NP 66 – The West Coast of Scotland Pilot (Reference 5);
- The Admiralty Tidal Stream Atlas NP222 – Firth of Clyde and Approaches (Reference 6);
- Admiralty Tide Tables NP 201 – Vol 1 UK and Ireland (Reference 7).

The Sound of Islay separates the islands of Islay and Jura. The Sound is used by mariners to avoid the open sea west of Islay and forms part of the Inshore Traffic Route[3]. It is not recommended for medium or large size vessels[4] on account of a rocky bank, with a least depth over it of 9.1m situated in the fairway and extending for 2.5nm south from the north entrance to the Sound and due to the strength of the tidal streams.

The main harbours and slipways in the Sound comprise the following:

- Port Askaig;
- Feolin Slipway;
- Bunnahabhain Bay Pier.

The general layout is shown at Figure 1.

[3] The Inshore Traffic Route along the West Coast of Scotland connects the Mull of Kintyre at the north end of North Channel with Rubha Reidh at the south end of North Minch. This route is only recommended for "small" vessels. (See Admiralty Sailing Directions –West Coast of Scotland Pilot NP 66, (Reference 5)).

[4] Vessel categories as used in ASD are not considered as standard, internationally accepted definitions but the following provides a rough guide to vessels sizes. Tonnage used here is displacement tonnage (in metric tons). "Small" = <2000te, "Medium" = 2000 – 20,000te, "Large" = > 20,000te.

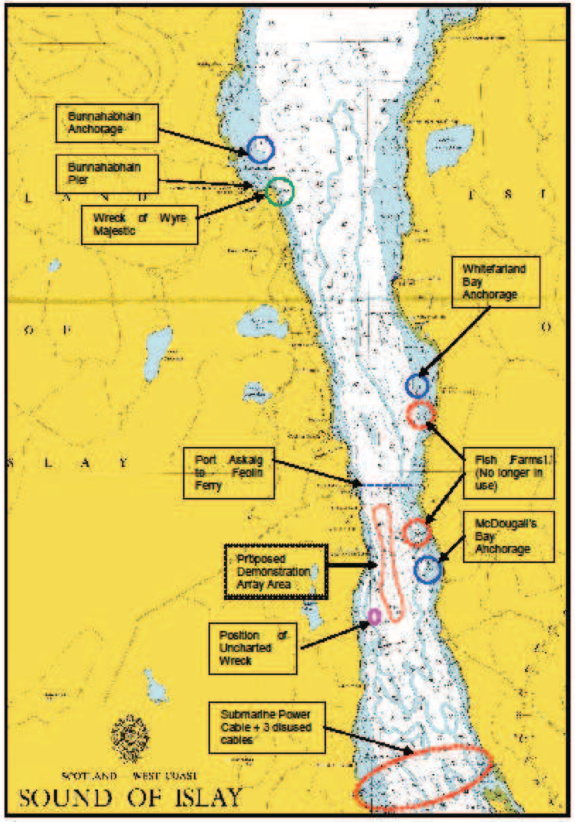

Figure 1 Sound of Islay

Not to be Used for Navigation. Reproduced from Admiralty Chart 2582 by permission of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk)

3.1.2 Search and Rescue

The Sound of Islay area lies within the UK Maritime Search and Rescue operational area administered by the Clyde Maritime Rescue Co-ordination Centre (MRCC) based at Greenock. The issues surrounding the impacts on SAR activities are discussed in Section 9.

3.1.3 Anchorages

The Sound is not recommended for anchorage except during fine weather in the summer as the tidal streams are strong and the bottom of gravel, rock and shells encumbered with long seaweed is very uneven and is not good holding ground.

The following anchorages within the Sound are marked on Admiralty Chart 2481 and are described in the Admiralty Sailing Directions:

- **McDougall's Bay** provides sheltered anchorage for small craft. It is approximately 1 cable offshore in a depth of 7m and lies out of the strength of the tidal stream.
- **Whitefarland Bay** affords shelter for small craft. It is on the east side of the sound opposite Caol Ila distillery in 7 - 8m water depth and out of the strength of the tidal stream.
- **Bunnahabhain Bay** affords good anchorage for small craft whilst awaiting slack water for passage southwards through the Sound. It lies 2 cables off the shore in 10m water depth.

3.1.4 Wrecks

There are a number of wrecks marked on Chart 2481 within the Sound. In addition, Seazone hydrospatial data indicates the presence of a wreck some 4.2 cables (778m) south of Carraig Mòr in 25m of water immediately adjacent to the proposed array area. The wreck lies just outside of the area surveyed by IX Survey on behalf of SPR. (See Figure 1).

3.1.5 Submarine Cables

A submarine power cable carrying the grid supply from Jura to Islay and three unused submarine cables cross the Sound between a point on the east shore, 2.5 cables (463m) north of Glas Eilean and a point on the west shore as shown on Figure 1.

3.1.6 Tidal Stream

The tidal stream sets generally in the direction of the channel. The rates at spring tides in the area of the Sound under consideration are in the order of 5kts as indicated on Chart 2481. Eddies occur in McDougall's and Whitefarland Bays. In the former, an eddy sets south during the north going stream and in the latter an eddy sets north during the greater part of the south going stream. There are no other tidal data associated with the Sound (e.g. tidal diamonds on the chart or observations recorded in the Tidal Stream Atlas for the area (Reference 6).

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A tidal stream survey was conducted between May/June 2009 using Acoustic Doppler Current Profilers (ADCPs) at a number of locations in the proposed deployment area in order to understand the tidal stream throughout the entire water column. The average tidal stream rates obtained by that survey are shown at Table 1.

Tidal Stream – Average Flow		
Spring Peak	2.7m/s	5.25kts
Neap Peak	1.6m/s	3.11kts

Table 1 Tidal Stream

3.1.7 Tidal Height

Tidal height data for Port Askaig, adjacent to the proposed site, for average meteorological conditions, is shown at Table 2. It is reported in the Admiralty Sailing Directions (Reference 5) that the height of tide in the Sound is greatly affected by the wind and barometric pressure. A south westerly wind and/or low pressure raises the level by up to 1m and a wind from the north east and/or high pressure reduces it by a similar amount.

	LAT	MLWS	MLWN	MSL	MHWN	MHWS	HAT
Standard Port – (OBAN)	0.0	+0.7	+1.8	+2.4	+2.9	+4.0	+4.5
Secondary Port Differences (PORT ASKAIG)		-0.3	-0.8		-1.4	-1.9	
Heights relative to Chart Datum		+0.4	+1.0		+1.5	+2.1	
			Mean Range (Neaps) 0.5 metres				
		Mean Range (Springs) 1.7 metres					

Table 2 Tidal Height Data – Port Askaig

Data collected between January 2010 and March 2010 (See Figure 2) verifies the Sailing Directions reports.

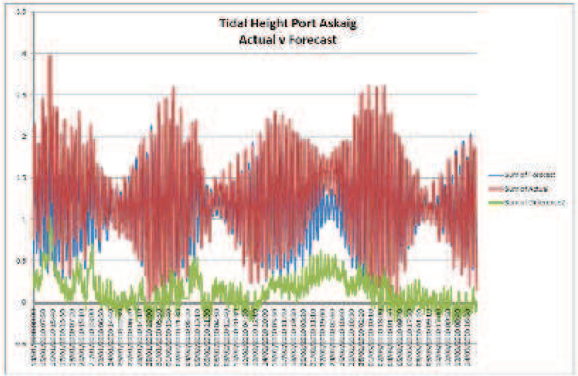


Figure 2 Tidal height Measurements – Port Askaig Jan – March 2010

3.1.8 Wave Climate

SPR commissioned an extreme wave analysis study (Reference 8) from RPS Consulting as part of the site investigation work. The findings of this study for the site off Port Askaig are shown in Tables 3 and 4. As can be seen the maximum wave heights (Hmax) predicted by the modelling occur at slack water and are in the order of 2m with a significant wave height (Hs) of around 1m[5].

Time in relation to slack tide	Direction of current flow	Significant wave height [m]	Max wave height [m] *	Peak wave period [sec]	Mean wave period [sec]	Peak wave direction [°]	Mean wave direction [°]
-6	353	0.93	1.99	3.45	2.67	157	162
-5	353	0.83	1.68	3.18	2.64	153	156
4	353	0.72	1.48	3.14	2.60	153	154
-3	353	0.69	1.47	3.12	2.59	153	154
-2	353	0.74	1.50	3.11	2.58	153	155
-1	352	0.87	1.88	3.17	2.63	153	156
slack water	-	1.04	2.10	3.60	2.99	157	161

Table 3 Extreme Wave Condition (1% AEP) at Site for Wave from Southerly Direction

[5] The height of the highest 1% of waves (H1/100) is approximately equal to 1.67 x Hs and a theoretical maximum wave height (Hmax) is approximately equal to 2 x Hs. Source: US Dept of Commerce, National Oceanographic and Atmospheric Administration.

Time in relation to slack tide	Direction of current flow	Significant wave height [m]	Max wave height [m] *	Peak wave period [sec]	Mean wave period [sec]	Peak wave direction [°]	Mean wave direction [°]
slack water	-	1.02	2.04	4.17	3.46	350	356
+1	174	0.77	1.58	3.13	2.60	2	6
+2	174	0.69	1.42	3.03	2.51	4	8
+3	171	0.63	1.30	2.90	2.40	5	9
+4	174	0.66	1.36	2.86	2.37	5	8
+5	176	0.70	1.44	2.91	2.42	2	4
+6	174	0.85	1.74	3.27	2.71	356	1

Table 4 Extreme Wave Condition (1% AEP) at Site for Wave from Northerly Direction

3.1.9 Weather Data

The climatic data at Table 5 is an extract of data for Orsay on the south west coast of Islay take from the Admiralty Sailing Directions for the West Coast of Scotland (Reference 5). The Sound of Islay is, to an extent, protected from the full force of the conditions affecting Orsay. It should be noted that, according the Admiralty Sailing Directions, the prevailing wind at Port Askaig is from the south east i.e. blowing up the line of the Sound.

Month	Av Press	Mean Daily Max Temp (°C)	Mean Daily Min Temp (°C)	Average Precipitation (mm)	Mean Wind Speed (Kts)	Number of Days with Gales	Number of Days with Fog
Jan	1007	8	3	136	20	10	1
Feb	1007	7	3	97	20	9	1
Mar	1009	8	4	126	19	6	1
April	1012	10	5	63	15	2	3
May	1013	12	7	52	16	1	3
June	1014	14	9	74	13	0	4
July	1013	16	11	91	13	Rare	6
August	1014	16	12	121	14	1	3
September	1012	14	10	94	16	2	1
October	1008	12	9	129	18	4	Rare
November	1007	10	6	112	19	6	Rare
December	1008	9	5	118	19	8	Rare

Table 5 Climatic Table for Orsay - Islay

3.1.10 Bathymetry

The bathymetric data on the Admiralty chart was obtained from surveys conducted in 1955-56. A detailed hydrographic survey has been undertaken of the proposed deployment area by IX Survey Ltd in July 2008. The resultant bathymetry, covering the proposed area of deployment is shown at Figure 3.

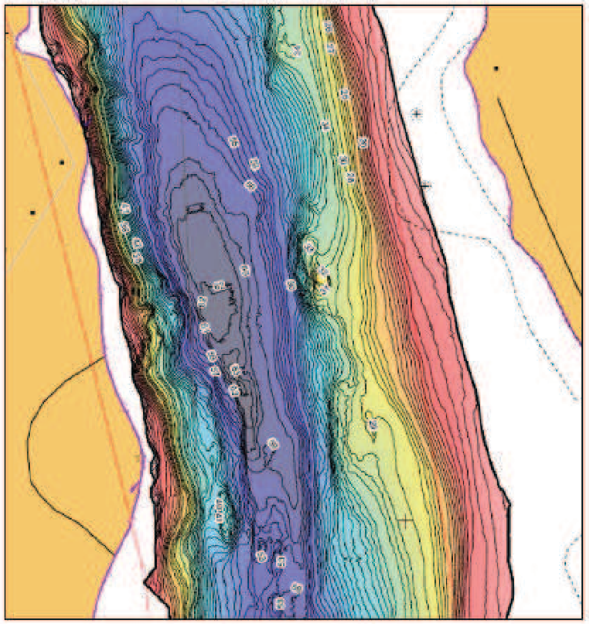


Figure 3 **Sound of Islay Bathymetric Survey**

It should be noted that limiting depths for vessels using the Sound are set by the relatively shallow areas in the north of the Sound where there is a rocky bank running along the line of the Sound with least depths of 9.1m at the northern end whilst the navigable channel to the east of the bank has a least depth of 10.2m.

4.0 Description of the Development and the Impact on the Marine Environment

The proposed demonstration array consists of the shore facility element and an offshore element. The shore facility will consist of a control building sited the position of which has yet to be finalised but is likely to be on Jura. The position of the shore facility has no impact on the navigational issues. The offshore element comprises a subsea cable and the devices situated within the overall demonstration area.

4.1 The Demonstration Array Area

4.1.1 Demonstration Array Area Selection

An extensive site selection study was carried out by SPR. It examined areas around the coast of the United Kingdom and Ireland to identify potential sites for the location of the tidal site. The following constraints were considered:

- Technical (including tidal resource, grid and accessibility);
- Environmental (habitats, species and seabed profile including bathymetry);
- Commercial (including fishing, shipping and recreation);
- Economics;
- Policy and Designation.

A range of external environmental organisations were also consulted during this study namely, Scottish Natural Heritage, Joint Nature Conservation Committee, Natural England, Maritime & Coastguard Agency, Chamber of Shipping, Fisheries Research Services, Crown Estates, Ministry of Defence, Royal Society for the Protection of Birds, Scottish Government and Northern Ireland Environmental Heritage Services. Information and comments received from the consultees were considered during the site selection process.

Based on the above study, three areas around the United Kingdom were identified as having potential for the location of the tidal array: Pentland Firth, North Channel and Islay.

A further review of these areas resulted in the selection of the Sound of Islay for the location of the demonstration tidal array.

4.1.2 Array Area

The criteria for the site included appropriate depths of water to accommodate the device intended for deployment. In general, the device requires water depths of greater than 40m. Within the Sound of Islay, the area identified as suitable is bounded by the 48m contour and is shown in Figure 4. The devices are arranged in 4 sub-arrays as shown. The individual positions and depths for each device are shown at Table 6.

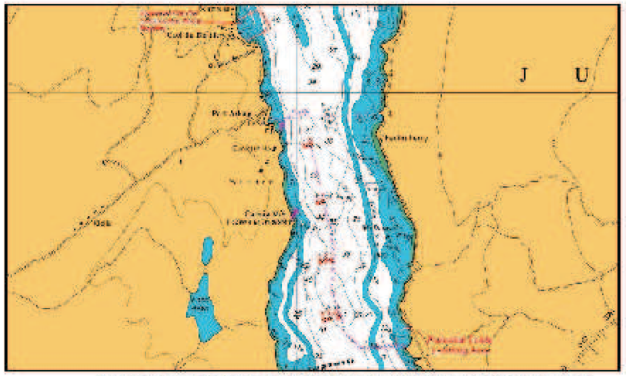


Figure 4 Proposed Area of Deployment

Turbine	Decimal degrees		Deg/decimal minutes		Depth
1	55.8459404	-6.1000058	55° 50.77'	006° 06.00'	56m
2	55.846049	-6.0992512	55° 50.76'	006° 05.96'	55m
3	55.841799	-6.0982966	55°50.51'	006° 05.90'	58m
4	55.8418901	-6.0976515	55°50.51'	006° 05.86'	57m
5	55.8374087	-6.0980071	55° 50.25'	006° 05.88'	52m
6	55.837494	-6.0973243	55° 50.25'	006° 05.84'	53m
7	55.8375724	-6.0966409	55° 50.25'	006° 05.80'	52m
8	55.8331985	-6.0975264	55° 49.99'	006° 05.85'	50m
9	55.8332561	-6.0968409	55° 49.99'	006° 05.81'	51m
10	55.8333864	-6.0956442	55° 50.00'	006° 05.74'	51m

Table 6 Device Positions and Depths

4.2 Tidal Energy Device

SPR intend using a tidal turbine device developed by Hammerfest Strøm AS (HSAS). Details of the device and the array are given below.

4.2.1 Hammerfest Strøm Device and Array Details

The tidal device to be deployed has been designed and developed by Hammerfest Strøm UK (HSUK), a subsidiary of HSAS and collaboration partner with SPR. The device is a development of a 300kW device currently undergoing a period of research, development and testing. The existing prototype device will be developed to provide a device of 1MW output to be deployed at the Islay site in a demonstration array of approximately 10 devices.

Figure 5 shows an artists impression of the deployed device and Figure 6 shows front and side elevations.

Figure 5 Hammerfest Strøm Tidal Turbine

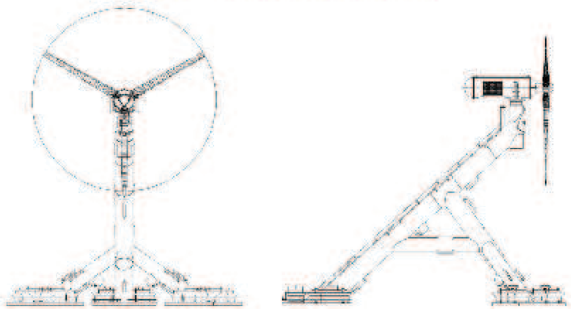


Figure 6 Hammerfest Strøm Tidal Turbine – Front and Side Elevations

4.2.2 Structure

The device structure has been designed using data gained from the lengthy testing of the prototype device in Norway. The design will be subject to third party validation by Det Norske Veritas (DNV) and undergo testing at the European Marine Energy Centre (EMEC) tidal test site in Orkney prior to being deployed in the Sound of Islay.

The generating turbine is mounted on a tripod support structure as shown at Figures 5 and 6. The structure may incorporate a self-levelling device to ensure that the turbine nacelle and, hence, the rotor are perpendicular to the flow. The structure itself will be oriented such that turbine was in alignment with the main tidal stream axis.

It is anticipated that the structure will be secured to the seabed by means of ballast weights placed on each foot. However, if seabed conditions show that this is not appropriate, alternatives, such as pinning, will be considered.

4.2.3 Nacelle Generator

The Hammerfest Strøm device consists of a single 1MW power train with a three-bladed rotor. The rotor hub, power train and electrical equipment form a single, long cylindrical nacelle structure, which is fixed to the tripod near its centre of gravity. The nacelle remains fixed in azimuth and does not rotate with changes in tidal direction. The nacelle contains a shaft, bearings, gearbox, generator, power electrical equipment, and auxiliary systems. The auxiliary systems include hydraulic systems for blade pitch control and mechanical brake operation. The rotor blades are controllable in pitch in order to maximise the energy extracted from the tidal stream depending on the tidal direction and strength.

The rotor diameter chosen for each location is dependent on the tidal stream, required power output, the depth of water and the required clearance above the device. The rotor diameter for the devices proposed for deployment at Islay will be 23m. The rotor is made of composite material.

A mechanical brake is located on the high speed shaft between the gearbox and generator. This, in conjunction with the pitch control system, allows the rotor to be stopped in an emergency or for maintenance and inspection purposes.

None of the nacelle components or elements of the rotor are buoyant. In the case of catastrophic failure of any part of the structure, the components will sink to the seabed and be subject to the forces of the tide.

The main parameters of the device and support structure are given at Table 7.

Item	Dimension
Height of Tripod Structure (without nacelle)	20m
Nacelle Hub centreline height above seabed	22m
Rotor diameter	23m
Height of device above seabed (to top of rotor swept arc)	33.5m
Estimated mass of device	320te
Gravity base securing masses	450te

Table 7 Hammerfest Strøm Tidal Turbine Dimensions and Mass

4.2.4 Subsea Cabling

There will be subsea electrical cabling between the array and the shore in order to export power to the national grid. There will also be a cable between the individual devices. The export cable will be a medium-voltage, armoured cable laid on the seabed. The landfall position for the subsea export cable will be on the Jura side of the Sound in the vicinity of 55° 49.8'N 006° 05.0'W (See Figure 4). A contingency plan is being considered in the vicinity of Feolin in the event of the principal landing point not being available. If this option is required, it is proposed to assess the navigational impacts in an addendum to this report.

Using this cable route and bringing the cable ashore some 1500m north of the Jura /Islay 33kv inter-connector (which is situated just north of Glas Eilean) takes advantage of the gradual slope in that area and facilitates connection with a grid sub-station in the area.

4.2.5 Lifecycle

It is currently proposed that the array will operate for a demonstration period of 15 (8 plus 7) years with the potential that operations will continue for the full turbine design life of 25 years. At the end of this period, the array will be decommissioned and the tidal devices removed to a standard meeting industry best practice at the time. Alternatively, a fresh application may be made to extend the life of the array, to 25 years or greater, or to replace the existing turbines.

4.3 Installation

The detailed installation methodology will be developed as part of the trial deployment at EMEC. Currently the principal installation methodology being considered by SPR to undertake the placement of the support structures and fitting of the nacelles is through the use of a heavy lift vessel fitted with a Dynamic Positioning (DP) system.

The general methodology for the installation process and the tasks will be in the order set out below:

1. Pre-installation activity.
2. Subsea Cable installation.

3. Device Installation

It is expected that the offshore elements of work will take place over 60 -80 days. The offshore installation activities will be subject to limiting environmental conditions e.g. tidal rate, wind speed and sea state. As the activities have not yet been trialled and the vessels not yet decided on, these limitations are, at present, unknown. However, it is expected that the installation of the support structure and fitting of the nacelles will be limited to short windows around slack water. Therefore, it is expected that the installation process will be limited to one support structure or nacelle for each period of slack water. Whether these windows will be limited to certain periods of the monthly tidal cycle (i.e. excluding periods around springs) has not yet been ascertained and will require further analysis of the tidal rates, the vessel capability and the characteristics of the structures being deployed.

The following sections describe in further detail the different installation activities, indicate the type of vessels that would, possibly, be involved and provide an indication of their time on site.

4.3.1 Pre-Installation Activity

Pre-installation activity will involve:

- Installation of temporary moorings in Caol Ila Bay (see Figure 4).
- Tow out of lighter barge(s) with support structures and nacelles embarked.

The pre-installation activities involve the use of Anchor Handling Tugs (AHTs), barge towing and mooring tugs, lighter barges and workboats. SPR expect that the pre-installation activities for the array would occupy approximately 2 weeks.

4.3.2 Subsea Cable Installation

It is currently expected that the inter-device cabling and the export cable will be laid after the support structures had been installed but before the installation of the nacelles. The subsea cable would be laid by a specialist cable laying vessel. The vessel is expected by SPR to be onsite for 10 - 12 days.

4.3.3 Device Installation

A number of vessel types were considered for the installation of the devices including the use of a moored barge. This latter option has been discarded due to, amongst other things, navigational safety issues involved with the mooring and the associated buoyage as well as difficulties involved in moving the barge and mooring between device deployments which result in the barge being on site for lengthy periods of time. The safety issues resulted in the risk for the moored barge option being assessed as "Tolerable with Additional Controls". However, the additional controls proposed required the closure of the channel for the duration of the barge's time on task.

The installation involves the lowering of the tripod base structure to the seabed and after which the ballast weights are lowered onto the feet of the tripod. It is

assumed that support structures would be deployed prior to the nacelle installation activity commences. The nacelle, complete with rotor, would be lowered onto each structure where it will be located with the help of guidelines and a self locating connection. No divers are intended to be used during the operation.

The outline process for devices installation using a DP vessel is as follows:

1. Installation vessel arrives on site.
2. Transfer 2/3 device support structures from lighter barge to installation vessel for first sub array.
3. Heavy lift crane vessel positions over sub-array position and installs 2/3 support structures comprising the sub array (including ballast).
4. Repeat process step 2 – 3 for remaining three sub-arrays.
5. Install inter-device and sub-sea export cable using specialist cable laying vessel.
6. Transfer 2/3 nacelles (with rotors attached) from barges at Caol Ila to heavy lift crane vessel.
7. Heavy lift crane vessel positions over individual support structures in sub array and installs nacelles including recovery and connection of subsea cable.
8. Repeat steps –6 - 7 for each sub array.
9. Demobilise heavy lift vessel and return to base port.
10. Remove barges from temporary moorings in Caol Ila Bay and tow to base port using AHTs.
11. Remove temporary moorings using AHT.

The installation would be planned to take place under the most favourable tidal and weather conditions. Certain activities may only be able to be conducted during the short periods of slack water. Given that it will not be possible to install all devices over a single period of favourable tides e.g. neaps, it is likely that the total time on site for the installation for the entire array of devices would be in the order of 60 - 80 days although the installation vessel will not be required on site in the Sound for that duration. Hence, the DP vessel will be involved in 20 discrete operations (10 support structures and 10 nacelles) over 20 tidal windows of short duration. This would probably amount to a total 40 hours (20 x 2hr periods) around slack water neaps. A moored barge, in comparison, would probably require to be on task for a period of 2 - 4 days around a period of neap tides for each sub-array deployment of both support structures and nacelles – a total in the order of 32 days.

4.4 Operation/Maintenance

It is assumed that, once in position, monitoring of the technical performance and function of the device will take place over the life of the device. Planned interventions for inspection or maintenance are currently estimated as requiring recovery of the nacelle every 5 years. It is estimated that the average number of interventions requiring a DP lift vessel will be in the order of 2 per year. It is probable that visits to the devices by workboats will also be undertaken for survey and inspection of the devices and for environmental monitoring purposes.

4.5 Decommissioning

At the end of the device/array lifecycle, the devices will be decommissioned. The decommissioning of devices involves a reversal of the installation process and is expected to have a reduced timescale.

5.0 Analysis of Marine Traffic

The siting of an OREI can, potentially, present a major hazard to shipping during all, or some, of the lifecycle phases. It is, therefore, necessary to have adequate information to enable the impact of the proposed demonstration array on vessel navigation to be fully assessed. Sources of vessel traffic information used in the report are discussed below.

5.1.1 Stakeholder Comment and Meetings

As part of the general consultation process prior to the PHA, a letter was sent to all the stakeholders identified at Annex A, requesting comment on the possible impact on the proposed installation. In some cases a direct response was forthcoming and in others arrangements were made for meetings with the stakeholders or an appropriate representative. Also, as part of the PHA, a number of key personnel from stakeholder organisations were interviewed during a visit to Port Askaig. (See Reference 3).

The initial analysis has been followed up by further examination of the issues in the light of the more detailed information now available e.g. array and device design characteristics, more precise locations and siting depths and installation methodologies. The following stakeholders were interviewed:

- Argyll and Bute Council Transportation Department (Statutory Port Authority responsible for Port Askaig);
- Caledonian MacBrayne (CalMac) Marine Operations Manager;
- The masters of CalMac Ferries MV HEBRIDEAN ISLES and ISLE OF ARRAN (Kennacraig to Port Askaig);
- ASP Management (Operators and Masters of EILEAN DHIURA) ferry (Port Askaig to Jura);
- Clyde Fishermen's Association (CFA) representative;
- Local creel fishermen;
- Station Manager of Port Askaig Lifeboat.

5.1.2 Hazard Identification and Risk Assessment

A key part of the risk assessment methodology is the Hazard Identification and Risk Assessment (HIRA) process intended to investigate the potential hazards, identify the possible consequences and the likelihood of such an event occurring and to estimate the associated risks. The methodology used was in line with the recommended methodology in the DTI/DECC Guidance (Reference 2).

The HIRA used the more detailed information on the array/device positioning and installation/operation, maintenance and decommissioning activities to ensure that, the hazards presented to marine users were identified using a structured process and an assessment made of the risks involved and any controls appropriate to control the risk by the stakeholders.

The HIRA was undertaken based on the stakeholders responses to the letter inviting comment and during the workshops held with specific stakeholders. The results of the assessment are contained at Annex D and form the "Hazard and Risk Control Log" required by the DTI/DECC guidance (Reference 2).

5.1.3 Automatic Information Systems (AIS)/Radar Survey Data

AIS data covering two 14 day periods in January and July 2007 for this area was obtained from Marico Marine Ltd in order to inform the PHA. This data provided an indication of the type of vessels and levels of traffic that have used the area. The PHA proposed that it would be unnecessary to undertake further AIS/Radar traffic surveys given the following:

- That further analysis of the 2007 survey was undertaken to establish additional data (i.e. range of draughts of the vessels);
- That the stakeholder input during that phase corroborated the AIS data;
- That it was unlikely that there would be any significant change to types, sizes and draught of vessel due to the nature of the area (specifically the depths in the Sound to the north of the proposed development).

The MCA agreed to the proposal (Reference 4).

5.1.4 Fishing Vessel Monitoring System (VMS) Data

Fishing vessels above 15m in length are required to have a monitoring system fitted which records and transmits, amongst other things, their position, course and speed. This data is collected by, in this case, the Scottish Fisheries Protection Agency (SFPA) (now known as Marine Scotland: Enforcement). VMS data has been obtained for the area and has been plotted by Royal Haskoning who is conducting the Environmental Impact Assessment (EIA).

5.1.5 Other Data Sources

DECC Maritime Traffic Database

The Department of Energy and Climate Change (DECC) has compiled a multi-source Marine Traffic Database which is available on-line[6]. Unfortunately, the database is not able to provide data that could be of use in this study due to the poor functionality of the website and the accessibility of the underlying data.

[6] Maritime Traffic Database at www.maritimedata.co.uk

RYA Cruising Routes

Details of recreational vessel activities were obtained from the Royal Yachting Association (RYA) UK Coastal Atlas of Recreational Boating (Reference 9) and through discussion with RYA representatives including the West Highlands Anchorages and Mooring association (WHAM) and the Clyde Yacht Clubs Association (CYCA).

5.2 Current Traffic Densities and Types

The Admiralty West Coast of Scotland Pilot (NP 66) (Reference 5) states that the Sound *"is used by mariners to avoid the open sea west of Islay and forms part of the Inshore Traffic Route"*. It further states that *"the sound is not recommended for medium sized vessels and above, due to a rocky bank, with a least depth over it of 9.1m situated in the fairway and extending for 2.5nm south from the north entrance to the Sound and also due to the strength of the tidal streams."* That said, a significant number of medium sized vessels have been identified as using the Sound of Islay. The AIS track data for 2 periods of 14 days each in January and June 2007 is shown at Figure C1 at Annex C. The breakdown of that data into various categories and by vessel is shown at Tables C1 and C2.

The average numbers of transits of the Sound is in the order of 6 per day – 2 coasters and 4 ferry movements.

The significant users are identified below.

5.2.1 Ferries

Caledonian MacBrayne (CalMac) run ferry services between Kennacraig and Port Askaig and Kennacraig to Oban and Colonsay via Port Askaig. The total number of movements in and out of Port Askaig amount to, approximately, 22 per week during the period April to October and 18 per week between the end of October and the end of March.

The ferries used on this route currently are:

Name	Length/Beam/Draught	Capacity
MV Isle of Arran	84.9m x 15.8m x 3.1m	62 cars/659 passenger
MV Hebridean Isles	85.2m x 15.8m x 3.1m	62 cars/494 passengers
Lord of the Isles	84.6m x 15.8m x 3.1m	54 cars/506 passengers

Table 8 Ferry Details

A new ferry is proposed for this route as a replacement for one of those listed above. However, the characteristics will not be too dissimilar.

The Port Askaig to Feolin ferry is operated by ASP Ship Management on behalf of Argyll and Bute Council. It crosses the Sound up to 40 times per day in summer. The ferry running this route is the EILEAN DHIURA (See Figure 7) which has a capacity 41t (approximately 6 cars or 1 road tanker). The direct route between Port

Askaig and Feolin is some 200m north of the northern sub-array. However, due to the effects of the tide, the route over the ground can be as much as 200m north or south of the direct line.

The Eilean Dhuira ferry is a twin engined, twin screw and twin rudder vessel with a draught of around 1.5m fully laden.

Figure 7 Islay to Jura Ferry "Eilean Dhuira"

5.2.2 Fishing vessels

Fishing activities within the Sound consists of creeling. No trawling, net or line fishing is reported to occur, or has occurred in the recent past, in the Sound. Creeling in the Sound is conducted by small, locally based, day-fishing vessels. These vessels range between 6m single handed to vessels over 10m manned by 3-4 people. The number of creel boats operating out of Port Askaig harbour is approximately 10 with the majority of fishing in the Sound of Islay taking place during the winter months.

Creeling involves the placing of long lines of creels (pots) on the seabed with a buoyed clump weight at each end. These lines may consist of up to 50 creels on a line of over 1000 metres in length overall. It is normally laid parallel to the land and relatively close-in to the shoreline of the Sound in waters up to 30m in depth. However, some of the creel fishermen have stated that they do lay fleets of creels across the Sound and in waters of greater than 30m charted depth. The creels are normally recovered, checked and re-laid daily.

5.2.2.1. Fishing Vessel Monitoring System (VMS) Data

VMS data has been obtained for the area and has been plotted by Royal Haskoning who is conducting the environmental impact assessment for this project. The complete plot for the area is at Annex C, Figure C2. An extract is shown in Figure 8. (The red and yellow star shapes are potential landfall sites for the proposed array sub sea cable whilst the potential array siting area is shown outlined in red.)

The fishing vessel plotted positions make some assumptions (in the same way as is done by fisheries authorities about whether a vessel is engaged in fishing or whether it is just in transit. When a vessels speed is indicated as less than 4kts it is assumed to be fishing and, when greater than 4kts, it is assumed to be in transit. These are shown in the plot extract below as green (with the differing shapes indicating different vessel/fishing types). Red shapes are vessels below 4 kts assumed to be engaged in fishing. There are 4 contacts in the Sound in the vicinity of the proposed array site which based on the speed/activity assumption, are fishing and which are further identified as trawlers engaged in bottom trawling. This is believed to be an incorrect indication as no trawling takes place in the Sound due to the seabed type. It is considered that this indication of activity is a result of the fact that the speed recorded is speed over the ground and that the vessels in question were on passage but in opposition to the tidal stream and hence their speed shows less than 4kts.

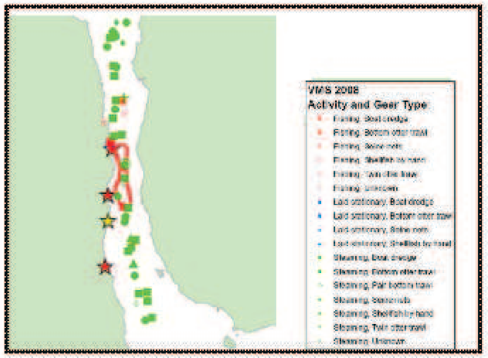


Figure 8 Fishing Vessel Monitoring System Data – 2008

Note: Yellow and Red Star symbols show potential cable landing points on the Islay shoreline

5.2.3 Cargo Vessels

There a number of cargo lines which have vessels which use the Sound on a regular basis as part of the inshore traffic route. They include:

- Aasen Shipping and Chartering (Norway)

- Seatrans (Norway)
- Lys Line (Norway)
- Scotline Marine Holdings (UK)
- Arklow Shipping Ltd (Ireland)

Of the vessels observed during the survey period the deepest draught was the MV Nornews Leader (since renamed MV Ohm Leader) at 6.6m (See Annex C table C1). There were nine vessels with a draught in excess of 5m. The average draught was 4.53m.

The breakdown of all vessels by draught is as follows:

Draught	Jan (2 weeks)	July (2 weeks)	Total
2.5 – 5m	13	48	61
>5m	10	23	33

Table 9 Vessel Traffic Analysis

The passage through the Sound of Islay is limited by the shallow waters in the north of the Sound where, even if vessels navigate with care to avoid the shallow bank with a minimum depth of 9.1m, the maximum charted depth of navigable waters is in the order of 10.2m.

5.2.4 Royal National Lifeboat Institution (RNLI)

The RNLI Islay Lifeboat is a Severn Class vessel (Helmut Schroder of Dunlossit II) berthed at Port Askaig.

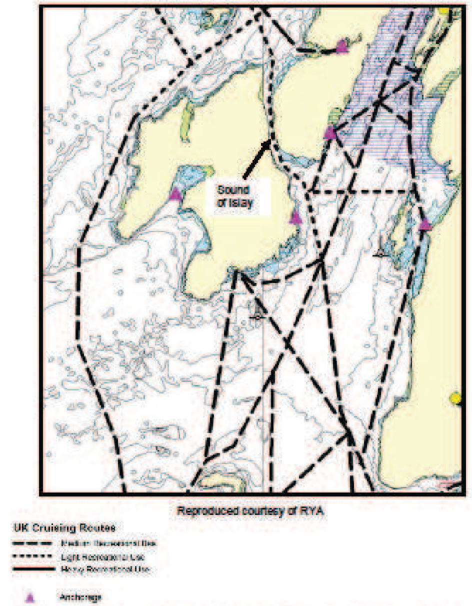
5.2.5 Recreational Diving

There are a number of diving sites associated with the Sound of Islay. The Underwater World Publication – Dive West Scotland by Lawson Wood (Reference 10) identifies two dive sites. The first is the "Port Askaig Deeps" and involves a "deep" dive within the proposed development area. The second is a drift dive undertaken at an average depth of 12 -15m in the shallower waters to the south of the proposed site in the vicinity of Glas Eilean.

The diving guide "Dive Islay Wrecks" by Steve Blackburn (Reference 11) identifies the wreck of the Wyre Majestic in position 55 53.0N, 006 07.22W site as a site of interest to divers. (See Figure 1.)This is some 4.3nm to the north of the proposed development.

5.2.6 Sailing and Motor Yachts.

The Sound of Islay is identified in Royal Yachting Association sailing directions as a route classified as a "Light Recreational Use". There are no yacht anchorages recommended by the RYA in their routing information. (See Figure 9.)



Reproduced courtesy of RYA

Figure 9 RYA Cruising Routes Around Islay and Jura

Discussions with a representative of the RYA (the Chairman of the RYA Scotland Cruising Committee who is the RYA "Coastwatcher" for the area as well as the Secretary of the West Highlands Anchorages and Moorings Association (WHAM))[7], indicated that the level of recreational vessel traffic was, approximately in the order of 6 – 7 craft per day during the season between April and September. It was stated that such vessels do not frequently anchor in the sound except, on occasion, to avoid adverse tides by using the anchorages between Am Fraoch Eilean and Brosdale Island, Bunnahabhain Bay and MacDougall's Bay. Such leisure craft are usually below 15m in length and draw up to a maximum of 2.5m.

[7] Mr David Vass

5.2.7 Military Usage

There are no military, surface Practice Exercise Areas (PEXAs) covering or immediately adjacent to the proposed area and there are no indications of the area as being a transit route for other than surface vessels. The Defence Estates Safeguarding department has been consulted with regard to the proposed deployment during the scoping comment exercise conducted by ScottishPower Renewables in the initial phase of this project. They have stated that they have no concerns regarding this development as it falls outside of a safeguarding area. That said, Naval vessels do transit the sound. Figure 10 shows the largest naval vessel known to have navigated the sound in recent years - HMS Bulwark (Length overall (LOA) 177m x 32m beam x 7.5m draught).

Photo Courtesy of Graham Paterson

Figure 10 HMS BULWARK on Passage through the Sound of Islay

5.3 Future Traffic Patterns, Densities and Types

There are no indications from the users of the Sound that there are any planned, significant changes to the level and types of traffic currently experienced. Neither is it envisaged that there will be any changes to the vessel types or size. Vessel draughts are constrained by the limiting depths in the northern area of the Sound. CalMac is planning on a replacement vessel to be used on the Kennacraig/Islay route which will have a draught of 3.4m.

5.4 Effect on Current Traffic Densities and Types

The effects of the proposed development on the traffic densities and types are considered to be the following:

- Additional construction/decommissioning vessel traffic including a cable laying vessel, a heavy lift vessel/barge, AHTs and dumb barges over a period of, approximately 4 months;

- The presence of a work boat for inspections and maintenance activities over the life of the array;
- The occasional presence of a heavy lift work vessel (similar in size to an AHT) for maintenance and unplanned repair interventions.

Such activities will, when present, both add to the current traffic levels, and cause vessels using the Sound to deviate to the eastern side of the Sound from their standard routes potentially increasing traffic density in that area. The risks from this potential effect are addressed in Section 6.

5.4.1 Construction and Installation

The construction phase will temporarily reduce the width of the navigational channel available to vessels passing the proposed array site when transiting the Sound.

The CalMac ferry, when approaching Port Askaig takes a route close to the shoreline off Carraig Mòr. This would entail passing through part of the proposed array area.

The construction traffic could, dependent on where such traffic would be based, affect the operations of Port Askaig. As such, the operations may impact on assumptions behind the safety response and oil spill contingency plans put in place by Argyll and Bute Council for Port Askaig.

5.5 Effect of the Development on Future Traffic Densities

The levels of traffic using the Sound are not expected to rise significantly in the foreseeable future. The inshore traffic route, of which the Sound is a part, is used by general cargo and wood carriers operating between Scandinavia and the west coast ports. There are no indications of developments that would be likely to significantly increase traffic levels in the future.

The extent to which operational, maintenance and decommissioning activities impact on marine traffic and the subsequent potential increase in risk is briefly considered below, and examined in more detail in Section 6.

5.5.1 Operations

The operation of the array will involve little or no activity that may present a hazard to marine users with the exception of the presence of the turbines themselves. However, there may also be some "funnelling" effect on traffic during the life of the array caused by vessels wishing to avoid the area of the turbines despite the fact that they would not be at risk from the presence of the devices. (See Section 6.) Given the current traffic density this effect is not considered to be significant.

5.5.2 Maintenance

The siting of the array and the associated maintenance activities will, to an extent, constrain the traffic using the Sound of Islay. This would include occasions when a range of support vessels are involved in, for example, routine surveys or inspections.

5.5.3 Decommissioning

It is expected that the impact of decommissioning activities will be similar to those arising from the construction and installation phases.

6.0 Navigation Risk Assessment

6.1 Hazard Identification, Risk Assessment and Controls

In order to identify the impacts of the potential hazards that the proposed demonstration array, structured discussions were held with the key local stakeholders who use the Sound of Islay. These discussions aimed to identify the perceived hazards presented by the siting of the array. Those included in the discussions were representatives from:-

- Caledonian MacBrayne (CalMac) Ferries.
- Local fishermen.
- RNLI.
- Argyll and Bute Council.
- Clyde Fishermen' Association.
- RYA/WHAM/CYCA .
- Islay/Jura Ferry (Argyll and Bute/ASP Management).
- Northern Lighthouse Board

6.2 Hazard Identification Methodology

The hazard identification process was conducted against the key issues identified in MGN 371 (Reference 1) and using the guidance contained in DTI/DECC publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2). These issues were used to generate keywords for assessing each activity phase (construction, operations & maintenance and de-commissioning) associated with the array or individual devices. The hazards associated with the array were then assessed for the risk that they presented to other mariners. The outcome of the assessment is tabulated in Annex D.

The following sections summarise the findings.

6.3 Construction/Installation

The navigational hazards and consequent risks arising from the construction/installation phase are considered below.

6.3.1 Subsea Cable Installation

Subsea cable installation will be carried out by a suitably equipped cable laying vessel. Given that the vessel may be required to operate out towards the centreline of the Sound, the vessel would present a hazard to shipping when engaged in cable operations when its ability to manoeuvre would be compromised.

However, the vessel would be required to comply with the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (Reference 12) and would show the appropriate signals and lights for such an activity. The marine contractor responsible for the cable lay activity, would notify the UK Hydrographic Office (UKHO) of the activity using the Maritime Safety Information (MSI) system for promulgation to all vessels by Notices to Mariners (NMs) and radio navigational warnings. This would also include the promulgation of the information regarding the installation activities over the marine VHF radio by the Maritime & Coastguard Agency. Given the width of the available channel (approximately 450m between the 20m contours) and the fact that the cable laying operation would be planned to be undertaken in the most favourable conditions of tide and weather, it is considered that with the risk control measure mentioned above, the risks from the cable installation activity would be tolerable with monitoring.

6.3.2 Array/Device Installation Using a DP Vessel

A DP vessel would require to be in position for the duration of each lift of a support structure or nacelle. The time on task for each installation activity is expected to be a matter of a short window either side of slack water. Hence, the time at risk would be reduced considerably compared with the use of a moored barge. When operating over the array the least width of the navigable channel between a DP vessel and the 20m contour would be in the order of 170m. (See Figure 11). Given the average, daily vessel traffic density of 2 transits by coastal traffic and 4 ferry transits, it is considered that it would be possible to manage activities to lower the risk to a tolerable level.

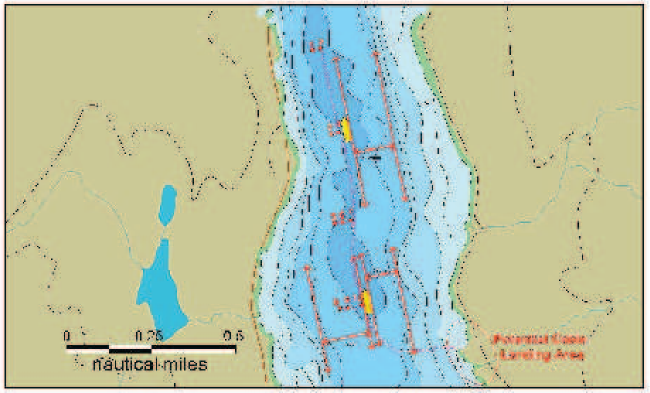


Figure 11 Clearance Distances Between Installation Vessel and 20m Contour

6.3.3 Risk Controls

Notice of the works would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Radio Navigational Warnings (NavWarns/WZs)). The installation vessels would comply with the COLREGS (Reference 12) in that they would display the appropriate lights and marks for vessels engaged in such activities.

Vessels may be at risk of collision if they either violate or incorrectly apply the COLREGs in a situation involving two vessels passing in the Sound. Given the traffic density, this is most likely to occur in a situation involving a vessel in transit and the DP vessel. However, the conspicuous nature of the (stationary) vessels involved and their proximity to the shore on the westerly side of the Sound is considered as being unlikely to lead to any ambiguity about the construction vessels activities which could result in the violation or incorrect application of the manoeuvring rules.

Vessels could also be put at risk if they were to suffer propulsion failure such that they were set down onto the construction vessel. However, the dwell time of vessels passing the spread in the "window" whereby failure of propulsion would cause them to be set down (by wind or tide) onto the spread, is small due to the limited extent of the spread and the fact that the prevailing wind and tides are likely to set vessels "not under command" (NUC) along the line of their planned route and not towards the vessel. The traffic density is such that the likelihood of such an occurrence can be considered as remote and, therefore, a probabilistic assessment is not considered appropriate.

6.3.3.1. Safety Zones

The establishment of a Safety Zone, in accordance with the Energy Act 2004 and Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007 (Reference 13), has been considered as a potential control for the reduction of such risks as arise from the installation and de-commissioning phases. The size of the "standard" zone for construction (500m) would, effectively, close off the Sound to other traffic completely. Even if a smaller zone were to be implemented the least distance between the device positions and the 10m contour, on what is a relatively steep-to shore, is in the order of 300m and any safety zone would reduce the navigable channel significantly. It is considered therefore that, with the promulgation of Maritime Safety Information through the normal means (i.e. NMs and NavWarns) and the presence on site of manned vessels capable of monitoring and advising the other marine traffic using the Sound of Islay, the establishment of a Safety Zone in accordance with Reference 13 is not appropriate in that it provides little or no additional reduction in risk beyond the normal measures that will be employed in the circumstances. In fact, it would further constrain vessels when passing the construction site to an extent that the risk of grounding on the Jura shore would be significantly higher than if they were free to navigate in accordance with the COLREGs. It may, also, cause vessels to re-route to the west of Islay in less sheltered waters.

6.3.3.2. Safety Vessels

The requirement for a dedicated safety vessel has also been considered for this operation. Such a vessel can, in certain circumstances and if properly manned and briefed, help reduce risk to other vessels by monitoring traffic and providing warning of the activities occurring in the area. The following factors need to be considered:

- The levels of traffic in the area;
- The time on task of the installation vessel;
- The size, bridge manning levels and capability of the vessel involved in the installation works which enables it to conduct the duties of safety vessel;
- The provision of adequate notice of such activity through the Maritime Safety Information services;
- Appropriate compliance with the COLREGS by the installation vessel;
- Application of appropriate environmental limits (sea state, visibility) such that installation activities will not proceed during adverse weather.

It is considered that a dedicated safety vessel would not be required as the installation vessel's time on task, as well as the onboard monitoring and warning capabilities are such that a safety vessel would not provide any additional risk reduction.

In the event of any incident occurring, SPR are required to have in place an Emergency Response Coordination Plan (ERCoP), covering the construction, operations & maintenance and decommissioning phases of the array. It requires to be agreed with the MCA's regional Maritime Rescue Coordination Centre (MRCC) for the Clyde based at Greenock. The plan is required to address such issues as:

- Details of companies involved (i.e. marine contractors, client etc)
- Responsibilities
- Points of contact (e.g. names, posts).
- Communication plan (e.g. VHF IMM Channels, MF Radio, mobile phone)

The risk from the construction and installation phases is, therefore, considered to be "tolerable with monitoring" provided the following risk control measures are put in place.

Risk Control Measures for Cable/Device/Array Installation:

- Liaise with CalMac concerning the planned activities to ensure risk to ferries arriving/departing Port Askaig is acceptable by maintaining clear approach and departure routes.
- Submission of adequate information to the UKHO and other authorities in good time to enable promulgation of national and local NMs/Radio Navigational Warnings.
- Installation vessel marked and lit in accordance with COLREGS.
- Emergency Response Coordination Plan (ERCoP) in place.
- Environmental limits for the installation process are developed and implemented.

6.3.3.3. Effects of Tide and Tidal Stream

The installation operations will be limited by the capability of the installation vessel to conduct the required activities in the prevailing tidal stream. At the time of this report those limitations have not been defined for the conduct of the various operations i.e. cable laying, structure offload, final positioning and nacelle/rotor installation. These limits will be established by, amongst other things, the testing to be conducted at EMEC and the capabilities of the vessel chartered. However, it is unlikely that the operations would be conducted in tidal stream rates which, for instance, present specific difficulties to vessels such as the CalMac and Jura ferries when approaching or departing Port Askaig such that they are hampered in their ability to manoeuvre. The conduct of the installation operations in less vigorous tidal conditions will also mean that, in the case of mechanical failure of such vessels as the ferries on approach to and departure from Port Askaig, there is a greater time margin for vessels to take such avoiding action as is possible given the distances involved.

6.3.3.4. Effects of Weather

Adverse weather, e.g. gales, heavy precipitation or fog, would reduce visibility and could increase the risk of collision. If the construction activities were to be conducted in the months when the risk of gales was at the minimum i.e. April to September, the risk of fog would be at its highest (1 – 6 days per month). However, the construction activities would be subject to daily review against stated environmental limits. In low visibility the vessels would be expected to act in accordance with the COLREGs and take appropriate action with regard to speed, lookout and sound signals etc.

Risk Control Measures:

- Establish environmental (including tidal) limits for the conduct of each installation activity
- Monitor meteorological forecasts such that operations will only be conducted in the appropriate, agreed environmental conditions.
- Develop and implement procedures for adverse weather avoidance.
- Ensure that a risk assessment is carried out for the vessel to ensure that the vessel is fully able to operate in any reasonably foreseeable environmental conditions.

6.3.3.5. Effects on Communications, Radar and Positioning Systems

There would be no adverse or unusual effects on communications, radar and positioning systems caused by the vessels or equipment used during the construction phase with the exception of the issue of the use of inappropriate International Maritime Mobile (IMM) VHF channels. The use of IMM VHF during construction for communication between ship and shore or between vessels could interfere with other marine activities. The Principal Contractor will liaise with local organisations (e.g. ferry companies) and the MCA (MRCC) to ensure that suitable working channels are selected to avoid compromising authorised communications.

Risk Control Measure:

- Liaise with MCA and local organisations to establish suitable working channels for construction related activities.

6.4 Array Operational Phase

The operational phase presents several potential hazards to other marine users.

6.4.1.1. Collision with Tidal Device

The devices will be sited in depths of 50m or greater. Therefore, the least depth above any of the devices in the array is expected to be 16.5m. This is some 6m greater than the channel depth which exists in the Sound i.e. 10.5m at the north end of the sound. Given that the greatest draught of any vessel known to have used the Sound is 7.5m (See Section 5.2 – HMS Bulwark), this would ensure an underkeel clearance (UKC) depth at Lowest Astronomical Tide (LAT) of 9m for such a vessel. Taking into account a possible negative surge of -1m (See Section 3.1.7) occurring simultaneously LAT, the worse case would result in a UKC of 8m. This is illustrated at Figure 12.

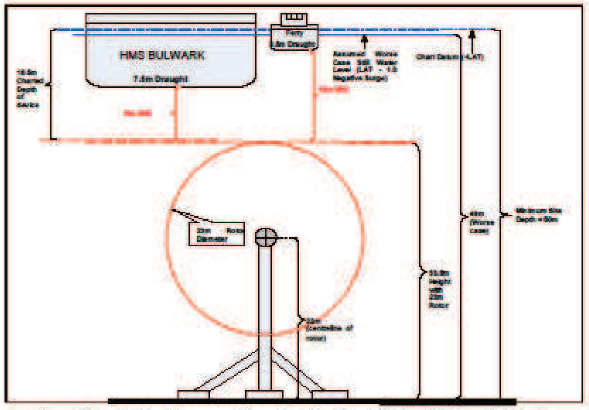


Figure 12 Device Clearances (Assuming 50m Siting Depth of Shallowest Device)

A CalMac ferry would have a worse case clearance of 12m whilst typical vessels using the Sound with draughts of 5-6m would have a clearance of 9.5 – 10.5m. Whilst these clearance figures are for still water clearance, the wave climate for this area of the Sound (as shown in Section 3.1.8), with significant wave heights of around 1m and with a periodicity of between 3 - 4 seconds, is such that it is unlikely to result in vessel pitch and heave motions that would reduce the underkeel clearance to such an extent that the vessels could collide with the devices. If it were to be the case that such a possibility existed then such vessels transiting the Sound in such conditions would, inevitably, ground in the northern end of the sound where the least depth is some 6m less than the individual charted depth of the shallowest device. Also, the northern entrance to the Sound is subject to considerable Atlantic sea swell (which does not reach down the Port Askaig area) which would lead to greater pitch and heave motions in that area. Hence, the risk of collision with the devices in exceptional sea states is considered to be substantially less than the background risk of grounding in the northern area of the Sound.

As with the construction phase, the establishment of a Safety Zone has been considered as a potential control for the reduction of risks during the operational phase. It is considered that no particular benefits would be conferred by the application of such an instrument and, indeed, such a measure would have an adverse effect on the safety of navigation of those vessels, such as the CalMac ferries, whose passage plan to and from Port Askaig would require them to pass over the devices (which they can do without risk) but which they would be prohibited from doing by the establishment of a Safety Zone. Such vessels are not put at risk by the presence of the devices but would be at considerable disadvantage in having to undertake their passage away from their well tried routes which make best use of the area to avoid the effects of tide. Therefore, the application of Safety Zones is not recommended for use in these circumstances.

Risk Control Measures:

- Appropriate charting of devices. (See Section 7).
- The designed clearance height above devices at LAT is greater than that which exists in the northern area of the Sound.

6.4.1.2. Fishing Gear Entanglement

The fishing activities conducted in the Sound of Islay consists only of creeling. As previously described, this is undertaken by small craft (usually under 10m in length) using fleets of creels up to 1000 metres in length.

The main safety concern is that the presence of the devices presents a significant hazard to the creel fishermen if they were to have a problem when recovering their gear. In normal circumstances they would drift with the tide whilst they cleared the snag with the gear. Drifting with gear over the side into the array area obviously presents a possibility of entanglement leading to vessel capsize given the tidal rates experienced in the area and the rotating blades of the devices.

With regard to general entanglement with the device, the fishermen would be required to treat the structures as they would other hazards with which fishing gear could become entangled. That is, to cut their gear if there was a perceived danger to their vessels from the turbines. In addition, the fitting of rope cutters to the devices (similar to cutters fitted to vessels' propellers) would, to a certain extent, mitigate the risk of the turbines "reeling in" the gear. Even with such mitigations the likelihood of capsize if a vessel's gear were to become entangled with either the support structure or rotor is still significant. The designation of the area around the array as a "No Fishing" area is addressed in Section 7.

Subsea cables provide a potential snagging hazard for fishing gear and that entanglement with them could cause fishing vessels to capsize when hauling in. If the subsea cables were not in full contact with the seabed (bridging) the potential for snagging is greater. Cable movement (caused by the force of the tidal stream) could endanger fishing gear when laid. The cable will be sited such that bridging is avoided so far as is possible. This will be achieved by careful sea bed survey and accurate positioning of the cable. Movement of the cable (particularly where it will be at an oblique angle to the direction of the tidal stream) will be assessed for likelihood of movement and the requirement for cable protection (e.g. mattressing, ductile iron protectors).

Risk Control Measures:

- Appropriate charting of devices. (See Section 7).
- Provision of device positional data to Kingfisher Information Services
- Fit rope cutters/anti-snagging devices to the individual devices.
- Cable protection where appropriate.
- Avoidance of bridging during cable lay.

6.4.2 Diving

The area of the proposed development is, as was stated in Section 5.2.5, identified in diving reference books as a recommended dive site. The dive is intended to make use of the depths available in this precise spot as opposed to the rest of the Sound which is, generally, less than 20m. Diving in an area where up to 10 turbine devices may be sited presents a risk of injury or fatality.

Risk Control Measures:

- Appropriate charting of devices as an area in which diving is prohibited. (See Section 7)
- SPR to include representatives of relevant diving organisations in consultation process

6.4.3 Failure

The design of the turbine and support structure will be subject to third party verification by Det Norske Veritas (DNV). Any failure of the device, either whole or in part, would be indicated by the device Supervisory Control And Data Acquisition (SCADA) system. Responses to such failure would include the shutting down of the individual device (or the array as a whole, where appropriate) by the application of the shaft brakes thus stopping the rotor and, hence, power generation.

In the unlikely event of a catastrophic failure of the device, any parts which become detached are unlikely to become a hazard to shipping as no component is positively buoyant. Any debris will sink to the seabed and be subject to the effects of the tide.

Risk Control Measures:

- Third party design verification.
- Hammerfest Strøm UK design stage analysis of failures.
- ScottishPower Renewables to have appropriate maintenance procedures for safety critical components e.g. nacelle locking.
- ScottishPower Renewables to develop and implement Emergency Response Procedures in case of device failure.

6.4.3.1. Anchoring

There is a designated anchoring area in McDougall's Bay on the Jura side of the Sound in 10m of water some 2.6 cables (480m) away from the closest device. The area where the array is proposed to be sited would not, in normal circumstance, be considered as a suitable anchorage due to its depth and the nature of the seabed. Between the point where the cable crosses the 20m contour and the possible landing point on the Jura shore, the seabed is charted as "rock" and relatively steep-to. Hence, it is unlikely that it would be used as an anchorage out of choice given that a suitable area exists in McDougall's Bay some 6.5 cables (1200m) to the north.

However, the possibility exists that, in an emergency such as a total loss of power, a vessel could consider using its anchor in the area to avoid going aground. It is considered unlikely that, given the depth of water, any vessel would attempt to anchor over the array but would wait until they had drifted into shallower water before doing so. There is, therefore, a potential risk to vessels anchoring in an emergency although, given the traffic density and the likelihood of such an event, the risk can be considered broadly acceptable.

6.4.3.2. Electro-Magnetic Interference (EMI)

The devices generate alternating current and with the nacelle at below 26m charted depth and the cable sited on the seabed, there is not expected to be any adverse EMI effects on navigational equipment from the devices or the cable.

6.4.3.3. Acoustic Interference

There are no known adverse effects on navigation systems from acoustic interference arising from the Hammerfest Strom device. The Ministry of Defence (MoD) (Defence Estates) response to the scoping document is assumed to include the assessment of any impacts on MoD acoustic monitoring equipment and other vessel equipment.

6.4.3.4. Effects on Communications, Radar and Positioning Systems

As the individual devices comprising the array are sub-surface they are not considered to present any hazard to communication, radar and positioning systems during operations.

6.5 De-commissioning Phase

It is intended that when the lifecycle of the array is complete, the devices and associated cables will be removed. The decommissioning phase is, therefore, a reversal of the installation process. The risks from the decommissioning activity are expected to be the same as for the installation process. Hence, similar control measures would be implemented.

7.0 Charting, Marking and Lighting

7.1.1 Charting

The charting of the individual devices and the arrays as a whole has been discussed with the key marine users of the area and with the UKHO[8]. The fishermen attending the HIRA were keen that extensive areas of the Sound are not removed from potential use by the application of any type of area which would exclude them fishing in the general area. They stated that they would prefer data on the precise positions of the devices in order that they can enter them into their chart plotters and thus ensure their safety by maintaining a distance appropriate to their activities and the conditions. The Masters of the CalMac ferries require only to know the general location of the devices as they would not consider them a hazard to navigation and would be happy to maintain their present passage plans passing over the devices.

In general, marine users subscribe to the philosophy that the chart should provide them with the appropriate information on the position and nature of the hazards and to allow them to make the decision on the appropriate distances and clearances required to ensure the safety of their vessels.

The scale of the current Standard Nautical Chart (SNC) (Admiralty Chart 2481) covering the area is 1:25000. Given the extent of the proposed array, this presents issues regarding the amount of data that can be shown within the area on the chart encompassing the array and the potential obscuration of detail necessary for the mariner. For Electronic Navigational Charts (ENCs), these issues are, to an extent, overcome.

7.1.1.1. Charting the Array Area

Given the risks to fishermen presented by the devices (as discussed in Section 6.4.1.2), it is recommended that the area containing the array is charted as an area in which fishing is prohibited. Application should, therefore, be made to the Scottish Government for the designation of the area as a "No Fishing" area.

Similarly, with the potential risks to divers using the area, it is recommended that the area is also designated as a "No Diving" area.

The designation of an area to exclude specific activity requires Scottish Government approval. If such approval is not gained then the alternative would be

[8] Mr Roger Millard Heads of Charting Area 1C Scotland and Ireland.

to chart the area as a "Marine limit in general, usually implying physical obstructions" with a standard international symbol of a black pecked line (International Symbol N1.1 - Admiralty Publication 5011, Symbols and Abbreviations used on Admiralty Charts (Reference 14)). This would indicate to the marine users that potential hazards exist within the area. This proposal is subject to agreement with the UKHO and further consideration of the issues of obscuring data on the chart given the scale.

An explanatory note is also recommended to be added to the chart explaining that subsea obstructions in the form of tidal turbines are sited within the area. The area would also be supplemented by the charting of the device positions (see below). Such an area and note will require to be clear in identifying the nature of hazards present.

7.1.1.2. Charting the Devices

Following the discussions with the UKHO, it has been agreed that, given the scale of the chart covering area and the practicalities of marking individual devices sited in 4 sub-arrays separated by, approximately, 470m between them, it would be possible if the devices were to be marked using the symbol for an underwater obstruction (e.g. Symbol L21 or 24 from Admiralty Publication 5011 (Reference 14). The symbol could be annotated by text alongside indicating that it was a Tidal Turbine. As the scale of the chart would mean that symbols marking individual devices of the sub arrays would overlap, the UKHO stated that the symbols would be linked together with a single depth within the symbol indicating the least depth of the sub-array. Each sub-array could be annotated as "Tidal Turbines" if there was considered sufficient space on the chart. Otherwise such information could be included in the note mentioned above.

In order that fishing vessels are provided with accurate information on the position of the individual devices such that the device locations can be entered into their plotters with sufficient accuracy, it is further recommended that the individual device positions are provided to the Kingfisher Information Service which provides fishermen with information on subsea cables and other "introduced" hazards in the marine fishing environment.

7.1.2 Marking and Lighting

The issues surrounding the requirements for marking and lighting the proposed demonstration array have been discussed with the Northern Lighthouse Board (NLB)[9]. The guidance on marking and lighting of offshore wave and tidal energy devices is laid down in the International Association of Lighthouse Authorities Recommendation O-139 "The Marking of Man-Made Offshore Structures" (Reference 15).

The IALA recommendation states that "*Areas containing surface or sub-surface energy extraction devices (wave and/or tidal) should be marked by appropriate navigation buoys in accordance with the IALA Maritime Buoyage System, fitted with the corresponding top-marks and lights. In addition, active or passive radar*

[9] Captain Phillip Day, Director of Marine Operations, 16th march 2010.

reflectors, retro reflecting material, racons and/or AIS transponders should be fitted as the level of traffic and degree of risk requires."[10]

It further states that "*The boundaries of the wave and tidal energy extraction field should be marked by lighted navigational buoys, so as to be visible to the Mariner from all relevant directions in the horizontal plane, by day and by night. Taking the results of a risk assessment into account, lights should have a nominal range of at least 5 (five) nautical miles. The Northerly, Easterly, Southerly and Westerly boundaries should normally be marked with the appropriate IALA Cardinal mark. However, depending on the shape and size of the field, there may be a need to deploy lateral or special marks.*"

The Recommendation makes no allowance for the risk (or absence of risk) presented by such arrays or devices to the vessels using the waters. Neither does it recognise the practicalities of establishing and maintaining such buoys in areas of strong tidal stream and depth where, in certain tidal states, buoys may be submerged due to the forces acting on them. In this case, where the channel is relatively narrow, the buoys would have to be sited a suitable distance clear of the array in order to ensure that the moorings cannot in any circumstances impact on the individual devices. The length of cable required to moor such buoys in the depths available - approximately 50m - using a standard mooring would be in the order of, at least, 200m. Such a mooring scope would, effectively, deny navigation of a much larger area than is required even for those vessels which either would wish to avoid the array or which could navigate without risk within the area.

It is also a case that the buoyage itself would present an additional collision hazard to vessels such as the CalMac ferries approaching and departing Port Askaig which would not be at risk from the devices themselves.

Given the low level of collision or other risk presented by the devices constituting the array, it is considered that the level of risk is in no way further reduced by the use of buoyage to mark the proposed array. In fact, it is considered that the risks are increased by the addition of buoyage in that:

1. They present a hazard to shipping approaching Port Askaig in strong tidal streams due to their closeness to the required approach track taken by CalMac Ferries.
2. The buoys and their moorings would present a further hazard to creel fishing vessels operating in the area.
3. They would present a hazard to shipping if they were to be submerged when subject to strong tidal streams.
4. They further constrain the available navigable waters of the Sound due to the distance off the array they would require to be sited.

[10] IALA Recommendation O-139 – The Marking of man-Made Offshore Structures Section 2.4.2 (2)

Risk Control Measures:

- Chart the sub-arrays as "Underwater Installations" (e.g. Symbol L21 or L24.
- Apply to the Scottish Government to designate the array area a "No Fishing" (Int. Symbol N21)and "No Diving" area
- If designating the array area as "No Fishing/No Diving" is not feasible, then the area should be charted as a "Marine Limit in General, implying physical obstructions" (Int. Symbol N1.1)
- Provide an explanatory note on the chart explaining the hazard.
- Device positional information provided to Kingfisher information service.

8.0 Status of Hazard and Control Log

The hazard and control log is at Annex D. The controls identified in the Log will be addressed by ScottishPower Renewables as part of the project risk management process. The major hazard and consequent risks arise from the installation process.

9.0 Search & Rescue (SAR) Overview and Assessment

9.1 Search and Rescue

The Sound of Islay is situated in the area of the UK Maritime Search and Rescue administered by Clyde Maritime Rescue Co-ordination Centre (MRCC). MGN 371 (M+F) Annex 4 (Reference 1) requires that an Emergency Response Co-ordination Plan (ERCoP) is established as part of the risk mitigation process for any OREI. The ERCoP is required to be in place for the construction, operation and decommissioning phases of the demonstration array. (See Section 6.3.2.1)

The plan is required to address a number of issues depending on the type and characteristics of the array and devices. Given that the proposed devices are sub-surface tidal devices, the recommendations in MGN 371(M+F) on such matters as marking of individual devices and operational procedures require to be determined "on a case by case basis", in consultation with appropriate stakeholders during the Scoping and Environmental Impact assessment processes.[11].

The requirements for such a plan have been discussed with the Clyde MRCC manager[12] and will be incorporated into an agreed ERCoP prior to the commencement of installation operations.

[11] MGN 371 (M+F) Annex 5

[12] Mr John Griffith

Abbott Risk Consulting Ltd

Risk Control Measure:

- Develop and implement an ERCoP covering the construction, operation and decommissioning phases of the demonstration array in cooperation with the MCA/MRCC Clyde.

9.2 RNLI

The Port Askaig lifeboat can, in general, operate within the array area without risk. There is a potential risk if the lifeboat were to be conducting a tow and the towline was submerged such that the line became entangled with the device rotors. The catenary of the tow line would require to be greater than 13m below the surface in order for this to happen. This issue was raised with the station manager and lifeboat crew and it was considered that, due to the likely size of the vessels which could be taken in tow in the area, the length, size and weight of line and the probable destination/place of safety, that there would be little likelihood of getting entangled with the devices.

There are no issues which are considered as affecting the use of helicopters within the demonstration array area.

It is considered that the array as a whole or the individual Hammerfest Strøm devices do not present an unacceptable risk to SAR activities above the background risks of operating in the close inshore area of the Sound.

10.0 Through Life Safety Management

10.1 Safety Management System

A Safety Management System (SMS) will be required to be established to cover the construction, operational and decommissioning phases of the demonstration array lifecycle. This shall be required to address the hazards and risks identified in the Hazard and Risk Control Log (Annex D). Hence, amongst other things, it shall address the development and implementation of an ERCoP. Such an ERCoP would be required to be tested as suitable intervals.

The SMS shall also contain emergency procedures for the control of marine work and other activities conducted by the array developer or their authorised contractors within the array area. It will detail responses to emergency situations including collision between vessels and other vessels/devices within the area, failure of devices or loss of power and injury to personnel involved in construction of maintenance activities. The system would require to be considered robust and subject to management review.

Risk Control Measure:

- Develop and implement an appropriate Safety Management System covering the construction, operation and decommissioning phases of the demonstration array.

11.0 Conclusions

The following conclusions are drawn:

1. That the risk to navigation from the use of a DP vessel during the installation phase is considered to be "Tolerable with Monitoring" subject to the application of such risk controls as are identified in this report;
2. That the risk to navigation (including vessels engaged in creeling) from the operational and maintenance phase is considered to be "Tolerable with Monitoring" subject to the application of such risk controls as are identified in this report;
3. That the risk to recreational divers is "Tolerable with Monitoring" subject to the application of such risk controls as are identified in this report;
4. That the individual devices/sub arrays require to be charted appropriately subject to the limitations of the scale of the chart and the need to avoid congestion of information;
5. That the area containing the demonstration array should be charted appropriately subject to a review of the issues involved with the UKHO;
6. That the use of buoyage as recommended by IALA guidance does not, in the circumstances, provide any benefit to the marine user and, in fact, adds to the hazards in a confined waterway;
7. That the scale and nature of the risks involved by the demonstration array, requires the development of a Safety Management System (including an ERCoP).

12.0 Recommendations

The following recommendations are proposed:

1. That the proposed development is given consent on the grounds that the installation and operational phases of this development do not represent an intolerable level of risk subject to the use of DP vessels for the installation process and the implementation of the risk controls identified in this report;
2. That application should be made for the area containing the array to be designated and charted as a "No Fishing (International Symbol N21) and No Diving" area.
3. That each sub-array is charted as an "underwater obstruction" providing the least depth of each sub-array using International Symbol L21 or L24. Where possible, given the scale of the chart, the symbol for each sub-array should be annotated as "Tidal Turbines". Where this is not possible, the explanatory note should be used to describe the type of device;

4. That, if Recommendation 2 is not accepted by the Scottish Government,, the area containing the demonstration array should charted as a "marine limit in general, implying physical obstructions" i.e. International Symbol N1.1;
5. That buoyage in accordance with the IALA recommendations is not mandated for marking the demonstration array;
6. That a Safety Management System (including an ERCoP, appropriate to the scale and nature of the risks involved by the demonstration array, is developed and put in place prior to installation of the array.

13.0 References

[1] Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371(M+F) - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues.

[2] Guidance on the Assessment of the Impact of Offshore Wind Farms – Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms. DTI/pub 8145/0.5k/12/05/NP November 2005.

[3] Abbott Risk Consulting Report ARC-266-002-R1 Revision 1 dated March 2009: Preliminary Hazard Assessment for ScottishPower Renewables Proposed Demonstration Tidal Site, Sound of Islay.

[4] Email: MCA/Capt P Townsend, Navigation Manager 06 May 2009 17:31.

[5] NP 66, Admiralty Sailing Directions – West Coast of Scotland Pilot, 15th Edition 2004.

[6] Admiralty Tidal Stream Atlas NP222 – Firth of Clyde and Approaches.

[7] Admiralty Tide Tables NP 201 – Volume 1 United Kingdom and Ireland.

[8] RPS Consulting Report IBE0310/BE/RP02 dated 10 August 2009.

[9] RYA UK Coastal Atlas of Recreational Boating – Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast.

[10] Underwater World Publications: Dive West Scotland by Lawson Wood ISBN 0 946020 36 1 published 2004.

[11] Dive Islay Wrecks by Steve Blackburn ISBN 0 9511397 0 3.

[12] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (as amended).

[13] Statutory Instrument 2007 No. 1948 The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

[14] Admiralty Chart 5011 – Symbols and Abbreviations used on Admiralty Charts (INT) 1 Edition 3.

[15] IALA Recommendation O-139 – Marking of Man-Made Offshore Structures. Edition 1 December 2008.

Annex A - Stakeholders

Organisation	Contact	Contact Details
MCA	Paul Townsend	MCA Bay2/30, Spring Place 105 Commercial Road Southampton SO15 1EG
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British Chamber of Shipping	Capt Saurabh Sachdeva	British Chamber of Shipping Carthusian Court London EC1M 6EZ
Caledonian MacBrayne Ferry	Mike Smith	Marine Manager, Calmac Ferries Ltd Ferry Terminal Gourock PA19 1QP
Scotline Ltd	Roy Brooks	75 Main Road Gidea Park, Romford Essex RM2 5EL
RNLI Scotland	Waveney Crookes	Royal National Lifeboat Institution Divisional Inspector of Lifeboats Scotland Unit 3 Ruthvenfield Grove Perth PH1 3UE
RNLI	Islay MacEachern	Station Manager Port Askaig, Isle Of Islay, PA46 7RB or 7 Keills Cottage Isle of Islay PA46 7RB
NLB	Peter Douglas	Navigation Manager Northern Lighthouse Board 84 George St Edinburgh EH2 3DA
Clyde Inshore Fisheries Group	Alex Watson Crook	Clyde IFG Executive Committee Local Coordinator Clyde I.F.G. PO Box 8509 Prestwick KA9 9AE

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Scottish Fishermen's Association	Michael Sutherland	Director of Business Development Scottish Fishermen's Federation (SFF) / SFF Services Limited (SFFS) 24 Rubislaw Terrace, Aberdeen, AB10 1XE
Mallaig & Northwest Fishermen's Association (MNWFA)	John Hermse	Harbour Offices Mallaig Inverness-shire PH41 4QB
Clyde Fishermen's Association (CFA)	Archie McFarlane	Clyde Fishermen's Association 4 Maol Bhuie Ardbeg Isle of Islay, Argyll PA42 7ED
RYA	Ms Pauline McGrow	RYA Scotland\ Caledonia House South Gyle Edinburgh EH12 9DQ
MoD, Defence Estates	Louise Dale	Safeguarding Section Defence Estates Kingston Road Sutton Coldfield West Midlands B75 7RL
Argyll & Bute Council Operational Services Department	Martin Gorringe	Operations Manager for Marine & Airports Operational Services Dept 1a Manse Brae Lochgilphead Argyll PA31 8RD
ASP Ship Management Ltd		Bergius House 20 Clifton Street Glasgow G3 7XS
QHM Clyde MoD RN	Cdr Ken Clark RN	HMNB Clyde Faslane Helensburgh Dunbartonshire G84 8HL
West Highland Anchorages and Mooring Association	David Vass	33 Odochy Park Dunblane FK15 0DX
Clyde Yacht Clubs Association		PO Box 5348 Helensburgh G84 8WH
British Marine Aggregate Producer's Association	Mark Russell	BMAPA Gillingham House 38-44 Gillingham Street London SW1V 1HU

Annex B - Islay Fishermen’s Consultation Meeting 3rd November 2009

Contact	Fishing Vessel/Organisation
Fraser Aitken	Keriolet
Chris Jameson	Speedwell
Craig McCuaig	Cynosure
Ian McCuaig	Sapphire
Paul Rennie	Paulanda
Islay McEachern	RNLI - Station Manager, Islay Lifeboat Station
David Cantello	ARC
Mhairi Cooper	ARC
Douglas Watson	ScottishPower Renewables
Andy MacDonald	Islay Energy Trust
Apologies	
John Crawford	Local branch secretary of the Clyde Fishermen's Association
Archie McFarlane	Secretary, Clyde Fishermen's Association

Annex C – Traffic Survey Data

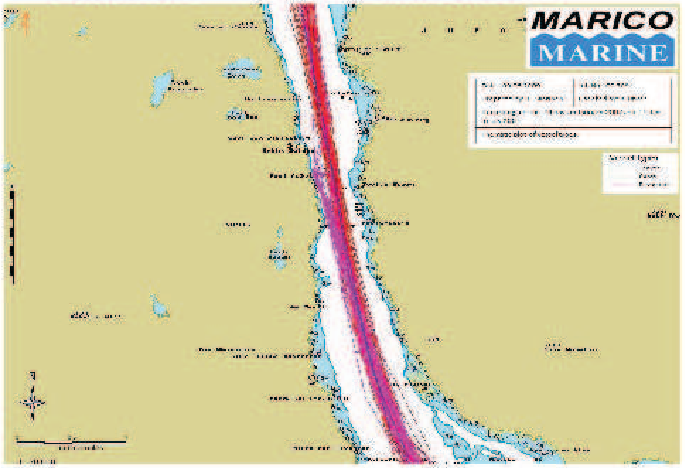

Figure C1 – AIS Track Data Showing Breakdown by Vessel Type

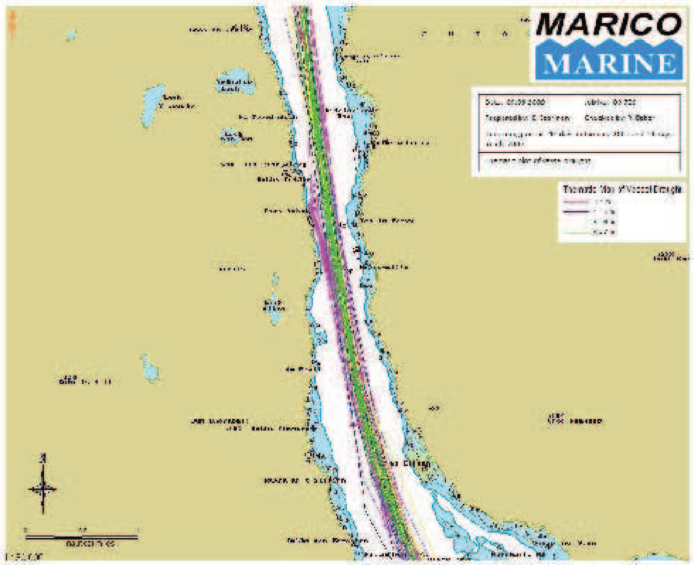

Figure C2 – AIS Track Data Showing Breakdown by Draught

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Vessel Traffic Analysis - SOUND OF ISLAY

Across Gate defined by co-ords								
Total Vessels in Transit (4 weeks)	94		Total Vessels in Transit (2 weeks Jan)	23		Total Vessels in Transit (2 weeks Jul)	71	
Group Breakdown			Group Breakdown			Group Breakdown		
Dry Cargo	56	59.57%	Dry Cargo	21	91.30%	Dry Cargo	35	49.30%
Tankers	2	2.13%	Tankers	0	0.00%	Tankers	2	2.82%
Navy	2	2.13%	Navy	0	0.00%	Navy	2	2.82%
Passenger	34	36.17%	Passenger	2	8.70%	Passenger	32	45.07%
Total	94	100.00%	Total	23	100.00%	Total	71	100.00%
Speed Through Area			Speed Through Area			Speed Through Area		
5-10 Knots	25	26.60%	5-10 Knots	12	52.17%	5-10 Knots	23	32.39%
10-15 knots	38	40.43%	10-15 knots	6	26.09%	10-15 knots	22	30.99%
15-25 knots	31	32.98%	15-25 knots	5	21.74%	15-25 knots	26	36.62%
Total	94	100.00%	Total	23	100.00%	Total	71	100.00%
Draft Of Vessels			Draft Of Vessels			Draft Of Vessels		
2.5-5m	61	64.89%	2.5-5m	13	56.52%	2.5-5m	48	67.61%
5-10m	33	35.11%	5-10m	10	43.48%	5-10m	23	32.39%
Total	94	100.00%	Total	23	100.00%	Total	71	100.00%
North of Port Askaig								
Total Vessels in Transit (4 weeks)	66		Total Vessels in Transit (2 weeks Jan)	23		Total Vessels in Transit (2 weeks Jul)	43	
Group Breakdown			Group Breakdown			Group Breakdown		
Dry Cargo	56	84.85%	Dry Cargo	21	91.30%	Dry Cargo	35	81.40%
Tankers	2	3.03%	Tankers	0	0.00%	Tankers	2	4.65%
Navy	2	3.03%	Navy	0	0.00%	Navy	2	4.65%
Passenger	6	9.09%	Passenger	2	8.70%	Passenger	4	9.30%
Total	66	100.00%	Total	23	100.00%	Total	43	100.00%
Speed Through Area			Speed Through Area			Speed Through Area		
0-2.5 Knots	2	3.03%	0-2.5 Knots	0	0.00%	0-2.5 Knots	2	4.65%
5-10 Knots	26	39.39%	5-10 Knots	12	52.17%	5-10 Knots	14	32.56%
10-15 knots	21	31.82%	10-15 knots	6	26.09%	10-15 knots	15	34.88%
15-25 knots	17	25.76%	15-25 knots	5	21.74%	15-25 knots	12	27.91%
Total	66	100.00%	Total	23	100.00%	Total	43	100.00%
Draft Of Vessels			Draft Of Vessels			Draft Of Vessels		
2.5-5m	33	50.00%	2.5-5m	13	56.52%	2.5-5m	20	46.51%
5-10m	33	50.00%	5-10m	10	43.48%	5-10m	23	53.49%
Total	66	100.00%	Total	23	100.00%	Total	43	100.00%

Table C1 – Vessel Traffic Analysis by Type, Speed and Draught

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NAME	DRAUGHT	IMO	SHIP TYPE
RED DUCHESS	2.8	6919851	Cargo Ship
RIVERDART	3	8012839	Cargo Ship
HEBRIDEAN ISLES	3.2	8404812	Passenger ship
ISLE OF ARRAN	3.2	8219554	Passenger ship
MV NORDIC AMANDA	3.2	9012989	Cargo Ship
BOISTEROUS	3.2	8131142	Cargo Ship
SCOT EXPLORER	3.3	9137193	Cargo Ship
FRI LAKE	3.4	9195664	Cargo Ship
CALEDONIAN ISLES	3.5	9051284	Passenger ship
NORDLANDIA	3.6	7524029	Cargo Ship
EMSLAND	3.6	8412857	Cargo Ship
FINGAL	3.6	8324658	Cargo Ship
SCOT ISLES	3.7	9243930	Cargo Ship
HENTY PIONEER	3.8	8416475	Tanker
HARVEST CAROLINE	3.8	7042291	Cargo Ship
SCOTPIONEER	3.9	8417235	Cargo Ship
TRINITY	4.2	8421717	Cargo Ship

NAME	DRAUGHT	IMO	SHIP TYPE
FAVORITE ARROW	4.3	8609917	Cargo Ship
DEXTEROUS	4.5	8401509	Tug Engaged in military Ops
AASTUN	4.6	7359204	Cargo Ship
FRI TIDE	4.6	9195676	Cargo Ship
ARKLOW SPRAY	4.7	9117961	Cargo Ship
PATRIOT	5	9083885	Cargo Ship
FRI RIVER	5.1	9013000	Cargo Ship
SCOT RANGER	5.2	9138769	Cargo Ship
LYS SKOG	5.4	8912039	Cargo Ship
FRI STREAM	5.4	9115896	Cargo Ship
LYSFOSS	5.5	8713653	Cargo Ship
NORNA	5.6	8608341	Law enforcement vessel
ANITA	6.2	7396654	Cargo Ship
AASHEIM	6.4	9247106	Cargo Ship
NORNEWS LEADER	6.6	8906781	Cargo Ship

Table C2 – Vessel Traffic Breakdown by Individual Vessel/Draught

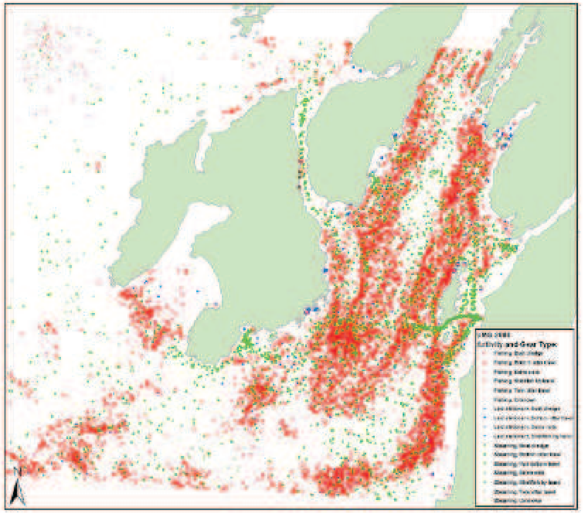

Figure C3 – Fishing Vessel Monitoring System Data for 2008

Annex D – Hazard Log

Risk Criticality and Risk Tolerability Matrices used in Risk Log

Risk Criticality	Condition	Explanation
Broadly Acceptable	None	Technical review is required to confirm the risk assessment is reasonable. No further action is required
Broadly Acceptable	None	Technical review is required to confirm the risk assessment is reasonable. No further action is required
Tolerable with monitoring	With a commitment to risk monitoring and reduction during operation	Risk must be mitigated with engineering and/or administrative controls. Must verify that procedures and controls cited are in place and periodically checked
Tolerable with Additional Controls	With a commitment to further risk reduction before operation	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class of 4 or below before construction
Tolerable with Modifications	With a commitment to further risk reduction before construction	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
Unacceptable	None	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
Unacceptable	None	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent

Hazard Identification Risk Assessment (HIRA)					
HIRA Risk Matrix					
	Consequence	Insignificant	Minor	Major	Catastrophic
Frequency	Definition	No significant harm to people	Injury to vessel crew Injury to OREI installation crew Injury on the shore	Loss of vessel crew members (1-3) Loss of OREI installation or maintenance crew members (1-3) Fatalities on shore (1-3)	Total loss of vessel crew Total loss of ORIE installation or maintenance crew Multiple fatalities onshore
Frequent	Likely to happen annually or more frequently	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable	Unacceptable
Reasonably Probable	Likely to happen during the license period of an ORIE (nominally 20 years)	Tolerable with monitoring	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable
Remote	Unlikely (but not exceptional) to happen during the license period	Broadly Acceptable	Tolerable with monitoring	Tolerable with Additional Controls	Tolerable with Modifications
Extremely Remote	Only likely to happen in exceptional circumstances	Broadly Acceptable	Broadly Acceptable	Tolerable with monitoring	Tolerable with Additional Controls

Sound of Islay ScottishPower Renewables - Hazard & Control Log

Element	Phase	Guide word	Hazard	Consequence	Initial Risk			Controls / Mitigation	Residual Risk		
					Frequency	Consequence	Risk		Frequency	Consequence	Risk
Subsea Cables	Installation & Commissioning	Shipping routes	Cable installation vessel: Restricted in Ability to Manoeuvre (RAM)	Vessel in transit collides with cable installation vessel(s)	Remote	Major	Tolerable with Additional Controls	Installation vessel compliant with COLREGs. Issue NMs/Radio Navigation Warnings. Warn frequent users e.g. ferry operators/ fishermen. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	Tolerable with monitoring
	Operation	Vessel engaged in fishing	Cable	Vessel capsize	Remote	Major	Tolerable with Additional Controls	Cable to be charted. Cable position to be provided to "Kingfisher" System No trawling takes place in area. Avoid "bridging". Mattress protection at vulnerable points. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	Tolerable with monitoring
		Anchorage	Cable	Vessel anchor snags on cable	Remote	Minor	Tolerable with Additional Controls	Cable to be charted. Avoid "bridging". Consideration of providing "mattress" protection at vulnerable points. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Minor	Broadly Acceptable
Devices (Structures and Nacelle)	Installation and Commissioning	Shipping routes	DP vessel conducting installation	Vessel (ferries/fishing vessels) collision installation vessel	Remote	Major	Tolerable with Monitoring	Installation vessel compliant with COLREGs. Issue NMs/Radio Navigation Warnings. Warn frequent users e.g. ferry operators/ fishermen. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Major	Tolerable with monitoring
		Shipping routes	Construction barges in Caol Ila Bay	Vessel (coasters, ferries/fishing vessels) collision with moored barge / mooring	Remote	Minor	Tolerable with Monitoring	Issue NMs/Radio Navigation Warnings. Warn frequent users e.g. ferry operators/ fishermen. ERCoP SMS – Emergency Response Procedures	Extremely Remote	Minor	Broadly acceptable
		Shipping routes	Vessel not under command (NUC)	Collision between NUC vessel and installation vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	Tolerable with Additional Controls	Notice to Mariners (NTM)/ Navigation Warning(NavWarns) Vessel Lighting and marking ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	Tolerable with monitoring
		Violation/ Mistakes/ Slips/ Lapses	Vessel collides with installation vessel	Collision between vessels leading to damage to vessel/injury /loss of life	Remote	Major	Tolerable with Monitoring	Vessel marked and lit appropriately. Monitoring of traffic by installation vessel ERCoP SMS – Emergency Response Procedures	Extremely remote	Major	Tolerable with monitoring