Preface

This Environmental Statement accompanies the application by ScottishPower Renewables (UK) Ltd to the Scottish Government, Marine Scotland for the construction and operation of a marine tidal array named the Sound of Islay Demonstration Tidal Array.

The Environmental Statement has been prepared by Royal Haskoning and ScottishPower Renewables UK Ltd and comprises the following:

- Non Technical Summary;
- Environmental Statement Volume 1: Environmental Statement; and
- Environmental Statement Volume 2: Technical Appendices.

Copies of the Environmental Statement can be viewed at:

Argyll and Bute, Islay, Council Office, Jamieson Street, Bowmore, Isle of Islay, PA43 7HP.

and

Islay Energy Trust, Custom House, Main Street, Bowmore, Isle of Islay, PA43 7JJ.

and

Jura Servicepoint, Schoolhouse, Craighouse, Isle of Jura, PA60 7XG.

and

The Scottish Government Library, Saughton House, Broomhouse Drive, Edinburgh,
EH11 3XD.

Copies of the Environmental Statement including the Non Technical Summary can be obtained from ScottishPower Renewables by calling 0141 568 2153 at a cost of £300, CD's are also available at a cost of £20, whilst the Non Technical Summary is available separately free of charge.

Or by writing to:

ScottishPower Renewables,
Cathcart Business Park,
Spean Street,
Glasgow,
G44 4BE

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1.0 Introduction

1.1 This document provides a Non Technical Summary (NTS) of the Environmental Statement (ES) produced in support of the consent application process for the Sound of Islay Demonstration Tidal Array, hereafter known as the Development. The ES is the formal report of an Environmental Impact Assessment (EIA) undertaken by ScottishPower Renewables (SPR), into the potential impacts of the construction, operation and eventual decommissioning of the Development.

1.1 ScottishPower Renewables (UK) Limited

1.2 The Development will have a capacity of up to 10MW of renewable power for export to the grid and will contribute to meeting the Scottish Government's targets of providing 50% of Scotland's electricity generation from renewable sources by 2020.

1.3 The Development will consist of up to 10 pre-commercial submerged tidal stream-generating devices.

1.2 Project Details

1.4 The Development will be subject to the required Consents and Licenses being obtained. It will be the first of its kind and should be considered to be a 'Demonstration Tidal Array'.

1.5 The location of the Development and proposed layout of individual turbines is shown in Figure 1.

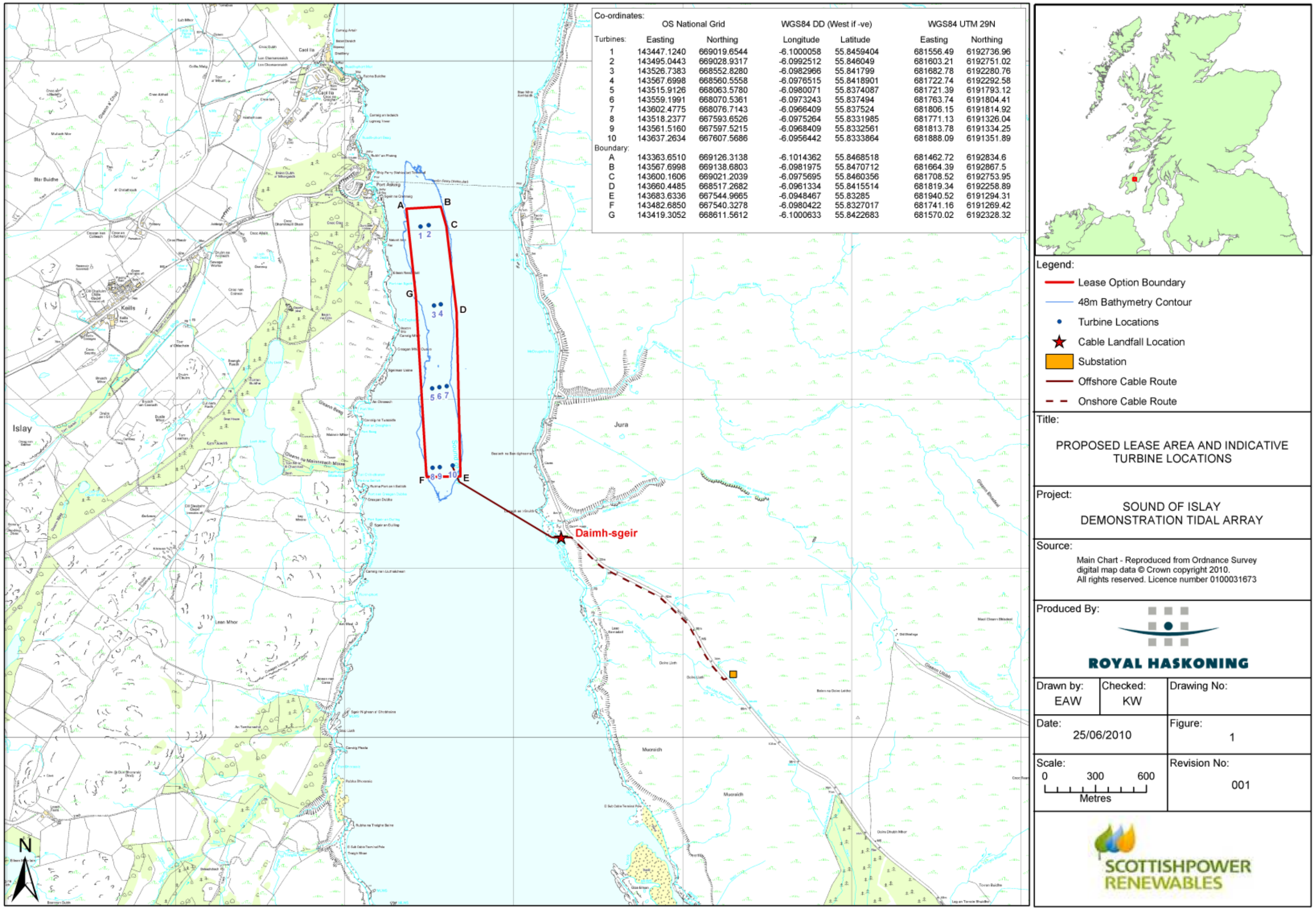
1.6 The proposed project will see ten 1MW devices installed in deep water (>48m) on an area of the seabed within the Sound of Islay, just south of Port Askaig. These will then be linked by seabed cable (indicated on Figure 1) to Jura, to connect to the grid (via a substation; indicated on Figure 1).

1.7 Flow modelling has been carried out in the Sound of Islay and this has been used to inform the design of the turbine layout. The ten turbines will be arranged so that they are spread out in four rows, the split being 2/2/3/3 from north to south of the Sound. The flow modelling work has determined that the optimum spacing for the turbines at this location is in the order of 1.5 diameters laterally and 20 diameters downstream.

1.8 Hammerfest Strøm UK (HSUK) is currently developing a 1MW demonstration tidal stream generating device to be deployed in Scotland, initially at the EMEC test facility on Orkney. This work builds on the development work undertaken for the Hammerfest Strøm AS device in Norway where a 300kW scale device has been successfully designed, built and operated for approximately 4 years.

1.9 The HS device is a fully submerged, bottom mounted, rotor, variable pitch turbine, similar in arrangement to a horizontal axis wind-turbine. The nacelle houses the turbine, gearbox, generator and associated components. The nacelle is attached to the tripod support structure and does not yaw like a traditional wind turbine. Figure 2 provides an illustration of the device.

1.10 The pitch of the rotors is variable, to present the most efficient angle of incidence to the oncoming flow, thereby generating the maximum energy from the flow at any given flow speed. When the tide reverses, the rotors alter pitch so that the turbine can extract energy from the flood, as well as the ebb tide. The turbine rotates in the opposite direction on the ebb tide.



Co-ordinates:

	OS National Grid		WGS84 DD (West if -ve)		WGS84 UTM 29N	
Turbines:	Easting	Northing	Longitude	Latitude	Easting	Northing
1	143447.1240	669019.6544	-6.1000058	55.8459404	681556.49	6192736.96
2	143495.0443	669028.9317	-6.0992512	55.846049	681603.21	6192751.02
3	143526.7383	668552.8280	-6.0982966	55.841799	681682.78	6192280.76
4	143567.6998	668560.5558	-6.0976515	55.8418901	681722.74	6192292.58
5	143515.9126	668063.5780	-6.0980071	55.8374087	681721.39	6191793.12
6	143559.1991	668070.5361	-6.0973243	55.837494	681763.74	6191804.41
7	143602.4775	668076.7143	-6.0966409	55.837524	681806.15	6191814.92
8	143518.2377	667593.6526	-6.0975264	55.8331985	681771.13	6191326.04
9	143561.5160	667597.5215	-6.0968409	55.8332561	681813.78	6191334.25
10	143637.2634	667607.5686	-6.0956442	55.8333864	681888.09	6191351.89
Boundary:						
A	143363.6510	669126.3138	-6.1014362	55.8468518	681462.72	6192834.6
B	143567.6998	669138.6803	-6.0981975	55.8470712	681664.39	6192867.5
C	143600.1606	669021.2039	-6.0975695	55.8460356	681708.52	6192753.95
D	143660.4485	668517.2682	-6.0961334	55.8415514	681819.34	6192258.89
E	143683.6336	667544.9665	-6.0948467	55.83285	681940.52	6191294.31
F	143482.6850	667540.3278	-6.0980422	55.8327017	681741.16	6191269.42
G	143419.3052	668611.5612	-6.1000633	55.8422683	681570.02	6192328.32

Figure 1: Proposed Lease Area and Indicative Turbine Locations

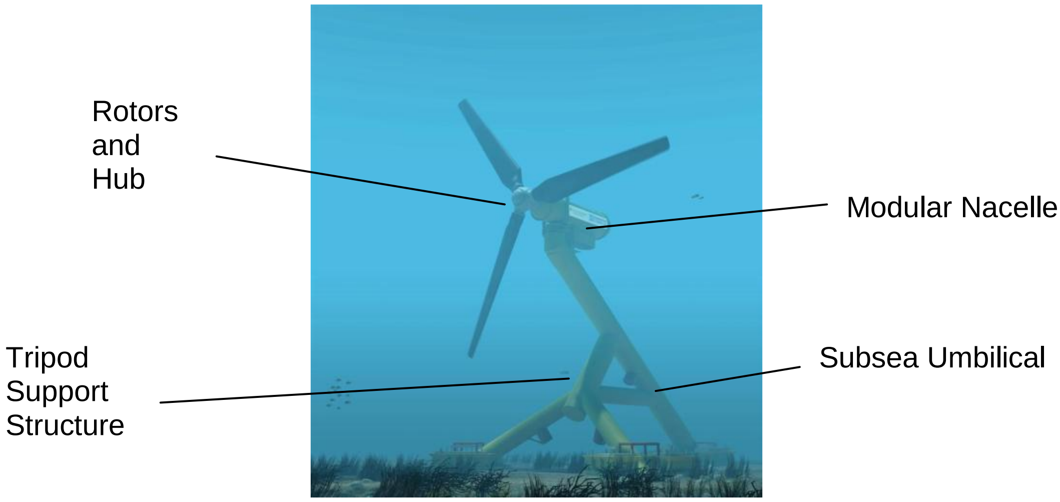


Figure 2: A schematic of the 300kW device

1.11 The tripod support structure dimensions are 15m (W) x 22m (L) and the nacelle will sit on the substructure with a hub height of 22m from the seabed.

1.12 A rotor diameter of 23m will give the device a total height from the seabed of approximately 33.5m. The siting of the devices in areas that have a minimum water depth of 48m will ensure that there is sufficient clearance draught to enable vessels to use the Sound unaffected by the turbines.

1.13 A tripod base, fixed to the seabed using gravity ballast in the legs, will support the nacelle and the rotor structure. Deployment of the Development in the Sound of Islay will allow tidal array deployment in a relatively sheltered environment, providing learning that will assist in developing effective procedures for installation of the devices in more energetic marine environments, such as the Pentland Firth.

1.14 The 1MW device to be used in the Sound of Islay is being designed to have a generating voltage of 6.6kV. The site will have up to 2 subsea cables laid from the array to the selected landfall point onshore. Subsea cables will also be used to connect the turbines together. The preferred cable landing site is on Jura as shown in Figure 1.

1.3 The Need for Renewable Energy

1.15 The central aim of UK Government energy policy is to establish a supply of energy that is diverse, sustainable, secure and is offered at competitive prices. Key to this goal is an 80% reduction of carbon dioxide (CO2) emissions by 2050 (Section 1 of the Climate Change Act 2008). The development of renewable energy plays a primary role in UK Government strategy for carbon reduction and has set a target that 20% of the UK's electricity supply should come from renewable sources by 2020 (Energy Review, 2006).

1.16 UK Government targets for renewable energy will help the UK to meet its international obligations, but also obtain greater security of energy supply through the promotion of indigenous electricity generation.

1.17 The Scottish Government has more ambitious targets than Westminster and is keen to achieve a target of 50% or energy from renewable sources by 2020. Plans are developing to ensure that marine renewable energy sources wave, tidal and offshore wind will make a full contribution to meet this target.

2.0 Regulatory Requirements and the Environmental Impact Assessment Process

2.1 Regulatory Consents

2.1 A number of consents are required for the construction and operation of the Development. The Marine Scotland Licensing Operations Team (LOT) is leading the consents process.

2.2 SPR has applied for the following key consents:

- Consent under Section 36 of the Electricity Act 1989 to construct and operate the tidal array, including all ancillary infrastructure;
- Licence under Section 5 of the Food and Environment Protection Act (FEPA) 1985 to deposit materials such as the turbine foundations and the subsea cables on the seabed. Marine Scotland, which takes responsibility for protecting marine ecosystems, is the consenting authority for the FEPA licence; and
- Consent under Section 34 of the Coast Protection Act (CPA) 1949 in order to make provision for the safety of navigation in relation to the export cables.

2.2 Details of Programme

2.3 Subject to all consents for the project being received during 2011, the Development will be constructed during 2013.

2.3 The Need for Environmental Impact Assessment

2.4 The proposed Development in the Sound of Islay is subject to an EIA, as required under the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000. The ES for the Development has been carried out in accordance with these regulations.

2.4 The Environmental Impact Assessment Process

2.5 EIA is a tool for systematically examining and assessing the impacts and effects of a development on the environment. The resultant ES contains:

- A description of the development, including any alternatives considered;
- A description of the existing environment at the site and surrounding areas;
- A prediction of the potential impacts on the existing human, physical and natural environment at the site and assessment of subsequent effects;
- A description of mitigation measures to avoid or reduce such effects; and
- A Non Technical Summary (This document).

2.5 Scoping and Consultation

2.6 A scoping exercise was carried out to identify the main issues that needed addressing as part of the EIA. Consultation as part of this process included statutory and non statutory bodies representing key interests and user groups on Islay and Jura and the wider area. Consultation and liaison continued throughout the EIA and is ongoing.

2.7 There have been a number of public exhibitions, consultations and meetings (including information distribution on the Islay Energy Trust Website) throughout the EIA process. Consultation has been undertaken in relation to specific receptors such as fisheries and navigation, as required.

2.6 Public opinion of the proposals

2.8 General opinion from the public has been positive with a proportionally small number of negative views. The main concern for the public has been focused on potential impacts on fisheries and perceived danger to fishery areas.

2.7 Original Data Collection and Surveys

2.9 The following surveys were undertaken as part of the EIA:

- Geophysical survey to understand the characteristics and features on the surface and subsurface of the seabed (ADCP, AWCP and geophysical);
- Drop down video survey work to establish seabed characteristics
- Metocean survey
- Land based bird and marine mammal visual observations;
- Fish surveys and observer trips on local fishing vessels;
- Activity survey of local fishermen;
- Landscape, seascape and visual impact assessment;
- Marine traffic survey;
- Archaeological assessment of both the sound and land surrounding the area; and
- Terrestrial and intertidal ecological survey.

3.0 Effects of Assessment and Mitigation

3.1 Impact identification and evaluation was carried out via a number of standard methods and techniques agreed during scoping and consultation. Due to the embryological nature of the technology there are areas where baseline information is still relatively unknown. The significance of residual effects has been assessed for each of the assessment chapters. Where possible this has been based on quantitative evidence; however, where it has not been possible to quantify effects they have been assessed qualitatively based on the best available knowledge and professional judgement.

3.2 Standardisation of the significance criteria generally leads to a common classification of the significance of effects. These are classified as Major, Moderate, Minor or Negligible. Effects are also described, where appropriate, according to whether they are Adverse, Neutral or Beneficial.

3.3 The potential impacts for each issue related to the Development have been produced with regards the following:

- Extent and magnitude of the impact (Table 1);
- Duration of the impact (short, medium or long-term);
- Nature of the impact (direct or indirect; reversible or irreversible);
- Whether the impact occurs in isolation or is cumulative in nature;
- Sensitivity of the receptor (Table 2);
- Whether the effects are positive or negative; and
- The level of mitigation that can be implemented to avoid, reduce or offset the effect.

TABLE 1 MAGNITUDE OF IMPACT	
Magnitude	**Description**
High	A fundamental change to the baseline condition of the receptor.
Medium	A detectible change resulting in the non-fundamental temporary or permanent condition of a receptor.
Low	A minor change to the baseline condition of the receptor (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

TABLE 2 SENSITIVITY OF THE RECEPTOR	
Receptor Sensitivity	**Description**
High	Environment is subject to major change(s) due to impact. For example, sites contain features of international or national conservation or cultural designation, or permanent reduction of anthropogenic activity such as fish landings
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. For example sites contain features of national or regional conservation or cultural designation, permanent modification of anthropogenic activity.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example sites of local conservation or cultural value or temporary modification of anthropogenic activity.
Negligible	Environment responds in minimal way to effect such that only minor change(s) are detectable. For example sites contain features of local interest, little or no change to anthropogenic activity.

3.4 Sensitivity criteria can be based both on the degree of environmental response to an impact, as well as the 'value' of the receptor. The sensitivity for each impact is determined by consideration of at least one of the following points:

- Comparison with Regulations or standards e.g. British Standards;
- Compliance with policy, plans and guidance documents e.g. Local Plan;
- Reference to criteria such as protected species, designated sites and landscapes;
- Consultation with stakeholders; and
- Experience and professional judgements by specialists on environmental sensitivity.

3.5 A detailed description of the criteria used to assess sensitivity or value for each receptor is provided in the relevant assessment chapter.

3.6 By combining the magnitude of the impact and the sensitivity of the receptor in a matrix (Table 3) the final significance of the effect (prior to the implementation of mitigation measures) can be obtained. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being significant.

TABLE 3 IMPACT SIGNIFICANCE MATRIX

Magnitude of Impact	**Receptor Sensitivity**			
	Negligible	**Low**	**Medium**	**High**
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

3.7 Due to the differences between the individual technical assessments throughout this ES there is no specific definition that can be applied. Therefore, each receptor has its own impact assessment and defines the criteria for the level of residual effect. Where it has been possible to do so this has been based upon accepted criteria, as well as by employing expert interpretation and value judgements.

4.0 Summary of Environmental Impacts

4.1 Introduction

4.1 The following sections summarise the potential environmental impacts associated with the Development, as detailed in the ES. Impacts on the following environmental parameters have been assessed, with mitigation requirements included where necessary.

4.2 Marine Fish/Shellfish

4.2 There have been no physical surveys completed for fisheries within the Sound of Islay for the Development. Data for the impact assessment is based upon data and fisheries statistics from Marine Scotland, DEFRA, CEFAS, UKOOA and the International Council for the Exploration of the Sea (ICES), with drop down video surveys completed for both the array and the proposed cable route, as well as substantial consultation with local fishermen, fishing management bodies and the local community.

4.3 The main potential impact on fish is considered to be the noise generated from construction activities, in particular from turbine placement and cable installation. The main noise production will be from DP installation vessels and workboats and the operation of machinery on the vessels themselves. The main potential receptor species identified is herring, a species of fish particularly sensitive to noise; however, sediments favoured as a spawning habitat by herring are not present in the Sound of Islay.

4.4 Potential impacts during operation of the Development include underwater noise and vibration, fish aggregating effects of the structures within the Development and the influence of electromagnetic fields on sensitive species. On assessment, all these issues are expected to be of negligible or no significant effect.

4.5 The construction methodology aims to minimise smothering effects. It is assessed that the Development will have, at worst, negligible adverse effects on marine fish and shellfish resources.

4.6 The potential for the Development to act as a physical barrier to the movement of fish is also considered and its significance is assessed as minor adverse.

4.3 Anadromous Fish

4.7 Surveys were completed for migratory and anadromous fish populations in potential natal rivers adjacent to the Sound of Islay in particular for salmonids (sea trout and salmon).

4.8 Local salmon fishery associations were consulted alongside Marine Scotland (Pitlochry) to ensure all viable records about migratory and anadromous populations were considered.

4.9 There is no evidence to suggest that anadromous fish use or transit the waters of the Sound of Islay. Furthermore, survey has shown that watercourses on Islay and Jura adjacent to the Development have limited potential to support anadromous fish populations. A precautionary approach to assessment has been taken, and it has been assumed that migratory fish species do make use of the Sound, although the Sound is not considered to be a site of particular importance for anadromous fish.

4.10 Few studies have considered specifically the effects of offshore renewables installations on anadromous fish species. However, available information has been reviewed and indicates that any effects on such species would be negligible.

4.4 Elasmobranchs

4.11 The proposed Development is unlikely to significantly impact elasmobranchs overall.

4.12 Collision could theoretically impact basking sharks and although the potential magnitude of this impact is considered to be low, given the high importance of this species, the significance of this effect has been assessed as moderate. All other impacts have been assessed as being of negligible significance.

4.13 To manage potential impacts and inform mitigation post installation monitoring for elasmobranchs could be combined with marine mammal monitoring. Whilst no mitigation is planned at this stage of the Development, monitoring will allow the significance of collision risk to be continually assessed and if required, appropriate collision mitigation will be implemented.

4.5 Ornithology

4.14 Under the terms of the EIA regulations it is concluded that the likely effects of the proposed development on all bird species are not significant. The available information indicates that the Development will not, either alone or in combination, have a significant effect on any classified or proposed SPAs. Disturbance to important assemblages of birds is considered as negligible with appropriate mitigation in place through all phases of the development.

4.6 Commercial Fisheries

4.15 There has been extensive consultation completed with local fisherman regarding the Development.

4.16 Due to the nature of the local physical environment, commercial fishing within the Sound of Islay is limited to the use of static gears. Fishing for crustacean species such as velvet swimming crab, brown crab, and lobster is practiced by approximately 10 fishing vessels, with concentrated effort occurring during the winter and spring months.

4.17 Concerns from local fishermen focused on loss of fishing area and navigational issues relating to entanglement and loss of boats and equipment. (Navigation is considered within a separate Navigational Safety Risk Assessment). Impacts of the proposed Development are deemed to range between minor adverse and minor beneficial levels providing the appropriate mitigation measures are implemented.

4.7 Terrestrial Ecology

4.18 The assessment of impacts on terrestrial ecology is based on two cable land fall locations at Daimh-sgeir. Except for otters and terrestrial habitat loss, significance of effect on terrestrial and intertidal receptors is assessed as negligible or no significant effect during construction, operation (including maintenance), and decommissioning of the onshore elements of the Development.

4.19 For otters, several feeding areas and potential holt sites have been identified within a 2km radius of the potential land fall site. Further otter surveying is proposed once the final footprint of cable landfall is confirmed to inform the need for a European Protected Species (EPS) licence from the Scottish Government should a holt or resting site be located within the footprint of the cable route. No potential resting sites have been recorded at the current proposed landfall site; however, feeding otters have been recorded there.

4.20 A worst case scenario assesses the significance of effects to otters to be moderately adverse, reduced to minor adverse with mitigation.

4.21 Approximately 1400m of cable will be routed across wet heath habitat, the dominant habitat type for the surrounding area. However, this cable route will run immediately adjacent to, and in the disturbance footprint of, an existing road that crosses the wet heath and disturbance and impacts are considered to be of minor adverse significant effect.

4.8 Transport and traffic

4.22 The Sound of Islay has a number of ferry routes which are of high importance to the local community. During construction, the Development could cause a relatively high level of disruption; however, this will be temporary, and with careful planning and mitigation, these effects can be reduced to minor / no significant effect.

4.23 The onshore traffic and transport facilities on Islay and Jura may be affected temporarily during construction. However, due to the high capacity of the roads in relation to the predicted levels of work traffic and the delivery of equipment and materials by boat directly to Jura the impacts are expected to be of negligible significant effect.

4.9 Tourism, recreation and socio-economics

4.24 The Development will bring with it minor beneficial socio-economic benefits. A small number of local jobs may be created during the construction of the project, and there will be a temporary increase in local spend associated with the installation phase, as well as ongoing spend associated with operation and maintenance.

4.25 SPR is working with the IET to maximise the potential benefits to the local community. This includes identifying opportunities for local businesses and liaising with stakeholders to minimise the impacts.

4.26 Tourism and recreation are vitally important to the economy and the communities of Islay and Jura. The Development is not expected to have any significant long term adverse effect on existing marine and coastal activities, or on visitor numbers / visitor experiences. Any negative effects will be short-term and limited to the construction phase. With mitigation, the significance of effect is assessed to be at worst minor adverse during construction and negligible during operation.

4.27 The Development will create a new attraction for Islay and Jura, increasing the islands' profiles for renewable energy and wet renewable development, with assessed minor beneficial significance to tourism and the local community.

4.28 The project will supply approximately the equivalent of Islay's electricity demand on average. ScottishPower has an agreement with Diageo to supply electricity to three of their facilities on Islay; namely the distilleries at Caol Ila and Lagavulin, and the malting at Port Ellen.

4.10 Munitions and Military

4.29 The Development is located outside of any designated military areas and submarines are not expected to use the site. During construction there may be minor disruption to military vessels operating near the Sound of Islay in adjacent PEXAs; however, ongoing communication with the Defence Estates and subsequent scheduling of works at the tidal site will ensure coordination of any potentially conflicting activities. The implementation of the safety procedures identified in the Navigational Safety Risk Assessment will reduce the significance of effects to negligible.

4.30 There are no known unexploded munitions within or near to the Sound of Islay. It is also unlikely that munitions from official disposal sites could migrate into the Sound of Islay, with the nearest site over 100 km away. Should any unexpected munitions be encountered at the Development the works will cease, contractors will leave the site and MoD and emergency services will be consulted as necessary. The significance of effect here is assessed as negligible.

4.11 Air Quality

4.31 Air quality impacts are only likely to arise during construction / decommissioning of the onshore works, based on impact to sensitive receptors (i.e. points where the public are likely to be regularly present and exposed for a period of time). The local population living close to the area where the cable will come ashore is minimal, with only 2 residences located close to the Feolin – Port Askaig ferry terminal. It is anticipated that the increase in traffic on the local road network and dust emissions during construction will be of negligible significance.

4.32 Machinery used in the onshore construction phase could cause an impact on air quality in the immediate vicinity of the works; however, the impacts will be local and short term lasting for the duration of construction only. They are assessed as being of negligible significance.

4.12 Physical Processes

4.33 The physical environment and coastal processes within the study area is dominated by strong tidal flows through the Sound of Islay, the form of which is the result of previous glacial activity and subsequent sub-aerial weathering and erosion, leading to the landscape today.

4.34 The impacts of the Development on the physical environment and coastal processes are deemed to be of negligible significance due to the limited scale of the footprint of the array, and the low amount of energy that is to be extracted during operation.

4.35 Changes due to the presence of the seabed structures are considered to be less than those experienced due to the natural variation in both the seabed and shoreline. The Development will have a negligible significant effect on the hydrodynamic sedimentary regime within the Sound of Islay.

4.13 Benthic Ecology

4.36 A number of surveys were carried out to characterise the biological environment of the site, and in and around Sound of Islay. The site was typical of the region and characterised by patches of coarse gravel and rocky substrate with typical species and plants found within the site. No species of conservation significance were present, and those species present are considered to be well adapted to living in a dynamic, high energy environment. The intertidal areas within the vicinity of the proposed cable landfall locations are a mixture of solid bedrock and steeply inclined boulder and gravel beaches typical of the high energy environment.

4.37 Indirect impacts from sediment disturbance and smothering resulting from construction activities are considered to be of negligible significance, species found within the Sound of Islay are common to this part of Scotland and tolerant of high energy environments.

4.38 Post construction there is the potential for habitat alteration to occur around the foundation structures. Foundations are expected to be readily colonised by local species from adjacent areas and may cause a localised increase in biodiversity, feeding opportunities and refuge habitats for a range of species.

4.39 The direct impact on habitats and species through the installation of foundation structures, subsea cables and associated infrastructure are considered to be of short term duration and negligible significance.

4.14 Marine mammals

4.40 The Inner Hebrides are known to support a range of marine mammals including harbour porpoise, species of whale and common and grey seal. Whilst not considered common in comparison to other areas of the UK, there have been infrequent recordings of marine mammals in the vicinity of Sound of Islay. Low numbers suggest that the Sound of Islay is not highly significant to populations of marine mammals.

4.41 There will be effects caused by impacts from noise and vibration during construction and operation. In general these potential effects are considered to be minor or negligible, but when considering collision risk and possible barrier effects they are assessed as moderate (reduced to minor with implementation of the proposed deploy and monitor strategy discussed below) as a result of unknowns regarding the Development and the associated behaviour of marine mammals.

4.42 There is potential for disturbance to European Protected Species (EPS) and any deployment would require granting of a licence to disturb.

4.43 A deploy and monitor strategy will be developed to support the deployment, with the following key components:

- Application for a license to disturb marine mammals to Marine Scotland;
- Establishment of key monitoring questions relating to the deployment and anticipated potential effects on marine mammals; and
- Commitment by SPR to put in place any mitigation reasonably required by the results of monitoring.

4.44 SPR is in consultation with SNH and Marine Scotland on the development of both monitoring and mitigation measures.

4.15 Onshore Noise

4.45 Noise effects may arise from machinery involved in the excavation of the cable landfall. Impacts through elevated noise levels during installation of the onshore works have been assessed as temporary in nature and short term. Noise impacts could affect local receptors around the landfall site during construction; however, the proposed landfall locations are distant from any locally substantial areas of population, with no residents around the landfall location.

4.46 Due to the distance offshore of the Development there will be minimal impact from the offshore construction activity or operation on residents.

4.47 Delivery of materials for the onshore construction works may pass close to a small number of residential properties at the Jura site. Mitigation measures will be put in place to reduce noise impacts and an overall impact of negligible significance is predicted.

4.16 Water and Sediment Quality

4.48 There has been limited anthropogenic input to the environment within the Sound of Islay, which combined with the high energy environment and lack of sedimentary substrate that has the potential to hold contaminants have led to a reasonable assumption that sediment quality is good.

4.49 From extensive water quality monitoring carried out by SEPA, water quality in the Development site is good. The main impacts from the proposed Development would relate to accidental spillages of materials during construction, operation (including maintenance) and decommissioning. The magnitude of potential spills within the Sound is assessed as being low, in a medium sensitivity environment, resulting in impacts assessed as minor significance. Similar impacts were predicted for construction, operation and decommissioning. Current best practice will be adhered to for site management such as CIRIA Guidance note C650 or SEPA PPG5. The environment of the Sound is such that even if small spillages occur materials will be quickly dispersed and be of very minor significance.

4.17 Landscape, Seascape and Visual Impact Assessment

4.50 The Sound of Islay covers a range of different landscape and seascapes, from high moorland plateau to coastal ridges, and the Isle of Jura is designated as a National Scenic Area (NSA).

4.51 There would be a moderate significant effect on views from the Dunlossit Estate on Islay, the Kennacraig to Port Askaig ferry and from the Jura road south of Feolin during construction. However, these impacts would be temporary lasting approximately 3 months. There would be no significant impacts on views during the operational phase.

4.52 In terms of designations the proposal would not compromise the objectives of the NSA designation (which are taken to be the special qualities identified in Scotland's Scenic Heritage and new work recently undertaken by SNH) or the overall integrity of the Jura NSA. There would be no significant effect on the Area of Panoramic Quality.

4.18 Shipping and Navigation

4.53 A Navigational Safety Risk Assessment (NSRA) was carried out to identify the impact of the Development on shipping and navigation within the Sound of Islay. Whilst not considered as a standalone chapter (being, instead, a technical appendix) it is required to be assessed due to the nature of vessel movement within the area, especially for fishing vessels.

4.54 The Sound of Islay is located away from the main shipping route in the area (i.e. the Minch and routes to the Atlantic and Outer Hebrides). There are a number of potential navigational risks associated with both the installation and the operational phases of Development. In particular, the NSRA found that the methodology proposed for installation, using a DP vessel, is considered to be "Tolerable with Monitoring" subject to the application of controls.

4.55 During operation and maintenance the risks to navigation were also considered to be "Tolerable with Monitoring".

4.56 Controls to be established include the development and implementation of an appropriate Safety Management System covering the construction, operation (including maintenance) and decommissioning phases of the Development.

4.57 The area of the Development will be charted appropriately subject to a review of the issues involved with the UKHO. Individual devices or sub arrays will also need to be charted appropriately, subject to the limitations of the scale of the chart, and the need to avoid congestion of information.

4.58 Application will also be made be made for the area containing the array to be designated and charted as a “No Fishing and No Diving” area.

4.19 Cultural Heritage

4.59 An archaeological assessment was undertaken to determine the potential for submerged artefacts, wrecks and coastal remains within the area of the Development and wider Sound of Islay, using geophysical data. A number of wrecks were identified, but none were within the Development site.

4.60 All relevant cultural heritage assets known have been identified and the potential for unknown remains also discussed. Five distinct impacts of negligible to major significance have been identified. Mitigation has been outlined which is considered to completely mitigate residual impacts, and which has the potential to result in positive impacts in some cases.

5.0 Conclusion

5.1 Overall, with implementation of the stated mitigation measures by SPR, combined with ongoing dialogue with interested stakeholders and the Regulatory Authorities, it is predicted that Sound of Islay should not have any unacceptable long term impacts.

5.2 For some key potential impacts, particularly relating to marine mammals and some elasmobranchs, the establishment of a 'deploy and monitor' strategy is proposed. Key elements of this strategy will be application for a licence to potentially disturb European Protected Species (EPS), establishment of a series of monitoring measures aimed at answering key questions about behaviour of, and effects on, key receptors, a commitment to put in place any mitigation that is indicated by the results of monitoring.

5.3 The project will make a significant contribution to national targets for renewable energy generation and is a key project to demonstrate the potential to harness tidal power in Scotland.

6.0 Further Information

6.1 Copies of the Environmental Statement (ES) are available for public viewing at the following locations within normal opening times:

- Argyll and Bute, Islay, Council Office, Jamieson Street, Bowmore, Isle of Islay, PA43 7HP.
- Islay Energy Trust, Custom House, Main Street, Bowmore, Isle of Islay, PA43 7JJ
- Jura Servicepoint, Schoolhouse, Craighouse Isle of Jura, PA60 7XG
- Scottish Government Library at Saughton House, Broomhouse Drive, Edinburgh, EH11 3XD.

6.2 Copies of the Environmental Statement may be obtained from: ScottishPower Renewables (UK) Limited (Tel: +44 141 568 2153) at a charge of £300 for a hard copy and £20 on CD (as PDF files for screen viewing only). Copies of a short non-technical summary (NTS) are available free of charge.

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Confidential Appendix	Appendix Title
14.2	Confidential Annexe to Sound of Islay Bird Report 2010

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1. Introduction

1.1 Background

1.1. ScottishPower Renewables (UK) Limited (hereafter referred to as ScottishPower Renewables or SPR), is wholly owned by Iberdrola Renovables S.A., the global leader in wind energy. At the end of 2009 Iberdrola Renovables S.A. had 10,752MW of global installed capacity, nearly 97% of which is wind. Of this capacity, 802MW was owned and operated by SPR, making it the leader in onshore wind in the UK.

1.2. SPR aims to continue to expand its renewables capacity in the UK order to help the Scottish and UK Governments to meet their 2020 electricity generation targets from renewable sources. This includes the development of some of the newer renewable technologies including wave and tidal renewables.

1.3. SPR wishes to construct, install and operate a demonstration tidal array within the Sound of Islay (Figure 1.1) (hereafter referred to as "the Development"). The Development will utilise the tidal flow running through the Sound to power tidal turbines during the flood and ebb tidal flows and generate electricity throughout these flow periods. The Development will comprise of up to 10, 1MW tidal turbines, which will be owned and operated by SPR.

1.4. The proposed Development could be the first tidal array in UK waters and it will deliver power directly into the National Grid. This will assist both the Scottish and UK Governments in meeting their future energy targets and their reduction of greenhouse gas emissions. The Development capacity of 10MW equates to an average production of 26.3GWh p.a., which is enough to supply over 5500 average domestic households (http://www.bwea.com/edu/calcs.html)[1].

1.5. An outline project description including the process involved is provided in *Chapter 5: Project Description*.

1.6. This Environmental Statement (ES) is a description of the process and findings of the Environmental Impact Assessment (EIA) procedure. It is submitted to the Scottish Ministers, along with an application for the proposed Development for consent under Section 36 of the Electricity Act 1989 ('the Act'). Additionally, Coastal Protection Act (CPA) and Food and Environment Protection Act (FEPA) consents will also be sought. The submission of an ES with a planning application is required for certain classes of project under the Environmental Impact Assessment Regulations (Scotland) Regulations 1999. An application for Section 36 consent under the Act comes with deemed planning permission, thereby removing the requirement for a separate planning application.

1.7. The preparation of this ES report is also an integral component in ensuring that the investigation of any environmental impacts of the proposed project is robust and comprehensive. It highlights the key environmental issues that were considered to be associated with the development, and allows an unbiased prediction of their effects and relative significance. This has ensured that these issues were fully addressed and integrated into the final design of the Development. This report will also assist Scottish Ministers and Argyll and Bute Council in reaching a decision as to whether permission should be granted for the proposals.

1.2 Brief Description of the Development Site and its Setting

1.8. The Development is to be located within the Sound of Islay, a narrow channel that separates the Isles of Islay and Jura on the west coast of Scotland (see Figure 1.1). The tidal resource of this channel is recognised as one of the best on the west coast of Scotland and is a preferred location for the first array of its kind as the local topography of the area provides an optimised working environment due to its shelter from westerly storms that are prevalent elsewhere along the coast.

1.9. The array will take advantage of the Hammerfest HS1000 tidal turbine technology (Figure 1.2), a fully submerged tripod mounted 1MW rated device, which will be deployed within the Sound of Islay at depths greater than 48m. The device is designed to generate electricity when the tidal flow rotates the turbine. It is capable of generating during the flood and ebb phases of the tidal cycle.

Figure 1.2: Representation of the tidal device to be installed in the Sound of Islay as part of the demonstration array

1.3 Proposed Development

1.10. The Development is described in detail in *Chapter 5: Project Description* and summarised here.

1.11. The Development comprises an array of 10 tidal turbines (Hammerfest HS1000) arranged below the 48m bathymetric contour (with the shallowest turbine being located in 50m of water) in the Sound of Islay, a channel of water between the islands of Islay and Jura. The turbines will comprise of a tripod substructure supporting a nacelle and three-bladed rotor turning about the horizontal axis – bearing much similarity with a modern wind turbine. However, the rotor diameter will be considerably smaller than a wind turbine, at only 23m. The maximum height to blade tip from the seabed is 33.5m. This will allow a minimum clearance from the surface of the water to the top of the blade of 16.5m.

1.12. The turbine to be employed for the purposes of the Development is the Hammerfest Strøm HS1000.

1.13. In addition to the turbines there will be some ancillary structures involved in the proposed Development. These include cabling to the island of Jura and a subsequent connection to a substation located there.

1.14. The operational life of the Development will be for a minimum of 7 years, with a potential extension of a further 7 years (totalling 14 years). After this there will be a decommissioning plan in place to remove the turbines and associated infrastructure; however, there may be the option at that time to gain further consent to extend the project beyond its 14 year life.

1.15. The Development will require a grid connection, which will be subject of a separate Section 37 consent under the Electricity Act 1989. This will be conducted separately to this EIA process and will not be considered further here.

[1] Note: This has been calculated using windfarm figures as none are currently available that are specific to tidal technology.

1.16. A description of the design and is provided in *Chapter 4: Site Selection* and a full description of the Development is provided in *Chapter 5: Project Description*.

1.4 Renewable Energy

1.17. Global Climate Change is seen as being one of the greatest environmental challenges facing the world today. One of the primary reasons for the current rate of temperature increase is the higher concentrations of greenhouse gasses in the atmosphere. One of the principal gasses is Carbon Dioxide (CO_2) primarily produced through our dependence on the burning of fossil fuels to generate our electricity.

1.18. Renewable energy sources (such as tidal, wave and wind) are infinite resources and create no CO_2 or other air pollutants during operation. Therefore, developments designed to capture such energy resources do not contribute to climate change during operation.

1.19. Renewable energy is an integral part of the UK Government's longer-term aim of reducing CO_2 emissions by 60% by 2050. In 2000 the UK Government set a target to produce 10% of electricity supply from renewable energy by 2010, and in 2006 announced its aspiration to double that level to 20% by 2020 (BERR, 2009). In November 2007 the Scottish Government set a new target to generate 50% of Scotland's electricity from renewable sources by 2020, with an interim target of 31% by 2011 (Scottish Government, 2007).

1.20. The energy produced from the Development would contribute to meeting the Scottish Governments target of providing 50% of Scotland's energy generation from renewable sources by 2020.

1.21. The Future Generation Group Report 2005: "Scotland's Renewable Energy Potential: Realising the 2020 Target", published by the Scottish Executive on behalf of the Forum for Renewable Development in Scotland (FREDS – a Government/Industry forum) in June 2005. This identifies for the first time that an installed capacity of 6,000MW is required to meet this 2020 target.

1.22. The Development has been proposed, in part, to respond to these requirements for renewable energy production.

1.5 Scotland's Tidal Resource

1.23. According to Scottish Government figures (Scottish Government, 2009) Scotland possesses 25% of the total European tidal resource.

1.24. The UK and Scottish Governments are committed to increasing the proportion of electricity produced through marine renewable sources. Costs remain high at the moment for both wave and tidal projects; however, this is a new industry sector and costs are likely to fall as they have done within the wind sector over the last decade. The experience of early projects will play a key role in promoting cost reduction.

1.6 Benefits in Reduced Emissions of Carbon Dioxide

1.25. The Development will provide significant benefits through the avoidance of fossil fuels for electricity generation. The potential reduction in emissions of CO_2 as a result of the 10 turbine tidal development is estimated to be approximately 11,300 tonnes of CO_2. This assumes that the 10MW tidal development operates at a capacity factor of 0.30 and is based on the calculations on the Renewable UK website (http://www.bwea.com/edu/calcs.html)[2].

[2] Note: This has been calculated using windfarm figures as none are currently available that are specific to tidal technology.

1.7 Planning Policy Context

1.26. The proposed footprint (Figure 1.1) of the Development (marine and terrestrial components) lies entirely within the local authority area of Argyll and Bute.

1.27. The planning policy context of the Development is summarised in *Chapter 6: Planning Policy Context*.

1.8 Environmental Statement Structure

1.8.1 Environmental Statement and Technical Appendices

1.28. This written volume is the main body of the ES (there is also a Non-Technical Summary volume and the various Technical Appendices). It is divided into a number of background and technical chapters detailing the various studies that have been carried out to support the production of the ES. A set of Appendices is also provided giving appropriate additional information to support the chapters. A list of the appendices is provided in Table 2.4 (*Chapter 2: Scoping and Assessment Methodology*):

1.29. SPR have secured a lease option for a substantial new tidal project at Ness of Duncansby in the Pentland Firth. At 95MW this is a major project which, in itself, could be a precursor to even larger developments in that area, although this is outwith the scope of this ES. The Islay Demonstration Tidal Array will provide technical, environmental and commercial learning which will be essential to facilitate the deployment of projects in the Pentland Firth.

1.8.2 Non-Technical Summary

1.30. A separate summary is presented, providing an overview of the Development, site selection and design alternatives, environmental effects and mitigation measures.

1.9 Project Team

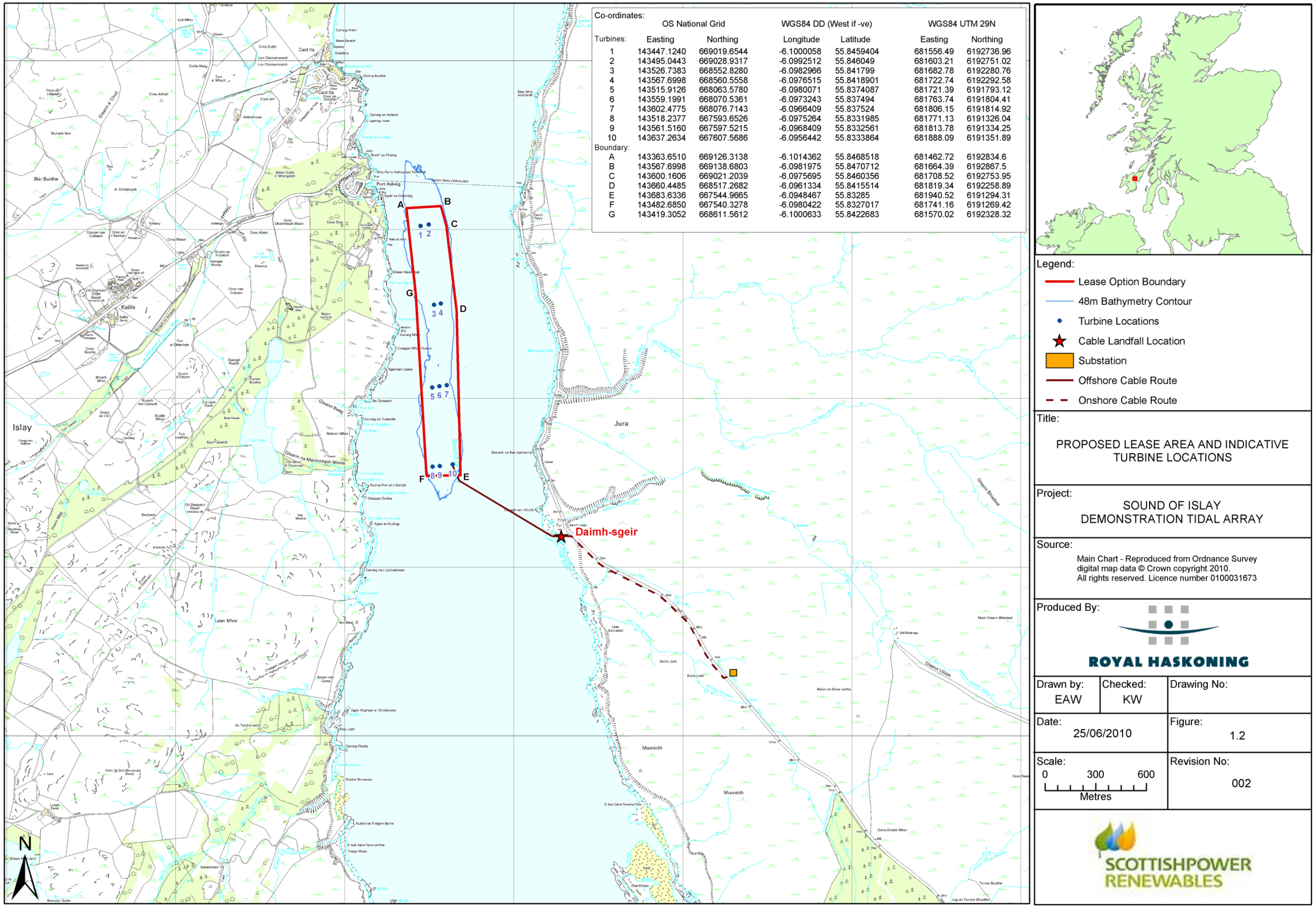
1.31. The ES has been compiled by Royal Haskoning (UK) Ltd. and presents the results of the assessment of environmental effects undertaken by a number of specialist consultants. These consultants are presented in Table 1.2, along with their respective disciplines and contribution to the ES.

1.32.

TABLE 1.2 EIA AND DESIGN TEAM	
Organisation	**Expertise/ES Input**
ScottishPower Renewables	Specialist project consultant to HSUK.
Royal Haskoning (UK) Ltd.	Environmental consultants responsible for the ES production.
Islay Energy Trust	Local knowledge and fisheries consultation.
Natural Research Projects Ltd.	Ornithological studies and report writing as well as marine mammal data gathering.
SeaStar Survey Ltd.	Benthic survey of array footprint.
Headland Archaeology	Cultural heritage assessment and report writing.
Abbot Risk Consulting	Navigational and Safety Risk Assessment and report writing.
Sea Mammal Research Unit	Assessment of the marine mammal data gathered during the course of fieldwork.
Hebridean Whale and Dolphin Trust	Provision of marine mammal data for the wider west coast of Scotland area.
Scottish Association of Marine Science	Underwater noise assessment of the Sound of Islay.
Office and Project Services	Initial archaeological assessment and review of project reports.
CD Campbell Marine Contracts	Technical support to the project throughout fieldwork.
ETA	Cabling assessment for the project.
Garrad Hassan	Flow modelling of the Sound of Islay to assist the turbine placement.

1.10 References

Scottish Government (2009). Renewables Action Plan. Renewable Energy Division, June 2009.



	OS National Grid		WGS84 DD (West if -ve)		WGS84 UTM 29N	
Turbines:	Easting	Northing	Longitude	Latitude	Easting	Northing
1	143447.1240	669019.6544	-6.1000058	55.8459404	681556.49	6192736.96
2	143495.0443	669028.9317	-6.0992512	55.846049	681603.21	6192751.02
3	143526.7383	668552.8280	-6.0982966	55.841799	681682.78	6192280.76
4	143567.6998	668560.5558	-6.0976515	55.8418901	681722.74	6192292.58
5	143515.9126	668063.5780	-6.0980071	55.8374087	681721.39	6191793.12
6	143559.1991	668070.5361	-6.0973243	55.837494	681763.74	6191804.41
7	143602.4775	668076.7143	-6.0966409	55.837524	681806.15	6191814.92
8	143518.2377	667593.6526	-6.0975264	55.8331985	681771.13	6191326.04
9	143561.5160	667597.5215	-6.0968409	55.8332561	681813.78	6191334.25
10	143637.2634	667607.5686	-6.0956442	55.8333864	681888.09	6191351.89
Boundary:						
A	143363.6510	669126.3138	-6.1014362	55.8468518	681462.72	6192834.6
B	143567.6998	669138.6803	-6.0981975	55.8470712	681664.39	6192867.5
C	143600.1606	669021.2039	-6.0975695	55.8460356	681708.52	6192753.95
D	143660.4485	668517.2682	-6.0961334	55.8415514	681819.34	6192258.89
E	143683.6336	667544.9665	-6.0948467	55.83285	681940.52	6191294.31
F	143482.6850	667540.3278	-6.0980422	55.8327017	681741.16	6191269.42
G	143419.3052	668611.5612	-6.1000633	55.8422683	681570.02	6192328.32

Figure 1.1: Proposed Lease Area and Indicative Turbine Locations

2. Scoping and Assessment Methodology

2.1. Introduction

2.1. This chapter of the Environmental Statement (ES) is designed to provide the reader with an overview of the Environmental Impact Assessment (EIA) process, and in particular the EIA requirements as set in place by The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (the "Regulations"; Scottish Executive (2000)).

2.2. This chapter has one technical appendix (Appendix 2.1) containing the Scoping Response from the Scottish Executive.

2.2. General Approach

2.3. The above EIA Regulations state that any development likely to have a significant effect on the environment must be subject to an EIA with the resulting ES submitted alongside the appropriate Section 36 consents application.

2.4. Schedule 1 of the Regulations lists all of the developments for which an EIA is mandatory. Schedule 2 describes those projects for which an EIA is determined on a case-by-case basis by the Scottish Ministers.

2.5. The proposed Sound of Islay Demonstration Tidal Array is classed as a Schedule 2 development – "*(1) a generating station, the construction of which (or the operation of which) will require a Section 36 consent but which is not Schedule 1 development*". If a project is classified as a Schedule 2 development and it is likely to have significant environmental effects due to factors such as its proposed size, location or nature, it is classified as "EIA development" and a mandatory EIA is required. Whether or not a Schedule 2 development is classified as an EIA development can be confirmed via a request to the Scottish Government through a "screening opinion" under Part 2 Regulation 5 of the Regulations. However, on the basis that the proposed demonstration tidal array is a Schedule 2 development, ScottishPower Renewables elected to undertake an EIA without seeking the aforementioned "screening opinion".

2.6. Under the EIA Regulations, an applicant may submit a "Request for Scoping Opinion". ScottishPower Renewables sought a "scoping opinion" re: the Islay tidal development from the Scottish Executive on the 8th August 2008 under Regulation 7. This requested the Scottish Executive to state in writing their opinion on the information that was to be provided within the main text of the ES. This "scoping opinion" was received on 12th January 2009 and the ES has been prepared on this basis. Appendix 2.1 contains the Scoping Opinion.

2.3. EIA Methodology

2.7. EIA is a systematic process, which identifies the issues of proposed works likely to have a significant impact upon the receiving environment. This process includes an assessment of the likely effects and the identification of a range of suitable mitigation options and management measures.

2.8. The assessment is carried out based on the data supplied by the developer proposing the works and the information gleaned from the scoping response and other consultee engagement processes (statutory consultees, stakeholders and public engagement).

2.9. The EIA process is designed to be as transparent as is possible and has a number of distinct stages. These include:

1. **Screening –** this stage determines whether the proposed development is likely to have a significant effect on the environment (see Section 2.2);
2. **Scoping** – this stage involves a formal process requesting an opinion on the proposed development from statutory consultees and coordinated by the Scottish Executive. The scoping process also identifies the existing environmental data present and the key issues at the site, thereby identifying any additional studies that are required for their assessment;
3. **Baseline studies** – this stage identifies the current status of the receiving environment and carries out further desk and field studies as required and/or identified during Stage 2;
4. **Assessment of Impacts** – this stage includes the assessment of the significance of the potential impacts related to the proposed development as well as the proposed mitigation and the resulting residual effects;
5. **Environmental Reporting** – compilation of the ES and the supporting documentation (e.g. appendices and technical reports.); and
6. **Submission and Consenting** – this stage involves the submission of the ES along with the appropriate consent applications. These then go through a determination process with the appropriate consenting body (e.g. Marine Scotland).

2.10. Although the EIA process has to cover the above areas it should be noted that it is designed to be an iterative process rather than a single appraisal of a finalised development design. Therefore, the EIA can then inform the project in order that the most appropriate final design is reached (see *Chapter 4: Site Selection*).

2.11. With respect to the EIA carried out for the Sound of Islay Demonstration Tidal Array the procedure that was followed is shown in Table 2.1.

Table 2.1: EIA Process stages undertaken for the Sound of Islay Demonstration Tidal Array

Stage	Date
Request for a Scoping Opinion	August 2008
Receipt of Scoping Opinion	January 2009
Survey start date	April 2009
Continued consultation	Throughout
Development and finalisation of project design (see *Chapter 4: Site Selection*)	Throughout
Public exhibition	February 2009
Impact assessments, mitigation and residual impact assessment	April 2009 – May 2010
Completion of ES	May 2010
Consent Applications	May 2010
Statutory consultation on the ES	May-July 2010
Second public exhibition	June 2010

2.4. Assessment Methodology

2.12. The ES (the end point of the EIA process outlined in Section 2.3) is based on a number of activities. These include:

- Consultee consultation;
- Consideration of relevant local, regional and national planning policies, guidelines and legislation;
- Development of significance criteria;
- Assessment of alternatives;
- Review of available data already present and not collected directly in relation to this specific ES (e.g. previous Environmental Statements, publicly available information, etc.);
- Surveys (desk-based and field) and monitoring; and
- Modelling (particularly of the tidal flow characteristics within the Sound of Islay).

2.13. The ES not only addresses the direct effects likely to be caused by the development, but also the indirect effects, cumulative effects, short, medium and long term effects, those that are both permanent and temporary and those effects that are beneficial or adverse in nature. Within each of the assessment chapters there are proposed mitigation measures, which have been designed to avoid, reduce or offset the most significant adverse effects of the proposed development. *Chapter 24: Mitigation, Monitoring and Management* provides a summary of the residual effects and mitigation measures for the development.

2.14. Additionally a standard approach, wherever possible, has been taken when outlining the geographical area to be considered in each of the technical chapters. This area usually termed the "study area" is of a different scale depending on the topic of the specific assessment chapter. Other terminology such as "area of interest" and "wider region area" are used to describe different geographical scales, and an explanation of these terms (if/when used) are included in each of the assessment chapters. For example in Chapter 15: Commercial Fisheries this will be:

- The entire Sound of Islay as the "study area";
- The lease Boundary option as the "area of interest"; and
- The area around the Sound which includes the Sound of Jura, the Kintyre peninsula, Colonsay etc. as the "wider region area".

2.15. The project design and EIA process follows a series of stages, which are outlined below:

- Site selection and project initiation;
- Screening – is an EIA required;
- Pre-application discussions;
- Scoping – consultation on the proposed scope to identify the potential effects of the project and the methodology on how these should then be assessed;
- Environmental baseline studies – an establishment of what is there;
- Assessment of the potential effects of the proposed development;
- Mitigation – modify the proposal in order to integrate the mitigation measures and then re-assess the residual effects;
- Production of an ES;
- Submission of consent applications supported by the ES;
- Consultation by the Scottish Government with the appropriate consultees, stakeholders and members of the public;
- Consent application consideration by the Scottish Government;
- Application decision with or without conditions; and
- Implementation and monitoring as required.

2.16. The process of identifying and assessing the environmental effects of the proposed development is iterative and cyclic and runs in parallel with the project design. If any of the potential effects are identified a being adverse in nature then the design can be altered, as and if required, to mitigate these effects. Consultation is ongoing throughout the EIA process and contributes to the identification of effects as well as the mitigation measures to avoid, reduce or offset these effects.

2.17. The Site selection and Scoping processes are detailed in *Chapter 4: Site Selection* and Section 2.5 of this chapter respectively. Due to the requirement for an EIA for the proposed development (as defined in the Regulations) a formal Screening process was not undertaken. The results of all of the environmental baseline studies, the assessment of effects and all of the mitigation measures proposed are outlined in Chapters 7 – 23 of this report, with a summary of all mitigation being outlined in *Chapter 24: Mitigation, Monitoring and Management*.

2.5. Scoping and Consultation

2.18. The purpose of the Scoping process is to identify the principal environmental issues at the earliest possible stage of the development process through the responses that are gained from the consultees. This assists in the appropriate targeting of the assessment studies and the identification of which elements of the development have the potential to cause significant environmental effects.

2.19. Consultation enables mitigation measures to be incorporated into the design of the project, thereby avoiding, reducing or offsetting any environmental effects. SPR identify the consultation process as being crucial to the success of any project and have, therefore, created a specific chapter to cover this topic. Thus, consultation beyond the Scoping process that has been undertaken by the project team is detailed in *Chapter 3: Consultation*. The remainder of this chapter will only deal with responses specific to the Scoping process.

2.20. A formal request for a Scoping Opinion from the Scottish Executive was submitted in August 2008. This took the form of an official Scoping Report with supporting letter requesting opinions on the proposed scope of work and methodologies related to the Sound of Islay Demonstration Tidal Array. The Scoping Report highlighted what, at this early stage in the process, were likely to be the main effects associated with the development and how these effects were proposed to be assessed. A response to this Scoping Opinion was received on the 12th January 2009.

2.21. Table 2.2 lists all of the consultees whose opinion was sought during the Scoping process.

2.22. The Scoping Opinion, which was received on the 12th January 2009, set out the views of the statutory consultees and what they felt the requirements were for the subsequent EIA, including what impact assessments should be undertaken.

2.23. In addition to the opinions of the statutory bodies the views and opinions of non-statutory bodies to the Scoping Report were also sought. These can also be seen in Table 2.2.

Table 2.2: List of consultees approached for a scoping opinion
Approached for a Scoping Opinion by the Scottish Executive
Argyll and Bute Council (incl. Port Authority and Pier Authority)
British Telecom Wholesale
Civil Aviation Authority (CAA)
Chamber of Shipping
The Crown Estate (TCE)
Defence Estates (MoD)
Forestry Commission
Health and Safety Executive (HSE)
Historic Scotland (HS)
Maritime and Coastguard Agency (MCA)
NATS
Northern Lighthouse Board (NLB)
Royal Yachting Association (RYA)
Royal Society for the Protection of Birds (Scotland) (RSPB)
Scottish Government Energy Consents Unit (ECU)
Scottish Government CPA Section 34 Team
Scottish Government FEPA (licensed by Fisheries Research Services (FRS) (now known as Marine Scotland: Science))
Scottish Government Transport Scotland
Scottish Fishermen's Federation (SFF)
Scottish Wildlife Trust
Scottish Environment Protection Agency (SEPA)
Scottish Natural Heritage (SNH)
Western Isles Fishery Trust
Approached for a Scoping Opinion by SPR
Argyll District Salmon Fisheries Board (ADSFB)
Argyll Fisheries Trust

Argyll Marine SAC Management Forum
Department for Business Enterprise and Regulatory Reform (BERR)
British Marine Aggregate Producers Association (BMAPA)
Caledonian MacBrayne Ferries (CalMac)
Islay Energy Trust (IET)
Joint Nature Conservation Committee (JNCC)
Laggan and Sorn (Islay) DSFB
Marine Conservation Society (MCS)
Royal National Lifeboat Institution (RNLI) – Islay
Scottish Federation of Sea Anglers
Scottish Fisheries Protection Agency (SFPA) (now known as Marine Scotland: Compliance)
Serco Denholm (operates Port Askaig to Feolin ferry)
Scottish Surfing Federation
Scottish Canoe Association
Scottish Fisheries Committee
Scottish Water
Scottish Creelers and Divers
Scotways
Scottish Coastal Forum
Sea Mammal Research Unit (SMRU)
Sea Fish Industry Authority
Scottish Southern Energy
Transco
West Highlands and Islands Sailing Club
Islay Community Council
Jura Community Council
Robin Currie (Islay Councillor)
Anne Horn (Islay Councillor)
John Mcalpine (Islay Councillor)
Landowner (c/o Malcolm Younger)

2.5.1. Public Consultation

2.24. Public consultation is a key element of any EIA process and essential to the production of a balanced and comprehensive EIA. Shortly after receiving the "scoping opinion" from the Scottish Executive (based on the statutory consultee responses) a public exhibition was held on Islay at the Columba Centre (Ionad Chaluim Chille Ìle) in Bowmore in February 2009.

2.25. This exhibition provided the local community to respond to the proposal for the tidal development at an early stage prior to the various EIA studies having been commenced. The concerns and issues that were raised at the meeting were fed into the EIA process and the design of the tidal array. A leaflet providing details of the development was available along with copies of the full Scoping Report. Additionally a questionnaire was available to enable the attendees of the exhibition to provide their views on the proposals and request additional information on the development from SPR. A further round of public consultations is also planned after the applications for consent have been submitted.

2.6. Key Issues

2.26. Following the scoping and consultation process re: the Scoping Report there were several key environmental concerns that were identified as requiring detailed assessment during the EIA process and these have been included within this ES. These were:

- Marine Mammals (incl. Otters);
- Ornithology (especially diving birds);
- Marine benthic habitats;
- Terrestrial habitats;
- Commercial fisheries;
- Underwater noise;
- Maritime Navigation;
- Construction traffic;
- Cultural Heritage;
- Landscape and Seascape;
- Fish (especially Elasmobranchs and Anadromous species); and
- Recreational sea users.

2.7. ES Composition

2.27. The ES comprises a number of elements which include:

- A Non-Technical Summary. This is a stand-alone document, although is also included at the beginning of the main ES. It summarises in non-technical language the findings of the ES.

- The ES (this document). This comprises of two principal parts. Chapters 1 – 6 describe the project and the legal and policy framework within which the application will be determined. This includes details of how the project design has evolved through time, especially after various rounds of consultation in order that potential effects can be avoided or mitigated against early on. Chapters 7 – 23 contain the individual assessments relating to the environmental (and other) issues that were identified during the scoping process and/or by SPR. The likely significant effects of the development on these are contained within this portion of the document, along with the proposed mitigation and the residual effects remaining. The full contents of the ES are listed in Table 2.3.

Table 2.3: Contents of the ES

Chapter Number	Chapter Title
NTS	See Paragraph 2.27
1	Introduction
2	Scoping and Assessment Methodology
3	Consultation
4	Site Selection
5	Project Description
6	Planning and Policy Context
7	Physical Environment and Coastal Processes
8	Benthic Ecology
9	Marine Mammals
10	Onshore Noise
11	Marine Fish and Shellfish Resources
12	Anadromous Fish
13	Elasmobranchs
14	Ornithology
15	Commercial Fisheries
16	Terrestrial and Intertidal Ecology
17	Landscape and Seascape
18	Cultural Heritage
19	Transport and Traffic
20	Socio-economics, Tourism and Recreation
21	Water and Sediment Quality
22	Munitions and Military
23	Air Quality
24	Mitigation, Monitoring and Management
Appendices	See Paragraph 2.27

- The Technical Appendix is a single document that contains all of the supporting documentation (e.g. technical reports, survey reports, etc.) that relate to each of the individual assessments. The full list of Appendices is provided in Table 2.4.

Table 2.4: List of Appendices

Appendix Number	Appendix Title
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.
8.1	Islay Demonstration Tidal Array - Site Surveys 2009: Drop-down camera survey report.
8.2	Sound of Islay Proposed Tidal Array Cable Route: Drop Down Video Survey.
9.1	Sound of Islay Demonstration Tidal Array: Marine mammal data for Environmental Statement.
9.2	Report to ScottishPower Renewables on the marine mammal species and basking sharks occurring in the Sound of Islay study region.
9.3	Acoustic characterisation of the proposed Sound of Islay tidal energy site.
9.4	Tidal turbine in Kvalsund, western Finnmark - underwater sound measurements.
12.1	Sound of Islay Demonstration Tidal Array: Salmonid Habitat Survey.
14.1	Sound of Islay Bird Report, 2010
15.1	Additional Statistics.
15.2	Fishermen Interviews – 25th May 2009.
15.3	Commercial Fishing Questionnaire.
15.4	Summary of fishermen questionnaire responses.
16.1	Sound of Islay Demonstration Tidal Array Phase 1 Habitat survey of potential cable routes.
16.2	Sound of Islay Demonstration Tidal Array Inter-tidal survey of potential cable routes.
16.3	Sound of Islay Demonstration Tidal Array Phase 1 Habitat survey of the Isle of Jura.
16.4	Sound of Islay Demonstration Tidal Array Inter-tidal survey of the Isle of Jura.
18.1	Gazetteer and Concordance.
18.2	Sources Consulted.
18.3	Shipwrecks recorded in the Sound of Islay derived from Moore and Wilson 2003.
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).
18.5	Vertical aerial photographs consulted in the Royal Commission of Ancient and Historic Monuments search room.
19.1	Navigational Safety Risk Assessment for ScottishPower Renewables (UK) Limited: Proposed Demonstration Tidal Site, Sound of Islay.

2.28. In addition, the following confidential appendix is available for view by appropriate bodies:

- Appendix 14.2 Confidential Annexe to Sound of Islay Bird Report 2010.

2.8. Structure of Technical Chapters

2.29. Where practicable a standard approach has been taken to the structure of each of the technical chapters. However, there are some chapters that have not lent themselves to this structure (e.g. Cultural Heritage) and have been treated individually.

2.9. Effect Assessment and Mitigation

2.30. The Impact Assessment section within each of the technical chapters considers the identified potential effects of the development on the baseline conditions present during the construction, operation, maintenance and decommissioning phases of the development.

2.31. The significance of each effect is discussed and any mitigation measures that are appropriate to reduce this significance level. These mitigation measures aim to avoid, reduce or offset the most significant adverse effects of the proposed development and there is a commitment from SPR that they will be implemented where possible during the appropriate phase (e.g. construction, operation [including maintenance] and decommissioning) of the development.

2.32. Throughout the design process a number of mitigation measures have been identified and implemented to avoid, reduce or offset effects, even where these were not deemed to be significant. Therefore, some of the mitigation measures that have been identified throughout the assessment chapters do not necessarily relate to significant adverse effects, but have been included to further reduce the levels of effects related to the Development.

2.10. Significance Criteria

2.33. The significance of residual effects has been assessed for each of the assessment chapters. Where possible this has been based on quantitative evidence; however, where it has not been possible to quantify these effects they have been assessed qualitatively based on the best available knowledge at the time and professional judgement.

2.34. The standardisation of the significance criteria generally lead to a common classification of the significance of effects. These are classified as Major, Moderate, Minor or Negligible. The effects are also described according to whether they are Adverse, Neutral or Beneficial. However, as noted in Paragraph 2.27 certain assessments have not married well with the defined chapter and/or significance criteria structure and, as such, have been treated individually.

2.35. The potential impacts for each issue related to the Sound of Islay Demonstration Tidal Array have been developed with regards the following:

- Extent and magnitude of the impact (Table 2.5);
- Duration of the impact (short, medium or long-term);
- Nature of the impact (direct or indirect; reversible or irreversible);
- Whether the impact occurs in isolation or is cumulative in nature;
- Sensitivity of the receptor (Table 2.6);
- The significance of effect, and whether the effects are beneficial or adverse; and
- The level of mitigation that can be implemented to avoid, reduce or offset the effect (where the significance of effect is noted at being low, medium or high).

Table 2.5: Magnitude of Impact

Magnitude of Impact	Description
High	A fundamental change to the baseline condition of the receptor.
Medium	A detectible change resulting in the non-fundamental temporary or permanent condition of a receptor.
Low	A minor change to the baseline condition of the receptor (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

Table 2.6: Sensitivity/Value/Importance of the Receptor

Receptor Sensitivity/Value/Importance	Description
High	Environment is subject to major change(s) due to impact. For example, sites contain features of international or national conservation or cultural designation, or permanent reduction of anthropogenic activity such as fish landings
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. For example sites contain features of national or regional conservation or cultural designation, permanent modification of anthropogenic activity.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example sites of local conservation or cultural value or temporary modification of anthropogenic activity.
Negligible	Environment responds in minimal way to effect such that only minor change(s) are detectable. For example sites contain features of local interest, little or no change to anthropogenic activity.

2.36. Sensitivity criteria can be based both on the degree of environmental response to any particular impact, as well as the 'value' of the receptor (for example; an area of international significance should be considered more sensitive to impact than an area of little or no conservation value). The sensitivity for each impact is determined by consideration of at least one of the following points:

- Comparison with Regulations or standards e.g. British Standards;
- Compliance with policy, plans and guidance documents e.g. Local Plan;
- Reference to criteria such as protected species, designated sites and landscapes;
- Consultation with stakeholders; and
- Experience and professional judgements by specialists on environmental sensitivity.

2.37. A detailed description of the criteria used to assess sensitivity or value or importance for each receptor is provided in the relevant assessment chapter.

2.38. By combining the magnitude of the impact and the sensitivity of the receptor in a matrix (see Table 2.7) the final significance of the effect (prior to the implementation of mitigation measures) can be obtained. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being significant.

Table 2.7: Impact Significance Matrix

Magnitude of Impact	Receptor Sensitivity/Value/Importance			
	Negligible	**Low**	**Medium**	**High**
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

2.39. Due to the differences between the individual technical assessments throughout this ES there is no specific definition that can be applied. Therefore, each of the individual assessments have also carried out their own impact assessment and defined the criteria levels for defining the level of residual effect. Where it has been possible to do so this has been based upon accepted criteria (e.g. for onshore noise and vibration effects and their associated guidelines), as well as by employing expert interpretation and value judgements in order that the extent of any given effect can be established.

2.11. Cumulative Effects

2.40. In accordance with the EIA Regulations the ES has given consideration to cumulative effects. These are effects that result from the combined changes to the environment in the vicinity of the proposed Development caused by past, present and foreseeable developments in combination with this development.

2.41. Development schemes that may cause cumulative effects with regards the Sound of Islay are:

- The Argyll Array (proposed offshore windfarm);
- Kintyre (proposed offshore windfarm);
- Islay (proposed offshore windfarm);
- The west of Islay tidal farm (proposed by DP Energy); and
- Port developments on Islay.

2.42. The possibility of cumulative effects within the Sound of Islay does not exist for all of the assessment chapters. Where there is deemed to be no potential for cumulative effects to occur, then this is clearly stated.

2.12. Assumptions and Limitations

2.43. The principal assumption, which has been made during the preparation of this ES is that:

- The information provided by third parties, including publicly available information and databases, is correct at the time of publication.

2.44. The EIA has been subject to the following limitations:

- Baseline conditions have been assumed to be accurate at the time of the physical surveys; however, due to the dynamic nature of the environment, conditions may change during the various phases of the development; and
- The assessment of cumulative effects has been reliant on the availability of accurate information on the proposed developments that may act in combination with the one outlined within this ES.

2.13. Project Team

2.45. For a full list of the Project Team see Table 1.2 in *Chapter 1: Introduction*.

2.14. References

Scottish Executive (2000). Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000.

4. Site Selection

4.1. Introduction

4.1. This Chapter describes the site selection process and the design considerations and constraints that have led to the final proposed development.

4.2. The requirement to outline the project alternatives comes from the Electricity Works (Environmental Impact Assessment) Scotland Regulations 2000. This stipulates that development alternatives be described and reasons given for the final preferred proposal.

4.2. Consideration and Constraints

4.3. Prior to the selection of the Sound of Islay as the location for the demonstration tidal array an extensive selection process was undertaken by ScottishPower Renewables. Various parameters were considered, including:

- Technical (tidal resource, grid and accessibility);
- Environmental (habitats, species and seabed profile);
- Commercial (fishing, shipping and recreation);
- Economics; and
- Policy and Designation.

4.4. In addition to the above, an extensive consultation exercise was also undertaken of various organisations to assist in the selection of the most appropriate area for the proposed development (see *Chapter 2: Scoping and Assessment Methodology*). These included:

- Scottish Natural Heritage (SNH);
- Joint Nature Conservation Committee (JNCC);
- Maritime and Coastguard Agency (MCA);
- Chamber of Shipping;
- Fisheries Research Services (FRS – now known as Marine Scotland Science);
- The Crown Estate (CE);
- Ministry of Defence (MoD);
- Royal Society for the Protection of Birds (RSPB);
- Scottish Government; and
- Argyll and Bute Council.

4.5. Using the above constraints and after the wide-ranging consultation process a number of locations around the coast of the United Kingdom were identified as potential locations for the placing of the proposed demonstration tidal array. The suitable locations were then shortlisted to:

- Pentland Firth; Scotland
- Sound of Islay, Scotland; and
- North Channel, Northern Ireland.

4.6. Field data was gathered for these locations (e.g. resource profile, seabed characteristics) and a review of the environmental and planning considerations undertaken in order to inform on the most suitable location for the tidal devices (see Section 4.5). The main points that highlighted Islay as being the most suitable location for this particular project were:

- Good tidal resource;
- Sheltered location;
- Accessibility;
- Minimal nature conservation designations on site and the areas surrounding the site; and
- Nearby grid access point, with access either to Islay or Jura.

4.3. Site Location

4.3.1. Background

4.7. Islay is the most southerly of the main Inner Hebridean Islands and is located south and west of Jura on the west coast of Scotland. The Sound of Islay is the stretch of water that separates the islands of Jura and Islay. The Sound is approximately 1km wide and reaches approx. 60m in depth. The proposed location for the array is shown in Figure 1.1 (*Chapter 1: Introduction*). The site lies within the local authority area of Argyll and Bute Council.

4.8. Figure 1.1 (*Chapter 1: Introduction*) shows indicative locations for the tidal devices within the site. However, these may be subject to micro-siting corrections dependant on detailed seabed assessments during the pre-installation phase. The devices will not be sited in depths less than 48m. The tidal conditions throughout the proposed area of the Sound are suitable for deployment of the HS1000 tidal device.

4.9. In addition to the tidal devices there is also a requirement for an export power cable from the tidal array to the onshore infrastructure (e.g. substation) (see Section 4.7.2). The planned route for the export power cable will come ashore near Daimh-sgeir on Jura.

4.10. A grid connection has also been secured with Scottish Hydro Electric Power Distribution Ltd. (SHEPD), which will allow the Development to go-ahead and supply the electricity it produces into the National Grid.

4.3.2. Islay and Jura

4.11. The site has been selected to avoid International and National designations. The potential area of interest is not subject to any existing nature conservation designations; however, consideration is given to designations in the vicinity of the area of interest as required under Regulation 48 of The Conservation (Natural Habitats, & c.) Regulations 1994. Details of relevant marine, coastal and terrestrial designations are provided in later chapters.

4.12. Port Askaig is one of the two main ports (the other main port is Port Ellen in the south-east) on the Isle of Islay and is located by the Sound close to the proposed tidal array site. It is accessed by land via the A846 and by sea via one of several ferry routes:

- Port Askaig (Islay) and Feolin (Jura);
- Port Askaig and Kennacraig; and
- Port Askaig and Colonsay (summer only)

4.4. Site Ownership/Land Use

4.4.1. Islay

4.13. The Dunlossit Estate owns much of the land on the Islay side of the Sound adjacent to the proposed area for the Development; however, the local council owns the harbour area of Port Askaig, with the area around the Port Askaig Hotel being privately owned.

4.14. Land to the north of the area of interest surrounding the Caol Ila distillery is owned by Diageo. Discussions are also being held with this landowner in connection to the possibility of mooring barges in the bay adjacent to the distillery. North of the distillery the land is owned and run by Islay Estates, who have been kept informed of the progress of the project.

4.4.2. Jura

4.15. Inver Estates own the land at the south-west end of Jura (from approximately 1km to the north of Feolin, where the Jura ferry comes over from Islay). At present Inver Estates are proposing the construction and operation of an 850kW hydro scheme on their land. This will be connected to the grid at a new substation location next to the A846 approximately 3km south of Feolin. The Development is unlikely to affect the land owned by Inver Estates as cable landfall will likely be made south of Feolin; however, SPR are in discussions with Inver over the joint operation of a substation, which could be utilised to service both the hydro scheme as well as the development.

4.16. Ardfin Estates own the land at the south of Jura. As they own all of the land adjacent to the proposed Development it is probable that they will be affected by the Development, particularly where the cable makes landfall and with the construction of a substation and control building and for the connection to the grid. Ardfin Estates have been kept informed on the progress of the Development.

4.4.3. Sound of Islay

4.17. The Crown Estate has been approached for the appropriate lease as they are the owners of the seabed from the Low Water Mark to 12 nautical miles (nm).

4.5. Sea Use

4.5.1. Existing Sea Use

4.18. Currently the primary traffic within the Sound of Islay relates to the ferry services serving Islay and Jura. These include the Islay-Jura ferry that runs across the Sound from Port Askaig, Islay to Feolin on Jura. Other, larger, ferries also operate a service linking Islay to Mainland Scotland and the Isles.

4.19. Cargo vessels, and other vessels in transit, that travel up and down the west coast of Scotland occasionally utilise the Sound as a short route to ports such as Oban. This allows them to shorten their sailing times as the route to the west of Islay would take considerably longer, thereby incurring additional costs in both time and fuel. Large vessels do not use the Sound due to shallower water at the north of the Sound.

4.6. Designated Areas

4.20. One of the specific reasons why this location was selected as a proposed area for the demonstration array was the lack of any conservation designations in the immediate vicinity. However, there are designations that will be considered within relevant chapters within the ES. These include the Special Protection Area (SPA) sites on the western part of Islay, the harbour seal Special Area of Conservation (SAC) to the south-east of Islay and the National Scenic Area (NSA) that covers much of Jura and the Sound.

4.7. Assessment of Alternatives

4.7.1 Tidal Array

4.21. The macro site selection process is detailed in Section 4.2. During this, the Sound of Islay was selected ahead of several other proposed locations as the optimum location for a demonstration tidal array. After this high level process there was a micro selection process looking at the Islay site in more detail.

4.22. Detailed bathymetric surveys were undertaken to chart the seabed within the Sound. When this data and the design of the tidal turbine were taken into account, it was decided that the best area for the Development would be the central portion of the Sound, below the 48m bathymetric contour.

4.23. It was initially proposed to install 20 tidal turbines into this area; however, after review of the planning and consenting considerations, it was decided that the installation of a maximum of 10 devices would be the most suitable for the site and maintain the demonstration status of the array (Iteration 1). Environmental considerations were also taken into account. Further iterations were then taken in response to the resource of the area and the maximising of the capacity factor for the tidal turbines.

4.24. As can be seen from Figure 1.1 (*Chapter 1: Introduction*) the 48m bathymetric contour forms a figure of eight shape. The initial array design was that all ten of the tidal turbines would be located in either the northern or southern portion of this figure of eight over a total of three rows (Iterations 2 and 3). This would have kept the area of the site relatively compact and would have kept open the rest of the figure of eight for potential future tidal development.

4.25. However, after a resource review by Garrad Hassan it was deemed necessary to spread out the tidal turbines further than initially anticipated to maximise their capacity factor (Iteration 4). Therefore, the entirety of the figure of eight has now been taken up by the ten tidal turbines arranged over four rows.

4.26. This process relating to the Development layout set out above has reduced the site from 20 to 10 tidal turbines. The iterations can be seen in Table 4.1.

Table 4.1: Summary of Iterations to Array Layout

Iteration Development Stages	Number of Turbines	Purpose in Change of Layout
Scoping Report	20	N/A
Iteration 1	10	Maintain the development as a Demonstration Site – 10MW or less
Iteration 2	10	Maintain discrete site within the southern portion of the Sound – perceived better resource and minimise impact with other sea users
Iteration 3	10	Maintain discrete site within the northern portion of the Sound – surveys and modelling show better resource present here
Iteration 4 - FINAL	10	Maximise capacity factor of array by increasing turbine spacing

4.7.2 Array Cabling and Cable Landfall

4.27. Initially it was proposed in the Scoping Report that the cable landfall would be defined once the proposed site for the array had been identified. Early work on the cable landfall indicated that the eastern shore of Islay would be the most suitable, given the infrastructure available on the island.

4.28. Once scoping report responses were received the site for the array was narrowed down to the area of the Sound below the 48m bathymetric contour. This allowed for the identification of four potential landfall locations on Islay (Iteration 1), which were determined by a number of factors including distance from turbines to the shore, cable distance to grid connection, local onshore infrastructure and access, any habitats that the cabling may pass through, potential cultural heritage (archaeological) impacts, landowners, seabed difficulty and suitability of bringing cable ashore.. After further consideration of the environmental and cultural heritage implications for each of the locations, this was reduced to three (Iteration 2).

4.29. Discussions with Diageo (one of the landowners on the eastern shores of Islay) identified their Caol Ila distillery as being a potential landfall location, thus increasing the number of options for landfall on Islay back up to four (Iteration 3).

4.30. A cabling study was undertaken and the conclusions of this showed that the Islay side of the Sound as being potentially difficult to bring a cable ashore due to the steep slopes at these potential landfall locations. Therefore, the number of landfall locations on the Islay side was reduced to one (Iteration 4).

4.31. Finally, Jura was viewed as a potential landfall location. This had been previously discounted due to the National Scenic Area (NSA) designation covering much of the island and the whole of the coastline adjoining the Sound. After discussion with Scottish Natural Heritage (SNH) and various field visits to assess the potential effects of the substation location on the NSA. Jura was selected as being the most favoured option as it posed the least amount of potential impacts. Additionally, a proposed development in this area allowed for the possibility of collaboration between the tidal project and the Inver Hydro project, which would clearly assist in being able to reduce land take, disturbance and the impacts of two developments going ahead in the same location. Three potential landfall locations were identified; however, after terrestrial, intertidal and subtidal surveys of the area, this has been reduced to one favoured site, close to the mouth of the Abhainn an Daimh-sgeir. If this location is deemed to be inappropriate by the consenting authorities there would be the possibility of making landfall at the more industrial area of the Feolin ferry slipway on Jura as all studies carried out in support of this ES also covered this area. However, only the Daimh-sgeir landfall has been assessed as part of this ES. The selection of the Daimh-sgeir landfall location also means that the length of cabling onshore is kept to a minimum.

4.32. A list of the iterations can be seen in Table 4.2.

Table 4.2: Summary of Iterations to Cable Landfall Location

Iteration Development Stages	Number of Landfall Locations	Purpose in Change of Layout
Scoping Report	TBC	N/a
Iteration 1	4	Identification of the potential area most suitable for the proposed array
Iteration 2	3	Study of the environmental and cultural heritage resources at each landfall location
Iteration 3	4	Discussions with Diageo opened up Caol Ila distillery as a potential landfall location
Iteration 4	1	Cabling studied identified that the Islay side of the Sound was difficult to cable over given its bathymetric profile
Iteration 5 - FINAL	1	Jura opened up as a landfall option after discussions with Inver Estates who are developing a hydro scheme

4.33. The site will most likely have 1 or 2 subsea cables laid from the device(s) to the selected cable landfall point onshore. When the Tidal Site is developed each device will be interconnected with other devices on the array via an umbilical.

4.34. As part of the cabling study (Paragraph 4.30) work is being undertaken to look at the optimum tidal array cabling design and installation approach. This work will ensure that the offshore cabling will be installed in a safe, cost effective and environmentally sensitive manner, whilst ensuring long-term reliability, maintainability and fault tolerance.

4.35. The final layout of the device(s) and therefore cables will largely depend on the site seabed conditions and bathymetry. However, the layout will be designed to minimise the cable lengths while maximising the level of redundancy. The techniques adopted for the laying of the subsea and landfall cable will depend on the local conditions and will either be buried or armoured, as appropriate.

4.7.3 Substation Location

4.36. The Scoping Report proposed that the location of any substation and other associated onshore infrastructure would be defined once the proposed site for the array had been established. However, in line with the initial thoughts for the cable landfall location, the most suitable location was thought to be Islay.

4.37. As the initial location for the array was narrowed down to the area of the Sound below the 48m bathymetric contour and the landfall location on the Islay side, the existing substation at Keills was identified as the most likely area to connect the power output from the Development (Iteration 1).

4.38. After the cabling study had identified the Islay side of the Sound as being difficult for cabling to be brought ashore to due to the steep slopes where the cable would transition onto land. A southerly potential landing point was then identified on Islay, which took advantage of a gentler slope between the Development and the landfall location (Iteration 2).

4.39. Once Jura had been identified as a potential landfall location, the potential for a substation on Jura was then investigated. This had the added advantage of collaborating with the proposed hydro scheme development on Jura (some of the advantages were mentioned in Paragraph 4.29), which had already identified a substation location. The slope between the proposed tidal array location and the coastline of Jura is also considerably more gentle that the slope west to Islay.

4.40. A list of the iterations can be seen in Table 4.3.

Table 4.3: Summary of Iterations to Substation Location

Iteration Development Stages	Location of Substation	Purpose in Change of Layout
Scoping Report	TBC	N/a
Iteration 1	Keills, Islay	Identification of the potential area most suitable for the proposed array and cable landfall on Islay
Iteration 2	Southern Islay	Cabling studied identified a gentler slope to the south – avoiding the steeper slopes connecting the cable to Port Askaig
Iteration 3 - FINAL	Jura	Jura opened up as an option after discussions with Inver Estates who are developing a hydro scheme

4.41. The area for the control building/substation will need to be large enough to accommodate a transformer, switchgear, power electronics, control equipment and auxiliary supplies. An approximate footprint of 14m x 8.65m (121.1m^2)[1] has been assumed; however, this is yet to be finalised. The indicative location of this substation can be seen in Figure 1.1 (*Chapter 1: Introduction*).

4.8. Mitigation through Site Selection and Layout Iteration

4.42. The proposed tidal array has gone through the iterative process detailed above and thus the final project design is seen as being the best solution available. As this final layout has been reached through this iterative process, it can be seen to have already incorporated several layers of mitigation into its final design through the avoidance of specific features of archaeology, ecology and technical difficulties.

4.43. The section of the site within the Sound of Islay has avoided International and Nationally designated areas where possible (with the exception of the Jura NSA).

4.44. The details of all mitigation measures are outlined in the technical chapters (Chapters 7-23) within the main body of the ES.

[1] Note: The substation will be combined with the transformer site for the Inver Hydro Scheme. A small footprint (40x40m – 1600m^2) has been purchased for this purpose.

5.0 Project Description

5.1 Introduction

5.1 ScottishPower Renewables (SPR) is proposing to develop a Demonstration Tidal Array in the Sound of Islay. The proposed Tidal Array will have a capacity of up to 10MW of renewable power for export to the grid and will contribute to meeting the Scottish Government's targets of providing 50% of Scotland's electricity generation from renewable sources by 2020.

5.2 The Tidal Array will consist of up to 10 pre-commercial demonstration submerged tidal stream-generating devices, deployed in an array.

5.3 The candidate tidal device will be the HS1000, developed by Hammerfest Strom UK. This design is based on an existing 300kW prototype device developed by Hammerfest Strøm AS. Hammerfest Strøm UK (a subsidiary of Hammerfest Strøm AS) is developing the design with adaptation for UK tidal conditions and an increased maximum output of 1MW. A 1MW turbine will be deployed at the European Marine Energy Centre (EMEC) for a period of testing, after which up to 10 devices will be deployed to form the demonstration tidal array in the Sound of Islay (SoI).

5.4 The deployment will be subject to the required Consents and Licenses being obtained (see *Chapter 6: Regulatory and Policy Context*). The Tidal Array will be the first of its kind and is, therefore, viewed as a 'Demonstration Tidal Array'.

5.5 In addition to the tidal device(s), there will be associated onshore/offshore infrastructure including Sub Sea and landfall cable(s), a control building, substation and onshore access. A grid application has been submitted to the National Grid and Scottish Hydro Electric Power Distribution Ltd. (SHEPD).

5.6 SPR are working with the Islay Energy Trust (IET), a community owned charity. SPR and IET have signed a Memorandum of Understanding (MoU) covering the joint development of the Sound of Islay tidal project, with SPR funding a full time development officer on the island under the employment of the IET.

5.7 SPR have secured a lease option for a substantial new tidal project at Ness of Duncansby in the Pentland Firth. At 95MW this is a major project which, in itself could be a precursor to even larger developments in that area. The Islay Demonstration Tidal Array will provide technical, environmental and commercial learning which will be essential to facilitate the deployment of the Pentland Firth resource.

5.2 Site Location

5.8 Islay is the most southerly of the main Inner Hebridean Islands and is located south west of the island of Jura on the west coast of Scotland. The Sound of Islay is the stretch of water that separates the islands of Jura and Islay. The Sound is approximately 1km wide and reaches 62m in depth. The site is shown on Figure 1.1 in *Chapter 1: Introduction*. The site lies within the local authority area of Argyll and Bute Council.

5.9 The array is to be located within the figure of eight created by the 48m contour line and below the route of the Islay - Jura ferry boundary line (allowing for at least 200m clearance to the nearest turbine location). Figure 1.1 also gives indicative coordinates for each of the tidal devices within the site; however these will be subject to micrositing. Depth and tidal conditions are all suitable for deployment of the tidal device within the proposed area.

5.10 In addition to the Tidal Array there will also be a requirement for an export power cable route from the Tidal Array as well as onshore infrastructure components such as a grid connection point, control building and substation. The location for these components is proposed for the island of Jura, as this connection gives the most favourable subsea cable routing as well as the least likely onshore effects of the proposed works. The grid connection point selected is on Jura where the Islay/Jura 33kV interconnector comes ashore.

5.11 Islay is home to some of Scotland's most spectacular birds and other wildlife, from the golden eagle to the rare and secretive corncrake. The RSPB Scotland Reserve at Loch Gruinart (on the north of the island) is internationally important for barnacle geese in winter and for breeding wading birds including snipe and lapwings in spring.

5.12 The site has been selected to avoid International and National designations (this is further detailed in *Chapter 4: Site Selection)*. The potential area of interest is not subject to any existing nature conservation designations. However consideration is being given to designations in the vicinity of the area of interest as required under Regulation 48 of The Conservation (Natural Habitats, & c.) Regulations 1994. Details of relevant marine, coastal and terrestrial designations are provided in *Chapter 8: Benthic Ecology; Chapter 9: Marine Mammals; Chapter 14: Ornithology; Chapter 16: Terrestrial and Intertidal Ecology and Chapter 17: Landscape and Seascape*.

5.3 Offshore Site Description

5.13 The stretch of water known as the Sound of Islay lies between the islands of Jura and Islay and is a deep-water U-shaped channel. The bathymetry of this channel constitutes a relatively flat and deep seabed (depths of up to 62m) with very steeply sloped sides. The steepest slope is on the Islay side with the Jura side of the channel having a slightly gentler gradient. The Sound is generally sheltered from the wave action which affects the west coast of the island. At the northern end of the Sound the bathymetry shallows to only 11-12m, whereas to the south it remains at up to 20m in depth.

5.14 The benthic environment consists of various sediment types ranging from sandy areas to areas dominated by pebbles, cobbles and boulders. The biological environment is typical of that found in highly tidal areas along the west coast of Scotland. This constitutes high abundances of filter-feeding organisms such as soft corals, hydroids, bryozoans, large sponges and anemones. In shallow water, kelp is a major constituent of the biological environment with areas of maerl also identified within the Sound.

5.4 Onshore Site Description

5.15 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.

5.4.1 Land Ownership

5.16 Land ownership is discussed in detail in *Chapter 4: Site Selection*.

5.4.2 Tidal Resource and Monitoring

5.17 Tidal resource measurements have been taken within the Sound. These have allowed an assessment of the flow regime to be made with the principal aim in identifying the most beneficial turbine siting locations in order to maximise the yield of the array in terms of power generated. Studies thus far have shown that the maximum flow within the Sound as being 3.7m/s, with a mean of 1.2m/s. However, the flow within the Sound is variable and dependant on the locations where the measurements are taken. SPR have commissioned modelling of the flows within the sound, therefore, the work leading towards the hydrodynamic modelling is critical to maximising the power output from the project.

5.5 Site Design and Layout

5.5.1 General Project Description

5.18 The proposed project will comprise of up to ten 1MW devices installed in deep water (>48m depth) on an area of the seabed within the Sound of Islay, just south of Port Askaig. These will then be linked by cable to Jura.

5.19 Flow modelling has been carried out in the Sound of Islay and this has been used to inform the design of the turbine layout. The ten turbines will be arranged so that they are spread out in four rows, the split being 2/2/3/3 from north to south of the sound. The flow modelling work has determined that the optimum spacing for the turbines at this location.

5.6 Tidal Turbines

5.20 Hammerfest Strøm UK (HSUK) are currently developing the HS1000, a 1MW demonstration tidal stream turbine. This will be deployed in Scotland, at the EMEC test facility on Orkney. Once proven, this design will be used for the 10 turbine array in the Sound of Islay. This work builds on the development work undertaken for the Hammerfest Strøm AS device in Norway where a 300kW scale device has been successfully designed, built and has operated for over 4 years. This makes Hammerfest Strøm AS (HSAS) the first company in the world to successfully convert kinetic energy from a tidal flow to electricity and connect it to the grid.

5.21 The HS device is a fully submerged, bottom mounted, three-bladed, variable pitch turbine, similar in arrangement to horizontal axis wind-turbine. The nacelle houses the turbine, gearbox, generator and associated components. The nacelle is attached to the tripod support structure and does not yaw like a traditional wind turbine.

5.22 The turbine features aerofoil section blades, which generate lift when presented to an oncoming flow. This lift force on the turbine blades causes the turbine to rotate and energy is extracted via a gearbox and generator.

5.23 In the 300kW machine, the generator is connected to the grid by means of a power export cable with a dry mate connection. An onshore transformer provides the step up grid connection voltage. The control system has been developed to allow remote operation and monitoring via a control room.

5.24 The pitch of the blades is varied to present the most efficient angle of incidence to the oncoming flow, thereby generating the maximum energy from the flow at any given flow speed. When the tide reverses, the blades pitch so that the turbine extracts energy from the flood, as well as the ebb tide. The turbine rotates in the opposite direction on the ebb tide.

Figure 5.1: Graphical Representation of the tidal device to be installed.

5.25 There has been no requirement to remove the nacelle due to any faults occurring during the 4-year operational period in Norway. However, the device was taken onshore in order to assess component wear and a forensic examination carried out. The components were found to be in good order and the device has since been successfully reinstalled (during August 2009).

5.26 Hammerfest Strøm are one of the few tidal device developers who have successfully installed a device and they have now proven the installation methodology a second time through the reinstallation of the refurbished nacelle in Norway.

5.6.1 Device Structure

5.27 The tripod support structure dimensions are 15m by 22m and the nacelle will sit on the substructure with a hub height of 22m from the seabed.

5.28 A rotor diameter of 23m will give the device a total height from the seabed of approximately 33.5m. The siting of the devices in areas that have a minimum water depth of 48m (the shallowest turbine is proposed to be in 50m of water) will ensure that there is sufficient clearance draft to enable vessels to use the sound unaffected by the turbines (a minimum of 16.5m is anticipated).

5.6.2 Operation

5.29 The turbine will be orientated to face the current in order to take advantage of the maximum tidal flow. The rotational speed of the turbine will be 10.2rpm with a maximum blade tip speed of approximately 12m/s.

5.30 The device can be controlled remotely via the SCADA connections and control system which can be used to start and stop the turbine, pitch the blades and operate the onshore electrical equipment to allow grid connection. They also communicate with the various operating systems and condition monitoring systems to provide status reports and alarms on a wide variety of performance indicators such as generator temperature, voltage, and water ingress amongst others. Under normal operating conditions the device can be operated automatically and will not require constant supervision to optimise output and carry out start up and shut down operations. However, it is possible to manually intervene with the device using the control systems.

5.6.3 Hydraulic Systems

5.31 The hydraulic system provides actuation as part of the pitch control mechanism for the turbine blades. In addition this system is used to operate the mechanical brake (during normal stop and emergency stop of the turbine, the pitch mechanism will act as a brake). The hydraulic system is sealed and contains oils for lubrication. Only recognised marine standard materials and substances will be used in the device.

5.6.4 Corrosion Protection

5.32 In compliance with established North Sea standards cathodic protection will be applied to all sub sea equipment. Any paint added to exposed surfaces will be applied in accordance with ISO 16272-1:2007.

5.6.5 Antifouling Protection

5.33 Methods for preventing marine growth will be investigated and tested on the test device at EMEC, primarily copper and thermoplastic based. Additionally a blade cleaning technology will also be tested.

5.6.6 Power Conversion System

5.34 The nacelle of the device will have a power rated capacity of 1MW and the rotational speed of the turbine blades will be approximately 10.2rpm.

5.35 Within the nacelle the gearbox will step up the rotational speed prior to the generator. This arrangement is similar to that found in many wind turbine designs. The low speed shaft connects the gearbox to the turbine rotor. The gearbox increases the rotational speed to allow the generator to produce electrical output at the required frequency for network connection. Electrical power is then transferred to shore via the connecting power and control cable.

5.6.7 Heating & Cooling Systems

5.36 A number of components within the nacelle produce heat during their operation. This is removed by a common cooling system, which is cooled, via a heat exchanger, by water from the external environment. The main heat producing components in the nacelle are the:

- Generator.
- Gearbox; and
- Main bearings;

5.6.8 Gravity Based Foundations

5.37 A tripod base, fixed to the seabed using gravity ballast in the legs, will support the nacelle and the blade structure. The structure is designed to withstand the appropriate level of loading. A review of various foundation and batch deployment options has identified the tripod base arrangement (as used in the 300kW device) as the optimum approach. It is possible that the device foundations will require to be pinned to the seabed as part of the installation procedure. However, at this stage of the Development this is deemed unlikely and only the ballasting of the devices has been considered as part of the assessment process within this ES. Development and testing installation methodologies are planned as part of the single device deployment at EMEC in 2011. Installation methods have already been demonstrated at Kvalsund. The test device at EMEC will provide the opportunity to trial improved open sea methods. When the devices for the Demonstration Array are deployed in the Sound of Islay, this will allow batch array deployment in a relatively sheltered environment, thus providing learning that will assist in developing effective procedures for installation of the devices at the Pentland Firth site.

5.38 The estimated mass of the tripod substructure itself will be 160 tonnes. The total mass of ballast used will be 800 tonnes and the nacelle will be approximately 160 tonnes. The tripod structure will be manufactured from carbon steel and the ballast weights are likely to be a mix of concrete and carbon steel.

5.6.9 Electrical Systems

5.39 The current generator design is a six pole, synchronous ac generator which will be rated at 1MW. The operating voltage of the generator is dependent on the availability of a suitably rated wet mate connector. The generator will generate at a voltage of 6.6kV.

5.6.10 Onshore Infrastructure and Facilities

5.40 The output from the array will be delivered to the network with a transformer being used to step up the voltage as required to connect to the local network.

5.6.11 Pre-construction Requirements

5.41 Site preparation and construction will consist of the following principal operations:

- Sourcing of aggregate from off-site sources for construction of the hardstanding area required by the substation;
- Construction of site substation;
- Deployment of substructures and nacelles;
- Subsea cable laying and trenching intertidally/onshore; and
- Connection of distribution cables.

5.42 Several of these operations will be able to be implemented and carried out concurrently. With this type of development the onshore works and the subsea works (with the exception of cabling) can be carried out entirely independently of one another.

5.43 Site restoration will be programmed and carried out to allow rehabilitation of disturbed areas as early as possible in the construction programme, for both marine and terrestrial habitats. Onshore, the construction methodology will minimise the storage of any excavated material on vegetation and will facilitate restoration at the earliest opportunity.

5.44 In the event that unsuitable seabed conditions are encountered during the installation of the substructures then there may be the need to micro-site some of the tripods. Micro-siting will be agreed with our environmental marine ecological advisor and Marine Scotland (with regards to the FEPA application) prior to their installation.

5.45 Due to the proximity of the onshore element of the works being adjacent to the A846 on Jura and the construction vehicles utilising this road for access then the contractor will adopt measures to ensure that this road is kept clean and free of debris. Wheel-wash facilities are likely to be located at the entrance/exit to the site. If conditions are such that site dust is likely to be an issue then measures (e.g. the watering of site access areas) will be carried out to mitigate this situation. Plant would access site via the A846 on Jura.

5.46 Vehicles working at the site will require a compound/laydown area when not in use. There are two options being considered in this regard if required. The limited number of construction vehicles will be located at the construction site itself on a separate area or the area near to the Feolin Ferry will be utilised. The area next to Feolin Ferry is already a large, well surfaced location and the storage of 3-4 vehicles will not inhibit access to the ferry link at this location. However, if the Feolin Ferry option is taken forward, this will have implications for the level of construction traffic utilising the A846. This is assessed in *Chapter 19: Traffic and Transport.*

5.7 Tidal Array

5.7.1 Installation Techniques

5.47 It is estimated that the devices can be installed over a period of approximately 72 days (not including weather downtime). This has made allowances for spring and neap tidal cycles. Offshore cable and pre-substructure installation activities will be conducted in advance of the installation of the nacelles.

5.48 The HS1000 is designed so that it can be installed without the need for specialised marine installation equipment or specially designed vessels. This will enable multiple competitive tender for installation works to be undertaken thus ensuring the most economic solution for the installation. Furthermore, the HS1000 will be designed to reduce the requirement for the use of divers during the installation and thereby minimise safety implications.

5.49 It is anticipated that the installation will consist of four phases:

- Pre installation of mooring systems and arrival of barges in preparation for construction activities;
- Heavy lift vessel on site to lift and move the substructures onto the barges;
- Anchor handling vessel to move substructures from the barge onto location for ballast operations and cable pull in; and
- A lift vessel will be used to install the nacelles once the site is prepared.

5.50 The principal option being considered for moored barge location is the bay at the Caol Ila distillery. Detailed bathymetric surveys were undertaken in summer 2008 but further survey work will be required to determine the optimum area to be used, taking into account the bathymetry of the near shore areas. In addition to this, analysis of the relevant depth contours and profiles will be undertaken to ensure that the sites selected are suitable and any impact on navigation for vessels transiting the Sound of Islay will be reviewed.

5.51 Each substructure can be lifted, transported and set down during a neap tide slack period. Once the substructure is in position, ballast weight will be installed onto the substructure to prevent sliding through the spring tide cycles prior to the nacelle installation and cable connection.

5.52 Once moved into position, additional ballast will be loaded onto the substructure to secure it against the overturning loads imposed by the turbine.

5.53 Once the substructure is secured into position and stabilised, the high voltage cable will be lifted to the substructure, pulled in and then secured ready for final mating.

5.54 The positioning, installation of ballast and/or pinning and the cable pull in will take approximately 56 hours. This preparatory work would take place during all tides and main installation activity during neap tide cycle phases. Pinning operations will be able to continue through spring tides.

5.55 In the Sound of Islay, the use of more than one installation vessel in parallel is unlikely to be possible due to navigational constraints.

5.56 A Navigational Safety Risk Assessment (NSRA) has been carried out, which assessed the possible impact of the installation activities (see Appendix 19.1).

5.8 Onshore Infrastructure

5.8.1 Access Track into Site

5.57 There will be no tracks constructed for access to the site. All construction traffic will utilise the existing road network (primarily the A846, which can be seen on Figure 1.1, *Chapter 1: Introduction*), which is the principal road on both Islay and Jura, and larger structures (e.g. the tidal turbines) will be transported in by sea.

5.8.2 Onshore Electrical Infrastructure

5.58 The electricity generated by the tidal turbines will be transmitted to the substation at 6.6kV and the turbines will be laid out in two separate electrical arrays. Once the cables (each will be approximately 100mm in diameter) reach the intertidal and terrestrial zones they will be installed in trenches approximately 0.45m wide and 1m deep.

5.59 Cables will be laid in sand or peat, and the trenches will then be backfilled with excavated subsoil and peat topsoil. Earthing cables and communications cables will be installed within the same trench.

5.8.3 Grid

5.60 It is anticipated that the cabling design will have two export cables coming ashore in a ring configuration with the turbines connected in series. This will mean that should one export cable fail over half the array will still be generating power, thus providing a certain level of redundancy within the system. The proposed onshore infrastructure site control building / substation will hold a transformer, switchgear, power electronics, control and communications equipment and auxiliary supplies.

5.61 The tidal array will generate electricity at 6.6kV. Two subsea cables would take the power to the shore providing some resilience and redundancy, after which a buried cable will run onshore to the substation where a transformer would step-up the voltage to 33kV for distribution.

5.8.4 Health, Safety and Environmental Management System

5.62 ScottishPower Renewables have an Environmental Policy and an Environmental Management System. Our Environmental Policy is the public statement of our commitment to manage our environmental impacts and improve our environmental performance. A copy of our Environmental Policy can be viewed http://www.scottishpowerrenewables.com/userfiles/file/SPR-ENV-001%20Environmental%20Policy.pdf

5.63 Our Environmental Management System is certified to IS0 14001 (awarded February 2010) and details the approach and procedures for ensuring compliance with applicable legislation, identifies the significant negative environmental impacts of our business and how these impacts are managed. The scope of the System is the development and outline design, detailed design, construction, operation and maintenance of renewable power generation sites.

5.64 Key construction activities are managed by setting out our minimum environmental requirements within our tender and contract documentation. This includes the requirements for the implementation of an Environmental Management System, Procedures and/or Environmental Site Plans, as appropriate, to the level of work to be undertaken. Compliance to these requirements are internally audited by the ScottishPower Renewables Environmental Team and also by our Project Managers.

5.65 During Operations, a requirement of our Environmental Management System is for all of our Operational sites to have an Environmental Site Plan. Our Operational sites are also internally audited by the ScottishPower Renewables Environmental Team.

5.9 Operation and Maintenance

5.66 The maintenance interval for the nacelle is scheduled to occur once every 5 years and the systems and their components are being designed so that this can be achieved.

5.67 In order to carry out maintenance, the nacelle will be removed from the substructure in a method similar to the installation in reverse, using a similar number and type of vessels. The nacelle will be taken from site to shore, where it will be maintained and any faults addressed in a clean environment.

5.68 Maintenance and intervention requirements out with the 5-year intervention period for the array will be minimal. Redundant systems and high reliability components will be used to extend the period between maintenance operations. ROV and possibly diver inspections will be carried out to visually inspect the condition of the nacelle, blades, structure and cabling.

5.69 The device will contain oils for lubrication, anti fouling agents and hydraulic fluids. Only recognised marine standard materials and substances will be used in the device.

5.10 Decommissioning

5.70 SPR are obliged under Section 105 of the Energy Act 2004 to ensure a full decommissioning plan is submitted for the removal of the turbine structures, power cables and all other infrastructure.

5.71 The HS1000 turbine device has been designed to allow ease of installation and decommissioning. The nacelle can be removed from the substructure in a single lift and brought to surface for transportation ashore for maintenance. The nacelle lift procedure will be well established by the time the array requires to be decommissioned.

5.72 The high voltage cable at the foot of the structure will be cut with ROV-deployed cutting equipment and recovered from the onshore end. The cables may be cut in the near shore locations and recovered by traction winch, with the deeper water lengths being recovered by a reverse deployment method that will require the cable end to be retrieved and spooled onto a cable drum.

5.73 The next step is the removal of the solid ballast weight to allow the substructure to be lifted. Solid ballast is designed for installation by placement into circular cells and stacking on the substructure feet. During deployment, remote recovery systems are utilised and the reverse principle is carried out for ballast recovery. The lifting mechanisms have been designed for a 25-year life. In addition, the substructure has been designed to allow lift of the substructure complete with ballast weight to aid the decommissioning process.

5.74 The final stage will then be the removal of the substructure. Lift and recovery to the deck of a vessel is the preferred option. However, the substructure could be lifted by smaller vessels and transported subsurface into shallow water 'wet Storage' areas whereupon a heavy lift vessel can then recover several units and install on the deck of a barge for tow away.

5.75 Following decommissioning, high-resolution, multi-beam surveys will be conducted to ensure the seabed is left clear. This is the proposed method of survey due to the limited amount of bottom survey time that can be conducted by ROV over such a large area.

5.76 Any unexpected objects identified from the survey will be investigated and construction debris recovered by ROV, as required. All of the above will be designed to satisfy the requirements of the BERR Decommissioning Guidelines.

5.11 Project Timescales

5.77 The planned installation start date for the Development is in early 2013 with the installation expected to be finished during the summer of 2013 and first power exported shortly after. In order to achieve this, the negotiation of wayleaves and leases for grid connections is expected to be completed early 2012.

6.0 Regulatory and Policy Context

6.1 Introduction

6.1. This chapter identifies the International and European legal drivers for climate change, decarbonisation and renewable energy, and the corresponding UK and Scottish policies which set the objectives and targets to meet these legal obligations. This chapter also shows how the proposed development fits within all relevant policy frameworks and, as such, how it will make a significant contribution to meeting these targets.

6.2. This chapter also outlines the regulatory and consenting requirements relating to the construction, operation and decommissioning of the proposed development, including the submerged turbines, the export cable route and onshore ancillary infrastructure[1].

6.2 Consent Requirements

6.3. New guidance on consenting of renewable energy developments in Scotland was issued by the Scottish Government in April 2010. The new approach to consenting will not come into force until 2011 and ScottishPower Renewables (SPR) expect consenting of this development to fall under the existing regime.

6.2.1 Seabed Leasing

6.4. Prior to any development on the seafloor, a seabed lease must be obtained from The Crown Estate (TCE). SPR is close to completing a lease agreement with TCE for the proposed development.

6.2.2 Section 36 Consent, FEPA, CPA and Marine License

6.5. The construction, extension or operation of a marine based generating station over a determined capacity within Scottish Territorial Waters[2] (over 1MW) or the Scottish Renewable Energy Zone[3] (REZ) (over 50MW) requires Scottish Ministers consent under Section 36 of the Electricity Act 1989 (s36). Licensing under s36 for marine renewable energy projects is now managed by Marine Scotland.

6.6. The proposed development will have an installed capacity of up to 10MW; this exceeds the 1MW threshold stipulated in the Electricity Act and therefore s36 consent is required.

6.7. A licence is currently required under Part II of the Food and Environment Protection Act 1985 (‘FEPA licence’) for the deposit of materials in, on or under the seabed. The Marine Scotland Licensing Operations Team (LOT) administer the FEPA licensing system in the waters adjacent to Scotland on behalf of the Scottish Ministers. The FEPA licensing process aims to protect the marine ecosystem and human health, and minimise interference and nuisance to others. Licence conditions are used to minimise impact if necessary, and monitoring activity may be requested to confirm that impacts are as predicted, and satisfactorily localised.

6.8. Consent under Section 34 of the Coast Protection Act 1949 (CPA) is also currently required for the construction, alteration or improvement of any works, under or over any part of the seashore, the deposit and movement of materials on/from the seashore below the level of mean high water springs. Consent is also now managed by the Marine Scotland CLPT. The CPA consenting process restricts works which may be detrimental to the safety of navigation, and in some circumstances also takes account of the potential environmental effects of works.

6.9. To simplify the consents application process, the Marine Scotland LOT, in Aberdeen, now provides a single point of application and initial enquiry for licensing under Section 36 of the Electricity Act (for marine projects), FEPA and CPA. This single point of application has been in place since 1st April 2010.

6.10. Section 20 of the new Marine (Scotland) Act 2010 will allow for FEPA and CPA licenses to be consolidated into one Marine Licence, to be administered by Marine Scotland’s Licensing and Policy Team. Marine Scotland have indicated that applications for Marine Licence will be possible from Spring 2011 (the final date is still to be set), at which point FEPA and CPA licensing will cease in Scotland. The Development is expected to proceed through consenting prior to this date.

6.11. Section 35 of the Marine (Scotland) Act 2010 allows special procedures to be put in place for management of s36 Electricity Act 1989 applications alongside applications for a Marine Licence. Scottish Ministers may modify by order the procedural provisions of the Electricity Act to allow this single licensing process to operate satisfactorily.

6.12. Applications under s36 may also include associated onshore works such as an electrical sub-station. In those circumstances, the applicant can apply to the Scottish Ministers for deemed planning permission under Section 57 of the Town and Country Planning (Scotland) Act 1997 as amended by the Planning etc (Scotland) Act 2008 to cover those associated works.

6.3 EIA Legislation

6.13. The following set of regulations applies to applications made under s36 of the Electricity Act 1989 and should be particularly noted by developers:

- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000; and
- The Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2008.

6.14. Section 36 development that is considered likely to have significant effects on the environment must be subject to EIA and an Environmental Statement (ES) submitted with the s36 application. Schedule 1 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 lists those developments for which EIA is mandatory, whilst Schedule 2 describes projects for which the need for EIA is judged by the Scottish Ministers on a case-by-case basis through a screening process. Schedule 3 describes the criteria to be used by the Scottish Ministers to determine if a development is ‘EIA development’.

6.15. Where EIA is required, environmental information must be provided by the developer in an ES.

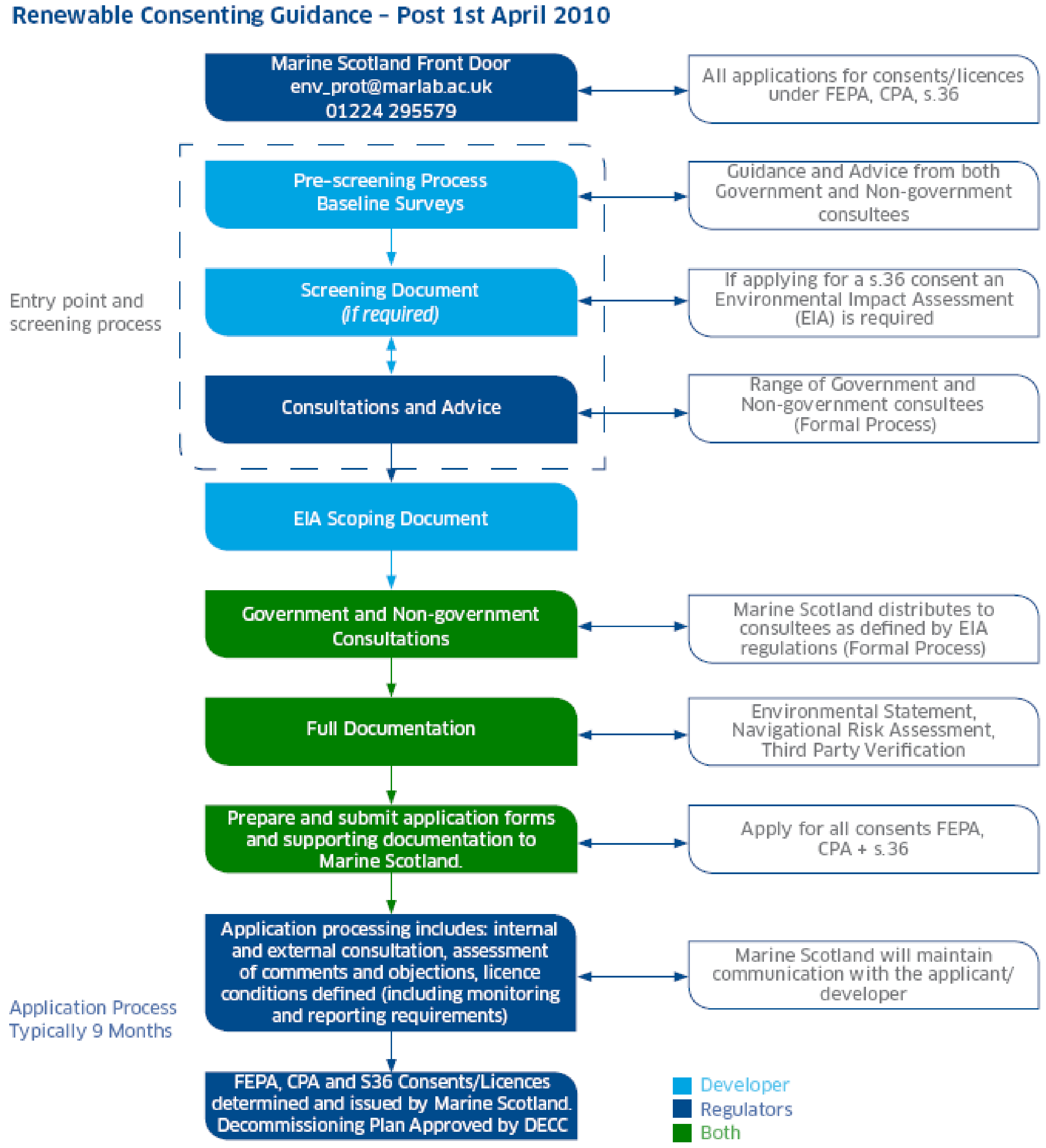
6.16. The Regulations prohibit the Scottish Ministers from granting consent for an EIA development without taking into account an ES, together with any associated environmental information.

6.17. The proposed development is a Schedule 2 development: “(1) a generating station, the construction of which (or the operation of which) will require a Section 36 consent but which is not Schedule 1 development.” If it is likely to have significant environmental effects because of factors such as its nature, size or location, it is ‘EIA development’, and a formal EIA is required. SPR independently proposed that the development should be subject to EIA.

[1] The Developer may opt to include onshore infrastructure (i.e. substation and associated cabling) within their consent application, requesting deemed planning permission for onshore works associated with the tidal array project.
[2] Scottish coastal waters out to 12 nautical miles.
[3] Area of the sea beyond the Territorial Sea which may be exploited for energy production, as defined in The Renewable Energy Zone (Designation of Area) (Scottish Ministers) Order 2005.

6.18. SPR has completed an EIA for all elements of the proposed development including those works associated with the offshore cable, landfall and onshore substation[4]. This ES supports application for consent under s36, FEPA, and CPA as well as deemed planning permission for onshore works under the Town and Country Planning (Scotland) Act 1997.

6.19. Renewables consenting procedures are outlined in Marine Scotland Topic Sheet No. 10 V3 – 'Progress Towards the One Stop Shop for Licensing in Scotland'. The flow chart below is taken from that Topic Sheet. Note that while the application process typically takes 9 months, this period can be significantly extended as a result of requests for further information from the consenting body, or possibly public inquiry, which can run for 6 – 18 months.



6.4 Habitats Regulations

6.20. Designated sites which have protected status for features, habitats and species etc. are fully considered within the assessment process and in establishing the impact significance criteria throughout this ES. Sites that are protected under national and international legislation are naturally considered to be more sensitive to change than those which are not and a greater significance is typically attributed to potential effects in designated areas.

6.21. Of particular importance to the designation of habitats and species is the Natura 2000 suite of sites (Special Areas of Conservation (SAC) and Special Protection Areas (SPA)). Under the European Union (EU) Habitats Directive (European Commission (EC) Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) Member States are required to nominate sites to be designated as SAC. Similarly under the Birds Directive (Council Directive 79/409/EEC) Member States are required to nominate sites as SPA for the conservation of wild birds. These sites are subject to the protection measures provided by the Directive to ensure that they will not be adversely affected by activities taking place.

6.22. Under the European Habitats and Birds Directives and the transposing Conservation (Natural Habitats, & c.) Regulations 1994, as amended by The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007 and The Conservation of Habitats and Species Regulations 2010[5] the competent authority (in this case the Scottish Government) must consider the effect of a development on European sites when considering whether to grant an application for consent.

6.23. The Directive and the Regulations require that an Appropriate Assessment is conducted in respect of any plan of project, which is not directly connected with the management of a site for conservation purposes and which is likely to have a significant effect on a European site (i.e. SAC or SPA) either alone or in combination with other plans or projects.

6.24. Studies undertaken in support of this EIA, and consultation with regulatory bodies, indicate that no Appropriate Assessment will be required for the Development if it can be determined at Habitats Directive screening that the Development is not likely to have a significant effect.

6.25. Under the regulations it is an offence to disturb or to recklessly capture or kill European protected species (EPS), including all cetaceans. A license to damage or disturb EPS can be applied for from Scottish Ministers; however, in granting such a license Scottish Ministers must make arrangements for monitoring the incidental capture and killing of EPS, as well as make arrangements for the carrying out of such research or the taking of such conservation measures as are necessary for ensuring that such incidental capture and killing does not have a significant negative impact on the species considered.

6.5 Policy Context for Energy

6.26. This section identifies the policy context and drivers for renewable energy developments at an International, European, UK and Scottish level.

6.27. With regard to the onshore elements of the project, a review of how the project fits within the planning context of the local authority is made.

[4] Note that onshore elements of the development (i.e. those above Mean Low Water Springs) are considered within the relevant chapters of this ES (i.e. where environmental receptors have the potential to be impacted by onshore development).

[5] The Conservation of Habitats and Species Regulations 2010 consolidate all the various amendments made to the 1994 Regulations in respect of England and Wales. In Scotland, the Habitats Directive is transposed through a combination of the Habitats Regulations 2010 (in relation to reserved matters) and the 1994 Regulations.

6.5.1 International Energy Context

6.28. The UK plays a leading role in tackling climate change at an international level, working through the EU, G8 and UN Framework Convention on Climate Change.

6.29. The 1997 Kyoto Protocol set internationally agreed and binding targets for reducing emissions of greenhouse gases up to 2012. The Kyoto targets must be seen as only a start, as it has been estimated that a 60-70% cut in greenhouse gas emissions will probably be needed to stabilise CO_2 levels in the atmosphere. Through the Kyoto Protocol, the UK has a legally binding target to reduce emissions of greenhouse gases by 12.5% below 1990 levels in the period 2008-2012.

6.30. The EU Climate and Energy package, formally agreed in April 2009, builds on Kyoto and commits the EU to achieving the '20-20-20' targets: a 20% cut in emissions of greenhouse gases by 2020 compared with 1990 levels; a 20% increase in the share of renewables in the energy mix; and a 20% cut in energy consumption.

6.31. The EU has also established an EU Emissions Trading System (EU ETS) to help meet these targets. Member states must ensure that each industrial or electricity generation plant covered by the scheme holds a greenhouse gas emissions trading permit - in effect, a licence to operate and to emit CO_2. Each permitted installation will receive an allocation of allowances, based on the Member State's National Allocation Plan. Companies that emit less CO_2 than envisaged in the cap arrangement can sell or bank surplus trading permits. However, if they exceed their cap, they will have to buy additional permits. The ETS therefore provides financial incentives for large energy users to reduce CO_2 emissions.

6.32. EU energy policy also sets targets for sectors not covered by the EU ETS, namely Directive 2001/77/EC of the European Parliament and Council, 27th September 2001, on the promotion of electricity from renewable energy sources in the internal electricity market, and Directive 2009/28/EC On the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC.

6.5.2 UK Energy Context

6.33. Table 6.1 summarises significant policy developments relevant to renewable energy over the past decade.

6.34. Increasing energy provision from renewable sources is seen as key to achieving the desired low-carbon energy future. The UK has signed up to the EU Renewable Energy Directive, which includes a UK target of 15% of energy from renewables by 2020.

6.35. Approaches to achieving this target have most recently been set out in the Government's UK Renewable Energy Strategy, published in 2009. The Strategy includes measures to strengthen the UK renewable industry and whilst acknowledging the importance of onshore and offshore wind in contributing to renewables targets, the strategy also recognises the potential contribution that could be made by wave and tidal energy.

Table 6.1: UK Energy and Climate Change Policies and Acts

POLICY	KEY ELEMENTS
UK Climate Change Programme (2000)	Sets out package of policies to deliver UK's Kyoto target. Policies included stimulating new, more efficient sources of power generation.
DTI White Paper (2003)	Expressed overall priorities for UK energy policy in the first quarter of the 21st Century. Aims including cutting CO_2 emissions by 60% by 2050 and maintaining the reliability of Britain's energy supplies.
Energy Review (2006)	Proposed to strengthen the framework that supports the development of renewable technologies in the UK in order to achieve a target of 20% electricity from renewable energy by 2020.
Energy White Paper (2007)	Entitled 'Meeting the Energy Challenge', detailed how measures set out in the 2006 review were being implemented in the UK to reduce CO_2 emissions and secure clean and affordable energy.
Energy Act (2008)	Implements the legislative aspects of the 2007 White Paper and reflects the availability of emerging renewable technologies.
Climate Change Act (2008)	Creates a new approach to managing and responding to climate change in the UK and sets a legally binding target of a reduction in emissions of 34% by 2020 against a 1990 baseline.
Low Carbon Transition Plan (2009)	Sets out the UK Government's response to climate change by setting out a Transition Plan for becoming a low carbon economy. This plan will deliver emission cuts of 18% on 2008 levels by 2020 (and over a one third reduction on 1990 levels), and updates the 2003 White Paper to state that by 2020 the UK will achieve a target of 30% of its electricity from renewable sources.
UK Renewable Energy Strategy (2009)	Sets out how and why the UK Government intends to increase our use of renewable electricity, heat and transport. It also sets out how the UK Government will meet their legally binding target to ensure 15% of electricity comes from renewable sources by 2020 and provides a route map for the implementation of the Climate Change Act (2008).

6.5.3 Scottish Energy Context

6.36. The Scotland Act 1998 established devolved government for Scotland. The Scottish Government has an energy policy for Scotland at variance with UK policy, and has planning powers to enable it to put its policy priorities into effect. Scotland's objectives as a devolved government are discussed below.

6.37. The Scottish Government is committed to promoting the increased use of renewable energy sources and has set the following ambitious targets, which move beyond those set by the UK Government:

- 80% reduction in greenhouse gas emissions by 2050, with an interim target of a 42% emissions reduction by 2020; and
- 50% of demand for Scotland's electricity to be met from renewable sources by 2020, with an interim milestone of 31% by 2011.

6.38. Statistics show that in 2008, renewables met 22% of Scottish electricity demand[6]. With 6.5GW of renewables capacity installed, under construction or consented around Scotland, the Scottish Government is set to surpass its 2011 target.

6.39. Table 6.2 summarises significant policy developments relevant to renewable energy in Scotland.

[6] http://www.scotland.gov.uk/News/Releases/2009/12/23114900

Table 6.2: Scottish Energy and Climate Change Policies and Acts

POLICY	KEY ELEMENTS
Securing a Renewable Future: Scotland's Renewable Energy (2003)	Published by the Scottish Executive in 2003 after extensive consultation, this document proposed that Scotland should aspire to generate as much as 40% of the electricity generated within the country from renewable sources by the year 2020.
Scotland's Renewable Energy Potential: Realising the 2020 Target (2005)	This study concluded that Scotland is well placed to meet the renewables target laid out in the 2003 document, perhaps before 2020, and could aspire to a greater renewables capacity if that was considered desirable.
Changing Our Ways: Scotland's Climate Change Programme (2006)	Sets out Scotland's plan of action for tackling climate change. The document states that 18% of Scotland's electricity should come from renewable sources by 2010, with this figure reaching 40% by 2020. Following a change in Scottish Government, a new target to generate 50% of Scotland's electricity from renewables by 2020, with an interim target of 31% by 2011, has been set.
Renewables Obligation Order (Scotland) (2009)	Encourages the development of Scotland's abundant renewable energy resources by obliging licensed electricity suppliers to provide a specified and increasing volume of the electricity they supply to customers from renewable sources. The Renewables Obligation (Scotland) Amendment Order 2009 introduced the concept of 'banding', a system which involves the award of different numbers of Renewables Obligation Certificates[7] (ROCs) in respect of generation from different renewable technologies. The Renewables Obligation (Scotland) Amendment Order 2010 was recently introduced. It makes a number of changes, including extending the Renewables Obligation to 2037, and introducing that new generators joining the RO now receive different numbers of ROCs, depending on their costs and potential for large-scale deployment.
10 Energy Pledges (2009)	The Pledges, set by the Scottish Government, form a coherent approach to energy issues in Scotland. The actions - ranging across key areas of energy generation and transmission, energy efficiency and transport - are focused on addressing both short and longer term opportunities for Scotland to benefit from competitive advantage. They are aimed at creating new jobs, reducing emissions and saving households and businesses money, thereby contributing to economic recovery and growth and to addressing climate change.
Renewables Action Plan (2009)	An Action Plan that sets out what needs to happen and by when to meet the Scottish Government's Renewable Energy targets, with a focus on the next 24-36 months. For example, in terms of marine energy, it identified the need for the development of a Marine Energy Road Map (published in 2009 – see Table 6.3). The Action Plan will be updated every 6 months with a focus on Scotland, but this will also consider how targets contribute to the UK Renewable Energy Strategy under the renewables obligation..
The Climate Change (Scotland) Act (2009)	Following the enactment of the Climate Change Act (2008), this Act aims to reduce greenhouse gas emissions and guide transitioning to a low carbon economy. Part 1 of the Act, creates the statutory framework for greenhouse gas emissions reductions in Scotland by setting an interim 42% reduction target for 2020, with the power for this to be varied based on expert advice, and an 80% reduction target for 2050. To help ensure the delivery of these targets, this part of the Act also requires that the Scottish Ministers set annual targets, in secondary legislation, for Scottish emissions from 2010 to 2050.
Climate Change Delivery Plan (2009)	Identifies transformational outcomes which will need to be substantially delivered by 2030 to put Scotland on the correct pathway to meet the 2050 target. Stresses aim for a largely decarbonised electricity generation sector by 2030, primarily using renewable sources for electricity generation with other electricity generation from fossil fuelled plants utilising carbon capture and storage.
Towards a Low Carbon Economy for Scotland (2010)	This discussion paper sets out the Scottish Government's plans to move towards a low carbon economy in Scotland, as part of the overarching Government Economic Strategy. The purpose of the paper is to invite views on the low carbon economic opportunities that offer the greatest potential to stimulate sustainable economic growth for Scotland, to inform the development of a Low Carbon Strategy that provides strategic direction for the public and private sectors alike.

[7] A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated.

6.6 Marine Energy in Scotland

6.40. In terms of tidal energy, the Scottish Government has stated that 'Scotland is uniquely placed to be a world leader in tidal power.'[8] This statement is supported by a number of recent studies and strategies, the most recent of which estimates that up to 2,000MW (2 Gigawatts (GW)) of marine energy could be installed in Scottish waters by 2020 (see Table 6.3)**.**

6.41. In 2007, and following from the results of these assessment of energy potential, the Scottish Government commissioned a Strategic Environmental Assessment (SEA)[9] to examine the potential effects on the environment from the development of wave and tidal power. The primary objective of the SEA was to assess, at a strategic level, the effects of meeting or exceeding the Marine Energy Group's (MEG's) estimate of 1,300MW of marine renewable energy capacity around Scotland by 2020. The results of the SEA show that it may be possible to meet MEG's estimate of 1,300 MW of capacity with, generally, minor effects on the environment. The SEA Environmental Report does note, however, that there are notable gaps in knowledge and that there are important exceptions to this general conclusion. Furthermore, the likelihood of the more significant effects occurring is very dependent on the particular characteristics of the projects being developed, in combination with the locations where they are being deployed. The Sound of Islay is identified as an area with exploitable tidal energy resource.

[8] http://www.scotland.gov.uk/News/Releases/2008/09/09111618
[9] Include relevant legislation for SEA (if relevant – it was very dodgy)

Table 6.3: Marine Energy in Scotland	
Study / Strategy	**KEY ELEMENTS**
Opportunities for marine energy in Scotland (2002)	This Scottish Executive study investigated the potential for Scotland to benefit from the emerging marine energy industry and considered a number of incentive mechanisms by which it could be encouraged to meet its potential. The report recognised the strengths that Scotland has to offer the industry, including a significant indigenous energy resource and a suitably skilled workforce. It recommended that strong policy direction, support for Research and Development, and a robust market support mechanism are all needed to help marine energy achieve its full potential.
Harnessing Scotland's Marine Energy Potential (2004)	The Marine Energy Group (MEG) was established by the Forum for Renewable Energy Development in Scotland (FREDS) in 2003. An early task for MEG was to assess the potential for developing wave and tidal energy in Scotland, and to produce an action plan for developing that potential framework. The MEG report published in 2004 identified that up to 10% of Scotland's electricity (about 1,300MW) could come from wave and tidal stream power by 2020, significantly contributing to Scottish Government renewable energy targets.
Scottish Marine Renewables Strategic Environmental Assessment (SEA) (2007)	Following from the findings of the 2004 report, "Harnessing Scotland's Marine Energy Potential", the Scottish Government commissioned an SEA to examine the potential effects on the environment from the development of wave and tidal power. The SEA process was used to inform the preparation and delivery of the Scottish Government's Strategy for the development of marine energy, which was published in 2009 as The Scottish Marine Energy Road Map (see below). The SEA covered waters off the west coast of Scotland, from the North Channel northwards to Orkney and Shetland and the Pentland Firth.
Scottish Marine Energy Road Map (2009)	In August 2009 the Scottish Government published the Scottish Marine Energy Road Map developed by FREDS, which charts a course for the development of wave and tidal power around Scotland. The Road Map reflects an up-to-date assessment of the status and potential of the marine energy industry in Scotland, alongside recommended actions to ensure its continuing growth. It considers three marine energy development scenarios, with the 'low' scenario envisaging 500MW installed by 2020, the 'medium' scenario looking at 1,000MW by 2020, and the 'high' scenario considering 2,000MW by 2020. The 'high' scenario would deliver the greatest benefits in terms of renewable energy generation and economic benefit and the Road Map recommends that this scenario, whilst very ambitious, should be aimed for and achieved. The study recognises that although marine energy in Scotland has not developed as quickly as predicted in the 2004 report "Harnessing Scotland's Marine Energy Potential" – due in part to technical difficulties and financial constraints relating to technology development – the sector as a whole has made some significant steps forward over the last five years. The study sets out scenarios for growth of the industry and identifies five key issues which will be vital in terms of realising the high growth scenarios; these are finance, grid, planning, infrastructure / supply chain, and Europe. Progress against the Road Map will be reviewed in 2012.

6.42. As the first operational commercial tidal array in the world, the Sound of Islay Demonstration Tidal Array will help towards meeting the renewables targets set by the Scottish and UK Governments. Most importantly, the project represents a significant and exciting step forwards in proving the viability of tidal energy and to aiding in the development of more of these projects in the future.

6.7 Marine Planning in Scotland

6.43. Marine spatial planning is recognised as the mechanism for achieving a more integrated, simplified and sustainable approach to the management of marine sectors and activities and increased protection of the natural marine and coastal environment. The Marine (Scotland) Act 2010 sets out provisions for marine planning in Scottish waters, and while not yet in force (they will be brought into force on 1 July 2010 (The Marine (Scotland) Act 2010 (Commencement Order No. 1) Order 2010)), it is recognised that the following may apply.

6.44. Marine planning in Scotland will be based on a 3-tier system:

- Scotland (National) Level Planning;
- Regional Level Planning; and
- International Level Planning.

6.45. The statutory status of the proposed plans has not yet been determined. However, it is anticipated that renewable energy developments would be incorporated as part of the proposed regional level planning. It is possible that plans may be in place during the period proposed for construction of the Development.

6.7.1 Scotland (National) Level Plans

6.46. Nationally there will be a single Scottish National Marine Plan, which will take approximately two years to produce. The plan will be prepared by Marine Scotland and will set national economic, social and marine ecosystem objectives alongside objectives relating to the mitigation of, and adaptation to, climate change. The plan may set out specific spatial requirements for particular types of activity or development where these are of national significance.

6.7.2 Regional Level Plans

6.47. These will be prepared for Scottish Marine Regions to take forward policies and priorities defined in the National Marine Plan. Regions will be defined by Marine Scotland and managed by a Marine Planning Partnership which will comprise some one nominated by the Scottish Ministers as well as one or more public authorities and/or stakeholders. The Partnership's will prepare a regional plan for their area, which is likely to include a vision for the marine area covered by the plan, management policies for specific sectors, and a framework for decision making in relation to development consents. The regional plans could take around 2 years to produce.

6.7.3 International Level Plans

6.48. The focus at the international level would be to set Scottish Waters within the wider UK, European, North Atlantic and global frameworks.

6.8 Land-based Planning in Scotland

6.49. As stated earlier, consent for the onshore project components associated with the Sound of Islay Demonstration Tidal Array will be sought as deemed planning permission (under Section 57 of the Town and Country Planning (Scotland) Act 1997 as amended by the Planning etc (Scotland) Act 2008) from the Scottish Ministers.

6.50. In granting deemed planning permission, the Scottish Ministers will need to be assured that the proposed onshore works accord with national and local planning policies, which guide development onshore above Mean High Water Springs. The relevant policies are summarised below.

6.8.1 National Planning

6.51. Scottish Ministers are responsible for the National Planning Framework for Scotland (NPF) which sits at the top of the policy hierarchy and is the long term strategy for the development of Scotland.

6.52. The first NPF (NPF 1) was produced in 2004 and provides a non-statutory spatial planning framework for Scotland for the period to 2025. It identifies key drivers of change in the environment and economy of Scotland and defines strategic infrastructure requirements to provide a basis for future planning.

6.53. Several provisions of the NPF are of relevance to the current proposals: for example, the need for sustainable development, and the need to promote and deliver the Scottish Government's renewable energy targets and aspirations. The framework also recognises the economic benefits that developing Scotland renewable energy potential could bring.

6.54. The second NPF (NPF 2) was published in 2009 and provides an important vehicle for the national debate about the sort of place we want Scotland to be. It will guide and provide a vision for Scotland's spatial development up to 2030, setting out strategic development priorities to support the Scottish Government's central purpose - promoting sustainable economic growth.

6.55. The introduction of NPF 2 is a big step towards securing the future of the renewable energy industry in Scotland; the Government clearly states its commitment to realising the power generating potential of all renewable sources of energy. NPF 2 recognises that longer term potential is likely to lie with new technologies such as wave and tidal power, biomass and offshore wind.

6.56. Scottish Planning Policy (SPP) is the statement of the Scottish Government's policy on nationally important land use planning matters. It was published in February 2010 as a result of the commitment to proportionate and practical planning policies. The SPP replaces a series of planning guidance documents, providing a shorter, clearer and more focused statement of national planning policy.

6.57. The SPP is a statement of Scottish Government policy on land use planning and contains the:

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

6.58. SPP contains 'subject policies', one of which relates to renewable energy. The following extracts are taken from this subject policy:

'Planning authorities should support the development of a diverse range of renewable energy technologies, guide development to appropriate locations and provide clarity on the issues that will be taken into account when specific proposals are assessed. Development plans should support all scales of development associated with the generation of energy and heat from renewable sources, ensuring that an area's renewable energy potential is realised and optimised in a way that takes account of relevant economic, social, environmental and transport issues and maximises benefits.'

'Off-shore renewable energy generation presents significant opportunities to contribute to the achievement of Government targets. Although the planning system does not regulate off-shore development, it is essential that development plans take into account the infrastructure and grid connection needs of the off-shore renewable energy generation industry. Development plans should identify appropriate locations for facilities linked to the manufacture, installation, operation and maintenance of off-shore wind farms and wave and tidal devices.'

6.8.2 Local Planning

6.59. The Local Development Plan (LDP) for an area comprises both the approved structure and the adopted local plan. The Development Plan relevant to the Sound of Islay Demonstration Tidal Array proposal consists of the:

- Argyll and Bute Structure Plan 2002; and
- Argyll and Bute Local Plan 2009.

6.60. The Argyll and Bute Local Plan is accompanied by an Action Plan (Argyll and Bute Local Plan (Action Plan and Monitoring Report) 2010-2012) that provides information on how the plan will be implemented by the Council and its community planning partners. The Action Plan was updated in June 2010.

6.61. The Planning etc (Scotland) Act 2006 requires Argyll and Bute Council to replace the existing Structure Plan and Local Plan with a single LDP. The LDP will set out the long-term vision for future development and land use across Argyll and Bute. The LDP is not expected to be finalised until 2012.

6.62. Table 6.4 identifies where relevant aspects of the LDP have been dealt with in this ES. The relevance of these policies is considered in each ES chapter.

Table 6.4: Adopted Development Plan policies.

ES Chapter	Argyll and Bute Structure Plan 2002	Argyll and Bute Local Plan 2009
Chapter 7 Physical Environment and Coastal Processes	None directly applicable.	None directly applicable.
Chapter 8 Benthic Ecology	STRAT DC 7 – Nature Conservation and Development Control	ENV 6 – Development Impact on Habitats and Species CST 4 – Development Impact on the Natural Foreshore
Chapter 9 Marine Mammals	STRAT DC 7 – Nature Conservation and Development Control	ENV 6 – Development Impact on Habitats and Species
Chapter 10 Noise and Vibration Affecting Human Receptors	None directly applicable.	None directly applicable.
Chapter 11 Marine Fish and Shellfish Resources	STRAT DC 7 – Nature Conservation and Development Control	ENV 6 – Development Impact on Habitats and Species
Chapter 12 Anadromous Fish	STRAT DC 7 – Nature Conservation and Development Control	ENV 6 – Development Impact on Habitats and Species
Chapter 13 Elasmobranchs	STRAT DC 7 – Nature Conservation and Development Control	ENV 6 – Development Impact on Habitats and Species
Chapter 14 Ornithology	STRAT DC 7 – Nature Conservation and Development Control	ENV 6 – Development Impact on Habitats and Species
Chapter 15 Commercial Fisheries	REC CP 2 – Sea-Fishing Interests	None directly applicable.
Chapter 16 Terrestrial and Intertidal Ecology	STRAT DC 7 – Nature Conservation and Development Control STRAT FW 2 – Development Impact on Woodland	ENV 6 – Development Impact on Habitats and Species ENV 7 – Development Impact on Trees / Woodland CST 4 – Development Impact on the Natural Foreshore
Chapter 17 Landscape and	STRAT SI 1 – Sustainable Development	ENV 9 – Development Impact on National Scenic Areas

Table 6.4: Adopted Development Plan policies.

ES Chapter	Argyll and Bute Structure Plan 2002	Argyll and Bute Local Plan 2009
Seascape	STRAT DC 8 – Landscape and Development Control	ENV 10 – Development Impact on Areas of Panoramic Quality ENV 19 – Development Setting, Layout and Design
Chapter 18 Cultural Heritage	STRAT DC 9 – Historic Environment and Development Control	ENV 11 – Development Impact on Historic Gardens and Designed Landscapes ENV 13a – Development Impact on Listed Buildings ENV 13b – Demolition of Listed Buildings ENV 14 – Development in Conservation Areas and Special Built Environment Areas ENV 15 – Demolition in Conservation Areas ENV 16 – Development Impact on Scheduled Ancient Monuments ENV 17 – Development Impact on Sites of Archaeological Importance ENV 18 – Protection and Enhancement of Buildings
Chapter 19 Traffic and Transport	PROP TRANS 1 – Development Control, Transport and Access	TRAN 4 – New and Existing, Public Roads and Private Access Regimes
Chapter 20 Socio-Economics, Tourism and Recreation	REC TOUR 1 – Water Related Tourism Opportunities	TOUR 2 – Safeguarding of Primary Tourist Areas
Chapter 21 Water and Sediment Quality	STRAT SI 1 – Sustainable Development	ENV 12 – Water Quality and Environment
Chapter 22 Military Activity and Munitions	None directly applicable.	None directly applicable.
Chapter 23 Air Quality	STRAT SI 1 – Sustainable Development	None directly applicable.

6.9 Summary

6.63. This chapter identifies relevant legislation and policies for the proposed Development and shows that SPR is cognisant of them.

7.0 Physical Environment and Coastal Processes

7.1 Introduction

7.1. This chapter describes the existing physical environment and coastal processes in the vicinity of the proposed development and at the location of the preferred cable landfall site. Baseline considerations include (amongst others) hydrodynamic and meteorological conditions, as well as geomorphology (seabed and coastal). Potential impacts arising from the construction, operation, maintenance and decommissioning activities have been assessed and mitigation measures outlined where appropriate. Reference is made throughout this chapter to the study area. This is defined as the Sound of Islay.

7.2 Potential Effects

7.2. Current, wave and tidal characteristics (the hydrodynamic regime) can be changed/ modified by the introduction of energy extraction devices to a water body, thereby altering the presently observed hydrodynamic regime. Such modifications may result in associated change(s) to sedimentary regimes and geomorphological expression of the seabed and coastline. Effects on the hydrodynamic and sedimentary regime maybe localised (in the immediate vicinity of devices), at the near-field scale (on the vicinity of the entire development), or at far-field scale (beyond the area of the development). This is as detailed in Chapter 3 of the Scottish Marine Renewables SEA (Scottish Executive, 2007, para. C3.4).

7.3. The development of any coastal or offshore infrastructure may alter hydrodynamic processes and coastal morphology. In this instance, the construction and operation of an offshore array, seabed cable and coastal infrastructure at the landfall has the potential to change the physical environment through alteration of existing hydrodynamic patterns (i.e. waves, currents), sediment patterns (i.e. scour at devices, transport and deposition change through alteration of hydrodynamics) and coastal erosion (i.e. introduction of hard points on the coastline).

7.4. Although the motion of water waves is most evident as a surface phenomenon, there are also movements below the water surface that decrease with depth, which could be influenced by the proposed array. In deep water, the water particles beneath a wave orbit around a circular path and wave motion does not tend to reach the seabed, except in shallow water environments, while in shallow water, the water particles have an elliptical orbit and wave motion is felt at the seabed. Modelling work completed by Garrad Hassan showed minimal impacts on wave conditions within the Sound once the array is deployed as a result of its depth and position. The array is to be sited in water depths averaging approximately -50m CD.

7.5. The above statement can be quantified via consideration of the interaction of wave orbital velocity and water depth at the location of the device.

Lo = (9.81/2PI) T^2

Where Lo = 9.81, PI =3.14, T = 13seconds

7.6. The maximum wave height recorded from site surveys was 1.2m with a wave period of 13 seconds. In terms of British Standards guidance, wave motion is most greatly affected by the presence of the sea bed where the water depth is < L/20 with L being the wavelength. Assuming deep water conditions the deep water wavelength Lo = (9.81/2PI) T^2 where T is equal to the wave period corresponding to the maximum wave expected (1.2m). Based on T being equal to 13 seconds, Lo = 264m Lo/20 = 13 metres.

7.7. Therefore, as long as the water depth to the structure is not less than 13m, which in the case given that the depth of the tidal array is 28m from tip of blade, there will be minimal effect on waves. Wave conditions are therefore not likely to be affected by the development and are not considered further within this ES.

7.3 Summary

The physical environment and coastal processes within the study area are dominated by strong tidal flows through the sound of Islay, the geomorphological form of which results from previous glacial activity and subsequent sub-aerial weathering and erosion to form the landscape seen today. In the study area, man is noted as having had very little impact which would have resulted in anthropogenic modification to hydrodynamic processes or the physical appearance of the Sound.

The impacts of the proposed development on the physical environment and coastal processes are deemed to be of **negligible** significant effect due to the limited scale of the footprint of the array and the low amount of energy that is to be extracted from the physical system during operation of the proposed Development.

7.4 Methodology

7.4.1 Legislation, Guidelines and Policy Framework

7.8. Legislation concerning Section 36 Consent, FEPA and CPA are discussed in *Chapter 6: Regulatory and Policy Control*.

7.9. There are no specific EIA guidelines developed for tidal turbines; however, in the case of the physical environment and coastal processes the guidelines developed for offshore wind farm EIA by CEFAS (2004) are largely applicable (Chapter 3 of that document – Coastal and Sedimentary Processes). These guidelines highlight that consideration should be given for direct impacts on both hydrodynamics and sediment dynamics, alongside potential indirect impacts, such as subsequent effects on water quality or benthic ecology which are covered within separate chapters of the ES (*Chapter 8: Benthic Ecology* and *Chapter 21: Water and Sediment Quality*).

7.10. The European Marine Energy Centre (EMEC) high level EIA Guidance for wave and tidal test sites has been considered (EMEC, 2005). This outlines legal and consenting requirements (EMEC EIA Guidance Section 1.2) and summarises survey and additional data requirements to inform the impact assessment.

7.11. Both of the above guidance documents have been utilised in the production of this impact chapter.

7.4.2 Data Collection

7.12. Partrac Ltd was commissioned by SPR to collect water current velocities via the deployment of Acoustic Doppler Current Profiler (ADCP) during the early stages of the development, in order to inform SPR of the possible energy yield from the site. Three bottom mounted ADCPs and one Acoustic Wave and Current Profiler (AWCP) were placed on the seabed within the Sound at four different locations shown on Figure 7.1. These were deployed after discussion with SPR to provide a high quality data set of current speed and direction within the Sound of Islay to enable an energy yield assessment to be undertaken. The ADCP were used to obtain current readings through the water column whereas the AWCP measured wave speed and current at surface and near surface. This would enable SPR to ensure that yield is maximised and currents would not be to the detriment of the turbines.

7.13. A marine resource site investigation was also undertaken by iXSurvey (2009), providing the basis for assessment of potential impacts on the physical environment. The investigation included:

- Measuring tidal current data – both as transects and static stations(further ADCP and AWCP);
- Mapping boundaries where seabed sediments change;
- The defining of subsurface geology; and
- The collection of accurate bathymetry data.

7.14. A detailed study of fluid movement was undertaken by Garrad Hassan providing the basis for assessment of potential impacts on existing currents and flow regimes. This study included:

- Analysis of temporal variation to inform long term flow regime estimation;
- Analysis of spatial variation to calculate the flow models to be used in the energy yield analysis;
- Long term flow variation estimation over the lifetime of the development (planning consent is being sought for an initial period of 7 years, with potential for extension for a further 7 years); and
- Flow field modelling - estimation of the flow variation across the development site and through the water column.

7.15. The reports from the intertidal surveys of potential cable landfall sites (Appendix 16.2 and Appendix 16.4) were taken into consideration for this chapter.

7.16. Other information has been collected through a desk-based data search. Important sources of information include:

- Scottish Executive (2007). Scottish Marine Renewables SEA;
- ScottishPower Renewables (2008). Proposed Demonstration Tidal Site, Sound of Islay. Request for a Scoping Opinion;
- Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C. and Buck, A.L. (Eds). (1997). Coasts and seas of the United Kingdom, Region 14 South-west Scotland: Ballantrae to Mull. Joint Nature Conservation Committee;
- Ramsay, D.L. and Brampton, A.H. (2000). Coastal Cells in Scotland: Cell 5 – Cape Wrath to the Mull of Kintyre. Scottish Natural Heritage RSM Report No. 147; and
- DTI (2004). Atlas of UK Marine Renewable Energy Resources. Produced by ABPmer, the Met Office, Garrad Hassan, Proudman Oceanographic Laboratory.

7.4.3 Consultation

7.17. Consultation with statutory bodies and key stakeholders was undertaken by SPR as part of the scoping exercise as detailed within '*Proposed Demonstration Tidal Site, Sound of Islay. Request for a Scoping Opinion*' (SPR, 2008). Responses made by Marine Scotland (formally, Fisheries Research Services) and Scottish Environment Protection Agency (SEPA) are relevant to this chapter. Consultation responses focused on alteration to the hydrodynamic and sedimentary regimes within the Sound and potential loss of substrate. For full details of the consultation process, including a summary of all the responses, see *Chapter 2: Scoping and Assessment Methodology*, Appendix 2.1 and *Chapter 3: Consultation*.

7.5 Assessment of significance

7.18. This section describes how the impacts of the construction, operation, maintenance and decommissioning of the development on the physical environment and coastal processes have been assessed.

7.19. Impacts have been assigned a level of likely significance (from major to negligible), according to the definitions described in *Chapter 2: Scoping and Assessment methodology*. The assignment of significance includes consideration of the coastal and near-shore system and the inherent uncertainty within a dynamic environment. The impacts are described quantitatively where possible.

7.20. Table 7.1 provides a description of the criteria used to assess impact magnitude. Levels of magnitude are shown with a general description of the meaning of each 'level' applied within the context of coastal processes.

TABLE 7.1 MAGNITUDE OF IMPACT	
Magnitude of Impact	**Description**
High	A fundamental change to the baseline condition of the receptor.
Medium	A detectible change resulting in the non-fundamental temporary or permanent condition of a receptor.
Low	A minor change to the baseline condition of the receptor (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

7.5.1 Sensitivity of receptor

7.21. The sensitivity or value of the receptor is determined from a set of accepted criteria these are outlined within *Chapter 2: Scoping and Assessment methodology*. A detailed description of the criteria used to assess sensitivity or value for each receptor is provided in Table 7.2 below.

TABLE 7.2 SENSITIVITY/VALUE OF THE RECEPTOR	
Receptor Sensitivity/Value	**Description**
High	Environment is subject to major change(s) due to impact. For example, sites contain features of international or national conservation or cultural designation, or permanent reduction of anthropogenic activity such as fish landings
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. For example sites contain features of national or regional conservation or cultural designation, permanent modification of anthropogenic activity.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example sites of local conservation or cultural value or temporary modification of anthropogenic activity.
Negligible	Environment responds in minimal way to effect such that only minor change(s) are detectable. For example, sites contain features of local interest, little or no change to anthropogenic activity.

7.22. Table 7.3 combines the assessment for the sensitivity of a receptor with the potential impact magnitude to give an overall assessment of the environmental impact significance. Impacts can be either beneficial (positive) or adverse (negative).

TABLE 7.3 IMPACT SIGNIFICANCE MATRIX				
Magnitude of Impact	Receptor Sensitivity/Value			
	Negligible	Low	Medium	High
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

7.23. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is regarded by the EIA Regulations as being of 'significant effect'.

7.6 Baseline description

7.6.1 Coastal and Seabed Geology and Geomorphology

7.24. The exposed coastal geology of the islands around the development comprises a complex mixture of metamorphic Dalradian rocks, including schists and quartzites, belonging to the Argyll and Appin Groups (Barne *et. al.,* 1997). This rock is relatively hard and is resistant to erosion by wave and tidal processes and, therefore, provides a stable platform for development purposes. Swathe bathymetry, geophysical survey and drop-down video surveys show that bedrock is exposed across some parts of the development site and cable route.

7.25. The geomorphology of both the coastline and the seabed of the Sound are formed from the result of extensive fault formation during the end of the Caledonian Orogeny. These have then been eroded by glacial action and subsequent weathering to form the features seen today.

7.26. The overall morphology of the sound of Islay and the development area within it is consistent with a glacial scoured valley. The western (Islay) side of the Sound has in general a shallower gradient between 6° and 10° compared to 11° and 18° seen on the eastern (Jura) side. Side scan sonar revealed that the seabed throughout the site is composed of two main lithologies:

- Exposed bedrock and subrock (bedrock partially exposed or just below the seabed); and
- Gravel and sand.

7.27. The bedrock morphology within the Sound, channels the flow of water in an approximate north-south orientation. Prominent rock outcrops occur in the northern part of the site, narrowing the channel from approximately 356m to 240m. As the channel widens further southwards, a centrally located outcrop approximately 900m long and 192m wide divides the channel into two, with deeper water found in the western channel.

7.28. Further isolated rocky outcrops also occur in the southern half of the Sound, these are mainly small exposed outcrops and pinnacles within a predominantly gravel seabed.

7.29. Much of the seabed throughout the study area is composed of gravel and sand; mainly in depressions within the bedrock and at the base of channels. It is anticipated that this sediment exists as a thin veneer overlying the bedrock, though this statement requires quantification. Throughout the site, numerous scattered boulders occur and these are most numerous in the middle region of the Sound, especially in an area just to the east of Port Askaig. (See Figure 7.2).

7.30. Surveys completed for the proposed development, have identified several discrete and relatively small areas of mega ripples in the sand and gravel; these are most numerous towards the southern end of the sound at -52m CD, where the ripples are up to 1m high with a wavelength of 10-15m. Larger mega ripples up to 1.5m high with a wave length of 25-35m were found to be present on the slopes and summit of a rise that is located in the centre of the channel offshore from Coal Ila (Figure 7.2).

7.31. Megaripples are common bedforms in estuaries, seas and sounds throughout the world where tidal currents in the range 0.6 - 1.3 m/s are encountered. They can be used to determine the prevailing direction of current as they will be aligned perpendicular to the current. The asymmetrical form of megaripples can also be used to indicate net sediment transport (Shepherd and Hails, 1984) as the least steeply angled side (the lee side) will orientate in the direction of predominant net sediment transport. These were not confirmed by the SeaStar Surveys (*Chapter 8: Benthic Ecology*).

7.32. Asymmetry of the mega ripples found in the Sound of Islay (as identified from previous geophysical surveys carried out (Shepherd and Hails, 1984)) is very slight; however, the general orientation of the ripples indicates a sediment transport direction of 343° from N (concurrent with the alignment of the Sound). This correlates with the ADCP data which indicates flow is primarily in a northerly direction during flood and a southerly direction during ebb tide.

7.33. The presence of mega ripples has been identified as a constraint of turbine location; as turbine performance will be hindered where deployed at angles > +/-15 ° from vertical therefore micro-siting techniques will be used to ensure that these formations are avoided. In addition, whilst completing modelling SPR, in discussion with Garrad Hassan, has scoped out slopes of greater than 6°, which are considered to be a constraint to site development.

7.34. The coastline of Islay adjacent to the development is comprised primarily of cliffs and raised beaches, with a shoreline dominated by gravel and exposed rock platform with boulders (Barne *et. al.,* 1997).

7.35. The coastline of Jura adjacent to the development is also comprised primarily of maritime cliff but also often displays a pebble and cobble dominated foreshore. On Jura, parts of the route of the A846 (the main road through the island) separates the cliffs from the foreshore.

7.36. Potential cable landing options were identified based on a review of video footage of the shoreline of the Sound, Ordnance Survey maps and Admiralty Charts, as well as limited on-site examination (See *Chapter 16: Terrestrial and Intertidal Ecology*). The preferred cable landing point at Daimh-sgeir is characterised by narrow pebble, cobble and boulder shoreline with exposed areas or rock platforms.

7.6.2 Bathymetry

7.37. At the northern and southern entrances to the Sound of Islay, the seabed depth generally varies between -10m CD and -20m CD. The bathymetry across the study area (shown in Figure 7.3 is characterised by a steep sided channel, typical of a glacially scoured valley, which is constricted between the islands of Jura and Islay. Along the western side of the channel the seabed rises steeply up from a maximum depth of -62m CD to the shoreline. On the eastern shore this also occurs at the narrowest point of the channel but in the wider sections the seabed rises to a plateau at around -10m CD to -20 m CD.

7.38. The morphology of the whole area of the Sound of Islay is such that there is very little in the way of flat seabed that is suitable for deployment of the tidal devices. However, there are two areas of seabed, at approximately -50m CD average depth, which have gradients of generally <5 degrees, and which have been identified as suitable for deployment. The preferred cable route to Daimh-sgeir on Jura, would ascend a fairly steep slope up to the -25m CD contour, approximately 1km from the shore.

7.6.3 Wind and Wave Climate

7.39. There are limited data for wind and wave climate specifically available for the Sound itself, the bulk of available data is focused on the western side of the island. Data indicate that the dominant winds are incident from the south-west, characteristic with much of Great Britain. Mean wind speeds exceeded 4m/s for 75% of the time (recorded between the years 1915-1960 across Islay and Jura) and the wind speed exceeded 20m/s for 0.1% of the time (averaged) across the western part of Islay (Barne *et.al.,* 1997). The critical fetches for local wind wave generation are 0° N and 150° N from the site. Previous work completed for a harbour development at Port Askaig, approximately 300m from the development, illustrated that the offshore/nearshore wave regime was characterised by wave heights of up to 2.9m as shown in Table 7.4 (Royal Haskoning, 2010).

7.40. The Sound of Islay is protected from open oceanic waves by the land mass of Islay. Locally generated wind waves, rather than swell waves, have a much greater influence across the development site. Another significant influence is waves generated by wind pushing against the tide. AWCP was deployed for a period of 31 days in the summer of 2009 capturing a full spring-neap-spring-neap monthly tidal cycle. Maximum wave heights of 1.2m, with a wave period of 13 seconds, were recorded over the monitoring period. The surveys carried out showed that the peak wave is relatively small in comparison to swell waves found in the open ocean.

Table 7.4: Wave parameters at Port Askaig - Calculated for MHWS (2.1 m CD)

Return period (years)	Direction (dgr. N)	Fetch (Km)	Wind speed (m/s)	Duration (hours)	Wave @ Port Askaig		
					Water depth (m)	Hs (m)	Tm (s)
1	0	45	18.1	6	10	1.7	6.1
	150	40	24.7	6	10	2.1	7.0
50	0	45	28.5	6	10	2.4	7.8
	150	40	37.5	6	10	2.8	8.8
100	0	45	30.4	6	10	2.5	8.1
	150	40	39.8	6	10	2.9	9.1

7.6.4 Tidal Range

7.41. Tidal water movement is a key characteristic of the Sound and the reason the site has been selected for the development. The main tidal flood stream flows up through North Sound and around the western coastline of Islay. Along the western mainland coast, the flood flows to the north along the coastline of the Kintyre peninsula and through the Sound of Jura and into the Firth of Lorn (HR Wallingford, 2000). The ebb acts in a reverse direction (Figure 7.4).

7.42. Tidal data is available to predict tidal range for various shoreline locations around the sound of Islay and inshore. Principally it is available from relevant Admiralty Chart (Chart No. 2168) for which locations are shown in Figure 7.5 below. In addition to the relevant Admiralty data SPR have also fitted tide gauges to the pier at Port Askaig to provide accurate local data to inform the project. The data collected by the tide gauge is shown within Table 7.5 below.

Table 7.5: Tidal levels and ranges

Location	MHWS	MLWS	Spring Range (m)	MHWN	MLWN	Neap Range (m)
Rubha a'Mhail	3.7	0.6	4.3	2.8	1.5	4.2
Ardnave Point	3.6	0.6	4.2	2.7	1.5	4.2
Orsay Island	2.6	0.5	3.1	2.3	1.3	3.6
Bruichladdich	2.3	0.8	3.1	1.5	1.4	2.9
Port Ellen	0.9	0.3	1.2	0.8	0.5	1.3
Port Askaig*	2.1	0.4	1.7	1.5	1.0	0.5
Craighouse	1.2	0.3	1.5	0.9	0.4	1.3
Sound of Gigha	1.5	0.6	2.1	1.3	0.8	2.1
*Taken from tidal gauge readings						

7.43. The geographical location of where these shore line measurements were taken is illustrated in Figure 7.5. The majority of the locations lie outside of the Sound; however, the data may be utilised herein to illustrate the potential tidal range to be expected within the geographical area for the purposes of assessment.

7.6.5 Tidal Currents

7.44. Strong tidal currents characterise the rapid constriction of the channel between Islay and Jura. An initial appraisal of currents can be gained from the information published on the Admiralty Chart for this coastline, which in this case details measured current speeds and directions for three locations, as illustrated in Figure 7.5. Data from the charts is reproduced in Table 7.6 and although none of the locations fall within the Sound of Islay, they provide an understanding of wider regional tidal conditions. Position A is located in the deep-water channel between Islay and Gigha (south-east of the Sound of Islay), Position B is located in shallow waters between the Kintyre peninsula and Jura (east of the Sound of Islay), and

Position C is located in shallow waters in the Sound of Gigha (south-east of the Sound of Islay).

Table.7.6: Tidal streams									
Time relative to HW Oban	Position A 55°40'.0N 5 53.0W			Position B 55° 53'.2N 5 49.0W			Position C 55° 40'.8N 5 42.6W		
	Dir (°N)	Speed (knots)		Dir (°N)	Speed (knots)		Dir (°N)	Speed (knots)	
		Spring	Neap		Spring	Neap		Spring	Neap
-6	359	0.3	0.1	350	0.8	0.3	000	1.0	0.3
-5	024	0.6	0.2	352	1.7	0.7	009	1.2	0.4
-4	018	0.5	0.2	000	1.8	0.7	012	1.1	0.4
-3	008	0.3	0.1	008	1.4	0.6	015	0.8	0.3
-2	358	0.1	0.0	017	0.9	0.4	011	0.5	0.2
-1	197	0.2	0.1	093	0.2	0.1	150	0.1	0.0
0	198	0.5	0.2	165	0.5	0.2	185	0.8	0.2
+1	198	0.6	0.2	182	1.0	0.4	193	1.2	0.4
+2	191	0.4	0.2	189	1.6	0.6	183	1.3	0.4
+3	181	0.2	0.1	192	1.6	0.6	174	1.0	0.3
+4	143	0.1	0.0	190	1.0	0.4	193	0.6	0.2
+5	010	0.1	0.0	190	0.2	0.1	312	0.2	0.1
+6	359	0.3	0.1	358	0.5	0.2	353	1.0	0.3

7.45. Admiralty data points are useful, but a more detailed appraisal of tidal currents across the development can be derived from field measurements. Current profiles were measured at 3 transect locations in the Sound of Islay through a 13-hour tidal cycle by IX Survey in 2009. The 13 hour timescale only provides limited data for current profiling. In addition to the transects completed, 3 fixed location ADCPs were setup on the seabed alongside the AWCP. These were in position and recording for a period of 31 days from 15th June to 17th July 2009.

7.46. Table 7.7 presents the highest recorded flows found from both sets of surveys. The highest recorded current speed (2.80 m/s or 5.44kts) occured at two hours after high water at the most northerly of the transects, indicating that the strongest tidal flows are associated with the flood phase of the tidal cycle.

Table 7.7: Highest recorded current flows during mid tides using vessel mounted ADCPs in the Sound of Islay. (See Appendix 7.3)					
Transect	Highest Recorded Flow (m/s)	Highest Recorded Flow(Knots)	High Water (± hrs)	Flow Direction (degrees)	Depth (m)
B	2.64	5.13	HW -4	024	24
C	2.62	5.09	HW +3	204	32
D	2.80	5.44	HW +2	180	8

7.47. The reason for high current speeds recorded at this transect is due to a shallow area in the middle of the transect (Figure 7.1) where there is a rock outcrop. The water here is constrained between the rock outcrop and the east coast of Islay. This constraining of the flow accelerates the water, then, once past the narrow area the deeper channel widens and the current speeds slow. This increase in current speed due to the constriction imposed by the geomorphological and bathymetric expression on the tidal flow is expressed within the law of continuity which outlines the conservation of volume and hence states that current speed must increase as an increased water volumes moves through a constricted space, such as found within the sound.

7.48. A review of vessel mounted ADCP data and bathymetric data (collection commissioned by SPR for the development) shows that on the ebb tide (when the flow is moving south) the fastest region of flow holds close to the west side of the channel (Islay side). The reason for this is three fold: an upstream bathymetric form forces more of the flow to that side, a slight change in channel direction after Port Askaig forces the flow to the outside of the bend and a fairly steep side on the western bank of the channel (Appendix 7.1). The bathymetry of the sound is shown at Figure 7.2 and 7.3

7.6.6 Seabed Processes and Sediment Transport

7.49. Seabed transport is driven by the direction and strength of hydrodynamic flows (tidal currents and combined wave and tidal current) with the degree of sediment transport being governed by sediment type (primarily cohesiveness, grain size, density and shape) alongside overall availability of bed sediment.

7.50. Sediments transport into the Sound of Islay is inferred to be from both the northern and southern entrances, driven predominantly by the tidal currents shown in Figure 7.2. Any sediment suspended carried within the tidal currents is likely to have originated from the Kintyre peninsula to the east of the Sound. There is an abundance of sediment along parts of the Kintyre peninsula, much of which is derived from glacial deposits. However, because there is little net transport of sediment away from these beaches (HR Wallingford, 2000), the amount of suspended sediment within the sound is likely to be low. Sediment that remains within the sound is likely to be coarse grained and of relatively high density, being typically more difficult to entrain and subsequently transport. Larger sediment sizes also have a tendency to settle to the seabed rapidly, subsequent to any transportation.

7.51. The very slight asymmetry of mega ripples found within the Sound (see Figure 7.2 and Paragraph 7.28) indicates that although there is little sediment transport; what limited transport there is, is likely to be in a north north-westerly direction of 343 degrees.

7.7 Assessment of Effects and Mitigation

7.52. In this section likely impacts of the proposed Development on the physical environment are assessed using the methodology described above and as outlined within *Chapter 2*: *Scoping and Assessment Methodology*.

7.7.1 Do nothing scenario

7.53. This section assesses how the physical environment may be altered in the future if the proposed development is not constructed.

7.54. Under a do nothing scenario it would be expected that the currently observed physical environment of the study area would remain largely unchanged except for anticipated change to sea level. The International Panel Climate Change(IPCC) third assessment, indicates that sea level is predicted to rise at an accelerated rate with sea level rising up to 10cm in Scotland by 2020 (Worst case scenario relative to 1961-1990 for the full range of global sea-level changes estimated by the IPCC, incorporating the updated isostatic adjustment data).(IPCC 2001).

7.55. There are no known plans for major development within the Sound of Islay itself or to its coastline. It is likely, however, that there will be some small scale development of the eastern coastlines of both Islay and the south western coastline of Jura, which will be primarily as a result of tourism (harbour and infrastructure development) (see *Chapter 20: Socio-economics, Tourism and Recreation*).

7.56. A proposed small-scale hydroelectric scheme (currently at the planning stage) is proposed on Jura as that area currently has no permanent electricity supply. It is unknown as to the extent that this development is likely to have on the overall physical environment and coastal processes that occur in the area.

7.57. Scottish and Southern Energy is currently progressing plans to develop an offshore wind farm to the west of Islay, which may lead to additional development at Port Askaig. The extent of development and further infrastructure required is currently unknown and therefore the impact should this proceed cannot be assessed.

7.7.2 Potential Impacts during Construction Phase

Impact 7.1: Displacement of sediment resulting in alteration or loss of bedforms and geomorphology

7.58. There is potential for seabed substrate (habitat) loss, which could alter sediment supply and mobility of presently occurring bedforms within the Sound of Islay at a) the site of the turbines, and b) the route of the cabling to shore. Loss of substrate will result from the footprint of the turbines and cable on the seabed, while bedform alteration may occur from laying the cable towards landfall and further onshore.

7.59. The footprint of each turbine is supported by three circular feet in a triangular layout. Each foot has a base of approximately 3.5m in diameter. This gives each foot a footprint of 10.99m² or 32.97m² per turbine. If the proposed 10 turbines are installed this will equate to a seabed (substrate) area of 329.7m^2 being lost due to the physical footprint of the turbines within the Sound.

7.60. The methodology for cable installation is to be confirmed but cable armouring is the preferred option of cable installation on the seabed. The only area of the seabed disturbed will be the footprint of the cable on the seabed. This has been estimated worst case scenario at 45cm width (providing a 35cm buffer of the 100 mm diameter of armoured cable). There is approximately 5km of cable to be laid for the device (this includes the inter-array). The cable footprint area therefore predicted is (5000m length x 0.45m) = 2250m².

7.61. The cable route may also alter the seabed bedforms currently seen on the site via alteration of near bed hydrodynamic and sedimentary processes. Sediment movement can be assessed by analysis of the Hjulstrom curve (Figure 7.7), which illustrates the relationship between the current velocity and mean grain size in terms of the expected dominant sedimentary regime (erosion, transport or deposition). Using the near bed velocity (obtained from ADCP survey) estimated to be <0.5m/s and a mean sediment grain size of 2-256mm for gravel the Hjulstrom curve illustrates that the environment is transport dominated. The proposed cable route lies perpendicular to the dominant flow direction, which is 160°-180° from North. The cable will therefore act as temporary barrier to sediment transport along this axis until sediment accretion attains an elevation sufficient to allow sediment bypassing of the structure. The scale of inhibition to bedform mobility within the development site is anticipated to be negligible. This is as a consequence of the proposed cable thickness being 10cm in elevation compared with mobile bedforms which attain elevations in the region of 1.0-1.5m. Due to the size of the cable relative to the migratory bedforms within the system a new dynamic equilibrium between the hydrodynamic and sedimentary regimes and the seabed infrastructure will quickly establish.

7.62. An area of cable trenching at landfall is proposed where sediment will be excavated. However, the trenching will be restricted to an area limited spatially to approximately 100m offshore. The trenched area will be infilled once the cable is in place with no anticipated permanent change to seabed or coastal morphology. The present environment is dominated by sediment transport and deposition, as shown by the shaded area beneath the curve in Figure 7.7. At present, it is assumed that the landfall will be achieved either by ploughing (with the volume being ploughed being restricted to 45m³ (worst case scenario) (0.45m wide x 1m depth x 100m from the shoreline). Horizontal directional drilling (HDD) is not being considered at this stage. If trenching is the methodology chosen, then there will be minimal impact on the shoreline Impacts during construction will be minimised provided that the foreshore levels are reinstated using the trenched material immediately following cable laying. The areas identified for cable landing are dominated by gravel and pebble beaches those materials are replaced then the coastal processes will not be affected by trenching as the material and profile that currently exists will remain.

7.63. During backscatter mapping of the Sound of Islay an area of approximately 3.57km^2 was mapped, covering less than 1/10th of the area of the entire Sound of Islay. The mapped area was found to be composed of almost 76% gravel (Figure 7.6) which equates to approximately 2.71km^2. The calculated footprint of the turbines is therefore likely to result in the loss of 0.05% of the development site and 0.005% of the full Sound of Islay.

7.64. Due to the grain size found within the Sound, gravel and coarser grained fractions, any sediment displaced as a result of the construction processes is likely to settle within metres of disturbance. Any material moved due to the construction methodology will rapidly return to the seabed, helped by installation of the proposed infrastructure during periods of slack water when sediment transport potential is reduced, with current velocity below the critical threshold for gravel size sediment entrainment and transport. Water quality issues are discussed in *Chapter 21: Water and Sediment Quality*.

7.65. Due to the small area (substrate) of the Sound lost as a result of the turbine footprint, the magnitude of the impact upon the sedimentary regime is considered to be low, while sensitivity of substrate loss is also deemed to be low. The overall impact of potential sediment loss is deemed to be **negligible**.

7.66. There is no change anticipated to the status of the geomorphology of the sound both at the coast and on the seabed as a result of the Development. The magnitude of impacts on geomorphological processes will be low with a short term localised restriction to sediment transport until such times as sediment accretes to the 10cm elevation of the emplaced cable. The observed sedimentary regime will return to present condition rapidly and it is expected that bedforms will be back to original condition within 12 months. Displaced material from any development is not expected to migrate long distances and the sensitivity of substrate/geomorphology is also low. Therefore the impact on substrate/geomorphology caused by displacing sediment is likely to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 7.1
• No mitigation required

Residual impact:

7.67. As no mitigation is required, the impact of displacing sediment is likely to be of **negligible** significant effect.

Impact 7.2: Increase in suspended sediment

7.68. Seabed sediment could potentially be disturbed as a result of construction activities on the seabed including:

- Installation of the turbines and gravity-based foundation structures (including any seabed preparation);
- Installation of inter-array and export cables; and
- Construction vessel activity (Potential anchoring, if required).

7.69. Any sediment that is disturbed and enters into suspension could subsequently be transported and dispersed by the prevailing tidal currents, and will be re-deposited on the seabed. This disturbance to surface sediments and bedrock has the potential to impact on water quality (also discussed in *Chapter 21: Water and Sediment Quality)* as a result of increased suspended sediment concentrations. The impact of suspended sediments on biological communities is discussed in the relevant chapters e.g. *Chapter 8: Benthic Ecology* and *Chapter 9: Marine mammals*.

7.70. Table 7.8 details estimated areas of substrate which could be disturbed and factors influencing dispersal. The amount of substrate lost has been estimated using the base surface area (footprint) of the devices and a buffered cable footprint. The results of this are considered minimal, due to the substrate within the Sound being predominantly gravel and exposed bedrock.

Table 7.8: Outline estimate of sediment displacement	
Turbine details	**Value**
Size of turbine footprint (m^2)	32.97²(per device) 329.7m² (for array)
Water depth	48m approx
Type of seabed substrate	Bedrock/ boulders/ gravel
Loss of substrate and change of seabed morphology from subsea export cable	Mooring will be used to secure cables to the seabed. The only area of the seabed to be disturbed will be the seabed substrate lost by the placement of the armoured cable on the seabed. This has been estimated conservatively at 45cm width (providing a 35cm buffer of the 10cm diameter of armoured cable) giving 2250m² . The placement of cable on the seabed will result in a temporary alteration in the bedform which is much smaller than current seabed features. The cable diameter is 10cm which will temporarily act as a barrier to sediment movement on the seabed until accretion results in cable burial.
Volume of sediment to be excavated and returned from trenching as the cable comes ashore	Landfall will be achieved either by ploughing (with the volume being ploughed being restricted to 45m³ (worst case scenario) (0.45m wide x 1m depth x 100m from the shoreline).

7.71. If the near bed velocity is high enough to exceed the critical shear threshold of the seabed and enable sediment to be entrained and subsequently brought into suspension, subsequent dispersion is inferred to occur within the wider environment of the Sound. The strength of the tide, the potential for dispersion, and the settling characteristics of the suspended sediment will determine the footprint over which the sediment will be deposited.

7.72. Due to the generally coarse nature (mostly gravel and larger grain sizes) of sediments, reworking of seabed bedforms under tidal currents is likely to continue to be the dominant sedimentary regime within the wider study area. Should sediments be suspended they are expected to settle back to the seabed very rapidly and therefore the sediment dispersion footprint is unlikely to extend any great distance from the cable route or the turbine and the magnitude of potential impact and sensitivity of the receptor are both considered to be low.

7.73. Construction will be undertaken during slack water which is assumed to have very low current velocities of less than $0.1ms^{-1}$. As shown within Figure 7.7, due to the Sound having gravel >2mm there will be no sediment transport taking place during this period. Cable installation will also take place during periods of low current velocity and over a limited area. Therefore, the significance of effect of the potential impact of sediment re-suspension is assessed as being **negligible**.

MITIGATION IN RELATION TO IMPACT 7.2
• No mitigation required

Residual Impacts

7.74. As no mitigation is required, the residual impact will remain of **negligible** significant effect.

7.7.3 Potential Impacts during Operation and Maintenance Phase

7.75. The impacts of sediment displacement or increase in suspended sediments are not predicted to be an issue post construction. Impacts during operation and maintenance are discussed below.

Impact 7.3: Alteration of the hydrodynamic regime

7.76. Currents would be modified in the immediate vicinity of the tidal devices and support structures. In the immediate lee of each device there will be a flow separation zone and downstream turbulence. Hydrodynamic modelling has been completed by Garrad Hassan to assess the most efficient layout and turbine height within the water column; however, to show any alteration in hydrodynamics, total energy of the tidal system within the Sound of Islay must be assessed.

7.77. There are limited data available to address the energy being removed from the tidal system by the turbines. For the proposed layout of the array newly developed modelling methodologies were used, although at the time of writing full scale validation of the models was still being undertaken. All the energy yield models used assume that the extraction of energy within the Sound does not significantly affect the flow.

7.78. Observations of two existing tidal turbine devices which have been developed by Marine Current Turbines (MCT) indicate that the overall impact of energy extracted by Seaflow (their first device which was located off the north Devon coast) was negligible and Computational Fluid Dynamics (CFD) modelling predicted the same to be true of Seagen (second device which is generating within Strangford Lough, Northern Ireland) (Royal Haskoning, 2005). The modelling studies undertaken for the MCT tidal devices “Seagen” in Strangford Loch found that there would be no measurable change in the tidal currents beyond 500m from the device. (Scottish Executive, 2007).

7.79. From studies completed by Garrad Hassan there are expected to be no significant changes predicted from the proposed development to the hydrodynamics of the Sound of Islay. There are likely to be negligible localised effects around the turbines themselves but these will not affect the broad scale flow regime within the Sound. This correlates with previous studies on devices of a similar nature completed within UK waters (see Paragraph 7.77). Even without any turbines installed, there is a substantial amount of 'work done' to push flow through the Sound. From basic mechanics (work = force x distance, pressure = force / area and flowrate = velocity x area), it can be shown that the power required to push a flowrate through a pressure loss in a steady-state system = pressure x volume flowrate. This is the standard way of calculating power losses in pipework systems. Note that this is not an 'available power' or an 'extractable power'; it is the power expended simply to push the water through the constriction of the channel. Any additional 'blockage' put in the channel will add to the power required to push a given amount of water through it. (Internal Email Scottish Power Renewables July 13th 2010).

7.80. Using a Mike21 model of the channel, the average power over the tidal cycle is 240MW. For comparison, the average power extracted by the turbines is (nameplate power x capacity factor / efficiency =) 3.3MW. This means that if the velocity through the channel remained unchanged by the introduction of the turbines, the pressure difference would increase by 1.37%. In practise, the pressure difference will remain roughly constant and the velocity through the channel will reduce. For a given loss coefficient, pressure drop is proportional to velocity squared, so the velocity will reduce by around 0.7%. Using the average power available during a tidal cycle comparing the average energy extracted by the array during a tidal cycle:

3.3/240(MW) =1.4% of available energy is extracted per cycle.

7.81. This can be used as a conservative estimate of energy extraction within the Sound. The amount of energy extracted is therefore of negligible sensitivity in comparison to the energy from tidal movement throughout the Sound, and the impact is predicted to be of low magnitude.

7.82. Therefore, the alteration of currents by the Development on a larger scale is likely to be of **negligible** significance.

7.83. Due to the **negligible** significance in altering hydrodynamics of the scheme there will be **no impacts** on potential sediment displacement during operation of the array. There is therefore **no significant effect** upon potential sediment displacement or alteration of bedforms.

MITIGATION IN RELATION TO IMPACT 7.3
• No mitigation required.

Residual Impact:

7.84. The impact of alteration of currents is likely to remain of **negligible** significance, with **no significant effects** upon potential sediment displacement or alteration of bedforms.

Impact 7.4: Impacts on the coastal hydrodynamic and sediment regime around the development site from operation of the tidal development.

7.85. The only impact will be from the cable lying on the seabed which will act as a temporary barrier to sediment movement. Sediment will accrete around the cable, returning to original condition within 12 months (as discussed within Paragraph 7.56). The magnitude of the potential impact is considered to be low.

7.86. Given that the foreshore and nearshore zone will be returned to pre-construction conditions immediately after trenching, the depth and distance to the underwater array and the low sensitivity of the receptor there will be **no significant effect** on coastal processes during operation. The cable route will be installed over a period of 6-8 weeks and will be trenched prior to be being put into operation.

MITIGATION IN RELATION TO IMPACT 7.4
• No mitigation required

7.87. As no mitigation is required, the impact on coastal processes will remain of **no significant effect**.

7.7.4 Potential Impacts during Decommissioning Phase

7.88. At the current time, no specific proposals have been set out for the decommissioning of the development or cables at the end of the project. It is assumed that permanently buried cables would be left in place, and that devices and support structures would be entirely removed. Any exposed or potentially exposed cable lengths would also need to be removed. Under this situation there would be no broad scale or long term impacts on seabed or coastal processes. Impacts would be similar to those identified during the construction phase, but with lower initial magnitude. As these were identified as being of **negligible** significance there is no requirement to detail these here. A decommissioning plan will be produced to outline how the approach to decommissioning will be undertaken.

7.8 Cumulative Impacts

7.89. There are a number of other projects underway that may have the potential to cumulatively impact on the proposal these include:

- Argyll Array (Offshore Wind farm under consideration to the West of Tiree, may alter the regional sedimentary regime.)
- DP Energy ((Tidal Farm at scoping stage) may act cumulatively to alter local hydrodynamic regime and sediment movement).
- SSE Jura Hydro Scheme (Through alteration of estuarine hydrodynamics)
- SSE proposed wind farm to the west of Islay, (may alter regional sedimentary regime)
- Coastal development for Port Askaig (Through alteration of the coastline).

7.90. As there are no impacts that are deemed to cause significant effects on the physical environment or coastal processes from the development there is no further potential for this development to act in combination with any other existing or proposed activities or projects to result in cumulative impacts on coastal processes.

7.9 Summary of significance of impacts

A summary of effects for all impacts is presented in Table 7.9 below.

Table 7.9 Summary of Effects								
	Construction/ Decommissioning				Operation/Maintenance			
Impact	**Magnitude of Impact**	**Sensitivity / value of receptor**	**Significance of effect**	**Residual significance of impact after mitigation**	**Magnitude of Impact**	**Sensitivity / value of receptor**	**Significance of effect**	**Residual significance of impact after mitigation**
Displacement of sediment altering bedforms / geomorphology	Low	Low	Negligible	Negligible	N/A	N/A	N/A	N/A
Increase in suspended sediment	Low	Low	Negligible	Negligible	N/A	N/A	N/A	N/A
Alteration in hydrodynamics	N/A	N/A	N/A	N/A	Low	Negligible	Negligible	Negligible
Impacts on coastal processes	N/A	N/A	N/A	N/A	Low	Low	No significant effect	No significant effect

7.10 Statement of significance

7.91. It is concluded that the potential impacts identified for impacts on the physical environment and coastal processes will be of **negligible** significant effect.

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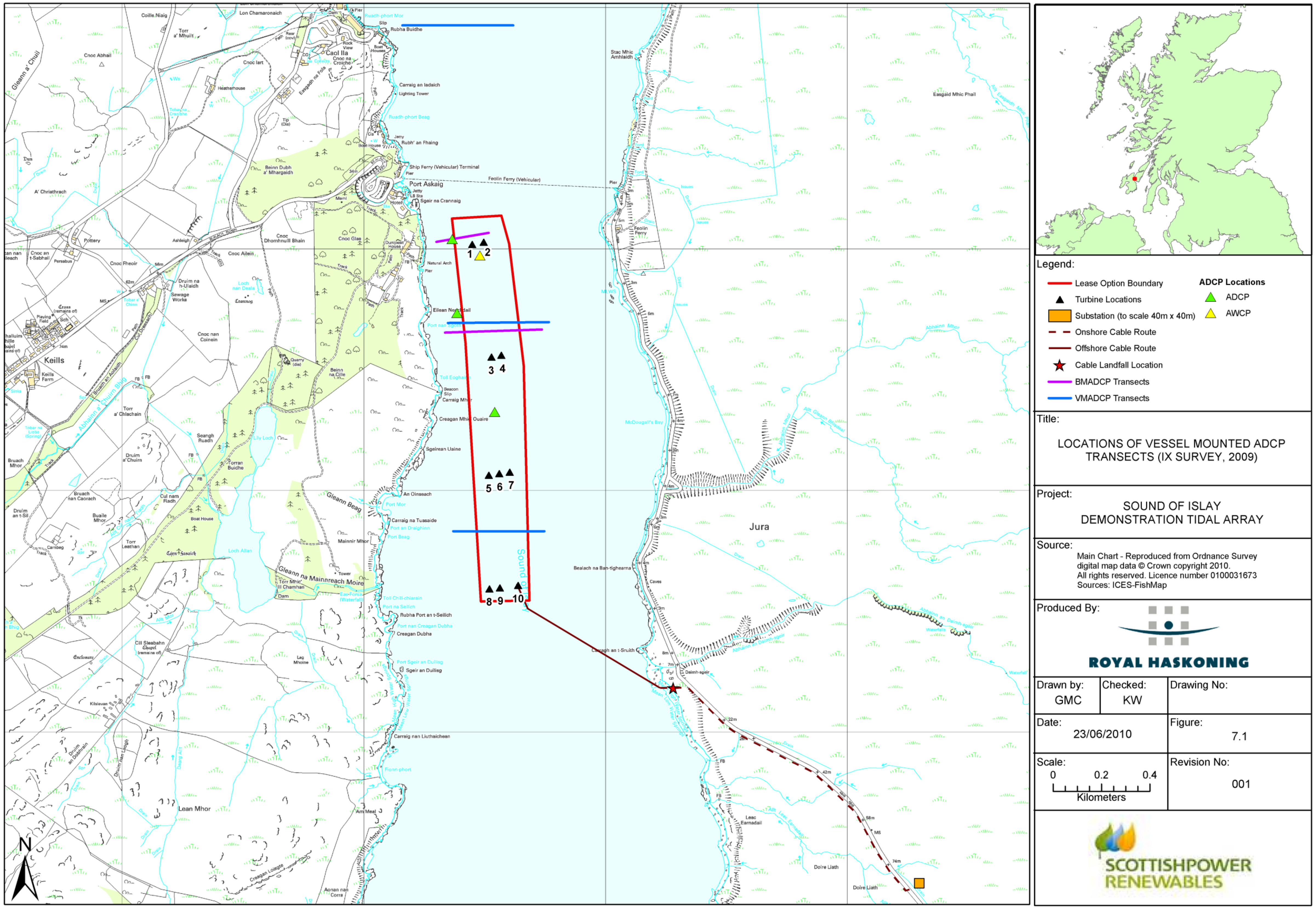
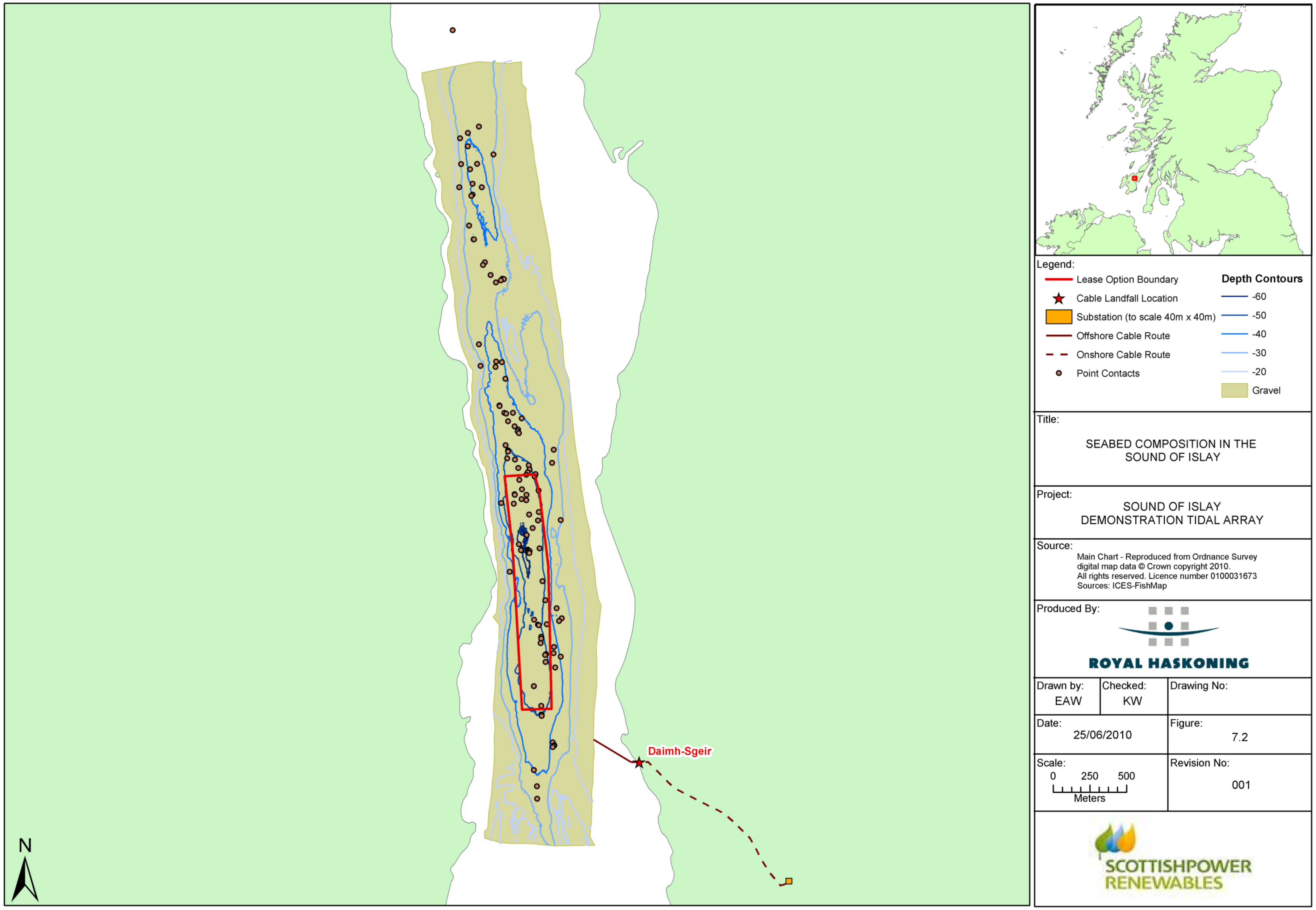

Port Askaig
Caol Ila
Keills
Jura
Sound of Islay
1 2
3 4
5 6 7
8 9 10
N
Legend:
Lease Option Boundary
Turbine Locations
Substation (to scale 40m x 40m)
Onshore Cable Route
Offshore Cable Route
Cable Landfall Location
BMADCP Transects
VMADCP Transects
ADCP Locations
ADCP
AWCP
Title:
LOCATIONS OF VESSEL MOUNTED ADCP TRANSECTS (IX SURVEY, 2009)
Project:
SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY
Source:
Main Chart - Reproduced from Ordnance Survey digital map data © Crown copyright 2010. All rights reserved. Licence number 0100031673
Sources: ICES-FishMap
Produced By:
ROYAL HASKONING
Drawn by: GMC
Checked: KW
Drawing No:
Date: 23/06/2010
Figure: 7.1
Scale:
0 0.2 0.4
Kilometers
Revision No: 001
SCOTTISHPOWER RENEWABLES


Daimh-Sgeir
N
Legend:
Lease Option Boundary
Cable Landfall Location
Substation (to scale 40m x 40m)
Offshore Cable Route
Onshore Cable Route
Point Contacts
Depth Contours
-60
-50
-40
-30
-20
Gravel
Title:
SEABED COMPOSITION IN THE SOUND OF ISLAY
Project:
SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY
Source:
Main Chart - Reproduced from Ordnance Survey digital map data © Crown copyright 2010. All rights reserved. Licence number 0100031673
Sources: ICES-FishMap
Produced By:
ROYAL HASKONING
Drawn by: EAW
Checked: KW
Drawing No:
Date: 25/06/2010
Figure: 7.2
Scale:
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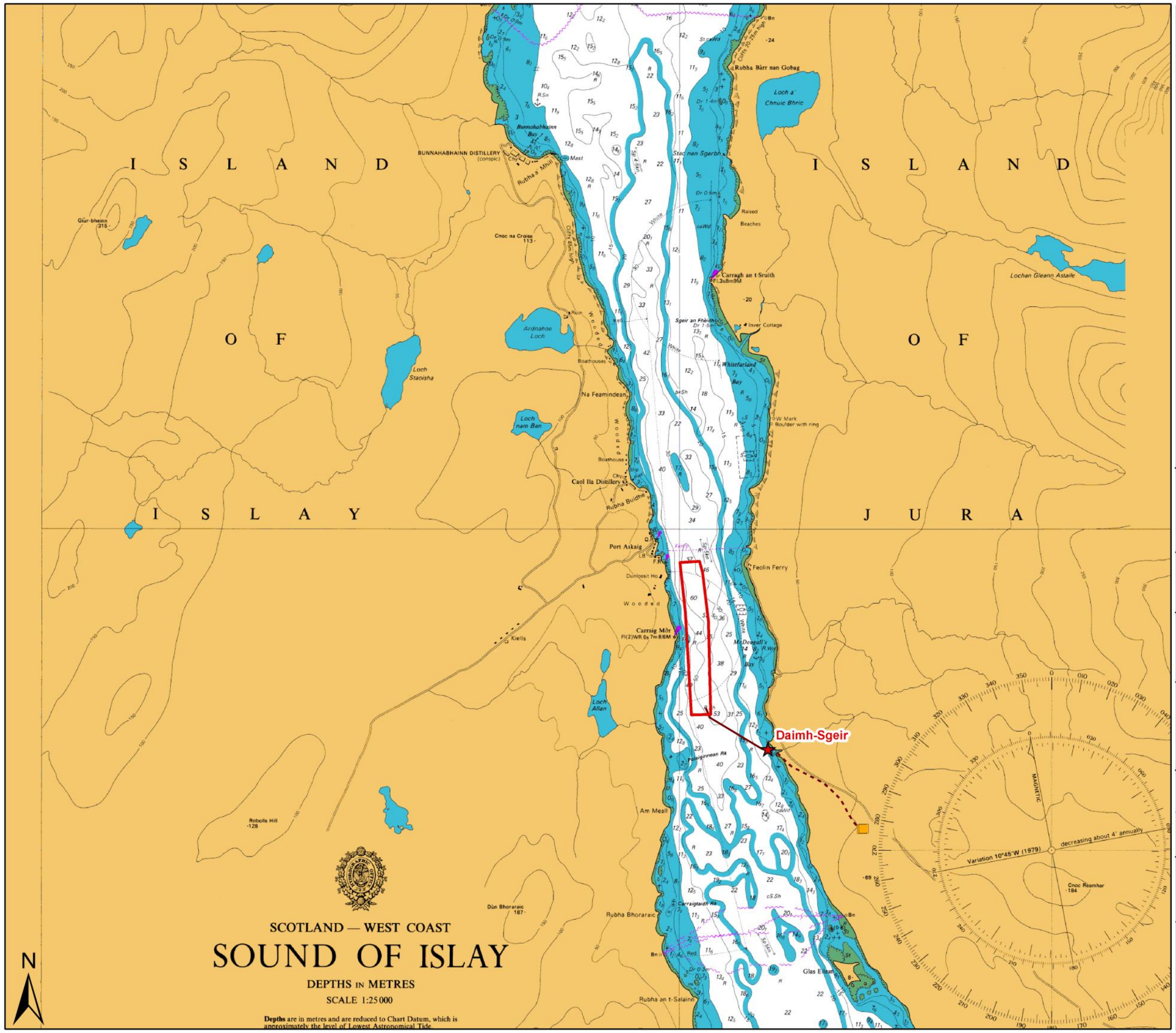
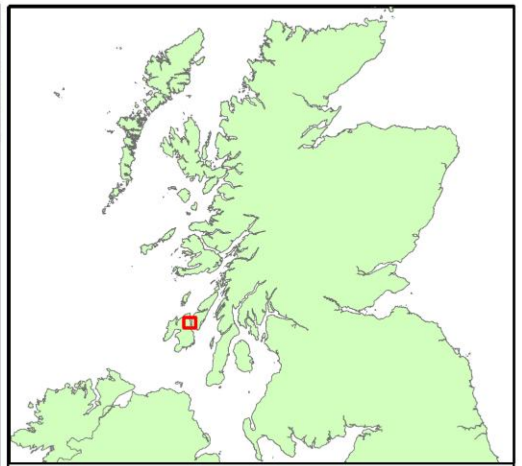
Meters
Revision No: 001
SCOTTISHPOWER RENEWABLES





Legend:
- Lease Option Boundary
- Cable Landfall Location
- Substation
- Onshore Cable Route
- Offshore Cable Route

Title:
ADMIRALTY CHART SHOWING THE SOUND OF ISLAY

Project:
SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY

Source:
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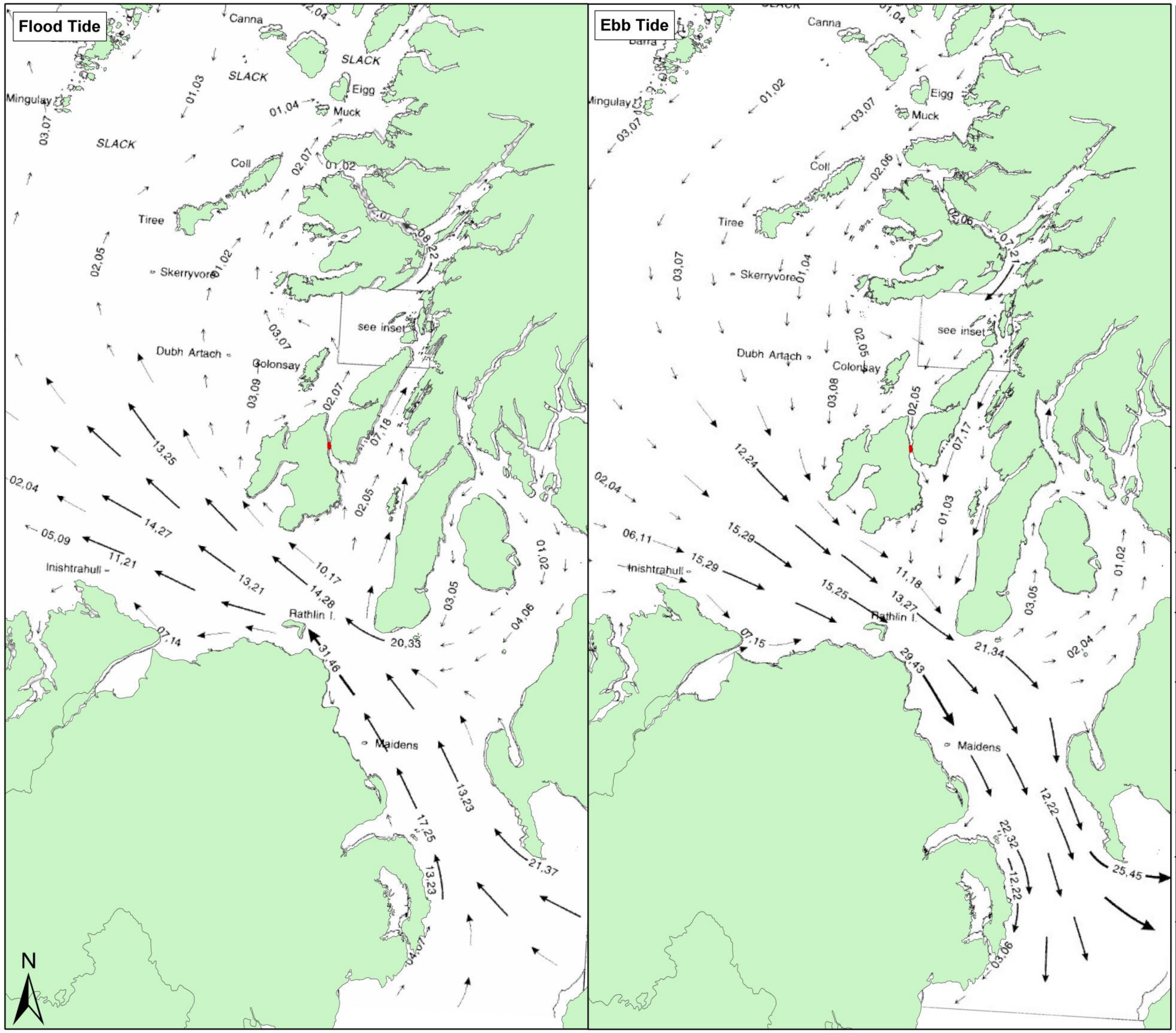
Produced By:
ROYAL HASKONING

Drawn by:	Checked:	Drawing No:
EAW	KW	

Date:	Figure:
25/06/2010	7.3

Scale:	Revision No:
0 500 1,000 Meters	001

SCOTTISHPOWER RENEWABLES



Legend:

Lease Option Boundary

Tidal Flow Direction

Title:

DIRECTION OF TIDAL FLOW IN THE SOUTHERN INNER HEBRIDES

Project:

SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY

Source:

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Sources: ICES-FishMap

Produced By:

ROYAL HASKONING

Drawn by:	Checked:	Drawing No:
GMC	KW	

Date:	Figure:
23/06/2010	7.4

Scale:	Revision No:
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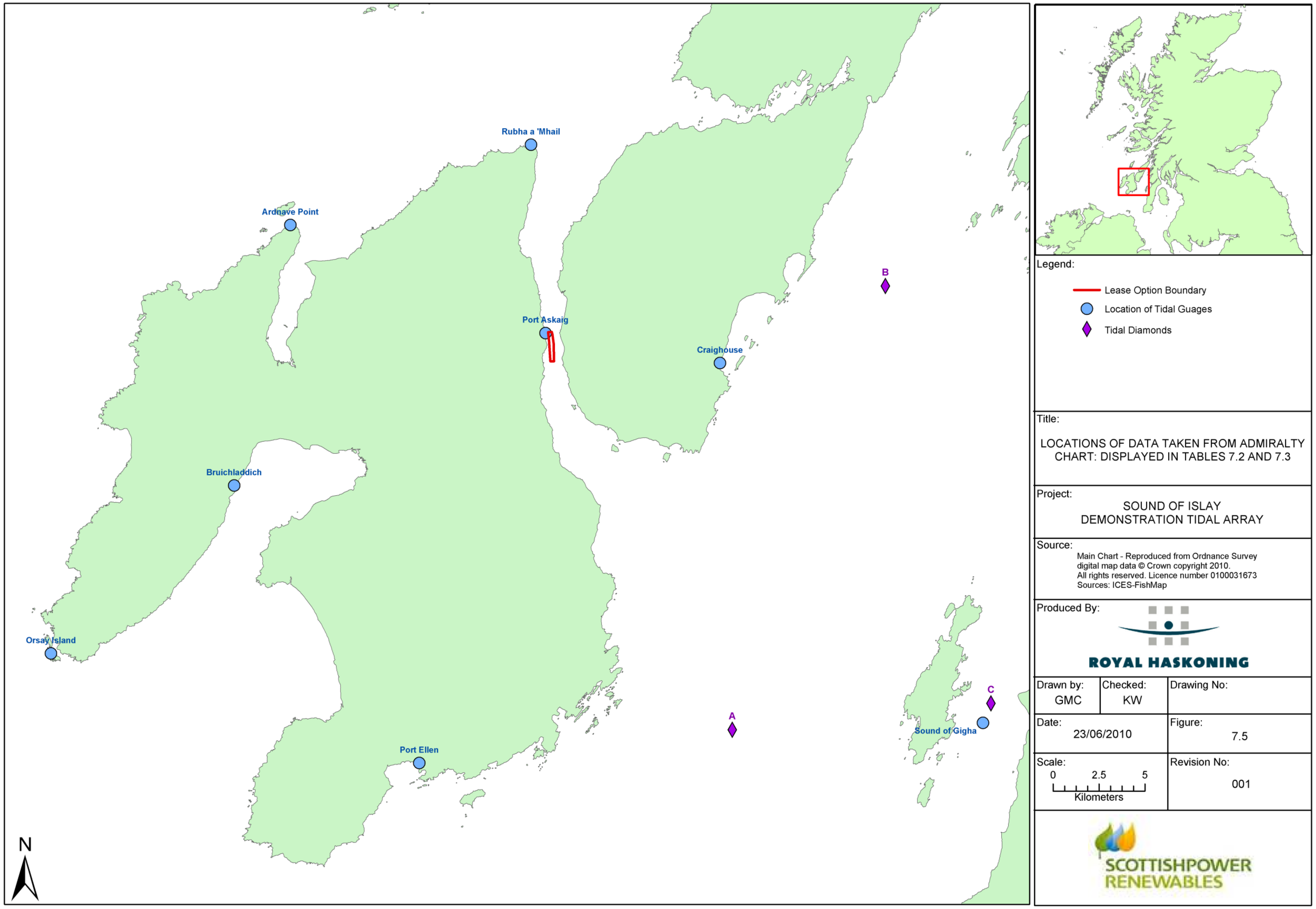
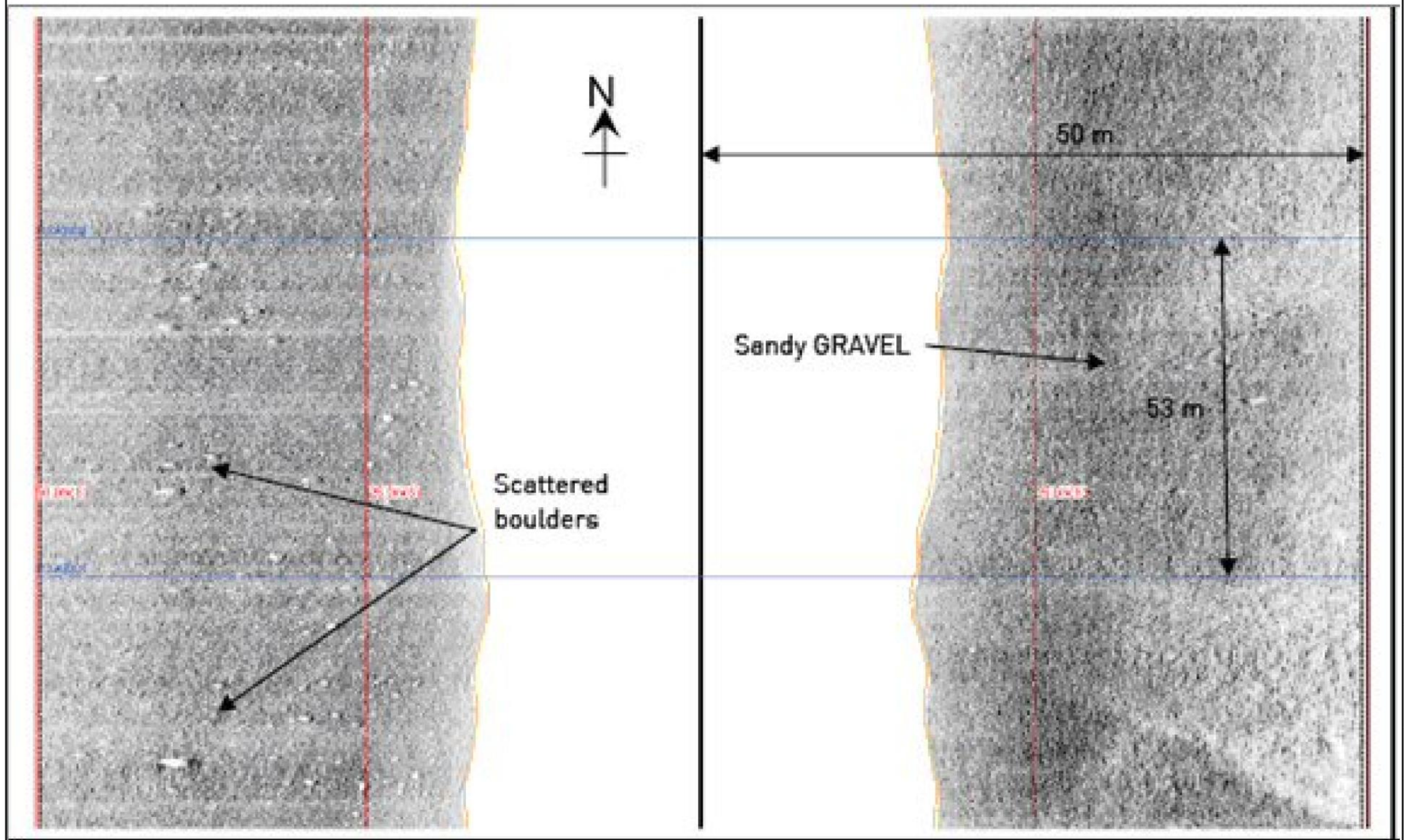
SCOTTISHPOWER RENEWABLES


Rubha a 'Mhail
Ardnave Point
Port Askaig
Craighouse
B
Bruichladdich
Orsay Island
Port Ellen
A
C
Sound of Gigha
N
Legend:
Lease Option Boundary
Location of Tidal Guages
Tidal Diamonds
Title:
LOCATIONS OF DATA TAKEN FROM ADMIRALTY CHART: DISPLAYED IN TABLES 7.2 AND 7.3
Project:
SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY
Source:
Main Chart - Reproduced from Ordnance Survey digital map data © Crown copyright 2010.
All rights reserved. Licence number 0100031673
Sources: ICES-FishMap
Produced By:
ROYAL HASKONING
Drawn by: GMC
Checked: KW
Drawing No:
Date: 23/06/2010
Figure: 7.5
Scale: 0 2.5 5 Kilometers
Revision No: 001
SCOTTISHPOWER RENEWABLES



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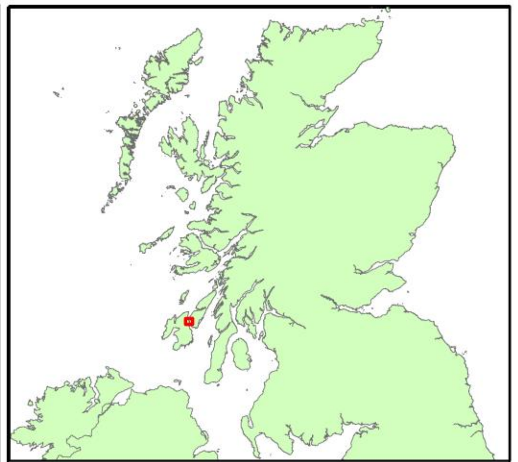


Legend:

Title:
SIDE SCAN SONAR IMAGE SHOWING SANDY GRAVEL AND SCATTERED BOULDERS

Project:
SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY

Source:
Main Chart - Reproduced from Ordnance Survey digital map data © Crown copyright 2010.

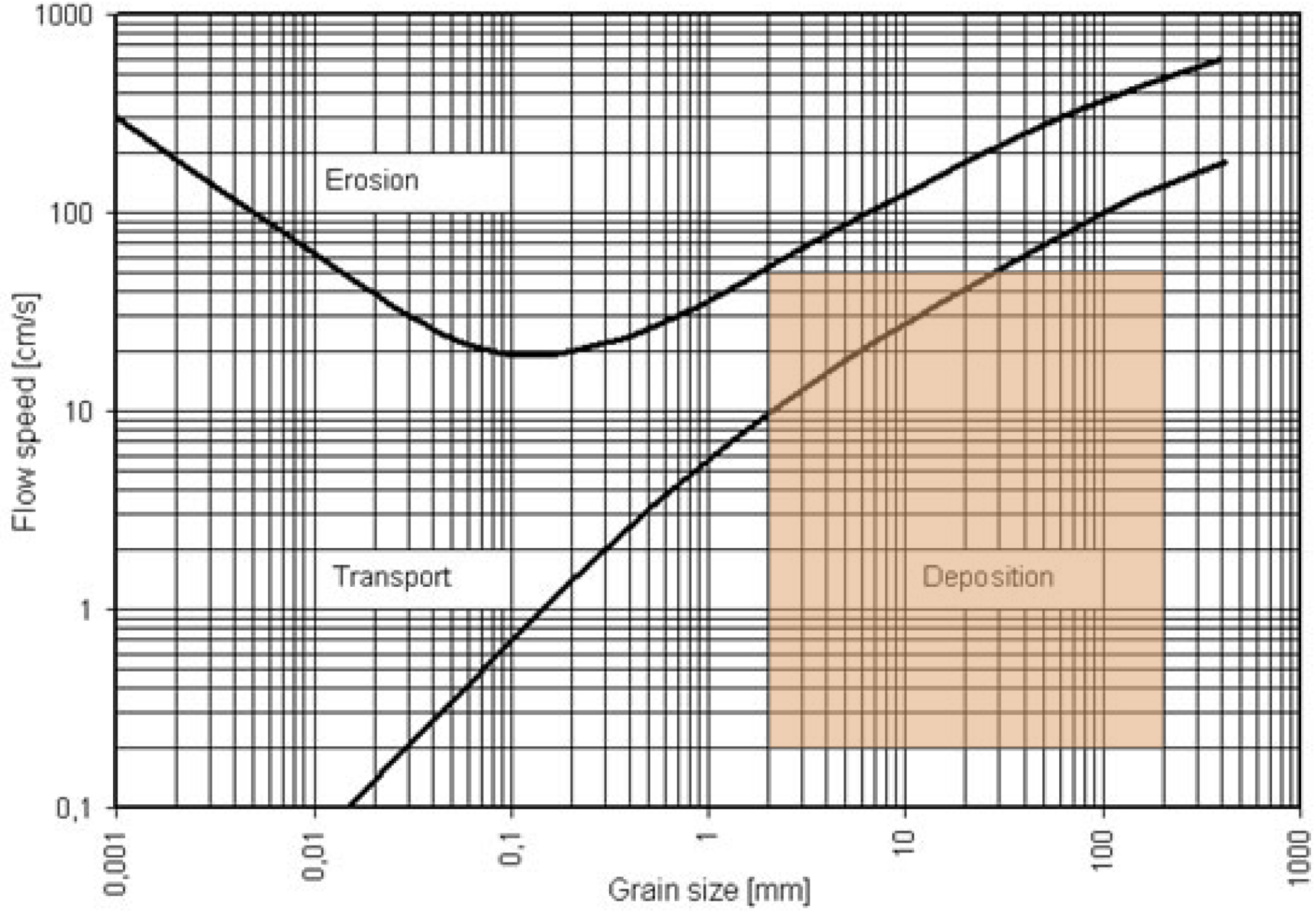
Produced By:
ROYAL HASKONING

Drawn by:	Checked:	Drawing No:
EAW	KW	

Date:	Figure:
29/06/2010	7.6

Scale:	Revision No:
Not to Scale	001

SCOTTISHPOWER RENEWABLES



N

Legend:
Sound of Islay interaction

Title:
INTERACTION BETWEEN NEAR BED VELOCITY AND PARTICLE GRAIN SIZE IN SOUND OF ISLAY

Project:
SOUND OF ISLAY DEMONSTRATION TIDAL ARRAY

Source:
Main Chart - Reproduced from Ordnance Survey digital map data © Crown copyright 2010.

Produced By:
ROYAL HASKONING

Drawn by:	Checked:	Drawing No:
EAW	KW	

Date:	Figure:
29/06/2010	7.7
Scale:	Revision No:
Not to Scale	001

SCOTTISHPOWER RENEWABLES

8.0 Benthic Ecology

8.1 Introduction

8.1. This chapter provides information on the presence, character and sensitivity of seabed communities within the vicinity of the proposed Sound of Islay Demonstration Tidal Array and export cable route.

8.2. In addition it also reviews the potential impacts to marine benthic communities in relation to the proposed development during construction, operation/maintenance and decommissioning. If required, potential mitigation measures to reduce these impacts are also discussed, along with the residual impact that remains post-mitigation.

Summary of Benthic Ecology: No habitats or species of conservation importance have been recorded within the development site. The impacts are expected to be of low magnitude and, therefore, the significance of all potential effects on benthic ecology is expected to be negligible.

8.2 Potential Effects

8.3. The footprint of the 10 turbine foundations and associated cable will lead to a loss of benthic habitat for the duration of the 15 year project. Dynamic positioning vessels will be used for turbine installation, avoiding the need for anchorage and therefore minimising habitat loss during the construction phase. Installation is predicted to take a maximum of 72 days during which time dumb storage barges will be present within Caol Ila bay. The gravity base structures are expected to cause minimal residual impact after the turbines have been removed from the Development site.

8.4. Localised changes to tidal stream characteristics within the Sound of Islay are possible as a result of the installed devices, and this may alter the benthic environment. The rotating blades of the turbine are designed to extract energy from the flow of water. As the amount of water passing through the swept rotor area is the same as the amount leaving it, the water occupies a larger cross section behind the rotor, resulting in some localised decrease in flow speed down current of the turbine. The amount of energy removed from the system is expected to be small in comparison to the total tidal energy available. This is discussed further in *Chapter 7: Physical Environment and Coastal Processes.*

8.5. Increased suspended sediments during construction can smother benthic organisms, particularly sessile filter feeders; however, surveys have shown limited sediment available for re-suspension. There are no known sources of seabed contamination with the Sound of Islay (*Chapter 21: Water and Sediment Quality*) and so disturbance of contaminated sediments is not a concern for the proposed scheme.

8.6. Possible leaching of compounds from the devices e.g. paints, hydraulic fuels and antifouling could cause localised toxicity to benthic species.

8.3 Methodology

8.3.1 Legislation, Guidelines and Policy Framework

8.7. The Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ('The Habitats Directive') aims to conserve biodiversity, providing a list of priority habitats (Annex I of the Directive) and species (Annex II of the Directive) to be protected by a Network of 'Natura 2000' areas including Special Areas of Conservation (SAC). The Conservation (Natural Habitats, & c.) Regulations, 1994 (including 2004 and 2007 amendments in Scotland) transpose the Habitats Directive into national law and outline the designation and protection required for 'European sites' and European Protected Species' (EPS).

8.8. The Nature Conservation (Scotland) Act 2004 places duties on public bodies in relation to the conservation of biodiversity and outline the required protection for Sites of Special Scientific Interest (SSSI).

8.9. The 1992 Convention on Biological Diversity in Rio de Janeiro called for the creation and enforcement of national strategies and action plans to conserve, protect and enhance biological diversity. In 1994 the UK government outlined the UK Biodiversity Action Plan (UK BAP) in response to the Rio Convention

8.10. Species of importance that are likely to be found within the Sound of Islay include *Modiolus modiolus* (horse mussel), *Lithothamnion* spp. (maerl) and *Phymatolithon calcareum* (maerl). Maerl and horse mussel beds are both a UK BAP priority habitat, *P. calcareum* and *Lithothamnion corallioides* are also UK BAP species and Habitats Directive Annex V species (animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures).

8.11. The application for the proposed Development will come under Section 36 of the Electricity Act 1989 as currently managed by Marine Scotland. A licence for placement of structures on the sea bed under the Food and Environmental Protection Act (FEPA) is also required. Further details regarding the legislative context for this application are provided in *Chapter 6: Regulatory and Policy Context*

8.12. There is no specific guidance available for the assessment of impacts of tidal arrays on benthic ecology. The equivalent guidance for offshore wind farm EIA by CEFAS (2004) has therefore been applied to this impact assessment. These guidelines highlight the need for potential impacts to be identified prior to commencement of benthic survey in order to inform survey design. The guidance indicates that the main impacts to benthic ecology are likely to occur during the construction period of any development and may include physical disturbance of seabed substrata and alterations to the local habitat, as well as indirect effects arising from the re-distribution of sediment.

8.13. The European Marine Energy Centre (EMEC) have produced high level EIA Guidance for their wave and tidal test sites in Orkney which has been considered (EMEC, 2005) in this chapter. This guidance outlines legal and consenting requirements (EMEC EIA Guidance Section 1.2) and summarises survey and additional data requirements to inform the impact assessment.

8.3.2. Consultation

8.14. Consultation with statutory bodies and key stakeholders was undertaken by SPR through the following scoping document: 'Proposed Demonstration Tidal Site, Sound of Islay. Request for a Scoping Opinion' (SPR, 2008). The responses made by Scottish Natural Heritage (SNH) are particularly relevant to this chapter. SNH provide statutory advice to Marine Scotland on nature conservation and have a particular interest in species and habitats of local and national importance.

8.15. SNH advised that the ES should provide an account of habitats within the development area. In response, SPR commissioned SeaStar Survey Ltd to carry out a drop down video survey to provide species and habitat (biotope) information. In order to extend the area of search, Royal Haskoning was later commissioned to undertake a further drop down video survey, collecting species and biotope information.

8.16. SNH highlighted that, if present, any rare and threatened habitats or habitats of conservation importance, including Biodiversity Action Plan priority habitats, should be identified.

8.3.3 Data collection

8.17. The presence, distribution and character of potential Annex I habitat and Annex II species (Habitats Directive EC/92/43/EEC) within the deployment site and the cable route has been assessed by drop down video.

8.18. The baseline conditions at the proposed deployment site and cable route have also been determined from information derived from existing data sources and discrete surveys. Existing biological information was available from historical diver surveys held within published reports or within the National Biodiversity Network (NBN) gateway website, as well as through consultation with local fishermen and recreational divers. Where knowledge gaps were identified, a Remotely Operated Vehicle (ROV) survey was conducted in August 2008 (Islay Energy Trust, 2008), followed by a more targeted drop down video survey in June 2009 (SeaStar Survey Ltd, 2009a). The timing and scope of the drop video survey (SeaStar Survey Ltd, 2009a) was agreed through consultation with the relevant stakeholders, including SNH. Following the identification of possible landfall sites on Jura, further drop down video work was carried out in March 2010 (Royal Haskoning, 2010) along two potential cable routes, including the eventual cable route option shown in Figure 8.1

8.19. The principal biological and physical data sources relevant to the marine benthic communities are shown below in Table 8.1.

Table 8.1 Existing benthic data for the Sound of Islay

Data source	Coverage	Author(s)	Year
NBN gateway	Limited to 3 diver surveys within the infralittoral zone close to Port Askaig	Christine Maggs, Dale Rostrum, Annette Little, Sarah Fowler	1982
Sublittoral diver survey	Limited to 7 sublittoral areas, mainly within the northern channel	Keith Hiscock	1983
SeaZone data – provides bathymetry data and some limited information on seabed texture. The shapefiles also include details of active/inactive aquaculture areas.	Entire area of interest	SeaZone	2007
Brodie *et al* (2007)	Maerl beds have been identified 0.8km NE of Port Askaig in the centre of the Sound (Grid reference NR435700). No mapping or survey information to accompany the citation. Recorded in the centre of the channel, at depth; therefore unlikely to be from Hiscock's 1982 diver survey.	Plantlife International	2007
Swath bathymetry and side scan acoustic surveys – provides seabed sediment interpreted from acoustic data (no ground truthing)	Entire area of interest	iX Survey	2008
IET ROV survey	2 day survey, with inshore circalittoral and infralittoral data on Islay side of Sound. Some penetration into deeper water (50-60m) to the north of the site. Also footage at 44-54m in central section of the site.	Robert Gordon University	2008
Sound of Islay drop video survey. June 2009 (Appendix 8.1)	Proposed northern and southern deployment sites as well as Islay potential cable route areas. The aim of the survey was to ground-truth existing sidescan data of the Sound using a drop-down video and stills camera. This ground-truthing enabled the nature of the seabed communities within the proposed lease option boundary (shown on Figure 8.2) and immediately surrounding area to be confirmed.	SeaStar Survey Ltd Survey Ltd	2009
Sound of Islay drop video survey. March 2010 (Appendix 8.2)	Proposed Jura cable route areas.	Royal Haskoning	2010

8.3.4 Assessment of significance

8.20. The significance of the effect imposed by the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 8.2.

Table 8.2: Description of magnitude.	
Magnitude of Impact	**Definition**
High	Fundamental change to the baseline condition of the receptor. Resulting in major alteration of the habitats, species or biodiversity.
Medium	Detectable change resulting in non-fundamental temporary or permanent consequential changes. Some deterioration observed in the quality of the most sensitive receptor leading to a partial alteration of habitats, species or biodiversity.
Low	Minor change with only slight detectable changes, which do not (or only temporarily) alter the baseline condition of the receptor.
Negligible	An imperceptible change to the baseline condition of the benthic community

8.21. To consider the sensitivity of the species and biotopes present in the development area and immediately surrounding area, the protocols and advice available from the Marine Life Information Network (MarLIN, accessed Jan 2010) have been used. The MarLIN sensitivity assessment allows a comparative assessment to be made of the sensitivity and recoverability of marine habitats and species.

8.22. The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 8.3.

Table 8.3: Sensitivity/Value/importance of marine flora and fauna environment.		
Receptor Sensitivity/Value	**Marine flora and fauna Importance**	**Site designations**
High	International/National	Sites or species that have been designated for their internationally or nationally important biodiversity or habitat (SACs, SPAs, Ramsar, SSSIs, NNR, UK BAP of Habitats).
Medium	Regional	Sites or species that have been designated for their regionally important biodiversity or habitat (LBAP species).
Low	Local	Sites or species that have been designated locally for their flora or fauna (LNR) or undesignated sites of some locally important biodiversity or habitat.
Negligible	-	Other sites or species with little or no locally important biodiversity

8.23. Table 8.4 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 8.4 Significance Prediction Matrix.				
Magnitude of Impact	**Receptor Sensitivity/Value**			
	Negligible	**Low**	**Medium**	**High**
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

8.24. Once the significance of the effect is determined, a suffix of “adverse” or “beneficial” can be attached to indicate the perceived nature of impact. It is not always clear weather an effect will be adverse or beneficial and as a consequence this approach is only taken when describing some of the impacts identified in section 8.5.1 and below.

8.25. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of ‘Moderate’ or ‘Major’ is regarded by the EIA Regulations as being significant.

8.4 Existing Environment

8.4.1 Habitat within the proposed array site

8.26. The location of the Sound of Islay Demonstration Tidal Array, along with associated onshore and marine infrastructure is shown in *Chapter 5: Project Description*.

8.27. The substrate within the proposed development area and immediately surrounding area was characterised by SeaStar Survey Ltd (2009a) as comprising mixed coarse sediments of sandy gravelly cobbles and small boulders. The SeaStar survey also recorded bedrock and boulders along the western edge of the 48m contour of the survey area and to a lesser extent on the eastern boundary. Acoustic data acquired by IX Surveys (2009) identifies that the array site is predominantly gravel, with turbine 8 located on megaripples (Figure 8.1). However, the video data also indicates a seabed of mixed substrata, with cobbles, pebbles, some gravel and occasional small boulders, not the megaripple feature suggested from the acoustic data (Figure 8.2).

8.28. The substrate to the north of the Sound (outwith the proposed array area) consists primarily of gravely sand and sand. Farrow *et al*. (1979) describe the seabed at the northern entrance of the Sound of Islay as having areas of *Lithothamnion* spp (maerl) gravel (‘some of it live’), megaripples and shell gravel. To the south of the Sound (and also outwith the proposed array area) the seabed sediments are comprised of gravely sand, sand, muddy sand and mud (British Geological Surveys, 1997).

8.29. Within the Development site, diverse benthic communities typical of a tide swept environment were recorded during the drop down camera survey (SeaStar Survey Ltd, 2009a). Dominant, widespread species include: dead man's fingers *Alcyonium digitatum*, the hydroid *Tubularia indivisa*, the anemones *Urticina* sp., *Actinothoe sphyrodeta*, and *Corynactis* and the byrozoans *Flustra foliacea* and *Alcyonidium diaphanum*. The sponges *Halichondria panicea*, *Esperiopsis fucorum, and Pachymatisma johnstoni*; crustacea (e.g. *Pagurus* sp.); Mollusca (e.g. *Calliostoma zizyphinum*) and Echinodermata (e.g. *Echinus esculentus*, *Asterias rubens*, *Henricia* sp. and *Crossaster papposus*); were also commonly recorded (SeaStar Survey Ltd, 2009a)

8.30. Species composition was found to be relatively similar throughout the majority of the proposed development site and immediately surrounding area. Some areas of deeper water were dominated by Serpulidae worms and barnacles, while shallower infralittoral areas were dominated by kelp, mainly *Laminaria hyperborea* and *Laminaria saccharina* (SeaStar Survey Ltd, 2009a).

8.31. Data from diver surveys (also outwith the Development site) identifies the presence of the horse mussel *Modiolus modiolus*, 2km north of Port Askaig (Seasearch, 1999). *M. modiolus* can form a UK BAP habitat if present as a dense bed. No *M. modiolus* was recorded within the development site during the 2009 drop down video survey (SeaStar Survey Ltd, 2009a).

8.32. Abundant (using the Marine Nature Conservation Review 'SACFOR' scale[1]) maerl was recorded in 1982 at two stations on the Islay coast, approximately 300m from the proposed array site in depths of between 3 to 13m. There were also six records (from various surveys conducted during a similar time period) 2km to the north, ranging in abundance of occasional to common as well as two records of abundant maerl near Jura, off Claig Castle, 6km to the south of the Development site at the southern entrance to the Sound (NBN Gateway, 2008). Foliose algae and sabellid polychaetes were noted among the associated flora and fauna of these maerl beds (Hiscock, 1983). A few of the nationally-rare or scarce benthic species listed by Plaza & Sanderson (1997) are believed to be confined to maerl habitats and, therefore, may occur in the Sound of Islay (Wilding *et al* 2005). Barne *et al.* (1997) reported that the central Sound of Islay contained maerl features, mostly consisting of dead maerl. No maerl was recorded within the development site during the SeaStar Survey Ltd (2009a) or Royal Haskoning (2010) surveys.

8.33. SeaStar Survey Ltd (2009a) recorded only one thallus of maerl (*Phymatolithon calcareum*); however, this was outside the proposed development site, 280m west of the proposed array. Footage was also collected of maerl beds approximately 2km to the south west of the development (SeaStar Survey Ltd, 2009b).

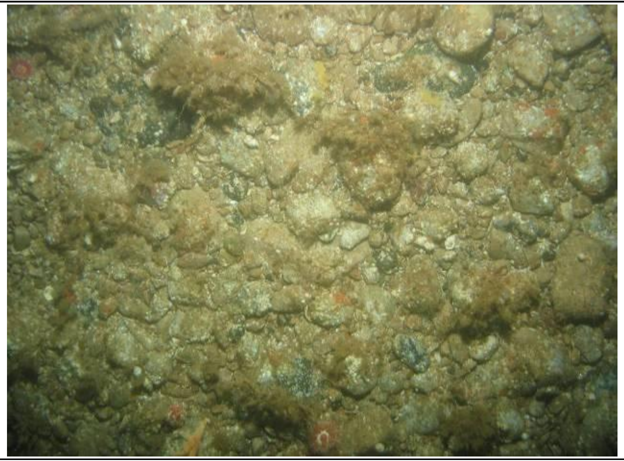
8.34. Images showing the biotopes recorded in closest proximity to each proposed turbine in the array are provided in Plate 8.1, with Figure 8.1 showing the location of the development in relation to the SeaStar Survey Ltd (2009a) biotope map. Stations were sampled using still photography and assigned Connor *et al* (2004) biotopes. The dominant biotope was classified by SeaStar Survey Ltd (2009a) as circalittoral mixed sediment (SS.SMx.CMx) combined with a biotope of *Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock CR.HCR.FaT.CTub.Adig, recorded by SeaStar Survey Ltd (2009a) as a combined biotope of "SS.SMx.CMx.(CTub.Adig)".

8.35. At stations where the SS.SMx.CMx and CTub.Adig combined biotope was recorded close to proposed turbine locations by SeaStar Survey Ltd (2009a), the substrate is shown in Figure 8.2 to be of cobbles and boulders and as a result may be best described as the Connor *et al* (2004) biotope CR.HCR.FaT.CTub.Adig

8.36. Stations close to four of the ten proposed turbine locations supported *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles, the biotope (SS.SCS.CCS.PomB). This biotope has been used for much of this impact assessment due to the availability of sensitivity details on MarLIN (accessed Jan 2010).

Plate 8.1: Drop down images from the station closest to each proposed turbine (Source: SeaStar Survey Ltd, 2009a). Turbine locations shown in Figure 8.1). Biotope codes according to Connor *et al* (2004)

a) Turbine 1, Station 1_22, Biotope SS.SCS.CCS.PomB



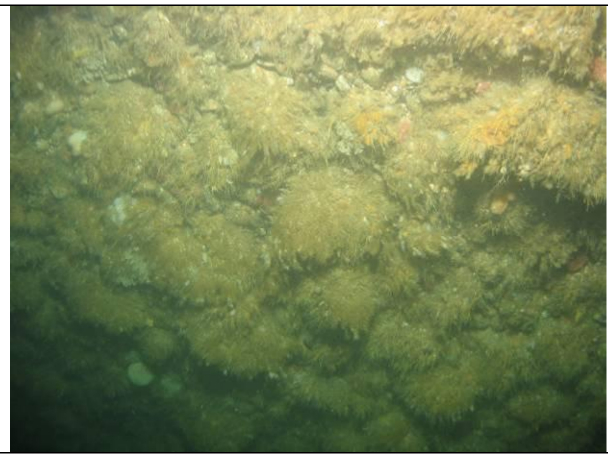
b) Turbine 2, Station 1_23, Biotope SS.SCS.CCS.PomB

c) Turbine 3, Station 2_41, Biotope CR.HCR.FaT.CTub.Adig

d) Turbine 4, Station 30_8, Biotope CR.HCR.FaT.CTub.Adig

[1] http://www.jncc.gov.uk/page-2684

Plate 8.1: Drop down images from the station closest to each proposed turbine (Source: SeaStar Survey Ltd, 2009a). Turbine locations shown in Figure 8.1). Biotope codes according to Connor *et al* (2004)

	
e) Turbine 5, Station 8_21, Biotope SS.SCS.CCS.PomB	f) Turbine 6, Station 7_25, Biotope CR.HCR.FaT.CTub.Adig
	
g) Turbine 7, Station 31_12, Biotope CR.HCR.FaT.CTub.Adig	h) Turbine 8, Station 8_10, Biotope CR.HCR.FaT.CTub.Adig
	
Turbine 9, No image	i) Turbine 10, Station 6_14, Biotope SS.SCS.CCS.PomB

8.4.2 Habitats along the preferred and potential cable routes

8.37. Cable routes for potential landfall sites at Caol Ila, Islay, Feolin, Jura and to the north and south of Daimh-sgeir, Jura have been investigated as part of the EIA. Subsequent to these surveys it was decided that the preferred landfall option would be at Daimh-sgeir and a summary of the existing environment including all cable route surveys, but with a focus on the Daimh-sqeir site is provided below.

8.38. A mixed rocky substrate of boulders, cobbles and pebbles were recorded across much of the survey area. Some small areas of bedrock and sand overlying bedrock were also recorded. No species of conservation interest were identified during any of the cable route surveys. Common species which are widely distributed around the UK were recorded including kelps and fucoids, the echinoderms *Crossaster papposus* and *Asterias rubens*, the anemone *Urticina spp* and a number of red seaweeds including *Chondrus crispus, Porphyra and Phycodrys, Dilsea* and *Plocamium.*

8.39. Kelp park of the Connor *et al* (2004) biotope code IR.MIR.KR.LhypTX.Pk and kelp forest IR.MIR.KR.LhypTX.Ft were recorded in the inshore areas at the Daimh-sgeir site as well as robust fucoid and/or red seaweed communities LR.HLR.FR. Mixed kelp and red seaweeds on infralittoral boulders, cobbles and gravel in tidal rapids IR.MIR.KT.XKTX was recorded close inshore at the Caol Ila site.

8.40. High abundances of red coralline algae were recorded during the cable route surveys. Within this algal crust high numbers of echinoderms were found to be present in discrete areas along the Daimh-sgeir routes and so the 'echinoderms and crustose communities' Connor *et al* (2004) biotope CR.MCR.EcCr was assigned. The most inshore transect on the southern Daimh-sgeir route (Figure 8.2) was found to have high levels of *Sabella pavonica* and so the SS.SMx.IMx.SpavSpAn biotope was assigned.

8.41. Two transects close to the array, along the Daimh-sgeir cable route were found to have high numbers of deadman's fingers *Alcyonium digitatum* and the hydroid *Tubularia indivisa* CR.HCR.FaT.CTub.Adig. The majority of the cable route option to Caol Ila was also found to have this biotope; however, a mixed substrate was recorded and so the biotope was classified by SeaStar Survey Ltd (2009a) as the combined SS.SMx.CMx and CTub.Adig biotope. Along the Caol Ila route, *Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock CR.MCR.EcCr.UrtScr were also recorded at a number of stations.

8.42. Although the decision was taken (with the help of the cable route surveys) to identify the Daimh-sgeir cable route as the final option; survey data of the other cables routes remained very useful in determining the existing environment of the study area and informing impact assessment.

8.5 Impact Assessment

8.5.1 Do nothing Scenario

8.43. Due to the lack of detailed historical datasets or on going monitoring in this area, it is not possible to know how the benthic community has changed naturally over time. However, in high energy environments, such as the Sound of Islay, natural changes will occur frequently within benthic communities.

8.44. During a 'do nothing scenario' the substrate type and tidal currents would not be expected to show any non natural change in the benthic environment.

8.4.1. Potential Impacts during Construction Phase

Impact 8.1: Habitat loss

8.45. The footprint from the turbine foundations cabling, and the anchors used to moor the dumb (storage) barges in Caol Ila bay, will result in the loss of benthic habitat within the Development site. The combined footprint of the ten devices is predicted to be 329.7m^2. Installation procedure (e.g. use of dynamic positioning in place of anchoring) will allow the development to cause minimal disturbance to the seabed.

8.46. All cabling will be 10cm in diameter and armoured, providing a maximum footprint diameter of 50cm at the point of contact with the seabed. For impact assessment purposes, a 200cm width along all cabling has been used to provide a conservative impact assessment and to allow for slight movements of the cables on the seabed.

8.47. The footprint for inter-array cables will be approximately 3506m^2 (assuming a cable running the length of the array, north – south with four perpendicular rows joining the turbines). The export cable route, from the array to the cable landfall site at Daimh-sgeir, creates a potential footprint of 1946m^2. The biotopes potentially impacted are present across the area covered by the benthic surveys (SeaStar Survey Ltd, 2009a and Royal Haskoning, 2010). The surveys covered an area in excess of 577,501m^2 and the area impacted by the turbine bases and cable route is small (0.02%) by comparison.

8.48. The nature and extent of the anchors used in the mooring of the dumb barges at Caol Ila is yet to be determined and therefore an assessment of impact associated with this activity can not currently be completed. It is not anticipated however, that the anchoring activity will result in the loss of benthic habitat over a large area.

8.49. The highly changeable nature of benthic habitats of this type and the relatively short life span (up to 15 years) of the Development suggest that any impact during installation will be both difficult to distinguish and rapidly reversible.

8.50. CR.HCR.FaT.CTub.Adig is the dominant biotope throughout the development site and is also a dominant biotope of Strangford Narrows, Northern Ireland (Royal Haskoning, 2005). Recent studies at Strangford have indicated that there has been no significant change (above those that would be expected as a result of natural variation) to the benthic community there following installation of the SeaGen tidal turbine (SNH, 2009).

8.51. As discussed previously (Paragraph 8.36), the biotope SS.SCS.CCS.PomB is an appropriate biotope to use for the assessment of possible impacts caused by the Development. This is because information on the sensitivity of this biotope is publically available on the MarLIN website and this biotope is present at four of the ten turbine locations. SS.SCS.CCS.PomB is expected to have very high recoverability to substratum loss (MarLIN, accessed Jan 2010).

8.52. In addition, it is likely that much of the array structure will provide suitable hard substrate for colonisation by marine species adapted to tidal environments, with the surface area available, being greater than the seabed area directly affected (as a result of the greater 3 dimensional scale of the device structure, compared to the impacted seabed).

8.53. No benthic species or habitats of local, national or European importance are expected to be impacted and, therefore, the receptor sensitivity of the receptor is negligible. The footprint of habitat loss will be relatively small compared to the available resource of similar habitats in the Development site and the effect will be temporary giving a medium impact magnitude. The effects of habitat loss are therefore expected to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 8.1
• No mitigation required

Residual impact

8.54. The impact of habitat loss on the benthic ecology during construction will remain of **negligible** significance.

Impact 8.2: Increased suspended sediments/ smothering

8.55. The disturbance of seabed sediments during installation of the gravity base and the potential impact on water quality are discussed in *Chapter 21: Water and Sediment Quality*.

8.56. Smothering may occur within the immediate vicinity of works with disturbed finer sediments carried in suspension potentially affecting sessile filter feeding species. However, limited quantities of fine sediments are present in the area. The tidal device has been designed to limit the need for intrusive seabed works by using gravity bases. This approach means that construction will be quick, will be completed in a single operation and will not use intrusive activities such as piling or levelling, resulting in limited scope for disturbance and re-suspension of fine sediments.

8.57. In a high energy environment, such as the Sound of Islay, rapid dispersal of any disturbed fine sediments means effects will be temporary and short term providing low magnitude. This combined with the negligible receptor sensitivity means that the effects of increased suspended sediments are likely to be of **negligible** significance.

8.58. Increases in suspended sediment concentrations may also be caused by changes to sedimentation patterns as a result of localised changes to tidal energy in the immediate vicinity of the array. However, the changes to tidal stream characteristics will be extremely localised, and may not be detectable given the high energy within the wider resource of the Sound of Islay and the small scale of the proposed array. This is further discussed in *Chapter 7: Physical Environment and Coastal Processes*

MITIGATION IN RELATION TO IMPACT 8.2
• No mitigation required

Residual impact

8.59. The impact of suspended sediments on the benthic ecology during construction will remain of **negligible** significance.

Impact 8.3: Risk of pollution incident during installation

8.60. The risk of spillage of contaminants from the devices and construction vessels during installation has been considered within *Chapter 21: Water and Sediment Quality*. Collision of vessels could result in spillages of contaminants, such as diesel.

8.61. The risk of pollution events will be minimised by following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA (e.g. PPG 5: Works and maintenance in or near water). Additionally, any chemicals used during construction will require prior approval through the FEPA licensing process and any lubricants will be non toxic, biodegradable and capable of dispersal in seawater.

8.62. Installation contractors will have in place appropriate Site Environmental Management Plans and Pollution Control and Spillage Response Plans that have been agreed with the relevant statutory bodies prior to offshore construction activities commencing. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, will ensure a rapid and appropriate response.

8.63. Given these management strategies and controls it is expected that should a spill occur, its scale and the nature of the contaminant will result only in a temporary and localised impact which will be of low magnitude. Due to the controls mentioned in paragraph 8.61 the sensitivity of the receptor will ne negligible. Therefore the overall effect of a pollution incident on the benthic ecology is likely to be of **negligible** significance. In a high energy marine environment, contaminants can be expected to rapidly disperse.

MITIGATION IN RELATION TO IMPACT 8.3
• No mitigation required

Residual impact

8.64. The impact of suspended sediments on the benthic ecology during construction will remain of **negligible** significance.

Impact 8.4: Noise disturbance

8.65. The majority of sessile benthic species such as tube worms, barnacles, hydroids, Cnidarians and bryozoans are unlikely to be sensitive to noise or vibrations. As the vast majority of organisms recorded during the benthic surveys (SeaStar Survey Ltd, 2009b and Royal Haskoning, 2010) were sessile, the benthic habitat is considered to be insensitive to noise impacts. Mobile species such as crabs and lobsters may be temporarily displaced from an area experiencing high levels of noise or vibration but this effect is of low magnitude to species and habitats of negligible sensitivity resulting in noise impact being of **negligible** significance to the benthic community.

MITIGATION IN RELATION TO IMPACT 8.4
• No mitigation required

Residual impact

8.66. The impact of noise on the benthic ecology during construction will remain of **negligible** significance.

8.4.2. Potential Impacts during Operational Phase (including maintenance)

Impact 8.5: Habitat alteration

8.67. Changes to tidal energy have the potential to impact on habitats and species which are sensitive to changes in tidal flows, with modification potentially resulting in long term effects on the richness and diversity of benthic flora and fauna. The preliminary results of benthic monitoring during operation of the SeaGen turbine, Strangford Lough, which were presented at recent conferences, show no change in the benthic community which can be attributed to the presence of that tidal turbine (SNH, 2009).

8.68. During operation, potential colonisation of the structures may increase the biodiversity providing a potentially beneficial impact. However an artificial substrate could alter the nature and composition of the species present and a bare surface could potentially enable non-native species to colonise providing an adverse effect.

8.69. No benthic species or habitats of local, national or European importance are expected to be lost giving a negligible receptor value and low magnitude of impact and so the overall effect is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 8.5
• No mitigation required

Residual impact

8.70. Following mitigation the impact of habitat alteration on the benthic ecology during operation/maintenance will remain of **negligible** significance.

Impact 8.6: Impacts due to accidental pollution incident during operation

8.71. The risk of spillage of contaminants during the operational phase is considered within *Chapter 21: Water and Sediment Quality*.

8.72. Given the lower levels of on-site activity, the risk of pollution caused by vessel collision during maintenance (e.g. spillage of vessel fuel) can be expected to be lower than during the construction phase.

8.73. Maintenance operations are expected to provide less risk to accidental spillage than during construction; however, any use and discharge of chemicals during maintenance will be subject to controls as part of consent requirements and it is expected that even should a spill occur, its scale and the nature of the contaminant will result only in a temporary, localised and impact which will be of low magnitude. In a high energy marine environment, contaminants can be expected to rapidly disperse. The benthic community is of negligible sensitivity and so the overall effect of pollution is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 8.6
• No mitigation required

Residual impact

8.74. Following mitigation the impact of accidental spillages during operation/maintenance on the benthic ecology will remain of **negligible** significance.

Impact 8.7: Noise

8.75. Predictions of noise levels that may be created during the operational phase of the Development were made by SAMS (2010). This was achieved by comparing the noise generated by the Hammerfest Strøm device with baseline noise levels from within the Sound of Islay created by both natural and anthropogenic sources. As a high energy tidal site, the Sound of Islay has high levels of ambient noise and in addition to high levels of naturally generated noise the site is subject to noise generated by vessels, primarily the ferries and any fishing vessels in the area. SAMS (2010) conclude that the Development will have little impact on existing noise levels within the Sound of Islay. Further information regarding the key findings of SAMS (2010) is outlined in *Chapter 9: Marine Mammals.*

8.76. The majority of sessile benthic species such as tube worms, barnacles, hydroids, Cnidarians and bryozoans are unlikely to be sensitive to noise or vibrations. As the vast majority of organisms recorded during the benthic surveys (SeaStar Survey Ltd ,2009b and Royal Haskoning, 2010) were sessile, the benthic habitat is considered to be insensitive to noise impacts. Mobile species such as crabs and lobsters may move away from the devices to avoid vibrations but the distance is expected to result in low magnitude impact and as a result of the negligible receptor sensitivity the overall effect is likely to be of **negligible** significance to the benthic community.

MITIGATION IN RELATION TO IMPACT 8.7
• No mitigation required

Residual impact

8.77. The impact of noise on the benthic ecology during operation/maintenance will remain of **negligible** significance.

8.4.3. Potential Impacts during the Decommissioning Phase

8.78. The potential impacts during decommissioning are expected to be of the same type and magnitude to those predicted during the construction phase. The loss of habitat during construction will transpose to a loss of artificial habitat during decommissioning and a return to the original situation (as described in the existing environment: section 8.4). Returning to the natural state has not been considered as an impact and due to the dynamic and changeable nature of a high energy environment, such as the Sound of Islay, it is expected that recoverability would be quick.

8.79. As discussed previously, CR.HCR.FaT.CTub.Adig is the dominant biotope throughout the development area and after decommissioning it is likely that much of the disturbed area would return to this biotope. However as discussed previously the biotope SS.SCS.CCS.PomB has been used during impact assessment due to the availability of sensitivity information on the MarLIN website. SS.SCS.CCS.PomB was present at four of the ten turbine locations and is expected to have very high recoverability to substratum loss (MarLIN, accessed Jan 2010) following decommissioning. Therefore after decommissioning has taken place it is likely that the benthic habitats would rapidly return to those detailed in the existing environment section (8.4).

8.6 Cumulative Impacts

8.80. There are currently no other developments proposed for construction within the Sound of Islay which are expected to impact on the benthic ecology (Argyll and Bute Council, 2009).

8.7 Conclusions

8.81. Within the proposed development area and immediately surrounding area there are no recent records of any rare and threatened species or habitats or those of conservation importance (e.g. UK BAP). Any impacts within the Sound of Islay are expected to be relatively localised to the foundations of the devices and along the cable route. It is considered that disturbance to benthic ecology will be across a limited area, reversible and occur within an already dynamic and changing biological environment. In high energy environments, such as the Sound of Islay, natural changes will occur frequently within benthic communities, as such changes as a result of the array will be of overall **negligible** significance. It is worth noting that preliminary results from the monitoring of the benthic habitat around SeaGen turbine in Strangford Lough, presented at recent conferences, has shown no significant change in the broad benthic community structure that can be attributed to the turbine presence (SNH, 2009). Biotopes potentially impacted by the SeaGen device (Environmental Statement, Royal Haskoning, 2005) are similar to the main biotopes identified within the lease area for the Sound of Islay.

8.8 Summary

Impact	Construction/ Decommissioning				Operation/ Maintenance			
	Magnitude of Impact	Receptor Sensitivity	Significance level	Residual impact	Magnitude of Impact	Receptor Sensitivity	Significance level	Residual impact
Habitat Loss	Medium	Negligible	Negligible significance	Negligible significance	N/A	N/A	N/A	N/A
Increased suspended sediment /Smothering	Low	Negligible	Negligible significance	Negligible significance	N/A	N/A	N/A	N/A
Pollution incident	Low	Negligible	Negligible significance	Negligible significance	Low	Negligible	Negligible	Negligible significance
Habitat alteration	Low	Negligible	Negligible significance	Negligible significance	Low	Negligible	Negligible	Negligible significance
Noise	Low	Negligible	Negligible significance	Negligible significance	Low	Negligiblee	Negligible significance	Negligible significance

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8.10 Figures

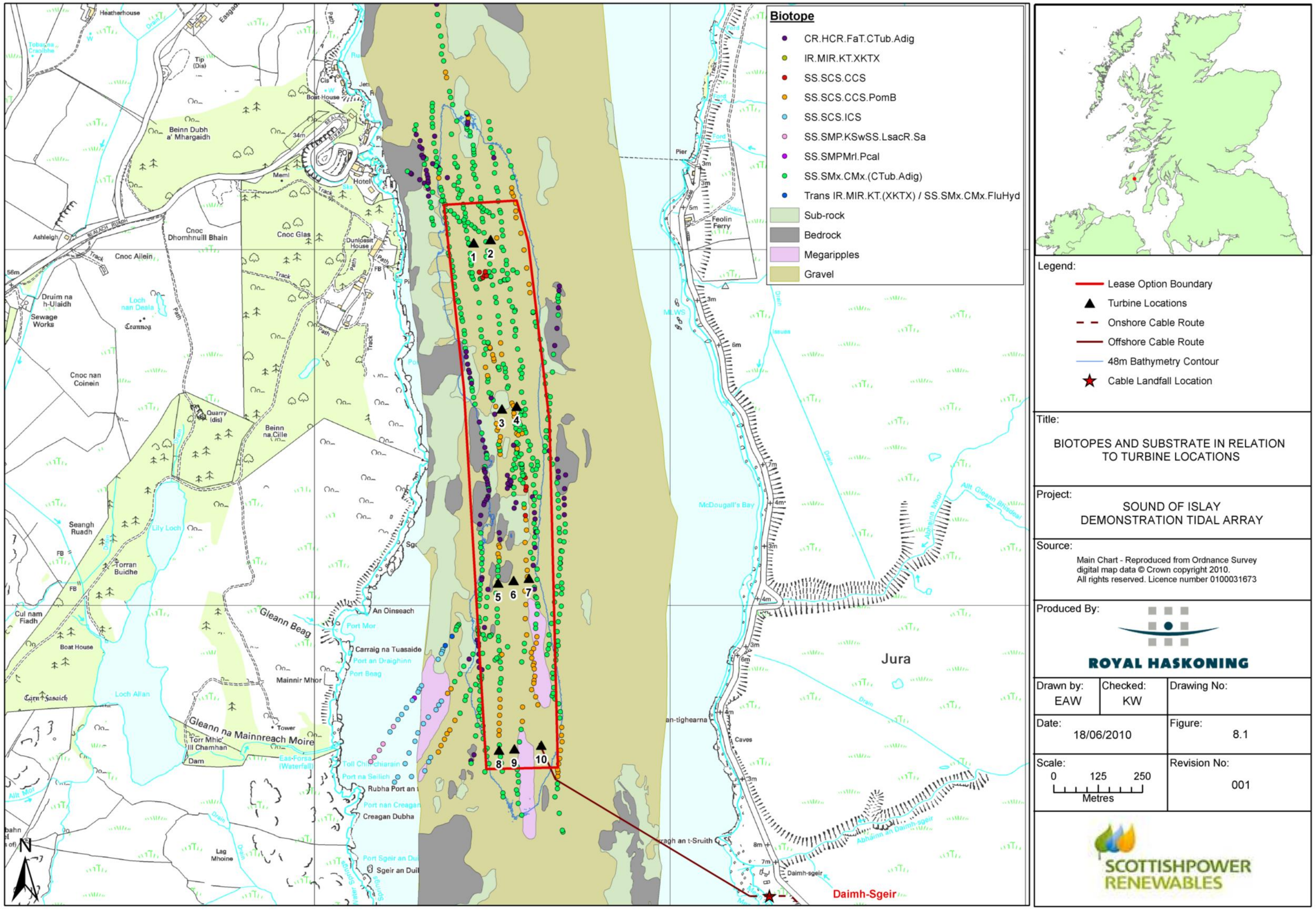

Figure 8.1: Biotopes and substrate in relation to turbine locations.

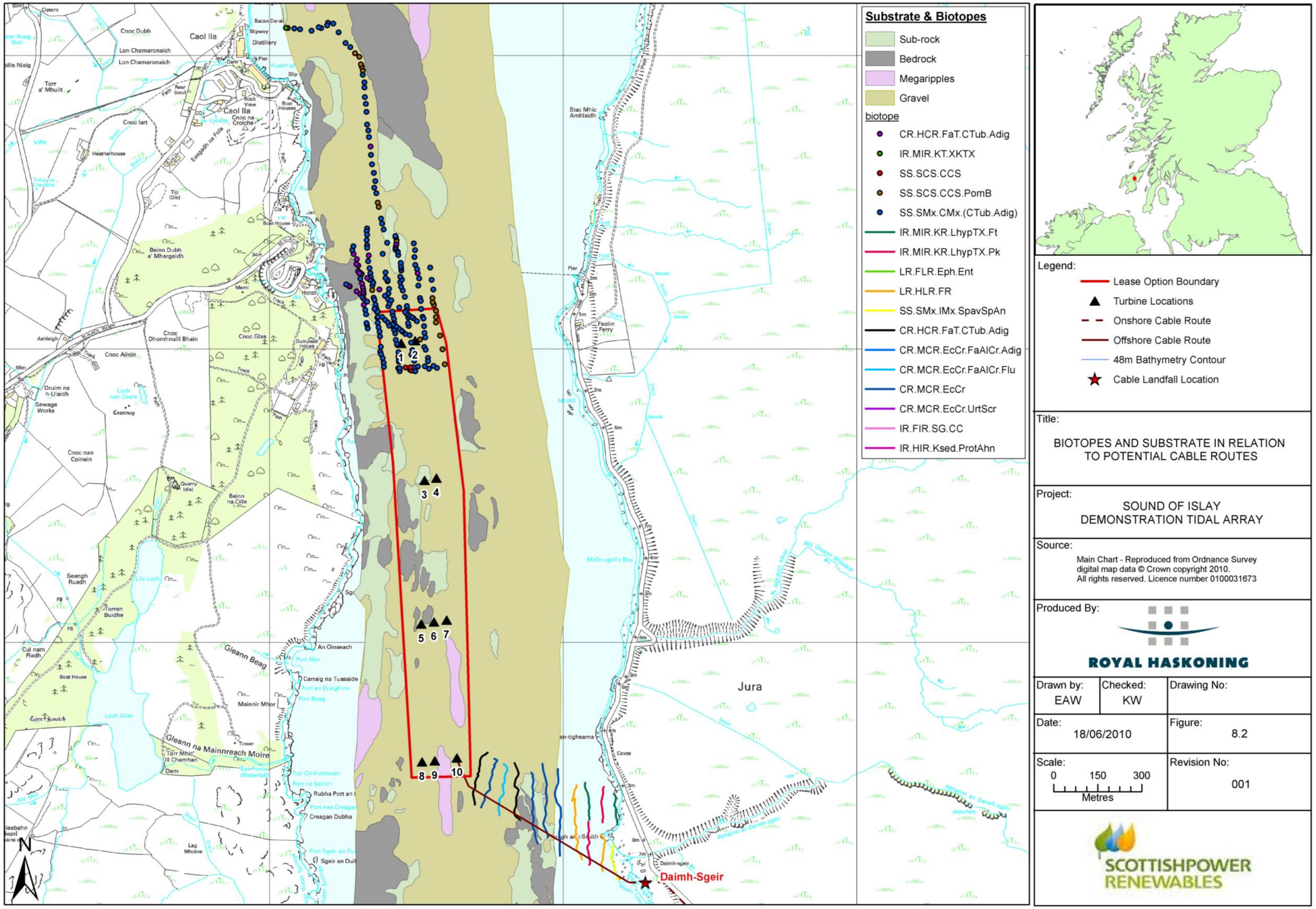

Figure 8.2: Biotopes and substrate in relation to final cable route.

9.0 Marine Mammals

9.1 Introduction

9.1. This Chapter provides information on the likely presence, relative abundance and distribution of marine mammals, and how they vary spatially and temporally, within the vicinity of the proposed Development and export cable routes.

9.2. In addition, it also reviews the potential impacts to marine mammals in relation to the proposed development during construction, operation/maintenance and decommissioning. Possible mitigation measures to reduce these impacts are discussed as are potential cumulative impacts.

9.3. This chapter should be considered with other chapters of this Environmental Statement (ES), including *Chapter 8: Benthic Ecology*, and *Chapter 11: Marine Fish and Shellfish Resources*, which discuss possible prey species for marine mammals.

9.4. *Chapter 15: Commercial Fisheries*, and *Chapter 20: Socio-economics, Tourism and Recreation*, discuss anthropogenic activities which may contribute to in-combination impacts on marine mammals, through activities such as commercial fishing and tourist sight seeing excursions.

9.5. Marine mammal species which use the Sound of Islay include the harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* (Appendix 9.1; SMRU, 2010). A killer whale *Orcinus orca* was recorded within the Sound of Islay during the intertidal survey work (Appendix 16.2).

9.6. Other species which may occur within the proximity of the Development include minke whale *Balaenoptera acutorostrata*, white beaked dolphin *Lagenorhynchus albirostris*, common dolphin *Delphinus delphis*, Risso's dolphin *Grampus griseus*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, long finned pilot whale *Globicephala melas* and humpback whale *Megaptera novaeangliae* (Reid *et al.,* 2004). Marine mammal species in and around the study area are discussed further in Section 9.3 Baseline Description.

Summary of Impact on Marine Mammals:

The Sound of Islay is not believed to be an area of high importance for marine mammals however studies have shown a presence of some marine mammal species within the Sound of Islay and with the nearby South East Islay Skerries SAC, harbour seals are the most common species.

As a result of the high conservation importance of marine mammals the significance of some impacts has been assessed as **moderate**, however, this represents a worst case and is a function of the high level of national and international protection afforded these species combined with a certain degree of uncertainty regarding the effects of an array of turbines on marine mammals.

SPR is committed to monitoring marine mammals following installation of the Development and providing mitigation to protect marine mammals if deemed necessary in the light of monitoring results. We anticipate that the significance of effects can be reduced to **minor,** either in the light of better understanding of the effects of the Development on Marine Mammals, or based upon implementation of mitigation.

9.2 Methodology

9.2.1 Legislative Background

Cetaceans

International

9.7. The Convention on the Conservation of Migratory Species (The Bonn Convention) aims to conserve migratory species and their habitats. The common dolphin is afforded strict protection as an endangered migratory species, listed under Appendix 1 of the Convention. This has been ratified in the UK by the Wildlife and Countryside Act (1981) (see Paragraph 9.12).

9.8. Common dolphin, bottlenose dolphin and harbour porpoise are awarded strict protection under Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). All remaining cetaceans not listed in Appendix II are listed in Appendix III of the Bern Convention providing these species with more limited protection. The Bern Convention was ratified by the Habitats Directive (92/43/EEC).

9.9. The bottlenose dolphin and harbour porpoise are listed as Annex II species within the Habitats Directive and should to be protected by the designation of a network of Natura 2000 sites.

9.10. All cetaceans are included in Annex IV of the Habitats Directive. These are European Protected Species (EPS) whose natural range includes Great Britain. These species must be protected against any deliberate killing, destruction or taking of eggs, and deterioration/ destruction of breeding or resting sites. These animal species are also listed under Schedule 2 of The Conservation (Natural Habitats, &c) Regulations (1994) as amended, often referred to as the Habitats Regulations (see Paragraph 9.18). The Habitat Regulations transcribe the Habitats Directive into UK law.

9.11. The OSPAR Convention outlines species and habitats which require further protection. Of the species expected within the Sound of Islay study area, the harbour porpoise is listed as threatened and declining (Annex IV).

National

9.12. The Wildlife and Countryside Act 1981 (as amended) ratifies the Bonn Convention (Paragraph 9.7) and provides for the protection of all cetaceans found within UK territorial waters. Under Section 9 of the Act, it is an offence to intentionally kill, injure or take cetaceans; and to cause damage or destruction to certain areas used by cetaceans for shelter and protection, or to intentionally disturb animals occupying such areas.

9.13. The Nature Conservation (Scotland) Act 2004 amends and improves the species protection provided by the Wildlife and Countryside Act 1981 (Paragraph 9.12) to provide extension to existing protections for cetaceans from intentional disturbance to encompass protection from reckless disturbance as an offence.

Phocidae

9.14. All seals found within Scottish waters are protected by a range of national and international obligations:

International

9.15. Harbour seal and grey seal are listed as Annex II species under the Habitats Directive and should be protected via Natura 2000 sites. Annex V (a) provides additional restrictions on methods of taking or killing of all phocidae.

9.16. Under Schedule 3 of The Conservation (Natural Habitats, &c) Regulations (1994), grey and harbour seals are listed as animals which may not be taken or killed in certain ways.

9.17. Where there is potential for disturbance to occur to European Protected Species (EPS) as a result of a plan or project (such as the proposed development), an application for a licence to undertake such disturbance can be made to the competent authority. Such a licence can be granted if an appropriate Monitoring and Mitigation plan is put in place.

National conservation

9.18. The Conservation of Seal Act 1970 will be replaced by Section 130 of the Marine (Scotland) Act 2010 when it comes into force later this year and the Development will fall under the Marine (Scotland) Act. Under the Marine (Scotland) Act it is an offence to kill, injure or take a seal at any time of year except to alleviate suffering or where a licence has been issued to do so by the Scottish Government. It will also be an offence to harass seals at haul-out sites. This contrasts with the lower level of protection under the Conservation of Seals Act, under which restrictions are only placed on the management of seals at prescribed times of the year, coinciding with breeding and moulting.

9.2.2 Consultation

9.19. Consultation with statutory bodies and key stakeholders was undertaken by SPR on the following scoping document: 'Proposed Demonstration Tidal Site, Sound of Islay. Request for a Scoping Opinion' (ScottishPower Renewables, 2008). The responses made by SNH are particularly relevant to this chapter.

9.20. SNH advise that the Firth of Lorn should be considered for its importance for harbour porpoise. SNH also provided advice regarding the European Protected Species (EPS) which could be expected to occur within the Sound of Islay.

9.21. SNH advised that the usage of the Sound of Islay by marine mammals should be established by the use of field work as well as literature review. SPR commissioned the following:

- HWDT to collate their effort corrected visual and acoustic data collected between 2003 and 2009 during vessel-based line transect surveys as well as sightings data reported by the public between 2000 and 2008;
- SMRU to carry out land based visual observations and aerial surveys; and
- SAMS to complete an acoustic characterisation of the Development site.

9.2.3 Data collection

9.22. Information has been collected through a desk-based data search and through the commissioning of specialist field surveys. Important sources of information include:

Table 9.1: Catalogue of marine mammal data for the proposed Development

Data source	Coverage	Author	Year
Scottish Marine Renewables Strategic Environmental Assessment (SEA).	Scotland wide	Faber Maunsell	2007
JNCC SAC database	SAC	JNCC	2009
SMRU shore-based visual observations[1]	Sound of Islay Study Site	SMRU	2010
SMRU aerial surveys	SAC data of moult and breeding surveys across Argyll and Bute	SMRU	2010 (ongoing)
HWDT visual and acoustic data from boat-based surveys [2]	Argyll and Bute. Limited coverage of the Sound of Islay Study Site	HWDT	2009
HWDT collation of public sightings[1]	Argyll and Bute	HWDT	2000-2008
Background information on marine mammals for SEA 7	North west Scotland	Hammond *et al.*	2006
NRP sightings[3]	Sound of Islay	NRP/SMRU	2009-2010

9.2.4 Assessment of Significance

9.23. The significance of the effect caused by the impact is assessed in relation to the sensitivity/value/importance of the receptor and the magnitude of the impact (Table 9.2).

9.24. All marine mammals in UK waters are of national or international importance for nature conservation and therefore are all assessed to be of high sensitivity.

9.25. Table 9.2 is based on the Scottish Executive (2007) Significance Assessment Criteria.

Table 9.2: Magnitude of the Impact

Magnitude of the Impact	Description
High	Affect an entire population / habitat causing a decline in abundance and / or change in distribution beyond which natural recruitment would not return that population / habitat, or any population / habitat dependent upon it, to its former level within several generations of the species being affected.
Medium	Damage or disturbance to habitats or populations above those experienced under natural conditions, over one or more generation, but which does not threaten the integrity of that population or any population dependent on it.
Low	Small-scale or short-term disturbance to habitats or species, with rapid recovery rates, and no long-term noticeable effects above the levels of natural variation experienced in the area. The impacts are not sufficient to be observed at the population level.
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

[1] Appendix 9.1
[2] Appendix 9.2
[3] Included in Appendix 9.1

9.26. Table 9.3 outlines the matrix used in assessing the significance of effect of each impact to marine mammals using both the importance of the receptor (in this case the marine mammals) and the magnitude of impact should it occur. This provides a worst case scenario and does not take into consideration the likelihood of occurrence. The magnitude of the impact may be influenced by the sensitivity of the receptor to the potential impacts (Table 9.3).

Table 9.3: Significance prediction matrix

Magnitude of Impact	Receptor sensitivity/value/importance			
	Negligible	**Low**	**Medium**	**High**
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

9.27. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being of significant effect.

9.28. It should be noted that because all marine mammals within the study area are of national or international importance and therefore of high sensitivity, the level of significance cannot be assessed as less than Minor and may necessarily be Moderate, even if the magnitude of a particular impact is considered to be low.

9.29. Table 9.4 outlines the sensitivities of marine mammal species to the specific impacts predicted for the Development as discussed by Scottish Executive (2007). While this is not considered directly during the impact assessment it provides some additional context when considering potential impacts.

Table 9.4: Marine mammal sensitivities

		Sensitivity					
Species	**Presence in Sound of Islay**	**noise & vibration**	**collision**	**increased suspended sediments**	**release of contaminants**	**barrier effect[4]**	**habitat exclusion**
Harbour seal	Highly likely	High	High	High	Low-medium	Medium	medium
Grey seal	highly likely	High	High	High	Low-medium	Medium	medium
Harbour porpoise	Highly likely	High	High	Medium	Low	High	High
Bottlenose dolphin	Likely	High	High	Medium	Low	Medium-high	Medium-high
Killer whale	Likely	High	High	Medium	Low	Medium-high	Medium-high
Common dolphin	Unlikely	High	High	Medium	Low	Medium-high	Medium-high
Risso's dolphin	Unlikely	High	High	Medium	Low	Medium-high	Medium-high
White beaked dolphin	Unlikely	High	High	Medium	Low	Medium-high	Medium-high
Atlantic white-side dolphin	Unlikely	High	High	Medium	Low	Medium-high	Medium-high
Long finned pilot whale	Unlikely	High	High	Medium	Low	Medium-high	Medium-high
Minke whale	Unlikely	Medium	High	Medium	Low	Medium-high	Medium-high
Humpback Whale	Unlikely	Medium	High	Medium	Low	Medium-high	Medium-high

9.3 Baseline Description

9.30. The following species were recorded in the Sound of Islay during the baseline surveys or are likely to be present within the Sound due to their natural range including the Sound and/or surrounding waters. This includes a number of deeper water and less frequently recorded species, which are considered to have potential to passage through the Sound, but for which data are limited.

9.3.1 Phocidae

9.31. Two phocid species are recorded in the UK, the harbour seal *P. vitulina* and grey seal *H. grypus*.

9.32. Sightings per unit effort collected by HWDT (2009) (Appendix 9.2) during boat based surveys show high numbers of grey, harbour and unidentified seals within the Sound of Islay, shown in Figure 9.4. This map shows the proposed array site to have lower numbers of seals as the South East Islay Skerries SAC. The proposed array site has a value of 0.064 to 0.080 seals per Km^2, whereas the SAC has a value of 0.080 to 0.112. Figures 9.5 and 9.6 show the number of grey and harbour seal counts from an aerial survey in August 2009.

Harbour seal

9.33. The harbour seal has a widespread distribution, it is found along most coastlines in the northern hemisphere from polar to temperate regions. There are five subspecies of *P. vitulina* occurring in the eastern north Atlantic. Approximately 85% of the UK harbour seal population is found in Scotland.

9.34. The South East Islay Skerries Special Area of Conservation (SAC) lies approximately 18 km to the south east of the proposed development site within the Sound of Islay (see Figure 9.6). As an Annex II species the harbour seal is the primary reason for the designation of this site. The skerries, offshore islands and rugged coastline between Lagavulin Bay and Ardmore Point (South coast of Islay) support a nationally-important regional group of around 600 harbour seal. This area is extensively used as a pupping, moulting and haul-out site by the seals, which represent between 1.5% and 2% of the UK population.

[4] Estimated in relation to habitat exclusion

9.35. A study of harbour seal movements (Cunningham *et al*., 2008) show haul out clusters within the Sound of Islay, as well as a large number around the coast of Islay, in particular on the south coast.

9.36. The Sea Mammal Research Unit (SMRU) carried out aerial surveys of harbour and grey seals along the coast surrounding the Sound of Islay, including Islay, Jura, West Kintyre, Colonsay and Oronsay, on 10th and 12th August 2009. Figure 9.5 shows three groups of up to 50 harbour seals were recorded in the southern part of the Sound of Islay and a number of smaller groups (1-5 seals) were recorded in the centre and to the north of the Sound. This corresponds with sightings made during the intertidal surveys on Jura and Islay, completed as part of this EIA (Appendix 16.2 and 16.4). Individual grey and harbour seals were recorded milling in the water near Feolin Ferry, around 400m to the east of the northern most turbine of the Development and near Traigh Bhan, around 2km to the south west of the Development. A single harbour seal was recorded hauled out at Traigh Bhan and fourteen were hauled out at Toll Chilli-chairain, approximately 800m to the south west of the Development.

9.37. SMRU (2010) recorded 398 harbour seal sightings within the Sound of Islay during their land based observations, April- November 2009. Of these 99% were recorded between July-November. 111 unidentified seals were also recorded within July-November.

9.38. Surveys of harbour seals around Scotland by SMRU in 2008 show the number of harbour seals in the SAC (and across the whole of Islay) to have increased between August 1990 and August 2007 (SMRU, 2008). This pattern is in contrast to the observed widespread decline in numbers at other locations throughout Scotland and the UK over the same period.

9.39. Harbour seals normally feed within 40-50km of their haul out sites, and feed on a variety of prey species including gadoids (particularly whiting), pelagic scad and herring (Pierce and Santos, 2003).

9.40. Harbour seal pupping occurs in June and July while moulting takes place in August and September. 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 (SMRU, 2010).

9.41. Harbour seals can detect noise within the 100Hz to 60kHz range but show peak hearing between 1 and 50kHz at 70dB re 1µPa (Wilson and Carter, 2010).

Grey seal

9.42. Grey seal are found across the North Atlantic with around 45% of the world population being found in Britain. Over 90% of the British population breeds in Scotland. Satellite telemetry data show that grey seals 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.,* 1999, cited in SMRU, 2010). Foraging trips usually last between two and five days, with seals generally feeding within 50km of the haul-out site (McConnell *et al.,* 1999; cited in SMRU, 2010). The shelf waters off the west coast of Scotland are clearly very important foraging habitat for the large numbers of grey seals within 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.

9.43. The grey seal moulting season occurs between February and April (SMRU, 2010) and the breeding season occurs during late summer / early autumn each year (Hammond *et al.,* 2006) when mature females will give birth to a single pup.

9.44. Figure 9.6 shows low numbers (1-5) of grey seals at sites within the Sound of Islay. Grey seals are most numerous to the north of the Sound, on the north of Skye and south of Oronsay.

9.45. The grey seal is a notified feature of the Oronsay and South Colonsay SSSI, which lies approximately 20km to the north of the proposed array site. The number of breeding seals within the SSSI remains stable and the site continues to be one of the best sites for pup production in the Hebrides and west coast of mainland Scotland (SNH, Accessed 2010).

9.46. SMRU (2010) recorded 86 grey seals within the Sound of Islay during their land based observations, April- November 2009. Of these 95% were recorded between July-October. In addition, 111 unidentified seals were recorded within July-November.

9.47. SMRU (2010) aerial survey results within the Sound of Islay study area (shown as a black box in Figure 9.6) found that grey seals decreased from 29 to 22 between 1990 and 2000. A large increase to 46 was recorded in 2007 and then a slight decrease to 35 was recorded in 2009. This was in contrast to the total numbers in the wider Strathclyde survey area which found that grey seal numbers fluctuated slightly between years but, on the whole, increased.

9.48. The diet of UK grey seals has been well studied and findings from the Hebrides in 2002 highlighted the importance of sandeels, gadoids and herring. In the Inner Hebrides benthic species are also considered to be an important component of their diet, including flat fish during the summer months (Hammond and Harris, 2006; cited in SMRU, 2010).

9.49. The hearing range of grey seals is expected to be similar to that of the harbour seal which can detect noise within the frequency range of 100Hz to 60kHz, with a peak hearing threshold of between 1 and 50kHz at 70dB re 1µPa.

9.3.2 Cetaceans

9.50. Cetacean species which have been recorded within the Sound of Islay include the harbour porpoise *P. phocoena* and bottlenose dolphin *T. truncatus* (SMRU, 2010).

9.51. The waters around Argyll and Bute have regular sightings of minke whale *B. acutorostrata*. According to UKDMAP, 1998 (cited in Scottish Executive, 2007) white beaked dolphin *L. albirostris*, common dolphin *D. delphis*, and Rissos's dolphin *G. griseus* are also seen regularly around Islay (including the Sound of Islay). Atlantic white-sided dolphin *L. acutus* and long-finned pilot whale *G. melas* have all been recorded with occasional abundance around Islay (including the Sound of Islay) (UKDMAP, 1998; cited in Scottish Executive, 2007). Killer whale *O. orca* was recorded in the Sound of Islay during the Aug 2009 Royal Haskoning intertidal survey (Appendix 16.2).

Toothed Whales

Harbour porpoise

9.52. Harbour porpoise are usually found near shore although they do also occur in deeper water. Porpoises are sighted in small groups or singly, frequently occurring in narrow sounds or bays. They are characteristically shy of boats and other anthropogenic activities; and this species is thought to be easily disturbed.

9.53. The Sea Watch Foundation carried out boat based surveys along the west coast of Scotland during the month of August in 1993, 1994, 1996 and 1997. Harbour porpoise sightings data indicated a preference for waters within 15km of the shore and between 50 and 150m depth. An apparent relationship between tidal currents and porpoise distribution was noted, with more sightings predicted for areas of high tidal currents and times of high tide. This study also found a high variability in the number of sightings within the study period (Marubini *et al.,* 2009; cited in SMRU, 2010).

9.54. Research by the Hebridean Whale and Dolphin Trust ("HWDT") reports that the Inner Hebrides are particularly important harbour porpoise habitat, with feeding hotspots around Mull, the Small Isles and the Sound of Jura (HWDT, Accessed 2010). This corresponds with a recent paper by Embling *et al.* (2009) (cited in SMRU, 2010) which identified four potential sites for marine protected areas for harbour porpoises in the Inner Hebrides, including the Sound of Jura and the Firth of Lorn, both approximately 17km from the proposed Development. This study found that higher relative densities of porpoises were detected during low tidal currents in contrast to the study discussed previously where porpoises were detected at higher rates during high tidal currents (Marubini *et al.,* 2009; cited in SMRU, 2010). This can be explained by the fact that the Embling study (Embling *et al.* 2009; cited in SMRU, 2010) was further north and the tidal regime in the southern Inner Hebrides has much higher tidal speeds which may not have been preferable to harbour porpoise.

9.55. Figure 9.1 shows acoustic detections per unit effort for harbour porpoise within the Sound of Islay, collected by HWDT (2009). Harbour porpoise were the most common species in the study region, followed by seals. Harbour porpoise detections were widespread in adjacent waters with highest densities in the Sound of Jura; however, there were a small number (0.102-0.186 detections/km) in the Sound of Islay itself and to the north, between Colonsay and Jura.

9.56. Public sightings between 2000 and 2008, collated by HWDT (2009), are shown in Figure 9.2. The dataset supports the findings of the acoustic study (Paragraph 9.54) indicating that harbour porpoise uses the Sound of Islay and is the most common cetacean species. This data is not effort limited and has therefore been interpreted with caution. One harbour porpoise was recorded in October during the SMRU (2010) land based observations which were completed during April-November 2009.

9.57. In UK waters, mating and calving are estimated to take place between May and September (Learmonth, 2006; cited in SMRU 2010) with a peak around June and July (Lockyer, 2007; cited in SMRU 2010). The diet of harbour porpoise in Scottish waters is dominated by small demersal and pelagic shoaling fish. In Scotland porpoises tend to feed primarily on two to four main species, including whiting and sandeels (Santos *et al.,* 2004; cited in SMRU, 2010). The distribution of these prey species is discussed further in *Chapter 11: Marine Fish and Shellfish Resources*.

9.58. Harbour porpoise hearing is expected to be similar to that of bottlenose dolphins which have good hearing at high frequencies with a peak at around 50dB re 1µPa at 50kHz becoming insensitive to sounds above 200kHz. Hearing is poor at low frequencies but they can hear 40 to 70Hz if the amplitude is sufficiently high (Wilson and Carter, 2010).

Bottlenose dolphin

9.59. Bottlenose dolphin is a predominantly coastal species, commonly occurring in groups of one to several dozen individuals but can also be seen in large groups of up to a hundred or more individuals. The Hebrides supports one of three known UK populations of bottlenose dolphin (HWDT, 2009).

9.60. Bottlenose dolphin is widespread on the west coast of Scotland, although numbers are lower relative to the east coast of Scotland. Bottlenose dolphin has been recorded close to the coast around Argyll in all months of the year, suggesting possible year-round residency (Mandelberg, 2006; cited in SMRU, 2010). There is also some evidence that a small resident or semi-resident community of bottlenose dolphins may occur around Islay and can therefore be expected within the Sound of Islay (Evans *et al.*, unpublished data).

9.61. Public sightings of bottlenose dolphins between 2000 and 2008, collated by HWDT (2009) show that the species does occur within the Sound of Islay (Figure 9.3). The data is not effort limited, therefore abundance cannot be determined.

9.62. Bottlenose dolphin has a varied diet. Studies on the Scottish east coast suggest that areas with strong tidal flows are a favoured foraging habitat (Mendes *et al.,* 2002; cited in SMRU, 2010). Santos *et al.* (2001) published dietary information for ten stranded bottlenose dolphin off the east coast of Scotland, the main prey items being cod, saithe and whiting. In contrast to the harbour porpoise, bottlenose dolphins are inquisitive and frequently approach boats.

9.63. Bottlenose dolphin has optimal hearing at high frequencies with a peak at around 50dB re 1µPa at 50kHz becoming insensitive to sounds above 200kHz. Hearing is poor at low frequencies but they can hear 40 to 70Hz if the amplitude is sufficiently high (Wilson and Carter, 2010).

Killer whale

9.64. Killer whale has the widest distribution of all marine mammals, found from the equator to the polar seas. 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 have been recorded in inshore Scottish waters around the Northern and Western Isles, where sightings are concentrated around Mull and the Treshnish Isles (Bolt *et al.,* 2009; cited in SMRU, 2010), and in the northern North Sea (Reid *et al.,* 2003). A killer whale was recorded in the Sound of Islay during the intertidal survey for the potential landfall sites on Islay in August 2010. The adult male was observed milling approximately 600m to the south west of the Development during low water slack (Appendix 16.2).

9.65. There are reports of killer whales predating upon grey seals, harbour seals and porpoises around Scotland (Weir, 2002; cited in SMRU, 2010). 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; cited in SMRU 2010). 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; cited in SMRU 2010).

9.66. Killer whales breed throughout the year, particularly during September to January in the northern hemisphere. Peaks occur during September to October (CRRU, Accessed 2010).

9.67. Killer whales are most sensitive to mid frequency sounds between 8 and 20kHz, with an upper limit of 120kHz (Wilson and Carter, 2010).

Common dolphin

9.68. Common dolphin has a widespread oceanic distribution in tropical to temperate waters throughout the Atlantic and Pacific. The species is found in continental shelf waters and is common in the Sea of Hebrides and to the south of the Minch, especially in the summer (SMRU, 2010). Common dolphin have occasionally been sighted around the Hebrides during monthly summer surveys carried out by the HWDT between 2003 and 2005; however, no sightings were made in the Inner Hebrides south of Coll and Tiree (SMRU, 2010). There are no known sightings of common dolphin within the Sound of Islay and their tendency towards deep water makes it unlikely that they would enter the Sound.

Risso's dolphin

9.69. Risso's dolphin is found in both hemispheres, mostly in continental slope areas from the tropics to temperate regions. Risso's dolphins have been sighted on occasion in Scottish waters, mainly to the west of the Outer Hebrides, generally between June-September (Hammond *et al.,* 2006). There are no known records of Risso's dolphin in the Sound of Islay. Whilst their presence in surrounding waters make it possible for Risso's dolphin to enter the Sound, their tendency towards deep water make it unlikely.

White beaked dolphin

9.70. The white-beaked dolphin is found in cool temperate and subarctic waters of the North Atlantic (Reid *et al.,* 2003). They are mostly distributed over the continental shelf and in the northern North Sea (off Scotland and northeast England) (Hammond *et al*., 2006). The species is generally found in waters between 50m and 100m depth, and rarely out to the 200m isobath (Reid *et al.,* 2003). Research indicates that white-beaked dolphin numbers are decreasing in north western Scotland and are being replaced by common dolphins (MacLeod *et al.,* (2005, 2007 and 2008); cited in SMRU, 2010). It is not expected that this species will be encountered within the Sound of Islay.

Atlantic white-side dolphin

9.71. The Atlantic white-sided dolphin shares most of its range with the white-beaked dolphin. The two species can be difficult to distinguish so there is a tendency for them to be recorded as *Lagenorhynchus spp*. Around Britain, sightings are largely concentrated in offshore waters to the north and west; however there are currently no abundance estimates for this region. The Atlantic white-sided dolphin has previously been found in the Hebrides (Hammond *et al.,* 2006); however, there are no known records in the Sound of Islay.

Long finned pilot whale

9.72. The long-finned pilot whale is a continental shelf species with a worldwide distribution in temperate and sub-polar seas. In UK waters sightings frequently occur around the 1,000 metre isobath, particularly north of Scotland where they are recorded west of the shelf edge. There are no known records of the long finned pilot whale within the Sound of Islay and with an offshore distribution and preference for deep water it is unlikely that the long finned pilot whale would enter the Sound of Islay on a regular basis.

Baleen whales

Minke whale

9.73. The minke whale is a predominantly coastal species, widely distributed throughout the world and is found from the subtropics to polar regions in both the Northern and Southern hemisphere. Within UK waters, minke whales are most frequently sighted in the north-western North Sea, the Hebrides and in the Irish Sea (Reid *et al.,* 2003). Minke whales have been found to be seasonally resident off the Inner Hebrides (Gill *et al.,* 2000; cited in SMRU, 2010), although some may be present year round (MacLeod *et al.,* 2004, cited in SMRU, 2010). Regular surveys in the Inner Hebrides 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., cited in SMRU, 2010). Opportunistic surveys on the Kennacraig to Port Askaig ferry reported two minke whale sightings in the Sound of Jura, to the south of the Sound of Islay on the 30 June 2009 (SMRU, 2010). While there are no known records of minke whale within the Sound of Islay their presence in surrounding waters make it possible that they could enter the Sound.

9.74. Breeding is thought to occur throughout the year, with apparent peaks in calving during winter months (CRRU, Accessed 2010).

9.75. Minke are known to feed in areas of strong tidal currents and around small islands and headlands (Anderwald *et al.,* 2008, cited in SMRU, 2010). 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, cited in SMRU, 2010). 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 minke whales stranded along the coast of Scotland, the diet was found to comprise mainly of sandeels and clupeids (Pierce *et al.,* 2004).

9.76. Very little is known about the hearing sensitivities of minke whales; however they are likely to be low frequency specialists, hearing sounds below frequencies of 1kHz but probably up to around 8kHz (Wilson and Carter, 2010).

Humpback Whale

9.77. Humpback whales are widely distributed globally and undertake long seasonal migrations between feeding and breeding areas. This species largely favours inshore waters and the continental shelf. They have been recorded occasionally (one or two per year) in the Hebrides, travelling between breeding grounds and feeding areas (HWDT, 2008)., however, there are no known records within the Sound of Islay.

9.3.3 Baseline Underwater Noise

Properties of Noise

9.78. Various physical parameters have an effect on noise and the propagation of sound waves through water. Temperature variations have a major effect on sound propagation in shallow waters; a mixed isothermal sea surface layer (which will form under certain conditions) may act as a duct which can 'trap' acoustic signals. Sediment types and seabed roughness will also affect noise propagation; a hard seabed such as that found across much of the Sound of Islay (*Chapter 7: Physical Environment and Coastal Processes*) will reflect noise effectively whereas soft silty or muddy seabed will absorb noise (Scottish Executive, 2007). However, low frequency noise can travel considerable distance within the sea-bed substrate to be emitted at distance from the source.

9.79. Background subsea noise results from contributions by many sources. These may be both naturally occurring noise, such as sea state, seismic disturbances, meteorological conditions or noise emitted by marine mammals or anthropogenic noise, such as shipping traffic, aggregate extraction activity or oil and gas production.

Naturally occurring noise

9.80. SAMS (2010) undertook a survey of underwater noise levels within the Sound of Islay study area (Appendix 9.3). The study was designed to avoid, where possible, the recording of anthropogenic noise and therefore concentrate entirely on natural noise levels. The constant operation of the Port Askaig to Feolin ferry meant that this was not possible across the entire study area particularly at the northern extent.

9.81. This study used the "Drifting Ears Method" (Wilson and Carter, 2008) to record underwater sound levels, within the proposed array site, over a period spanning neap and spring tides during September 2009.

9.82. As often is the case in the marine environment (Scottish Executive, 2007), low frequencies were found to dominate the sound spectrum within the Sound of Islay. It was also found that as flow rate associated with tidal conditions within the Sound increased the level of background noise also increased.

9.83. Mean noise levels within the sound were found to range between 69 dB re 1µPa (during slow ebb at a frequency of 20kHz) and 116 dB re 1µPa (during fast flood at a frequency of 5kHz) over the 6 frequencies studied and varied (spatially across the width of the Sound) greatly across a spatial scale. Overall background noise levels were considered, by SAMS, to be high especially when compared with studies that have been conducted in the open ocean. Most sampling took place during sea states 0-2 (noise levels generally increase with greater sea state) and recorded noise levels within the Sound, even at these calm sea states, were considerably greater than recordings during sea state 6 (very rough) in open ocean.

9.84. It was found that noise levels increased as the speed of tidal flow increased and conversely decreased as tidal flow slowed. This suggests that physical processes such as water flow or gravel transport are contributing significantly to the soundscape within the Sound of Islay. During poor weather conditions, noise caused by wind and precipitation can dominate the noise levels in the underwater environment.

Anthropogenic noise

9.85. During the SEA program funded by the DTI (now DECC) a noise study was conducted of background noise within the area known as SEA 7 which contains the waters off western Scotland and therefore the Sound of Islay. This study concluded that "the SEA 7 area carries a significant amount of commercial shipping" (Harland and Richards, 2006). The Scottish Executive SEA (Scottish Executive, 2007) identified that the dominant noise source during calm conditions within the seas around Islay and Jura is that of "distant shipping".

9.86. The noise spectrum from all powered craft is relatively broadband but with a strong low frequency content and a number of tonal 'lines' emanating from engines and machinery. Above 1kHz engine/machinery noise diminishes and the dominant noise source is caused by water displacement and the resulting entrained bubbles. The noise of distant shipping tends to dominate the 50 to 300Hz part of the spectrum (Harland and Richards, 2006).

Ferries

13.1. Within the coastal waters of Scotland a significant contribution to shipping noise will be from the interisland ferries (Harland and Richards, 2006). It is therefore likely that greatest current source of anthropogenic noise emissions in the Sound of Islay are the ferries which operate within the Sound.

9.87. There are two ferry services that operate in the Sound: the Kennacraig to Port Askaig service (which also extends to Colonsay during the summer months) and the Islay to Jura service which operates all year round.

9.88. There is no specific data available on the acoustic output of the Caledonian MacBrayne ferries but a study of the effects of vessel noise on the marine environment found that noise levels produced by ferries ranged from between 137 dB re 1µPa at 220m to 120 dB re 1µPa, at a distance of 950m (Sara *et al.*, 2007). These levels were always greater than the background noise levels in the study area. Whilst gathering data for this study it was found that ferries generated the highest noise levels in the lower frequencies and at about 600m from the noise source all but the lowest frequencies (<6KHz) had dropped below background levels (Sara *et al.*, 2007). Further studies completed have found that a typical ferry creates a sound wave of 160-170dB re 1µPa @ 1m. These studies show that vessels create a virtual wall of "white noise" that has a constant loudness (US Department of Transport, 2010).

9.89. The Kennacraig to port Askaig ferry docks in Port Askaig up to 10 times a week, visiting once or twice a day. Natural background noise levels within the Sound were found to be between 86.8 and 159.8dB re 1µPa and it is, therefore, likely that these ferries make a significant contribution to current background noise levels. It should be noted that the report produced by SAMS (2010) did not include measurements of noise levels when the Caledonian MacBrayne ferries were in the Sound. Therefore, the noise created by these ferries will be in addition to the background noise levels reported by SAMS (2010).

Fishing vessels

9.90. Away from the main shipping lanes within SEA 7 a major contribution to underwater noise is likely to come from fishing boats (Harland and Richards, 2006)

9.91. Approximately 10 small fishing vessels use the Sound, mainly in winter (*Chapter 15: Commercial Fisheries*). A brief search of current literature (Chung *et al.*, 1995; Erikson G 1979; Sara *et al.*, 2007) indicates that fishing vessels produce noise levels of between 50 and 140dB re 1µPa. The vessels that operate within the Sound of Islay are generally small (<10 m in length (*Chapter 15: Commercial Fisheries*)) and as a result it is likely that their acoustic output will be at the bottom of this range. Therefore, it is reasonable to infer that as the background noise levels in the Sound range from 86.8 to 159.8dB re 1µPa, it is unlikely that fishing vessels contribute significantly to background underwater noise levels.

Potential Future Noise Generated by Turbine

9.92. The SAMS (2010) (Appendix 9.3) study takes the recorded acoustic output of the Hammerfest Strøm HS 1000 device reported by Akvaplan-niva (2010) (Appendix 9.4) and uses those figures to calculate the amount of noise these devices would produce within the Sound of Islay. The maximum acoustic output from one device was reported to be 113dB re 1µPa.

9.93. Note the calculations used in the SAMS (2010) report do not attempt to scale up the noise produced by the HS 1000 device which produces 330kW and the device to be used in the Sound of Islay which is predicted to produce 1MW. The scale and general design characteristics of the proposed 1MW device differ only marginally from those of the 300kW device and it is anticipated that differences in terms of noise characteristics will be limited.

9.94. Background noise levels within the Sound of Islay are much higher than those in open ocean (SAMS, 2010) and it is anticipated that they are often at higher levels than those recorded during the SAMS survey (86.8 – 159.8dB re 1µPa), given that survey was conducted in calm conditions and avoided anthropogenic noise such as that from the ferries using the Sound.

9.95. Marine turbines by their nature can (currently) only operate in areas where high ambient sea noise levels already exist (Subacoustech, 2005; Akvaplan, 2010) due to the high energy environments they require. Additionally, tidal turbines typically produce noise at low frequencies (between 50 and 1000Hz). Noise produced by shipping and natural noise associated with high energy coastal environments is also generally around the lower frequencies; therefore it is anticipated that the operational noise of the turbine will be masked by the background noise of shipping as well as natural environmental background noise.

9.96. SAMS (2010) calculated the distance that the noise produced by the Development would travel before it fell below background noise levels. Once below background noise levels it is assumed to have no impact on any receptors.

9.97. Using both the spherical transmission loss formula and the cylindrical spreading formula it was predicted that the distance that underwater noise from each turbine would travel before it dropped below background levels would be between 20m and 400m. Figure 9.7 illustrates spatially the distance that noise may travel from each of the 10 devices. The Akvaplan (2010 pp.19) report concludes that the cylindrical spreading loss formula (which predicted a distance of 400m) is more appropriate for calculating transmission loss from tidal turbines, than the spherical transmission loss formula. However, the propagated noise levels are likely to be at the lower end of this range due to the factors described below.

9.98. The theoretical upper range limit of 400m would only occur if a turbine was positioned in the location of lowest levels of background noise, emitting noise a maximum level. This is an unlikely scenario for the following reasons:

- Soundscape maps produced by SAMS (2010) show that the lowest background noise levels in general occur in the south east or south west of the study area (Appendix 9.3; Figure 6) depending on the state of tide. The proposed turbine locations, which are plotted in Figure 9.7, are in the northern half of the study area, general, is characterised by higher levels of background noise;
- Secondly, it is likely that turbine noise will increase as the rotational speed of the turbine rotors increase as the current flow-rate increases. This will correspond with an increase in background noise levels which was found to occur as a result of the current speed increasing (SAMS 2010). Hence, the increasing turbine noise should be masked by the increase in background noise. However, this factor has not been taken into account when calculating the extent to which noise will travel before it falls below background levels, so allow for conservative assessment of this effect; and
- Due to the shielding effect caused by Islands of Islay and Jura (Scottish Executive, 2007) noise generated by the turbines will be modified and is not likely to travel out of the Sound.

9.99. SAMS (2010) concluded that ten operational turbines within the Sound of Islay would have very little impact on existing noise levels.

13.2. No known underwater noise measurements have been made of gravity support structure installation, and no behavioural observations have been made. However, it may be possible to draw some conclusions from a case study relating to seabed rock placement for scour protection.

9.4 Assessment of Effects and Mitigation

9.4.1 Do Nothing Scenario

9.100. Grey and harbour seal abundances in the South-east Islay Skerries marine SAC have been seen to increase between 1990 and 2007 and human activities within the SAC are currently relatively low and tolerated by seals (JNCC, 2001). However, while harbour seal numbers on the west coast of Scotland and the Hebrides appear to be comparable with numbers for previous years (based on 2005 and 2006 data) numbers for the northern isles and east coast show a decline (SNH, 2007).

9.101. The local increases are expected to include increased movements and haul out within the Sound of Islay. During a 'do nothing scenario' seals in the area could be expected to fluctuate naturally around the current population level.

9.102. Public sightings data from 2000 to 2008 (HWDT, 2009) suggest that harbour porpoise would be expected to be seen on a regular basis in and around the Sound of Islay, bottlenose dolphin is also sighted in this area, although less frequently.

9.103. The sporadic occurrence of other cetacean species such as the minke whale makes the 'do nothing' scenario difficult to predict. For example, natural variation in the distribution of prey species is likely to have a significant effect on their presence.

9.4.2 Potential Impacts during Construction Phase

Impact 9.1: Noise and vibration

9.104. The use of ballasted gravity base tidal devices will reduce the noise generated by construction in comparison to the pile driving or drilling activities which are required for offshore windfarms and some other tidal devices.

9.105. Increased vessel traffic, including some vessels using dynamic positioning (DP), may be a major source of noise during construction. However, due to the number of vessels already using the Sound of Islay, the relatively limited duration over which increased levels of vessel activity will occur, and the existing levels of background noise, the impact is expected to be relatively low. Vessel noise can be reduced by maintaining a consistent speed and slowing down/ accelerating gradually (DSP, 2009).

9.106. The audible range of construction activities will depend on the interplay between: (1) the hearing sensitivities of receptive species; (2) the acoustic output at source; (3) masking effects by background noise; and (4) the propagation potential of the environment (as a function of temperature, underlying substrata, etc). Studies of the noise generated during construction of the SeaGen turbine in Strangford Lough showed that drilling activities produced noise levels resulting in a low likelihood of disturbance to marine mammals up to 115m from the noise source. At 3m from the drilling site the level of noise was expected to cause some avoidance reactions from marine mammals (Nedwell and Brooker, 2008). The construction activities for the Development are expected to produce significantly less noise than the Strangford case study for example due to the absence of drilling activities within the construction programme for the Islay array.

9.107. Marine mammals travelling through the Sound of Islay or seals hauled out close to the site could theoretically be temporarily displaced by the noise generated during construction. However, shore based marine mammal surveys undertaken during the installation of the SeaGen turbine in Strangford Lough, Northern Ireland, showed no evidence of change in relative seal abundance or distribution in the area. Measures of harbour porpoise activity (echolocation 'clicks' collected via passive acoustic monitoring) within Strangford Lough narrow also indicate that passage in and out of the lough remains at similar levels pre and post installation (Scottish Natural Heritage, 2009). It suggested that existing high levels of existing background noise and vibration may have played a role in this lack of response.

9.108. Based upon the lack of evidence of disturbance effects during installation of the SeaGen device and considering the potential noise of installation in the context of the existing, considerable, noise environment of the narrows a negligible magnitude is predicted for the Sound of Islay, with no measurable response or change anticipated. Given that receptor sensitivity must be considered high, due to the legislative status of the species assessed, the impact is predicted to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 9.1
• SPR appreciates that this Development is the first tidal array and that that consideration of magnitude includes consideration of elements where knowledge is incomplete. As a result SPR commits to putting in place a programme of post installation monitoring and any mitigation considered necessary by regulators, as part of an ongoing programme of adaptive management. • There is a theoretical potential to cause disturbance to marine mammals, and while our judgement is that this is of minor significance in this instance, based on industry experience gained from SeaGen and wider assessments, knowledge is incomplete and effects from an array rather than a single device are unknown. A deploy and monitor strategy is proposed, with ongoing monitoring, linked to management of the Development. An important component of that strategy will be an application for a licence to disturb EPS, to enable regulators to allow deployment while further knowledge regarding effects (or lack of effects) from the Development is obtained. • As part of a wider adaptive management and environmental monitoring strategy, SPR is committed to mitigating relevant significant effects identified by ongoing monitoring.

Residual Impact

9.109. Due to the sensitivity of marine mammals as a receptor and our incomplete knowledge the significance of the impact remains **minor**.

Impact 9.2: Collision risk

9.110. Worldwide, shipping collision is a recognised cause of marine mammal (particularly cetacean) mortality (Scottish Executive, 2007). Due to the number of vessels already using the Sound of Islay and the relatively limited duration over which vessel activity will increase as a result of installation of the Development it is considered that the likelihood of collision is low. There is no current evidence of ongoing collisions with marine mammals in the Sound.

9.111. Studies such as the Dolphin Space Programme (DSP) (2009) show that a steady speed should be maintained to allow marine mammals to move away from vessels. A protocol will be established to ensure installation vessels travelling in to the area maintain a suitably safe speed. The vessels involved in installation will move at a steady speed and in a predicable and planned manner throughout the operation.

9.112. There is no evidence suggesting any collisions with marine mammals during construction (or subsequently) for SeaGen in Northern Ireland. A number of monitoring measures are in place there, including specific carcass survey measures (SNH, 2009).

9.113. Based on existing levels of vessel activity in the Sound, the limited scale and timeframe for installation, as well as the lack of any evidence of collision risk from other tidal turbine installation works, a negligible magnitude is predicted. Given the high receptor sensitivity, collision risk is therefore predicted to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 9.2
• The available evidence from existing tidal turbines e.g. SeaGen in Strangford Lough indicates that collision risk during construction is minimal, with no evidence of any interactions. • As detailed previously, SPR is committed to the establishment of any post installation monitoring required in support of a deploy and monitor strategy. It is anticipated that the data from visual observations before, and after installation will play a role in this. In addition, a carcass survey programme proposed by Marine Scotland as part of its ongoing support of wet renewable installations, provide an additional check and reassurance that reasonable measures are in place to detect any serious interaction. • Application of a vessel management protocol based on existing 'best practice' will ensure reasonable mitigation is in place to reduce potential for collision.

Residual Impact

9.114. As a result of the importance of marine mammals as a receptor the significance of collision risk will remain of **minor** significant effect.

Impact 9.3: Increased suspended sediment

9.115. Disturbance of sediment during construction could cause localised and short term increased turbidity and therefore reduced visibility. Harbour and grey seals have been reported as having high sensitivity to poor visibility, whilst cetaceans have moderate sensitivity (Scottish Executive, 2007).

9.116. The site has predominantly coarse gravelly substrate which would be expected to settle out of suspension rapidly. In high energy sites such as the Sound of Islay any fine sediment present would be expected to disperse rapidly. Based on this the magnitude of this impact is considered to be negligible. Given the high sensitivity / value of marine mammals, the impact has been assessed as being of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 9.3
• No mitigation required

Residual Impact

9.117. As a result of the importance of marine mammals as a receptor the significance of suspended sediments must remain of **minor** significant effect.

Impact 9.4: Accidental release of contaminants

9.118. The risk of spillage of contaminants, such as oils, during the construction phase has been considered within *Chapter 21: Water and Sediment Quality*.

9.119. The risk of pollution events will be minimised by following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA (e.g. PPG 5: Works and maintenance in or near water). Additionally, any chemicals used during construction will require prior approval through the FEPA licensing process and any lubricants will be non toxic, biodegradable and capable of dispersal in seawater.

9.120. Installation contractors will put in place appropriate Site Environmental Management Plans and Pollution Control and Spillage Response Plans that will be agreed with the relevant statutory bodies prior to offshore construction activities commencing. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, will ensure a rapid and appropriate response.

9.121. Seals and cetaceans generally have low sensitivity to contamination, although sensitivity increases for seals in the vicinity during breeding (Scottish Executive, 2007).

9.122. In a high energy marine environment, contaminants can be expected to rapidly disperse and it is expected that should a spill occur, its scale and the nature of the contaminant will be limited.

9.123. As a result a negligible magnitude is predicted and, given the high receptor sensitivity, the impact is predicted to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 9.4
• No mitigation required

Residual Impact

9.124. As a result of the importance of marine mammals as a receptor the significance of accidental release of contaminants must remain of **minor** significant effect.

Impact 9.5: Habitat exclusion

9.125. Noise disturbance and visual presence of the construction works could potentially displace marine mammals (seals) from habitats within the Sound of Islay including potentially feeding, breeding and social areas.

9.126. The Sound of Islay, including the area of the Development and associated installation works, is not known as a particularly important area for marine mammals in terms of feeding or breeding. Important designated haul out areas exist south of the Sound, however, these are sufficiently distant to not experience disturbance through the main mechanisms of visual and acoustic disturbance. Some non designated seal haul out sites are present nearby and there could be some disturbance to animals using these; however, given the limited timescale of the construction works it is expected that the effect, if any, will be short term.

9.127. As detailed earlier in this section an appropriate vessel management protocol will be put in place before commencement of installation. The protocol will identify known haul out areas in the vicinity of the proposed works and associated activity, and reasonable measures will be taken to avoid those locations.

9.128. Evidence from the installation of SeaGen, inside a site designated for seals, indicates no disturbance to the activity of marine mammals as a result of installation (SNH, 2009) or subsequently.

9.129. Based on the limited potential for disturbance indicated by the scale of the works and evidence from other installations of tidal devices, the magnitude of the potential impact is assessed as negligible. Given the high receptor sensitivity (given the conservation status of marine mammals) the significance of effect of habitat exclusion has been assessed as **minor.**

MITIGATION IN RELATION TO IMPACT 9.5
• Appropriate vessel management measures will be put in place to reduce or remove potential disturbance to haul out areas in the Sound. • SPR is committed to mitigating relevant significant effects identified by ongoing monitoring.

Residual Impact

9.130. As a result of the importance of marine mammals as a receptor the significance of habitat exclusion must remain of **minor** significant effect.

9.4.3 Potential Impacts during Operational Phase

Impact 9.6: Noise and vibration

9.131. SAMS (2010) (Appendix 9.3) undertook a survey of baseline underwater noise within the Sound of Islay and carried out modelling of predicted operational noise of the Development.

9.132. Background noise levels within the Sound of Islay are much higher than those in open ocean (SAMS, 2010) and are often likely be at higher levels than those recorded during the SAMS survey (86.8 – 159.8dB re 1µPa) as that survey was conducted in calm conditions and avoided the recording of anthropogenic noise such as the large ferries that frequent the Sound.

9.133. Marine turbines by their nature can (currently) only operate in areas where high ambient sea noise levels already exist (Akvaplan, 2010) due to the high energy environment. Additionally, tidal turbines typically produce noise at low frequencies (between 50 and 1000Hz). Coincidentally, noise produced by shipping and natural noise associated with high energy coastal environments is also generally centred around the lower frequencies; therefore, operational noise of the turbines will be masked by the background noise from shipping and the natural environment.

9.134. Due to the shielding effect caused by Islands of Islay and Jura (Scottish executive, 2007; pp 3) noise generated by the turbines will be modified and is therefore not likely to travel out of the Sound.

9.135. A study for the SeaGen tidal turbine in Strangford Lough prior to installation of the device suggested that mild aversion reactions could be expected at 108m and 15m from the device during operation, for harbour porpoise and common seal respectively. Strong aversion reactions were expected at 9m for harbour porpoise and 1m for common seal (Parvin *et al.,* 2005).

9.136. Data from post installation monitoring of SeaGen has not shown any significant effect on the activity of marine mammals in the area of the device (SNH, 2009).

9.137. The SAMS (2010) study concluded that the devices are unlikely to significantly add to underwater noise. However, the noise generated by the turbines is likely to be audible between 20 and 400m depending on the prevailing tidal conditions (Paragraph 9.145).

9.138. Although during the operational phase there is theoretical potential for disturbance effects from the periodic increase in vessel activity during maintenance operations, as detailed previously for construction, given background noise from the Port Askaig - Feolin ferry, it is expected that marine mammals in the area will be accustomed to vessel noise. Marine mammals continue to use the Sound. Noise effects from maintenance vessels (if any) are expected to be both short term, limited in scale and transitory.

9.139. Based on levels of existing noise and the limited scale of potential noise impacts, combined with evidence of no effect from other tidal turbine sites, the magnitude of any impact is assessed as negligible and, given the high receptor sensitivity, noise and vibrations are predicted to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 9.6
• There is no evidence from existing tidal turbines that noise during operation will have an effect on marine mammals. However, SPR appreciates that this Development is the first tidal array and that that consideration of magnitude includes consideration of elements where knowledge is incomplete. As a result SPR commits to putting in place a programme of post installation monitoring. • There is a theoretical potential to cause disturbance to marine mammals, and while our judgement is that this is of minor significance in this instance, based on industry experience gained from SeaGen and wider assessments, knowledge is incomplete and effects from an array rather than a single device are unknown. A deploy and monitor strategy is proposed, with ongoing monitoring, linked to management of the Development. An important component of that strategy will be an application for a licence to disturb EPS, to enable regulators to allow deployment while further

- knowledge regarding effects (or lack of effects) from the Development is obtained.
- As part of a wider adaptive management and environmental monitoring strategy, SPR is committed to mitigating relevant significant effects identified by ongoing monitoring.

Residual Impact

9.140. As a result of the importance of marine mammals as a receptor the significance of noise and vibration during operation and maintenance must remain of **minor** significance.

Impact 9.7: Collision risk

9.141. The interaction of open stream tidal energy devices and marine mammals is largely unknown. The likelihood for collision may depend on other variables such as underwater visibility, how perceptible the devices are to marine mammals above background noise levels and the rotation speed of the rotor blades.

9.142. There may be potential for the turbines to attract aggregations of fish therefore the array site could become an attractive feeding point for marine mammals, increasing the risk of collision with the turbine rotors. The inquisitive nature of some marine mammals, particularly seals, could also draw them towards the turbines. However, carcass studies relating to the SeaGen device in Strangford Lough have shown no marine mammal deaths which are likely to have been caused by the tidal turbine have occurred and no changes in behaviour have been recorded attributable to SeaGen (SNH, 2009).

9.143. The proximity to the South East Islay Skerries seal breeding colony increases the potential for juvenile seals to be exposed to the devices. Studies on seal entanglement (principally in relation to fishing gear) suggest that younger seals may be most susceptible (Gubbay and Knapman, 1999). However, the device structures do not appear to present any obvious mechanism for entanglement based on current knowledge and experience.

9.144. The tip speed of the rotors will be up to 12m/s during full tidal stream, decreasing towards slack water (see *Chapter 5: Project Description*). Because of the far greater density of water compared to air, if a tidal turbine is compared to a wind turbine it can be seen that considerably slower rotation, slower tip speed and shorter rotors are all characteristics of tidal devices, reducing potential for any theoretical collision.

9.145. It is predicted that the noise generated by the devices during peak flow could be detected up to a distance of between 20 and 400m (Carter and Wilson, 2010). This noise will alert mammals to the presence of the devices when they are operating at full power and enable avoidance measures to be taken. Based on these distances, marine mammals drifting with the tide during a peak flow of 5.44 knots (2.78m/s) would have between 7.1s and 142.9s to react. Cetaceans and otariids (including the phocids family) can reverse course in approximately 0.13 – 1.22 and 0.25 seconds respectively (Carter, 2007).

9.146. The progressive reduction of tiers of mitigation has been ongoing for the SeaGen device since shortly after its installation, as part of an adaptive management approach, where mitigation and ongoing monitoring are closely linked. To date no adverse interactions have been reported. It is anticipated that the removal of the last elements of precautionary mitigation, use of active sonar to instigate shutdown if animals are detected approaching within 50m of the device, may be possible in late 2010, allowing monitoring to fully record any active interaction between the operating turbine and marine mammals (SNH, 2009).

9.147. The noise of the devices during operation increasing awareness of the devices, the environmental awareness and maneuverability of the animals, the relatively slow movement of the rotors on each device and the positive reports from other tidal devices of limited evidence of negative interaction, are all assessed as providing a low magnitude of impact. Given the high receptor sensitivity, the impact is assessed to be of potentially **moderate** significant effect.

MITIGATION IN RELATION TO IMPACT 9.7

- The available evidence from existing tidal turbines indicates that tidal turbines have minimal effect on behaviour of marine mammals and that collision risk is low. However, this information is still incomplete and at the time of writing some precautionary mitigation measures were still in place for SeaGen. SPR appreciates that this Development is the first tidal array and that that consideration of magnitude includes consideration of elements where knowledge is incomplete. As a result SPR commits to putting in place a programme of post installation monitoring.
- There is a potential to cause disturbance to marine mammals, and while our judgement is that this is may be negligible, based on industry experience gained from SeaGen and wider assessments, knowledge is incomplete and effects from an array rather than a single device are also unknown. A deploy and monitor strategy is therefore proposed, with ongoing monitoring, linked to management of the Development.
- An important component of the deploy and monitor strategy will be an application for a licence to disturb EPS, to enable regulators to allow deployment while further knowledge regarding effects (or lack of effects) from the Development is obtained.
- Monitoring measures may include monitoring of rotor data to ascertain if any impacts with 'objects' has occurred, visual observations of marine mammal activity to determine there is evidence for any change in behaviour, promotion of the proposed Marine Scotland carcass survey programme for wet renewables in order to determine cause of death.
- As part of a wider adaptive management and environmental monitoring strategy, SPR is committed to mitigating relevant significant effects identified by monitoring.

Residual Impact

9.148. The proposed monitoring programme will ensure impacts are detected and significant effects under the terms of the EIA regulations are avoided. Therefore, the significance of collision risk after mitigation is unlikely to reach the levels of moderate and is likely to be of a **minor** significant effect.

Impact 9.8: Accidental release of contaminants during maintenance

9.149. As with installation, any use and discharge of chemicals during operation/ maintenance will be subject to controls as part of consent requirements. It is expected that should a spill occur, its scale and the nature of the contaminant will be limited and in a high energy marine environment, contaminants can be expected to rapidly disperse.

9.150. The risk of pollution events will be minimised by following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA (e.g. PPG 5: Works and maintenance in or near water). Additionally, any chemicals used during maintenance activities will require prior approval through the FEPA licensing process and any lubricants will be non toxic, biodegradable and capable of dispersal in seawater.

9.151. Installation contractors will put in place appropriate Site Environmental Management Plans and Pollution Control and Spillage Response Plans that will be agreed with the relevant statutory bodies prior to offshore maintenance activities commencing. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, will ensure a rapid and appropriate response.

9.152. As a result a negligible magnitude is predicted and, given the high receptor sensitivity, the impact is predicted to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 9.8
• No mitigation required

Residual Impact

9.153. As a result of the importance of marine mammals as a receptor the significance of accidental release of contaminants must remain of **minor** significant effect.

9.154.

Impact 9.9: *Barrier effects*

9.155. Noise disturbance and visual presence of the turbine array could potentially displace marine mammals from preferred migratory and transit routes within the Sound of Islay.

9.156. During ongoing operation of the SeaGen turbine no significant barrier effect has been observed. Continual passive sonar and acoustic monitoring, using TPODS, indicates that harbour porpoise are able to pass through the narrows where the turbine is located and seals continue to use the area without any significant change to behaviour (SNH, 2009).

9.157. An array of devices could have more potential to act as a barrier than the single SeaGen device; however, with approximately 500m between the array and the shore, towards the Jura side, as well as clearance above and below the rotors in the water column, it is expected that the magnitude will be low. Given the high receptor sensitivity, the impact is predicted to be of **moderate** significant effect.

MITIGATION IN RELATION TO IMPACT 9.9
• The available evidence from existing tidal turbines indicates that barrier effects will be minimal. However, SPR appreciates that this Development is the first tidal array and that that consideration of magnitude includes consideration of elements where knowledge is incomplete. As a result SPR commits to putting in place a programme of post installation monitoring. • There is a potential to cause disturbance to marine mammals, and while our judgement is that this is may be negligible, based on industry experience gained from SeaGen and wider assessments, knowledge is incomplete and effects from an array rather than a single device are also unknown. A deploy and monitor strategy is therefore proposed, with ongoing monitoring, linked to management of the Development. • An important component of the deploy and monitor strategy will be an application for a licence to disturb EPS, to enable regulators to allow deployment while further knowledge regarding effects (or lack of effects) from the Development is obtained. • Monitoring measures may include visual observations of marine mammal activity to determine if there is evidence for any change in behaviour. • As part of a wider adaptive management and environmental monitoring strategy, SPR is committed to mitigating relevant significant effects identified by monitoring.

Residual Impact

9.158. The proposed monitoring programme will ensure impacts are detected and significant effects under the terms of the EIA regulations are avoided. The significance of collision risk after mitigation is likely to be of **minor** significant effect.

Impact 9.10: Habitat exclusion

9.159. Noise disturbance and visual presence of the turbine array could theoretically displace marine mammals from habitats within the Sound of Islay including feeding, breeding and social areas. However, the Sound of Islay is not known to be important to marine mammals for feeding and breeding.

9.160. Seal haul out sites within designated sites are sufficiently distant not to be affected by disturbance effects, although smaller nearby haul outs, close to the Development but outside the SAC, could theoretically be affected. Given the entirely subtidal nature of the Development and the minimal increase in vessel activity in relation to baseline activity proposed during operation, it is expected that there will be minimal disruption to haul out sites during operation and maintenance resulting in negligible magnitude of impact.

9.161. Evidence from SeaGen suggests that no change to sea and marine mammal use of the area has occurred around that device (SNH, 2009).

9.162. Given the conservation status of marine mammals resulting in high sensitivity/ value the significance of effect of habitat exclusion has been assessed as **minor.**

MITIGATION IN RELATION TO IMPACT 9.10
• It is expected that habitat exclusion during operation is unlikely. However, SPR appreciates that this Development is the first tidal array and that that consideration of magnitude includes consideration of elements where knowledge is incomplete. As a result SPR commits to putting in place a programme of post installation monitoring. • There is a potential to cause disturbance to marine mammals, and while our judgement is that this is may be negligible, based on industry experience gained from SeaGen and wider assessments, knowledge is incomplete and effects from an array rather than a single device are also unknown. A deploy and monitor strategy is therefore proposed, with ongoing monitoring, linked to management of the Development. • An important component of the deploy and monitor strategy will be an application for a licence to disturb EPS, to enable regulators to allow deployment while further knowledge regarding effects (or lack of effects) from the Development is obtained. • Monitoring measures may include visual observations of marine mammal activity to determine if there is evidence for any change in behaviour. • As part of a wider adaptive management and environmental monitoring strategy, SPR is committed to mitigating relevant significant effects identified by monitoring.

Residual Impact

9.163. As a result of the importance of marine mammals as a receptor the significance of contamination must remain of **minor** significant effect.

9.4.4 Potential Impacts during Decommissioning Phase

9.164. The potential impacts during decommissioning are expected to be of the same nature and significance as the construction impacts.

9.4.5 Cumulative Impacts

9.165. Scottish Territorial Water windfarms are proposed for a site immediately west of Islay (approximately 40km west of the Sound of Islay) and at Kintyre (approximately 50km to the south of the Sound of Islay). The cumulative impacts related to the construction of additional projects will depend on the duration of the installation phase. The period of construction of offshore windfarms depends greatly on the size of the farm however this could be up to approximately one year.

9.166. The cumulative impacts are expected to be of the same type as those for the Development alone:

- Noise and vibration;

- Collision increased;
- Suspended sediments;
- Release of contaminants;
- Barrier effect; and
- Habitat exclusion.

9.167. As discussed previously, the noise generated during construction of offshore windfarms can be significantly higher than the noise expected during the construction of the Islay tidal array due to the level of drilling requirements for offshore windfarms. It is not expected that the construction of both the tidal array and the offshore windfarm would occur simultaneously and so there are not expected to be cumulative construction effects; however, the effects during construction of one project could act cumulatively with operational effects of the other.

9.168. It is not expected that collision risk, suspended sediments or release of contaminants will be of greater significance as a result of cumulative impacts from the proposed wind farm developments.

9.169. During operation, it is possible that the cumulative effects of the wind farm and Islay tidal array could cause disturbance to marine mammals as a result of noise/ vibrations, physical presence and increased activity in the area resulting in cumulative barrier effects and habitat exclusion. It is expected that this would be of **moderate** significance.

9.5 Summary of effects

Table 9.5: Summary of predicted significance of effects								
	Construction/ Decommissioning				**Operation/ Maintenance**			
Impact	**Magnitude of Impact**	**Receptor Sensitivity/Value/ Importance**	**Significance of effect**	**Residual impact**	**Magnitude of Impact**	**Receptor Sensitivity/Value/ Importance**	**Significance of effect**	**Residual impact**
Noise and vibration	Negligible	High	Minor	Minor	Negligible	High	Minor	Minor
Collision	Negligible	High	Minor	Minor	Low	High	Moderate	Minor
Accidental release of contaminants	Negligible	High	Minor	Minor	Negligible	High	Minor	Minor
Suspended sediments	Negligible	High	Minor	Minor	N/A	N/A	N/A	N/A
Barrier effects	N/A	N/A	N/A	N/A	Low	High	Moderate	Minor
Habitat exclusion	Negligible	High	Minor	Minor	Negligible	High	Minor	Minor

9.6 Proposed Monitoring

9.170. Post installation monitoring can be carried out in order to detect any impacts which need to be addressed promptly. The following monitoring is proposed:

- Use of impact sensors on the rotors to detect potential collisions;
- Visual surveys in the first year after deployment to monitor for changes in use of the Development area and wider Sound by marine mammals;
- Passive acoustic monitoring of echolocatory species, particularly harbour porpoise within the Sound of Islay;
- Development with Marine Scotland of procedure for reporting marine mammal carcass findings and carrying out post mortem, as part of wider national support to wet renewable industry by Scottish Government; and
- Ongoing SMRU aerial surveys will provide approximate adult seal and pup numbers/ distribution and highlight any significant changes in the Sound of Islay.

9.7 Statement of Significance

9.171. It is anticipated that the proposed development will have at worst a **moderate** effect on marine mammals. However, continued monitoring to detect impacts and implementation of necessary mitigation measures will reduce the effect to **minor.**

9.172. Collision and barrier effects provide the most potential to impact upon marine mammals during the operation phase.

9.173. While limited mitigation has been outlined at this stage it is felt that a deploy and monitor strategy will help to target any subsequent mitigation should it be required.

9.8 Figures

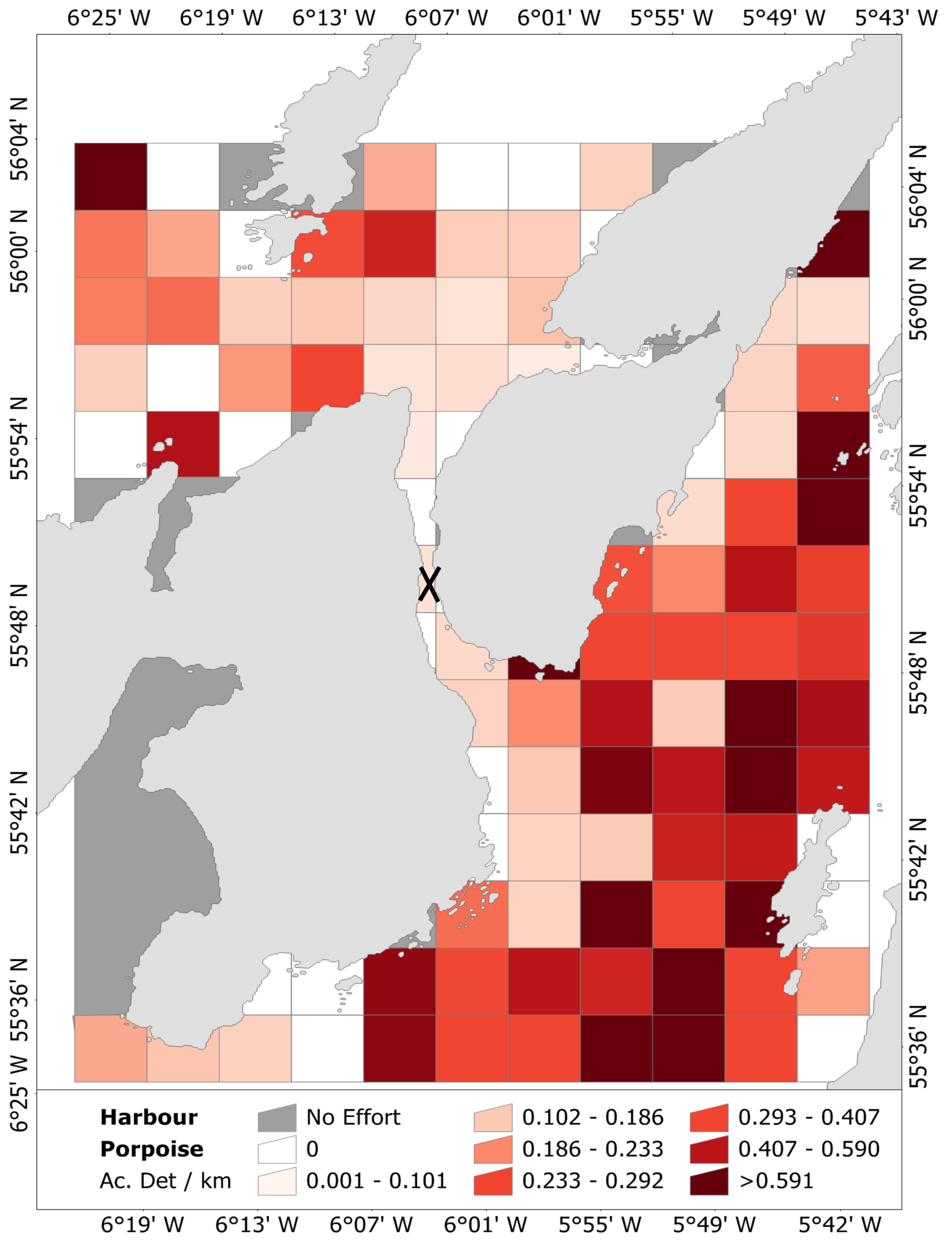

Figure 9.1: Harbour porpoise acoustic detections per unit effort in the Sound of Islay region (shown in shades of red – darker shades indicate higher detection rates). Grid cells not surveyed shown in dark grey. (Source, HWDT, 2009). Black cross shows the location of the Development.

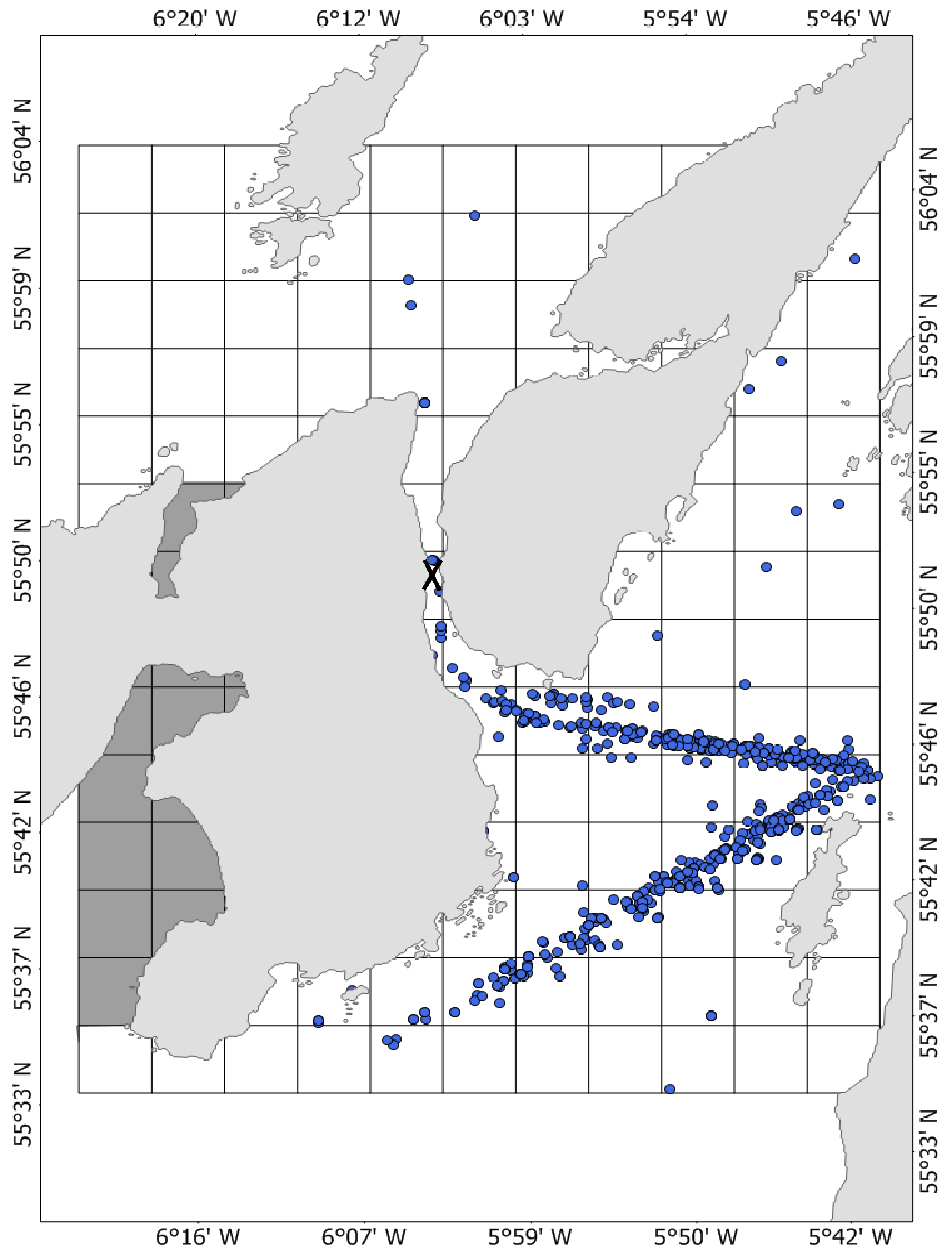

Figure 9.2: Harbour Porpoise public sightings (not effort corrected) 2000-2008 (blue dots) in the Sound of Islay region (Source: HWDT, 2009). Black cross shows the location of the Development.

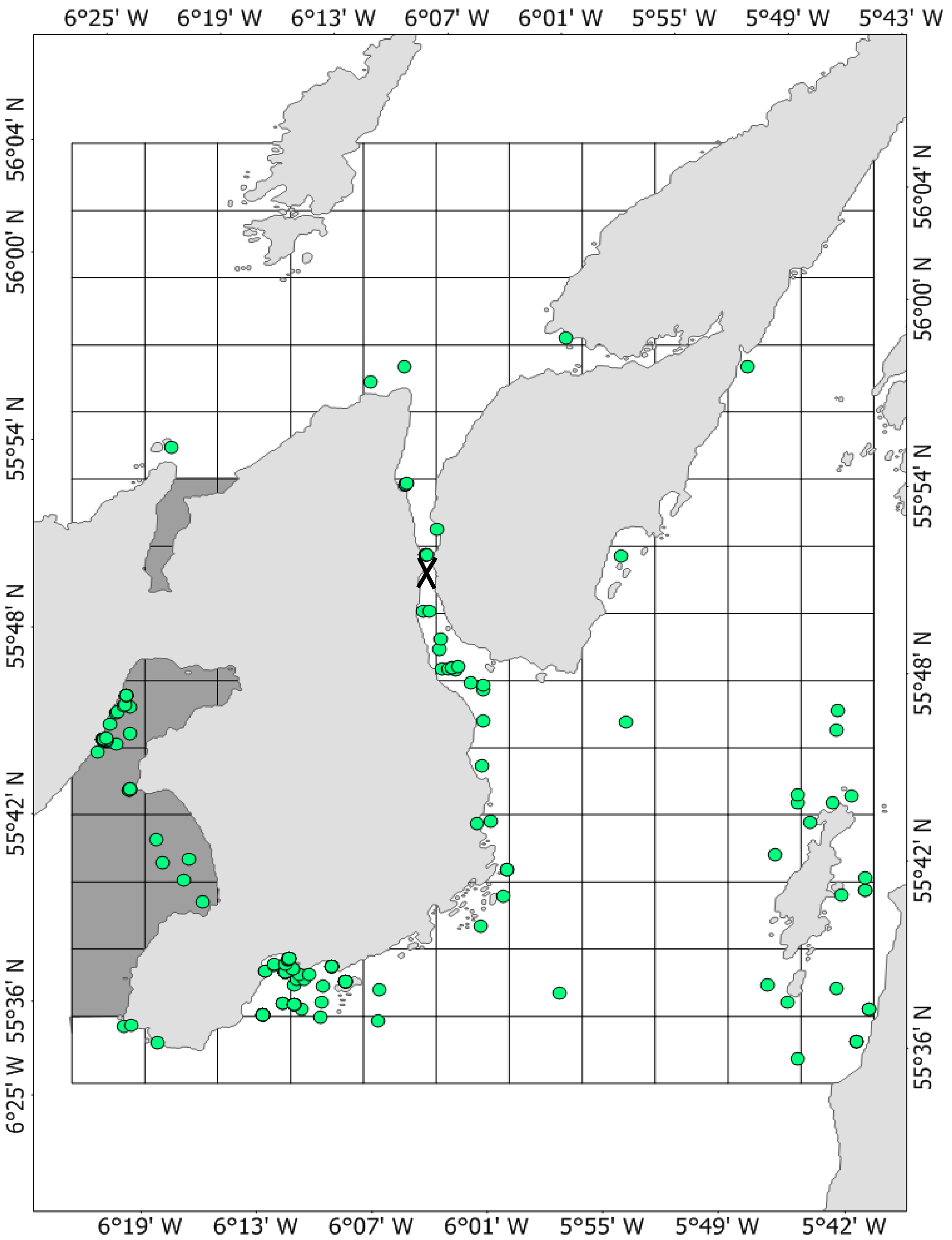

Figure 9.3: Bottlenose dolphin public sightings (not effort corrected) 2000-2008 (light green dots) in the Sound of Islay region (Source: HWDT, 2009). Black cross shows the location of the Development.

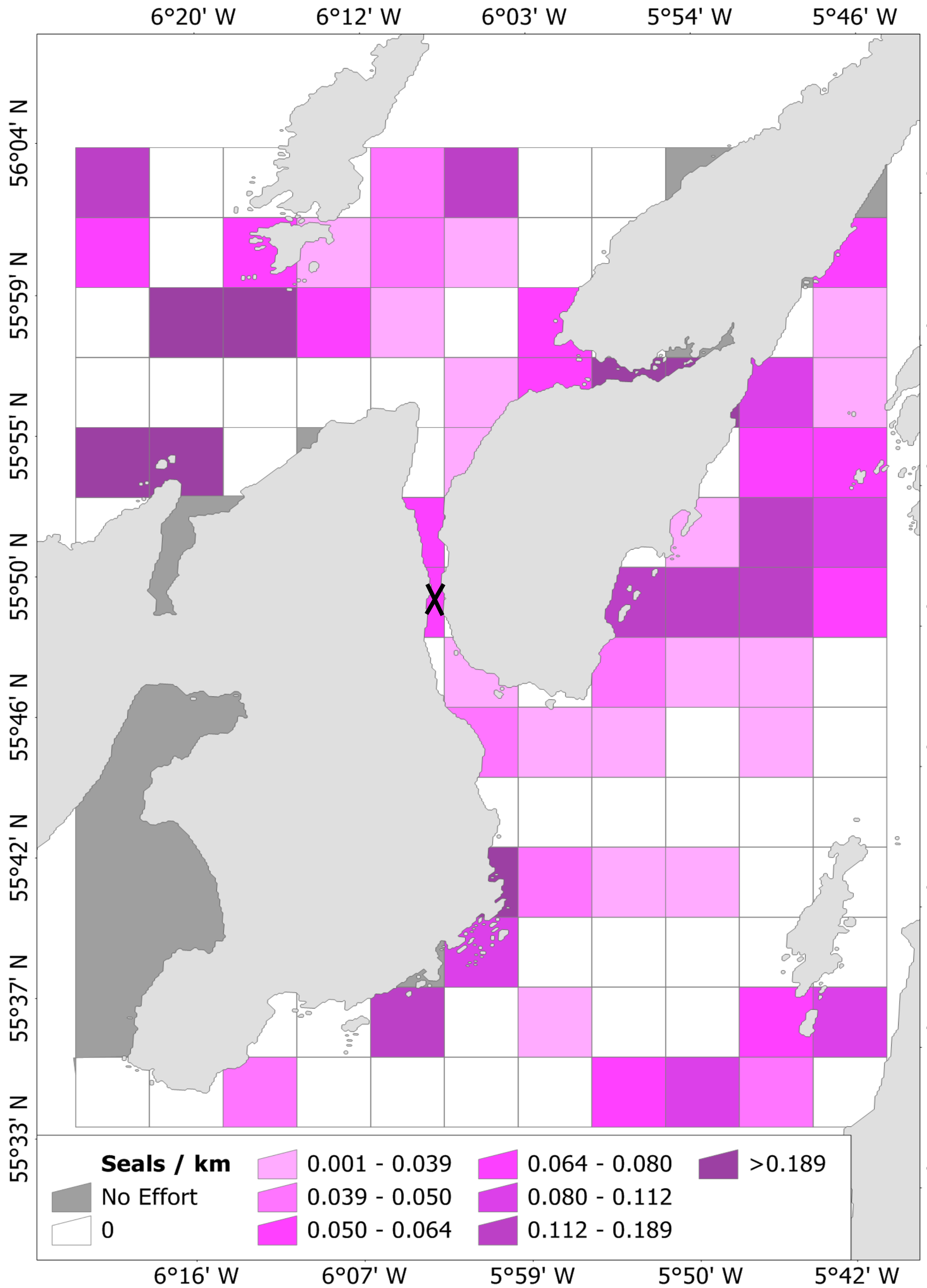

Figure 9.4: Combined sightings per unit effort of grey, harbour and unidentified seals in the Sound of Islay region (shown in shades of purple – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (Source: HWDT, 2009). Black cross shows the location of the Development.

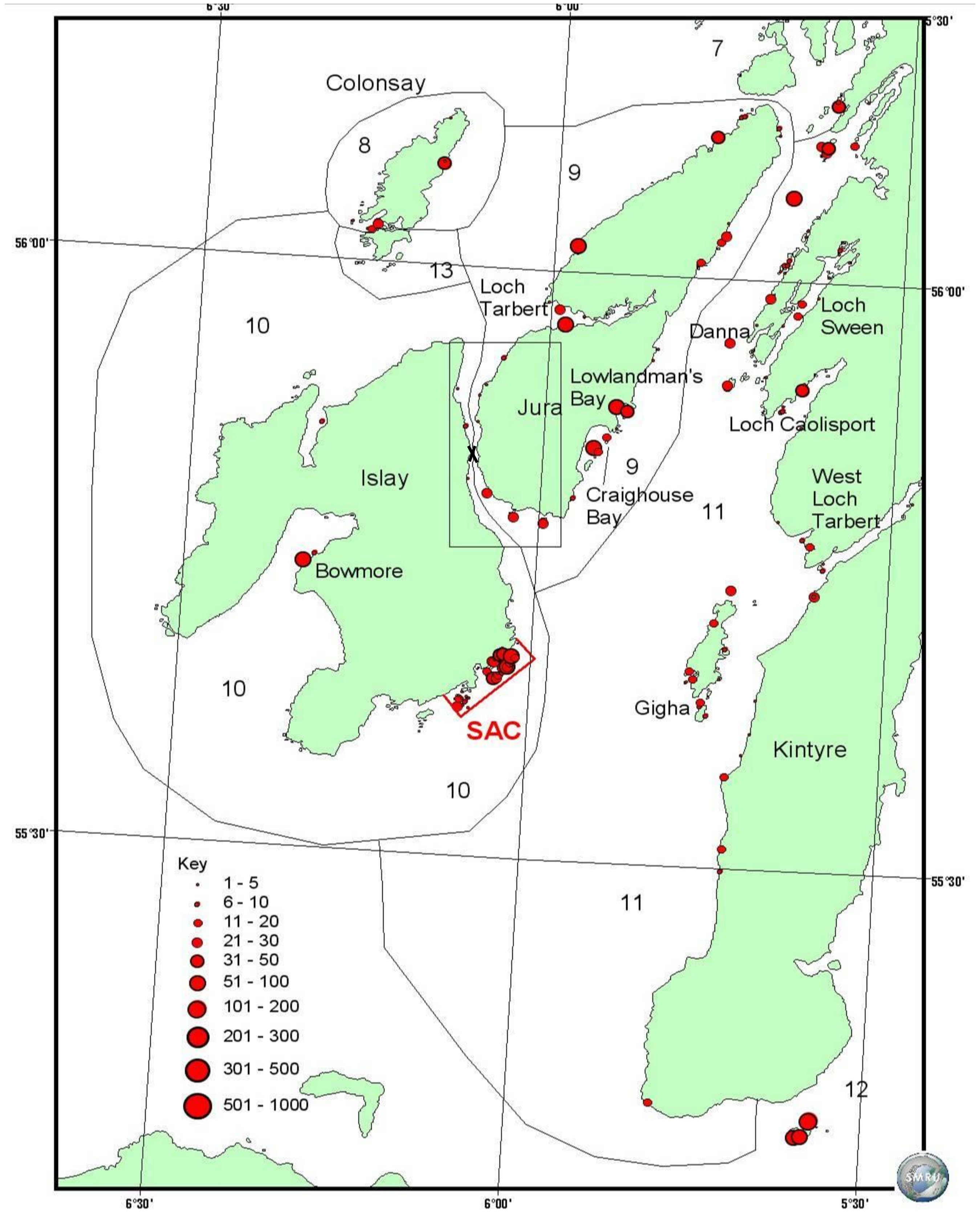

Figure 9.5: Harbour seal counts from an aerial survey around the Sound of Islay, August 2009 (Source: SMRU 2010). Red box shows the boundary of the South east Islay Skerries SAC and the black cross shows the location of the Development.

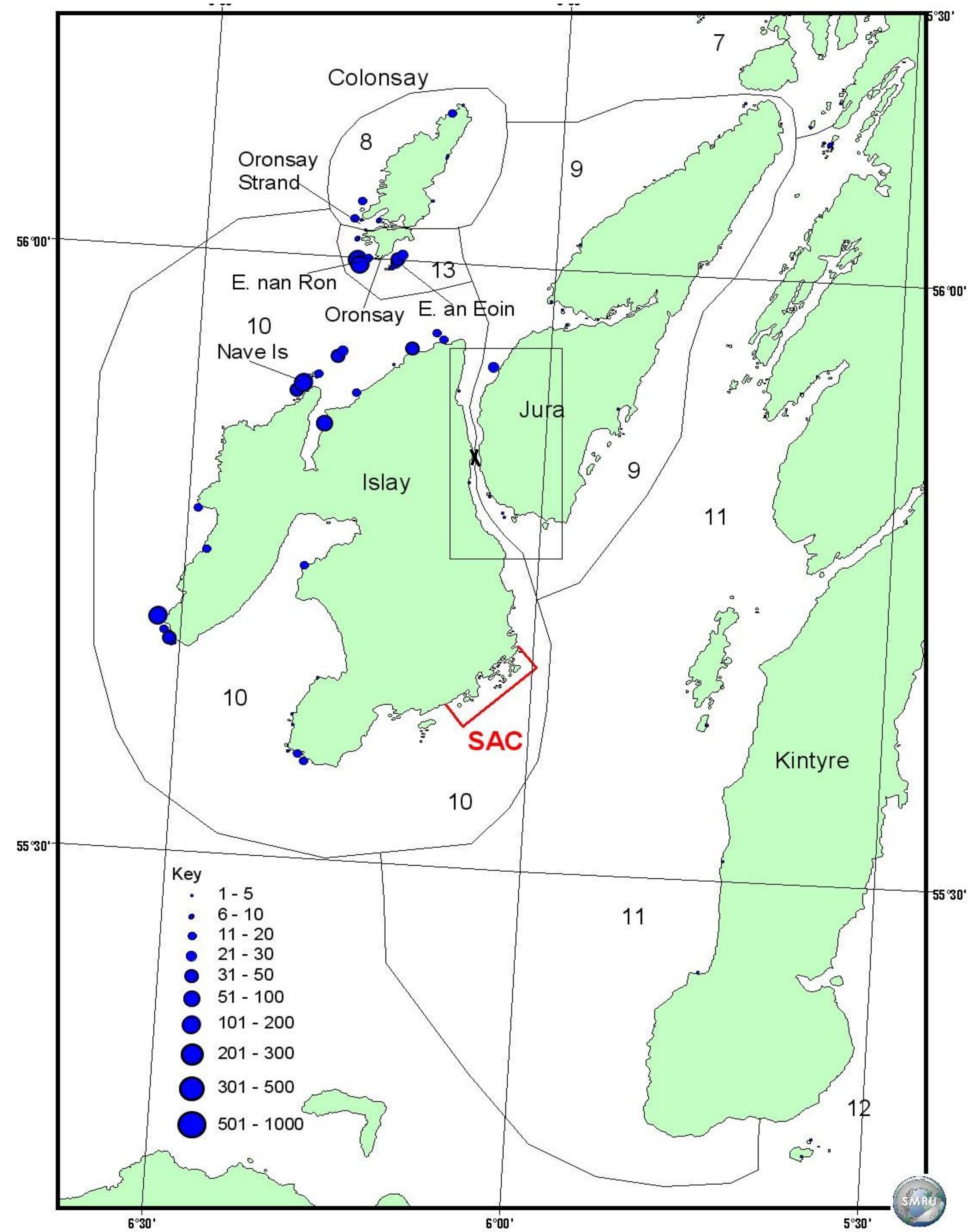

Figure 9.6: Grey seal counts from an aerial survey around the Sound of Islay, August 2009 (Source: SMRU 2010). Red box shows the boundary of the South east Islay Skerries SAC.

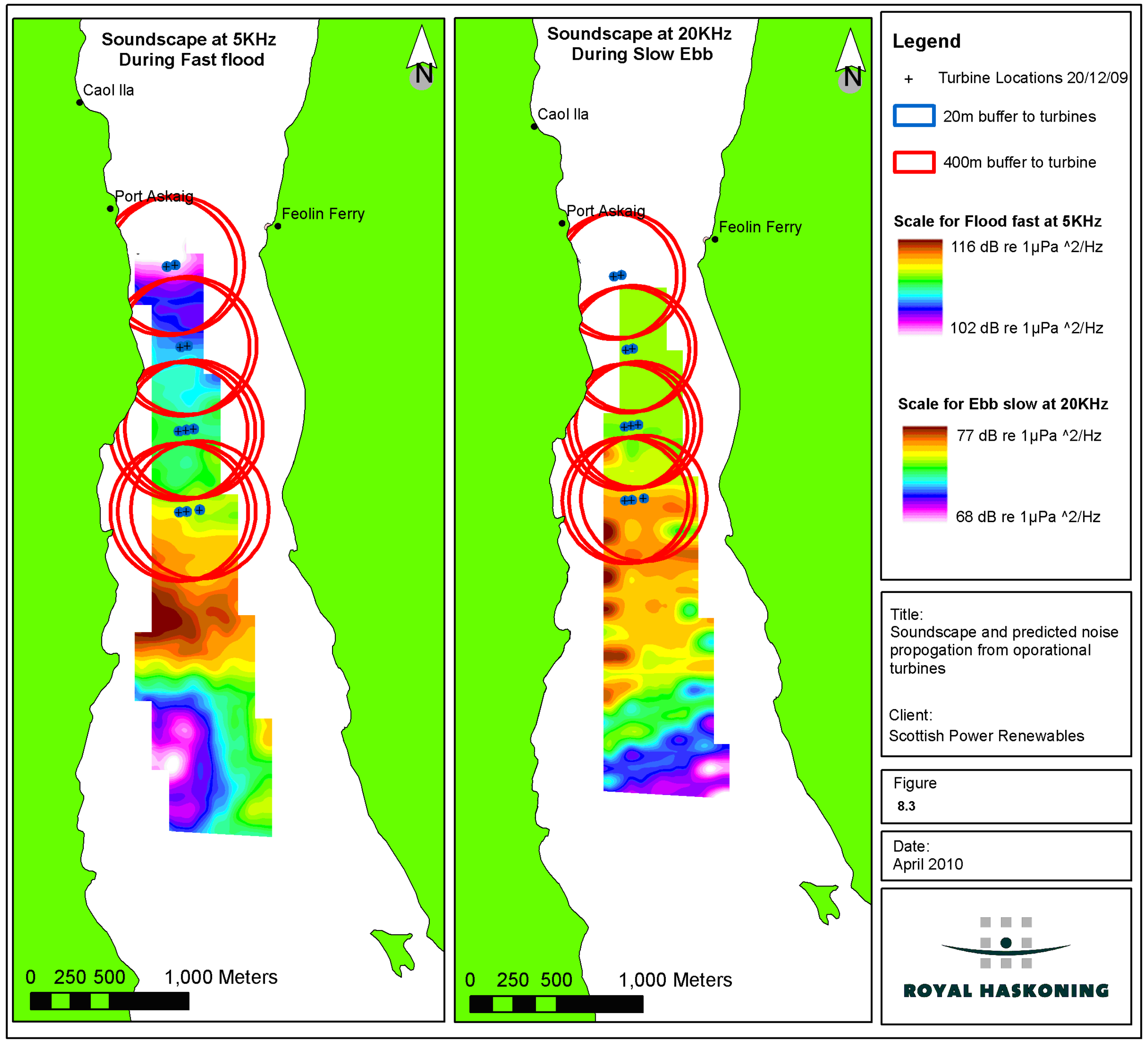

Figure 9.7: Illustration of the distance that noise within the Sound of Islay may travel from each turbine using two calculations for noise propagation, overlaid on Soundscape maps (produce by SAMS, 2010) of background noise levels within the Sound of Islay. Figure shows data for two states of tide (flood and slow ebb) and two frequencies (at 5KHz during full flood tide the highest recorded noise levels and at 20KHz during slow ebb, the lowest noise levels occurred).

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11.0 Marine Fish and Shellfish Resources

11.1 Introduction

11.1. This Chapter evaluates the marine fish and shellfish resource present within the study area (as defined in paragraph 11.19). Baseline conditions with regard to fish and shellfish communities are presented and the potential impacts relating to the construction, operation/maintenance and decommissioning phases of the array are assessed. Mitigation measures are proposed where necessary and approaches to monitoring are discussed.

11.2. Marine fish and shellfish, benthic habitats, commercial fisheries, noise and ornithology are intrinsically linked and as such, this chapter should be read in conjunction with *Chapter 8: Benthic Ecology*, *Chapter 12: Anadromous Fish*, *Chapter 13: Elasmobranchs*, *Chapter 14: Ornithology*, and *Chapter 15: Commercial Fisheries* in order to gain a full overview of baseline conditions and potential impacts.

Summary of impacts on Fish and Shellfish Resources: The construction methodology aims to minimise the significance of smothering effects on marine fish and shellfish. It is anticipated that the proposed development will have at worst **minor** effects on marine fish and shellfish resources with the main impacts being noise and vibration during construction and operation, along with the risks of turbines acting as a physical barrier to the movement of fish along the Sound of Islay and those associated with potential collision. Effective mitigation is not possible and therefore the significance of these effects remain as (worst case scenario) **minor**.

11.2 Potential Effects

11.3. Fish and shellfish species can potentially be impacted in a number of ways by tidal array developments. These are outlined in the Scottish Marine Renewables SEA (Scottish Executive, 2007) and summarised below:

- During installation of the devices and cables, disturbance of species may occur as a result of seabed habitat loss or alteration;
- During installation, fish spawning habitat and filter feeding species may be affected as a result of increased turbidity and smothering as a result of disturbance to mobile seabed sediments;
- Disturbance may occur as the result of the presence of installation vessels and equipment, and associated noise. Depending upon noise levels and proximity of animals to the noise source, behavioural or physiological impacts may also result (a summary of the underwater noise background noise levels within the Sound and how the Development will impact upon these levels can be found in Section 8.4.3 in *Chapter 8: Benthic Ecology*);
- Noise generated by the devices during operation might potentially have an effect upon fish species;
- During operation of the array, there may be potential for the array to act as a barrier to fish movements;
- Some species may interact with the devices and there is a risk of collision resulting in physical trauma or death;
- Electromagnetic Fields (EMF)[1] generated by subsea cables may have effects on fish; and
- There may be effects on fish and shellfish resource associated with the creation of artificial reef structures on the seabed (e.g. fish aggregation around devices).

11.3 Methodology

11.3.1 Legislation, Guidelines and Policy Framework

EIA Guidance

11.4. The European Marine Energy Centre (EMEC) has developed EIA guidance for wave and tidal energy developers seeking consent within the EMEC test site on Orkney. These guidelines give an overview of the potential impacts of marine energy development on fish and shellfish resources, but do not discuss detailed EIA reporting requirements. The guidance suggests that the following potential effects on fish resources should be considered:

- Behavioural changes and altered well-being associated with noise, light and other disturbances;
- Changes in fish health resulting from release of contaminants; and
- Entrapment / collision with underwater devices.

11.5. There are no other specific EIA guidelines developed for tidal turbines; however the guidelines developed for undertaking EIA in support of licensing of offshore wind farm developments under the Food and Environment Protection Act 1985 (FEPA) and the Coast Protection Act 1949 (CPA) by Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (2004) are largely applicable. As discussed in detail in *Chapter 6: Regulatory and Policy Context* the new Marine (Scotland) Act 2010 will allow for FEPA and CPA licenses to be consolidated into one Marine Licence, to be administered by Marine Scotland's Licensing and Policy Team. However this will not be implemented until April 2011 and will not directly relate to the proposed Development.

11.6. The CEFAS guidance states that there is potential for the "*construction, development and use of offshore wind farms (in this case tidal arrays) to adversely affect fish and shellfish resources*", and details what an EIA should take into account when assessing impacts on those resources.

[1] Power cables for transmitting electricity, such as those used to export electricity generated by tidal arrays, produce E and B fields when current passes through them. The B field is felt outside of the cable structure and this in turn induces a further E field (iE); studies have shown that EMF radiates beyond the cable into both seawater and the seabed.

11.7. The EIA should present information that describes fish and shellfish resources within the demonstration tidal array site and in the context of the wider area. The impact on 'Important' fish and shellfish resources are considered. Important fish and shellfish resources are considered to be those that are:

- Of significant importance to commercial and recreational fisheries;
- Of conservation importance;
- Sensitive to the potential effects of electromagnetic fields (EMF); and
- Of restricted geographical distribution and are locally abundant in the area.

11.8. For those resources identified as important, the following ecological aspects need to be considered:

- Spawning grounds;
- Nursery grounds;
- Migration routes;
- Feeding grounds; and
- Over wintering areas for crustaceans.

Appropriate Assessment Guidance

11.9. The principal aim of the European Habitats Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora is to sustain biodiversity through the conservation of natural habitats and wild flora and fauna in the territory of European Member States. These targets are principally being met through the establishment of nature conservation sites, Special Areas of Conservation (SACs). Designated SAC features include a number of fish species listed under Annex II of the Directive, namely: sea lamprey; Brook lamprey; River lamprey; Allis shad; Twaite shad; Atlantic salmon; Spined loach; and, Bullhead. An SAC may be designated on the basis of the presence of these species, and an objective of the designation will be to maintain or restore these species at a favourable conservation status.

11.10. The Directive requires that any plans or projects, whether inside or outside of the SAC, that are likely to have a significant effect on the conservation status of the site's features shall be subject to an Appropriate Assessment. Therefore where a proposed Development is located within, or would be likely to significantly affect, a designated, proposed or candidate[2] SAC, consenting authorities must ensure an Appropriate Assessment is carried out under the Directive. Where a proposed project does not fall within the boundaries of an SAC (as is the case for the proposed Sound of Islay Development) an Appropriate Assessment will only be required if it is considered (and fully justified) that a significant effect on an SAC site is likely. It is the responsibility of the competent authority (Marine Scotland), with advice from the conservation agencies, to determine whether a proposed project is likely to have a significant effect on an SAC.

11.3.2 Assessment Methods

Data Collection

11.11. The main sources of information used to establish baseline conditions are as follows:

- Marine Scotland: Compliance (formally Scottish Fisheries Protection Agency) landings statistics by species by ICES rectangle[3] for the period 2003 – 2008;
- Marine Scotland: Science (formally Fisheries Research Services)
- Centre for Environment, Fisheries and Aquaculture Science (CEFAS, 2004) and other current research publications;
- CEFAS fish and shellfish spawning and nursery ground maps;
- UK Offshore Operators Association (UKOOA, now UK Oil and Gas) Fish Sensitivity Charts;
- International Council for the Exploration of the Sea (ICES) Reports and Research Publications;
- Technical reports and reviews produced in support of Strategic Environmental Assessments for offshore renewable energy and oil and gas development in UK waters (e.g. Gordon, 2006).
- Stakeholder consultation (which is summarised in *Chapter 3: Consultation* and in Paragraphs 11.13 to 11.16) ;and
- Drop down camera survey reports of the study area produced by SeaStar Survey Ltd and Royal Haskoning for SPR.

11.12. The information sources listed above provide sufficient information to describe the fish and shellfish resources likely to be encountered in the study area. Site-specific fish surveys for the EIA have not been undertaken across the study area, partly for this reason, and partly because tidal conditions across the site do not support the deployment of suitable survey gears. As there is a lack of site specific data for the study area a precautionary approach is taken to this assessment using an extended species list that not only includes species which are known to be present within the study area but also species which are known to be present within the wider region.

[2] Candidate SACs are sites that have been submitted to the European Commission, but not yet formally adopted and Proposed SACs are sites that have been formally advised to UK Government, but not yet submitted to the European Commission.

[3] The International Council for the Exploration of the Sea (ICES) has developed a grid system derived from degrees latitude and longitude that divides the seas into rectangles.

Consultation

11.13. A scoping opinion was sought from statutory consultees (the details of which are set out in *Chapter 3: Consultation*) in August 2008. Responses are detailed in *Chapter 3: Consultation*, and a short summary of the main points pertinent to marine fish and shellfish raised during this process, along with an explanation of how they were addressed, is provided below.

11.14. A key concern of many respondents (including fisheries committees and fisheries boards) was that within the scoping report migratory fish such as salmon and sea trout were not considered in enough detail. As a result of this concern, an entire chapter (*Chapter 12: Anadromous Fish*) of this ES is dedicated to such species.

11.15. The effects that underwater noise could have on fish populations were also raised as a major concern, by many respondents including FRS and the Laggan and Sorn District Salmon Fishery Board. Therefore a study looking at the baseline noise of the Sound was undertaken and an assessment of the potential additional noise created by the proposed turbines (a summary of the findings of this report can be found in Section 8.4.3 of *Chapter 8: Benthic Ecology*) was conducted.

11.16. It was also highlighted during the scoping process that the possible effects of EMF created by cables and in particular their effects on elasmobranchs should be considered in detail. Consequently an entire chapter of this ES (*Chapter 13: Elasmobranchs*) has been dedicated to this group of fish species, and the issue of EMF is fully explored in that chapter. Impacts of EMF on other fish species are however considered in the current chapter.

11.4 Assessment of significance

11.17. The broad methodology used for determining impact significance is outlined in *Chapter 2: Scoping and Assessment Methodology*. The significance of the impact is assessed on the basis of both the magnitude of the impact (Table 11.1) and the sensitivity/value/importance of the receptor (Table 11.2). Also to be taken into account when making the assessment is the potential for impact occurring and the nature of the impact.

Table 11.1 Magnitude of the impact

Magnitude	Description
High	A fundamental change to the baseline condition of the marine fish or shell fish resource.
Medium	A detectible change in the baseline condition resulting in the non-fundamental temporary or permanent condition of marine fish and shellfish resources.
Low	A minor change to the baseline condition of marine fish and shellfish resources (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

Table 11.2 Sensitivity/Value/Importance of the receptor

Sensitivity/Value/Importance	Description
High	Environment is subject to major change(s) due to impact. For example, study area contains species of international or national conservation importance/ value that will be permanently significantly altered by the Development.
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. For example study area contains species of national or regional conservation importance/value which will be permanent significantly altered by the Development.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example study area contains species of local conservation importance/ value which will be permanently significantly altered.
Negligible	Environment responds in minimal way to effect such that only minor change(s) are detectable. For example sites contain features of local conservation importance/ value.

11.18. By combining the magnitude of the impact and the sensitivity/value/importance of the receptor in a matrix (Table 11.3) the final significance of the effect (prior to the implementation of mitigation measures) can be obtained. The level of significance will then be described as either 'major', 'moderate', 'minor', 'negligible' or 'no significant effect'' based on the outcome of the impact matrix.

Table 11.3 Impact significance matrix

Magnitude of Impact	Receptor Sensitivity/Value/Importance			
	Negligible	**Low**	**Medium**	**High**
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

11.5 Baseline description

11.5.1 Seabed habitats

11.19. For the purposes of the marine fish and shellfish resources assessment there are a number of geographical scales referred to in this chapter. The "Development site" is defined as the area within the lease boundary and the offshore cable route and is displayed in Figure 15.13 (*Chapter 15: Commercial Fisheries*). The "study area" is defined as the extent of the Sound of Islay and is displayed in Figure 15.12 (*Chapter 15: Commercial Fisheries*). As many fish species are highly mobile and as there has been no site specific fish survey (due to the hostile nature of the local environment) this assessment also extends beyond the study area and considers data from the "wider region" which includes the much of the coast of south west Scotland. As such the species list considered may include a greater range than regularly use the study area, but this approach was considered necessary due to the lack of site specific data.

11.20. The seabed environment within much of the study area is described in detail in *Chapter 8: Benthic Ecology* and *Chapter 7: Physical Environment and Coastal Processes*.

11.21. In summary, seabed habitats across the array site are characterised by a coarse sedimentary environment of sandy gravel, cobbles and small boulders along with areas of exposed bedrock.

The seabed is dominated by biological communities typical of sounds, narrows and tide-swept areas, with hydroids and bryozoans, anemones and sponges.

11.22. Shallower-water areas within the study area are dominated by either kelp communities with sparse red seaweeds on boulders and coarse sediments, or sandy sediments with little epifauna, depending upon location.

11.23. Maerl, which provides important nursery grounds for many commercial species (Barbera *et al*., 2003; UK Marine SACs Project website) including: scallops (Hall-Spencer, 2003), cod, saithe and pollock (Kamenos *et al.,* 2004) has been identified within the study area (Hiscock, 1983; Brodie *et al*., 2007). The closest indentified maerl bed is located approximately 300m from the Development site in depths of between 3 to 13m. The extent of and conservational interest of maerl is discussed in *Chapter 8: Benthic Ecology*.

11.5.2 Shellfish and Finfish Species

11.24. In order to identify the presence of, and obtain an indication of the abundance of fish and shellfish species in the study area, fisheries landings data for the period 2003 – 2008 have been analysed. Graphical representation and explanations of these analyses can be seen in *Chapter 15: Commercial Fisheries*. Landings data relating to ICES Statistical Rectangles 40E3 and 40E4, which include the study area and the wider region, indicate that shellfish species account for the majority (over 95%) of landings (scallops, velvet swimming crab, brown crab, lobster and Nephrops).

11.25. It is recognised that fishing methods and species targeted in a particular sea area are, to a large extent, market driven. In addition to landings data, other sources of information have been used to determine the presence of fish and shellfish species and to assess their relative importance. A primary reference point has been the list of finfish and shellfish species presented in the Scottish Marine Renewables Strategic Environmental Assessment (SEA) (Scottish Executive, 2007), which considers a wide study area that encompassed much of the west coast of Scotland, including the study area.

11.26. Table 11.4 lists those species known to occur throughout the wider region (West Coast of Scotland) on the basis of fisheries landings data and the findings of the Marine Renewables SEA (Scottish Executive, 2007).

Table 11.4 Shellfish and finfish species potentially present in the Sound of Islay and adjacent waters.

Shellfish	Fish
Crustaceans	Cod *Gadus morhua*
Lobster *Homarus gammarus**	Ling *Molva molva*
Nephrops *Nephrops norvegicus*	Whiting *Merlangius merlangus*
Squat lobster *Galathea squamifera*	Mackerel *Scomber scombrus*
Crawfish *Palinurus elephas*	Sandeels *Ammodytes spp.*
Edible crab *Cancer pagurus* *¤	Sprat *Sprattus sprattus*
Green crab *Carcinus maenas*	Pollack *Pollachius pollachius*
Velvet crab *Necora puber* *¤	Plaice *Pleuronectes platessa*
Spider crab *Maja verrucosa*	Saithe *Pollachius virens*
Brown shrimp *Crangon crangon*	Haddock *Melanogrammus aeglefinus*
Bivalves	Norway pout *Trisopterus esmarkii*
King scallop *Pecten maximus*¤	Flounder *Platichthys flesus*
Queen scallop *Aequipecten opercularis*	Monkfish (angler) *Lophius piscatorius*
Razor clam *Ensis ensis*	Witch *Glyptocephalus cynoglossus*
Horse mussel *Modiolus modiolus*	Striped red mullet *Mullus surmuletus*
Mussel *Mytilus edulis*¤	John dory *Zeus faber*
Cockle *Cerastoderma edule*	Sea bream *Spondyliosoma cantharus*
Native oyster *Ostrea edulis*	Bass *Dicentrarchus labrax*
Molluscs	Hake *Merluccius merluccius*
Squid *Loligo spp.*	Gurnards *Triglidae spp*
Whelk *Buccinum undatum*¤	Dab *Limanda limanda*
Common periwinkle *Littorina littorea*	Turbot *Psetta maxima*
	Dover sole *Solea solea*
	Lemon sole *Microstomus kitt*
	Megrim *Lepidorhombus whiffiagonis*
	Conger eel *Conger conger*
	Herring Clupea harengus
	Atlantic halibut *Hippoglossus hippoglossus*
	Red gurnard *Aspitrigla cuculus*
	Brill *Scophthalmus rhombus*
	Long rough dab *Hippoglossoides platessoides*

Note: Anadromous and Elasmobranch species are considered separately in Chapters 12 and 13 respectively

* indicates key species identified during consultation with fishermen within the Sound of Islay

¤ Indicates species identified during the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010)

11.27. As part of the EIA process it is not considered necessary to assess potential impacts on each of the species listed in Table 11.4. In line with the EIA guidance (CEFAS, 2004) outlined in Section 11.3.1, only those resources considered to be important (see criteria in Paragraph 11.7) need be the subject of assessment. However it has been deemed practical to take a precautionary approach and therefore other species of potential importance to commercial fisheries have also been assessed.

11.28. Species are also deemed to be important or potentially important if they have spawning or nursery grounds within the study area.

11.29. Furthermore, given their behavioural characteristics and habitat preferences, it is not likely that all of the species listed in Table 11.4 will be encountered across the tidal array site or cable route. For example, although fisheries landing data indicates that Nephrops are a commercially important species in a regional context, it is unlikely that they would be encountered across the array site or cable route since the substrate in these locations (i.e. coarse and mobile sediments) would not allow the construction of suitable burrows. Also note native oyster (due to its conservation importance) as an example of a species whose habitat won't be present within the study area. Exclusions such as these are only possible as these species are benthic species (living on the seabed). It is not possible to exclude the more mobile fish species that inhabit the water column in such a way.

11.30. Taking Table 11.4 as a starting point, and based upon the criteria in Paragraph 11.7, species descriptions of "important species", "potentially important species" and groups of species are provided below.

11.5.3 Important Species: Shellfish

11.31. Landings from both ICES rectangles 40E3 and 40E4 combined, (and therefore the wider region), are shown in Appendix 15.1; Figure 3. These landings data show that Nephrops is the most important species for the wider region with scallop and crab species also forming a large part of the landings.

11.32. Shellfish species of greatest commercial interest when ICES rectangle 40E3 is taken in isolation, in order of value, are scallops, velvet swimming crab, brown crab, lobster and Nephrops (Appendix 15.1; Figure 1). Consultation with local fishermen and analysis of landings at Port Askaig (see *Chapter 15: Commercial Fisheries*) has confirmed that species of greatest commercial importance (in order of greatest value first) within the study area are velvet swimming crab, brown crab and lobster. Fishermen do occasionally target scallops within the study area; however these occasions are rare and therefore scallops within the study area do not form a commercially important natural resource. Common whelk are also known to be present within the study area (figure 15.13 *Chapter 15: Commercial Fisheries*) but are not currently targeted there.

Velvet swimming crab

11.33. The velvet swimming crab *Necora puber* (also known as the devil crab), is, along with edible crab and lobster, one of the three main species targeted by fishermen in the study area. They comprise the greatest percentage of landings at Port Askiag of any species and are therefore currently considered to be the most important commercial species within the study area (see *Chapter 15*: *Commercial Fisheries*). Velvet crabs are targeted using a type of static gear called a creel. This information was confirmed during the consultation process where interviews were conducted with local fishermen (Appendix 15.3).

11.34. Velvet swimming crabs are mostly found in rocky areas with reefs, boulders and large stones. After spawning (in late summer or autumn), eggs are carried by the female under the abdomen until they are ready to hatch. Hatching normally takes place in early summer, and the larvae are distributed by water movements before settling to the seabed as miniature adults. Velvet crabs are rarely thought to undertake any significant migrations (Fisheries Research Services, undated (b)). During the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010) two velvet swimming crabs were identified close to the coastline, the closest of these was approximately 308m from the nearest potential tidal turbine site (Figure 15.13 *Chapter 15: Commercial Fisheries*).

Brown crab

11.35. Brown crab *Cancer pagurus* (also called the edible crab) are also one of the three main species that are targeted by fishermen in the study area (Appendix 15.3). Along with velvet swimming crab and lobster they are targeted using static gears. Similar size creels are used to target both species of crab.

11.36. Like velvet crabs, edible crabs are found in rocky areas, but they may also be found on sand, gravel and mud. Breeding takes place during winter months and spawning and hatching generally follows the same pattern as that described for velvet crabs. Tagging studies have shown that edible crabs may move up to a few kilometres a day, and hundreds of kilometres in the long term (Fisheries Research Services, undated, (b)).

11.37. Edible crabs inhabit the intertidal down to as deep as 100m (Niel and Wilson, 2008) and are therefore likely to exist throughout most of the study area. During the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010) 21 individuals of this species were identified at locations throughout the survey area, many of which were within the Development site (Figure 15.13 *Chapter 15: Commercial Fisheries*).

Lobster

11.38. Lobsters are the third of the main species targeted by fishermen within the study area; they are landed using static gear; either creels of the same dimensions as those used for crabs or larger purpose built lobster pots (Appendix 15.3).

11.39. Lobsters have a preference for rocky reef habitats. Spawning and hatching generally follows the same pattern as that described for velvet crabs. They are rarely thought to undertake any significant migrations (Fisheries Research Services, undated (b)).

11.40. Lobsters inhabit water depths from the intertidal down to 60m, appearing to prefer mid to high energy environments (Galparsoro *et al*., 2009) so it is likely that they will occur on their preferred habitats throughout much of the study area. No lobsters were identified during the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010), however lobster are highly mobile cryptic species that could easily avoid detection by a video sled.

Scallops

11.41. The great scallop *Pecten maximus* (also known as king and giant scallop) is the most-landed species in terms of live weight and value from ICES rectangle 40E3 (Appendix 15.1. Figure 1) Queen scallop (*Aquinopecten opercularis*) are also landed, though not in as great a number as they have less market value. Consultation with fishermen has revealed that scallops are targeted occasionally within the study area, with effort concentrated in the extreme north and extreme south of the study area due to local ground and tidal conditions. Diving for handpicked scallops is also known to have occurred in the past and may occur again in the future.

11.42. Scallops are not expected to occur abundantly across the Development site, though may be present in patches of softer sediments. During the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning 2010) one single *P. maximus* specimen was recorded in shallow waters on the western side of the Sound (Figure 15.13 *Chapter 15: Commercial Fisheries*).

Nephrops

11.43. *Nephrops norvegicus* (also known as the Dublin Bay prawn, langoustine, scampi and Norway lobster) distribution is limited by the extent of suitable relatively soft stable sediment in which they construct burrows. Populations exist in depths as shallow as a few metres down to 500m in an area which includes much of the Hebrides. Nephrops spend most of their time in burrows, only coming out to feed and look for a mate, and the timing of emergence appears to be related to light level (Fisheries Research Services (d)).

11.44. Female Nephrops usually mature at three years of age and reproduce each year thereafter. They mate in early summer and spawn in September, carrying eggs under their tails until they hatch in April or May. The larvae develop in the plankton before settling to the seabed around eight weeks later. The study area lies within a wider region that is known to be a Nephrops spawning and nursery ground (Figure 11.1). The relative size of the Development site in relation to the area of the Nephrops spawning and nursery grounds and the minimum distance from the spawning and nursery grounds to the site are given in Table 11.5 and a summary of spawning times for this species is shown in Table 11.8.

Table 11.5 Distance to Nephrops spawning and nursery areas and relative area covered by the array site.						
Species	Distance to nearest spawning area (km)	Nearest spawning area (km2)	% of nearest spawning area covered by site	Distance to nearest nursery area (km)	Nearest nursery area (km2)	% of nearest nursery area covered by site
Nephrops	0	54847	0.001	0	54531	0.001

11.45. As a result of their habitat requirements, Nephrops are not likely to be encountered in the Development site, but may be encountered in the study area. No Nephrops or Nephrops burrows were recorded during the benthic surveys of the study area (SeaStar Survey Ltd, 2009 and Royal Haskoning 2010) and it is very unlikely the Development site is used as spawning or nursery ground by this species.

Common whelk

11.46. The Common whelk *Buccinum undatum* is not landed in any great numbers from ICES rectangle 40E3 (which contains most of the study area) and they are not thought to be targeted at all within either the Development site or the study area.

11.47. Whelk were identified during the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning 2010) and were found to be present within Development site (Figure 15.13, *Chapter 15: Commercial Fisheries*) the closest being within 100m of the nearest potential turbine location. Occasionally intertidal but more usually subtidal whelks are caught using purpose built pots and usually inhabit muddy sand gravel and rock habitats (Agar, 2008). The common whelk breeds in winter between November and January when the female produces large bundles of eggs which are normally stuck to stones or solid objects.

11.48. Discussions with local fishermen did not indicate that whelks are currently or could potentially be targeted within the study area.

Common mussel

11.49. The common mussel *Mytilus edulis* (also known as the blue mussel) is not landed in any great numbers from ICES rectangle 40E3 (see *Chapter 15: Commercial Fisheries*) and are not targeted within the study area as seabed topography and tidal conditions do not allow for harvesting.

11.50. Common mussels were identified in one sample during the benthic surveys (SeaStar Survey Ltd, 2009) in shallow waters in the north western part of the survey area (Figure 15.13, *: 15 Commercial Fisheries)* at approximately 281m from the nearest potential turbine location. Found in the intertidal through to the shallow subtidal (Tyler-Walters, 2008) mussels need a rocky substrate to attach to and are therefore unlikely to be found at the locations on which the turbines will be placed and were not recorded at any locations within the Development site.

11.5.4 Important Species: Fish

11.51. Fin fish species are not commercially targeted in the study area, where ground and tidal conditions mean that appropriate fishing gear types can not be safely deployed. As a result, it is difficult to assess the abundance of particular species within the study area. 'Important' species are therefore identified on the basis of their importance to commercial fisheries, their conservation importance, sensitivity to potential effects (including the presences of spawning or nursery grounds within the study area), of restricted geographical distribution (as per criteria outlined in Paragraph 11.7), and/or where they are known to be locally abundant representing a potentially valuable resource.

11.52. Fish can be divided into two main categories; pelagic and demersal. Pelagic fish are those that live in mid-water, often in shoals, such as herring and mackerel. Demersal fish are those that live at or close to the seabed. Some demersal fish, such as the flatfish and ray species, are more associated with the seabed while others such as the gadoid fishes, forage in a layer that can be tens of metres above the seabed (Scottish Executive, 2007). Both pelagic and demersal species can make extensive migrations between spawning and feeding grounds and are therefore likely to use the study area or transit through it.

Species of Conservation Importance

11.53. Table 11.6 shows species encountered on the west coast of Scotland, which are of conservation importance. 'Relevance' to marine renewable energy projects (and not to the specific assessment in this chapter) has been defined upon the basis of criteria provided by CEFAS guidance (2004).

11.54. The UK Biodiversity Action Plan (UK BAP) is the part of the UK Government's response to the Convention on Biological Diversity (UK Bap, 2010). It provides detailed plans for the protection of biological resources (species and habitats) of conservation importance. The IUCN Red List of Threatened Species identifies and provides information on plants and animals at risk of extinction.

Table 11.6 Species of conservation importance.		
Species	**Conservation status**	**Relevance**
Cod	IUCN red list	Medium
Haddock	IUCN red list	Medium
High – Species present in the study area, which need to be considered in EIA Medium – Species that were historically present in the area but may not be present now, and species that may only occasionally occur in the area. These species may need to be considered in EIA but data are likely to be scant. N/A – Species not normally in the area.		

Note: Anadromous and Elasmobranch species of conservation importance are assessed in Chapters 12 and 13 respectively.

Spawning and Nursery Areas

11.55. The Development site and/or study area may currently act as a spawning and/or nursery ground during early stages of development for a number of species. The relative size of the Development site in relation to the area of the spawning and nursery grounds and the minimum distance from the spawning and nursery grounds to the site are given in Table 11.7.

Table 11.7 Distance to spawning and nursery areas and relative area covered by the array site.						
Species	**Distance to nearest spawning area (km)**	**Nearest spawning area (km2)**	**% of nearest spawning area covered by site**	**Distance to nearest nursery area (km)**	**Nearest nursery area (km2)**	**% of nearest nursery area covered by site**
Sprat	0	489399	0.0001	na	na	na
Cod	na	na	na	0	22277	0.003
Saithe	na	na	na	0	48140	0.001
Plaice	na	na	na	15	1.2	0

11.56. A summary of spawning times of the relevant species is shown in Table 11.8.

Table 11.8 Principal spawning times (by month) of fish species relevant to the array site (Fisheries Research Services, undated and ICES, undated).												
Species	J	F	M	A	M	J	J	A	S	O	N	D
Nephrops	Berried			Eggs hatch						Berried		
Sprat												

Sensitivity to Tidal Array Development

11.57. The Scottish Marine Renewables SEA (Scottish Executive, 2007) identifies the sensitivity of fish species to impacts associated with wave and tidal array developments. Table 11.9 below is adapted from the SEA and lists those species or species groups which may be considered sensitive to the proposed Development.

Table 11.9 Sensitivity of fish to impacts from tidal arrays. Source: Scottish Executive (2007).						
Species	**Smothering**	**Change in suspended sediment**	**Substratum loss**	**Decrease in water flow**	**EMF**	**Underwater noise**
Herring	High	Medium	High	High	Not sensitive	High
Sprat	Not sensitive	Medium	Not relevant	Not relevant	Not sensitive	Unknown
Cod	Not sensitive	Not relevant	Not relevant	Not relevant	Yes	High
Sandeels	High	Low	High	Medium	Not sensitive	Unknown
Lemon sole	Low	Low	Not relevant	Not relevant	Not sensitive	Low
Plaice	Low	Low	Not relevant	Not relevant	Yes	Low

Note: Anadromous and Elasmobranch species are considered in Chapters 12 and 13 respectively

Cod

11.58. Cod (*Gadus morhua*) is a widely distributed demersal species that occurs throughout UK waters. Tagging has revealed that cod migrate in late summer and early autumn from the west coast of Scotland to the north coast, and return in the late winter and early spring (Scottish Executive, 2007). The study area is however within a large nursery ground (Figure 11.1) that covers 22277 km^2 and therefore individuals may occur across the development site.

11.59. Spawning can occur from January to April, usually peaking in February, and there is a significant spawning area around the Outer Hebrides; however, the study area is not within this spawning area (Figure 11.1). The eggs, larvae and juvenile up to about 7cm in length are pelagic and there is no evidence of daily vertical migration through the water column. Demersal juvenile nursery areas are located in coastal waters from the Clyde northwards and they exhibit a preference for rocky substrates. The Sound of Islay is completely within a large cod nursery area (Figure 11.1)

11.60. Much of the prey of all sizes of cod consists of a variety of small fish and crustaceans. The remainder is made up of smaller quantities of molluscs and worms (Wheeler, 1978).

11.61. Although an important exploited fish species in the North Atlantic, cod is not targeted by fisheries in the study area and catches have declined across the wider region. Stocks are considered to be seriously depleted and outside of safe biological limits. The spawning stock biomass for west of Scotland cod has been estimated at an all time low and recruitment has been declining over the last decade (Fisheries Research Services (a)).

Haddock

11.62. Haddock (*Melanogrammus aeglefinus*) is a demersal species that shoals in colder waters and is usually found over rock, sand, gravel or shells (Barnes,2008). Haddock is widely distributed across western Scotland with adults found at depths from about 40 to 300m and is likely to occur within the study area. Spawning areas are in deeper water to the west of the Outer Hebrides. Spawning takes place from February to May (Scottish Executive, 2007).

11.63. The nursery grounds are widely distributed and are mostly offshore; therefore do not occur within the Sound of Islay. There is some evidence to supporting the theory that migration of Haddock between the North Sea and the northwest coast of Scotland occurs. Haddock is listed as vulnerable in the IUCN Red List (Table 11.6).

Sprat

11.64. Sprat (*Sprattus sprattus*) is a short-lived pelagic species that is widely distributed off western Scotland. They occur from the surface to about 100m depth but are generally found in shallower waters and are likely to occur across the study area. Sprat are batch spawners that spawn throughout the summer producing pelagic eggs. Nursery areas are in inshore waters along the west coast of Scotland. Mature fish often migrate inshore during the winter (September to March) and are sometimes commercially exploited.

11.65. The study area is within a wider area known to be a sprat spawning ground (Figure 11.1). However the Sound of Islay is not known to be used by sprat as a nursery ground (Figure 11.1).

Plaice

11.66. Plaice (*Pleuronectes platessa*) is widely distributed on sandy bottoms in the wider region from the intertidal to depths of around 80m.

11.67. Plaice spawn throughout their adult range and localised spawning concentrations occur in some areas. There are no spawning grounds within the study area and the nearest spawning sites are located to the west of Islay and south of the Kintyre peninsula. Plaice eggs are pelagic and metamorphosing larvae enter coastal areas. Sandy beaches are the nursery ground for plaice and four distinct nursery grounds are present around Islay (Loch Gruinart, Loch Indaal (Figure 11.1), Laggan Bay and Machir Bay), none of which fall within the study area and all of which are located more than 10km from the proposed Development site. After a year spent in nursery areas, plaice gradually disperse offshore. They can make extensive migrations between spawning and feeding grounds.

11.68. Plaice are benthic feeders, consuming polychaete worms, amphipods, mysids, molluscs and brittlestars. During the benthic survey no habitats that are likely to support plaice were identified; however the benthic survey only covered the area of interest and not the entire study area.

Saithe

11.69. Adult saithe (*Pollachius virens*) are found in deep waters (approximately 100 – 200m) at the edge of the continental shelf. Spawning takes place from January to April to the west of the Outer Hebrides. Juveniles are located in coastal waters that cover the entire west coast of Scotland and do not migrate into offshore waters until they reach 2 – 3 years old. The migration takes place in spring.

11.70. The pelagic eggs and larvae are widely distributed and nursery areas are in the inshore waters of the west of Scotland and around Orkney and Shetland. The study area is included in a large saithe nursery ground (Figure 11.1 and Table 11.7) and therefore this species may be sensitive to the effects of the proposed development.

11.71. The diet of juvenile saithe comprises both pelagic and demersal organisms, with copepods, amphipods, decapods and polychaetes being the dominant taxa taken. Adult saithe feed mostly on euphausiids and fish. During the benthic survey no habitats that are likely to support saithe were identified; however the benthic survey only covered the Development site and not the entire study area.

Herring

11.72. Herring (*Clupea harengus*) is a pelagic species that is widely distributed off the west coast of Scotland and are likely to be present across the study area and Development site. During the daytime they remain close to the seabed or in deep water, and they undertake diurnal feeding migrations into surface waters.

11.73. Although a pelagic species, they are demersal spawners, depositing sticky eggs on stone and gravel in waters down to 200m. For this reason, herring are considered particularly sensitive to seabed developments that affect their spawning grounds. The major northwest Scotland spawning area (with spawning occurring in both spring and autumn) lies to the west of the Outer Hebrides and extends north along the north coast of mainland Scotland. Other spawning events include autumn spawning around the Inner Hebrides and a spring spawning period within the Firth of Clyde. After hatching the larvae are pelagic and drift with the currents and the juvenile nursery grounds tend to be close inshore from the Clyde along the entire west coast of Scotland and both the inner and outer Hebrides. Herring are not thought to spawn in, or use the study area as a nursery ground.

11.74. Generally, crustaceans (shrimps and copepods) and juvenile sandeels are the main components of the diet of herring (Fisheries Research Services (b)). There are no marked differences between the diets of juvenile or adult herring; only the proportions of different food items change with the size of the herring (DTI, 2007). During the benthic surveys no habitats that are likely to support herring were identified; however the benthic survey only covered the development site and not the entire study area.

11.75. Based on the most recent estimates of the spawning stock biomass and fishing mortality, it is considered that the herring stock is currently fluctuating at a low level (Fisheries Research Services (c)).

Sandeels

11.76. Although there are five species of sandeel in Scottish waters about 90% of the commercial catch consists of one species, *Ammodytes marinus*. Sandeels are a shoaling species that lie buried in sand during the night and emerge during the day to feed in midwater. During the winter they remain in the seabed sediment only emerging to spawn. Given the coarse nature of the seabed sediments in the study area, it is unlikely that this species would be encountered across the array site.

11.77. Spawning takes place from November to February and is widespread. Eggs are demersal and are laid in sticky clumps on sandy substrates. Larvae are pelagic and after about 2 to 5 months they adopt the demersal habit. All known sand eel spawning and nursery grounds lie over 25km from the proposed array site.

Lemon Sole

11.78. Lemon sole (*Microstomus kitt*) is a deeper living (40 – 200m) demersal species that occurs throughout waters off the west coast of Scotland, though is in greater abundance around the Outer Hebrides and off Orkney and Shetland (Scottish Executive, 2007).

11.79. Spawning runs from April to July in deep water and the pelagic eggs and larvae occupy progressively deeper water as they develop.

11.6 Impact Assessment

11.6.1 Do nothing scenario

11.80. Apart from creeling on a small scale, there has been very little direct anthropogenic influence on the natural fish and shellfish resources within the study area. It is anticipated that this practice will continue regardless of whether the Development is constructed or not. Therefore, if the proposed tidal array is not deployed the existing environment discussed above is likely to remain in its current status. However, it is recognised that commercial fishing within the area is very much driven by demand which can fluctuate. So if demand for the three main species (velvet crab, brown crab and lobster) targeted within the study area were to increase significantly then fishing effort is likely to increase as a response. Demand for these species is currently believed to be relatively stable.

11.6.2 Potential Impacts during Construction Phase

11.81. *Chapter 8: Benthic Ecology* presents the assessment of habitat disturbance upon the benthic assemblage within the development site. It is estimated that the total loss of seabed within the footprint of the devices will be a maximum of 329.7m^2; the footprint for the inter-array cables will be approximately 3506m^2, and the maximum export cable route, will be 1946m^2 (with a 200cm buffer). This equates to a total loss of 0.02% of the total seabed within the area of interest and 0.002 % of the study area. The seabed upon which it is proposed that the array will be placed is comprised of coarse seabed sediments. Due to the strong tidal currents in the Sound of Islay, the area is deemed to be unsuitable as feeding ground for demersal species and this impact is not assessed.

Impact 11.1: Habitat disturbance of mollusc species

11.82. Direct impacts caused by habitat disturbance during the construction phase are expected to be greater on sessile (immobile bottom dwelling) organisms and species whose limited mobility will inhibit avoidance reactions. The great scallop *Pecten maximus*, the mussel *Mytilus edulis* and the whelk *Buccinium undatum* were all identified as present within the study area during the benthic survey (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010); and it is these species that are most likely to be affected by habitat disturbance.

11.83. These species were not found to be common within the study area or to inhabit the preferred sites for turbine location and therefore the magnitude of the impact can be considered to be low. None of these species are considered to be of national or international conservation importance and although these species are of local value it is unlikely that anything other than very minor changes in their abundance would be detectable post Development. Consequently the sensitivity of the receptor can be considered to be low.

11.84. As both the magnitude of the impact and the sensitivity of the receptor (in this case mollusc species) are low the direct impact due to habitat disturbance of these species is considered to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 11.1
• No mitigation is required

Residual impact:

11.85. As no mitigation is required the impact of habitat disturbance of mollusc species will remain of **negligible** significant effect.

Impact 11.2: Habitat disturbance of crustaceans

11.86. Crustaceans, such as velvet crab, brown crab and lobster, have a greater mobility than mollusc species allowing them to exhibit avoidance responses to disturbance. They also have a preference for rocky, cryptic habitats, which will not be preferred substrates for turbine placement.

11.87. However, these species, in particular the edible crabs, were either found to be relatively abundant within the study area and Development site during the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning 2010) or were identified as present by local fishermen (Appendix 15.1). It is likely that only a minor change to the baseline condition of these species will be detected by the fishermen and as such the magnitude can be considered to be low. None of these species are of national or international conservation importance, but due to the commercial importance of these species this receptor is locally valuable, therefore the sensitivity can be considered to be low.

11.88. As both the magnitude of the impact and the sensitivity of the receptor (crustacean species) are considered to be low the impacts of habitat disturbance on crustaceans are likely to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 11.2
• Micro-siting to avoid any known sensitive habitats such as rocky reefs

Residual impact

11.89. If the above mitigation is implemented then there is likely to be **no significant** effect of the development upon crustaceans.

Impact 11.3: Loss of spawning grounds

11.90. The study area has been identified (using the CEFAS data) as being part of wider spawning grounds for two commercially exploited species which are sprat and Nephrops (Figure 11.1).

11.91. The wider spawning ground for sprat covers an area of 489,399km^2 and the construction phase of the project will impact upon 0.1×10^5% of this total spawning area; this coupled with the fact that sprat produce pelagic eggs which are unlikely to be affected by the development mean that the magnitude of impacts of the development on sprat spawning grounds are likely to be imperceptible giving a negligible impact magnitude and a negligible sensitivity.

11.92. Due to the unavailability of suitable habitats, Nephrops are unlikely to be present within the study area and therefore the development is likely to cause **no significant effect** to this species.

11.93. Therefore even with uncertainties it is not unreasonable to predict that with a negligible magnitude of impact and the negligible sensitivity of the receptor (Nephrops and sprat) that there would be **no significant effect** of the Development on spawning grounds.

MITIGATION IN RELATION TO IMPACT 11.3
• No mitigation is required

Residual Impact:

11.94. As no mitigation is required the impact of the Development on spawning grounds will remain **no significant effect**.

Impact 11.4: Loss of Nursery grounds

11.95. The study area has been identified (using CEFAS data) as being part of wider nursery areas for cod, saithe and Nephrops (Figure 11.1). Construction of the development will affect less than: 0.003% of cod, 0.001% of saithe and 0.001% of Nephrops nursery grounds. As juveniles cod and saithe are highly mobile, any individuals within the site at the time of construction are likely to vacate the area once construction begins. Also due to their habitat requirements, juvenile Nephrops are not likely to be encountered in the area of interest (see Impact 11.3). Therefore it is unlikely that any change to the baseline condition of these species caused by the Development will be imperceptible making the magnitude of the impact and the sensitivity of the receptor negligible.

11.96. Although not within the study area itself plaice are known to use the inshore waters of the both Islay and Jura as nursery areas (Figure 11.1). The closest of these to the Development site is located 15km to the north east, on the west coast of Jura. Due to its distance from the site the impacts of the development on plaice nursery grounds are likely to be negligible.

11.97. As both the magnitude of the impact and the sensitivity of the receptors (fish nursery grounds) are negligible it is considered that there will be **no significant effect** to nursery grounds caused by the Development.

MITIGATION IN RELATION TO IMPACT 11.4
• No mitigation is required

Residual impact

11.98. As no mitigation is required, the impact on nursery grounds will remain of **no significant effect**.

Impact 11.5 Noise and vibration on fin fish species

11.99. The main activities related to the construction of the tidal array with the potential to cause an impact to natural fish resources are cable laying and burial, and rock placement (and associated vessel movements). These activities are discussed in more detail in *Chapter 5: Project Description*.

11.100. An assessment of underwater noise within the study area (SAMS, 2009) concluded that high levels of background noise currently exist with there. A summary of this report can be found in *Chapter 9: Marine Mammals*. Therefore any additional noise sources within the study area would have to be at a very high level to be detected by fish species.

11.101. According to Vella *et al*. (2001) the sensitivity of species to noise and vibration is dependent on:

- The audible threshold;
- The presence of a swim bladder and its size and physical coupling to the ear;
- The resonance frequency of the otolith system; and
- Behavioural factors, such as aggregation or shoaling behaviour.

11.102. Hearing sensitivities of important or potentially important species are included in Table 11.10.

Table 11.10 Hearing specialisation of Important fish species. Source: Nedwell *et al* (2004).

Species	Family	Swim Bladder Connection	Sensitivity
Herring	Clupeoidea	Prootic auditory bullae	High
Sprat	Clupeoidea	Prootic auditory bullae	High
Cod	Gadidae	None	Medium
Plaice	Pleuronectidae	No swim bladder	Low

Note: sensitivity to noise of anadromous and elasmobrach species are discussed in Chapters 12 and 13 respectively

11.103. The effects of noise on fish can be divided into the following categories (Hastings and Popper, 2005):

- Lethality and physical injury;
- Traumatic hearing damage (i.e. temporary and permanent hearing loss); and
- Behavioural responses and masking of biologically relevant sounds.

11.104. Most of the fish species likely to be encountered within the Development site have a relatively low sensitivity to noise. Within this impact assessment, herring has been used as the example against which all impacts are assessed, as it is considered to be the most sensitive species present and believed to be present within the region.

11.105. It is likely that as herring are sensitive to noise disturbance they will show a minor detectable change in behaviour if present within study area. The magnitude of this impact can therefore be considered to be low.

11.106. Herring is a UK BAP species meaning it is of national importance, this together with the high sensitivity of this species to noise (Table 11.10) means that the sensitivity of this receptor must be considered to be medium. It is not considered to be of high sensitivity as the definition in Table 11.2 states that for high sensitivity a species will be "permanently significantly altered by the Development". This is not likely to be the case for the herring population within the study area or within the wider region.

11.107. Taking account for the fact that the magnitude of the impact is low and the sensitivity of the receptor medium, which is in fact a precautionary approach, and given that pile driving is not an activity expected to take place during construction, it is likely that the impact of noise and vibration on fish species can be considered to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 11.5
• Use of soft start (gradual ramping up) to any operations that will emit noise and vibrations into the Sound • Adherence to best practice outlined in BS5228-2 (2009) British Standards Code of practice for noise and vibration control on construction and open sites during all construction activities • Adherence to best practice guidance in CIRIA C584 (2003) Coastal and Marine Environmental Site Guide during all construction activities

11.108. With best practice mitigation in place, the impact of noise and vibration on fish species can be considered to be of **negligible to minor** significant effect.

Impact 11.6 noise and vibration on shellfish species

11.109. In the case of shellfish, there is limited research on the effect of noise upon these species. Due to the absence of swim bladders, it is generally assumed that shellfish are relatively insensitive to noise. The effect of noise is expected to cause some localised avoidance behaviour at worst. Therefore the magnitude of this impact can be considered low and the sensitivity of the receptor low.

11.110. As both the magnitude of the impact and the sensitivity of the receptor are low it can be considered likely that the impact of construction noise on shellfish will be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 11.6
• Use of soft start (gradual ramping up) to any operations that will emit noise and vibrations into the Sound • Adherence to best practice outlined in BS5228-2 (2009) British Standards Code of practice for noise and vibration control on construction and open sites during all construction activities • Adherence to best practice guidance in CIRIA C584 (2003) Coastal and Marine Environmental Site Guide during all construction activities

Residual impact

11.111. If the mitigation above is implemented during construction the residual impact of noise and vibration on shellfish species is likely to be of **negligible** significance.

Impact 11.7: Increased turbidity affecting fin fish

11.112. Activities related to the construction of the tidal array, such as cable laying and device placement can result in a temporary increase in turbidity through sediment re-suspension (OSPAR, 2004). However, these effects will be short term and will only affect localised areas during construction, with suspended sediment re-settling soon after works stop in a given place. Coarser sediment fractions are likely to be re-deposited on the seabed within approximately 50m of the works (Scottish Executive, 2007). The sediment within the study area is mainly coarse grained and it is thought that fine grained sediments are rare. Therefore, the majority or re-suspended material will fall out of suspension within 50m of the works and the effect on turbidity will be localised and minimal.

11.113. Increases in suspended sediment concentrations and turbidity can have effects on foraging, social and predator/prey interactions (Scottish Executive, 2007) of many species. A summary of risks to fish and their habitat associated with increased concentrations of suspended sediments are given in Table 11.11.

Table 11.11 Risks to fish and their habitat by sediment concentration. Source: Department of Fisheries and Oceans, Canada (2000).

Sediment Increase (mg/l)	Risk to fish and their habitat
0	No risk
<25	Very low risk
25-100	Low risk
100-200	Moderate risk
200-400	High risk
>400	Unacceptable risk

11.114. Herring and sprat have “medium sensitivity” to increases in suspended sediment concentrations (Scottish Executive, 2007). The SEA states that all other fish and shellfish species (relevant to this chapter), for which sensitivity is known, have “low” or “no sensitivity” to this impact.

11.115. *Chapter 7: Physical Environment and Coastal Processes* provides an assessment of the impact of increases in suspended sediment (Impact 7.2). Reference is made in that section to the fact that, due to the strong currents within the study area, any increase in suspended sediments and therefore turbidity will be small and short lived. Consequently the magnitude of this impact can be considered to be low.

11.116. As is stated above the maximum sensitivity of any species likely to be within the study area is said to be medium, and therefore taking a precautionary approach it is this level of sensitivity which is used in the significance matrix. Therefore the overall impact of increased turbidity on fin fish is likely to have a **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 11.7
• Carry out works at or close to slack tide when any suspended sediment will re-settle more rapidly and in the vicinity of the work site

Residual impact

11.117. If the mitigation suggested above is implemented than the residual impact of increased turbidity upon fin fish is likely to be of **negligible** significant effect.

Impact 11.8: Increased turbidity effecting bivalves

11.118. Filter feeding species are considered to be most at risk from potential effects associated with increased suspended sediments and turbidity. The Scottish Marine Renewables SEA (Scottish Executive, 2007) concludes that scallops and mussels both have medium sensitivity to increases in suspended sediment concentrations. The SEA states that all other shellfish species (relevant to this chapter), for which sensitivity is known, have low or no sensitivity to this impact.

11.119. Scallops and mussels are both commercial bivalve species that were found to be present within the study area during the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010). These species are filter feeding organisms, which collect algae, detritus and organic material for food. The systems for achieving this are delicate and have the potential to become blocked if a substantial increase in suspended sediment and turbidity occurs. It is therefore likely that a small change in turbidity as predicted in *Chapter 7: Physical Environment and Coastal Processes* will result in a minor detectable change in the baseline condition of these species. Taking the above into account the magnitude of this impact can be regarded as low.

11.120. Although neither of these species are considered to be of National importance (neither are a UK BAP species), they are both considered to be of local value and importance, therefore the sensitivity of must be considered to be low.

11.121. Low magnitude and low sensitivity mean that the impact of increased turbidity on bivalves is likely to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 11.8
• Use cable and device installation methods that minimise sediment re-suspension

Residual impact

11.122. With the above mitigation implemented the residual impact of increased turbidity on commercially important bivalves is likely to remain of **negligible** significant effect.

Impact 11.9: Smothering marine fish and shellfish

11.123. There is no evidence to suggest that elevated suspended sediment levels would significantly impact the larval stages or eggs of species that are likely to be present within the study area such as cod, saithe, Nephrops sprat and plaice, all species that use the study area or its vicinity as spawning or nursery grounds.

11.124. There is limited information available on the effect of increased suspended sediment on crustacean species. However, the Marine Life Information Network (MarLIN) provides sensitivity assessments for the brown crab (*Cancer pagurus*), for both its larval and adult stages. A summary of the sensitivity of adult edible crab to increased suspended sediment concentration and turbidity is given in Table 11.12. Neal and Wilson (2008) suggest that the larval stages of the edible crab, as they are pelagic, are unlikely to be affected by increased sediment concentrations.

Table 11.12 Sensitivity of adult brown crab (Cancer pagurus). Source: Neal and Wilson (2008).

Physical Impact Factor	Intolerance	Recoverability	Sensitivity	Evidence / Confidence
Smothering	Low	Very high	Very low	High
Increased suspended sediment	Low	High	Low	Very low
Increased turbidity	Tolerant	Not relevant	Not sensitive	Very low

11.125. MarLIN also provides sensitivity assessments for a number of filter-feeding shellfish species. Tables 11.13 and 11.14 summarise the results of the MarLIN assessments for great scallop and common mussel (two commercially important species) occurring within the Sound of Islay (and therefore of potential local value), albeit in low abundances. The assessments indicate that scallops are tolerant of smothering and that mussels show intermediate tolerance, with both species having high recoverability where effects have occurred.

Table 11.13 Sensitivity of adult great scallop. Source: Marshall and Wilson (2008).

Physical Impact Factor	Intolerance	Recoverability	Sensitivity	Evidence / Confidence
Smothering	Low	High	Low	Low
Increased suspended sediment	Low	High	Low	Moderate
Increased turbidity	Tolerant	Not relevant	Not Sensitive	Not relevant

11.126. Smothering associated with the deposition of sediments disturbed by installation of the turbines and associated cables is expected to be a temporary impact, as excess material deposited will be re-suspended and distributed by natural hydrodynamic processes (Scottish Executive, 2007).

11.127. On this basis, and taking account that pile driving is not part of construction methodology, it has not been considered necessary to undertake a modelling exercise to predict the levels of sediment that could be put into suspension.

Table 11.14 Sensitivity of adult common mussel. Source: Tyler-Walters (2008).

Physical Impact Factor	Intolerance	Recoverability	Sensitivity	Evidence / Confidence
Smothering	Intermediate	High	Low	Low
Increased suspended sediment	Low	Intermediate	Not sensitive	High
Increased turbidity	Tolerant	Not relevant	Not sensitive	Not relevant

11.128. While increased sediment concentrations could trigger some short-term avoidance behaviour in adult crabs and lobsters, both the magnitude of this impact (smothering) and sensitivity of the receptor (marine fish and shellfish) can be considered to be low. Therefore by using the significance matrix (Table 11.3) it is predicted that the impact of smothering on marine fish and shellfish species is likely to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 11.9
• Use cable and device installation methods that minimise sediment re-suspension.

Residual impact:

11.129. With the above mitigation implemented the residual impact of smothering of marine fish or shellfish is likely to remain of **negligible** significant effect.

Impact 11.10: Release of sediment bound contaminants

11.130. Disturbance of contaminated sediments during device and cable installation may cause potentially detrimental impacts on species that are sensitive to contamination. However, there is no indication that seabed sediments present across the array site or cable route have been contaminated. The impacts of sediment quality have been discussed in further detail in *Chapter 22: Water and Sediment Quality* and *Chapter 8: Benthic Ecology*.

11.131. As it is not thought that there is any significant degree of contamination of sediments within the study area, both the magnitude and sensitivity of this impact are considered **low** and therefore by using these criteria in the significance matrix, the impact of sediment bound contaminants being released is likely to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 11.10
• Use cable and device installation methods that minimise sediment re-suspension

Residual impact:

11.132. The residual impact of sediment bound contaminants being released is likely to remain of **negligible** significant effect.

11.6.3 Potential Impacts during Operational Phase

Impact 11.11 Increase of available habitat

11.133. The device foundations and any associated scour protection are likely to be colonised by numerous marine organisms. On the basis of evidence from offshore wind farms, the array structure may also act as a refuge for some species (Linley *et al*., 2007). The establishment of epifauna and flora on the new substrates may also increase food availability (OSPAR, 2004). However, this may not necessarily result in increased productivity, but a spatial shift in the fish resource (i.e. the array could act as a fish aggregation device) (CEFAS, 2004).

11.134. Surveys conducted in 2004 on the operational Horns Rev offshore wind farm found that the wind farm had become a nursery ground for various species, particularly in the case of edible crab, with juveniles found in large numbers on the monopiles and larger individuals observed in scour protection crevices (Leonhard and Pedersen, 2005). Horns Rev also appeared to be an important nursery ground of masked crab and possibly for sea urchin. In addition, egg masses of species such as whelk and sea slug were commonly found (Leonhard and Pedersen, 2005). Monitoring also revealed marked increases in fish fauna diversity, with shoals of cod, bib and whiting observed around the turbine bases (Leonhard and Pedersen, 2004).

11.135. Post-construction monitoring at other offshore wind farm sites around the UK have not identified any short term negative environmental impacts on fish and shellfish populations caused by wind farm construction (npower renewables, 2007; BOWind, 2008).

11.136. Benthic post-installation monitoring around the SeaGen tidal turbine in Strangford Lough has concluded to date that installation has not resulted in any significant changes to the benthic environment, and all observed changes are natural and seasonal (SeaGen project presentation, undated).

11.137. In view of the above, the magnitude of the impact is likely to be low, as was found at Horns Rev or negligible as was found in the other studies mentioned above. It is difficult to judge the sensitivity of the fauna in the study area to an increase in available habitat but, it is considered likely that the environment will respond in a minimal way and therefore the sensitivity of the receptor is low.

11.138. Therefore it is likely that increased habitat availability during the operational phase of the Development will lead to a effect of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 11.11
• No mitigation is required

Residual impact:

11.139. As no mitigation is required for this impact the residual effect will remain **negligible.**

Impact 11.12: Noise on fish and shellfish.

11.140. During the operational phase of the Development the main source of underwater noise will be rotating turbine blades and mechanically generated vibration, which will be transmitted into the sea.

11.141. Martec Limited (2004) found that acoustic outputs from operational pipelines included sound at frequencies ranging from 34 to 100 Hz, well within the sound detection frequency range of crustaceans. Pipeline sounds were detected on either side of the pipeline at a maximum distance of 200m. The maximum measured SPLs (sound pressure levels) were approximately 10dB above the ambient sound level. Using a 'catch and release' program, the study did not detect any behavioural impacts on crustaceans, indicating these species are not adversely affected by substantial increases in noise and therefore the sensitivity of shell fish can be considered to be low.

11.142. It is possible that some avoidance behaviour may be detected in some finfish species that are particularly sensitive to noise such as herring and sprat (Table 11.10). However these changes will not be major and therefore according to the Table 11.2 a medium sensitivity is likely.

11.143. An assessment of underwater noise within the study area (SAMS, 2009) concluded that high levels of background noise currently exist there. It was also concluded that it was "*unlikely that the turbine devices would represent a significant source of sound pollution within the area*". A summary of this report can be found in *Chapter 9: Marine Mammals*. The magnitude of this impact can therefore be considered to be low.

11.144. With a low impact magnitude and medium sensitivity (using the "worst case scenario") of the receptor the overall operational impact of noise on fish and shellfish is likely to be of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 11.12
For maintenance activities the following best practice should be adhered to: • Use of soft start (gradual ramping up) to any operations that will omit noise and vibrations into the Sound • Adherence to best practice outlined in BS5228-2 (2009) British Standards Code of practice for noise and vibration control on construction and open sites during all construction activities • Adherence to best practice guidance in CIRIA C584 (2003) Coastal and Marine Environmental Site Guide during all construction activities

Residual impact:

11.145. It is likely that if the mitigation suggested is implemented the residual magnitude of the impact will be negligible, therefore reducing the significance of the effect to **negligible**.

Impact 11.13: Electromagnetic fields on Fish and shellfish species

11.146. Elasmobranchs are a group of fish that contain sharks skates and rays, and are particularly sensitive to electromagnetic fields (Gill *et al*.,2008). Impacts of EMF on elasmobranchs are discussed in detail in *Chapter 13: Elasmobranches*.

11.147. A COWRIE funded report (Gill *et al*., 2008) concluded that, of the non elasmobranch species observed that could detect EMF, it was not possible to ascertain if the effects are adverse or beneficial. I was found that general patterns in the response of any species to EMF were difficult to predict and were specific to the individual specimen and not to the species or group of species. The cable armouring, designed to protect the underwater cables (both inter array and export cable) as part of the project design, will dampen effects of EMF.

11.148. Therefore even taking a precautionary approach it is likely that the magnitude and sensitivity of the important species to this impact is low and that the overall impact of EMF on fish and shellfish species is of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 11.13
• No mitigation is required

Residual impact:

11.149. As no mitigation is required, the residual impact of EMF on fish and shell fish will remain of **negligible significant effect**.

Impact 11.14: Physical barriers to movement

11.150. There is a potential for the Development to form a barrier to usual migration and transit patterns of marine finfish, either because of collision risk, aversive reactions to underwater noise, or perceptions of devices and associated infrastructure. This is particularly relevant in 'constrained' areas (such as the mouths of sea lochs or in this case a narrow Sound).

11.151. Any barrier effect is most likely to be felt by mobile fish species which frequently transit through the study area. The Sound of Islay is not known to support any particular fish transit or migratory movements (relevant to this chapter), whereby fish are known to specifically use this stretch of water.

11.152. All ten turbines will be located in water that is deeper then 48m thus leaving a minimum of 14.5m of the water column above the device for movement of fish. The turbines will be positioned in 4 rows either 2 or 3 wide (Figure 1.1). Table 11.15 gives the width in meters that each row could potentially occupy as physical barrier to movement of fish in relation to the width of the Sound at that point.

Table 11.15 Linear distance of the Sound of Islay that is occupied by each row of the turbine array

Turbine row	Number of turbines	Width of row (m) (total width between eastern and western turbine)	Width of Sound at that point (m)	% width of the Sound influenced by the development
Most northern	2	49	720	6.81
2nd most northern	2	42	825	5.09
2nd most southern	3	88	1,085	8.11
Most southern	3	120	1,055	11.37

11.153. The maximum width of the study area that will be taken up by the array is 120m which is occurs at the southern most row of turbines (Figure 1.1). This equates to the maximum percentage of the Sound occupied which is 11.37%. In this row of the array there will also be a large gap between the turbines of approximately 76m which will allow fish to pass through; however this is not included within the barrier calculations as they have been calculated based on a worst case scenario.

11.154. Due to there being no evidence that the study area is important for the movement of any particular fish or shellfish species, and that a minimum of 88.63% of the width of the Sound will be unaffected by the development, the impact of the array as a physical barrier is likely to be at most, of low magnitude.

11.155. The species likely to respond to the impact of a physical barrier imposed by the Development will not be impacted upon at a national or international level and are only considered important at a local level. Therefore the sensitivity of the receptor is considered to be low.

11.156. As this impact (a physical barrier to movement) can be considered to be of medium magnitude and the receptor (marine fish) to be of low sensitivity these criteria result in the anticipated impact being of **minor** significant effect (as a worst case scenario).

MITIGATION IN RELATION TO IMPACT 11.14
• No mitigation is required

Residual impact:

11.157. Given mitigation of this impact is unlikely to be effective, the significance of the array causing a physical barrier to movement of fish species through the sound is likely to remain of **minor** significant effect.

Impact 11.15: Collision risk

11.158. Collision risk with rotating turbines is considered to be a key potential effect during device operation (Scottish Executive, 2007). A collision in the context is understood to be an interaction between a marine vertebrate and a marine renewable energy device that may result in a physical injury (however slight) to the organism. A collision may therefore involve actual physical contact between the organism and device or an interaction with its pressure field.

11.159. Of the important species identified it is the pelagic species, sprat and herring that are most likely to be involved in a collision with the tidal array as these species occupy the same level in the water column as the turbine blades. Cod may also be affected as although they are classified as a demersal species they are known to also travel through the water column.

11.160. The Scottish Executive commissioned a study which investigated collision risk between marine renewable energy devices and fish to support the Scottish Marine Renewables SEA (Wilson *et al*., 2007). The study identified the following:

- Collision risks are not well understood for any marine vertebrates;
- Man-made collision risks are more diverse and common than generally supposed;
- Underwater collision risks typically become well studied after they have become a conservation concern;
- Animals may appear to behave illogically when faced with novel situations;
- Subtleties of gear design (e.g. shape, colour, etc.) as well as environmental conditions (e.g. turbidity, flow rate, etc.) can markedly change collision rates;

- Objects in the water column will naturally attract fish and their predators;
- Stationary objects in flowing water can herd fish upstream until they become exhausted limiting their behavioural options;
- The proximity and relative orientation to other objects will impact escape options and the combined collision risk while topography will impact escape options and animal approach angles;
- Collision risk will vary with age of organisms, with juveniles likely to be more at risk than adults because of reduced abilities or experience;
- The potential for animals to escape collisions with marine renewable devices will depend on their body size, social behaviour (especially schooling), foraging tactics, curiosity, habitat use, underwater agility and sensory capabilities; and
- A variety of warning devices and gear adaptations have been developed for fish in recognition of underwater collision issues.

11.161. Whilst the study presents a useful overview of the factors likely to influence collision risks posed by marine renewable energy devices, given the lack of empirical knowledge it is still not possible to quantify the risk posed by the Development.

11.162. It is generally considered that pelagic fish (in this case herring, sprat) will be the most likely to be impacted by collisions with devices as their diurnal vertical migration behaviour forces them to occupy all depths of the water column at some time during the day (Scottish Executive, 2007), though demersal species making vertical migrations (e.g. plaice and cod) could also be potentially impacted. Demersal fish spending all their time near the seabed are unlikely to be affected by the moving parts of each turbine.

11.163. The study conducted by Wilson *et al*. (2007), using herring as an example of a species that may be at risk of collision, modelled potential encounter rates between 100 horizontal axis 8m radius turbines operating off the Scottish coast and existing populations of herring. The model incorporated a number of assumptions about the vertical distribution of herring, their swimming speeds and distribution. As escape (avoidance and evasion) behaviours by the fish to this type of device are currently unknown it was also assumed that the animals were neither attracted to nor avoided the immediate area around the turbine. While these assumptions could be further refined, the intent was to derive an estimate for the number of potential physical encounters between rotors and animals. The model predicted that in a year of operation, 2% of the herring population would encounter a rotating blade. The calculated encounter rates between herring and turbines are of relatively low significance compared to losses from fisheries. Furthermore it must be stressed that encounters are not collisions. An encounter may lead to a collision but only if the animal in question does not take appropriate avoidance or evasive action. At this point in time, there is no information on the degree to which marine animals will make appropriate manoeuvres. However, many species occupying the same part of the water column as the turbines are predatory animals that are also preyed upon; therefore they are manoeuvrable and aware of their environment. The turbine is relatively slow moving compared to predators.

11.164. The Wilson *et al*. (2007) study also ran the model for harbour porpoise populations (discussed further in *Chapter 9: Marine Mammals*), which showed a higher (3.6%) encounter rate. A comparison of findings for herring and harbour porpoise indicated that the difference between the proportion of herring and the proportion of porpoises encountering the turbines in the model is attributable to the greater swimming speeds and body size of the porpoises. It is apparent that collision risk increases with increasing organism size.

11.165. The Wilson *et al*. (2007) model does not allow for laminar flow effects which may carry smaller animals (such as fish) around the rotors, thus minimising the effects of collision.

11.166. Based on the information available, it is assumed that any effect of herring, sprat or cod, fish associated with collision risk would not result in an impact magnitude greater than at a medium level. It is unlikely that effects of this impact would be felt at anything greater than a local scale and therefore the receptor can be said to be of low sensitivity to this impact.

11.167. As the magnitude of the impact is medium and the sensitivity of the receptor (marine fish) is low and by using the significance matrix in Table 11.3 it can be predicted that the impact of collision with turbines will be no more than of **minor** significant effect.

MITIGATION IN RELATION TO IMPACT 11.15
• No mitigation is required.

Residual impact:

11.168. No mitigation is required and therefore the significance of effect of the impact of collision risk of fish with the turbines is deemed to remain **minor** significant effect.

Impact 11.16: Changes in water flow

11.169. The changes in water flow resulting from extraction of tidal energy will potentially impact on habitats and species which are sensitive to changes to tidal flows and wave exposure. This impact mainly applies to shellfish species (identified in Section 11.5.3) which have low – medium sensitivity to changes in tidal flows, and to herring spawning grounds (Scottish Executive, 2007), of which there are none in the vicinity of the study area.

11.170. The total extraction of energy by the Development from the existing high energy environment will be minimal (*Chapter 7: Physical Environment and Coastal Processes*) and it is likely that any changes in flow will be extremely localised. Also, the hydrodynamic design of the tripod devices offers little resistance and creates minimal downstream turbulence. Therefore, the impact of changes in water flow will be at worst of medium magnitude to shellfish species (as they are less mobile) and of low magnitude to fish species (which are more mobile).

11.171. The effects of this impact will only be realised at a very local level and consequently the sensitivity of the receptor can be considered to be low.

11.172. Based on the above magnitude of the impact and the sensitivity of the receptor it is predicted that the impact of changes in water flow is likely to be of **minor** significance for shellfish species, and **negligible** for herring spawning grounds.

MITIGATION IN RELATION TO IMPACT 11.16
• No mitigation is required

Residual impact:

11.173. With implementation of the above mitigation the residual impact of changes in flow to fish and shellfish is likely to remain of **minor** significant effect for shellfish species and of **negligible** significant effect for herring spawning grounds.

11.6.4 Potential Impacts during Decommissioning Phase

11.174. The impacts produced during decommissioning are expected to be of the same nature and magnitude as those on the construction phase. In addition, if there has been any habitat creation on the structures there may be potential for this to be lost, reversing any beneficial impact created.

11.7 Cumulative Impacts

11.175. The principal offshore activities which could result in in-combination effects with the Sound of Islay tidal array are commercial fisheries and marine traffic, both of which create noise in the marine environment.

11.176. The Navigation Risk and Safety Assessment that has been completed for this for this Development (Appendix 19.1) recommends that an application be made by SPR to the Scottish Government to designate the Development site an area of “No Fishing” and “No Diving”. This would displace current commercial fishing which is exclusively creeling (*Chapter 15: Commercial fisheries*) from the Development site. However, there is no evidence to suggest that the level of fishing displaced from the Development site will be displaced on a scale that would have any significant cumulative impact.

11.177. Current activities that may have an overlap with the Sound of Islay project are:

- Islay offshore Windfarm
- Argyll Array Wind farm;
- Kintyre territorial Wind farm; and
- Further port development at Port Askaig
- DP Energy proposed tidal turbine of west coast of Islay.

However it is unlikely that the construction phase of any of these projects will overlap with the construction phase of the current Development.

11.178. In the high energy, dispersive environment of the Sound, any temporary effects on the release of sediments into the water column associated with the tidal array are not expected to act in combination with these existing activities to result in cumulative impacts. Each of these activities is located at considerable distance from the study area and is therefore considered to be of **negligible** significance.

11.8 Summary

11.179. Table 11.16 summarises the findings of the impact assessment of Marine fish and shellfish resources

Table 11.16 Impact assessment summary

Impact	Construction				Operation and maintenance			
	Magnitude	Sensitivity/Value/ significance	impact	Residual impact	Magnitude	Sensitivity/Value/ significance	impact	Residual impact
Habitat disturbance of mollusc species	Low	Low	Negligible	Negligible				
Habitat disturbance of crustaceans	Low	Low	Negligible	No significant effect				
Loss of spawning grounds	Negligible	Negligible	No significant effect	No significant effect				
Loss of nursery grounds	Negligible	Negligible	No significant effect	No significant effect				
Noise and vibration on fin fish species	Low	Medium	Minor	Negligible/Minor				
Noise and vibration on shellfish species	Low	Low	Negligible	Negligible				
Increased turbidity effecting bivalves	Low	Low	Minor	Negligible				
Smothering of marine fish or shellfish	Low	Low	Negligible	Negligible				
Release of sediment bound contaminants	Low	Low	Negligible	Negligible				
Increase of available habitat					Low	Low	Negligible	Negligible
Noise impacts on fish and shellfish					Low	Medium	Minor	Negligible
Electromagnetic fields on fish and shellfish					Low	Low	Negligible	Negligible
Physical barriers to movement					Medium	Low	Minor	Minor
Collision risk					Medium	Low	Minor	Minor
Changes in water flow					Medium	Low	Minor (shellfish species) & Negligible (fish species)	Minor (shellfish species) & Negligible (fish species)

11.9 Conclusions

11.180. The construction methodology aims to minimise the significance of smothering effects on marine fish and shellfish. It is anticipated that the proposed development will have at worst **minor** effects on marine fish and shellfish resources with the main impacts being noise and vibration during construction and operation, along with the risks of turbines acting as a physical barrier to the movement of fish along the Sound of Islay and those associated with potential collision. Effective mitigation is not possible and so the significance of these effects remains as **minor** (when taking the “worst case scenario”).

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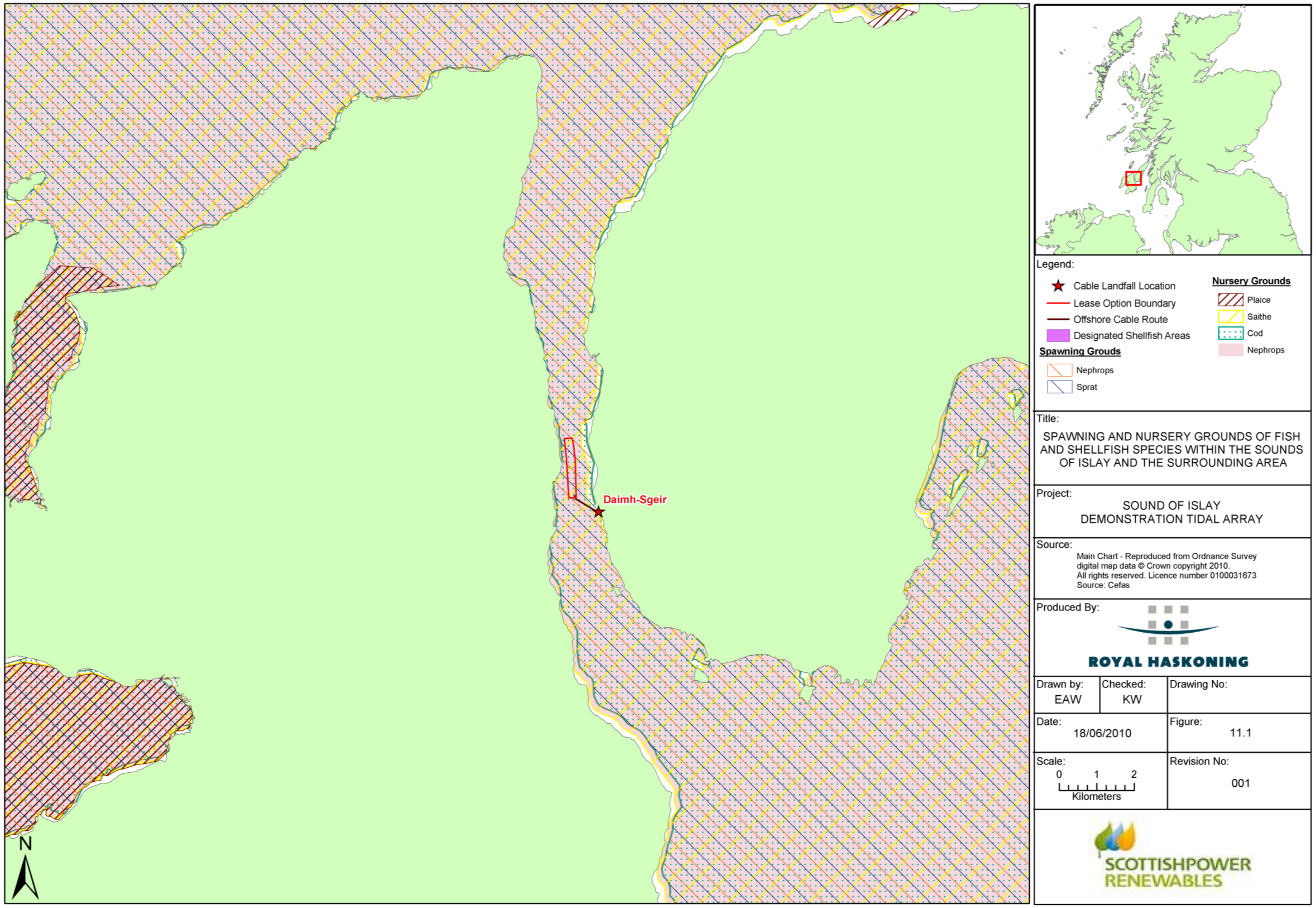

Figure 11.1 Spawning and Nursery grounds in the vicinity of the study area. Data Source: CEFAS

12.0 Anadromous Fish

12.1 Introduction

12.1 This Chapter of the Environmental Statement evaluates anadromous fish (also known as migratory fish), which are fish species that spend part of their life at sea, but migrate up rivers in order to breed. Baseline conditions with regard to migratory fish communities within the study area (as defined in Paragraph 12.12) are presented and the potential impacts relating to the construction, operational (including maintenance) and decommissioning phases of the Development are assessed. Mitigation measures are proposed where necessary and approaches to monitoring are discussed.

12.2 Several species of fish living in Scottish rivers migrate between the sea and the upper reaches of rivers during their life cycle. This chapter focuses on two of these species: the Atlantic salmon (*Salmo salar)* and sea trout (*Salmo trutta*) together being salmonids [1],which are known to occur in waters off the west coast of Scotland, and which are of commercial and recreational importance to the Argyll region. Throughout this chapter where the term salmonid is mentioned, it refers to these two species.

Summary of Anadromous Fish Chapter: There is little evidence suggesting that migratory fish use the Sound of Islay regularly or in any great numbers, and watercourses within the Sound show limited potential to support anadromous fish populations. All available information relevant to potential impacts of offshore renewables on migratory fish suggests that effects on such species are likely to be **negligible**.

12.2 Potential Effects

12.3 Migratory fish species can potentially be impacted in a number of ways by tidal array developments. These are outlined in the Scottish Marine Renewables SEA (Scottish Executive, 2007) and summarised below. Effects may result in behavioural changes or physiological impacts.

12.4 The main concern expressed by consultees during scoping and additional consultation (detailed later in this chapter) is any potential there might be for the Development to deter or delay salmonid migration of either returning adults or of smolts[2] leaving their natal river[3].

12.5 During installation, maintenance and decommissioning of the devices and cables, disturbance of species may occur as the result of the presence of installation vessels and equipment, and associated noise.

12.6 One of the most significant sources of noise during offshore wind farm installation is piling activity during construction (CEFAS, 2004). The tidal devices used within the Development will have gravity based foundations and neither pile driving nor pin piling will be required.

[1] Of, belonging to, or characteristic of the family Salmonidae, which includes the salmon, trout, and whitefish.
[2] Juvenile salmonids at the stage intermediate between the parr and the grilse, when it becomes covered with silvery scales and first migrates from fresh water to the sea.
[3] When the adult fish are ready to spawn, they return to the river in which they were born (natal river).

12.7 During operation of the Development, there may be potential for the array to act as a barrier to fish movements and migrations. Additionally, some species may also interact with the devices and there may be some risk of collision.

12.8 Other effects of primary concern are those associated with underwater noise and vibration generated by the devices and Electromagnetic Fields (EMF) generated by subsea cables.

12.3 Methodology

12.3.1. Legislation, Guidelines and Policy Framework

EIA Guidance

12.9 The European Marine Energy Centre (EMEC) has developed EIA guidance for wave and tidal energy developers seeking consent within the EMEC test site on Orkney. These guidelines give an overview of the potential impacts of marine energy development on fish resources, but do not discuss detailed EIA reporting requirements. The guidance suggests that the following potential effects on fish resources should be considered:

- Behavioural changes and altered well-being associated with noise, light and other disturbances;
- Changes in fish health resulting from release of contaminants; and
- Entrapment / collision with underwater devices.

12.10 There are no other specific EIA guidelines developed for tidal turbines. However, the guidelines developed for undertaking EIA in support of licensing of offshore wind farm developments under the Food and Environment Protection Act 1985 (FEPA) and the Coast Protection Act 1949 (CPA) by CEFAS (2004) are largely applicable.

12.11 The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) guidance states that there is potential for the construction, development and use of offshore wind farms (in this case tidal arrays) to adversely affect fish resources, and it details a number of factors an EIA should take into account when assessing impacts on those resources. This is considered further below.

12.12 The EIA should present information that describes fish resources within the “Development site” (which in this case is the lease boundary and cable route displayed in Figure 1.1) and in the context of the “wider area” (which in this case includes the Islands of both Islay and Jura and the waters that surround them). Only migratory fish species that are considered to be important to the “study area” (which for the purpose of this assessment is defined as the Sound of Islay and is displayed in Figure 15.12 *Chapter 15: Commercial Fisheries*) and the wider area are subject to an impact assessment. Important migratory fish and shellfish resources are considered to be those that are:

- Of significant importance to commercial and recreational fisheries;
- Of conservation importance;
- Sensitive to the potential effects of EMF; and / or
- Of restricted geographical distribution and are locally abundant in the area.

12.13 Migratory fish including salmonids would be considered important as a result of their conservation value.

12.14 For those resources identified as important, the following ecological aspects need to be considered:

- Spawning grounds;
- Nursery grounds;
- Migration routes; and
- Feeding grounds.

12.15 For migratory fish, such as salmonid species, it is anticipated that the key aspects to be considered for inshore waters in Scotland are potential impacts on migration routes and access to spawning grounds.

12.16 The CEFAS guidance acknowledges that where wind farm sites (in this case the Development) are in inshore waters, there may be the possibility of negative impacts on the migration routes of diadromous [4] fishes and other migratory species, particularly during construction, and that these impacts may need to be considered in EIA to address local concerns.

12.3.2. Appropriate Assessment Guidance

12.17 The principal aim of the European Habitats Directive 92/43/EEC (Habitats Directive) on the conservation of natural habitats and of wild fauna and flora is to sustain biodiversity through the conservation of natural habitats and wild flora and fauna in the territory of European Member States. These targets are principally being met through the establishment of nature conservation sites: Special Areas of Conservation (SACs). Designated SAC features include a number of fish species listed under Annex II of the Directive, namely sea lamprey; brook lamprey; river lamprey; allis shad; twaite shad; Atlantic salmon; spined loach; and, bullhead. An SAC may be designated on the basis of the presence of these species, and an objective of the designation will be to maintain or restore these species at a favourable conservation status.

12.18 The Habitats Directive requires that any plans or projects, whether inside or outside of the SAC, that are likely to have a significant effect on the conservation status of the site's features, shall be subject to Appropriate Assessment. Therefore, where a proposed tidal array is located within, or would be likely to significantly affect, a designated, proposed or candidate SAC, consenting authorities must ensure an Appropriate Assessment is carried out under the Habitats Directive. Where a proposed project does not fall within the boundaries of an SAC (as is the case for the Sound of Islay array) an Appropriate Assessment will only be required if it is considered (and fully justified) that a significant effect on the site is likely. It is the responsibility of the competent authority (Marine Scotland), with advice from the conservation agency (Scottish Natural Heritage), to determine whether a proposed project is likely to have a significant effect on an SAC. There are no SACs designated for migratory fish adjacent to, or in the wider area of, the proposed site.

12.3.3. Assessment Methods

Data Collection

12.19 The main sources of information used to establish baseline conditions were:

- Reports and information from the Argyll Fisheries Trust (Argyll Fisheries Trust, 2009);
- Technical reports and reviews produced in support of Strategic Environmental Assessments for offshore renewable energy in Scottish waters (Faber Maunsell, 2007);
- Results of a salmonid habitat survey undertaken in January 2010 (Appendix 12.1); and
- Stakeholder consultation (discussed below).

12.20 While the data sources listed above provide some information on the presence of salmon and sea trout in rivers in the wider region, there are no existing data relating to the use or importance of the study area as a migratory route for salmonids, or on the origin of any salmonids that may use the Sound.

12.21 No site-specific fish surveys have been undertaken across the Development site. The collection of such data is considered impractical in the extreme tidal conditions encountered in the Sound of Islay.

12.22 A precautionary approach has been taken for the purposes of this EIA, and it has accordingly been assumed that migratory fish species do make use of the waters in the Sound of Islay.

Consultation

12.23 Consultation with statutory bodies and key stakeholders was undertaken by ScottishPower Renewables (SPR) on the following scoping document: 'Proposed Demonstration Tidal Site, Sound of Islay, "Request for a Scoping Opinion" (ScottishPower Renewables, 2008).

12.24 Further consultation has been undertaken by SPR throughout the EIA process with the following stakeholders:

- Marine Scotland: Science (Freshwater Laboratory);
- Argyll Fisheries Trust;
- Argyll District Salmon Fisheries Board;
- Association of Rivers and Fisheries Trusts of Scotland; and
- Laggan and Sorn District Salmon Fisheries Board.

12.25 Concerns were raised by the above fisheries boards and trusts in relation to potential impacts of the proposed array on fish behaviour. In particular they queried the effects of noise, vibration and EMF[5] on salmonids. They also queried the extent to which the Development might act as a barrier to migration. The boards and trusts agreed that primary (fatalities) and secondary (injury) effects associated with the Development were not likely.

Impact Assessment

12.26 The broad methodology used for determining impact significance is outlined in *Chapter 2: Scoping and Assessment Methodology*. The significance of the impact is assessed on the basis of both the likelihood of a potential impact occurring, importance of the species, the magnitude of impact and the sensitivity of the receptor (in this case a fish resource) to that impact.

[4] Migratory between fresh and salt waters. Note: anadromous are also diadromous fish but anadromous refers to the fish migrating from the sea to fresh water to breed (e.g. salmon and sea trout).

[5] Power cables for transmitting electricity, such as those used to export electricity generated by tidal arrays, produce E and B fields when current passes through them. The B field is felt outside of the cable structure and this in turn induces a further E field (iE); studies have shown that EMF radiates beyond the cable into both seawater and the seabed.

12.27 Impact assessment is based on an assessment of the magnitude of the impact and the sensitivity of the receptor. The criteria used to determine the magnitude of likely impacts and sensitivity/importance/value are described below in Tables 12.1 and 12.2 respectively, while impacts have been assigned a level of significance of effect (from major to no significant effect) as defined in Table 12.3.

12.28 The definitions used for magnitude, and in the assignment of significance have drawn on detailed criteria for significance developed for the Scottish Marine Renewables SEA (Scottish Executive, 2007)

Table 12.1: Magnitude of impact on anadromous fish	
Magnitude of Impact	**Description of Magnitude**
High	▪ Prolonged / widespread disturbance to anadromous fish species, with long term or permanent effects on any or all of the following: spawning grounds; nursery grounds; migration routes; and / or feeding grounds.
Medium	▪ Short-term and localised disturbance to anadromous fish species, with temporary affects on : spawning grounds; nursery grounds; migration routes; and / or feeding grounds.
Low	▪ Detectable disturbance to: spawning grounds; nursery grounds; migration routes; and / or feeding grounds.
Negligible	▪ Imperceptible or no changes to: spawning grounds; nursery grounds; migration routes; and / or feeding grounds.

12.29 Table 12.2 provides a framework for assessing the sensitivity/value/importance of the receptor.

Table 12.2: Sensitivity/value/importance of anadromous fish	
Receptor Sensitivity/value/importance	**Description**
High	• Area designated for its ecological importance for anadromous fish species designated under Annex II of Habitats Directive or UK Biodiversity Action Plan (BAP) species within zone of influence of impact; and • Species is highly sensitive to impact under consideration;
Medium	• Area designated for its ecological importance for anadromous fish species designated under Annex II of Habitats Directive or UK Biodiversity Action Plan (BAP) species, within zone of influence of impact, and • Species has low to moderate sensitivity to impact under consideration; or • Area inhabited by anadromous fish species which are nationally rare; and • Species highly sensitive to impact considered;
Minor	• Non designated spawning grounds; nursery grounds; migration routes; and / or feeding grounds of common or widespread anadromous species are within the predicted zone of influence of impact; and • Species shows low to moderate sensitivity to impact considered.
Negligible	• No spawning grounds; nursery grounds; migration routes; and / or feeding grounds are within the predicted zone of influence of the impact.

12.30 Table 12.3 combines the assessment for the sensitivity/importance/value of the receptor (Table 12.1) with the potential impact magnitude (Table 12.2) to give an overall assessment of the environmental impact significance of effect. Further detail is provided within *Chapter 2: Scoping and Assessment Methodology*.

Table 12.3 Impact Prediction Matrix.				
Magnitude of Impact	**Receptor Sensitivity/value/importance**			
	Negligible	**Low**	**Medium**	**High**
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

12.4 Existing Environment

12.4.1 Regional Fish Resource

12.31 The diverse freshwater resource of mainland Argyll and the Islands sustain a variety of fish species and habitats that are an important part of the region's biodiversity. Fish resources also offer a range of fishery opportunities that have the potential to be a significant contributor to the local economy and recreational amenity (Argyll Fisheries Trust, 2009).

12.32 There are over 100 rivers in the Argyll region supporting migratory fish populations such as Atlantic salmon and/or sea trout. On the west coast of Scotland main rivers are located from the Awe northwards to Laxford, with a few on the Isle of Skye and some to the south on the Ayrshire and Dumfriesshire coasts (Faber Maunsell, 2007).

12.33 Migratory salmonid fish have formed the basis of the net as well as the rod and line fisheries resources in Argyll and the Islands. Historically these fisheries have been an important source of food and more recently employment and tourist related income for local communities. However, fishery catches of salmon and sea trout have decreased substantially over recent times, although cause(s) for this are unclear and contentious (Webb *et al*, 2009). Data collected by Marine Scotland (formerly Fisheries Research Services) indicate that the recorded numbers of Atlantic salmon landed in Argyll have declined from a peak of 12,000 fish in the early 1960s to less than 2,000 in recent years and this may reflect a wider decline in stocks reported for western Scotland (Webb et al, 2009). Similarly, the reported number of sea trout landed in Argyll has also declined significantly since the 1960s, although the decline in catches appeared to begin earlier in the 1970s compared to that of salmon.

12.34 Data also show that catches from rivers around the study area have historically accounted for a minimal proportion of overall catch volumes. Figures 12.1 and 12.2 provide an overview of catches, for salmon and sea trout respectively, for the Argyll area, with catches for Islay shown (Argyll Fisheries Trust, 2009).

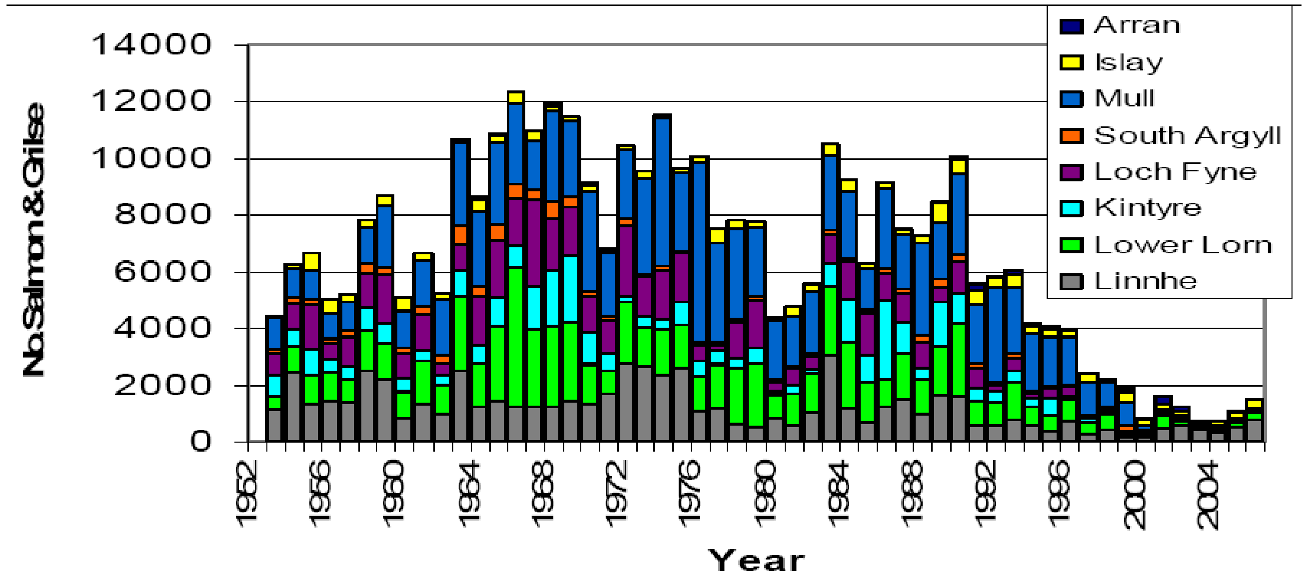

Figure 12.1 Trend in reported catches of Atlantic salmon (all methods). Source: Argyll Fisheries Trust, 2009.

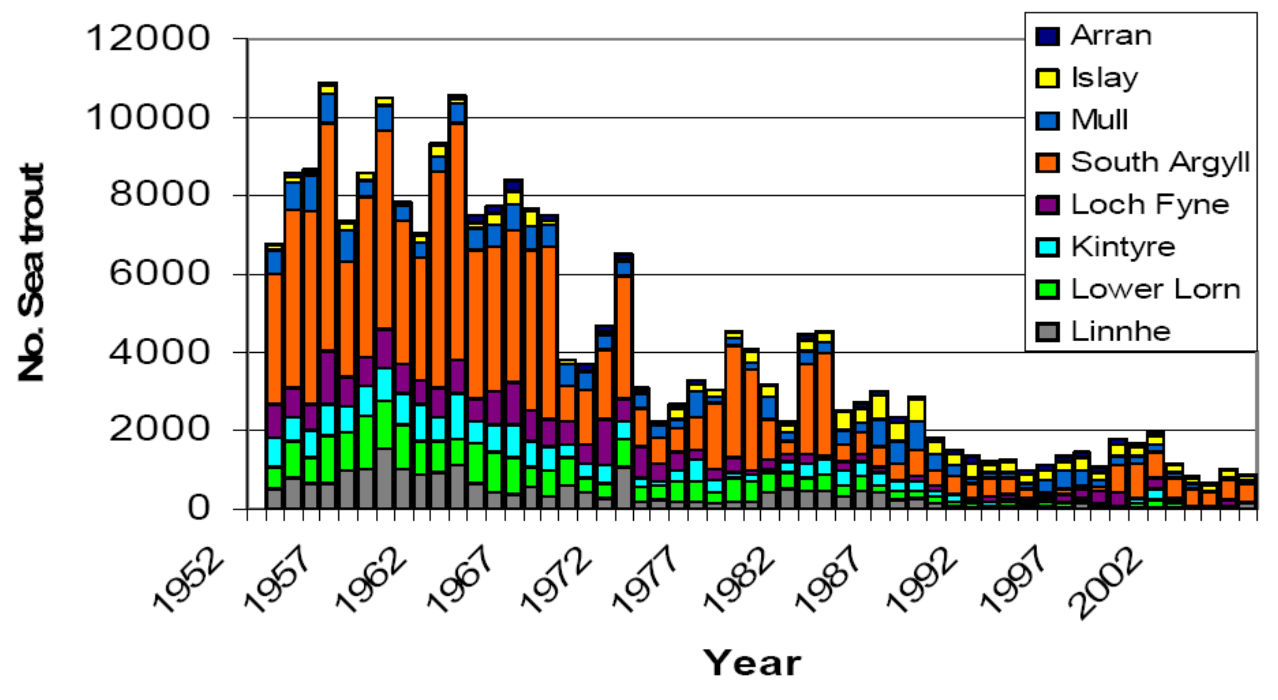

Figure 12.2 Trend in reported catches of sea trout (all methods). Source: Argyll Fisheries Trust, 2009.

12.35 There are no coastal salmonid net fisheries in the Study area. Locally fished catchments are shown in Figure 12.3. The primary catchments are the Laggan and Sorn on Islay (Laggan District) and the Lussa on Jura (Inner District). The Laggan and Sorn Rivers are the main salmon and sea trout fishing rivers proximate to the Development site, and are located on the west coast of Islay 56 and 66 km distant from the potential array, respectively. Catch data provided by Marine Scotland indicate that in 2008 156 salmon and 119 sea trout were caught by rod in the Laggan District, while in 2007 catch numbers were 74 and 147 respectively. Over the same period in the Inner District, 4 salmon and 41 sea trout were caught in 2008 and 1 salmon and 16 sea trout in 2007.

12.36 The Kintour River, on the east coast of Islay, 16km south of the Development site, is also fished although catch numbers are reported to be low (pers. comm. Malcolm Younger, Laggan and Sorn DSFB, July 2009).

12.37 No catch data are available for the smaller rivers and burns that run into the Sound of Islay. In support of this EIA, a salmonid habitat survey was carried out in January 2010 to examine the potential for the presence of salmonid species in the smaller rivers and burns adjacent to the Sound of Islay (four sites on the west coast of Jura and one on the east coast of Islay). The survey report is provided in Appendix 12.1. Salmonids have not previously been recorded in any of the five targeted rivers and the survey showed that impassable barriers (for example, waterfalls or other barriers where vertical sections are too high to allow passage) prevented the watercourses from being suitable for salmonid spawning. It is unlikely that any of the surveyed watercourses are accessible by salmonids.

12.38 There is no evidence, anecdotal or otherwise, available to suggest that salmonid fish migrate through the Sound of Islay.

12.5 Species Characteristics

12.5.1 Atlantic salmon

12.39 The Atlantic salmon is widespread throughout Scotland. The amount of time they spend in the coastal zone is limited and their distribution is dependent on the location of rivers suitable for spawning.

12.40 The adult fish may spawn in quite small headwater streams as well as in suitable areas in larger watercourses. The adult fish enter rivers from the sea at almost any time of year, but they migrate into smaller spawning streams on elevated flows following rainfall in the autumn (September – November). After spawning in October – December the adult fish return seawards over a period of up to several months.

12.41 The eggs are laid in areas of gravel where there is an adequate flow of water. After hatching, the young fish (known as fry) remain within the gravel for several weeks, eventually emerging in March to May. The fry disperse for distances of up to several hundred metres downstream. As the fish grow (known as parr at this stage) they redistribute themselves, generally downstream in direction. After 2 to 4 years the parr develop a silver colour and migrate seawards, usually in April to June. At this stage they are termed smolts. The survivors return to spawn after 1 to 3 years of feeding and growing in the sea (Scottish Executive, undated).

12.42 There is no information available which would indicate whether salmon pass through the Sound of Islay. Therefore, a precautionary approach has been taken and, for the purposes of impact assessment, it has been assumed that salmon do pass through the Sound during their migration. Therefore, although we have no direct evidence, based on migration timings, salmon might therefore be present in the Sound of Islay from April to June/July.

12.43 There is limited information pertaining to the at-sea migration of salmon. Smolts are believed to move offshore in schools to deep-sea feeding areas. While the best-known feeding locations are in the Norwegian Sea and the waters off Southwest Greenland, there are known to be many other sub-arctic feeding areas (Atlantic Salmon Trust website). The routes by which they depart from and return to natal rivers in the Argyll region is not known, but it is assumed that on their return they swim along the coast seeking olfactory cues that help identify the correct river (Lockwood, 2005).

12.44 Salmon tagging studies suggest that whilst at sea, salmon may travel throughout the water column, from near surface down to 600m depth (e.g. Sturlaugsson, undated). The complex near-shore directional patterns in the salmon movements remain poorly understood, and behaviour may be linked to a range of local environmental conditions such as tidal movements, diurnal rhythms, home river discharge, etc.

12.5.2 Sea Trout

12.45 The sea trout, the migratory form of the brown trout, has a life history very similar to that of the salmon. The main differences are that the sea trout may return to fresh water after only a few months at sea, and the adults are generally smaller than salmon (typically 25 to 60cm). The adults may also enter smaller spawning tributaries earlier than salmon, often penetrating to the upper headwaters during the summer. A higher proportion survive to spawn again than is the case for salmon (Scottish Executive, undated).

12.46 There is no information available which would indicate whether sea trout pass through the Sound of Islay. A precautionary approach has therefore been taken for the purposes of this impact assessment, and it has been assumed that sea trout do pass through the Sound during their migration.

12.47 As with salmon, little is known about the behaviour of sea trout whilst undertaking migration at sea although they are thought to generally remain in coastal areas, staying at sea for anything from a few weeks to more than two years (SNH, 2010).

12.5.3 Other Migratory Species

12.48 A number of other migratory species may occur in the waters off the west coast of Scotland, including lamprey species and eels. However, given their behavioural characteristics and ecological preferences, it is not likely that they would interact with the Development. Furthermore, these species have not been identified as being of local commercial importance during consultation. They are accordingly not considered further here, only salmonids are.

12.5.4 Fisheries Management

12.49 The fisheries of Argyll are managed by a mixture of fishery interests, ranging from angling clubs, individual and organised groups of owners in River & Loch Improvement Associations, to District Salmon Fishery Boards (DSFBs), which have statutory powers and responsibilities. Along with these local fishery interests, other parties with an interest in fisheries also contribute to the management process through representation on Argyll District Salmon Fishery Board and the Argyll Fisheries Trust.

12.50 Management of the Laggan and Sorn on Islay is overseen by the Laggan and Sorn DSFB. There is currently no DSFB overseeing management of the Lussa on Jura.

12.51 The Argyll Fisheries Trust has developed the “*Argyll & The Islands Strategic Fishery Management Plan”* (Argyll Fisheries Trust, 2009). This plan seeks to provide a framework for the strategic approach to improving management and regeneration of the local fish resource. The plan is to engage all stakeholders into the on-going process of management with an aim to conserve and restore all native fish populations and their habitats in Argyll and the Islands for the benefit of local biodiversity and the fisheries resource.

12.6 Impact Assessment

Do Nothing Scenario

12.52 It is not possible to accurately predict the future status of anadromous fish populations under a ‘do nothing scenario’. Aside from the fact that we cannot be certain to what extent Atlantic salmon and sea trout use the study area, if at all, there are other considerations. For example, Scottish Atlantic salmon do not constitute a single population whose fortunes can be summarised in a single trend line. Neighbouring tributaries may vary independently due to a wide range of pressures that differ among locations and with time. Such pressures include habitat change, predation and targeted fisheries. In addition, tributaries may contain genetically distinct populations, which may respond differently to some or all of these pressures (Eatherley *et. al.*, 2005).

12.53 However, there is currently no reason to expect a dramatic change in status of migratory fish populations under a ‘do nothing scenario’. However, as the reasons for the apparent decline in populations of salmonids on the west coast of Scotland is uncertain, there is clearly potential for this reduction to continue. However there is potential for the decline to cease or for the trend to be reversed and populations increase

12.3.4. Potential Impacts during Construction phase

Impact 12.1: Impacts due to noise and vibration

12.54 An assessment of underwater noise within the study area (SAMS, 2009) concluded that high levels of background noise currently exist there. It was also concluded that it was “*unlikely that the turbine devices would represent a significant source of sound pollution within the area*”. A summary of this report can be found in *Chapter 9: Marine Mammals*.

12.55 The main activities related to the construction of the Development with the potential to cause an impact are cable laying and placement of the turbines, as well as associated vessel movements. These activities are discussed in more detail in *Chapter 5: Project Description*.

12.56 In terms of offshore renewable energy development, pile driving of turbine foundations is typically considered to be the main cause for concern due to the high sound pressure levels and broad band noise generated (Nedwell and Howell, 2004). Studies investigating the effects of noise and vibration on fish have accordingly focused on the effects of piling-associated noise and vibration. There will not be any requirement for piling during installation of the tidal array.

12.57 Studies relating to the effects of noise and vibration on fish have focused on hearing-sensitive species. The hearing ability of fish varies greatly across species types, though both Atlantic salmon and sea trout are considered to have insensitive hearing and are adapted to living in coastal, shallow water environments in which background noise levels are relatively high (Parvin *et al*, 2005; Nedwell *et al*, 2004). To place their hearing ability in some context, a number of marine fish species that may be encountered in the Sound of Islay, including herring, cod and mackerel, are considered to have a greater hearing sensitivity than salmon or trout (Nedwell *et al.*, 2004). Cod and herring have typically been the fish species referenced in studies examining noise effects on fish, and are considered in *Chapter 11: Marine Fish and Shellfish Resources*, as they are not anadromous fish.

12.58 According to Vella *et al.* (2001) the sensitivity of species to noise and vibration is dependent on:

- The audible threshold;
- The presence of a swim bladder and its size and physical coupling to the ear;
- The resonance frequency of the otolith system; and
- Behavioural factors, such as aggregation or shoaling behaviour.

12.59 The effects of noise on fish can be divided into the following categories (Hastings and Popper, 2005):

- Lethality and physical injury;
- Traumatic hearing damage (i.e. temporary and permanent hearing loss); and
- Behavioural responses and masking of biologically relevant sounds.

12.60 Studies and data relating to the effects of non-piling offshore wind farm construction noise on fish are reviewed by Nedwell *et al.* (2004). Available information is limited; a summary of relevant findings is presented below.

Vessel Activity

12.61 During construction, small and large vessel support will be required. Vessels which are likely to be present during the installation of the Development include a small Rigid Inflatable Boat (RIB) to transfer crew from one vessel to another, large construction support Barges (Dumb Barges) and a heavy lift dynamic positioning vessel. All these will create underwater noise in the vicinity of the Development adding to the general level of vessel and machinery noise from existing shipping. Boat noise is predominantly propeller noise, except when operating at very low speeds where hull radiated noise dominates. During the Development construction, both propeller noise from small boats or ships underway and hull radiated noise from stationary vessels conducting works may be significant sources.

12.62 A set of noise measurements were taken of major construction works at a large ferry terminal in Southampton docks during September 2003. The objective of the measurements was to monitor pile driving, but during construction down time they gave an insight into sound levels in a busy port. The study also involved the monitoring of caged brown trout (a salmonid species), observed to detect any behavioural changes associated with noise levels. The result of double blind analysis of the caged fish video recordings showed no significant behavioural reactions during the course of the survey. Thus, for brown trout (and therefore for sea trout, which is the same species), these measurements show that an increase in vessel traffic is unlikely to create significant behavioural changes (Nedwell *et al.*, 2003).

Gravity Based Support Sub-Structure Installation

12.63 The turbines within the Development site each consist of a pre-fabricated tripod foundation that is either floated out to the array location or carried on a heavy lift vessel. The structure will be filled with either sand or a fluid so that it sinks to the seafloor where it is secured using additional weights (approximately 150t per foot). The turbine nacelle is then fixed to the structure.

12.64 No known underwater noise measurements have been made of gravity support structure installation, and no behavioural observations have been made.

Armouring

12.65 A large amount of cable (approximately 5km) will be installed as part of the Development both, as interconnections between the individual devices and cables to the shore based substation. To protect the cables from damage they will be armoured.

12.66 No measurements of shallow water armoured cable laying noise have been published; however, they are not thought to be likely to be significant.

12.67 There is limited available information concerning the potential effects of noise and vibration on salmonid fish species during the installation of gravity based structures. However, on the basis of impact assessments and literature relating to offshore wind farms, it is clear that the main concern in terms of effects on fish relates to noise and vibration associated with piling, which will not be required at the Development site.

12.68 Salmonids are not considered to be particularly sensitive to the effects of noise and vibration given that they are not a hearing-sensitive fish species. In addition, no known migratory routes or spawning grounds are known to exist within the study area, suggesting that sensitivity can be categorised as minor. There is no evidence of significant salmonid presence in the Sound; however, if these are assumed to be present, construction-related noise and vibration will be temporary and short-lived. If present, salmonids will only encounter noise impacts between April and July and not during the full period of possible migratory movement. It is assumed that some detectable disturbance may occur; however, the magnitude of this will be low. On the basis of minor sensitivity and low magnitude, any impact is assessed as being of **negligible** significant effect for noise and vibration on salmonids.

MITIGATION IN RELATION TO IMPACT 12.1
• No mitigation required.

Residual Impact

12.69 As no mitigation is required, any impact is predicted to remain of **negligible** significant effect.

Impact 12.2: Impacts due to increased suspended sediment concentration, turbidity and smothering

12.70 Activities related to the construction of the Development, such as cable laying, may result in a temporary increase in turbidity through sediment re-suspension (OSPAR, 2004). However, these effects will be short-term and affect localised areas during construction with suspended sediment re-settling soon after works stop in a given place. Coarser sediment fractions (which are the dominant fractions in the area of the proposed array) are likely to be re-deposited on the seabed within about 50m of the works (Scottish Executive, 2007).

12.71 Increases in suspended sediment and turbidity are unlikely to be significant across the Development site (*Chapter 7: Physical Environment and Coastal Processes*). Given the coarse nature of the seabed substrate and the high energy tidal conditions, it is expected that little material will be put into suspension during construction works, and what does enter suspension will be rapidly dispersed.

12.72 Increases in suspended sediment concentrations and turbidity can have effects on foraging, social and predator/prey interactions (Faber Maunsell, 2007). However, sensitivity assessments presented in the Scottish Marine Renewables SEA indicate that salmonids are not considered to be sensitive to the impacts of increased suspended sediment concentrations or smothering (Scottish Executive, 2007).

12.73 There are no known migratory routes or spawning grounds which could potentially be affected by the limited potential for disturbed sediment. In addition, salmonids are not thought to be particularly sensitive to increased sediment, suggesting a minor or negligible sensitivity to this impact. The localised nature of any potential sediment suspension suggests that the magnitude of impact from suspended sediment will be low or negligible. Minor or low sensitivity combined with low or negligible magnitude leads to an assessment of **negligible** significance or **no significant** effect.

MITIGATION IN RELATION TO IMPACT 12.2
• No mitigation required; however, contractors will adhere to good construction practice guidance (e.g. CIRIA guidance, SEPA Pollution Prevention Guidelines).

Residual Impact

12.74 As no mitigation is required, and in light of the seabed conditions in the study area (i.e. coarse sediments, fast currents), the significance of effect is expected to remain **no significant** effect in relation to changes in suspended sediments.

Impact 12.3: Impacts due to the release of sediment bound contaminants

12.75 Disturbance of contaminated sediments during device and cable installation could cause potentially detrimental impacts on species that are sensitive to contamination. However, there is no reason to expect seabed sediments present across the Development site or cable route to be contaminated. The coarse nature of the sediment present, lack of significant historic or ongoing industrial activity, absence of fine sediments which could contain such contaminants and the highly dispersive nature of the site all contribute to this conclusion.

12.76 There is no evidence to suggest that sediments within the study area are contaminated and consequentially magnitude of impact from this source is considered to be negligible. Sensitivity is considered to be minor or negligible as a result of the limited presence of salmonid species in the Sound and the absence of evidence of effects on migratory or spawning routes. Consequently **no significant** effect or **negligible** significance is predicted. The impacts of sediment quality are discussed in further detail in *Chapter 21: Water and Sediment Quality*.

MITIGATION IN RELATION TO IMPACT 12.3
• No mitigation required; however, contractors will adhere to good construction practice guidance (e.g. CIRIA guidance, SEPA Pollution Prevention Guidelines).

Residual Impact

12.77 As no mitigation is required, **no significant** effect or **negligible** significance is predicted to remain the case.

12.6 2. Potential impacts during Operation phase

Impact 12.4 Impacts due to noise and vibration

12.78 During the operational phase of the Development the main source of underwater noise will be from the rotation of the turbine rotors and vibration mechanically generated from the turbines, which will be transmitted into the sea.

12.79 No existing studies have considered the noise and vibration effects of an operational tidal array on fish species and the most relevant data comes from assessments of the noise effects of offshore wind farm turbines. Table 12.4 summarises existing information relating to the effects of operational noise (from offshore wind farm turbines and other marine renewable devices) on fish.

Table 12.4: Information regarding operational noise effects on fish.

Location / Project	Species Present / Considered	Research Approach	Key Findings	Any significant effect on salmonids?
Scottish Marine Renewables SEA, Chapter 17 (Faber Maunsell and Metoc, 2007)	Atlantic salmon	Desk-based literature review and specialist study (QinetiQ, 2007)	Assesses the potential noise impacts of operational tidal and wave arrays (based on available field noise measurements from MCT and Pelamis and assumptions regarding array layout). For assessment detail please refer to the document, but in summary, fish would need to be in close proximity to the devices over a long period of time (several hours) for a significant impact to occur.	**NEGLIGIBLE**
Effects of offshore wind farm noise on marine mammals and fish (Thomsen *et.al*., 2006)	Atlantic salmon	Field noise measurement (of a single 1.5MW wind turbine) and desk-based literature review	The operational noise of wind turbines will ‘probably’ be detectable up to a distance of 1km for salmon. Within this zone, masking of communication and behavioural and/or physiological (stress) effects are possible – however, they should be restricted to very close range. Based on present knowledge, it is ‘highly unlikely’ that sound levels during wind turbine operation will cause physical damage to fish fauna.	**NEGLIGIBLE** (tertiary only)
Gwynt y Mor Offshore Wind Farm Environmental Statement (npower Renewables, 2005)	Salmonids and eels	Desk-based literature review and modelling	Effects of turbine operational noise on fish were considered. The distance at which turbine noise falls below background noise levels (and therefore undetectable by fish) is predicted to be 4m for hearing specialist fish, including salmon. Levels of predicted operational noise were found to be insufficient to cause avoidance reactions (including changes in migratory routes), permanent hearing damage, or impairment of prey detection in fish species (including salmon, sea trout and eels). Evidence of fish aggregation around current operational offshore wind farms (e.g. Horns Rev, Svante, North Hoyle) indicates that structures can act as fish attraction devices.	**NEGLIGIBLE**
Beatrice Offshore Wind Farm Environmental Statement (Talisman Energy, 2005)	Atlantic salmon	Desk-based literature review and modelling	The EIA focused on those activities which may produce noises loud enough to result in an animal displaying a ‘strong avoidance reaction’ or cause a temporary change in hearing ability. Noise above 90 dB taken as threshold. Potential effects of turbine operation are considered based on published data on source noise levels from operating wind farms (reviewed by Nedwell & Howell, 2004). The ES states that ‘If the underwater noise from the operating Wind Turbine Generators is of a low frequency range, it would essentially not be detectable by bottlenose dolphin, harbour porpoise, common seal or salmon.’	**NO SIGNIFICANT EFFECT**

12.80 There is no evidence to suggest that operational noise associated with individual tidal turbines would cause any long-term effect on salmonids.

12.81 A technical underwater noise assessment commissioned by SPR for the Sound of Islay (SAMS, 2010 – Appendix 9.4) concluded that natural sound levels within the study area are substantially higher than would be encountered in open ocean environments for equivalent weather conditions. As such, the acoustic footprint of the Development is likely to be small in the context of a ‘noisy’ background. If placed in areas of high acoustic intensity then their outputs will not exceed the ambient background noise levels. If placed in quieter regions then their sphere of acoustic impact will be in the order of tens to the low hundreds of meters.

12.82 Studies detailed earlier in this chapter considered the effects of noise from piling and from vessel traffic (Nedwell *et al.*, 2003) and concluded that the brown trout (and by definition sea trout, which is the same species) are not sensitive to significant noise impacts. The hearing of salmon is also poor with narrow frequency span, poor power to discriminate signals from noise, and low overall sensitivity (Hawkins and Johnstone 1978; referenced in Thomsen *et al*, 2006).

12.83 Although there is no evidence of salmonid use of the study area, they have been assumed to be present for the purposes of this assessment. In the context of the natural background noise within the Sound, the noise generated by the Development is unlikely to be detectable to salmonids and the potential magnitude of impact is considered to be low. The absence of designated areas of importance for salmonids and the low sensitivity of salmonids to noise suggest a minor or low sensitivity. Minor or low sensitivity and low magnitude leads to an assessment of potential impact significance of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 12.4
• No mitigation required

Residual Impact

12.84 Any impact is predicted to remain of **negligible** significance.

Impact 12.5: Impacts of electromagnetic fields (EMFs)

12.85 The University of Liverpool Centre for Marine and Coastal Studies and Cranfield University (CMACS, 2003; Gill *et al.*, 2005) have undertaken studies, funded through COWRIE, to investigate electromagnetic field (EMF) emission from typical offshore subsea cables, in the context of the electric (E) and magnetic (B) fields. Studies have been largely been driven by the need to consider the effects of EMF resulting from offshore wind farm subsea cabling.

12.86 Desk-based, laboratory and field studies have been undertaken in the course of this research. However, it is still generally considered that the current state of knowledge regarding the EMF emitted by subsea power cables is too variable and inconclusive to make and informed assessment of any possible environmental impact of EMF (CMACS, 2003).

12.87 The first report of the COWRIE EMF study (Gill *et al*, 2005) made the following findings:

- There is no direct generation of an E-field outside of the cable;
- B-fields generated by the cable created ‘induced’ E-fields (iE) outside of the cable, irrespective of shielding;
- B-fields are present in close proximity to the cable and the sediment type in which a cable is buried has no effect on the magnitude of the B-field generated;
- The magnitude of the B-field within millimeters of the cable, referred to as its ‘skin’, is approximately 1.6µT, which will be superimposed on any other B-fields in the surrounding area (e.g. the Earth’s geomagnetic field of 50 µT); and
- The magnitude of the B-field associated with the cable falls to background levels within 20m.

12.88 The major group of organisms that are known to detect EMF are the elasmobranchs (sharks, skates and rays), although diadromous species have also been found to respond to iE and B fields (COWRIE, 2005), as summarised in Table 12. 5. Open water species, including salmonids, are not considered to be as reliant on this sense, and are therefore considered to be significantly less sensitive than elasmobranchs to EMF (Faber Maunsell, 2007).

12.89 Encounters with a B-field may cause behavioural changes such as a change in swimming direction. However, the type of cable likely to be used at the array will reduce B-field emissions to well below the magnitude of the Earth’s geomagnetic field.

12.90 Table 12. 5 summarises the findings of available research relating to migratory fish species and EMF. Reference is made to a number of offshore wind farm sites, where subsea cable specifications are likely to be similar to those associated with the Sound of Islay tidal development. A much wider body of research is available relating to elasmobranch species, but this is not considered here (see *Chapter 13: Elasmobranchs*).

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Table 12.5: Evidence of EMF effects on fish.				
Location / Project	**Species Present / Considered**	**Research Approach**	**Key Findings**	**Any significant effect on salmonids?**
COWRIE research (primarily COWRIE, 2005)	Atlantic salmon Sea trout European eel Sea lamprey European river lamprey	Desk-based literature review (later mesocosm studies didn't include teleost fish)	The Collaborative Offshore Wind Research into the Environment (COWRIE) programme has sponsored a significant volume of EMF research. A particularly useful study was published in 2005, which reviewed the findings of all available Round 1 and Round 2 offshore wind farm data relating to EMF effects. In total 10 offshore wind farm Environmental Statements and 6 scoping reports were reviewed. None of the reviewed documents considered that EMF would adversely affect salmonids or eels (because the species were not present across the site / because EMF emissions were not significant – due to cable design or burial / because species were not considered sensitive to EMF). The study reports on ongoing or planned environmental monitoring at operational wind farms (North Hoyle, Robin Rigg and Lynn & Inner Dowsing). Monitoring of EMF is focused on effects on elasmobranchs and does not make specific reference to salmonids or eels. The study draws no firm conclusion regarding the effects of EMF on salmonids or eels. It acknowledges that information available on magnetosensitive species is limited, though points out that potential interaction with B fields could occur.	**NO SIGNIFICANT EFFECT**
Scottish Marine SEA (Faber Maunsell & Metoc, 2007)	Atlantic salmon Sea trout European eel	Desk-based literature review	Whilst they are at sea, salmon and trout are likely to be present in the main water column and therefore would be unlikely to come into close contact with the magnetic field of any cable. 'Atlantic salmon, eels and sea trout are believed to be sensitive to magnetic fields. However, evidence from existing cables indicates that navigation and migration in these species is unlikely to be affected by the magnetic field produced by the operation of wave and tidal devices.' 'Marine teleost fishes do not react to electric field strengths of less than 6 V/m (several orders of magnitude greater than the estimated field strength from the inter array and export cables for the proposed Development. No impacts are expected.'	**NO SIGNIFICANT EFFECT**
Burbo Offshore Wind Farm – Electromagnetic Fields and Marine Ecology (2007)	Migratory teleosts and eels	Desk-based literature review (prepared as response to FEPA licence conditions)	Reports that on the basis of available information, a negligible impact due to magnetic field effects on magnetically sensitive species such as migratory teleosts and eels was predicted in the Burbo Offshore Wind Farm EIA because of the localised and low-level magnetic field (very much smaller than the background geomagnetic field) and over-riding importance of olfaction (smell) for salmonids navigating coastal waters'. However, the environmental monitoring programme to be implemented during and post-construction will include monitoring of all potentially impacted species, should this be required.	**NO SIGNIFICANT EFFECT**
Beatrice Offshore Wind Farm Environmental Statement (Talisman Energy, 2005)	Atlantic salmon	Desk-based literature review	The ES reviews factors considered to be relevant to salmon migratory movements (e.g. water salinity and temperature, the olfactory senses of salmon, etc. as well as E and B fields). The degree to which migrating salmon rely on E and B fields compared to other olfactory and physical stimuli is not known. On the basis of a review of other UK offshore wind farm ESs, it is concluded that 'there is a general consensus that the EMF likely to be present around a wind farm development will not have a significant environmental impact'.	**NO SIGNIFICANT EFFECT**
Gwynt y Mor Offshore Wind Farm Environmental Statement (npower Renewables, 2005)	Salmonids and eels	Desk-based literature review	'The potential impacts on migratory species and other teleost fish species are considered to be of negligible to low significance. This is due to the low significance of magnetic cues in their behaviour in coastal waters and the limited spatial extent of the predicted EMF arising from the Gwynt y Mor cabling'. Note that cable burial was assumed to play a role in significantly reducing EMF. Emissions from unburied cables were not considered.	**NO SIGNIFICANT EFFECT**

12.91 On the basis of available evidence (i.e. the known EMF emissions from cables and the known responses of marine teleost fish to electric field strengths) there is no reason to expect significant impacts of EMF on migratory fish species in the study area.

12.92 The magnitude of the potential impact due to EMF is considered to be low as a result of the limited evidence for use of the study area by salmonids and the localised scale of the potential impact. The sensitivity of salmonids is considered to be minor due to the absence of areas of importance to salmonids and no evidence of effects of EMF on salmonids. Based on these criteria the impact significance due to EMF, on salmonid species, is currently considered to be of **negligible** significant effect.

MITIGATION IN RELATION TO IMPACT 12.5
• No mitigation is required.

Residual Impact

12.93 As no mitigation is required, impacts are expected to remain of **negligible** significant effect.

Impact 12.6 Impacts of barriers to movement

12.94 Any barrier effect would be most likely to be felt by mobile fish species which frequently transit through the study area. The Sound of Islay is not known to support any particular fish transit or migratory movements.

12.95 As detailed in previous sections, salmonid species are not believed to be sensitive to noise and vibration, or EMF, the two main mechanisms via which the array could be perceived as a barrier.

12.96 The tidal devices will be placed in deep water (~50>48 m) on the seabed. With a blade diameter of 23 m there will be at least 14.5 m between the tip of the blade and the surface of the water at Lowest Astronomical Tide. It is estimated that the maximum cross section of device rotors will amount to less than 1% of the estimated cross section of the Sound. This assumes a worse case scenario of devices deployed side by side across the Sound presenting the maximum theoretical cross section to the movement of water, while approximating the cross section of the Sound based on an average depth of 45m and width of 1km. It is also assumed that each rotor presents a solid circular barrier – rather than a slow moving obstacle, occupying only a fraction of its theoretical cross section at any time.

12.97 There is no evidence to indicate that salmonids use the study area as a migration route; however, it is assumed that some use of the Sound for this purpose does occur. Additionally, it is not anticipated that the array will be perceived by salmonid species as a barrier. If this assumption were to prove to be incorrect, the array will occupy only a small fraction of the potential area of the Sound, leaving the majority of the Sound available for migration.

12.98 The magnitude of impact is assessed as low to negligible based on the limited evidence of use of the Sound and limited potential scale of effect. Sensitivity is considered to be minor because of the absence of known areas of importance to salmonid species and lack of evidence of potential for barrier effects. Based upon this assessment significance of this potential effect is considered to be **negligible** to **no significant effect**.

MITIGATION IN RELATION TO IMPACT 12.6
• No mitigation required.

Residual Impact

12.99 As no mitigation is required, impacts will remain **negligible** or **no significant effect**.

Impact 12.7: Impacts of collision risk

12.100 Collision risk with rotating turbines is considered to be a key potential effect during device operation (Faber Maunsell, 2007). A collision in this context is understood to be an interaction between a marine vertebrate and a marine renewable energy device that may result in a physical injury (however slight) to the organism. A collision may therefore involve actual physical contact between the organism and device or an interaction with its pressure field.

12.101 The Scottish Executive commissioned a study which investigated collision risk between marine renewable energy devices and fish to support the Scottish Marine Renewables SEA (Wilson *et al*., 2007). The study identified the following:

- Collision risks are not well understood for any marine vertebrates;
- Underwater collision risks typically become well studied only after they have become a conservation concern;
- Animals may appear to behave illogically when faced with novel situations;
- Subtleties of gear design (shape, colour, etc.) as well as environmental conditions (turbidity, flow rate, etc.) can markedly change collision rates;
- Objects in the water column will naturally attract fish and their predators;
- The proximity and relative orientation to other objects will impact escape options and the combined collision risk while topography will impact escape options and animal approach angles;
- Collision risk will vary with age of organisms, with juveniles likely to be more at risk than adults because of reduced abilities or experience; and
- The potential for animals to escape collisions with marine renewable devices will depend on their body size, social behaviour (especially schooling), foraging tactics, curiosity, habitat use, underwater agility and sensory capabilities.

12.102 The study conducted by Wilson *et al*. (2007), using herring as an example of a species that may be at risk of collision, and simplistically modelled potential encounter rates between 100 horizontal axis 8m radius turbines operating off the Scottish coast and existing populations of herring. The model predicted that in a year of operation, 2% of the herring population could encounter a rotating blade. It is important to note that encounters are not collisions and no account was taken of the potential for fish species to actively avoid obstacles. In addition, the movement of species throughout the full water column is also assumed by Wilson’s model, when in reality many species will have preferences for discrete parts of the water column.

12.103 Based on the small and limited cross section of the Sound potentially occupied by the turbine array, the slow moving nature of the turbine rotors, the ability of salmonid fish to both actively avoid predators and hunt prey, as well as limited evidence of salmonid species using the Sound as a migration route, the magnitude of the potential impact on migratory fish is considered low. No areas of sensitivity for salmonids are present and their sensitivity to collision is considered to be minor. Based on this assessment, significance of potential effects due to collision are considered **negligible.**

MITIGATION IN RELATION TO IMPACT 12.6
• No mitigation is required

Residual Impact

12.104 As no mitigation is required, impacts are expected to remain of **negligible** significant effect.

12.3.5. Potential Impacts during decommissioning phase

12.105 The impacts produced during decommissioning are expected to be, at worst, of the same nature, magnitude and significance as those during the construction phase.

12.7 Cumulative Impacts

12.106 The principal offshore activities which could result in in-combination effects with the Sound of Islay Development are commercial fisheries and marine traffic, both of which create noise in the marine environment. The natural background noise within the Sound is considerable (Appendix 9.4) and during periods of peak flow the noise generated by the devices is not predicted to rise above background levels.

12.8 Summary

12.107 Table 12.6 below summarises the findings of significance of effect of the impact assessment of anadromous fish

Table 12.6: Impact assessment summary								
	Construction/Decommissioning				Operation and maintenance			
Impact	**Magnitude of Impact**	**Sensitivity/Value/ Importance of Receptor**	**Significance of effect**	**Residual impact**	**Magnitude of impact**	**Sensitivity/Value/ Importance of Receptor**	**Significance of effect**	**Residual impact**
Noise and vibration	Low	Minor	Negligible	Negligible	Low	Minor / Low	Negligible	Negligible
Suspended sediment	Low/Negligible	Minor/Low	Negligible / No Significant effect	Negligible / No Significant Effect				
Sediment Contamination	Negligible	Minor / Negligible	Negligible / No Significant effect	Negligible/No Significant Effect				
EMF					Low	Minor	Negligible	Negligible
Barrier					Low / Negligible	Minor	Negligible / No Significant Effect	Negligible / No Significant Effect
Collision					Low	Minor	Negligible	Negligible

12.9 Conclusions

12.108 There is no evidence to suggest that anadromous fish use or transit the waters of the Sound of Islay. Furthermore, a recent survey has shown that watercourses on Islay and Jura adjacent to the array site show very limited potential to support anadromous fish populations.

12.109 In the absence of data for the Development site, a precautionary approach to assessment has been taken, and it has been assumed that migratory fish species do make use of the Sound. However, the Sound is not considered to be a site of particular importance for anadromous fish.

12.110 Few studies have considered specifically the effects of offshore renewables installations on anadromous fish species. Available information has been reviewed and indicates that any effects on such species would be of **negligible** significant effect.

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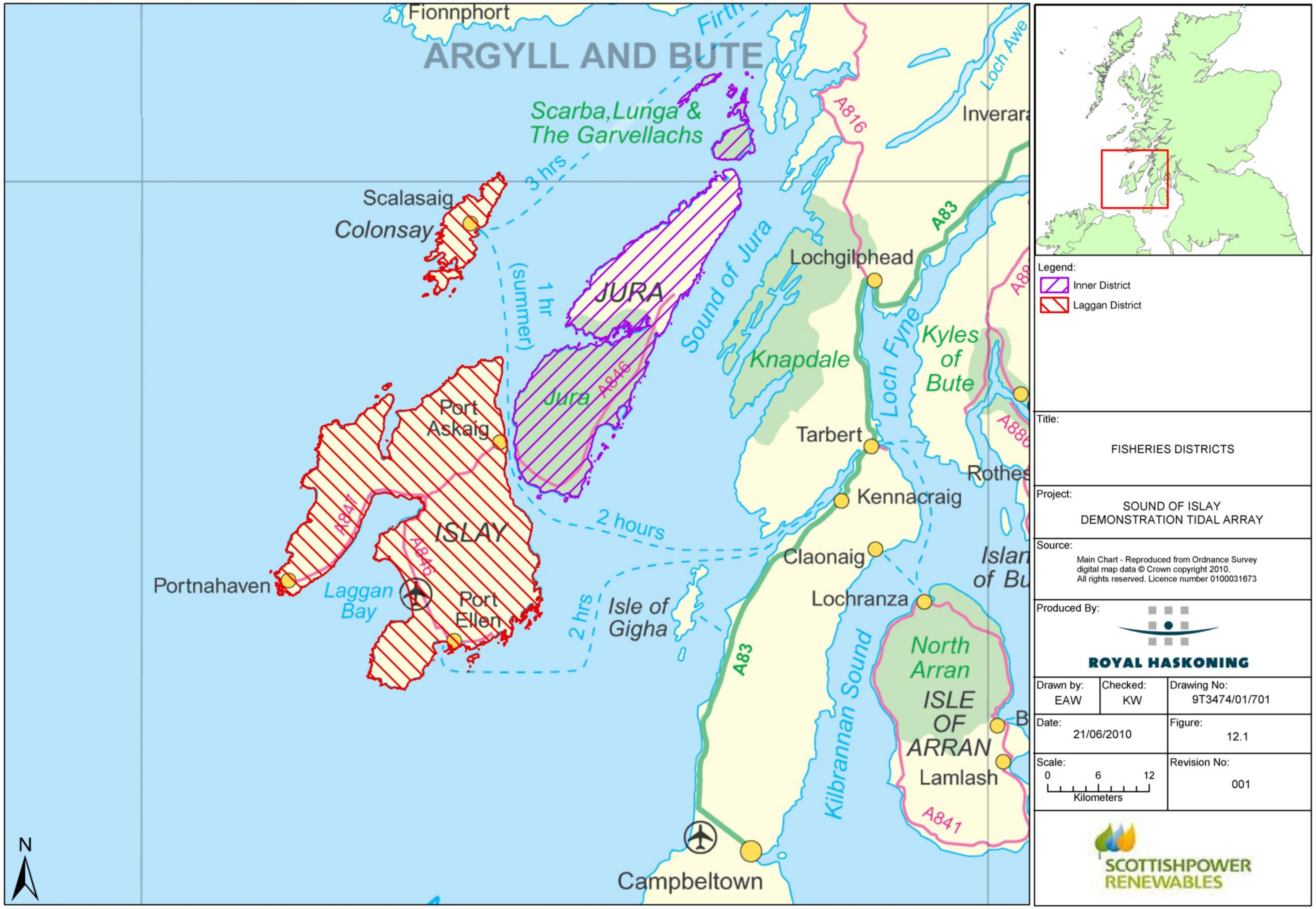

Figure 12.3 Relevant fisheries districts. Source: Argyll Fisheries Trust, 2009.

13.0 Elasmobranchs

13.1 Introduction

13.1. This section of the Environmental Statement considers the likely presence of elasmobranch species (sharks, rays and skates) within the Development. Baseline conditions with regard to elasmobranch communities are presented and the potential impacts relating to the construction, operational and decommissioning phases of the array are assessed. Mitigation measures are proposed where necessary and approaches to monitoring are discussed.

13.2. Elasmobranchs are considered separately here as they have unique characteristics, with different levels of sensitivity to the potential impacts compared to fish and other receptors. Fish resource, benthic habitats, commercial fisheries and ornithology are intrinsically linked and section should be read in conjunction with *Chapter 8: Benthic Ecology*, *Chapter 11: Marine Fish and Shellfish Resources*, *Chapter 14: Ornithology* and *Chapter 15: Commercial Fisheries* in order to gain a full overview of baseline conditions and potential impacts.

13.3. Elasmobranch species which have been recorded or are expected to be found in and around the Sound of Islay include:

- *Cetorhinus maximus* basking shark;
- *Lamna nasus* porbeagle shark;
- *Galeorhinus galeus* tope;
- *Squalus acanthias* spurdog;
- *Scyliorhinus canicula* lesser spotted dogfish;
- *Isurus oxyrinchus* shortfin mako;
- *Prionace glauca* blue shark;
- *Scyliorhinus stellaris* nurse hound;
- *Raja naevus* cuckoo ray;
- *Raja montagui* spotted ray;
- *Raja clavata* thornback ray; and
- *Dipturus batis* common skate.

Summary of Impact on Elasmobranchs:

The Sound of Islay is not believed to be an important area for elasmobranchs; however, with the surrounding waters supporting a number of elasmobranch species, there is potential for these to occur in, or travel through, the Sound of Islay. The impacts of the proposed Development on elasmobranchs are expected to be of low magnitude and unlikely to occur. Where the development may impact upon species of high importance the significance of the impact is assessed as **moderate**, but this is reduced to **minor** after mitigation. This applies to collision risk, whereas all other impacts have been assessed as being of **negligible** significance.

13.2 Potential Effects

13.4. Elasmobranch species (as well as other fish species) can potentially be impacted in a number of ways by tidal array development. These are outlined in the Scottish Marine Renewables SEA (Scottish Executive, 2007) and summarised below.

13.5. Sediment suspended, particularly during construction works and decommissioning may cause smothering of spawning habitats and egg cases.

13.6. The temporary footprint from construction vessels and permanent footprint from the arrays gravity bases and cabling (for a full description of the installation process see *Chapter 5: Project Description*) will result in the loss of seabed habitat used by most elasmobranch species for spawning and nursery areas, as well as feeding.

13.7. Changes to presence and distribution of prey species such as teleost fish (*Chapter 11: Marine Fish and Shellfish Resources*) and invertebrates (*Chapter 8: Benthic Ecology*) as a result of the Development may in turn influence the presence and distribution of elasmobranchs in the Sound of Islay.

13.8. Accidental pollution such as spillage of oils during construction, operation, maintenance and decommissioning has been considered within the *Chapter 22: Water and Sediment Quality*. Any use and discharge of chemicals during construction will be subject to controls as part of consent requirements and so it is expected that, should a spill occur, its scale and the nature of the contaminant will result in negligible impacts on elasmobranchs. In a high energy marine environment such as the Sound of Islay contaminants are expected to rapidly disperse.

13.9. Noise produced during construction, operation, maintenance and decommissioning (discussed further in *Chapter 9: Marine Mammals*) can impact upon elasmobranchs, which can both produce and hear marine noise. Although not fully understood, noise is thought to be associated with alarm calls and social behaviour in elasmobranchs. Studies have found that noise such as is generated by shipping activity can cause avoidance or attraction reactions in fish species (Thomsen *et al.,* 2006). Thomsen *et al.* (2006) did not cover elasmobranchs specifically; however, this finding may well be applicable to elasmobranchs.

13.10. Vessel movement during installation, operation, maintenance and decommissioning has an associated potential for collision with some species of elasmobranch. The greatest collision risk due to species size, limited ability to manoeuvre and feeding habits is thought to be basking shark. High current speeds added to swimming speeds produce potentially high approach velocities, with consequently reduced avoidance or evasion response times (Scottish Executive, 2007).

13.11. Electromagnetic frequency (EMF) emissions caused by electricity cables can potentially affect migration and prey detection in elasmobranchs, which have specialised electro-receptors that detect bioelectric emissions from prey, predators and competitors. This 'E-sense' is used to support navigation, foraging activity and interaction with other species/individuals. Research indicates that the E-sense is used when in close proximity to their source of interest (e.g. a prey item) and that other senses (such as hearing or smell) are used at distances of more than 30cm (CMACS, 2005). EMF has the potential to interfere with the electro-reception in some elasmobranch species, and thus affect species behaviour.

13.12. The presence of an array in the Sound of Islay, as well as associated activities to install or decommission it, could act as a barrier to possible elasmobranch movements, through a number of potential effects, either singly or in combination.

13.3 Methodology

13.3.1 Legislation, Guidelines and Policy Framework

13.13. Basking shark is included in Appendix II (strictly protected species) of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979). Short fin mako, porbeagle and blue shark are included in Annex III (protected species) of the Bern Convention.

13.14. The Bern convention was implemented in the UK by the Wildlife and Countryside Act in 1981 and basking sharks are protected under Schedule 5 of the Act which prohibits the killing, injuring or taking by any method of those wild animals listed on Schedule 5 of the Act.

13.15. The Nature Conservation (Scotland) Act 2004, Part 3 and Schedule 6 make amendments to the Wildlife and Countryside Act 1981, strengthening the legal protection for threatened species to include 'reckless' acts. The Act makes it an offence to intentionally or recklessly disturb basking sharks.

13.16. The OSPAR Convention outlines species and habitats which require further protection. Of the species expected within the Sound of Islay basking shark and common skate are included on the list of threatened or endangered species.

13.17. IUCN red lists of threatened species include the following species:

- Basking shark is 'globally vulnerable';
- Common skate is 'critically endangered'; and
- Spurdog is 'vulnerable'.

13.18. Basking shark is listed under Appendix II (not currently threatened with extinction but will become so if their trade or any products made from them, are not subjected to strong regulations) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

13.19. The UK Biodiversity Action Plan (UKBAP) identifies a list of Species of Conservation Concern in response to the Convention on Biological Diversity, from which elasmobranch priority species which have potential to be present in the Sound of Islay include: blue shark; porbeagle shark; common skate; shortfin mako; tope; basking shark; and spurdog.

13.3.2. EIA Guidance

13.20. The European Marine Energy Centre (EMEC) has developed EIA guidance for wave and tidal energy developers seeking consent within the EMEC test site at Orkney. These guidelines give an overview of the potential impacts of marine energy development on fish, but do not discuss elasmobranchs specifically or EIA reporting requirements.

13.21. There are no other specific EIA guidelines developed for tidal turbines; however, the guidelines developed for undertaking EIA in support of licensing of offshore wind farm development under the Food and Environmental Protection Act 1985 (FEPA) and the Coast Protection Act 1949 (CPA) by CEFAS (2004) are largely applicable.

13.22. Much of the CEFAS guidance for offshore windfarms (CEFAS, 2004) is considered to be applicable to tidal arrays. Little mention is made for elasmobranchs separately; however in relation to fish in general the guidance states that there is potential for the construction, development and use of offshore wind farms (in this case tidal arrays) to adversely affect fish, and details what an EIA should take into account when assessing impacts on those resources.

13.23. In relation to elasmobranchs the CEFAS guidance states that the EIA should make special mention of elasmobranchs, which may be susceptible to the effects of EMF, and which may also be of commercial and recreational importance. Aspects of the guidance referring to fish and shellfish which are relevant to elasmobranchs state that the EIA should:

- Identify which fish species are present at the site and in the surrounding area and if there are any of commercial, recreational or conservation importance;
- Identify possible spawning, nursery and feeding grounds;
- Examine possible migration routes through the Sound of Islay;
- Identify when the relevant species spawn;
- Assess whether construction will affect the physical habitat used by egg-laying species;
- Suggest mitigation which will enable construction activities to least impact on spawning behaviour;
- Assess the relative importance of the habitat for the region as a whole.

13.3.3. Data Collection

13.24. The main sources of information used to establish baseline conditions were:

- Department for Environment, Food and Rural Affairs (Defra) landings statistics by species by ICES rectangle for the period 2003 – 2008;
- Technical reports and reviews produced in support of Strategic Environmental Assessments for offshore renewable energy and oil and gas development in UK waters;
- Marine Conservation Society basking shark sightings reports;
- Marine Life Information Network (MarLIN) and National Biodiversity Network (NBN) websites; and
- Hebridean Whale and Dolphin Trust (HWDT) (Appendix 9.2) and Sea Mammal Research Unit (SMRU Ltd) (Appendix 9.1) report on basking sharks (and marine mammals) in the Sound of Islay.

13.25. The information sources listed above provide sufficient information to describe the elasmobranch resource potentially encountered in the Sound of Islay. No site-specific fish surveys have been undertaken across the array site for this reason, and also because tidal conditions across the site do not support the deployment of suitable survey gear.

13.3.4. Consultation

13.26. A scoping opinion was sought from statutory consultees in August 2008 and the responses are detailed in *Chapter 3: Consultation*. The key points raised during this process, which apply to elasmobranchs, along with an explanation of how they were addressed, are provided below.

13.27. Concerns were raised by many respondents (including SNH, Laggan and Sorn (Islay) DSFB and SMRU) with regard to the effects of noise on elasmobranchs. In response to these concerns two studies were commissioned by ScottishPower Renewables (SPR): The Scottish Association of Marine Science (SAMS) were commissioned to measure underwater noise levels within the Sound of Islay (SAMS, 2010) and Akvaplan-niva were commissioned to investigate noise emissions of a Hammerfest Strøm HS 1000 device (Akvaplan-niva, 2010). The findings of these have been applied, where possible, to the impact assessment outlined for Impact 13.5.

13.28. It was also highlighted during the scoping process that the possible effects of Electromagnetic Fields (EMF) on elasmobranchs should be considered in detail. These effects are discussed below under Impact 13.8.

13.4 Existing Environment

13.29. Shark species expected in the area around the Sound of Islay include basking shark, porbeagle shark, tope, spurdog and lesser spotted dogfish (Scottish Executive, 2007); shortfin mako, blue shark and nurse hound may also be present around Islay (MarLIN, undated).

13.30. The main species of skate and ray on the west coast of Scotland are cuckoo ray, spotted ray, thornback ray and common skate (Scottish Executive, 2007). The thornback ray is expected to be the most often encountered ray species in west coast waters (Scottish Executive, 2007).

13.31. There are no known records of elasmobranchs within the Sound of Islay; however given the reef habitat demersal species such as the lesser spotted dogfish would be the most likely to be encountered. The characteristics of those species that are expected within the area surrounding the Sound of Islay are described below.

Basking shark (Cetorhinus maximus)

13.32. The basking shark is a widely distributed pelagic species, and is the largest fish in British waters (second largest in the world) growing up to approximately 10m in length. Basking sharks generally live in open waters but migrate towards the shore in summer, when they can be seen ‘basking’, or swimming slowly, at the surface with the mouth wide open. Basking sharks are viviparous, producing live pelagic young.

13.33. UK-wide basking shark sightings data are collated by the Marine Conservation Society (2008), producing annual sightings reports. Sightings distribution maps show large concentrations of shark sightings in the Inner Hebrides, where sightings have always remained high. Looking at the annual variability in sightings numbers, sightings in Scottish waters have decreased in recent years and in 2008 were down by almost a third since 2007 (from 345 to 108 – a 69% decrease in sightings). Reasons for the decrease in sightings are not explored in the Marine Conservation Society 2008 Annual Report (Marine Conservation Society, 2008), but should be considered with caution as they may be an artefact of reduced sightings effort or poor sightings conditions.

13.34. On the west coast of Scotland, sightings data gathered and collated by the Hebridean Whale and Dolphin Trust (HWDT) show basking sharks are encountered frequently in the Hebrides between May and October and are seen in highest numbers around the islands of Coll, Tiree and Mull (though this pattern of distribution may be an artefact of sightings effort). Recent tagging work has shown that they make extensive horizontal and vertical migrations to locate feeding hotspots, often associated with frontal systems (Scottish Executive, 2007).

13.35. A study by HWDT collating visual and acoustic survey data between 2003 and 2009 as well as public sightings data between 2000 and 2008 concluded that there was a low number of basking sharks sighted in the area, 56.04^{o}N 6.41^{o}W to 55.58^{o}N and 5.70^{o}W, around Islay and the Sound of Jura. Basking sharks have previously been recorded at the mouth of the Sound of Islay to the north and south but not within the Sound (Appendix 9.2). SMRU land based visual observations, carried out between April and November 2009 recorded two basking sharks in August and again in September within the Sound of Islay (Appendix 9.1).

Porbeagle (Lamna nasus)

13.36. The porbeagle is a pelagic, viviparous species of up to 3.5m in length and is widely distributed off the west coast of Scotland from the surface to approximately 145m depth. It is mainly an offshore species but does also occur closer inshore, and appears to migrate northwards in the summer. Occasional porbeagle fisheries have developed off the west coast of Scotland. It is reportedly often found around man-made structures, such as North Sea oil platforms (Scottish Executive, 2007).

Tope (Galeorhinus galeus)

13.37. The tope is a pelagic species with a widespread distribution at depths down to about 50m. They are viviparous growing up to around 1.9m in length. They tend to be solitary, migrating offshore in winter to deep water and arriving in coastal waters in September/October/November (Scottish Executive, 2007). Tope are active, strong swimmers (The Shark Trust, undated) and they are a popular fish with anglers, with hotspots from the Mull of Galloway to the Shetland Islands.

Spurdog (Squalus acanthias)

13.38. The spurdog is a small pelagic dogfish (up to 1.6m in length), widely distributed, including off the west coast of Scotland, mainly at depths between 10 and 100m. They tend to aggregate in shoals of the same size or sex. There is some evidence that they may undertake extensive migrations. They are viviparous and mature females migrate inshore to give birth to live young. ICES has estimated that the Northeast Atlantic stock is severely depleted and advised a zero TAC (Total Allowable Catch) in recent years (Scottish Executive, 2007).

Lesser spotted dogfish (Scyliorhinus canicula)

13.39. The lesser spotted dogfish is small shark, reaching up to around 75cm in length. It is commonly encountered off the west coast of Scotland, living at depths down to about 60m (Scottish Executive, 2007). It is a bottom living species with a preference for sandy, gravely or muddy bottoms, and it feeds on molluscs, crustaceans and slow-moving benthic species. Spawning takes place in shallow waters and egg purses are found close inshore where they are attached to the substrate.

Shortfin mako (Isurus oxyrinchus)

13.40. The shortfin mako is a pelagic shark found throughout the UK from surface waters to depths of around 700m, as well as venturing into close inshore waters. It is thought to be one of the fastest shark species reaching speeds of up to 80mph. The shortfin mako is viviparous and has a rapid growth rate compared to other pelagic sharks reaching up to 4m in length. The shortfin mako feeds mostly on bony fish (MarLIN, undated).

Blue shark (Prionace glauca)

13.41. The blue shark is a pelagic species, though bottom-living fish and invertebrates can be included in its diet. The shark feeds mostly on relatively small prey, including squid and teleost fish. The blue shark is often found in surface waters although it can descend to depths of around 400m. It is a migratory species, undertaking north-south migrations in the north east Atlantic, visiting western Britain and Ireland in the summer months. This shark species is viviparous with a gestation period of around 9 to 12 months, producing between 4 and 135 young per litter. They survive around 20 years and reach up to 3.8m in length (MarLIN, undated).

Nurse hound (Scyliorhinus stellaris)

13.42. The nurse hound inhabits inshore and offshore waters to a maximum depth of around 100m. It is a bottom dwelling species, usually found on rugged rocky substrates or coralline and seaweed beds. This is a small dogfish reaching up to 1.6m in length. It feeds on a variety of benthic organisms including teleost fish, crustaceans and cephalopods. The nurse hound is oviparous, producing eggs in shallow waters.

Cuckoo ray (Raja naevus)

13.43. The cuckoo ray is a benthic species inhabiting coastal waters between 20 and 250m, found throughout the west coast of Britain and feeding on a wide range of benthic organisms. Egg cases are laid on the seabed throughout the year with up to 100 eggs produced by each female (Marine Species Identification Portal, undated).

Spotted ray (Raja montagui)

13.44. The spotted ray inhabits sandy and muddy substrates between 25 and 120m depth and is found widespread throughout the coasts of Britain and Ireland. Adult spotted rays feed mostly on crabs while the juveniles feed on amphipods, isopods and shrimp (National Museums of Northern Ireland, 2009).

Thornback ray (Raja clavata)

13.45. The thornback ray, which occurs at depths between 2 and 60m, is likely to be the ray species most often encountered across the tidal array site. It is a demersal species that frequents a wide variety of grounds from mud, sand, shingle and gravel. Although mainly a non-migratory, oviparous species, the fish often moves close inshore during the winter and spring. Egg placement is thought to occur during the summer, with hatching occurring towards winter.

Common skate (Dipturus batis)

13.46. Common skate is oviparous, breeding every other year and producing between 11 and 100 eggs. Populations only tend to survive where there is no commercial fishing. The known population distribution in the UK is limited to the Isles of Scilly, western British channel, west and north Ireland and west Scotland. Findings of skate tagging of the Sound of Mull and Firth of Lorne population indicate that the species does not undertake extensive migration. Egg placement is thought to occur during the summer, on sandy or muddy flats; however, the location of important breeding grounds is poorly understood (MarLIN, undated).

13.5 Assessment Methods

13.47. The significance of the impact is assessed on the basis of both the importance/sensitivity/value of the receptor (in this case the elasmobranch resource) and the magnitude of effect should it occur. This provides a worst case scenario and does not take into consideration the likelihood of occurrence.

13.48. The level of significance will be described as either 'major', 'moderate', 'minor' or 'negligible' on the basis of detailed criteria provided by the Scottish Marine Renewables SEA (Scottish Executive, 2007) developed for fish and shellfish as well as taking into account some elements of the marine mammal criteria, where applicable. Tables 13.1 and 13.2 below have been adapted for elasmobranchs.

Table 13.1: Definitions of Magnitude

Magnitude of Impact	Description of Magnitude
High	Affect an entire population causing a decline in abundance and / or change in distribution beyond which natural recruitment would not return that population / habitat, or any population / habitat dependent upon it, to its former level within several generations of the species being affected.
Medium	Damage or disturbance to populations above those experienced under natural conditions, over one or more generation, but which does not threaten the integrity of that population or any population dependent on it. Impact on a known spawning or nursery area where an elasmobranch species that has a low to moderate sensitivity to the impact in question is within the zone of influence of that impact.
Low	Small-scale or short-term disturbance to species, with rapid recovery rates, and no long-term noticeable effects above the levels of natural variation experienced in the area. The impacts are not sufficient to be observed at the population level.

Table 13.2: Sensitivity/Importance/value of elasmobranchs.

Receptor Sensitivity/Importance/ Value	Importance value of Marine flora and fauna	Site designations
High	International/National	Species listed under National or International legislation and policies e.g. UK Biodiversity Action Plan (BAP) priority species.
Medium	Regional	Species that have been designated for their regional importance (Local BAP species). Impact on a known area inhabited by an elasmobranch species that is nationally rare or scarce which has a high to very high sensitivity to the impact in question
Low	Local	Impact on an elasmobranch species not designated under national or international legislation and that has a low to high sensitivity to the impact in question is within the zone of influence of that impact
Negligible	Lesser	Other species with little or no local importance or sensitivity to the impacts in question

13.49. Following the criteria laid out in Table 13.2 the elasmobranch species expected to be present within the Sound of Islay are either covered by national / international legislation and so will be of high value (e.g. basking shark) or are covered by no legislation and are predicted to have little or no sensitivity to the array and so negligible value (e.g. cuckoo ray).

13.50. Table 13.3 combines the definitions of magnitude with the level of conservation importance, to give a prediction of overall impact.

Table 13.3: Significance Prediction Matrix

Magnitude of Impact	Receptor Sensitivity/Importance/Value			
	Negligible	Low	Medium	High
High	Minor	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate

13.51. The Scottish Marine Renewables SEA (Scottish Executive, 2007) identifies the 'sensitivity' of fish species to impacts associated with wave and tidal array developments. Table 13.4 is adapted from the SEA and lists those elasmobranch species which may be considered sensitive to tidal array development. Available data indicate that, of the potential effects caused by tidal array development, the possible effects of EMF on elasmobranch behaviour are of greatest concern. While this detailed species sensitivity is not used directly during the impact assessment it provides an important component of the appraisal.

Table 0.4: Sensitivity of certain elasmobranch species to impacts from tidal arrays. Source: Scottish Executive (2007).

Species	Smothering	Change in suspended sediment	Substratum loss	Decrease in water flow	EMF	Underwater noise
Spurdog	Not sensitive	Not relevant	Not relevant	Not relevant	Yes	Unknown
Lesser spotted dogfish	Low	Not relevant	Not relevant	Not relevant	Yes	Unknown

Table 0.4: Sensitivity of certain elasmobranch species to impacts from tidal arrays. Source: Scottish Executive (2007).						
Species	**Smothering**	**Change in suspended sediment**	**Substratum loss**	**Decrease in water flow**	**EMF**	**Underwater noise**
Basking shark	Not sensitive	Low	Not relevant	Not relevant	Yes	Unknown
Porbeagle	Not sensitive	Not relevant	Not relevant	Not relevant	Yes	Unknown
Tope	Not sensitive	Not relevant	Not relevant	Not relevant	Yes	Unknown
Thornback ray	Low	Not relevant	Not relevant	Not relevant	Yes	Low
Common skate	Low	Not relevant	Low	Not relevant	Yes	Not sensitive

13.52. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being of significant effect.

13.6 Impact Assessment

13.6.1. Do Nothing Scenario

13.53. There are currently few direct anthropogenic influences on elasmobranchs in and around the Sound of Islay. Therefore if the proposed tidal array is not deployed the existing environment is likely to remain in its current status. Natural variation in elasmobranch species is expected to be relatively high, particularly with pelagic species which are influenced by the presence of prey species and for basking sharks where planktonic species are susceptible to high variability.

13.6.2. Potential Impacts during Construction Phase

Impact 13.1 Smothering of spawning habitat

13.54. Smothering due to suspended sediments from construction activities, such as placement of foundations or cable on seabed is expected to have no direct impact on adult elasmobranchs which are expected to move away from the limited area of smothering. Egg cases may be more sensitive (MarLIN, undated). However, the Sound is not a known breeding habitat for any elasmobranch species and sensitivity is therefore considered to be low. Of the species expected in or around the Sound of Islay the ray and skate species as well as the lesser spotted dogfish and nurse hound are oviparous, and would be expected to move away from any disturbance before giving birth

13.55. Due to the relatively coarse nature of the substrates in the Sound of Islay (mainly sand and gravel) suspended sediments are likely to be limited in quantity and to be dispersed rapidly in the energetic tidal environment, suggesting a low magnitude of effect. Any smothering is expected to be temporary as excess sediment deposit may be resuspended by natural hydrodynamic processes (Scottish Executive, 2007) and dispersed. The significance of effect of any smothering on elasmobranch spawning habitat is therefore expected to be **negligible.**

MITIGATION IN RELATION TO IMPACT 13.1
• No mitigation required

Residual impact

13.56. As no mitigation is required, the residual impact of smothering of any spawning habitats during construction is likely to remain of **negligible** significant effect**.**

Impact 13.2 Loss of seabed

13.57. Seabed within the footprint of the devices once in their final position will be lost for the duration of their installation.

13.58. The footprint of ten devices is predicted to be 329.7m^2. With a 25m buffer width for cabling impact, the footprint for the inter-array cables will be approximately 43,825m^2 (assuming a cable running the length of the array, north – south with four perpendicular rows joining the turbines). The maximum export cable route, to the southern most cable landing option at Daimh-sgeir gives a footprint of approximately 24,325m^2 (with a 25m buffer). The Sound of Islay is approximately 40km^2 and therefore the area impacted by the turbine bases and cable route is small by comparison and magnitude of potential impact is considered to be low. The sensitivity of elasmobranch species to this low magnitude impact is considered to also be low and as a result any habitat loss is considered to be of **negligible** significant effect to elasmobranchs.

MITIGATION IN RELATION TO IMPACT 13.2
• No mitigation required

Residual impact

13.59. As no mitigation is required, the residual impact of seabed loss during construction will remain of **negligible** significant effect**.**

Impact 13.3 Changes to prey species

13.60. The potential for the Development to cause changes to prey species such as benthic invertebrates and bony fish is limited (see *Chapter 8: Benthic Ecology* and *Chapter 11: Fish and Shellfish Resources*). The magnitude of any potential effect is assessed as low and the potential mechanism for interaction and resulting sensitivity of elasmobranchs is negligible. The significance of any effect is considered to be **negligible**.

MITIGATION IN RELATION TO IMPACT 13.3
• No mitigation required

Residual impact

13.61. As no mitigation is required, the residual impact of changes to prey species during construction will remain of **negligible** significant effect**.**

Impact 13.4 Accidental pollution

13.62. Use, management and discharge of chemicals during construction will be subject to controls as part of consent requirements, with best practice being followed. Should a spill occur, its scale and the nature of the contaminant will have a low magnitude. In a high energy marine environment, contaminants can be expected to rapidly disperse and the pathway for potential exposure for elasmobranchs is limited both spatially and temporally.

13.63. The sensitivity of elasmobranchs to such a low magnitude impact in a highly dispersive environment is considered to be low, resulting in **negligible** significant effect to elasmobranchs.

MITIGATION IN RELATION TO IMPACT 13.4
• No mitigation required

Residual impact

13.64. As no mitigation is required, the residual impact of accidental pollution during construction will remain of **negligible** significant effect***.***

Impact 13.5 Noise

13.65. Baseline noise levels are discussed in *Chapter 9: Marine Mammals*. The impact of underwater noise on the elasmobranch species which may occur within the Sound of Islay is largely unknown; however, common skate and thornback ray are expected to be 'not sensitive' and have 'low sensitivity' respectively (Scottish Executive, 2007).

13.66. The level of noise during construction of the tidal array is expected to be relatively low in comparison to data for windfarm construction (Nedwell and Howell, 2004) as drilling or piling methods are not being used for the Development. There will be some noise generated from vessel activity and placement of the devices on the seabed

13.67. Noise studies in the Sound (SAMS, 2010; Appendix 9.4) demonstrated that normal, natural background noise levels in the Sound are high, even when anthropogenic noise, such as that generated by ferries, is excluded (see *Chapter 9: Marine Mammals*). The potential input from ferries and shipping is a considerable addition to the existing background noise levels.

13.68. The magnitude of noise impacts in the already noisy environment of the Sound is considered to be low, as is the potential sensitivity of elasmobranch species to noise. The significance of effect of noise impacts on elasmobranchs during construction is expected to be **negligible**.

MITIGATION IN RELATION TO IMPACT 13.5
• No mitigation required

Residual impact

13.69. As no mitigation is required, the residual impact of noise on elasmobranchs during construction will remain of **negligible** significant effect***.***

Impact 13.6 Collision

13.70. Basking sharks are relatively slow moving, particularly when feeding and, therefore, the potential does exist for collisions to occur with vessels. Therefore, they are considered to be the most at risk of the elasmobranch species from collision. However, in modification of this assessment, it is important to note that there are no data suggesting any history of collision with the vessels currently using the Sound, suggesting that the potential for such interaction is low.

13.71. Due to the number of vessels already using the Sound of Islay and the relatively limited duration over which vessel activity will increase as a result of the development, and the relatively low frequency of basking shark occurrence in the Sound, it is considered that the potential for a collision and the magnitude of such an impact is low. However given the conservation status of basking sharks the sensitivity of the species is high and the subsequent significance of effect of a collision is considered to be **moderate**.

MITIGATION IN RELATION TO IMPACT 13.6
• The use of vessel and / or shore based visual observers would allow teams undertaking installation works to be alerted to the presence of basking sharks in the Sound. On receiving such an alert, appropriate mitigation would be put in place, potentially including avoidance of areas where sharks are feeding and modification (e.g. slowing of vessels) or cessation of installation activity until the sharks have moved on from the installation area. Appropriate procedures would be agreed with Marine Scotland. • SPR accepts that there is some uncertainty about some potential impacts from the Development and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. • To the extent further mitigation is required over and above the first two mitigations proposed for Impact 13.6, SPR is committed to working with the regulator to identify reasonable measures to mitigate against this impact..

Residual impact

13.72. The residual impact of collision during construction could be reduced by mitigation to **minor** significance of effect***.***

13.6.3. Operational Phase

Impact 13.7 Barrier effect

13.73. The noise and physical presence of the array has been suggested as potentially causing a barrier to the movement of elasmobranchs through the Sound of Islay. However, the limited cross sectional and seabed area of the sound occupied by the array, combined with a lack of evidence of importance of the Sound of Islay as a passage way or feeding / breeding area for elasmobranchs suggest that the magnitude of such an impact should be considered to be low.

13.74. Based upon the low magnitude of impact, in combination with the low sensitivity of elasmobranchs to noise, it is proposed that the significance of effect of any barrier effect will be **negligible**.

MITIGATION IN RELATION TO IMPACT 13.7
• No mitigation required

Residual impact

13.75. As no mitigation is required, the residual impact of barrier effects during operation is likely to remain of **negligible** significant effect***.***

Impact 13.8 Impacts of electromagnetic fields

13.76. Ambient electric (E) and magnetic (B) fields detected within the marine environment are generated by either natural (e.g. Earth's magnetic field) or anthropogenic (e.g. subsea power cables) sources.

13.77. Power cables for transmitting electricity, such as those used to export electricity generated by tidal arrays, produce E and B fields when current passes through them. The B field is felt outside of the cable structure and this in turn induces a further E field (iE); studies have shown that EMF radiates beyond the cable into both seawater and the seabed.

13.78. Figure 13.1 provides a simplified overview of the fields associated with industry-standard submarine power cables, highlighting the magnetic and induced electrical fields that are of interest in terms of potential effects on elasmobranch species.

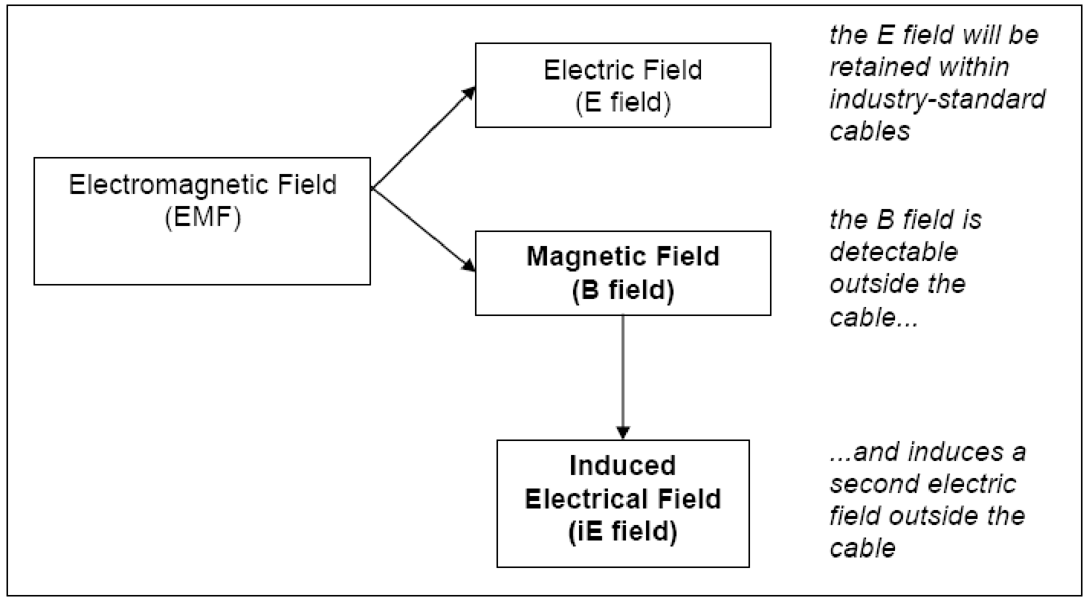

Figure 13.1: Overview of fields associated with subsea power cables, such as those that will link the tidal array to the onshore grid network. Source: Gill *et al* (2005).

13.79. The University of Liverpool Centre for Marine and Coastal Studies and Cranfield University (CMACS, 2003; Gill *et al*, 2005) have undertaken studies, funded through COWRIE, to investigate EMF emission from typical offshore subsea cables, in the context of the E and B fields. Studies have been largely driven by the need to consider the effects of EMF resulting from offshore wind farm subsea cabling.

13.80. Desk-based, laboratory and field studies have been undertaken in the course of this research. However, it is still generally considered that the current state of knowledge regarding the EMF emitted by subsea power cables is too variable and inconclusive to make and informed assessment of any possible environmental impact of EMF (CMACS, 2003).

13.81. The first report of the COWRIE EMF study made the following findings:

- There is no direct generation of an E-field outside of the cable;
- B-fields generated by the cable created ‘induced’ E-fields (iE) outside of the cable, irrespective of shielding;
- B-fields are present in close proximity to the cable and the sediment type in which a cable is buried has no effect on the magnitude of the B-field generated;
- The magnitude of the B-field within millimetres of the cable, referred to as its ‘skin’, is approximately 1.6µT, which will be superimposed on any other B-fields in the surrounding area (e.g. the Earth’s geomagnetic field of 50 µT); and
- The magnitude of the B-field associated with the cable falls to background levels within 20m.

13.82. Considering the results of the modelling in respect of its significance to electro-sensitive fish, the report found the following:

- That the EMF emitted by an industry standard subsea cable will induce E-fields;
- Cables will produce an E-field of approximately 91µV/m at the seabed adjacent to a cable buried to 1m. An E-field of this magnitude is at the lower limit of emissions that are expected to attract and repel the most sensitive species (i.e. elasmobranchs);
- The iE-fields calculated from the B-field were also within the range of detection by elasmobranchs;
- Changing the permeability of conductivity of the cable may effectively reduce the magnitude of the iE-field;
- To reduce the iE-field such that it is below the level of detection of elasmobranchs will require a material of very high permeability, hence, any reduction in iE-field emission will minimize the potential for avoidance reaction but may still result in an attraction response; and
- The relationship between the amount of cabling present, producing iE-fields, and the available habitat of electro-sensitive species is an important consideration.

13.83. In addition, further research funded by COWRIE conducted by Gill *et al* (2009) in which the impact of controlled EMF (with the magnitude and characteristics associated with offshore wind farms) on electro-sensitive fish was studied, found the following:

- There is evidence that benthic elasmobranch species studied did respond to the presence of EMF emitted by a subsea cable. The responses were, however, found to be highly variable between species and during times of cable switch on and off, day and night;
- The overall spatial distribution was found to be non-random. Dogfish appeared to be more likely found within the zone of EMF emission and moving faster during times when the cable was switched on; and
- No differences between fish response by day or night or over time were found.

13.84. The array cabling will include 1.5km of subsea cable to the Daimh-Sgeir landfall location.

13.85. It is currently not known what extent the exact magnitude of the B and iE-field emissions will be from the cables used for the array, but it is considered likely to be in line with the predictions made in the COWRIE reports. This implies that the B-field will potentially be detectable to magnetically sensitive fish species and that the iE-field would be within the range that could either attract or repel electro-sensitive fish species (Gill *et al*, 2009).

13.86. Species potentially occurring in the local area for which there is evidence of response to B-fields include elasmobranch species (Gill *et al*, 2005). Encounters with a B-field may cause behavioural changes such as a change in swimming direction. The type of cable likely to be used at the array will reduce B-field emissions to well below the magnitude of the Earth’s geomagnetic field.

13.87. Species potentially occurring in the local area for which there is evidence of response to iE-fields also include elasmobranch species (Gill *et al*, 2005). Electro-sensitive species will be expected to detect the iE-field emitted by a shielded cable up to a distance of 20m from the cable. The magnitude of the iE-field falls at the boundary between the likely attraction and repulsion of elasmobranch species. There is currently no evidence to show whether either attraction or repulsion will have a detrimental impact upon an elasmobranch species.

13.88. There are insufficient data available with which a judgment can be made about the potential for EMF to impact on a particular elasmobranch species. However, it is thought that effects will be influenced to some extent by their habitat preferences. For example, bottom dwellers such as skates/rays and dogfish use electroreception as their principal sense for locating food. More open water species, such as tope, may encounter EMF near the seabed but spend significant time hunting in the water column. The potential for impact is considered highest for species that depend on electric cues to detect benthic prey (CMACS, 2005).

13.89. There is no evidence to suggest any particular importance of the Sound for benthic elasmobranchs. This combined with the limited spatial potential for EMF effects suggests that the magnitude of potential impacts can be considered low. Species such as basking shark are not benthic feeders and are therefore unlikely to be affected.

13.90. There is no evidence from studies undertaken to suggest any negative impacts on magnetically and electrically sensitive species as a result of EMF and sensitivity is also considered to be low. As a result the significance of effect of impacts due to EMF is considered to be **negligible**.

MITIGATION IN RELATION TO IMPACT 13.8
• No mitigation required

Residual impact

13.91. As no mitigation is required, the residual impact of EMF during operation is likely to remain of **negligible** significant effect.

Impact 13.9 Collision

13.92. The significance of potential collisions between elasmobranchs and the Development is not fully known and may vary with changes in seasonal behaviour and species. Each device will have clearance of 10.5m from the seabed and therefore it could be expected that demersal and benthic elasmobranchs will pass under the device without collision.

13.93. Basking sharks are typically recorded close to the surface and will therefore pass over the turbines, the tips of which will be at a minimum depth of 14.5m.

13.94. Other pelagic species may be within the depth range of the turbine rotors; however with smaller body size and faster swimming speeds these species may be able to avoid the turbine rotors which will rotate at a maximum tip speed of 12m/s.

13.95. The number of vessels during maintenance and operation will be significantly lower than during construction and should be minor in the context of the existing vessel movements within the Sound representing no significant increase in risk of collision. There are no known instances of vessels colliding with elasmobranchs, including basking sharks.

13.96. Excluding basking sharks and benthic species from assessment of collision risk as result of their occupying surface waters away from turbine operation, the sensitivity and importance of other elasmobranch species is considered to be low. It is not clear that there will be any impacts due to collision and there is no interaction with breeding areas; however, a precautionary approach, because interactions with pelagic species is unknown, suggests a medium magnitude and subsequently **minor** significance of effect.

MITIGATION IN RELATION TO IMPACT 13.9
• SPR accepts that there is some uncertainty about some potential impacts from the Development and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. • To the extent further mitigation is required over and above the first two mitigations proposed for Impact 13.9, SPR is committed to working with the regulator to identify reasonable measures to mitigate against this impact.

Residual impact

13.97. The residual significance of collision during operation is likely to remain of **minor** significance of effect.

Impact 13.10 Noise

13.98. Baseline noise levels and predicted operational noise levels are discussed further in *Chapter 9: Marine Mammals*. As discussed previously, the impact of underwater noise on elasmobranchs is largely unknown, although common skate and thornback ray are expected to be 'not sensitive' and have 'low sensitivity' respectively (Scottish Executive, 2007).

13.99. Due to the shielding effect caused by the islands of Islay and Jura (Scottish executive, 2007) noise generated by the turbines will be modified and is therefore not likely to travel out of the Sound.

13.100. *Chapter 9: Marine Mammals* details the area of the Sound within which sound generated by the Development may propagate and considers this in the context of high levels of background (natural) noise. Noise from the Development may not be detectable above background.

13.101. Marine turbines by their nature can (currently) only operate in areas where high ambient sea noise levels already exist (Subacoustech, 2005; Akvaplan, 2010) due to the high energy environment. Additionally, tidal turbines typically produce noise at low frequencies (between 50 and 1000 Hz). Coincidentally, noise produced by shipping and natural noise associated with high energy coastal environments is also generally centred around the lower frequencies; therefore, the operational noise of the turbine will be masked by the background noise of shipping and the natural environment.

13.102. The significance of effect of noise on elasmobranchs is therefore expected to be **negligible** based on the anticipated low sensitivity of elasmobranch species to noise, as well as the limited area of the Sound within which low magnitude noise might be propagated and the high levels of background noise present within the Sound.

MITIGATION IN RELATION TO IMPACT 13.10
• No mitigation required

Residual impact

13.103. As no mitigation is required, the residual impact of noise during operation is likely to remain of **negligible** significant effect.

13.6.4. Potential Impacts during Decommissioning Phase

13.104. The potential impacts during decommissioning are expected to be of the same nature and magnitude as the construction impacts:

- Smothering of spawning habitat;
- Loss of seabed
- Changes to prey species;
- Accidental pollution;
- Noise disturbance;
- Collision.

13.105. The significance of all impacts during decommissioning has been assessed as **negligible** except collision which is predicted to be **minor / negligible**.

13.7 Cumulative Impacts

13.106. Principal offshore activities which could result in in-combination effects with the Sound of Islay tidal array include:

- Commercial fisheries;
- Marine traffic;

- A proposed array of tidal devices by DP Energy, for which exact location is currently unknown, however will be off the West coast of Islay; and
- Scottish Territorial Waters windfarms, which are proposed for 40km west of the Sound of Islay and at Kintyre, 50km south of the Sound of Islay.

13.107. The likely impacts of these projects include smothering of spawning habitat; loss of seabed; changes to prey species; accidental pollution; noise disturbance; and collision. It is expected that the cumulative significance of these impacts would be of similar significance to the Sound of Islay development i.e. collision could be of **moderate** significance (prior to mitigation) while the other impacts would be expected to be of **negligible** significance.

13.8 Summary

Impact	Construction/ Decommissioning				Operation/ Maintenance			
	Magnitude of Impact	Receptor Value/ Sensitivity/ Importance	Significance of effect	Residual impact	Magnitude of Impact	Receptor Value/ Sensitivity/ Importance	Significance of effect	Residual impact
Smothering	Low	Low	Negligible	Negligible	Low	Low	N/A	N/A
Loss of Seabed	Low	Low	Negligible	Negligible	Low	Low	N/A	N/A
Changes to prey species	Low	Low	Negligible	Negligible				
Accidental pollution	Low	Low	Negligible	Negligible	N/A	N/A	N/A	N/A
Noise	Low	Low	Negligible	Negligible	N/A	N/A	N/A	N/A
Collision	Low	High	Moderate	Minor	Medium	Low	Minor	Minor
Barrier Effect	N/A	N/A	N/A	N/A	Low	Low	Negligible	Negligible
EMF	N/A	N/A	N/A	N/A	Low	Low	Negligible	Negligible

13.9 Conclusions

13.108. It is expected that the Development is unlikely to significantly impact elasmobranchs. The magnitude of the impacts is predicted to be low, and elasmobranchs in many cases with either not directly interact with the impact, or have low sensitivity to it. Collision could have an impact on basking sharks; therefore given the high importance of this species, the significance of this effect has been assessed as **minor –** after mitigation. All other impacts have been assessed as being of **negligible** significance.

13.109. Post installation monitoring for elasmobranchs, specifically basking sharks, may be combined with data collection for marine mammal monitoring (*Chapter 9: Marine Mammals*).

13.110. Some mitigation of vessel collision risk is proposed at the construction phase (due to the large increase in vessel activity); however, it is not anticipated that any further mitigation will be required.

13.111. There is not considered to be any significant potential for collision as a result of increased vessel activity during operation, given that the numbers of vessel movements will be small in relation to existing activity.

13.112. It is anticipated that the feeding and behavioural ecology of basking sharks means that their potential for direct interaction with turbines within the Development is very low. However, there continues to be uncertainty regarding collision risk and monitoring may be appropriate.

13.113. Monitoring would allow the significance of collision risk to be continually assessed and if required collision mitigation will be implemented. Key post installation monitoring relevant to collision risk could include monitoring of impact sensors on each device and collection of basking shark activity data through shore based observers.

13.10 References

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14.0 Ornithology

14.1 Introduction

14.1. This Chapter of the Environmental Statement (ES) evaluates the potential effects on birds of the proposed Sound of Islay Tidal Demonstration Array (hereafter referred to as "the proposed Development"). This Chapter compliments the separate evaluation of potential ecological effects in *Chapter 8: Benthic Ecology* and *Chapter 16: Terrestrial and Intertidal Ecology* and has been completed by Natural Research Projects Limited (NRP).

14.2. This Chapter is supported by the following Technical Appendix provided in Volume 2 of this ES:

- Appendix 14.1 Birds Technical Report.

14.3. In addition, there is one Confidential Appendix:

- Appendix 14.2 Peregrine nest site and White-tailed eagle locations.

14.4. The Chapter describes the methods used to establish the bird interest within the Development and its hinterland, together with the process used to determine the Nature Conservation Importance (as discussed at paragraph 14.3.2.5 of this Chapter) of the bird populations/species present. The ways in which birds might be affected by the construction, operation, decommissioning of the Development are explained, the magnitude of any probable effects of the scheme considered, and the significance of any likely effects is assessed.

14.2 Potential Effects

14.5. Ornithological interests have the potential to be affected (directly or indirectly) by the following key elements of the Development:

- Construction activities;
- Operational activities, including turbine function and maintenance vessels;
- Decommissioning of the proposed Development; and
- Cumulative effects of the proposed Development when taken alongside other tidal power developments in the area whether operational or in application.

14.6. The types of potential effect of the proposed Development on birds that have been evaluated within this Chapter, include:

- The effects of direct sea-bed habitat loss due to the placement of submerged turbines;
- The effects of indirect habitat loss due to the displacement of birds as a result of Development activities, in particular disturbance from vessels and operational turbines;
- The effects of habitat modification due to the placement of marine turbines in the Development site; the Development site is defined as the sea bed lease area (including the subsea cable footprint) together with the proposed terrestrial cable route and substation site on Jura (see Figure 1.1 in *Chapter 1: Introduction* and *Chapter 5: Project Description*);
- The effects of bird collision with marine turbine rotors, and other structures such as vessel mooring lines;
- The effects of pollution and contamination, in particular from vessel discharges, anti-foulants and accidental leakage of turbine lubricants, and;
- The effects of disturbance and habitat change on land birds along the terrestrial cable route and vicinity of the proposed sub-station on Jura; and
- The beneficial contribution made by the Development towards countering climate change. Uncertainties regarding climate change predictions mean that it is not possible at present to carry out a quantitative assessment of these effects on birds. However, climate change is widely perceived to be the single most important long-term threat to the global environment, particularly to biodiversity and to birds. Thus, the continued rise in mean global temperatures is predicted to affect the size, distribution, survival and breeding productivity of many British bird species (Leech 2010).

14.7. A detailed description of the proposed Development, turbine layout and construction and operational procedures is presented in *Chapter 1: Introduction* and *Chapter 5: Project Description* of this ES.

14.3 Methodology

14.3.1 Legislation, Guidelines and Policy Framework

14.8. The following guidance and legislation was taken into account during this assessment:

- Directive 2009/147/EC on the Conservation of Wild Birds (Birds Directive);
- Directive on Conservation of Natural Habitats and of Wild Flora and Fauna 92/43/EEC (Habitats Directive);
- The Wildlife and Countryside Act 1981 (as amended) (WCA);
- The Conservation (Natural Habitats &c.) Regulations 1994 (as amended); (The Habitats Regulations);
- The Nature Conservation (Scotland) Act 2004 (as amended); and
- The Environmental Impact Assessment (Scotland) Regulations 1999 (as amended) (Scotland Executive 1999);
- UK Biodiversity Action Plan (BAP); and
- Birds of Conservation Concern (BoCC 3) 'Red list'.

14.9. At present there are no ornithological survey guidelines for tidal power developments. However, there is guidance for onshore and offshore windfarms and this was taken into account where appropriate (SNH, 2005, Camphuysen *et al.,* 2004).

14.10. The Planning Policy context is summarised in *Chapter 6: Regulatory and Policy Context* of this ES.

14.11. With regard to The Habitats Regulations, the following is of note:

a. The Development site is not statutorily designated at international or national level for ornithological interests;

b. The Jura, Scarba and Garvellachs proposed Special Protection Area (pSPA) for golden eagle covers almost all of Jura including the coast and hinterland adjacent to the Development site;

c. The North Colonsay and Western Cliffs SPA, classified for its internationally important breeding seabird assemblage (notably common guillemot and kittiwake), is over 25 km away from the Development site. This site is made up of two SSSIs, namely West Colonsay Seabird Cliffs and North Colonsay;

d. Although breeding seabirds are not a qualifying interest of the Rinns of Islay SPA, this SPA includes the Glac na Criche SSSI (22 km west of the Development site) for which breeding seabirds, including auks, are a noted feature; and

e. All SPAs within 25 km of the Development site are designated for non-seabird species, in particular wintering geese, breeding corncrake and chough. These comprise: The Rinns of Islay; Gruinart Flats; Bridgend Flats; Laggan Peninsula and Bay; and The Oa and Eilean na Muice Duibhe. All of these sites are located on Islay and are also designated SSSIs.

14.12. Given the different Regulations governing assessment of potential effects of proposed developments on Natura 2000 sites, these are considered separately in this Chapter (Section 14.11).

14.3.2 Assessment Methods

14.3.2.1 Consultation

14.13. Scoping responses were received from SNH (SNH, 2008) and RSPB (RSPB, 2008) and these are summarised in Table 14.1.

14.14. SNH highlighted that some seabirds using the Sound of Islay could originate from SPA breeding colonies, in particular common guillemots, kittiwakes and razorbills. However they point out that the closest seabird SPA, North Colonsay and Western Cliffs SPA, is over 25 km away; therefore the Sound (and thereby the Development site) is unlikely to be regularly used by foraging seabirds from this colony. The SNH response states that '*SNH does 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*.'

14.15. Despite this SNH advised that the EIA for the Development should consider potential impacts on seabirds.

14.16. RSPB identified black guillemot, common guillemot, razorbill, cormorant, shag, eider, common scoter, great northern diver and red-throated diver as species that are potentially affected at a local scale by displacement and collision.

14.17. RSPB suggested that the provision of artificial nest sites located away from the Development could help mitigate effects on black guillemots.

TABLE 14.1 SUMMARY OF CONSULTEE RESPONSES	
Consultee	**Response**
SNH	Do not consider that the Development is likely to have any effects on seabird populations at designated SPA seabird colonies. It would be helpful for the EIA to consider potential impacts on seabirds.
RSPB	Suggest that the EIA should consider the placement of suitable nest structures for black guillemot away from the development area as a potential mitigation measure.

14.3.2.2 Desk Study

14.18. NRP identified the following key field survey requirements:

- year-round vantage point (VP) surveys to assess the use of the sea and shorelines in the vicinity of the Development by seabirds, waterfowl and waders;
- walkover surveys of terrestrial habitats within 1 km of the Development site;
- surveys of scarce breeding raptors and breeding black guillemot within 2 km of the marine habitats and adjacent shore of the Development site;
- surveys of birds of conservation concern present during the non-breeding period at the within 1 km of the Development Site; and
- surveys of seabirds using the outer Sound of Islay from CalMac passenger ferries, subject to any ferry timetable constraints.

14.3.2.3 Field Survey

14.19. Due to the novelty of the Development and the geography of the site (a narrow sea channel), a survey method had to be developed for the Development that enabled accurate mapping of the locations of birds seen on the sea from elevated VPs. The method was developed and trialled during visits in February and April 2009 (Technical Appendix 14.1). Regular VP observations were made from May 2009 to November 2009. Certain changes were made to the VP programme in August 2009 following a review of fieldwork in which it was decided that greater survey effort was required in the close vicinity of the proposed Development site. The main change was to limit observations to the four VPs overlooking the Development site and other marine areas within approximately 1 km (Figure 2. in Technical Appendix 14.1). Initially observations were also made from three additional VPs overlooking the northern part of the inner sound.

14.20. Approximately 48 hours of VP observations were conducted monthly and as far as possible this was evenly spread between VPs and across the day light hours and tidal conditions (Technical Appendix 14.1). The VP survey programme was designed to collect data on the distribution, abundance and behaviour of marine mammals as well as birds. The assessment of the marine mammal results is covered in *Chapter 9: Marine Mammals*. VP surveys consisted of repeated alternating short bouts of three activities, 15 minute snap-shot scans of marine mammals, 10-15 minute snap-scans for sea birds; timed; and timed flying bird watches (five minutes). Separate scans were undertaken for marine mammals and birds to minimise observer bias.

14.21. The snap-shot scans were designed to give instantaneous samples of the distribution, abundance and behaviour of all birds using the sea and coastlines within approximately 1 km of a VP, with the exception of flying birds passing through the sound. The precise position of birds was recorded in terms of a compass bearing and angle of declination. Full details of the VP method, sampling design, timing of surveys and system of calculating bird positions are given in the Birds Technical Report (Technical Appendix 14.1).

14.22. The timed 5-minute flying bird watches were designed to systematically quantify the numbers of birds flying through the sound. Full details of the flying-bird watch method and timing of watches are given in the Birds Technical Report. (Technical Appendix 14.1)

14.23. A pre-breeding survey of black guillemots covering the whole of the inner sound was made in early April 2009 (Figure 2 in Technical Appendix 14.1).

14.24. The shorelines and adjacent habitat along the inner sound were surveyed for scarce breeding birds, non-breeding birds of conservation concern and waders by walkover surveys (Figure 2 in Technical Appendix 14.1). These surveys also included all terrestrial habitat within 1 km of the Development site (Figure 2 in Technical Appendix 14.1). Walkover surveys were conducted in February, April, May, July, and September 2009. All incidental records of scarce species seen at other times were also recorded.

14.25. The proposed terrestrial route for the underground cable and proposed location of the substation (both close to the main road on Jura) were not decided in time for 2009 breeding season surveys. As a consequence the 2009 surveys did not fully cover all areas within 1 km of these proposed features. They did however receive incidental coverage throughout 2009 as they are highly visible from the main road. To ensure comprehensive baseline data were available these areas were fully surveyed for scarce breeding birds in the 2010 breeding season (April – June).

14.26. Data on seabird distribution and abundance from the outer parts of the Sound of Islay were also collected by conducting surveys from CalMac ferries (Figure 1 in Technical Appendix 14.1) using the European Seabirds at Sea method (Camphuysen *et al*., 2004). Surveys from Port Askaig to West Loch Tarbert on the Scottish mainland (i.e. including the south outer sound) were made at least once a month from April to November 2009. Surveys from Port Askaig to Colonsay (i.e. including the north outer sound) were made from May to October 2009 only due to this ferry service not being operational through the winter months. Full details of timing and methods used for the ferry surveys are given in Technical Appendix 14.1.

14.27. Data on vessel activity were systematically collected during baseline surveys of birds and marine mammals to provide a source of reference for any subsequent monitoring.

14.28. The collection of baseline data is ongoing and is planned to continue until a full year of data has been collected.

14.3.2.4 Assessment of Significance

14.29. The evaluation follows the process set out in the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 1999 ("the EIA Regulations") and guidance on the implementation of the Birds and Habitats Directives (SERAD, 2000). Owing to the distance of the Development from two internationally designated sites (see Section 14.3.1) regard has been had to the Birds and Habitats Directives as transposed by the Conservation (Natural Habitats &c.) Regulations 1994 (as amended). For the purposes of assessing the effect of the proposed Development on the SPAs, the process undertaken within this assessment has ensured that the appropriate authority has sufficient information to determine whether the proposal (either alone or in combination with other plans or projects) is likely to have a significant effect on the integrity of the SPAs and, accordingly, whether or not an appropriate assessment should be undertaken (see Section 14.11).

14.30. Where there is a potential effect on a bird population that forms part of the qualifying interest of an internationally or nationally designated site (or where such designation is proposed) i.e. Ramsar sites, SPAs, SSSIs, pSPAs or a site that would meet the criteria for international or national designation, so far as possible, effects are judged against whether the Development could significantly affect the site population and its distribution. Where bird populations (the population does not meet the criteria for national/international designation) are not protected by designated sites, judgement is made against a more general expectation that the Development would not have a significant adverse effect on the overall population, range or distribution; and that it would not interfere significantly with the flight paths of migratory birds. In assessing the effects consideration is given to the relevant populations of the species. Trivial or inconsequential effects are excluded.

14.31. The assessment determines the potential effects of the Development and the likelihood of their occurrence. In judging whether a potential effect is significant or not, two factors are taken into account:

- The magnitude of the likely effect; and
- The Nature Conservation Importance (NCI) of the species involved.

14.32. The significance of potential effects is determined by integrating the assessments of Nature Conservation Importance and magnitude of effects in a reasoned way. In making judgements on significance, consideration is given to the population status and trend of the potentially affected species. If a potential effect is determined to be significant, measures to avoid, reduce or remedy the effect are suggested wherever possible.

14.3.2.5 Methods Used to Evaluate Nature Conservation Importance

14.33. The Nature Conservation Importance (NCI) of the bird species potentially affected by the proposed Development is defined according to Table 14.2.

14.34. Species listed in Local Biodiversity Action Plans (LBAPs) would be considered moderately important only if the Development supported at least 1% of the regional population.

TABLE 14.2 DETERMINING FACTORS FOR NATURE CONSERVATION IMPORTANCE

Importance	Definition
High NCI	Species listed in Annex 1 of the EU Birds Directive. Breeding species listed on Schedule 1 of the Wildlife and Countryside Act (WCA).
Moderate NCI	• Other Species listed in the UK Biodiversity Action Plan (BAP) • Other Species listed on the Birds of Conservation Concern (BOCC) 'Red' list • Regularly occurring migratory species, which are either rare or vulnerable, or warrant special consideration on account of the proximity of migration routes, or breeding, moulting, wintering or staging areas in relation to the proposed Development. • Species present in regionally important numbers (>1% regional population).
Low NCI	All other species not covered above.

14.3.2.6 Methods Used to Evaluate the Magnitude of Effects

14.35. Effect is defined as a change in the assemblage of bird species present as a result of the Development. Change can occur either during or beyond the life of the Development. Where the response of a population has varying degrees of likelihood, the probability of these differing outcomes is considered. Note that effects can be adverse, neutral or favourable.

14.36. In determining the magnitude of effects, the behavioural sensitivity and ability to recover from temporary adverse conditions is considered in respect of each potentially affected population. Behavioural sensitivity is determined according to each species' ecological function and behaviour, using the broad criteria set out in Table 14.3. The judgement takes account of information available on the responses of birds to various stimuli (e.g. predators, noise and disturbance by humans). Note that behavioural sensitivity can differ even between similar species (Schueck *et al.,* 2001; Garthe and Hüppop, 2004) and that, within a particular species, some populations and individuals may be more sensitive than others, and sensitivity may change over time, for example due to habituation. Thus the behavioural responses of birds are likely to vary with both the nature and context of the stimulus and the experience and 'personality' of the bird. Sensitivity also depends on the activity of the bird. For example, a species is likely to be less tolerant of disturbance whilst breeding than at other times; however tolerance is likely to increase as breeding progresses (Holthuijzen, 1985).

TABLE 14.3 DETERMINING FACTORS FOR BEHAVIOURAL SENSITIVITY

Sensitivity	Definition
High	Species or populations occupying habitats remote from human activities, or that exhibit strong and long-lasting reactions to disturbance events.
Moderate	Species or populations that appear to be warily tolerant of human activities, or exhibit short-term reactions to disturbance events.
Low	Species or populations occupying areas subject to frequent human activity and exhibiting mild and brief reaction (including flushing behaviour) to disturbance events.

14.37. Effects are judged in terms of magnitude in space and time (Regini, 2000). There are five levels of spatial effects and four levels of temporal effects (Tables 14.4 and 14.5).

TABLE 14.4 SCALES OF SPATIAL MAGNITUDE	
Magnitude	**Definition**
Very High	Total/near total loss of a bird population due to mortality or displacement. Total/near total loss of productivity in a bird population due to disturbance. *Guide: >80% of population affected*.
High	Major reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. *Guide: 21-80% of population affected*.
Moderate	Partial reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. *Guide: 6-20% of population affected*.
Low	Small but discernable reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. *Guide: 1-5% of population affected*.
Negligible	Very slight reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the "no change" situation. *Guide: < 1% population affected*.

Table 14.5 SCALES OF TEMPORAL MAGNITUDE	
Magnitude	**Definition**
Permanent	Effects continuing indefinitely beyond the span of one human generation (taken as approximately 25 years), except where there is likely to be substantial improvement after this period.
Long term	Approximately 15 - 25 years or longer (refer to above).
Medium term	Approximately 5 - 15 years.
Short term	Up to approximately 5 years.

14.38. In the case of non-designated sites, magnitude of effect is assessed in respect of an appropriate ecological unit. In the present case the appropriate regional unit is taken to be Natural Heritage Zone (NHZ) 14 'Argyll West and Islands' for terrestrial species of bird. For most seabirds, the appropriate unit is considered to be 'Argyll and Bute', which covers a similar area to NHZ 14, because this corresponds to one of the areas used to summarise data from national seabird censuses reported in 'Seabird Populations of Britain and Ireland' (Mitchell *et al.,* 2004). For gannet the regional population is taken to include birds breeding on Ailsa Craig. This island lies just inside the boundary of NHZ 14 but outwith 'Argyll and Bute' and is the only breeding colony in the region. For Manx shearwater the regional population is taken to include the Copeland Islands, Northern Ireland, the largest colony in the region. The Copeland Islands lie outwith 'Argyll and Bute' and close to the border of NHZ 14.

14.39. Where the available data allows, the conservation status of each potentially affected terrestrial bird species is evaluated within NHZ 14 or, for breeding seabirds, within Argyll and Bute or the defined regional population. For these purposes conservation status is taken to mean the sum of the influences acting on a population which may affect its long-term distribution and abundance.

14.4 Existing Environment

14.40. The inner Sound of Islay comprises an approximately 1 km wide marine channel between the islands of Islay and Jura. The channel varies in depth; the deepest parts exceed 60 m and the proposed Development is to be located below the 48m bathymetric contour. The great majority is shallower than 48m. A strong tidal current flows through the sound. The coastlines comprise a mix of rocky-shore, low sea cliffs, shingle beaches, and the outlets of several small rivers. On the Jura side the adjacent land is blanket moorland whereas on the Islay side there is a mix of native woodland, extensive grazed grassland, conifer plantation and moorland (see *Chapter 16: Terrestrial and Intertidal Ecology*). The small village and ferry port of Port Askaig is located on the Islay side approximately half way along the inner sound and just north of the proposed Development site. The Jura ferry operates between Port Askaig and Feolin Pier, which is situated directly opposite on the Jura side.

14.41. A significant number of medium sized vessels use the Sound of Islay (see Appendix 19.1) with relatively high numbers of vessel movements (approx. 3.4 per day - see Appendix 19.1). These include large CalMac vehicle ferries that operate between the Scottish mainland, Islay and Colonsay; the small vehicle ferry that operates between Port Askaig and Jura; numerous small fishing vessels mainly operating out of Port Askaig; commercial shipping passing through the sound; and various recreational craft.

14.42. The following summary of the ornithological observations is based on baseline studies of the proposed Development site and adjacent areas of the inner Sound of Islay made from February 2009 to November 2009. Details of spatial extent, timing and methods used in field surveys are given in Technical Appendix 14.1. As will be explained later on in this Chapter, in view of the low likelihood that the additional surveys will identify additional bird sensitivities or elevate existing sensitivities, the current information is considered sufficient for the purpose of evaluating effects of the proposed Development site.

14.43. The areas surveyed in the inner Sound of Islay covered a larger area than that of the proposed Development (as described in *Chapter 1: Introduction*). The location and coverage of the four VPs overlooking the Development site, the coastal walkover survey routes and the areas searched for scarce birds are illustrated in Figure 2 in Technical Appendix 14.1.

14.44. The Nature Conservation Importance (NCI) is indicated for each recorded species: this is explained in the Section 14.3.2 'Assessment Methods'. While all bird species rely on terrestrial habitats in order to breed and to varying degrees at other stages of their life cycle, to ease interpretation, species have been placed into three categories depending on the extent and form of their exploitation of the marine environment to obtain food:

- Terrestrial: species which rely entirely, or predominantly, on terrestrial habitats (i.e. raptors, geese, waders, passerines);
- Surface diving seabirds: seabirds which feed by diving, typically relatively deeply, from the surface of the sea (i.e. divers, auks, sea-ducks, shags/cormorants); and
- Plunge diving and surface active seabirds: seabirds which dive from above the surface of the sea to feed in the upper reaches of the sea column or at/above the sea surface (i.e. gulls, gannet, skuas, Manx shearwater).

14.45. In summarising the observations of species collected during baseline surveys (documented by subsequent sub-sections of Section 14.4) descriptions are thorough regarding the assemblage recorded. Reference has been made, nevertheless, to the potential effects of the Development (Section 14.2) in evaluating whether the observation records constitute evidence for the species to be considered as being potentially affected by the Development (under basic criteria described by Section 14.3). If species are not considered to be remotely affected under these criteria then this is noted; obviating any further consideration under the subsequent assessment process.

14.4.1 Terrestrial Species

14.46. A pair of immature white-tailed eagles (high NCI) bearing yellow wing tags with the letters ‘P’ and ‘L’ respectively was regularly seen in the autumn and winter months. Both birds hatched in 2006 from nests on Mull (D Sexton RSPB, email to NRP). They were seen hunting in the inner sound and in the autumn and winter sometimes roosted within 2 km of the proposed Development site (Figure 1 in Confidential Technical Appendix 14.2). At times during the winter months they were joined by a third, apparently untagged bird, probably a one-year-old based on its plumage.

14.47. The white-tailed eagles using the sound are part of a Scottish population which currently numbers about 46 established pairs. The immature pair is likely to start breeding in the next few years and it is possible that their regular occurrence in the inner Sound of Islay indicates that they may be establishing a territory there. Because of the current rarity of this species even a single pair is regarded as nationally important (>1% of the national population), although strictly speaking an immature non-breeding pair should not be considered as part of the breeding population.

14.48. Single hen harriers (high NCI) were noted on six occasions through the year hunting over the coastal moorland of Jura. Although there was no evidence of breeding within 1 km of the proposed Development site (including proposed cable route and sub-station) a pair was suspected to be breeding locally somewhere on the Jura moors. A single pair is well below 1% of the regional population. It is highly unlikely that any form of the Development process (section 14.2) could potentially affect hen harrier, therefore this species is not considered further.

14.49. Merlins (high NCI) were seen on two occasions (maximum 2 birds) both in the autumn or winter. There was no evidence that merlin bred within 1 km of the proposed Development site (including proposed cable route and sub station) but they are reported as breeding in small numbers on Jura and Islay. It is highly unlikely that any form of the Development process (section 14.2) could potentially affect merlin, therefore this species is not considered further.

14.50. During reconnaissance for VP locations a pair of peregrines (high NCI) was incidentally discovered breeding over 2 km from the proposed Development site. One pair is > 1% of the regional population. However, as the nest site was well away from any likely source of effect from the proposed Development (Whitfield *et al.,* 2008) and no peregrines were seen during any other surveys, therefore this species is not considered further.

14.51. The only feeding barnacle geese (high NCI) seen were a winter flock of 350 feeding on the island of Glas Eilean (approximately 3 km south-west of the proposed Development site). Several small flocks (maximum 20) were seen flying over the inner sound in the autumn.

14.52. Flocks of up to 90 Greenland white-fronted geese (high NCI) were recorded flying over the inner sound on several occasions in the autumn and winter. Some of these flocks appeared to be travelling between feeding grounds on Islay to a probable roost site somewhere on Jura. No Greenland white-fronted geese were seen feeding on the coastal lands within 1 km of the Development site.

14.53. Whilst both species of geese which were recorded are high NCI, their observation during baseline surveys is not unexpected given their regional abundance. Based on these observations, however, it is highly unlikely that any key elements of the Development (section 14.2) could potentially affect geese under any process. Barnacle goose and Greenland white-fronted goose are therefore not considered further in this Chapter.

14.54. A few pairs of oystercatcher, ringed plover and common sandpiper (all low NCI) bred along the coasts of the inner sound especially on the Jura side. In all cases the numbers present were well below 1% of the regional population. Given these species’ conservation status and their local abundance in relation to regional populations, they are not considered further in this Chapter.

14.55. A small flock (maximum 10) of twite (moderate NCI) was occasionally seen in the summer feeding on the Jura coast opposite the proposed Development site. These were probably of local breeding origin. Twite breed in moderate numbers across the region; a single pair is likely to represent well below 1% of the regional population. It is highly unlikely that any form of the Development process (section 14.2) could potentially affect twite, therefore, this species is not considered further in this Chapter.

14.4.2 Surface Diving Seabird Species

14.56. Seventeen species of seabird were recorded using the inner sound both in the breeding season and at other times of year. This involved nine species classed as surface diving species: red-throated diver, great northern diver, black guillemot, common guillemot, razorbill, shag, cormorant, eider and common scoter.

14.57. Red-throated divers (high NCI) occurred in small numbers in the inner sound throughout the year but mostly in summer. The birds present in the summer were probably local breeding birds that visit the sound to feed. These birds were seen flying from central Jura where it was presumed they were nesting. The estimated population size for Argyll is about 80 pairs (Forrester and Andrews, 2007) and therefore it is likely that a single pair represents >1% of the NHZ 14 regional population.

14.58. The few red-throated divers recorded outside the breeding season were likely to be birds from breeding sites outwith the region; either passing through on migration or visiting for the winter. The winter population for the Argyll and Clyde coasts is estimated to be 232 birds (approximating to NHZ 14 and NHZ 17 combined) (O’Brien *et al.,* 2008). Therefore, the few birds intermittently present in the Sound of Islay outside the breeding season are unlikely to exceed 1% of the regional population.

14.59. The sightings of red-throated diver were not evenly distributed over the inner sound, because there was a tendency for the shallower areas to be favoured and the proposed Development site to be avoided.

14.60. Approximately 2-4 great northern divers (high NCI) were typically present in the inner sound survey area during the winter months. These birds were also commonly seen flying through the sound, probably on migration. There were proportionally few records of great northern diver from the deepest areas of the inner sound that coincide with the proposed Development site (Figure 6 in Technical Appendix 14.1).

14.61. The over-wintering population of great northern diver in Scotland is estimated at approximately 2000-3000 (Forrester and Andrews, 2007). No population estimate is available specifically for the NHZ 14 region; however, Argyll alone is known to support up to a few hundred individuals (Craik 2002). Therefore, 2-4 birds typically present in winter are unlikely to exceed 1% of the regional population, therefore the inner sound (and consequently the Development site) is not considered to be of regional importance.

14.62. Black guillemot (moderate NCI) is a resident auk species that breeds in small colonies on sea cliffs and rock outcrops along the Islay side of the inner sound (Figure 3 in Technical Appendix 14.1). A total of 66 individuals were counted in a pre-breeding survey in April 2009 suggesting a breeding population of around 35 pairs. This estimate represents about 2.3% of the regional (Argyll and Bute) population of 3046 individuals (Mitchell *et al*., 2004) and is thus considered to be of regional importance. Approximately four pairs apparently bred on low cliffs adjacent (within 200 m) to the western edge of the proposed Development site. Approximately 5 further pairs apparently bred within

300 m of Port Askaig, approximately 100 - 500 m north of the proposed Development site (Figure 3 in Technical Appendix 14.1).

14.63. Black guillemot were seen on the sea of the inner sound throughout the year and commonly foraged. They showed a strong tendency to avoid the deep water areas including the proposed Development site (Figure 4 in Technical Appendix 14.1.) Black guillemots usually make feeding dives to the sea bed to hunt for small fish and it is likely that it is unprofitable for them to hunt in depths greater than about 40m.

14.64. Two other auk species, razorbill and common guillemot, do not breed within the sound but can range far from their breeding colony (up to 50 km or more) to feed and both have relatively large populations breeding within the region. Numbers recorded in the inner sound, however, were well below 1% of the regional populations and for this reason these species are rated as low NCI (see Table 14.2). Razorbill and common guillemot make deep dives to catch small fish prey. The distributions of these species on the sea in the inner sound showed that the birds generally avoided the deepest areas including the proposed Development site (Figure 5 in Technical Appendix 14.1). In most cases it is impossible to know whether seabirds seen during the breeding season were breeding or non-breeding individuals and, if the former, which colonies they originate from. In the case of razorbill, some of the birds seen in late summer had attendant dependent young and so were definitely breeding birds.

14.65. Shags (low NCI) occurred commonly in the inner Sound of Islay throughout the year. On average there were approximately 15-20 individuals present in the spring and summer, 20-25 in the autumn and 40 in the winter. These numbers are well below 1% of the regional population size (approximately 3341 pairs) and are therefore not considered to be of regional importance. No shags were noted breeding in the inner sound but there were small breeding colonies in the outer sound. Shags make deep dives to hunt fish on or close to the sea-bed. The distribution of shags recorded on the sea indicates that they tended to avoid areas greater than 40m depth, including the proposed Development site (Figure 7 in Technical Appendix 14.1).

14.66. Cormorants (low NCI) were present in the inner sound in very small numbers (maximum 3) throughout the year. This is well below 1% of the regional population. As a result of the very low abundance of cormorants, the species is not considered further in this Chapter.

14.67. Eider (moderate NCI) occurred in the inner sound in moderate numbers in the late summer and autumn. The maximum count was 156 individuals but on average there were less than 100 individuals present. The peak numbers using the inner sound are of regional importance representing approximately 3% of the wintering population in Argyll (Forrester and Andrews, 2007). Eider feed by diving to the seabed to catch mainly bivalve molluscs. The records of eider were not evenly distributed in the inner sound: they showed a strong preference for the shallower areas and almost completely avoided the deep waters of the proposed Development site (Figure 9 in Technical Appendix 14.1).

14.68. Common scoter (high NCI) was recorded on passage in very small numbers in autumn and winter flying through the sound. There was no evidence that inner sound regularly supported any wintering or moulting common scoter or that there was suitable feeding habitat present. The numbers seen were below 1% of the regional winter population (up to approximately 500 individuals, though numbers are highly variable between years). Although common scoter is a high NCI species, the low numbers observed and the apparent lack of any dependence on the sound as a feeding site indicate that potential effects of the proposed Development (Section 14.2) will be unlikely to be relevant. This species, therefore, is not considered further in this Chapter.

14.4.3 Plunge Diving and Surface Active Seabird Species

14.69. Of the seventeen species of seabird recorded using the inner sound eight species were classed as plunge diving and surface active species: Arctic tern, gannet, Manx shearwater, Arctic skua, kittiwake, herring gull, great black-backed gull and common gull.

14.70. A pair of Arctic skua (moderate NCI) probably breed locally on moorland habitat on Jura (the exact location was not determined but was >1 km from the Development) and regularly fed in the inner sound. Arctic skua is a scarce breeding bird in the region with a population of only 21 pairs, so a single pair is of regional importance. Arctic skuas were also recorded flying through the sound on several occasions in August although these were likely to be passage birds.

14.71. Small numbers (maximum 4) of arctic tern (high NCI) were seen feeding in the inner sound regularly from May to July. This represents well below 1% of the regional population (1823 pairs). The birds seen were probably from the small arctic tern colony located on the Jura coast approximately 3km north of the proposed Development site.

14.72. Small numbers of herring gull (moderate NCI), common gull, and great black-backed gull (both low NCI) were recorded in the inner sound throughout the year. In all cases the numbers are well below 1% of the regional breeding population totals (herring gull 15,370 pairs, common gull 2,683 pairs, great black-backed gull 1736 pairs). Several pairs of common gull bred locally along the shores.

14.73. Three other seabird species, none of which nest locally, used the inner sound for feeding, especially in the late summer. These are gannet, Manx shearwater, and kittiwake (all low NCI). All these species typically range far (up to 50 km or more) from breeding colonies to feed and all have relatively large populations within the region (kittiwake 8976 pairs, gannet 35,825 pairs all at Ailsa Craig, Manx shearwater approximately 3249 pairs) and elsewhere in western Scotland. In all cases the numbers present at any one time in the inner sound were well below 1% of the regional populations. Nonetheless although of low NCI, these three species were regularly present and sometimes common in the inner sound.

14.5 Impact Assessment

14.74. Potential effects are evaluated in respect of all species of high or moderate Nature Conservation Importance (Table 14.6). Emphasis is given to species identified as sensitive receptors. In considering the NCI of potentially affected species, consideration has been given to the criteria in Table 14.2. Given the novelty of tidal power developments and, therefore, the desire to address the full breadth of potential ornithological concerns in this ES (and satisfy SNH's scoping request concerning assessment of seabirds: see Section 14.3.2.1), potential effects are also evaluated for certain seabird species that are rated as low NCI but that were regularly present in the inner Sound of Islay (Table 14.6).

TABLE 14.6 NATURE CONSERVATION IMPORTANCE OF POTENTIALLY AFFECTED SPECIES	
Importance	**Species**
High	Red-throated Diver, Great Northern Diver, White-tailed Eagle, Arctic Tern
Moderate	Eider, Black Guillemot, Arctic Skua, Herring Gull
Low	All other species, including Shag, Gannet, Razorbill, Common Guillemot, Manx Shearwater and Kittiwake

14.75. To reiterate Section 14.2 of this Chapter, the types of potential effects on birds which can be quantitatively assessed, resulting from the proposed Development, are likely to be:

- displacement of birds as a result of construction and decommissioning disturbance activities;
- displacement due to operational maintenance activities (especially from vessel movements and, perhaps, loud noise), and/or due to the presence of the operating tidal turbines close to feeding sites;
- collision with rotating turbine blades during operation;
- the effects of pollutant contamination during operation; and
- direct loss of sea-bed habitat due to turbine bases.

14.76. Due to the differing biology of the three classes of species described earlier (Section 14.4) it is apparent that not all of the potential effects are relevant to each class. Notably, for terrestrial species the only potential effect will be increased land-based disturbance during construction and decommissioning e.g. activities close to and on shore related to cable landfall activities, construction compound, substation location and underground cables.

14.77. All electrical cabling between the proposed turbines and the onshore substation would be either sub-sea cables or buried underground. Electrical connection to the national grid would be the subject of a separate planning application.

14.78. The relevant regulations and codes of best practice covering the safe use of oil, lubricants, chemicals and antifouling paints in the marine environment will be fully complied with. Contingency plans for dealing with any accidental release of these pollutants will be drawn up as part of the site construction plans. As well as being made a matter of high priority operational policy.

14.79. The land take caused by the proposed Development will result in negligible loss of terrestrial habitat, being restricted to a small area (likely to be <0.1 ha) of rough moorland coinciding with the proposed footprint of the sub-station on Jura.

14.80. The loss of sea-bed habitat caused by the deployment of turbine bases will be <33m^2 for each turbine, and so for 10 turbines would amount to approx. 330m^2 in total. With respect to the proposed site boundary this represents approximately 0.3% of the proposed Development site. Although this loss will, based on the duration of any granted consent – initially 7 years - and possible extension – likely 8 years, be Medium to Long Term temporally (Table 14.5) it will be Negligible spatially (Table 14.4). Therefore the effects of direct habitat loss due to sea-bed take and land take are deemed not significant for all species under the terms of the EIA Regulations.

14.5.1 Potential Impacts during Construction Phase

14.81. Surveys to locate the nests of birds listed in Schedule 1 of the WCA will be undertaken prior to construction (and prior to decommissioning) works during the period March-August. In the event that an active nest of a Schedule 1 species is discovered within distances (of construction activities) given by Whitfield *et al*. 2008 (or a 500 m radius of the nest for species not listed by Whitfield *et al*., 2008) then activities within the specified distance, including vessel movements, would be halted immediately. A disturbance risk assessment (prepared under a Breeding Bird Protection Plan for the site) would be undertaken and any measures considered necessary to safeguard the breeding attempt (e.g. exclusion zones or restrictions on timing of works) would be submitted to SNH for agreement before recommencing work.

14.82. Construction activities close to the active nest sites of specially protected species (those on Schedule 1 of the WCA) would be avoided (see above) and therefore disruption of active breeding attempts is highly unlikely. On the basis of the breeding distribution of specially protected species in 2009 (including the prospective pair of white-tailed eagle) it is unlikely that any of these species will nest within 1 km of the Development during construction and so the Breeding Bird Protection Plan is unlikely to be required. It is likely that noise and disturbance from vessels associated with construction activities would temporarily displace some foraging or resting birds, particularly seabird species. Potential effects are likely to be greatest during the period when birds breed, though some birds, like those that migrate through or are winter visitors, may encounter potential effects at other times. Birds that are disturbed at breeding sites are vulnerable to a variety of potential effects that may lead to a reduction in the productivity and survival rates of bird populations, including:

- the chilling or predation of exposed eggs / chicks;
- damage or loss of eggs / chicks caused by panicked adults;
- the premature fledging of young; and
- disturbed birds may also feed less efficiently and breed less successfully.

14.83. Disturbance effects on birds during construction would be confined to areas close to shore activities, such as piers, construction compounds, the cable route and sub-station, the routes travelled by construction, maintenance and survey vessels, and the vicinity of turbines. Construction is anticipated to last approximately 3 months, including approximately 1 breeding season.

14.5.1.1 Terrestrial Species

14.84. No nest sites of terrestrial species (or potential nest sites for white-tailed eagle) were recorded at distances at which disturbance of breeding birds should occur (Whitfield *et al*., 2008). Therefore, it is unlikely that there will be any direct effects on breeding terrestrial birds during construction.

14.85. As noted earlier, construction disturbance may also potentially have an adverse effect through displacement of foraging birds. For species which forage in terrestrial habitats the terrestrial area which will be affected during construction is small relative to foraging ranges of the species concerned. Moreover, observations suggested that no 'terrestrial' species made frequent use of the areas liable to be affected during construction. In addition, since construction will be short-term it is unlikely that there will be any measurable effect on populations of terrestrial species (i.e. merlin, hen harrier, white-tailed eagle) and so disturbance effects during construction will not be significant for these species under the terms of the EIA Regulations.

14.5.1.2 Surface Diving, Plunge Diving and Surface Active Seabird Species

14.86. Due to the distance of onshore construction activities from recorded nests sites, relative to known distances at which breeding birds may be disturbed (e.g. Whitfield *et al*., 2008), the only breeding seabird species of conservation concern which may be affected at breeding sites during construction is the black guillemot (moderate NCI). This species nests on the coastline of the inner sound including those parts closest to the proposed Development site. Frequent disturbance during construction close to black guillemot nest sites could lead to reduced breeding success. There are no published observations of disturbance distances of this species at the nest. Nevertheless, 250 m is probably reasonable and precautionary as a distance at which direct disturbance should not occur, based on other species and the anecdotal observations of black guillemots breeding in the Sound of Islay during baseline surveys. It is estimated that there were four pairs of black guillemots nesting within a distance at which direct disturbance of nesting birds may be affected by construction activities within the proposed Development site. Additional pairs may be affected by movements of construction vessels outwith the proposed Development site boundary; this will depend on the routes taken by vessels. Some, perhaps all, of the birds which may be affected will already be subject to a relatively high level of background disturbance and the species can apparently readily habituate to such disturbance, judging by the locations which can be used as nest sites (e.g. holes in quay walls of busy harbours) (Greenwood 2010). Given these observations and that, at worst, breeding success will probably be only slightly depressed short-term, and only in a negligible proportion of the population, it is reasonable to conclude that the effect of construction disturbance on black guillemots will be negligible and not significant under the terms of the EIA Regulations. While not necessary under the EIA Regulations, measures are described in the Breeding Bird Protection Plan that, in the interests of best practice, will mitigate against potential adverse effects on black guillemots.

14.87. None of the other seabird species of high or moderate NCI breed in or close to the areas that will be potentially affected by construction disturbance. Therefore the effects at breeding sites due to construction are likely to be nil and, therefore, not significant under the terms of the EIA Regulations.

14.88. All seabird species that feed in the inner sound would be potentially affected by displacement due to disturbance from construction vessels and construction noise (*Chapter 10: Noise and Vibration Affecting Human Receptors*). However, this disturbance is expected to be only moderate in comparisons to the baseline activity of vessels using the sound and the associated noise this creates. Although the baseline levels of vessel activity inevitably causes some localised temporary disturbances of seabirds there is no evidence that this has any adverse effects on the seabird populations using the sound. Furthermore, the additional disturbance from construction vessels will be concentrated within the proposed Development site, an area that is generally avoided by surface-diving seabird species (e.g. diver and auk species, shag and eider) (Technical Appendix 14.1) which suggests that it is unimportant, even locally, as a foraging area. This is probably because of the relatively large sea depth within the proposed Development site. Therefore, most of the additional disturbance will be away from the area preferred locally by surface-diving seabirds. Any construction disturbance of seabirds would be temporary and of short duration. Based on observations of the response of seabirds disturbed by vessels during baseline survey work, the most likely effect of any additional disturbance from construction vessels would be for birds to be temporarily inconvenienced as they relocate to a nearby (up to a few hundred meters away) location.

14.89. Furthermore, in all cases the numbers of individuals of each seabird species using the inner sound represent at most a small proportion of the regional populations. Therefore, the short-term displacement effects on seabirds are deemed not significant under the EIA Regulations.

14.90. Overall, therefore, although construction disturbance could potentially affect almost all bird species using the inner sound, it is predicted that the effects of any disturbance will be **negligible**. It is unlikely that the effects would have a measurable effect on abundance, survival or productivity at the regional scale. Therefore, the predicted effects are not significant under the terms of the EIA Regulations.

14.5.2 Potential Impacts during Operational Phase

14.5.2.1 Terrestrial Species

14.91. For all terrestrial species of high or moderate nature conservation importance, operational effects of the proposed Development will be neutral or barely discernible and will therefore not be significant under the terms of the EIA Regulations.

14.5.2.2 Surface Diving Seabird Species

14.92. For surface diving seabirds, a potential effect during the operational phase of the proposed Development is disturbance by displacement from foraging areas, principally from maintenance and survey vessels. Although essentially similar in nature to vessel disturbance caused during the construction phase, the frequency and duration of any disturbance caused during the operational phase is likely to be much less and against a background of substantial vessel activity in the absence of the proposed Development. Therefore, following the additional reasoning outlined in Section 14.5.1, it is predicted that the likely effects of vessel disturbance on surface diving seabird species during the operational phase will be negligible and not significant under the terms of the EIA Regulations.

14.93. The tidal turbines themselves could plausibly directly affect only those species that potentially occupy the same location, i.e. the sea bed and water depths where turbines are sited. The turbine rotors would occupy depths between approximately 16.5-40 m below the sea surface. Therefore, the surface diving seabird species could be directly affected by turbines through avoidance of the vicinity of the turbines (i.e. displacement) and by collision with rotors possibly causing injury or death (i.e. in a similar fashion to the familiar issue of flying birds colliding with wind turbine rotors). Due to the novelty of the technology and the lack of studies there is no information on how diving birds are actually affected by operational tidal turbines. This information gap requires investigation (Shields, 2009).

14.94. Nevertheless, the numbers of surface diving seabirds listed above that regularly use the inner sound are in all cases small in a regional context; numbers of only two species recorded by the bird surveys of the inner sound (black guillemot and eider) exceeded 1% of the regional population and then only marginally. The proposed Development site occupies approximately 10% of the area of the inner sound (i.e. the area covered by bird surveys). Furthermore, all surface diving seabird species showed a tendency to avoid the propose Development site (Technical Appendix 14.1). Therefore, even under the worst case scenario where all surface diving seabirds would be permanently displaced from the proposed Development site (which is unlikely), the effects of displacement by operational turbines would result in a negligible loss of foraging habitat to these species at a regional level. This effect is not considered to be significant under the terms of the EIA Regulations.

14.95. The issue of the potential collision threat to surface diving seabirds is more difficult to predict. Studies are required to establish how diving seabirds, and their fish prey, respond to submerged turbines and to quantify the extent to which they are able to avoid collision (Shields, 2009). The indications from studies at the SeaGen installation in Strangford Lough have so far provided no evidence of collisions with diving seabirds.

14.96. The baseline bird surveys provide strong evidence that the assemblage of surface diving seabirds generally avoided the areas of deepest water for feeding (Technical Appendix 14.1). Although these species sometimes occurred on the sea surface within the proposed Development site they were seldom observed to dive in the deep water areas where the proposed Development will be located. This is not surprising as it is likely that most of these species are usually diving to the seabed (or close to it) to forage and diving to depths greater than about 30m is likely to be increasingly energetically less profitable than foraging in nearby shallower areas (Wanless *et al*., 1997). If, as seems likely, the spatial distribution of foraging activity by surface diving seabirds during the operational phase will be similar to that observed during baseline surveys then these species will seldom dive into the space occupied by turbine rotors; therefore, there will be a **negligible** risk of collision. Thus, to a large extent, diving birds are predicted not to occupy the same water space as turbine rotors; therefore, they are predicted to be exposed to **negligible** collision risk. Furthermore, if operational turbines have a displacement effect on diving seabirds then the potential for collision will be reduced correspondingly. However, given the uncertainties of the underwater behaviour of diving birds and how they might respond to submerged turbines a precautionary approach to the assessment of risk is warranted. Paying heed to the likely limits of such uncertainties, the magnitude of the risk of collision to diving seabirds is assessed as being low in a local context: in a worst case scenario a small number of individuals could be killed (or injured) over the lifetime of the project. It is not possible to quantify the actual numbers due to the limitations of the current information on how diving birds respond to turbines. Nevertheless, given that for each species the numbers of individuals that could plausibly be killed or injured are at most a small proportion of the birds that use the inner sound and these in turn constitute only a small proportion of the regional populations, it is predicted that collision mortality would have negligible effects on the regional populations of surface diving seabird species.

14.97. It is possible that the submerged turbines, the upper parts of which would be in water depths regularly visited by feeding surface diving seabirds (i.e. <30 m), might attract fish prey which in turn could attract diving birds. If this happened then surface-diving seabirds might be at a slightly greater risk of collision than the above reasoning suggests. It is not possible to quantify this risk due to the lack of understanding of how fish and birds respond to submerged turbines. Recognising these uncertainties but also applying knowledge that the numbers of surface diving seabirds using the inner sound comprise only small proportions of the regional populations, it is likely that, at worst, the overall effect of this theoretical collision risk on regional populations will be **low**.

14.98. Therefore, the effects of collision on all species are not considered to be significant under the terms of the EIA Regulations.

14.99. The release of oil and other marine pollutants and the toxic effects of anti-fouling chemicals could have lethal and sub-lethal effects on seabirds and their prey. For example it is well known that oil slicks can kill seabirds. As the various regulations and codes of practice covering the safe use of oil, lubricants, chemicals and antifouling paints in the marine environment will be fully complied with, the risks of such contamination occurring would be limited to accidental release. Even so, the Development will also adopt an explicit policy to deal rapidly and effectively with any accidental release of pollutants.

14.100. Given such a contingency policy, and: a) that the quantities of any oil or chemicals accidentally released are likely to be relatively small; b) that the strong tidal currents would quickly disperse and dilute any contaminants and, c) that the numbers of all seabird species using the inner sound are small in a regional context, then the likely effects on regional seabird populations (for both classes of species) are assessed as **negligible**. These effects are not considered to be significant under the terms of the EIA Regulations.

14.5.2.3 Plunge Diving and Surface Active Seabird Species

14.101. Plunge diving and surface active seabirds could potentially be affected by the operational phase of the proposed Development due to displacement from foraging areas, principally from maintenance and survey vessels. However, as reasoned for surface diving seabirds, it is unlikely that the operational displacement by vessels connected to the proposed Development will have a material influence on plunge diving and surface active seabirds and will not be significant under the terms of the EIA Regulations.

14.102. As noted in the previous section, the tidal turbines themselves could plausibly directly affect only those species that potentially occupy the same location. The turbine rotors would occupy depths between approximately 16.5-40 m below the sea surface in areas of the Sound that exceed at least 48m water depth (below chart datum). Plunge diving and surface active species such as Arctic skua, gannet, kittiwake, Arctic tern and Manx shearwater do not regularly attain such depths and so are unlikely to be directly affected by the turbines. Gannets can sometimes attain depths >15m (Brierley, 2001) when targeting large prey but their dives are typically <5 m when targeting small prey (Garthe, 2007). Consequently it is considered unlikely that any displacement or collision risk due to the submerged turbines will influence this group of seabirds (and whose abundance within the whole inner sound, moreover, was relatively low). Displacement and collision effects due to the sub-sea turbines are therefore not deemed significant under the terms of the EIA Regulations.

14.5.3 Potential Impacts during Decommissioning Phase

14.103. Habitat reinstatement requirements would be set out in consultation with the statutory authorities at the time of decommissioning. It is anticipated that turbines would be removed at the end of the operational phase (approx. 15 years). Disturbance effects due to decommissioning are anticipated to last approximately three months and be of lower intensity than during construction, and so effects would be similar in nature but of lower magnitude than during installation.

14.104. The magnitude of decommissioning effects on all species is considered to be **negligible**. Even in the case of species of highest NCI (refer to Table 14.6) these effects are judged unlikely to be significant under the terms of the EIA Regulations.

14.6 Mitigation and Management

14.105. No effects were identified as significant under the terms of the EIA Regulations. Nevertheless, it is considered good practice to implement appropriate measures to mitigate any local effects and thereby minimise potential (albeit assessed as negligible) adverse impacts.

14.106. As noted earlier (Section 14.5.1) surveys to locate the nests of birds listed in Schedule 1 of the WCA will be undertaken prior to construction (and decommissioning) works during the period March-August. These surveys will be undertaken to inform measures to safeguard any breeding attempts from disturbance.

14.107. The risks to seabirds of accidental release of marine contaminants will be minimised by adopting safe working practices and having contingency plans for dealing with incidents

14.108. Good practice would aim to minimise disturbance by vessels associated with the proposed Development to seabirds using the inner sound during all phases of the proposed development by avoiding where possible preferred feeding areas and adopting voluntary speed restrictions whenever possible. Studies elsewhere indicate the severity of disturbance by boats is related to speed (Ronconi and Cassady St. Clair, 2002). Vessel speed limits are commonly used to limit disturbance to seabirds in the vicinity of colonies and feeding sites; however there is no accepted maximum permissible speed.

14.109. Artificial nest sites for black guillemots located away from the immediate vicinity of the proposed Development site should help reduce disturbance effects on the breeding population of this species (see also Section 14.3.2.1). It could also lead to an increase in the local population size (though this is likely to be limited by food supply) and breeding success, thereby helping offset any adverse effects on this species. Artificial nest sites should take the form of specially designed nest boxes or providing suitable cavities in stone walls or quays next to the sea. It is anticipated that approximately ten such sites should be constructed given the numbers of existing nest sites that may be affected by the proposed Development and that not all artificial sites may be occupied.

14.7 Residual Effects

14.110. Any construction and decommissioning effects leading to direct disturbance of nesting Schedule 1 species will be avoided due to the Breeding Bird Protection Plan (BBPP) (Section 14.5.1).

14.111. The risks to seabirds of accidental release of marine contaminants will be minimised by adopting safe working practices and having contingency plans for dealing with incidents.

14.112. Adoption of voluntary speed limits to minimise disturbance whenever possible and avoiding preferred seabird feeding areas should reduce any disturbance effects due to vessel traffic.

14.113. Provision of artificial nest sites for black guillemots away from regularly disturbed areas should help reduce potential disturbance effects on this species (primarily during construction) and may well create a net beneficial effect.

14.114. Other regional effects assessed in Section 14.5 would remain unaffected by the proposed mitigation.

14.8 Cumulative Impacts

14.115. The EIA Regulations require that the proposed Development be assessed cumulatively along with other projects or plans. In doing so, SNH guidance (2005) on assessing cumulative effects has been followed. In considering cumulative effects it is necessary to identify any effects that are minor in isolation but which may be major additively.

14.116. 'Target' species were taken to be those species of high and medium Nature Conservation Importance (Table 14.2) and for which there was some indication of a potential impact as a result of the proposed Development which may be exacerbated cumulatively. In assessing cumulative impacts of development projects only tidal power developments were considered; whilst terrestrial species may be affected by other forms of development (e.g. onshore wind energy schemes) the predicted impacts of the proposed Development described herein on these species were so small that they could not conceivably contribute measurably to any cumulative regional effects.

14.117. The only other tidal power development within the regions considered by the assessment of the proposed Development is a planned tidal array off the west coast of Islay, approximately 40km away from the proposed Development site. This project is currently in the early stages of collecting baseline survey data (i.e. it has not reached a planning application stage) and so no information on predicted effects is available. It has an offshore location and is therefore not likely to have any effects on the various species of terrestrial bird species (raptors, geese, waders, passerines) nor the inshore coastal seabird species (divers, eider, black guillemot, Arctic tern) that form the bulk of species plausibly affected by the Sound of Islay Demonstration Tidal Array.

14.118. In conclusion, the cumulative combined effects of the proposed Development and other projects are likely to be **negligible** and so not deemed to be significant under the terms of the EIA Regulations.

14.9 Summary

14.119. Effects are summarised in Table 14.7.

TABLE 14.7 : SUMMARY OF EFFECTS		
Potential effect	**Mitigation**	**Residual Effect**
Sea-bed take (all phases)		
All species	None	**Negligible**
Disturbance (construction and decommissioning))		
Breeding Schedule 1 species	Breeding Bird Protection Plan	**Nil/Negligible**
Disturbance (all phases)		
Seabird species	Limit marine vessels to speeds that allow seabirds time to move away. Choose vessel routes that avoid preferred feeding areas.*	**Negligible**
Black Guillemot	Provide nest boxes away from places subject to regular disturbance*	**Nil/Negligible**
Other species	None	**Negligible**
Collision (operational phase)		
All species	None	**Negligible/Low**
Pollutant contamination (all phases)		
Seabird species	Adopt safe working practices, draw up contingency plans for accidents and have equipment available for dealing with incidents	**Negligible**
Cumulative		
All species	None	**Negligible**
* N.B. Under best practice recommendations only		

14.10 Proposed Monitoring

14.120. None of the proposed Development's potential effects on birds are deemed to be significant. Even so, best practice dictates that an appropriately detailed monitoring programme should be agreed and implemented. The value of monitoring the Sound of Islay Demonstration Tidal Array to the wider tidal renewables industry is likely to be particularly high given that this would be one of the first tidal renewable projects, the geography of the site facilitates survey work (as much can be done from the land) and there is a relatively high level of pre-construction baseline survey data for comparison.

14.121. Under the BBPP surveys to locate the nests of birds listed in Schedule 1 of the WCA will be undertaken prior to construction (and decommissioning) works during the period March-August. These surveys will be undertaken to inform measures to safeguard any breeding attempts from disturbance.

14.122. Monitoring studies of greatest value include:

- Pre-breeding surveys of black guillemot in the Sound of Islay, including the monitoring of any nest boxes provided;
- Surveys to quantify the distribution, abundance and behaviour of diving seabirds using the Development site and other parts of the Sound of Islay. The behavioural surveys should collect evidence of changes in behaviour in response to the proposed Development including disturbance, displacement, attraction and habituation; and
- Surveys to quantify the level of human activity, in particular vessel movements, associated with the construction and operation phases of the proposed Development.

14.123. The surveys noted above should be conducted during construction and in years 1 – 3, 5 and 10 of the proposed Development's 15-year operation period. However, flexibility will be retained to cancel this monitoring programme if it is clear that beneficial information is not being collected.

14.124. Given the Development's novelty, an appropriately detailed bird monitoring programme should be agreed, with an Ornithological Steering Group for the Sound of Islay Demonstration Tidal Array to establish protocols and review results on a suitably frequent basis. If distribution and abundance surveys indicate a high likelihood of interaction it would be beneficial to attempt to monitor any mortality which results from collision with the turbines. The need for and methods used to monitor collisions would be considered by the Ornithological Steering Group.

14.11 Potential Effects on SPA Interests

14.125. Whilst the Conservation (Natural Habitats &c.) Regulations 1994 ('the Habitats Regulations') provide that an assessment of the possible effects of a proposed Development on a SPA is the responsibility of the competent authority, this section of the ES Chapter provides a summary examination of the relevant issues pertaining to the potential effect of the proposed Development.

14.126. The proposed Development is in a location where (although the Development is not a statutorily designated site either at international or national level) there is a possibility that it may potentially influence the qualifying interest of two SPAs: the Jura, Scarba and Garvellachs pSPA with golden eagles as the qualifying interest, and the North Colonsay and Western Cliffs SPA, classified for its internationally important breeding seabird assemblage.

14.127. Therefore, there are two European Directives that are relevant, namely the Birds Directive and the Habitats Directive (SERAD 2000, and materials therein). The WCA transposed many parts of the Birds Directive into domestic legislation. The Habitats Directive was transposed in the UK through The Habitats Regulations. Guidance for the implementation of the Directives in Scotland is provided in Scottish Executive Circular No. 6/1995 (revised June 2000) (SERAD, 2000).

14.128. Article 6 of the Habitats Directive refers to conservation measures and assessment procedures for plans or projects affecting Natura 2000 sites (including SPAs), and the steps for assessment are outlined in Article 6 (3) and (4). Part IV of the Habitats Regulations transposes these steps into domestic legislation, with Regulations 48 and 49 being relevant.

14.129. Regulation 48 of the Habitats Regulations refers to three assessment steps: the outcome of the first two steps determining whether or not the third needs to be implemented. The three steps, set out below as questions, are:

- Step 1: Is the proposal directly connected with or necessary to the management of the site?;
- Step 2: Is the proposal, alone or in combination, likely to have a significant effect on the site? If a significant effect is likely, then an appropriate assessment is necessary; and, hence, if so
- Step 3: Can it be demonstrated in light of the conservation objectives that the proposal will not adversely affect the integrity of the site?

14.130. It is important to note that step 2 only applies to the qualifying species of the SPA and the decision is informed by the SPA's conservation objectives. The European Court of Justice (ECJ) ruling of 7 September 2004 (C-127/02) on the Waddenzee mechanical cockle fishery clarified that Article 6 (3) of the Habitats Directive should be interpreted as meaning that any plan or project (other than those directly concerned with the management of the SPA) should be subject to step 3 if under step 2 "*it can not be excluded, on the basis of objective information, that it will not have a significant effect on that site, either individually or in combination with other plans or projects*". Further, if a plan or project "*is likely to undermine the site's conservation objectives it must be considered likely to have a significant effect. The assessment of risk must be made in light of, amongst others, the characteristics and specific environmental conditions of the site concerned*." Under step 3 there is an onus on demonstrating that there will be no adverse effect on integrity, in light of best scientific knowledge, and the 2004 ECJ ruling has clarified that the consenting authority can only consent a plan or project if it is confident that a plan or project will not adversely affect site integrity, that is, when there is no reasonable scientific doubt as to the absence of such effects.

14.131. With respect to the Development, which does not lie within the boundary of a SPA, the revised Scottish Executive Circular (SERAD, 2000) advises that in order to determine the implications for the interest protected *within* the Natura 2000 site, the need for considering the assessment steps referred to by Regulation 48 of the Habitats Regulations also potentially extends to plans or projects *outside* the boundary of the site. Hence, it is a proposal's potential effect on the SPA's interest which is relevant, rather than its location with respect to the SPA boundary *per se*. Thus, the assessment steps need to be considered for the proposed Development.

14.132. **Step 1.** The construction of marine turbines and ancillary developments and activities under the proposed Development are clearly not directly connected with or necessary to conservation management of the SPAs, and therefore the next step needs to be considered.

14.133. **Step 2.** The sites' conservation objectives (relevant to both Steps 2 and 3 of an assessment) are designed to achieve the obligations set out in Article 6.2 of the Habitats Directive (which applies to SPAs) by using the components of favourable conservation status for species as set out within Article 1(i) of the Habitats Directive. This approach is recommended by the EC in their Guidance on Managing Natura 2000 Sites, Section 2.3. (European Commission, 2000). The conservation objectives for SPAs are the same as for other Natura sites in Scotland in having an overarching conservation objective to avoid deterioration of the habitats of the qualifying interest, or significant disturbance to the qualifying interest, thus ensuring that the integrity of the site (SPA) is maintained. The component conservation objectives which encapsulate the maintenance of site (SPA) integrity in the long-term, are as follows:

- ensure for the qualifying species that there is no significant disturbance;
- ensure for the qualifying species that the structure, function and supporting processes of habitats supporting the species are maintained in the long term;
- ensure for the qualifying species that the distribution and extent of habitats supporting the species are maintained in the long term;
- ensure for the qualifying species that the distribution of the species within the site is maintained in the long term; and
- ensure for the qualifying species that the population of the species is maintained as a viable component of the site.

14.134. Almost the whole of Jura, including the coast along the inner Sound of Islay, forms part of the proposed Jura, Scarba and Garvellachs pSPA (Natura, 2009). The only qualifying species for this pSPA is the golden eagle. The proposed Development lies several kilometres from the nearest golden eagle territory centre and no golden eagles were seen in the vicinity of the proposed Development site during baseline survey work in 2009 or 2010, suggesting that the area is of negligible or no importance to the species. The only part of the Development that directly impinges on the pSPA is approximately 50 m of the underground cable route and part of the sub-station compound (likely to be an area <0.04 ha) adjacent to the main road on Jura. These will result in only very minor (and in the case of the cable route, temporary) changes to the terrestrial habitats on Jura. Furthermore the proposed Development will not result in any disturbance or habitat loss that could plausibly adversely affect golden eagles under any of the site's conservation objectives. Therefore, it is unlikely that the proposed Development would have a significant effect on the ornithological interest for which the pSPA qualifies. For these reasons the proposed Development is considered not to present any plausible risk to the pSPA's interest and therefore an Appropriate Assessment under the Habitat Regulations is not required.

14.135. SNH indicated in their scoping response (SNH, 2008) that they do not consider it likely that the proposed Development would have any effects on breeding seabird SPAs because all these are located over 25km from the proposed Development site. Specifically, the closest seabird SPA, North Colonsay and Western Cliffs SPA, is over 25 km away and therefore the Sound is unlikely to be regularly used by foraging seabirds from this colony. Observations collected during the baseline surveys do not provide a reasonable basis for a contradiction of this opinion. While some razorbills apparently had dependent young (and so were from a breeding colony) numbers were small and overall numbers of all seabird species were relatively small, in keeping with SNH's opinion. Moreover, as described in previous sections the risk posed by the proposed Development to seabirds would not constitute a violation of SPA conservation objectives. Therefore, it is unlikely that the proposed Development would have a significant effect on the ornithological interest for which the SPA qualifies. For these reasons the proposed Development is considered not to present a plausible risk to the SPA's interest and therefore an Appropriate Assessment under the Habitat Regulations is not required.

14.136. **Step 3**. As recorded under Step 2, it is unlikely under the scrutiny of reasonable scientific evidence that the Development would give rise to a significant effect on the ornithological interest of the (p)SPAs. Accordingly, it is considered that no appropriate assessment is required under Step 3 to be undertaken by a competent authority under the Conservation (Natural Habitats &c.) Regulations 1994. The quantity of evidence obtained in the course of identifying and assessing the ornithological effects of the proposed Development together with the level of scientific scrutiny and assessment undertaken corroborate the finding that no appropriate assessment is required (and, hence, for the North Colonsay and Western Cliffs SPA, corroborate SNH's scoping response). Rather than omit this material from this ES on the basis that it is not considered necessary for an appropriate assessment to be undertaken, the relevant material has been presented above as it would be considered in a three-stage assessment under the Habitat Regulations.

14.137. Potential cumulative (in combination) effects have been described in Section 14.8 and it is apparent that the proposed Development will not have a significant effect on (p)SPA interests in combination with other projects.

14.138. Overall, therefore, it is reasonable to conclude that the Development will not have a significant effect on the integrity of (p)SPAs, either alone or in combination with other developments.

14.139. It follows that there will be no detrimental effects on the respective SSSI designations which spatially overlap those of the (p)SPAs.

14.12 Conclusions

14.140. The likely effects of the proposed Development were evaluated in accordance with Section 14.3 and the significance of each potential effect stated under Section 14.3.

14.141. It is concluded that the likely effects of the proposed Development on all bird species are **not significant** under the terms of the EIA Regulations.

14.142. The available information indicates, beyond reasonable scientific doubt, that the Development will not, either alone or in combination, have a significant effect on any classified or proposed SPAs.

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15.0 Commercial fisheries

15.1 Introduction

15.1. This chapter presents the existing environment within the study area (as defined at Paragraph 15.26) and assesses the impact of the proposed Development and export cables on commercial fisheries within this area.

15.2. The fishery resource within and around the Development site and those directly dependent upon this resource are considered. The catching sector supports a range of associated upstream activities such as vessel and gear suppliers, and downstream activities such as marketing, processing and distribution.

15.3. This chapter should be read in conjunction with *Chapter 11: Marine Fish and Shellfish Resources*, *Chapter 12: Anadromous Fish*, *Chapter 19 Transport and Traffic* and *Chapter 13: Elasmobranchs*. Also accompanying this chapter is Appendices 15.1 to 15.4 which contains:

- Additional statistics;
- The Fisheries Liaison Officers (FLO) notes on discussions with fishermen;
- Fishermen Questionnaire; and
- A summary of fishermen's responses

Summary of Commercial Fisheries and impacts: Due to the nature of the local physical environment, commercial fishing within the Sound of Islay is limited to the use of static gears and occasional diving for scallops. Fishing for crustacean species such as velvet swimming crab, brown crab, and lobster is practiced by approximately 10 fishing vessels, with concentrated effort in the Sound of Islay occurring during the winter and spring months. Impacts of the proposed Development are deemed to range between **minor adverse** and **minor beneficial** levels providing the appropriate mitigation measures are implemented.

15.2 Potential Effects

15.4. Commercial fisheries could potentially be impacted in a number of ways by tidal arrays. The three main effects are likely to be: disturbance of fishing grounds, displacement of fishing vessels, (as outlined in the Scottish Marine Renewables SEA (Scottish Executive, 2007)) and safety implications for the fishermen. Also identified in the SEA as potential impacts are: marine noise, electromagnetic fields (EMF), changes in suspended sediment, contamination, smothering, increased turbidity and changes in hydrodynamic regime.

15.3 Methodology

15.3.1 Legislative Background and Guidance

15.5. There is no specific legislation or statutory guidelines which inform management of impacts on commercial fisheries from tidal turbines, other than through protection of the natural resources on which they depend. These are detailed in *Chapter 11: Natural Fish and Shellfish Resources*.

15.6. The European Marine Energy Centre (EMEC) has developed EIA guidance for developers seeking consent within the EMEC site on Orkney. These guidelines are very useful particularly in relation to detailing the information required for describing the project. The guidelines also give an overview of potential impacts highlighting that the loss of any substantial fishery should be considered a major impact, but do not discuss baseline reporting requirements

15.3.2 Consultation

15.7. A dedicated Fisheries Liaison Officer (FLO) was appointed by SPR at the start of the EIA process. The FLO also acted as a Community Liaison Officer (CLO) and was based full-time on Islay.

15.8. A number of group meetings were held with the fishermen, as outlined below in Table 15.1.

Table 15.1 Record of meetings regarding commercial fisheries

Date	Activity	Location	Organiser	Attendance
05/1/2009	Preliminary Hazard Assessment meeting	Port Askaig Hotel	David Cantello	7 Fishermen, Local CFA Secretary,
04/2/2009	Tidal Project Open Day	Columba Centre, Islay	Andrew Macdonald	1 Fisherman, CFA Secretary, Local CFA Secretary
04/2/2009	Islay Energy Trust (IET) AGM, Presentation on Tidal Project	Columba Centre, Islay	Andrew Macdonald	50 General Public
05/3/2009	Clyde Fishermen's Association	IET Office	Andrew Macdonald	CFA Secretary
16/4/2009	Tidal Project Update	Local CFA Secretary's Office	Andrew Macdonald	Local CFA Secretary
01/5/2009	Informal Interviews with fishermen	Various	Andrew Macdonald, Stephen Appleby	5 Fishermen
13/5/2009	Clyde Fishermen's Association	IET Office	Andrew Macdonald, Stephen Appleby	CFA Secretary
13/8/2009	Islay Show (IET Stand with Project Information)	Bridgend	Andrew Macdonald	1 Fisherman, 100 General Public
16/9/2009	Sample Fishing Trip	At sea	Andrew Macdonald	1 Fisherman
21/10/2009	Tidal Project Update	Local CFA Secretary's Office	Andrew Macdonald	Local CFA Secretary
29/10/2009	Letter to Fishermen with invite to NSRA	Royal Mail	Andrew Macdonald	21 Islay Fishermen
03/11/2009	Navigational Safety Risk Assessment meeting	ServicePoint, Bowmore	David Cantello	5 Fishermen
09/11/2009	Navigational Safety Risk Assessment meeting	Glasgow	David Cantello	CFA Secretary
09/11/2009	NSRA Minutes and Questionnaire posted	Royal Mail	Andrew Macdonald	8 Port Askaig Fishermen
07/04/2010	Update letter to Fishermen	Royal Mail	Andrew Macdonald	21 Islay Fishermen
12/4/2010	Clyde Fishermen's	IET Office	Andrew Macdonald	CFA Secretary

Table 15.1 Record of meetings regarding commercial fisheries				
Date	**Activity**	**Location**	**Organiser**	**Attendance**
	Association – review of draft EIA			

Interviews and observer trips

15.9. Local fishermen have been consulted about the project in a variety of ways including:

- Open Day event and information stands at local events;
- Meetings with the Clyde Fishermen's Association representatives;
- Formal group meetings in January and November 2009;
- Informal discussions with individual fishermen throughout the year;
- Questionnaires sent direct to fishermen across Islay (Appendix 15.3);
- An observer trip on a crabbing vessel in September 2009; and
- Project updates in the local press and IET website.

Scoping opinion

15.10. A scoping opinion was sought from statutory consultees in August 2008; responses are detailed in *Chapter 3: Consultation*, and a short summary of the main point's pertinent to commercial fisheries that were raised during this process, along with an explanation of how they were addressed, is provided below.

15.11. A key concern raised by many of the respondents such as the Scottish Environment Protection Agency (SEPA) and the Laggan and Sorn District Salmon Fishery Board was that not enough consideration had been given to the possible impacts to migratory fish such salmon and trout. In response to this an entire chapter of this ES (*Chapter 12: Anadromous Fish*) has been dedicated to anadromous fish (fish that travel between salt and fresh water) and the possible impacts to this group has been assessed there. A second concern raised by fishermen during both the scoping stage and in further consultation was the risk that the Development may pose to the health and safety. This concern has been addressed by SPR by commissioning Abbot Risk Consulting (arc) to complete a Navigational Risk and Safety Assessment (NRSA) of the Development. This documented is contained in Appendix 19.1 and addresses key issues associated with health and safety of fishermen.

15.3.3 Data collection

15.12. Information was collated from a number of sources including Marine Scotland: Compliance (formally Scottish Fisheries Protection Agency), Marine Scotland: Science (formally Fisheries Research Services), Cefas, Marine Fisheries Agency (MFA), FLO appointed for the project by SPR, local fishermen and an observation trip.

15.13. Several data sets were obtained from Marine Scotland: Compliance Marine Monitoring Centre, including:

- Annual landings by all vessels detailing live weight, value and species landed by vessel length category and port of landing from ICES Statistical Rectangles 40E3 and 40E4 (see Figure 15.12 for ICES rectangle boundaries) for 2003 to 2008;
- Monthly landings from ICES rectangles 40E3 and 40E4 for 2008, by species, live weight and value;
- MFA UK fishing vessel list for vessels under and over 10m (DEFRA, 2008);
- Air surveillance data detailing vessel gear type, activity and number of sightings by year, month and day for ICES Statistical Rectangles 40E3 and 40E4 for 2003 to 2008; and
- Vessel Monitoring System (VMS) data for vessels over 15m within the Sound of Islay and surrounding area detailing vessel gear type, activity, directional course and number of VMS logs recorded by year, month and day.

15.14. Other reports have provided important background reading, including:

- A report on the perceptions of the fishing industry into the potential socio-economic impacts of offshore wind energy developments on their work patterns and income (Mackinson *et al.*, 2006);
- Scottish Marine Renewables Strategic Environmental Assessment: Chapter C10 Commercial Fisheries and Mariculture (Scottish Executive, 2007);
- Environmental Statements for other tidal sites including SeaGen, Strangford Lough (Royal Haskoning, 2005) and Fall of Warness (Aurora Environmental, 2005); and
- Strategic Research Assessment for Wet Renewables (Davies, 2008).

Risks and uncertainty

15.15. The Registration of Fish Buyers and Sellers and Designation of Fish Auction Sites Regulations 2005 have had a significant impact on the recording of first hand sales in the fish trade. Under these regulations buyers and sellers must be registered and therefore all landings are captured in official statistics that provide an accurate representation of the commercial fishing industry.

15.16. Landing statistics are reported by ICES rectangles which are 30 minutes latitude and 1° longitude in size, and are thus approximately 30 nautical miles square. Therefore, it is not possible to report landings from a smaller specific area. However, other factors can be considered when assessing landing statistics to provide a better picture of the local fleet's activity, including vessel length category, gear type and landing port.

15.17. The overflight data used to asses fishing grounds is only a snapshot in time as the spotter plane that records this data will only fly in suitable conditions and therefore only represents a small amount of the fishing activity that occurs in the area. VMS data is now widely accepted to be a more accurate method of assessing the locations and intensity of fishing effort. However, VMS data from the Sound of Islay area could also provide a misleading indication of fishing effort levels for the following reasons: Firstly it is not a legal requirement for vessels under 15m (which includes all vessels that are known to fish within the Sound) to carry VMS equipment (therefore VMS will not pick up local fishing activity) and secondly VMS data is generally speed filtered to indicate when a vessel is fishing. However, in areas with strong currents, such as the Sound of Islay vessels in transit (not fishing) that are travelling against the tide can be slowed and will artificially appear to be fishing. As vessels slow down to enter ports such as Port Askaig (located within the Sound (Figure 15.13) they will also appear from VMS data, as though they are fishing.

15.3.4 Assessment of Significance

15.18. This section describes the methodology behind how the impacts of the construction, operation, maintenance and decommissioning of the Development on commercial fisheries have been assessed.

15.19. Impacts have been assigned a level of likely significance (from major to negligible), according to the definitions described in *Chapter 2: Scoping and Assessment Methodology*.

15.20. The impact assessment is based on an assessment of the magnitude of the impact and the sensitivity/value and/or the importance of the receptor (which in this case is commercial fisheries).

15.21. Table 15.2 provides a description of the criteria used to assess impact magnitude. Levels of magnitude are shown with a general description of the meaning of each 'level' applied within the context of commercial fisheries.

Table 15.2 Magnitude of the impact

Magnitude	Description
High	A fundamental change to the baseline condition of the commercial fisheries.
Medium	A detectible change in the baseline condition resulting in the non-fundamental temporary or permanent effect on commercial fisheries.
Low	A minor change to the baseline condition of commercial fisheries (or a change that is short lived in nature).
Negligible	An imperceptible and/or no change to the baseline condition of commercial fisheries.

15.22. The assessment of significance is based upon the magnitude and features of the impact and the sensitivity or value of the receptor. The sensitivity/value and/or importance of the receptor are determined from a set of accepted criteria (Defined within Scottish Executive SEA 2007). A detailed description of the criteria used to assess sensitivity/value and/or importance for the receptor of each impact to commercial fisheries is provided in Table 15.3 below.

Table 15.3 Description of Sensitivity or Importance/Value of Receptor.

Sensitivity / value and/or importance of receptor	Description
High	Environment is subject to major change(s) due to impact. For example, Impact on commercial fishing causing a long term (for the life of the device array) significant reduction in landings, or a permanent reduction of the fishing fleet (i.e. number of vessels) that operate within the study area.
Medium	Impact on commercial fishing activities that may cause; fishing fleets to permanently modify their fishing activities (e.g. modification of methods or gear), or, long term (for the life of the array) reduced access to traditional fishing grounds or greater transit times to grounds, or, temporary total loss of access to grounds. The total quantity of landings from the study area or the number of vessels in the fishing fleet would not be significantly reduced.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example commercial fishing activities that may cause; fishing fleets to temporarily modify their fishing activities (e.g. modification of methods or gear), or temporary reduced access to traditional fishing grounds. The total quantity of landings from the area or the number of vessels in the fishing fleet may not show a reduction that can be attributed to the Development.
Negligible	An imperceptible and/or no change to commercial fisheries.

Note: This table has been adapted from the Scottish Executive SEA (2007) significance criteria table for the purposes of this assessment. .

15.23. Table 15.4 combines the assessment for the sensitivity of a receptor with the potential impact magnitude to give an overall assessment of the environmental impact significance.

Table 15.4 IMPACT SIGNIFICANCE MATRIX

Magnitude of Impact	Receptor Sensitivity			
	Negligible	**Low**	**Medium**	**High**
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

15.24. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being a significant effect.

15.4 Baseline Description

15.4.1 Study area

15.25. The location of the proposed Sound of Islay Demonstration Tidal Array, along with associated onshore and marine infrastructure, is shown in Figure 1.1 (*Chapter 1: Introduction*).

15.26. A number of different terms are used to describe various spatial scales considered in this Chapter. The "wider region" is a term used to describe The Sound of Islay and surrounding waters. The "study area" is, for the purposes of this assessment, the term used to describe the Sound of Islay (the extent of which is displayed in Figure 15.12) and the "development site" is defined as the lease boundary option and is displayed in Figure 15.13.

15.27. The study area is predominantly within ICES rectangle 40E3 (with a very small section falling within rectangle 40E4), and therefore quantitative analysis is concentrated on this rectangle. Due regard, is also given to ICES rectangle 40E4 in relation to describing other fishing activities in the "wider region"

15.28. The main landing port within the study area is Port Askaig, and this is where the vast majority of the catch within the study area will be landed. Alternatively, Port Ellen can be used to land catches in bad weather. Other landing ports of significant importance to 40E3 and 40E4 are presented in Table 15.5 and their locations are displayed in Figure 15.12.

Table 15.5 Local ports with significant landings (£'000) during 2003-2008 from ICES rectangles 40E3 and 40E4

Port	Landings from ICES rectangle 40E3 and 40E4 combined (value £'000)	Landings from ICES rectangle 40E3 (value £'000)
Port Ellen	3379	3230
Port Askaig	2306	2245
Bowmore	1262	1186
Oban	1621	559
Troon and Saltcoats	3681	351
Campbeltown	2795	176

Table 15.5 Local ports with significant landings (£'000) during 2003-2008 from ICES rectangles 40E3 and 40E4		
Port	**Landings from ICES rectangle 40E3 and 40E4 combined (value £'000)**	**Landings from ICES rectangle 40E3 (value £'000)**
Tayinloan	3188	154
West Loch Tarbert	3932	106
Bruichladdich	46	46
Jura	130	40
Crinin	828	30

15.29. The study area covers approximately 40km^2 and contains water depths of up to 65m which occur in deep channels within the centre of the Sound. The Development site is located in water greater than 48m deep, where the seabed habitat is predominately gravel with large boulders and rocky ground. Further information on the seabed habitat, ground conditions and water conditions are presented in *Chapter 7: Physical Conditions and Coastal Processes and Chapter 8: Benthic Ecology*.

15.30. The local conditions and current speed within much of the study area render the site unsuitable for fishing practices using mobile gears, such as dredging or trawling. The main fishing activity within the study area is therefore carried out using static gears, mainly creeling for crab and lobsters. However, consultation with local fishermen has revealed that scallop dredging does occasionally occur in the most northern and most southern parts of the study area and some diving for scallops has occurred in the past (this may resume in the near future). Scallop diving is generally only conducted in water depths of less than 25m.

15.4.2 Fisheries management

15.31. Management of marine fish and shellfish stocks varies with species and is largely dependant on the scale, distribution and value of the fisheries. National and international bodies carry responsibilities for fisheries management and within Scotland this is delivered by Marine Scotland: Sea Fisheries Division and enforced by Marine Scotland: Compliance (formally Scottish Fisheries Protection Agency).

15.32. As a member of the EU and with important stocks widely distributed across other European countries, the UK is subject to the Common Fisheries Policy (CFP). Under the CFP, the EU Fisheries Commission is responsible for making recommendations/proposals, from which the Council of Ministers base management decisions for specific species.

15.33. One of the principle management tools used by the EU is the Total Allowable Catch (TAC) which is implemented through the allocation of quotas. However, the CFP is currently being reviewed and control is focusing more on effort management including days/hours at sea and technical conservation measures (TCM) such as mesh and size restrictions.

15.34. Quotas and days at sea restrictions are enforced for specific important stocks and are allocated by ICES Division. The West of Scotland is located within ICES Division VI which itself is split into VIa (West Scotland – Clyde stock) and VIb (Rockall). The area VI has quotas for the following species: spiny dogfish, anglerfish, tusk, cod, megrims, horse mackerel, haddock, greenland halibut, roundnose grenadier, herring, norway lobster (Nephrops), pollack, saithe, ling, blue ling, mackerel, whiting, blue whiting, hake, plaice, skate and ray, sole and porbeagle.

15.35. The Inshore Fishing (Scotland) Act 1984 (as amended by the Inshore Fishing (Scotland) Act 1994) gives Marine Scotland: Sea Fisheries Division managers the powers to open and close inshore areas and control the activities of certain fishing gears. Non quota species such as lobster, crab species and scallops are therefore managed at a national and/or local level through restrictions such as minimum landing sizes and number of dredges per side (for scallops) and voluntary measures such as returning berried lobster and/or crab and v-notching lobster.

15.36. The inshore fleet is due to have another means of management through the forthcoming Inshore Fishery Groups (IFGs). There are to be twelve IFGs which span the coast of Scotland out to 6 nautical miles offshore. Once established the South west IFG will be responsible for an area which includes the study area. The role of the South West IFG will be expected to include the following:

- Formulation and implementation of management plans;
- Preparation of spatial management initiatives;
- Setting up of voluntary agreements to improve working relationships amongst different types of fisheries; and
- Assessing proposals for funding priorities for an area's fisheries and communities.

15.4.3 Species of Commercial Interest in the Study Area

Overall landings

15.37. Species of greatest commercial interest landed from ICES rectangle 40E3 during the period 2003 to 2008, in order of highest value first are as follows: great scallop, velvet swimming crab, brown crab and lobster (Figure 15.1). The main species of commercial interest in the wider region (ICES rectangles 40E3 and 40E4), in order of the highest value first, are as follows: great scallop, brown crab, velvet swimming crab and lobster.

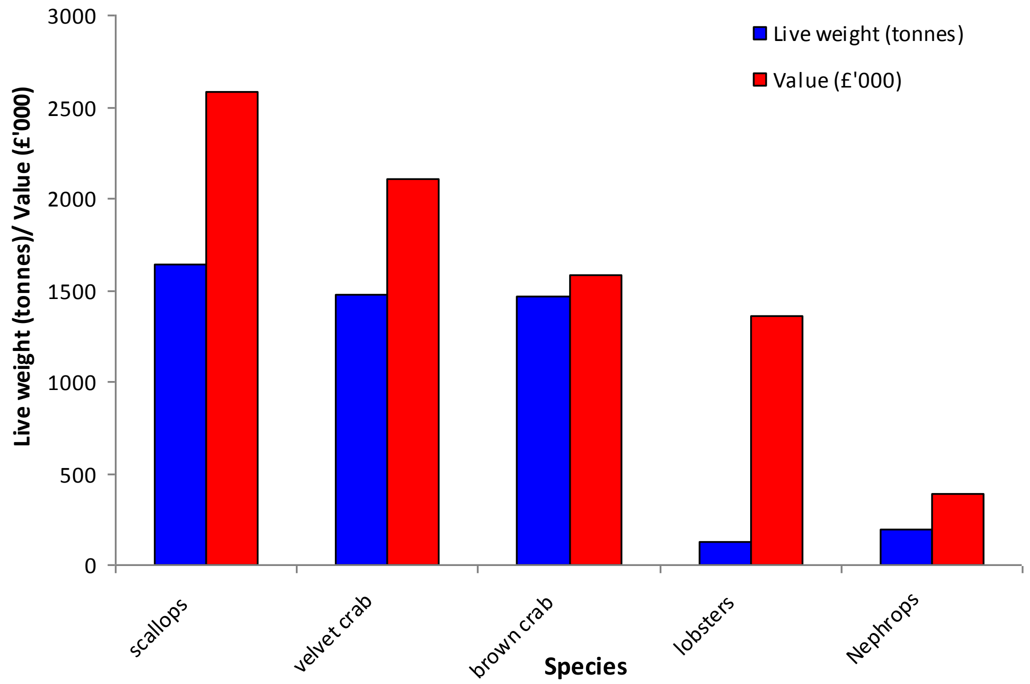

Figure 15.1 Total live weight (blue) and value (red) of landings from 40E3 by the most valuable species between 2003 and 2008.

15.38. Between 2003 and 2008 the overall value of landings from rectangle 40E3 has increased, while the live weight landed has fluctuated but overall has decreased, with the most dramatic decrease occurring from 2004 to 2005 (Figure 15.2). The total live weight landed from 40E3 in 2008 was 900 tonnes with a value of approximately £1.8 million.

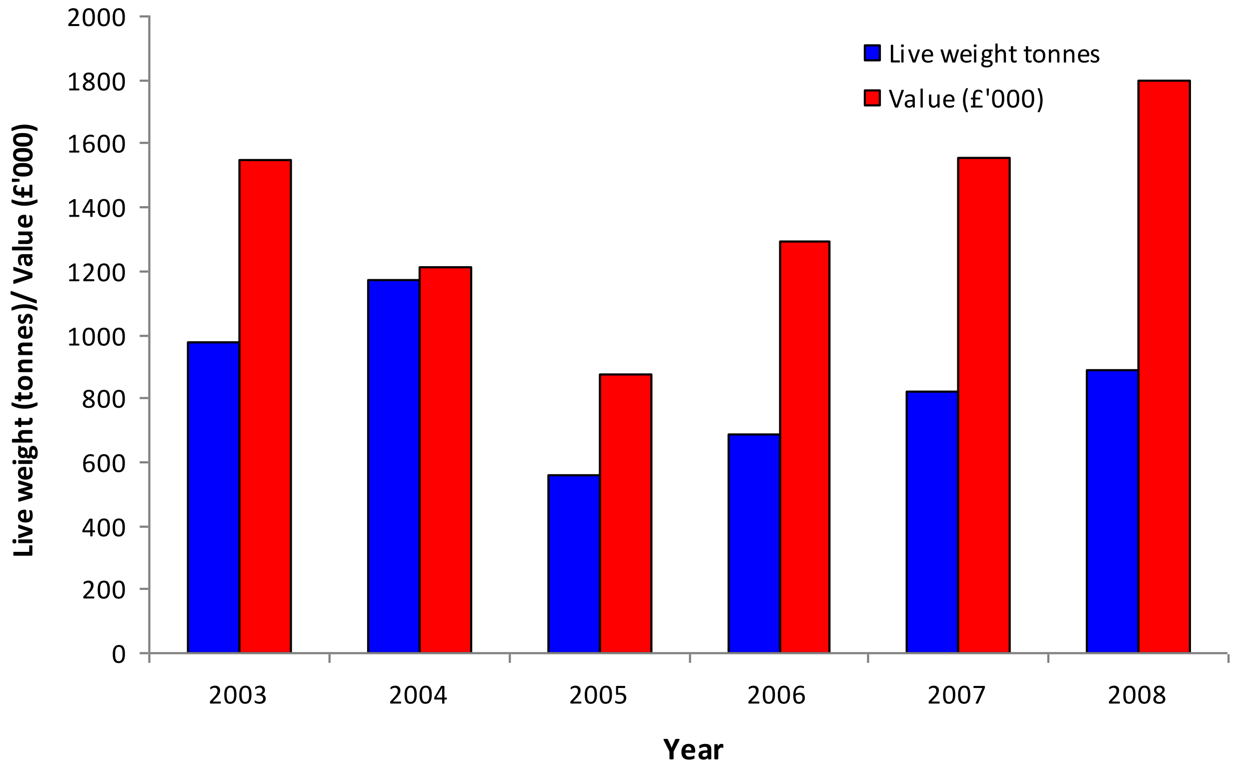

Figure 15.2 Total live weight (blue) and value (red) of landings from 40E3 by Year species.

Seasonality and distribution

15.39. Calculations of the average landing by live weight and by value per month from ICES rectangle 40E3 were conducted to highlight any general patterns with season over the time period 2003 to 2008. In terms of the live weight landed (tonnes) fishing shows clear seasonality with the highest amount of fishing being done in the summer (July to October) and the least in the winter (December to March). However, in terms of value (£'000), there is a less clearly defined trend with a high value for fish in April, May, June, August and December distorting the pattern that is seen in landings by live weight (Figure 15.3).

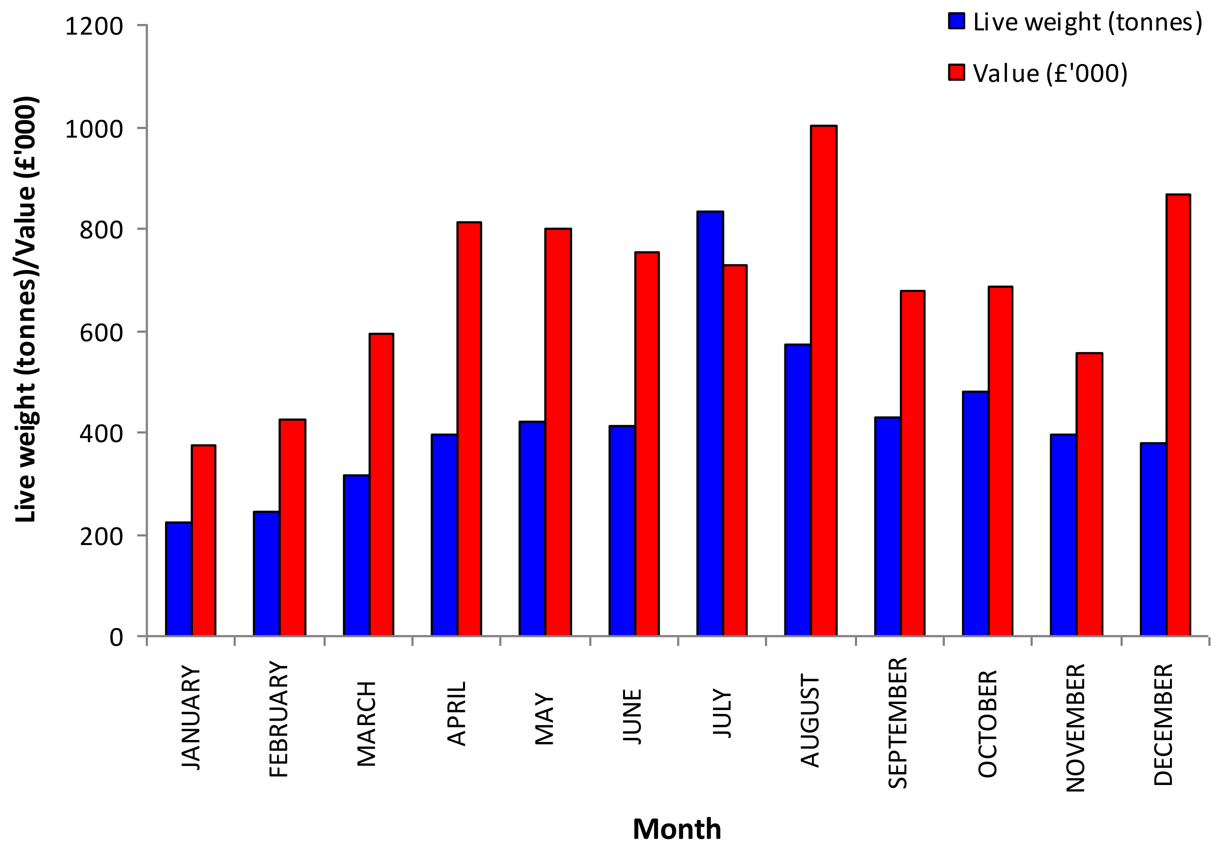

Figure 15.3 Total live weight (blue) and value (red) of landings from 40E3 by month. (Data source: Marine Scotland Compliance, 2009).

15.40. Landings at Port Askaig, which is likely to represent the majority of commercial fishing within the study area, are mostly comprised of velvet swimming crab, edible crab and lobster (Figure 15.4). These species are clearly important to commercial fisheries with the study area and have therfore been identified as “Key species”.

15.4.4 Key Species

Velvet swimming crab

15.41. Between 2003 and 2008 the velvet swimming crab *Necora puber* comprised 26% of the value of landings from ICES rectangle 40E3 and 24% of the total live weight. At Port Askaig velvet swimming crabs comprised 48% of the value of landings and 59% of the live weight.

15.42. Velvet crabs are targeted by vessels operating static gear (creelers) and interviews with local fishermen have confirmed that they are fished within the study area by up to ten vessels with the majority of activity occurring during the winter months (Appendix 15.2). Landings data confirms this seasonal trend, showing that landings of velvet swimming crab are approximately double during the latter part of the year (Figure 15.5). This increase in landings is driven by the increase in sale value over this period (by £1.81 per kg) which is likely to be due to the increased demand at Christmas from European markets.

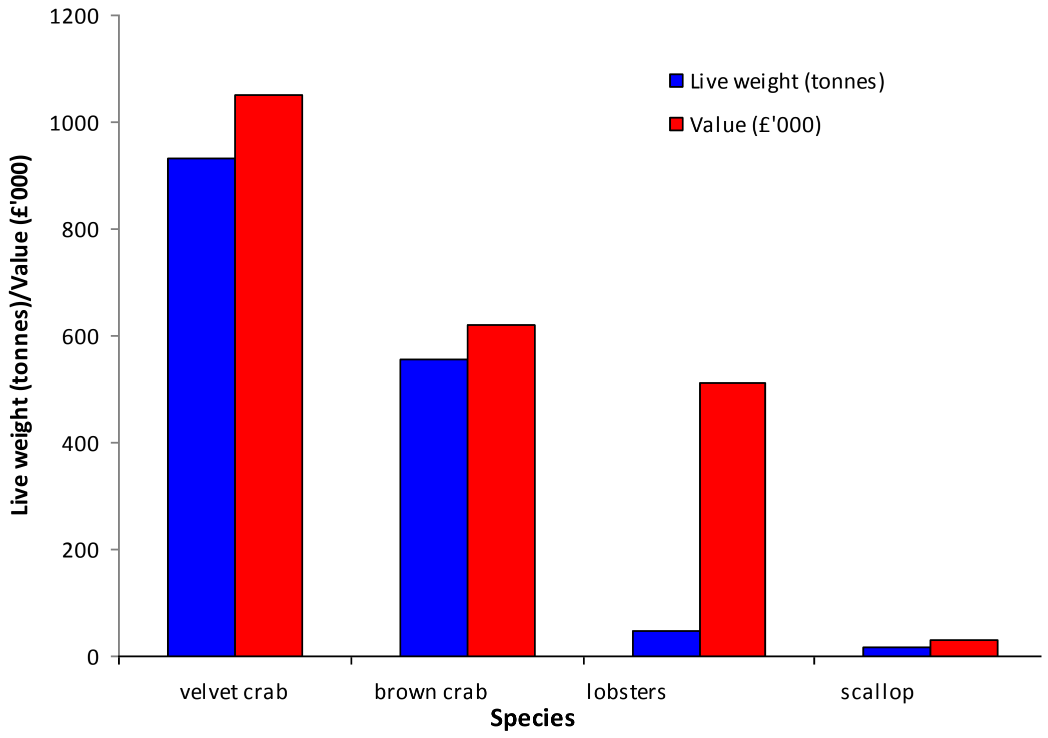

Figure 15.4 landings at Port Askaig from 2003-2008 in live weight (blue) and value (red) (Data source: Marine Scotland Compliance, 2009)

15.43. Construction activities are unlikely to be conducted during winter months due to the increased chance of bad weather during this period.

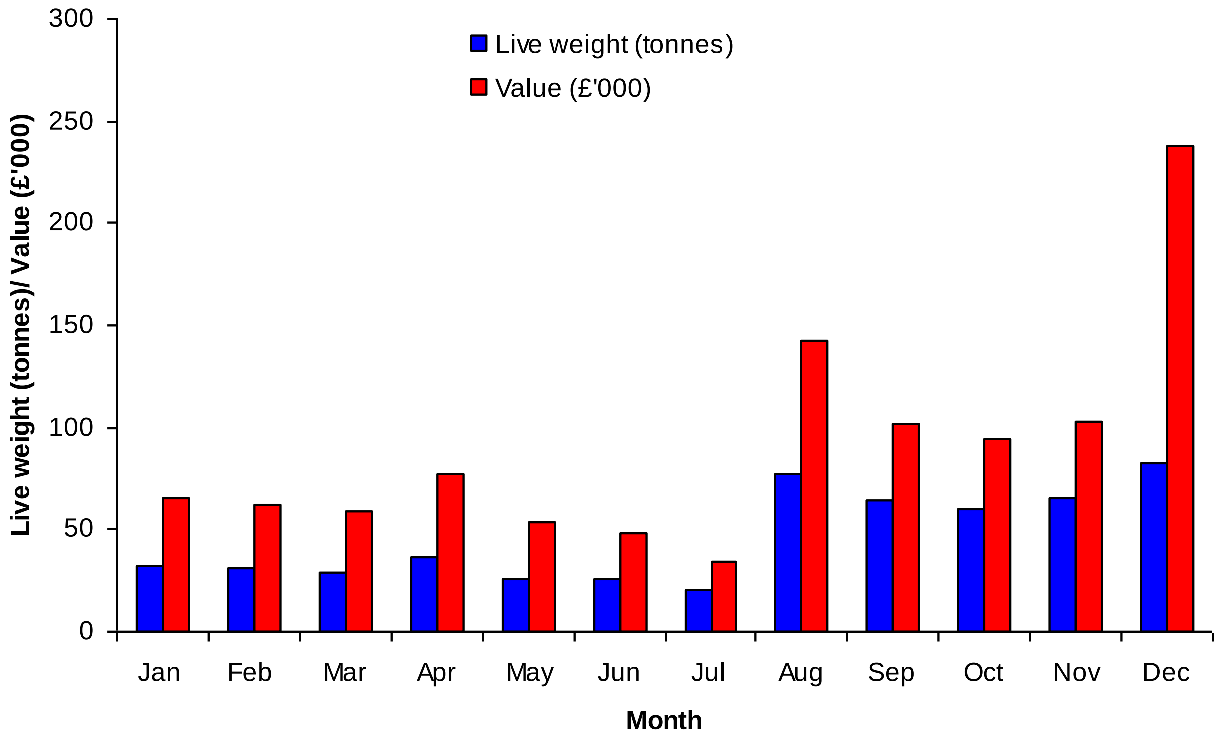

Figure 15.5 Seasonal trends for live weight (blue) and value (red) of landings of velvet swimming crab at Port Askaig from 2003 to 2008 (Data source: Marine Scotland Compliance,2009).

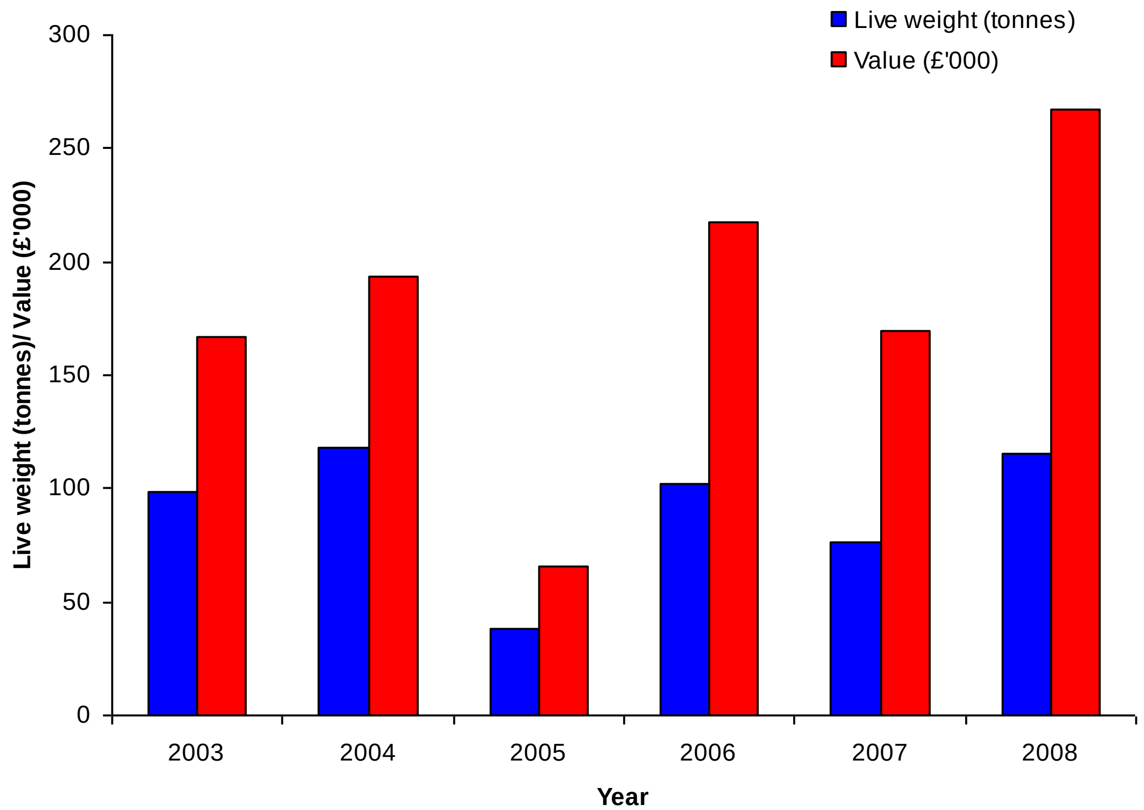

Figure 15.6 Annual trends for live weight (blue) and value (red) of landings of velvet swimming crab landed at Port Askaig from 2003 to 2008 (Data source: Marine Scotland Compliance, 2009)

15.44. The trend in annual landings of velvet crab at Port Askaig is shown in Figure 15.6. Live weight and value have remained relatively consistent since 2003, with the exception of 2005 which saw a marked decrease in landings. While the landed weight has remained similar across 2003 to 2008, the value has increased over this period giving a sales value of £2.28 per kg in 2008, compared to £1.69 per kg in 2003.

15.45. Velvet crabs are mostly found in the intertidal and shallow water on stony and rocky substrata, being most abundant on moderately sheltered shores (Wilson, 2008a). Therefore the preferred habitat for these crabs will not overlap with the development site, but will overlap with the cable landfall route (see *Chapter 5: Project description*). Also vessels targeting these species are likely to transit through the development site whilst travelling to sites or hauling pots. During the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning 2010) there were two sighting of a velvet swimming crab, both were in shallow near-shore waters (Figure 15.13) and the closest was approximately 150m from the development site and 308m from the nearest potential turbine location.

Brown crab

15.46. Brown crabs are targeted by vessels operating static gear (creelers) and are known to be landed from within the study area. Consultation with local fishermen has also confirmed that this species is targeted within the development site.

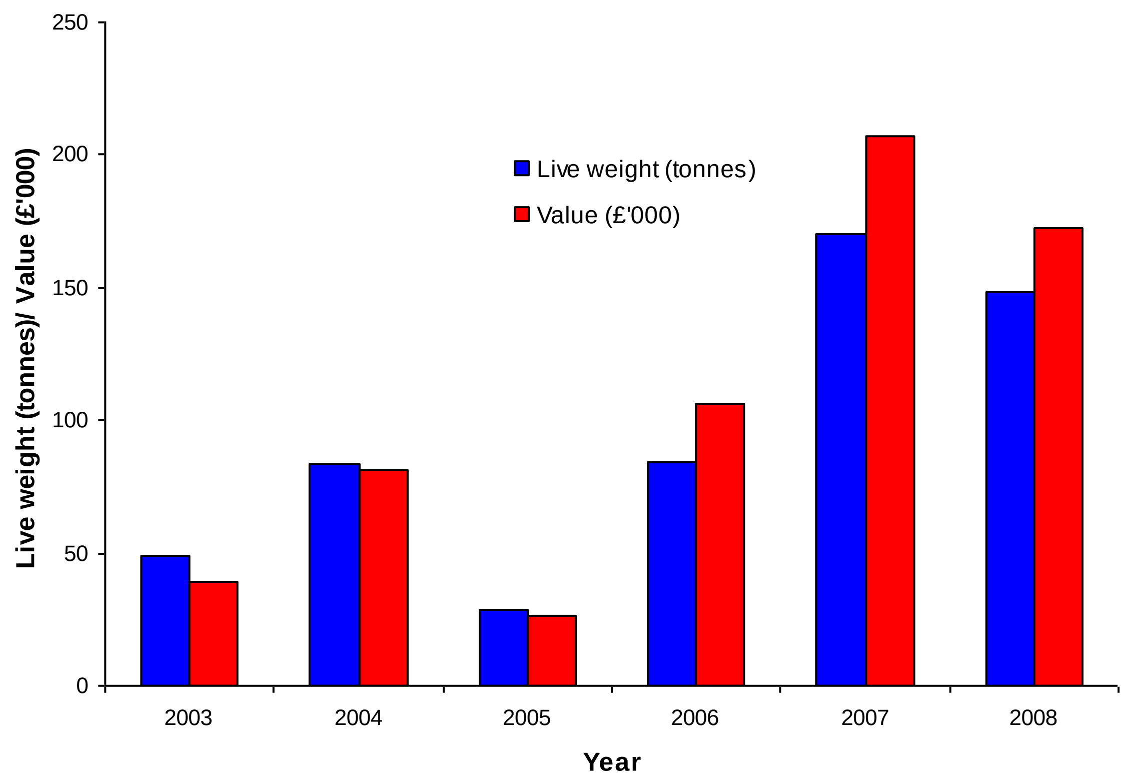

Figure 15.7 Annual trends for live weight (blue) and value (red) of brown crab landed at Port Askaig from 2003 to 2008 (Data source: Marine Scotland Compliance, 2009).

15.47. The brown crab *Cancer pagurus* (also known as the edible crab) comprise 29% of the overall weight and 19% of the overall value of landings of all species from ICES rectangle 40E3 between 2003 and 2008 making it the third most important species in terms of weight landed (Appendix 15.1, Figure 1). However, the value of brown crab is relatively small per unit weight when compared to other "key species" which explains why it comprises much less of the percentage value landed from this rectangle.

15.48. Between 2003 and 2008 brown crab landings at Port Askaig comprised 35% of the live weight landed and 28% of the total value. Overall both value and weight of brown crab landings at Port Askaig increased between 2003 and 2007, before falling in 2008 (Figure 15.7). After a dip in landings in 2005 a rapid increase was seen in the years 2006 to 2008. The seasonality of brown crab landings at Port Askaig from years 2003 to 2008 show a similar trend to that of velvet swimming crab with landings increasing during autumn and then dropping of at the beginning of the year(Figure 15.8). This appears to be driven by an increase in value over this period.

15.49. The favoured habitats of brown crab are bedrock including under boulders, mixed coarse grounds, and offshore in muddy sand. Lower shore, shallow sublittoral and offshore to about 100m (Neil & Wilson, 2008). During the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning 2010) brown crabs were sighted at many locations within the development site and in close proximity to proposed turbine locations (Figure 15.13).

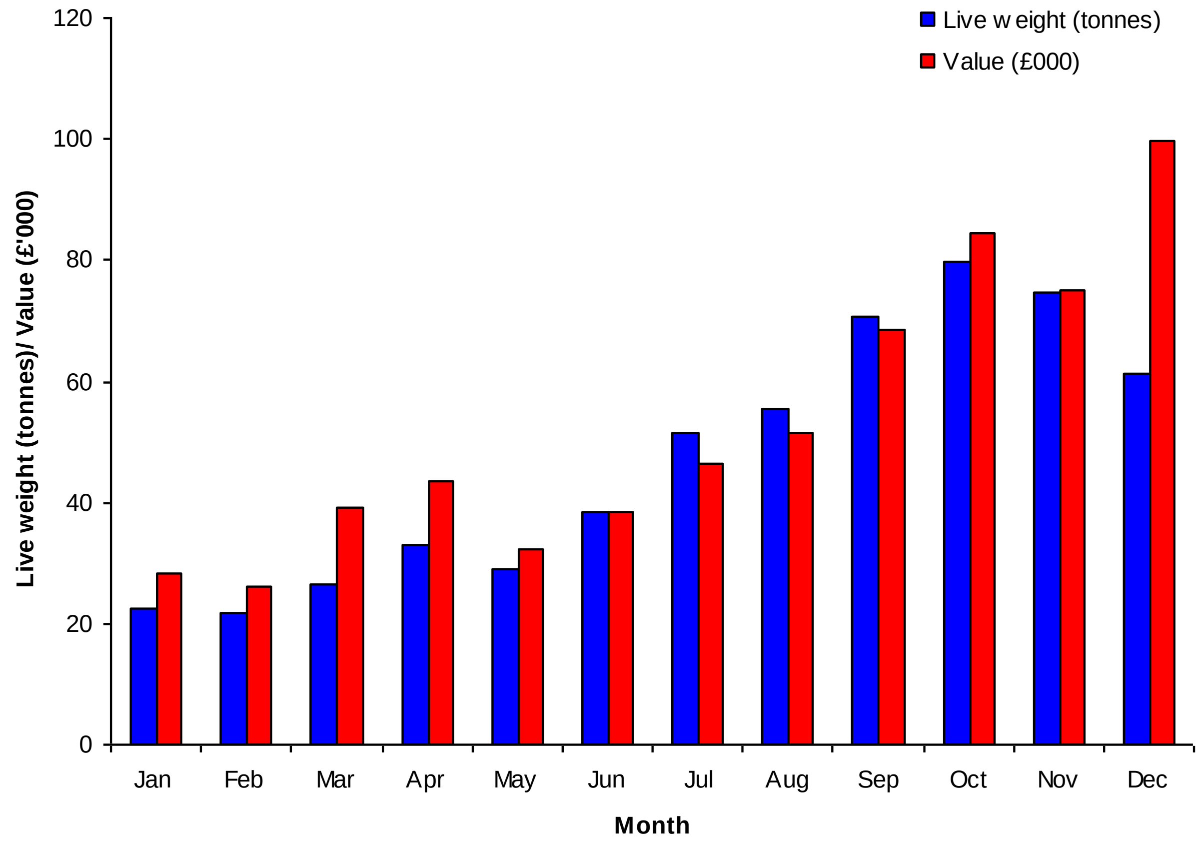

Figure 15.8 Seasonal trends for live weight (blue) and value (red) of landings of brown crab landed at Port Askaig from 2003 to 2008 (Data source: Marine Scotland Compliance, 2009).

Lobster

15.50. Lobster which are currently targeted within the study area comprise only 2.4% of the live weight landed from rectangle 40E3 during the period 2003 to 2008, but due to the high value of lobster this constituted 16% of the value of landings. Landings of lobster from this rectangle fell constantly between 2003 and 2005 but then increased rapidly between 2005 and 2008 (Appendix 15.1, Figure 2 (d)). A clear trend in seasonality was seen in all years for lobster landings with an increase in spring leading to the highest landings occurring in the summer months, reducing in late autumn and winter (Figure 15.9).

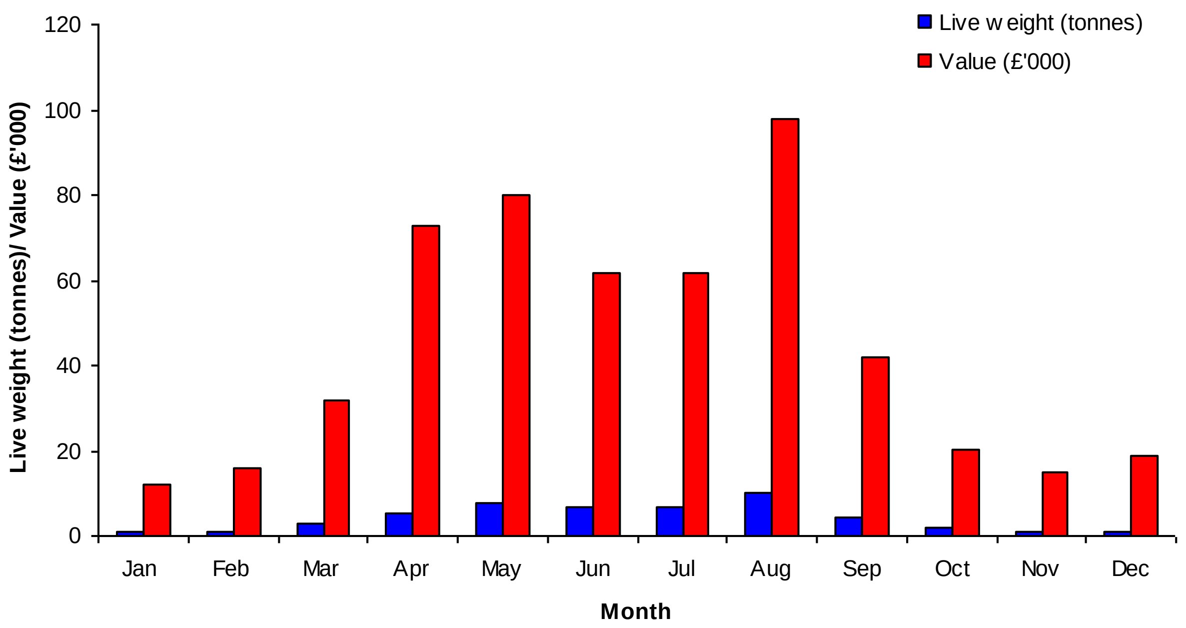

Figure 15.9 Seasonal trends for live weight (blue) and value (red) of landings of lobster landed at Port Askaig from 2003 to 2008 (Data source: Marine Scotland Compliance, 2009).

15.51. At Port Askaig Lobster comprised 2.9% of the live weight landed and 22.7% of the value landing during the years 2003 to 2008. In contrast to landings from the ICES rectangle 40E3 landings at Port Askaig increased from 2003 to 2004 and then dropped sharply in 2005. Since 2005 lobster landings at Port Askaig have seen an overall increase (Figure 15.10). Landings at Port Askaig mirrored the landings from ICES rectangle 40E3 in terms of seasonality (Figure 15.9).

15.52. Lobsters prefer rocky substrata, living in holes and excavated tunnels from the lower shore to about 60m depth (Wilson, 2008b). Consultation with local fishermen has revealed that during certain periods lobster are also present in mixed substrata habitats. During the benthic surveys (SeaStar Survey Ltd 2009 and Royal Haskoning, 2010) lobsters were not sighted. However, they are a generally cryptic species, not often observed via remote video methods.

15.53. Lobsters are targeted by vessels operating static gear. Creelers are known to operate within the Sound and consultation with fisherman operating within study area revealed that one vessel specifically targets lobster within the development site.

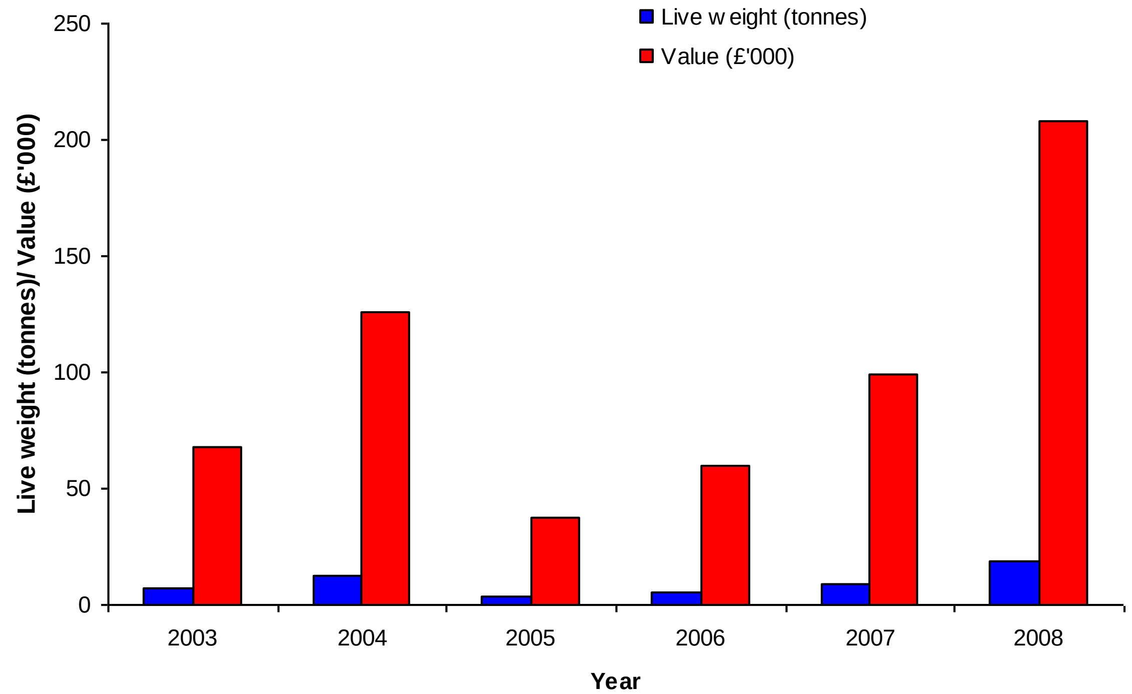

Figure 15.10 Annual trends for live weight (blue) and value (red) of lobster landed at Port Askaig from 2003 to 2008 (Data source: Marine Scotland Compliance, 2009)

Great Scallop

15.54. The great scallop *Pecten maximus* (also know as the king scallop) comprised 32% of the total live weight and 31% of the value of landings from ICES rectangle 40E3 for the period 2003-2008 making them consistently the most landed species from this ICES rectangle. However, at Port Askaig scallops only comprised 1.1% of landings in terms of weight and 1.3% of landings in terms of value between 2003 and 2008 (Figure 15.4).

15.55. Although scallops are not an important species in terms of volume landed from within the study area, they are an important species for the wider region. It is possible that the scallops within the study area are helping to populate the wider region from which scallops are fished.

15.56. Scallops were found to be present within the study area during the benthic surveys (SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010) but not within the development site (Figure 15.13). Scallops are not expected to occur abundantly across the Development site, though they may be present in patches of softer sediments. Consultation with local fishermen indicated that scallops have been targeted using divers in the past but this does not currently occur on a large scale. Scallop diving usually only occurs in water less than 25m deep and so would not occur within the development site.

Other species.

15.57. Although only crab, lobster, and to a far lesser extent, scallops, are targeted within the study area other species which have not been defined as “Key species” in this assessment are landed from ICES rectangle 40E3. For calculations of the live weight and value of other species landed from ICES rectangle 40E3 see Appendix 15.1 (Figure 1).

15.4.5 Fishing Activity in the Area (Local Fleet)

Overview of the local fleet

15.58. Fishing activities within the study area currently consist almost entirely of creeling with the exception of occasional scallop dredging at the very far north and south of the Sound. No evidence has been acquired during consultation with fishermen that trawling, net or line fishing occurs on a regular basis, or has occurred on a commercial scale in the recent past within the study area (Appendix 15.4). Creeling in the study area is conducted by small, locally based, day-fishing vessels. These vessels range between 5.6m single handed vessels and vessels up to 11.8m (Table 15.6) manned by 3-4 people. The number of creel boats operating in the study area is approximately 10 with roughly 8 using the area on a regular full-time basis (Appendix 15.2).

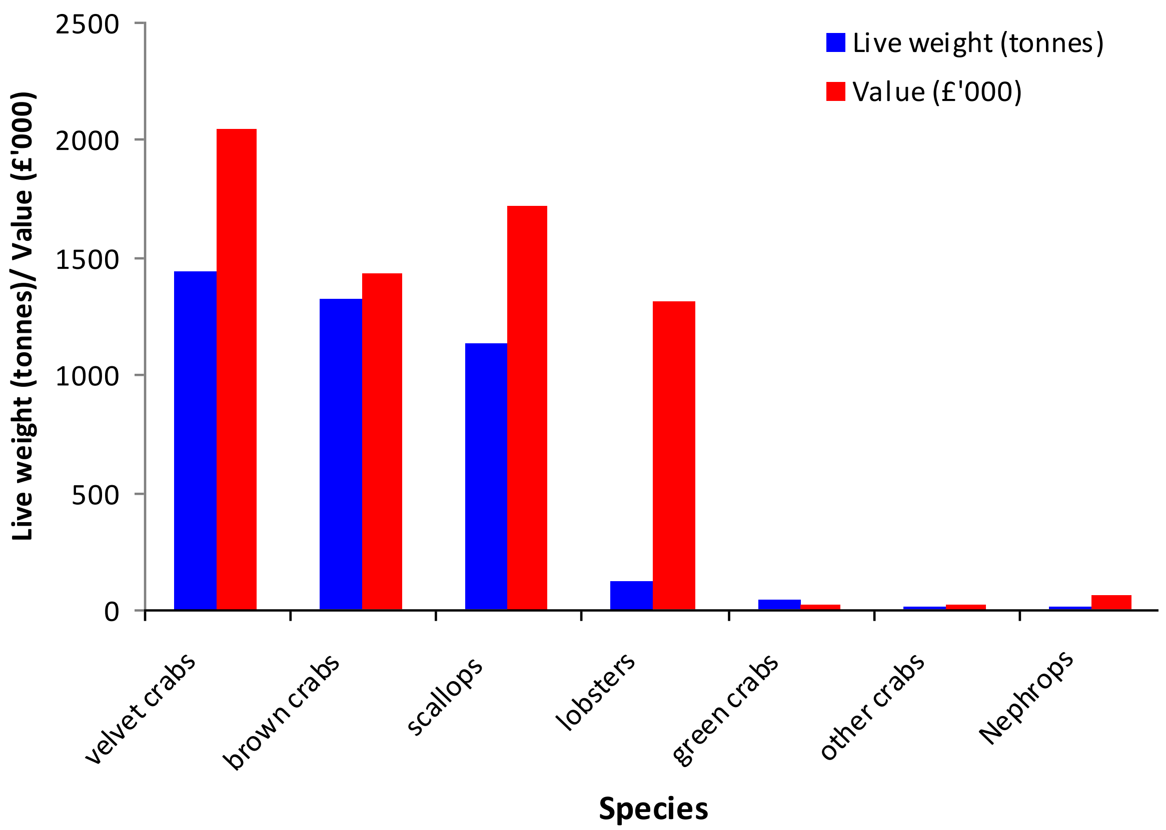

Figure 15.11 landings at all ports on Islay from 2003 to 2008 live weight (blue) and value (red). (Data source: Marine Scotland Compliance, 2009)

15.59. Comparing the overall landings for Islay (Figure 15.11) with those of Port Askaig (Figure 15.4) highlights the significant scallop dredging activity that occurs elsewhere around Islay. In particular, 60% of all scallops harvested from ICES rectangle 40E3 were landed at Port Ellen (located on the southern side of Islay) between 2003 and 2008.

Vessels

15.60. Both the DEFRA vessel list (which was collated by the MFA) and consultation with local fishermen was used to identify which vessels are active within the study area. A list of these vessels is displayed in Table 15.6. All but two of these vessels are less than 10m in length and all are less than 12m. The entire fleet of vessels identified in Table 15.6 are registered with Campbeltown as their administrative port.

Table 15.6: List of vessels that fish within the study area.

Vessel name	Overall length	Registered tonnage	Engine Output
Speedwell of Glenariffe	8.2	4.76	164
Hazel Ann	9.94	7.85	261
Cynosure	6.45	1.44	53
Lynn Louise	5.62	1.16	22.38
Sapphire	6.2	1.5	32
Paulanda	11.28	12.14	132
Exuberant	6.4	2.41	23
Jacamar	8.57	3.07	180
Calon Mor	11.8	11.64	134.2
Golden Opportunity	9.7	10.03	89

Gears used

15.61. Landings data for Port Askaig was used to calculate what type of fishing gear was responsible for the majority of landings from within the study area. During 2003 to 2008, 1555 tonnes (with a value of £2,215,184) was landed using pots and 17 tonnes (with a value of £30,000) was landed using dredges. This is to be expected as crab lobster and scallop constitute the vast majority of the landings from ICES rectangle 40E3 (Figure 15.1) and all of these species are landed by pots and dredges.

15.62. Creels or pots are usually set in 5-30m of water for crabs and as deep as 60m for lobster, although this is dependent on the location being fished, the size of the vessel and the equipment on board (e.g. the size of the hauler). During the consultation process it was revealed that some local fishermen target brown crab below 30m within the study area. The baited pots are normally strung together on a lead line of up to 20 pots, but can also be set singularly. The pots set within the development site are used to target brown crab and lobster (Appendix 15.2 and 15.4).

Fishing effort of the local fleet

15.63. There are a number of small harbours and ports within the wider region, with the main administrative ports in the being Oban and Campbeltown. According to the DEFRA vessel list, (DEFRA, 2009) there are 186 vessels less than 10m registered to Campbeltown and Oban (18 of which have their home port in Islay) and 88 vessels over 10m (2 of which have their home port in Islay). These vessels have an average registered tonnage of 14.64 and power of 107.77 kW. The average vessel age is 24 years, with 30% being built after 1990.

15.64. During consultation with local fishermen it was identified that 10 vessels are active within the study area. These vessels are detailed in Table 15.6 and approximately eight of them are known to use the study area on a regular basis with the majority of their effort occurring in winter and early spring when the Sound offers shelter that is not found in the surrounding waters.

Defined fishing grounds

15.65. Consultation with local fishermen has not enabled pin pointing of exact fishing locations within the Sound; however, of the three primary species targeted within the study area (velvet swimming crab, brown crab and lobster) only brown crab and lobster are targeted in water depths greater than 30m. As turbines are to be located in water depths greater than 48m it is only lobster and brown crab that can be targeted within the development site (Figure 15.13).

15.66. The VMS data illustrated in Figure 15.14 indicates that the study area is subjected to low or moderate levels of fishing by vessels that are over 15m in length. This appears to contradict the outcomes of the consultation process in which many local fishermen confirmed that it is only small vessels, under 15m in length that fish in the study area. The reason for this discrepancy can be explained by the fact that there is a landing facility at Port Askaig which larger vessels (over 15 m) occasionally use. The VMS data is speed filtered so that only vessels travelling between 3 and 10km per hour are included in Figure 15.14; therefore as the vessels slow down on approach to Port Askaig they register in the data as apparently fishing when actually vessels are in transit to or from Port Askaig.

15.67. Also as a result of the speed filtering process fishing vessels that are travelling through the study area against the tidal flow and vessels that take shelter within the study area will appear in the data as if they are fishing when in fact they are not.

Socio-economics

15.68. The 2006 economic survey of the UK fishing fleet (Seafish, 2008) calculated that the average income of a potting/creeling vessel between 10 and 12m in length was £84,200 in 2004 £99,000 in 2005 and £88,000 in 2006. This equated to an average crew member aboard these vessels generating an income of £42,100, £49,500 and £37,843 in the years 2004, 2005 and 2006 respectively. These figures are calculated for vessels between 10-12m which only represents the two largest vessels that regularly fish within the study area, so income for the majority of local vessels is assumed to be lower. Although this survey is the most recent it was conducted four years ago and therefore earnings are likely to have increased in line with inflation and higher demand for seafood. During consultation with the local fishing industry it was suggested that the gross income per boat would need to be in the region of £120,000 to £150,000 to make the boat economically viable.

15.4.6 Other EU and UK fishing vessels

Other UK vessels and EU Member States vessels

15.69. All vessels that landed fish from ICES rectangle 40E3 (which contains the study area) between 2003 and 2008 were registered within the UK. The majority of landings were from vessels that are registered in Scotland. Although vessels from outside of Scotland were travelling to ICES rectangle 40E3 during this period, it is unlikely that they were targeting the study area itself as creels (the only practical method of fishing within the Sound) are usually left for 12-40 hours and then recovered, making this method of fishing viable only to local vessels. Also, strong currents and variable substrate make it a very difficult place to fish.

15.5 Assessment of Effects and Mitigation

15.5.1 Do nothing scenario

15.70. If the proposed development is not realised, commercial fisheries within the study area are likely to continue much as described in the base line condition (Section 15.4). Consultation with fishermen that use the study area has determined that there are no current plans to increase fishing pressure within the Sound either by increasing the number of vessels or the number of creels used. It is recognised that fishing pressure within the study area would respond to the market forces, however such forces are difficult to predict.

15.5.2 Potential Impacts during Construction Phase

Impact 15.1: Temporary exclusion from fishing grounds

15.71. Commercial fishing within the study area is almost exclusively carried out by small vessels that use creels to catch crab and lobster. Ten boats use the Sound for creeling with approximately eight vessels using it regularly. Most of the fishing is conducted in winter and early spring when other grounds can't be accessed due to seasonal bad weather; however some vessels do use the study area all year round.

15.72. Installation of the proposed development is likely to take place during the summer months in order to avoid any potential bad weather.

15.73. The Navigation Safety Risk Assessment (NSRA) commissioned by SPR (Appendix 19.1) concluded that it would be inappropriate to implement safety zones, which encircle installation vessels or turbine structures. However in reality, during construction, fishermen will be unable to fish within the immediate vicinity of the construction vessels due to safety considerations of both the installation vessels and the fishing vessels. The NSRA (Appendix 19.1) also recommends that an application be made by SPR to the Scottish Government to designate the Development site an area of "No Fishing" and "No Diving". It is likely that this application will be made prior to construction and therefore if granted will prevent fishing within the development site during the construction phase.

15.74. In addition fishermen will also be unable to safely fish in Caol Ila Bay where temporary moorings are to be installed affecting an area of approximately 0.041km^2 (Figure 15.13) for the duration of the construction period (predicted to be between 60 and 80 days). Taking a precautionary approach, it is possible that a detectable change in the baseline condition may consequently occur due to the exclusion of fishing from these areas and therefore the magnitude of this impact can be considered to be medium.

15.75. Additionally, a temporary modification of fishing activities is likely to occur due to the impact and therefore the sensitivity of the receptor (local commercial fisheries) can be considered low.

15.76. As the impact of temporarily restricting access to fishing grounds is of a medium magnitude and the sensitivity of the receptor (local commercial fisheries) is low the overall effect is likely to be of **minor** significance during the short duration of the installation period.

MITIGATION IN RELATION TO IMPACT 15.1
• Install turbines and cables during periods of least fishing activity within the Sound (creeling activity is at its lowest in the summer). • Close consultation with local fishermen to identify methods of installation which minimise the area and the time period for any restriction.

Residual impact

15.77. If the mitigation suggested above is implemented then the significance of the impact will be reduced slightly but the effect overall is likely to remain of **minor** significance.

Impact 15.2: Change in abundance of targeted species

15.78. *Chapter 8: Benthic Ecology* and *Chapter 11: Marine Fish and Shellfish Resources* present an assessment of habitat disturbance upon the benthic assemblage and the impact to commercially important species within the tidal array site. It is estimated that the total loss of seabed within the footprint of the devices will cover a very small percentage of the Sound (see *Chapter 11: Marine* *and Shellfish Resources* and *Chapter 8: Benthic Ecology* for detailed calculations) and therefore the magnitude of the impact will be low.

15.79. Furthermore, velvet swimming crabs, which provide the greatest value of landings on Islay and in particular at Port Askaig (Figure 15.4), are usually found intertidally or in shallow water and therefore are not likely to inhabit the deep waters (deeper than 48m) of the study area such as the Development site. However, the cable route will be taken through the intertidal and will result in maximum habitat loss of approximately 1946m^2 which is less than 0.01% of the available habitat for velvet swimming crabs within the study area.

15.80. The only flat areas of seabed upon which the turbines will be placed are comprised of coarse sediments. Of the target species within the study area (velvet swimming crabs, lobster and brown crabs), only brown crab and lobster are likely to use such habitats. According to Neal and Wilson (2008) and Jackson *et. al.* (2008) both crab and lobster have intermediate or very little sensitivity to smothering or habitat loss (which may potentially be caused by construction of the proposed Development); therefore these species can be considered to have a medium or low sensitivity to the impacts of the Development.

15.81. As the magnitude of the impact is low and the sensitivity of the receptor (crab and lobster) is, at worst, medium, the loss of available habitat and possible decrease in abundance of targeted species is likely to have an effect of **minor** significance**.**

MITIGATION IN RELATION TO IMPACT 15.2
• Micro-siting to avoid reef areas which may potentially be used by lobster.

Residual impact

15.82. If the above mitigation is implemented then the effect of the Development upon the abundance of targeted species is likely to be of **negligible** significance.

Impact 15.3: Displaced fishing effort targeting new or other existing fishing grounds

15.83. Vessels that currently fish in the study area mainly do so during the winter and early spring when other fishing grounds are not accessible due to bad weather (Appendix 15.2 and 15.4); however, some smaller vessels utilise the study area year-round. Alternative fishing grounds for creeling are located to the north of the study area (Appendix 15.2) and to the south. During construction the majority of the study area will be accessible to fishermen for creeling (Appendix 19.1) and therefore the magnitude of this impact will be low.

15.84. The local fishing fleet may need to temporarily modify their fishing activities during the construction period in order prevent collision with construction vessels and avoid interactions with installed infrastructure. However, as the displaced effort would be small (approximately 10 vessels, many of which only operate within the Sound over winter and spring months) and much of study area will still be accessible to the fleet the sensitivity of local commercial fisheries can be considered to be medium or low. Therefore (using the significance matrix) the effect of displaced fishing effort targeting new or other fishing grounds is likely to be at worst, of **minor** significance.

MITIGATION IN RELATION TO IMPACT 15.3
• Where practicable timing of installation should coincide with times when the least fishing is being conducted within the study area. This will be agreed after further consultation with the local fishermen.

Residual impact

15.85. If the above mitigation is implemented the effect of the proposed development on other new or existing fishing grounds is likely to be of **negligible** significance.

Impact 15.4: Loss of fishing gear due to entanglement

15.86. The consultation process identified that there are occasions when singly operated fishing vessels drift whilst untangling fouled fleets of creels. If this situation were to arise whilst the fishing vessel were upstream of the construction area there is potential for the fishing gear to become entangled in either installed infrastructure or vessels and machinery associated with construction process.

15.87. The likelihood of this situation occurring and therefore the magnitude of the impact is low due to the fact that close consultation has and will continue to inform all fishermen of how and when development of the array is progressing.

15.88. The costs incurred to a fisherman (and therefore the sensitivity of this impact) if an entire fleet of creels was lost would be in the region of £1500 (Appendix 15.2) which would be significant for that individual when compared to their earnings (see Paragraph 15.68). Therefore the sensitivity to the individual involved could be considered to be high/medium; however when this is considered across the whole fleet (10 vessels) the sensitivity is only likely to be medium or low.

15.89. Therefore with a low magnitude of impact and medium/low sensitivity of the receptor, the loss of fishing gear due to entanglement is likely to be result in an effect of **minor** significance.

MITIGATION IN RELATION TO IMPACT 15.4
• Consultation with fishermen to ensure that they are fully aware of the locations and timings of installation. • Fishing vessels to be provided with accurate information on the position of the individual devices immediately after they are installed. • All crews operating installation vessels and any shore based workers to remain vigilant at all times, and alerting such fisherman to the potential danger. • Dedicated safety boat to safely manage any unpowered vessels that come within the vicinity during installation.

Residual impact

15.90. If some or all of the above mitigation is implemented then the likelihood of fishing gear being lost due to entanglement with turbines and associated infrastructure will be reduced still further resulting in an effect of **negligible** significance**.**

15.5.3 Potential impacts during operational (and maintenance) phase

Impact 15.5: Long term exclusion from fishing grounds

15.91. During operation of the Development a small area of the study area will become unsafe to fish. An application will be made by SPR to the Scottish Government to designate the development site a “No Fishing” (Int. Symbol N21) and “No Diving” area. This area will be in existence for the life time of the development which is currently believed to be approximately 15 years and is likely to be similar in area to the lease option boundary displayed in Figure 15.13, which is 0.35km^2.

15.92. This “No Fishing” area, if granted is likely to cause the greatest impact to fishermen targeting lobster and brown crab (as these are the only species in the study area that are commercially targeted below 30m and the turbines will be located in water depths greater than 48m). Furthermore consultation with local fishermen has revealed that of the three key species (velvet swimming crab, brown crab and lobster) it is only lobster that will favour the substrates upon which the turbines will be located and even lobster only use these substrates for short time periods; therefore the magnitude of this impact can be considered to be low.

15.93. The amount of lobster landed (live weight) at Port Askaig and on Islay as a whole is far less than that of other key species targeted within the study area (Figures 15.4 and 15.11). However the value per unit weight of lobster greatly increases its importance to the commercial fisheries within the study area, therefore the sensitivity can be considered to be medium to low.

15.94. Taking this into account and allowing for the fact that only a small number of vessels fish the study area (and for discrete parts of the year), the effect of long term displacement from fishing grounds is likely to be of **minor** significance.

MITIGATION IN RELATION TO IMPACT 15.5
• No mitigation required

Residual impact

15.95. As no mitigation has been suggested the long term displacement of fishermen from fishing grounds is likely to continue to have an effect of **minor** significance.

Impact 15.6: Displaced fishing effort targeting new or other existing fishing grounds

15.96. During operation the impacts caused by displacement of fishing effort are likely to be similar to those outlined during the construction phase (Impact 15.3). However, impacts during the operation phase will differ slightly in that the duration of the impact will be longer. As the expected life span of the development is 15 years it is likely that there will be slightly increased pressure on other existing fishing grounds over the winter season during this period. However, the magnitude of this impact is considered to be low.

15.97. Small scale modification of the local fishing fleet's activities may occur due to operation of the proposed Development, and these activities will occur over the long term (the life span of the project). Consequently the sensitivity of the receptor (commercial fisheries) can be considered to be medium.

15.98. As a result of the low magnitude and medium sensitivity, there is likely to be an overall effect of **minor** significance caused by displacement of fishing effort.

MITIGATION IN RELATION TO IMPACT 15.6
• No mitigation suggested

Residual impact

15.99. As no mitigation is suggested this effect is likely to remain of **minor** significance.

Impact 15.7: Loss of fishing gear due to entanglement with turbines and associated infrastructure

15.100. The consultation process identified concerns that fishermen have in regards to loss or damage of fishing gear. It is conceivable that a situation may arise where a fishing vessel is trying to haul a tangled fleet of creels whilst drifting toward the Development site. In this situation pots may have to be cut free by the fisherman as safety measures to ensure against vessel capsize.

15.101. The replacement cost of a creel is £50 and the ropes used in a fleet of creels cost £80 per 220 metre coil (Appendix 15.2). A fleet on average contains approximately 25 creels (see Appendix 15.2) and can be up to half a mile long. Therefore if an entire fleet was lost the cost would be in the region of £1500 and could potentially be a lot more, if marker buoys and other associated equipment were also lost.

15.102. As all local fishermen have, and will continue to be updated with regards the progress of the proposed Development the magnitude of this impact is considered to be medium.

15.103. The costs incurred to the individual fisherman (and therefore the sensitivity of the receptor) if an entire fleet of creels was lost would be significant when compared to their earnings (see paragraph 15.68). Therefore the sensitivity to the single fishermen could be considered to be high, however when this is considered across the whole fleet (10 vessels) the sensitivity is only likely to be low.

15.104. With a medium magnitude and a low sensitivity, it is likely that the loss of fishing gear will result in an effect of **minor** significance to commercial fisheries.

MITIGATION IN RELATION TO IMPACT 15.7
• Consultation with fishermen to ensure that they are fully aware of the locations of the turbines. • Provision of device positional data to Kingfisher Information Services and to local fishermen (so they can input into their plotters). • Designate the array area a "No Fishing" (Int. Symbol N21) and "No Diving" area. • That an explanatory note be included in navigational charts explaining the nature of the hazards caused by the turbines. • The reporting of any accidents or near misses should occur in a clear and concise manor. A procedure for achieving this should be decided upon which should clearly outline who is responsible for reporting and how it should occur.

Residual impact

15.105. If the above mitigation is implemented then the likelihood of fishing gear being lost due to entanglement with turbines and associated infrastructure will be reduced still further resulting in an effect of **negligible** significance.

Impact 15.8: Change in abundance of targeted species

15.106. The exclusion of fishermen from the immediate area around the turbines may have the effect of providing a refuge for targeted species. Lobster and brown crab are the only species that are currently targeted within the development site from which fishing will be excluded. Furthermore it is possible that the turbine support structures may act as "artificial reefs" increasing productivity and growth of invertebrates (this point is discussed further in *Chapter 8: Benthic ecology*) upon which crab and lobster may feed. The possible increase in food availability and the cessation of fishing pressure may have the effect of increasing lobster and brown crab populations locally within the turbine array (this point is discussed in more detail and the impacts are assessed in detail in *Chapter 11: Marine fish and shellfish resource*).

15.107. This potential increase in population may then spill over into areas that fishermen can target, increasing their catch. The magnitude of this impact is likely to be low to medium and the sensitivity can be considered beneficial leading to an overall effect that is of **negligible** or **minor** significance.

MITIGATION IN RELATION TO IMPACT 15.6
• No mitigation suggested

Residual impact

15.108. As no mitigation is suggested this effect is likely to remain at **negligible** or **minor** significance.

15.5.4 Potential Impacts during decommissioning Phase

15.109. The impacts caused during decommissioning are expected to be, at worst, of the same nature and magnitude as those during the construction phase. A decommissioning plan will be completed when the array nears the end of the operational phase to assess the impacts that will occur during array decommissioning.

15.5.5 Cumulative Impacts

15.110. Exclusive development rights were awarded in 2009 for an offshore windfarm site located to the west of the study area (Royal Haskoning, 2009). Fishermen are likely to be excluded from this site during construction and possibly during operation as well. However it is unlikely those construction periods will overlap and there is no evidence to suggest that the level of fishing displaced from the study area will be displaced on a scale that would have any significant cumulative impact.

15.111. The Irish renewable energy company DP Energy has announced their intention to develop a 400MW tidal turbine near Islay. No details of the proposed development are currently available and it is not possible to assess cumulative potential without details of location and technology.

15.6 Summary of effects

15.112. Table 15.7 summarises the findings of the commercial fisheries impact assessment.

15.7 Conclusion

15.113. There is likely to be some restriction of area open to the fishermen during construction operation maintenance and decommissioning; however seasonal management of timing works and constant and clear consultation with local fishermen should minimise any impacts that may result. After installation the area of the seabed used will have a minimal direct affect on fishing within the study area (based on current information), so only impacts of **minor** or **negligible** significance are anticipated.

Table 15.7 Significance of effect of Impact: summary table									
		Construction/ Decommissioning				Operation/Maintenance			
Impact	Impact number	Magnitude	Sensitivity / value of receptor	Impact	Residual significance of impact after mitigation	Magnitude	Sensitivity / value of receptor	Impact	Residual significance of impact after mitigation
Exclusion from fishing grounds	15.1 and 15.5	Medium	Low	Minor	Minor	Low	Medium to low	Minor	Minor
Change in abundance of targeted species	15.2 and 15.8	low	Medium/ low	Minor	Negligible	Medium to low	Medium to low	Beneficial	Beneficial
Displaced fishing effort targeting new or other existing fishing grounds	15.3 and 15.6	Low	Medium/low	Minor	Negligible	Low	Beneficial	Minor	Minor
Loss of fishing gear due to entanglement	15.4 and 15.7	Low	Medium/ low	Minor	Negligible	Medium	Low	Minor	Negligible

15.8 References

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Wilson, E. 2008b. *Homarus gammarus*. Common lobster. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom.

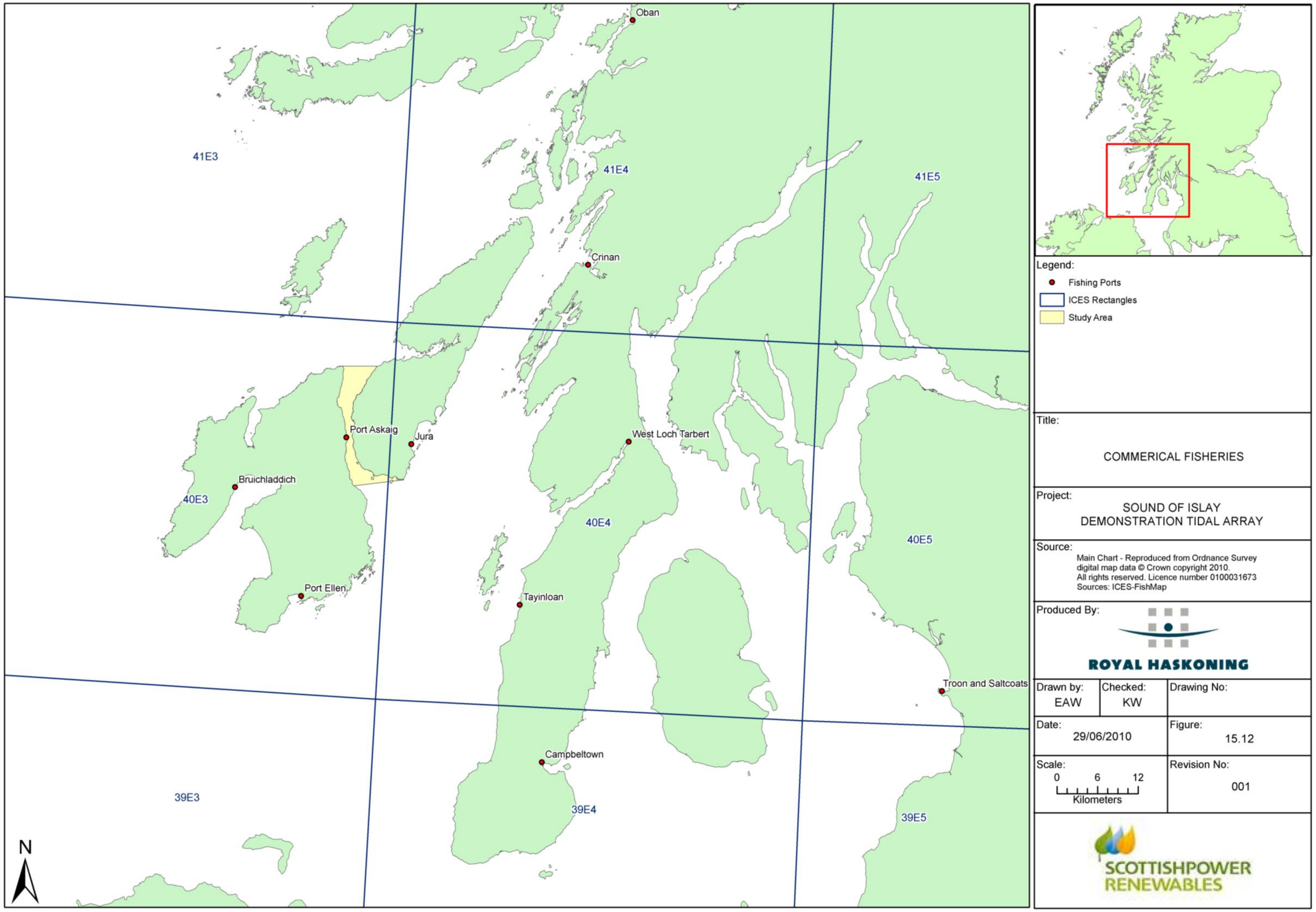

Figure 15.12 Showing the Fish landing ports, the study area and ICES rectangles in the wider region.

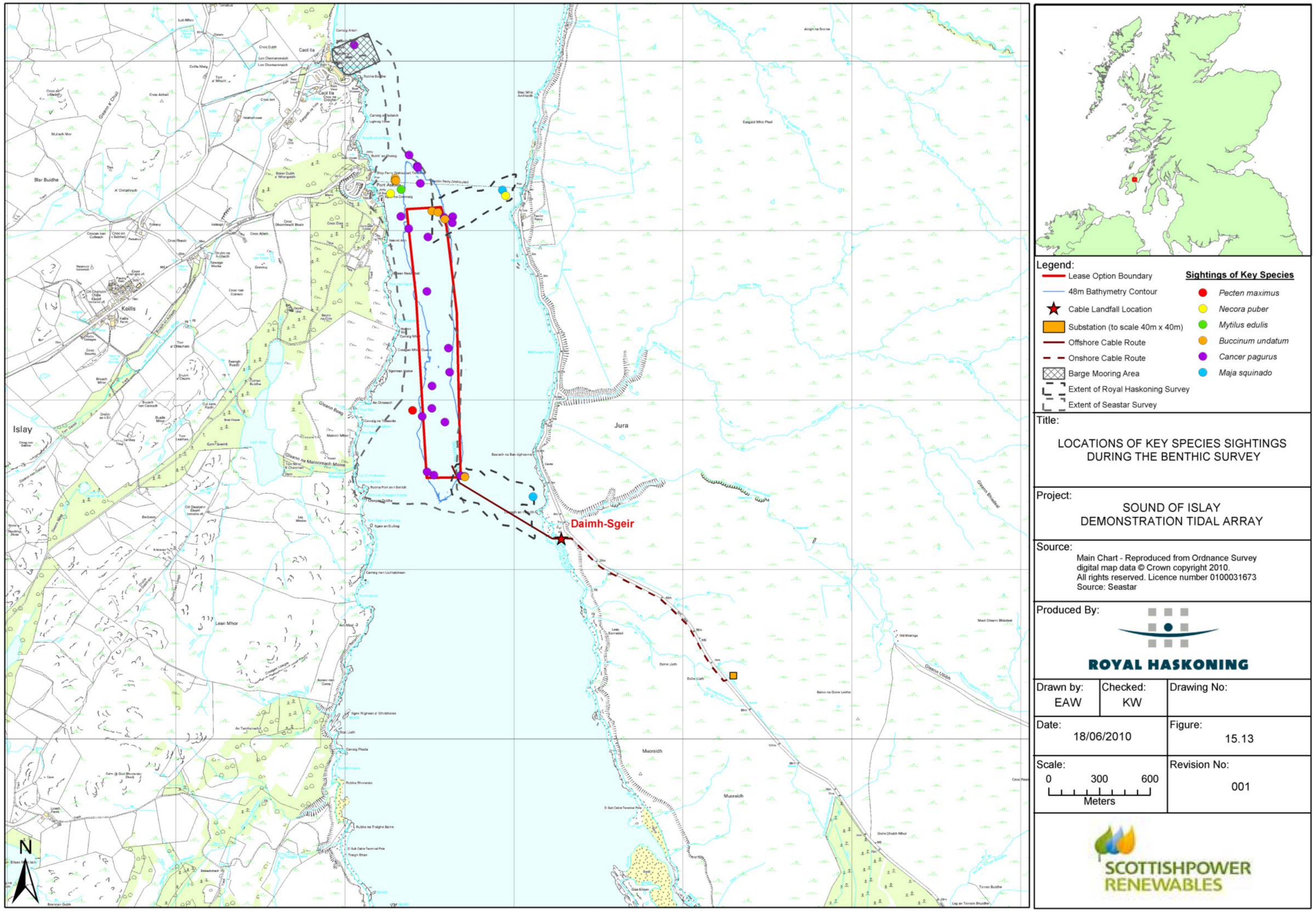

Figure 15.13 Showing the locations of sightings of key species during the benthic survey (data from SeaStar Survey Ltd, 2009 and Royal Haskoning, 2010).

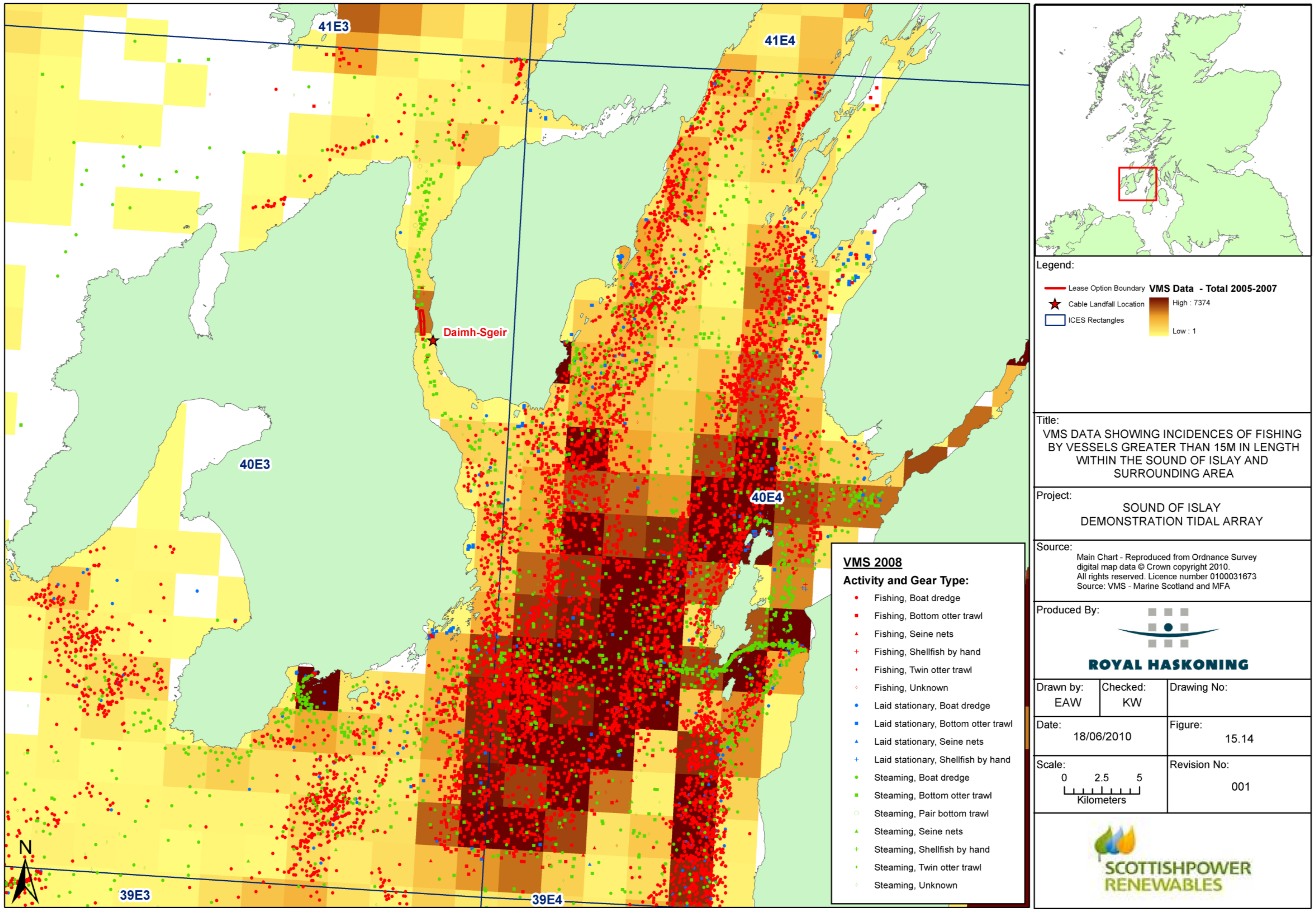

Figure 15.14 VMS data, showing amount of fishing effort by vessels greater than 15m in length within the study area and the wider region

16.0 Terrestrial and Intertidal Ecology

16.1 Introduction

16.1. This chapter addresses the impacts of the proposed Development relevant to terrestrial and intertidal ecology, with particular reference to the impacts associated with cable landing sites and associated onshore infrastructure including the substation and connecting cabling, along with potential access tracks required.

16.2. For the purposes of the ES, the intertidal ecology is combined with the terrestrial ecology and not with the benthic ecology. Nature conservation features have been defined as terrestrial flora and fauna, including mammals (which may be partially marine e.g. otter) and reptiles, along with intertidal biotopes and species from strandline to low water spring tide.

16.3. The aims of this chapter are to:

- Outline the present state of the existing terrestrial and intertidal ecology and nature conservation features;
- Establish the prognosis for these under the 'do nothing' scenario;
- Assess the implications of the proposed Development for these features;
- Recommend a range of mitigation measures to minimise the impacts;
- Assess cumulative impacts; and
- Consider the residual effects (after mitigation of impacts).

16.4. A wide study area was surveyed, encompassing 10 potential cable landfall and substation options across the islands of both Islay and Jura, and this is shown outlined in red in Figure 16.1. Through consideration of several factors, including engineering feasibility and ecological sensitivity, one landfall location has been selected at Daimh-sgeir, on the Isle of Jura (marked as Site J-C on Figure 16.1). This is further discussed in Chapter 4 *Site Selection*. The preference for the landfall at Daimh-sgeir is to land south of the river, with the cable laid alongside the road to the substation (see Figure 16.1). Further details are provided in Chapter 5 *Project Description*. Within this chapter, the term 'Development' refers to the preferred intertidal and terrestrial cable route and substation.

16.5. This chapter deals solely with the potential impacts of the proposed Development on terrestrial and intertidal habitats and species, including nature conservation issues and the risk of spreading terrestrial and coastal invasive and/or non native species. Potential impacts on birds, marine mammals, marine benthos, and salmonid fish, are assessed in *Chapter 8: Benthic Ecology*, *Chapter 9: Marine Mammals*, *Chapter 12: Anadromous Fish* and *Chapter 14: Ornithology.*

16.6. The aesthetic and landscape implications of onshore infrastructure are dealt with separately in *Chapter 17: Landscape and Visual*

16.2 Potential Effects

16.7. The potential adverse effects of the Development's cable landfall and onshore infrastructure on terrestrial and marine ecology relate to habitat disturbance or removal, death, injury or disturbance of flora and fauna and/or their habitat, and the spread of invasive species. In particular, disturbance to protected species may have legal implications (see Section 16.3.1 and *Chapter 6: Regulatory and Policy Context*). Adverse impacts can be mitigated through best practice and habitat enhancement, and opportunities for mitigation are discussed in each impact section.

16.3 Summary

Assessment is based on the proposed substations and cable route incorporating one cable land fall location at Daimh-sgeir. Except for otters and terrestrial habitat loss, all terrestrial and intertidal receptors the significance of effect are assessed as being negligible or no significant effect during construction, operation and maintenance of the onshore elements of the proposed Development.

With regards to otters, several feeding areas and potential holt sites have been identified already within a 2km radius of the potential land fall site. Further otter surveying is proposed once the final footprint of cable landfall is confirmed to inform the need for an EPS licence from the Scottish Government should a holt or resting site be located within the footprint of the cable route. This will be informed by a targeted otter survey once the cable route plan is finalised. No potential resting sites have been recorded at the proposed landfall site (J-C),however feeding otters have been recorded and the river is likely to be an important freshwater resource for this species. With the cable to come ashore south of the bridge, therefore avoiding the more sensitive river habitat, the significance of effects is assessed to be **minor**.

There will be approximately 1400m of cable routing across wet heath habitat, the dominant habitat type for the surrounding area. However, this cable route will run adjacent to an existing road that crosses the wet heath and therefore disturbance and impacts here are considered of **minor** significant effect.

16.4 Methodology

16.8. This environmental impact assessment considers the likely effects of the Development on terrestrial and intertidal ecology that may arise during the construction, operational (including maintenance) and decommissioning phases of the proposed scheme, particularly the cable and cable landfall, and onshore infrastructure. The sections below describe the assessment methodology, including relevant legislation, policies and plans, consultation, data collection and surveys, and impact assessment criteria that were used to undertake the impact assessment.

16.4.1 Legislative Background

16.9. This section identifies the legislation, policies, plans and guidance that are relevant to terrestrial and intertidal ecology and which have been considered in relation to the proposed Development.

16.10. The relevant legislation and policies are outlined in Table 16.1 and further detail is provided in *Chapter 6: Regulatory and Policy Context*.

Table 16.1 Relevant legislation, policy or plan – Terrestrial and Intertidal Ecology

Legislation, Policy or Plan
Wildlife and Countryside Act (1981) as amended by the Nature Conservation (Scotland) Act (2004)
Nature Conservation (Scotland) Act (2004) (as amended)
Town and Country Planning (Scotland) Act 1997 (Section 57 (2))
The Environmental Impact Assessment (Scotland) Regulations 1999
The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)
Coastal Protection Act (1959) Section 34
Marine Scotland Act 2010

Table 16.1 Relevant legislation, policy or plan – Terrestrial and Intertidal Ecology
Legislation, Policy or Plan
SEPA Policy 21 – Strategy for implementing actions under the UK Biodiversity Action Plan (UK BAP)
Marine (Scotland) Act 2010
SNH Policy 0203– Wilderness in Scotland's Countryside
SNH Policy 0102 SNH's Policy on Renewable Energy
NPPG 14 (Natural Environment)
PAN 60 (Planning for Natural Heritage)
SNH, 2002, A Handbook on Environmental Impact Assessment, Guidance for Competent Authorities, Consultees and others

Development Plan Policy

16.11. The intertidal area (to mean low water mark) and onshore infrastructure of the proposed Development lies within the local planning authority area of Argyll and Bute Council.

16.12. The current structure plan for the area is the Argyll and Bute Approved Structure Plan (2002) and recognises the potential of all forms of renewable energy in Argyll and Bute. Relevant policies to this chapter are identified in *Chapter 6: Regulatory and Policy Context*, Table 6.4.

16.13. The Local Plan for Argyll and Bute was adopted in August 2009. Relevant policies regarding this chapter are presented in Table 16.1. A new Argyll and Bute Local Development Plan (LDP) as required under the Planning etc (Scotland) Act 2006 is proposed for adoption in 2010, (www.argyll-bute.gov.uk), which will replace the current Local Plan and Structure Plan.

16.4.2 Consultation

16.14. Consultation with statutory bodies and key stakeholders was undertaken by ScottishPower Renewables on scoping document: 'Proposed Demonstration Tidal Site, Sound of Islay. Request for a Scoping Opinion' (ScottishPower Renewables, 2008). In their response to the Sound of Islay Scoping Opinion (Appendix 2.1), SNH, FRS and SEPA requested that:

- The impact on designated sites be assessed;
- Opportunities to improve ecological interest in line with the Local BAP be included;
- Collision risk of otters be assessed; and
- Baseline surveys of reptiles, amphibians and invertebrates to be included.

16.4.3 Data sources

16.15. The baseline conditions of all ecological elements, including conservation areas and protected species or habitats within or adjacent to the proposed Development, along with potential substation locations and cable route areas have been determined from existing data sources.

16.16. Data sources included the following:

- Scottish Executive (2007) Scottish Marine Renewables Strategic Environmental Assessment (SEA);
- Argyll and Bute Local Biodiversity Action Plan;
- SNH Scotland wide otters surveys (1977-79; 1984-85 and 1991-94);
- JNCC website (www.jncc.gov.uk);
- SNH website (www.snh.gov.uk);
- Spatial environmental data from Magic website (www.magic.gov.uk);
- Islay Phase 1 habitat survey (including invasive species and protected species) (Royal Haskoning, August 2009 (Appendix 16.1));
- Islay Intertidal Survey (Royal Haskoning, August 2009 (Appendix 16.2));
- Jura Phase 1 habitat survey (including invasive species and protected species) (Royal Haskoning. December 2009 (Appendix 16.3)); and
- Jura Intertidal Survey (Royal Haskoning. January 2010(Appendix 16.4)).

16.5 Impact Assessment Methodology

16.5.1 Assessment Methods

16.17. This section identifies the impact assessment methodology. The criteria used to determine the magnitude of the impact and sensitivity (importance / value) are described below in Table 16.2. A full description of the EIA process and methodology is provided in *Chapter 2: Scoping Assessment Methodology*.

Impact magnitude

16.18. Impact magnitude is the potential degree of change that an impact may cause compared to baseline conditions (as determined from ecological surveys and consultation). This is a qualitative judgement based on our assessment of the likely impacts of the Development. However, wherever possible, quantitative information is used to support the impact assessments.

Table 16.2 Magnitude of Impact		
Magnitude of Impact	**Description**	**Ecological Vulnerability**
High	A fundamental change to the baseline condition of the receptor.	The local population of the species or the habitat are likely to be permanently removed/displaced by the impact under consideration
Medium	A detectible change resulting in the non-fundamental temporary or permanent condition of a receptor.	Some individuals of a species / population or part of a habitat may be permanently removed/displaced by the effect under consideration and the viability of a species population / habitat may be adversely affected
Low	A minor change to the baseline condition of the receptor (or a change that is temporary in nature).	Some individuals of a species / population or part of a habitat may be permanently removed/displaced by the impact under consideration but the viability of a species population / habitat will not be affected
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.	No detectable impact on the species / population / habitat is likely

16.19. Based on the determined level of magnitude from Table 16.2 and the importance or value of the feature (refer to Table 16.3 below), the significance of the impact can then be assessed using the characterisation identified in Table 16.4. The importance or value of the feature used in Table 16.3 has been adapted and modified to fit a Scottish context from Regini (2000) and IEEM (2002).

Table 16.3; Sensitivity / Value of the Receptor

Sensitivity/Value of Receptor	Importance	Description
High	International	Sites supporting populations of internationally important species. Any regularly occurring population of an internationally important species which is rare or threatened in the UK, i.e. a Red Data Book species, or listed occurring in 15 or fewer squares in the UK, or of uncertain conservation status or of global conservation status or of global conservation concern in the UK BAP.
Medium	National / Regional / County	Any regularly occurring population of a nationally important species which is threatened or rare at a regional scale (see Local BAP). A regularly occurring, regionally significant population of any nationally important species during a critical phase of its life cycle. Sites supporting viable breeding populations of Nationally Scarce species (occurring in 16-100 10km squares in the UK) or those included in a regional Biodiversity Action Plan (BAP) on account of their rarity, or supplying critical elements of their habitat requirements. A regularly occurring, locally significant number of a regionally important species during a critical phase of its life cycle.
Low	District / Local	Site supporting viable breeding populations of a species known to be rarities on a local scale. A regularly occurring, locally significant number of a locally important species during a critical phase of its life cycle.
Negligible	Undesignated	A widespread species.

Table 16.4: Derivation of Significance Criteria for Magnitude / Value Comparisons

Magnitude of Impact	Receptor Sensitivity/Value			
	Negligible	Low	Medium	High
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

16.20. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being of significant effect .

16.6 Existing Environment

16.21. The existing environment, with regards to designated sites and habitats, and designated fauna, along with the results of the surveys are discussed within this section.

16.6.1 Designated Sites and Habitats

16.22. This section outlines the terrestrial and coastal designated sites and habitats within, adjacent or close to the footprint of the study area. Designations relating to marine or ornithological features are discussed in *Chapter 8: Benthic Ecology, Chapter 9: Marine Mammals* and *Chapter 14: Ornithology,* with geological designations discussed in *Chapter 7: Physical Environment and Coastal Processes*. Designated sites and their proximity to the proposed Development are shown on Figure 16.2.

16.23. Argyll and Bute is an internationally important area for nature. The convoluted coastline hosts a variety of important sheltered and exposed habitats, such as mudflats, saltmarsh, deepwater muds, coastal sand dunes, and machair (Argyll and Bute LBAP).

International Designations

16.24. Special Areas of Conservation (SACs) are protected sites under the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the "Habitats Directive"), for which the Conservation (Natural Habitats, &c.) Regulations 1994, as amended, (the "Habitats Regulations") apply. These sites are part of a network of important high value conservation sites which contain species or habitats listed in Annex I or Annex II of the Habitats Directive. The proposed Development is located approximately 15km from the nearest SAC. Islay and Jura have several SACs within or adjacent to their geographical coverage, presented in Table 16.5. Those sites designated for marine mammals are discussed in *Chapter 9: Marine Mammals* and are not considered further here.

Table 16.5: International Designations

Site	Feature	Approximate distance from proposed Development
Rhinns of Islay SAC	Marsh fritillary butterfly *Euphydryas aurinia**	20km West
Feur Lochain SAC	Blanket Bogs* Natural dystrophic lakes and ponds Depressions on peat of *Rhynchosporion*	20km West
Eilean na Muice Duibhe SAC	Blanket Bogs* Depressions on peat of *Rhynchosporion*	15km South West
Glac na Criche SAC	Blanket Bogs* Vegetated seacliffs of the Atlantic and Baltic coasts European dry heaths Marsh fritillary butterfly	18 km West

Table 16.5: International Designations		
Site	**Feature**	**Approximate distance from proposed Development**
South East Islay Skerries SAC	Harbour seal*	18km South

*Primary feature for designation

16.25. Three terrestrial habitats listed under Annex I of the Habitats Directive are abundantly present on the islands of Islay and Jura. These are as follows:

- North Atlantic wet heath;
- Blanket bog; and
- European dry heath.

16.26. Both wet and dry heaths are dominating habitats across much of the study area of both islands, with Sphagnum bog features present in hollows within the topography of the study area.

National Designations

16.27. Sites of Special Scientific Interest (SSSI) are designated under the National Parks and Access to the Countryside Act 1949 and have since been re-notified under the Wildlife and Countryside Act 1981 and the Nature Conservation (Scotland) Act 2004. All SSSIs on Islay and Jura are outwith the Sound of Islay, and are presented in Table 16.6.

16.28. In addition to the SSSIs stated in Table 16.3, Feur Lochain Moine Nam Faoileann SSSI and The Oa SSSI are designated for bird populations (and are discussed in *Chapter 14: Ornithology*) and Beinn Shiantaidh SSSI, Rubh' A' Mhail To Uamhannan Donna Coast SSSI and West Coast Of Jura SSSI are designated for geological features are discussed in *Chapter 7: Physical Environment and Coastal processes*.

16.29. A National Nature Reserve (NNR) is defined as an area of importance for flora, fauna or features of geological or other special interest, which are reserved and managed for conservation and to provide special opportunities for study or research. There are no nature reserves relevant to the proposed tidal development site within the Sound of Islay, and no National Nature Reserves are present on Jura (http://www.nnr-scotland.org.uk). The Isle of Jura is designated as a National Scenic Area, discussed in further detail in *Chapter 17: Landscape and Seascape*.

16.30. The RSPB Loch Gruinart Nature Reserve lies to the North West of Islay and covers some 1600ha. 23% of the reserve comprises of farm land for grazing, silage or arable crop production. The rest consists of approximately 250ha of mud flats and salt marsh, and 980ha of heather moorland (http://www.islayinfo.com).

Table 16.6: National designations			
Island	**Site**	**Feature**	**Approximate distance from proposed Development**
Islay	Laggan Peninsula And Bay SSSI	Blanket bog Greenland barnacle goose (non breeding) Greenland white fronted goose (non breeding) Sand dune	18km
	Bridgend Flat SSSI	Saltmarsh Sandflat breeding bird assemblage Greenland barnacle goose (non-breeding) Greenland white fronted goose (non-breeding) Greylag goose (non-breeding)	12km
	Rinns Of Islay SSSI	Beetles Blanket bog Breeding bird assemblage Chough (breeding) Coastal geomorphology Corncrake (breeding) Greenland barnacle goose (non-breeding) Greenland white-fronted goose (non-breeding) Hen harrier (breeding) Machair	18km
	Loch Tallant SSSI	Basin fen	14 km
	Glac Na Criche SSSI	Blanket bog Chough (breeding) Seabird colony (breeding)	18 km
	Gruinart Flats SSSI	Blanket bog Brent goose (non breeding) Chough (breeding) Chough (non-breeding) Coastal geomorphology Dalradian Greenland barnacle goose (non-breeding) Greenland white-fronted goose (non-breeding) Lichen assemblage Mudflat Saltmarsh Sand dune Shingle	12km
	Ardmore, Kildalton And Callumkill Woodlands SSSI	Upland oak woodland	15km

Table 16.6: National designations			
Island	**Site**	**Feature**	**Approximate distance from proposed Development**
	Eilean Na Muice Duibhe (Duich Moss) NNR	Blanket bog Greenland white fronted goose (non-breeding)	16 km
	Loch Gruinart RSPB Nature Reserve	Greenland white fronted goose Greenland barnacle goose	12km
	Craighouse Ravine, Jura SSSI	Bryophyte assemblage Upland oak woodland	9km
Oronsay and Colonsay	Oronsay And South Colonsay SSSI	Chough (breeding) Corncrake (breeding) Grey seal Machair Sand dune	17km

Regional / Local Designations

16.31. There are no Local Nature Reserves (LNR), County Wildlife Sites (CWS) or Sites of Interest to Natural Science (SINS) within or adjacent to the study area.

16.32. Argyll and Bute have several habitats and species, for which Biodiversity Action Plans (BAPs) have been developed, which were found within the study area. They are recorded in Table 16.7.

Table 16.7 Argyll and Bute Biodiversity Action Plan habitats and potential species within the study area (refer to *Chapter 14: Ornithology* for bird species included in the BAP)	
Habitats	
Broad habitats	Coniferous woodland
	Improved grassland
	Rivers and streams
	Standing open water and canals
Local habitats	Open hill ground
	Peatlands
	Species rich grassland
	Unimproved/semi-improved grassland
Priority Habitats	Coastal vegetated shingle
	Maritime cliff and slopes
Species (non birds)	
Red deer *Cervus elaphus*	
Otter *Lutra lutra*	
A lichen *Pseudocyphellaria norvegica*	
Bats	

16.6.2 Terrestrial Habitats

Islay

16.33. A Phase 1 habitat survey was completed on the East coast of Islay encompassing the locations of all potential cable landing sites on that Island. The study area consisted of 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 was included in the study area approximately 1.5km South of Fionn-phort, at Traigh Bhan, at the location of the existing Islay-Jura cable. As the preferred land fall location is for Jura, the terrestrial habitats on Islay are no longer considered within this assessment. A Phase 1 Habitat Report listing species and habitats or the study area is provided in Appendix 16.1, with the intertidal report provided in Appendix 16.2.

Jura

16.34. A Phase 1 habitat survey for Jura was conducted over 16th-19th November 2009. The study area extended approximately 4km down the Sound of Islay, and approximately 1km inland, encompassing four potential cable landing sites and one substation location. The results are shown in Figure 16.1, with the full report provided in Appendix 16.3. The majority of the study area was dominated by wet heath habitat, with areas of sphagnum bog, flushes, bracken and marshy grassland/neutral grassland complexes forming a matrix throughout the habitat. These habitats were observed to extend 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 found to be waterlogged, supporting sphagnum mosses with drier heath habitat or bracken characteristically on sloping ground. Other characteristic species present included cotton grass *Eriophorum angustifolium*, lousewort *Pedicularis sylvatica*, soft rush *Juncus effusus*, heath rush *Juncus squarrosus*, purple moor grass *Molina caerulea* ling *Calluna vulgaris*, tormentil *Potentilla erecta*, *Cladonia floerkeana*, *Cladonia portentosa*, *Polytricum commune*, bog myrtle *Myrica gale*, cross leaf heather *Erica tetralix* bell heather *Erica cinerea*, bog asphodel *Narthecium ossifragum, Polytricum commune*, sharp flowered rush *Juncus acutiflorus*, bilberry *Vaccinium myrtillus*, devils-bit scabious *Succisa pratense* and round leaved sundew *Drosera rotundifolia*. 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.

16.35. The ferry slip for the Islay-Jura ferry is located in the Northwest corner of the study area at Feolin (Site J-A), where a couple of small buildings are also present. The existing Islay- Jura cable connection lies in the South west of the study area (Site J-D), where the undersea cable connects power lines. Vehicle access on Jura itself is limited to a single track road (Site J-B) along the South west coastline of the island, 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 (Site J-C). The only other evidence found of anthropogenic management or influence were areas of peat cutting.

16.36. The whole Jura study area is freely roamed and grazed by red deer.

16.37. Plates 16.1 and 16.2 show the bracken, heath and grassland matrix around the Daimh-sgeir site (J-C), the proposed landfall site, along with the stone road bridge and riparian habitat along the steep river banks. There are options to bring the cables ashore either North or South of the Abhainn an Daimh-sgeir river, with preference to the South. The narrow riparian habitat at the river consists of lichen covered deciduous trees, including holly *Ilex aquifolium*, white willow *Salix alba*, common alder *Alnus glutinosa*, grey alder *Alnus incana*, crack willow *Salix fragilis*, and many silver birch *Betula pubescens*. Within the study area on Jura, trees are predominantly limited to within the riparian habitats of the major rivers. South of the river, marshy grassland is present between the coast and the shore, with bracken dominating the steep ground, leading to wet heath habitat along the road and beyond the location of the proposed substation for the Development, at NR 45260 66350.

Plate 16.1:
Daimh-sgeir from the Sound of Islay, showing potential landing sites North (N) and South (S) of the river

Plate 16.2:
Daimh-sgeir taken from the Isle of Jura, showing potential landing sites North (N) and South (S) of the river

16.6.3 Otters

16.38. Otter *Lutra lutra* is classed as a European protected species.

16.39. Otters are also fully protected under the Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007 it is now illegal to:

- Deliberately or recklessly kill, injure or take (capture) an otter;
- Deliberately or recklessly disturb or harass an otter; and
- Damage, destroy or obstruct access to a breeding site or resting place of an otter (i.e. an otter shelter).

16.40. Thus, otter shelters are legally protected whether or not an otter is present.

16.41. If otters, their holts, couches or other places of shelter are found within the Development footprint, the impact on this species must be assessed. Wherever possible these impacts should be avoided or minimised. However, if they can't be avoided and the development might otherwise result in an offence being committed, than a licence would be necessary to be able to proceed. Licences to permit development can only be granted subject to strict tests being met. Scottish Government is the appropriate licensing authority for such licences.

16.42. Otters are also a priority UK BAP species.

16.43. Populations in coastal areas utilise shallow, inshore marine areas for feeding but also require fresh water for bathing and terrestrial areas for resting and breeding holts (JNCC, 2004). Where otters live in coastal areas (particularly in Scotland) they tend to have a largely diurnal habit, live in group territories, and have home ranges of less than 5km (Kruuk, 1996).

16.44. Otters were recorded at several locations throughout the study area and given the relatively undisturbed environment on Islay and 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 Jura 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 of the potential cable landing sites during summer 2009 (Appendix 16.1 and 16.2), and otters were recorded just North of the proposed footprint on Jura during surveys for the proposed Inver Estate Hydro scheme (MacGillivray, 2009). As a mobile species, otters and their habitat are considered for both islands.

Islay

16.45. On Islay, the majority of otter signs and activity were found in the Southern half of the Islay study area (Figure 16.3), with an otter observed foraging just North of Site I-D, and otter spraints and crustacean remains found at Sites I-C and I-A. An otter footprint was also found at Caol Ila Distillery (Site I-E) (Appendix 16.1 and 16.2).

16.46. At intertidal Site I-A, otter spraints, anal jelly and crustacean remains were located on pronounced bedrock by Transect 2 (NR 43047 65472). At intertidal Site I-C, otter spraints were identified on the rocky headland at the seaward end of the wall, and up the river as far as the large Eas Forsa waterfall. Approximately 200m North of Intertidal Site I-D, an otter was observed foraging, fishing and eating along the sea-coastal margin. At intertidal Site I-E, several otter prints and crustacean remains were identified in the dirt on the road margin on the coastal front of the distillery buildings.

Jura

16.47. During the intertidal survey of site J-B a large otter was spotted approximately 30m offshore at 13:40pm (on the incoming tide), from there it moved south along the shore whilst fishing (Figure 16.3). 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), which it ate on the intertidal substrates. 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 new road bridge over the stream (NR 4427 6802) and it is possible that the otter may have retreated to a lie-up within the rock armouring. During further salmonid habitat surveys in January 2010 (Appendix 12.1) very fresh spraints, along with older spraints were found by the rock armouring immediately East of the new road bridge (Figure 16.3).

16.48. During the survey at site J-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.

16.49. During the salmonid habitat surveys in January 2010 (Appendix 12.1) many spraints were recorded close to small undercut streams approximately 200m upstream from the coast at Mucraidh, Southwest Jura. Given the distance from the shore, this indicated the presence of a breeding holt nearby.

16.6.4 Reptiles, amphibians and invertebrates

16.50. 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).

Islay

16.51. On Islay, a female adder was discovered basking on the track at Site I-A (Figure 16.3), 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 a cabling study walkover (August 2009). Suitable habitat (including heath, bog and open woodland) is present across much of the Islay study area.

16.52. Caterpillars of the Cinnabar moth *Tyria jacobaeae* were recorded grazing on ragwort in the study area on Islay. This species is not protected. No other invertebrates have been recorded in walkover surveys.

16.53. No evidence of amphibians has been recorded during the habitat walkover surveys.

Jura

16.54. The habitat walkover surveys on the Isle of Jura were completed in November, and therefore it is likely adders would have been hibernating. Similar habitat to that present at the lower Islay study area, i.e. heath and bog, was also present throughout Jura, therefore it can be assumed that adders are likely to be present within the Jura study area also.

16.55. No evidence of either amphibians or invertebrates has been recorded during the habitat walkover surveys.

16.6.5 Coastal and Intertidal Habitats and Species

16.56. The coastline of Islay and Jura adjacent to the Sound of Islay is comprised primarily of steep vegetated cliffs (predominantly bracken or heath habitat consisting of ling and bell heather, with occasional rowan, birch and sycamore trees established on the cliffs) and raised beaches, characteristically of bedrock boulder, shingle and sandy substrates. Cliff and cliff-top vegetation in the region varies markedly even over short distances and cliff habitats in the Sound may include: bare ground; spray-zone lichen-covered rock; rock-crevice; cliff edge, seabird colony, maritime grassland; or maritime heath (Davidson, 1997). Northern Islay has some of the highest and largest spreads of late glacial raised beach shingle in Scotland. Raised beach habitats in the Sound are formed of gravel and exposed rock platforms with boulders (Davidson, 1997 and MAGIC website).

Islay

16.57. An intertidal survey was completed on Islay from the 5th to 7th August 2009 (Royal Haskoning, 2009) at six potential embayments (coded I-A to I-F) Full details are provided in Appendix 16.2 of this ES; however as Islay is no longer considered to be a suitable landfall option these are not considered further within the impact assessment.

Jura

16.58. An intertidal survey was completed on Jura from the 17th to 19th November 2009 (Appendix 16.4 at four potential embayments (coded J-A to J-D) where cables could be potentially brought ashore. A description of each landfall area on Jura is provided in Appendix 16.4, with the survey results at Site J-C (the preferred location) discussed below.

16.59. The biotopes recorded during the intertidal survey at site J-C are identified in Table 16.8. Full species lists are provided in the intertidal report (Appendix 16.4).

Table 16.8 Biotopes present in potential landing sites J-C

Biotope Code	Biotope Description
LR.MLR.BF.PelB	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
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.FLR.Lic.YG	Yellow and grey lichens on supralittoral rock
LR.FLR.Lic.Ver.B	*Verrucaria maura* and sparse barnacles on exposed littoral fringe rock
LS.LCS.Sh	Shingle (pebble) and gravel shores
LS.LSa.St	Strandline

16.60. **Site J-C** was surveyed just to the South of the mouth of the Abhainn an Daimh-sgeir river and was accessed via the A486 which had adequate roadside parking. 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 river 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 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. 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. The lower and mid shore across much of the bay was dominated by fucoids and *A. nodosum*, whilst the upper shore supported few species. The upper shore was bordered by a bank upon which was matrix of marshland and grassland habitat existed. The bank was steeper and higher in the North and less than 1m high in the South. Two transects were surveyed at this site – the first (NR 44241 67190 at 195˚) took a line from the base of a small headland down through the edge of the border between bedrock and shingle and was positioned to capture as many different habitats as possible. The second transect (NR 44267 67167 at 225˚) 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. These are amalgamated in Table 16.8, with further details provided in Appendix 16.4. A walkover of the shore North of the river identified no further biotopes to those identified to the South.

16.61. Plates 16.3 and 16.4 show the South beach and North beach at Daimh-sgeir respectively.

Plate 16.3 – South Beach at Daimh-sgeir

Plate 16.4 – North Beach at Daimh-sgeir and mouth of Abhainn an Daimh-sgeir

16.62. No rare or protected biotopes were found at any bay within the footprint of the proposed scheme during the intertidal surveys on Islay and Jura, and the zonation of biotopes identified were typical of the area.

16.6.6 Non-native Species

16.63. Non-native species are considered within this chapter as there is a risk they may be spread to new areas during construction activities.

16.64. During the Phase 1 habitat and intertidal surveys (Appendix 16.3 and 16.4) recordings were made of terrestrial and marine invasive and/or non-native species encountered. No records were made of freshwater aquatic invasive species during the habitat walkover or salmonid habitats surveys.

Rhododendron

16.65. Rhododendron (*Rhodendron ponticum*) can be difficult to control. It forms dense impenetrable thickets that are difficult to treat, and is a threat to biodiversity by out-competing native species and monopolising local environments. Rhododendron also exudes toxic chemicals into the soil around them to suppress competing vegetation.

16.66. Rhododendron is not required by legislation to be removed. No further work is therefore required for this species by law; however, accepted best practice would be to ensure minimisation of spread.

16.67. On Jura, rhododendron was sparser than that recorded on Islay, and was predominantly recorded in the North of the study area at Feolin.

16.6.7 Summary of Findings

16.68. The Jura study area is dominated by wet heath habitat, with Sphagnum bog and oligotrophic lochans, with two streams running East to West across the footprint. The coastal margin is characterised by steep vegetated sea cliffs set back from and separated from the shore by Jura's single track road. Small shingly embayments are present along the length of shore, with bedrock protruding particularly at small headlands. The footprint of the proposed Development is characterised by marshy grassland leading to wet heath, and is characteristic of the surrounding area.

16.69. No rare or protected intertidal floral species or biotopes were recorded during the survey on either Islay or Jura.

16.70. Otters are prevalent throughout the study area on both sides of the Sound of Islay, with several individuals observed and prints, spraints and potential holts recorded.

16.7 Assessment of Effects and Mitigation

16.71. The impact assessment is based on the cable landfall to occur at site J-C, near to the mouth of Abhainn-an-Daimh-sgeir. It is assumed the landfall will occur South of the river, and this impact assessment is conducted accordingly. As per the scheme description in *Chapter 5: Project Description*, it is assumed cables will be buried both intertidally and terrestrially, and once ashore, will follow the road South to a substation site construction by the Inver Estate Hydro scheme at grid reference NR 45260 66350.

16.7.1 Do Nothing Scenario

16.72. On Islay the existing ecology is unlikely to change in the near future in either terrestrial or intertidal environments. In particular, the Southern section of the study area is unlikely to be developed due to its remoteness. The areas around Port Askaig and Caol Ila have potential to be further developed in the future.

16.73. Activity in the study area on Jura, is currently limited to deer grazing across the site (inhibiting natural succession processes) and associated stalking activities, as well as rare peat cutting activities.

16.74. The proposed hydro scheme at the Inver Estate, North of the Jura footprint, would cause some disruption to the wet heath habitat during construction, as cables are currently planned to be buried and connected to a small substation close to the road (NR 45260 66350) within an extensive area of wet dwarf shrub heath before linking with the existing Jura electricity line.

16.75. During a 'do nothing scenario' there is unlikely to be a major significant change to the terrestrial and intertidal ecology at the footprint on either island.

16.7.2 Potential Impacts during Construction Phase

Impact 16.1: Impact to Designated Sites

16.76. There are no terrestrial or intertidal designated sites within or adjacent to the study area with the closest SSSI situated 9km from the proposed development. Although designated sites are of high value, no element of the terrestrial or intertidal works planned as part of the proposed scheme is predicted to have any impact on any of the designated sites of the wider area. Therefore the significance of effect of the impact to designated sites is **no significant effect**.

MITIGATION IN RELATION TO IMPACT 16.1
• No mitigation required

Residual impact

16.77. As no mitigation is required, the significance of effect of the impact to designated sites will remain **no significant effect**.

Impact 16.2: Terrestrial habitat loss

16.78. The electricity generated by the tidal turbines will be transmitted to the substation at 6.6kV and the turbines will be laid out in two separate electrical arrays. Once the cables (each will be a precautionary estimate of 500mm in diameter, however are likely to be in the region of 100mm) reach the intertidal and terrestrial zones they will be installed in trenches approximately 0.45m wide by 1m deep. There will be approximately 1400m distance of trenching required to link the cabling to the onshore substation, across wet dwarf shrub heath. The trench will run alongside the road from the landfall site at Daimh-sgeir, minimising the disturbance of the heath habitat. Access will also be required for vehicles and personnel to the shore, the footprint of which is currently unknown.

16.79. Cables will be laid in sand or peat, and the trenches will then be backfilled with excavated subsoil and peat topsoil. Earthing cables and communications cables will be installed within the same trench. Trenching of the cable route constitutes a short term temporary impact to the wet heath; however this disturbance will be situated adjacent to the existing road therefore having a lesser impact to the terrestrial habitat than works within the less frequently disturbed and therefore higher quality wet heath away from the existing road.

16.80. This avoids bringing the cables ashore North of the Abhainn an Daimh-sgeir river. The narrow riparian habitat here consists of lichen covered deciduous trees, including holly, white willow, common alder, grey alder, and many silver birch. Within the study area on Jura, trees are predominantly limited to within the riparian habitats of the major rivers, and by choosing the South option, SPR have reduced the potential for adverse effects to the terrestrial habitats, aquatic habitats and riparian trees.

16.81. The substation has a proposed footprint of 30x50m and will be dug into the hillside to camouflage into the landscape. Further details are provided in *Chapter 17: Landscape and Visual*. The existing environment at the proposed substation location is similar to the surrounding area. As the road contours around a hillside at the location of the substation, the ground rises to the East, allowing the footprint of the substation to be cut into the hillside with limited impact to the terrestrial habitat. The substation housings will be single storey to reduce their impact and will be coloured green or brown to blend with the surrounding landscape. The substation will be combined with the transformer site for the Inver Hydro Scheme for Inver Estate North of the Jura study area. A small footprint (40x40m) of regionally important wet heathland will be permanently removed by the substation, with short term temporary disturbance of the construction footprint.

16.82. The BAP and Annex I habitats which will be impacted by the cable routing are as follows:

Bap habitat	Annex 1 Habitat	Impact
Open hill ground		Temporary impact from trenching of cable (1400m) and construction footprint. Permanent removal within footprint of substation (40x40m).
Peatlands	North Atlantic wet heath, blanket Bog, European Dry Heath	Temporary impact from trenching of cable (1400m) and construction footprint. Permanent removal within footprint of substation (40x40m).

16.83. During construction, the following best practice activities will be followed:

- Construction activities, materials, machinery and vehicles will be limited to defined construction areas and routes, minimising the footprint to prevent disturbance of nearby habitat;
- During trenching of the cable route, heathland turf from the site will be stored within the construction footprint away from watercourses. Once cabling is installed, the turf will be replaced to increase the speed of re-vegetation of the disturbed wet heath habitat;
- All construction material will be removed from site;
- Clearance or trimming of trees and shrubs will be undertaken in accordance with British Standard 3998 – Recommendations for tree work;
- Trees to be removed will be marked clearly by the contractor and checked by the contract supervisor;
- Trees to be retained close to construction works will be temporarily fenced to protect them during construction using British Standard Methods;
- All trees or branches will be appropriately disposed of or re-used within the site; and
- Planting schemes of species of native, local provenance will be planted within any disturbed ground within the footprint of the proposed Development.

16.84. The proposed scheme will therefore have low magnitude impact on terrestrial habitats. Whilst Annex I habitats are of international importance, the area is not designated and these habitats are assessed to be of regional, medium importance. The BAP habitats are also of regional importance, so the terrestrial habitats can be seen as being of **minor** sensitivity.

MITIGATION IN RELATION TO IMPACT 16.2
• No mitigation required.

Residual impact

16.85. As no mitigation is required, the significance of effect of the impact of terrestrial habitat loss will remain **minor**.

Impact 16.3: Intertidal habitat loss

16.86. No rare or protected species were recorded during intertidal surveys along the study area coastline. It is proposed the cables will be buried within both the intertidal and terrestrial environments (as per *Chapter 5: Project Description*) and therefore temporary short term disturbance will occur to intertidal habitats. There will be some temporary localised smothering of intertidal habitats over a limited area; however, of the species recorded within the site at Daimh-sgeir, only *A. nodosum* is recorded to be sensitive to smothering with low recoverability (http://www.marlin.ac.uk) and this species was common along the surveyed coastline of the Jura study area.

16.87. The following best practice activities will be followed during construction:

- Construction activities, materials, machinery and vehicles will be limited to defined construction areas and routes, minimising the footprint to prevent disturbance of nearby habitat;
- Construction material will be removed from site; and
- Material removed from the intertidal habitat will be stored and replaced within the same intertidal zone following the trenching of the cables.

16.88. There is predicted to be short term low impact on undesignated intertidal habitats and species of negligible significance, resulting in an expected **negligible** effect on the intertidal zone during construction.

MITIGATION IN RELATION TO IMPACT 16.3
• No mitigation required.

Residual impact

16.89. As no mitigation is required, the significance of effect of impact of construction on intertidal habitats will remain **negligible**.

Impact 16.4: Disturbance to otters

16.90. The Scottish Wildlife Series publication 'Otters and development' is available from http://www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

16.91. Otters and signs of otter activity have been recorded throughout the coastline of the study areas on both Islay and Jura. It is therefore recognised that this coastline is an important habitat for this species. An otter was recorded feeding on rocks just off shore of the landfall site at Daimh-sgeir (J-C) during intertidal surveys (Royal Haskoning, 2010) and the river itself is likely to be important for otters to wash their fur. No evidence of holts, lie ups or couches were identified at this location, however in the absence of a detailed survey this cannot be seen as definitive. The cable landfall is planned for the South of the river, thus avoiding disturbance to this habitat, and the potential impact to otters will be considerably less, particularly as the river will be sheltered from construction noise and disturbance by the small headland immediately to the South.

16.92. Potential holts have been recorded close to site J-D and at the road bridge over Abhainn Mhor, South and North respectively of the proposed cable landfall site. Given the cable will follow the line of the road, there is not expected to be any impact of this species away from the coastline. As otters are known to utilise this area of coast, impact assessment is based on worse-case scenario and is expected to be short term and temporary having low disturbance impact on otters. As this species is of high value, this is assessed to be of **moderate** significance of effect.

MITIGATION IN RELATION TO IMPACT 16.4
• Detailed otter surveys will take place prior to final cable landfall design to check the footprint for holts, lie-up and couches and other otter activities in consultation with SNH. This will be used to inform the application for a licence to disturb otters which may be required. • Construction work will be undertaken during agreed daylight working hours (07:00-18:00), where practicable. Artificial light will not be used next to the coastline or rivers at night to allow otters to migrate through the area undisturbed. During summer months, construction may continue later into the evening without the need for artificial lighting.

MITIGATION IN RELATION TO IMPACT 16.4
• Construction areas will be left in a safe condition during periods of inactivity, with chemicals and construction materials stored safely in accordance with SEPA's Pollution Prevention and Chemical Guidelines (PPG2- Above ground oil storage tanks, and PPG5 – Works in, near or liable to affect watercourses). Key measures may include capping all pipes, covering all trenches or providing a means for otter to escape. • Construction activities will maintain a strict footprint of works for the corridor of the cable trenching, and construction vehicles and equipment will not be active on or stored by the coastline for longer than is necessary.

Residual impact

16.93. Following mitigation the significance of effect of the impact to otters and otter habitat will be reduced to **minor**.

Impact 16.5: Disturbance to reptiles, amphibians and invertebrates

16.94. The walkover of the study area on Jura was conducted in November, and so amphibians, reptiles or invertebrates could not be assessed. There is potential for the site to provide habitat for some of this group of species, some of which are protected and the proposed works could lead to the removal of some individual and some species supporting habitat. There would be potential for a low magnitude of impact on species of national importance, resulting in a worse case of **minor** significance of effect to these species.

MITIGATION IN RELATION TO IMPACT 16.5
• On final decision of cable landfall site, detailed surveys for amphibians, reptiles and invertebrates will be conducted within the footprint, and should any protected species or sign of protected species be found, the necessary mitigation will be implemented after consultation with SNH.

Residual impact

16.95. Following mitigation the significance of effect of the impact of disturbance to reptiles, amphibians and invertebrates will be **negligible** in the worst case.

IMPACT 16.6: Spread of non-native invasive species

There is a small chance that rhododendron will be present within the footprint of the cable route and substation. As best practice, should rhododendron be present within the finalised footprint of the cable landfall, this species will be removed from the construction area and disposed of. The surrounding habitats are of medium sensitivity to the spread of non-native species; however there is an expected negligible risk of spread of rhododendron. There will therefore be the significance of effect for the spread of non-native species during construction is deemed to be **negligible**

MITIGATION IN RELATION TO IMPACT 16.6
• No mitigation required.

Residual impact

16.96. The significance of effect of the risk of spread of non-native species during operation and maintenance remains as **negligible**.

16.7.3 Potential Impacts during Operational Phase

Impact 16.7: Terrestrial habitat loss

16.97. During operation, maintenance to the substation may be required. The substation is adjacent to the existing road, and therefore there will be no disturbance to terrestrial habitats during access to this site. It is presumed that maintenance to the buried cabling would not be required. No detectable effect on the regionally important habitat is predicted and the significance of effects is expected to be **negligible**. As best practice, maintenance at the substation will adhere to a tight footprint to avoid damage to surrounding habitats.

16.98. There will be **negligible significance of effect** during operation in addition to the permanent habitat loss already discussed during construction.

MITIGATION IN RELATION TO IMPACT 16.7
• No mitigation required.

Residual impact

16.99. Following mitigation the significance of effect of the impact of terrestrial habitat loss during operation and maintenance remains **negligible**.

IMPACT 16.8: Disturbance to otters

16.100. A number of factors combine to indicate that direct interaction with the turbines is unlikely, including the highly tidal environment at the Sound of Islay, the depth of water required for turbine installation, the depth at which the rotors operate, and the preference of otters to feed in shallower waters where the water velocity is calmer. Otters show a strong preference for multiple short dives in shallow waters of 0-3m of depth, with evidence suggesting deep dives are less successful for catching prey (Nolet *et al.*, 1993). Therefore, although otters may cross the Sound of Islay, it is unlikely they would dive in deeper water in search of food, and highly unlikely they would dive to sufficient depth to interact with the turbine rotors.

16.101. Although otters are of high value, no interaction between the Development and otters are expected during operation. No detectable effect is therefore likely on otters during operation of the turbines, resulting in a **negligible** significance of effect.

16.102. There is not predicted to be any impact to otters during onshore maintenance work, as this will be limited to works in the vicinity of the substation, away from the coast and water courses.

MITIGATION IN RELATION TO IMPACT 16.8
• No mitigation required

Residual impact

16.103. As no mitigation is considered necessary for this impact the significance of effect for the impact of disturbance to otter populations will remain **negligible**.

16.7.4 Potential Impacts during the Decommissioning Phase

16.104. The potential impacts during decommissioning are expected to be of the same type and magnitude to those predicted during the construction phase, with the assumption that cabling will be dug up and removed from site, and that the substation will be dismantled. As per construction, adhering to tight footprints of works.

16.7.5 Cumulative effects

16.105. Construction work for the Inver Estate Hydro scheme will also construct a corridor of cabling through the wet heath habitat on Jura. As the cable routing for the current project will run adjacent to the existing road, the impacts of the tidal array cable route will be less than that of the Hydro scheme. This is due to the fact that the area occupied by the road already suffered disturbance when the road was built and continues to suffer disturbance due to traffic using the road. The two schemes are considering aligning their substation works to enable them to share an area for their substations. This in turn will reduce the impacts on the terrestrial habitats. The significance of cumulative effects are assessed to be **minor** significant effect during construction, and **negligible** significant effect during operation and maintenance.

16.7.6 Summary of effects

Impact	Construction				Operation and maintenance				Decommissioning			
	Magnitude	Sensitivity	Impact	Residual impact	Magnitude	Sensitivity	Impact	Residual impact	Magnitude	Sensitivity	Impact	Residual impact
Impact to Designated sites	Negligible	High	No significant effect	No significant effect					Negligible	International	No significant effect	No significant effect
Terrestrial habitat loss	Low	Medium	Minor	Minor	Negligible	Medium	Negligible	Negligible	Low	Medium	Minor	Minor
Intertidal habitat loss	Low	Negligible	Negligible	Negligible					Low	Negligible	Negligible	Negligible
Disturbance to otters	Low	High	Moderate	Minor	Negligible	High	Negligible	Negligible	Low	High	Moderate	Minor
Disturbance to reptiles, amphibians and invertebrates	Low	Medium	Minor	Negligible					Low	Medium	Minor	Negligible
Spread of non native invasive species	Negligible	Medium	Negligible	Negligible					Negligible	Medium	No significant effect	No significant effect

16.8 Conclusions and Statement of Significance

16.106. Assessment is based on the proposed substations and cable route incorporating one cable land fall location at Daimh-sgeir. Except for otters and terrestrial habitat loss, all terrestrial and intertidal receptors the significance of effect are assessed as being negligible or no significant effect during construction, operation and maintenance of the onshore elements of the proposed Development.

16.107. With regards to otters, several feeding areas and potential holt sites have been identified already within a 2km radius of the potential land fall site. Further otter surveying is proposed once the final footprint of cable landfall is confirmed to inform the need for an EPS licence from the Scottish Government should a holt or resting site be located within the footprint of the cable route. This will be informed by a targeted otter survey once the cable route plan is finalised. No potential resting sites have been recorded at the proposed landfall site (J-C),however feeding otters have been recorded and the river is likely to be an important freshwater resource for this species. With the cable to come ashore south of the bridge, therefore avoiding the more sensitive river habitat, the significance of effects is assessed to be **minor**.

16.108. There will be approximately 1400m of cable routing across wet heath habitat, the dominant habitat type for the surrounding area. However, this cable route will run adjacent to an existing road that crosses the wet heath and therefore disturbance and impacts here are considered of **minor** significant effect.

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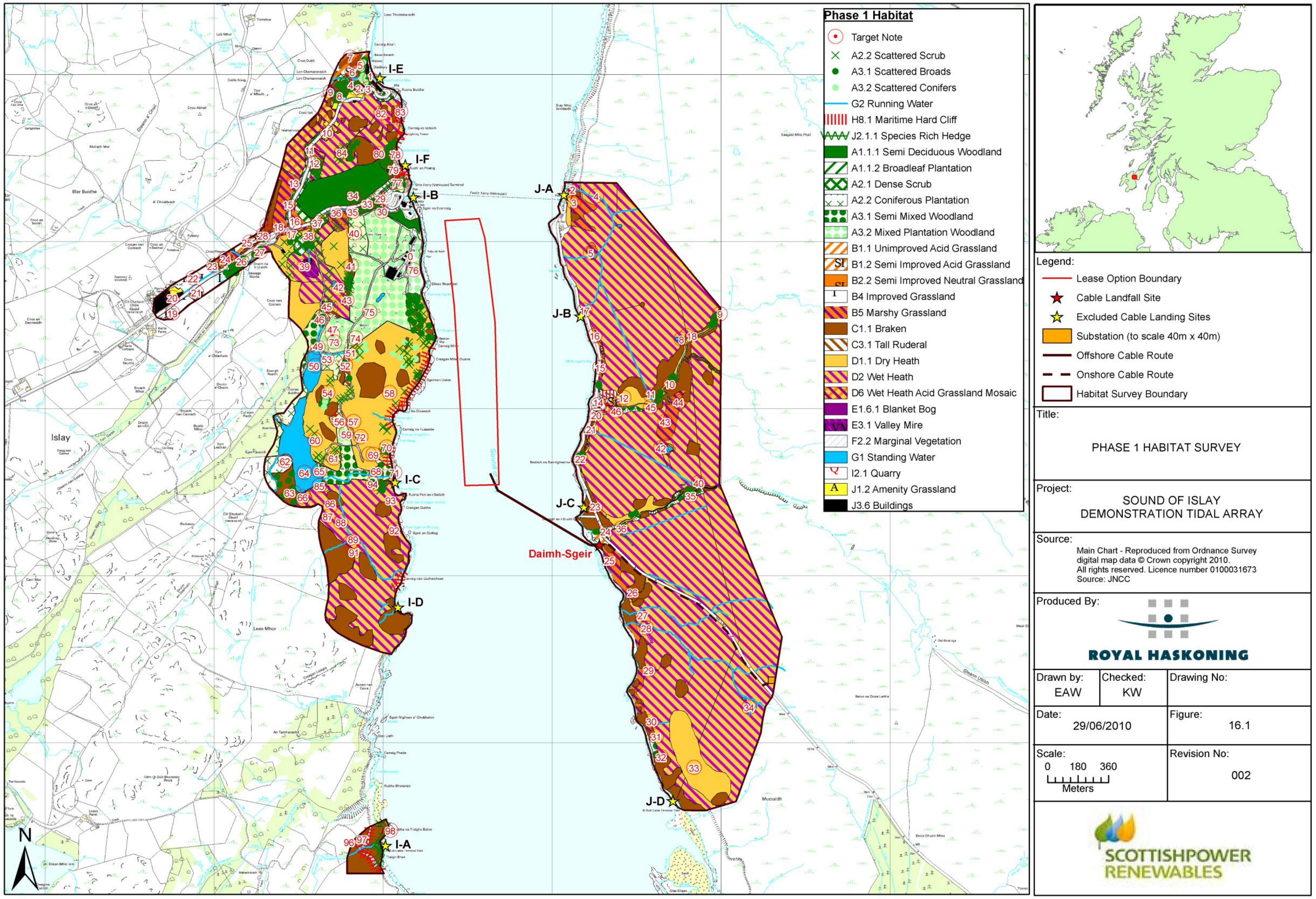

Figure 16.1 Phase one habitat surveys and the locations of potential land fall sites where intertidal surveys were completed. Site J-C identifies the preferred cable landing sites at Daimh-sgeir.

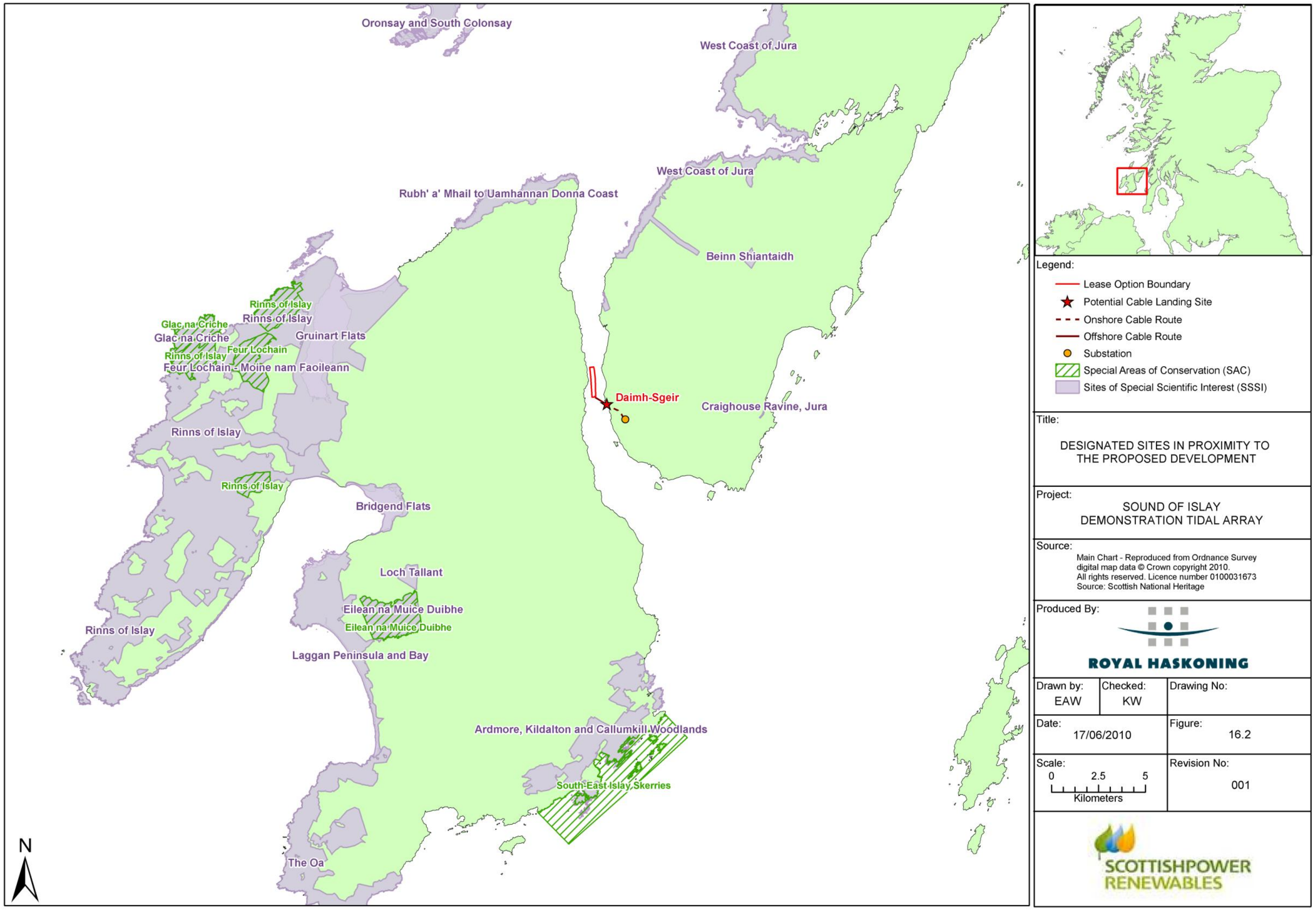

Figure 16.2 Designated sites in proximity to the proposed Development

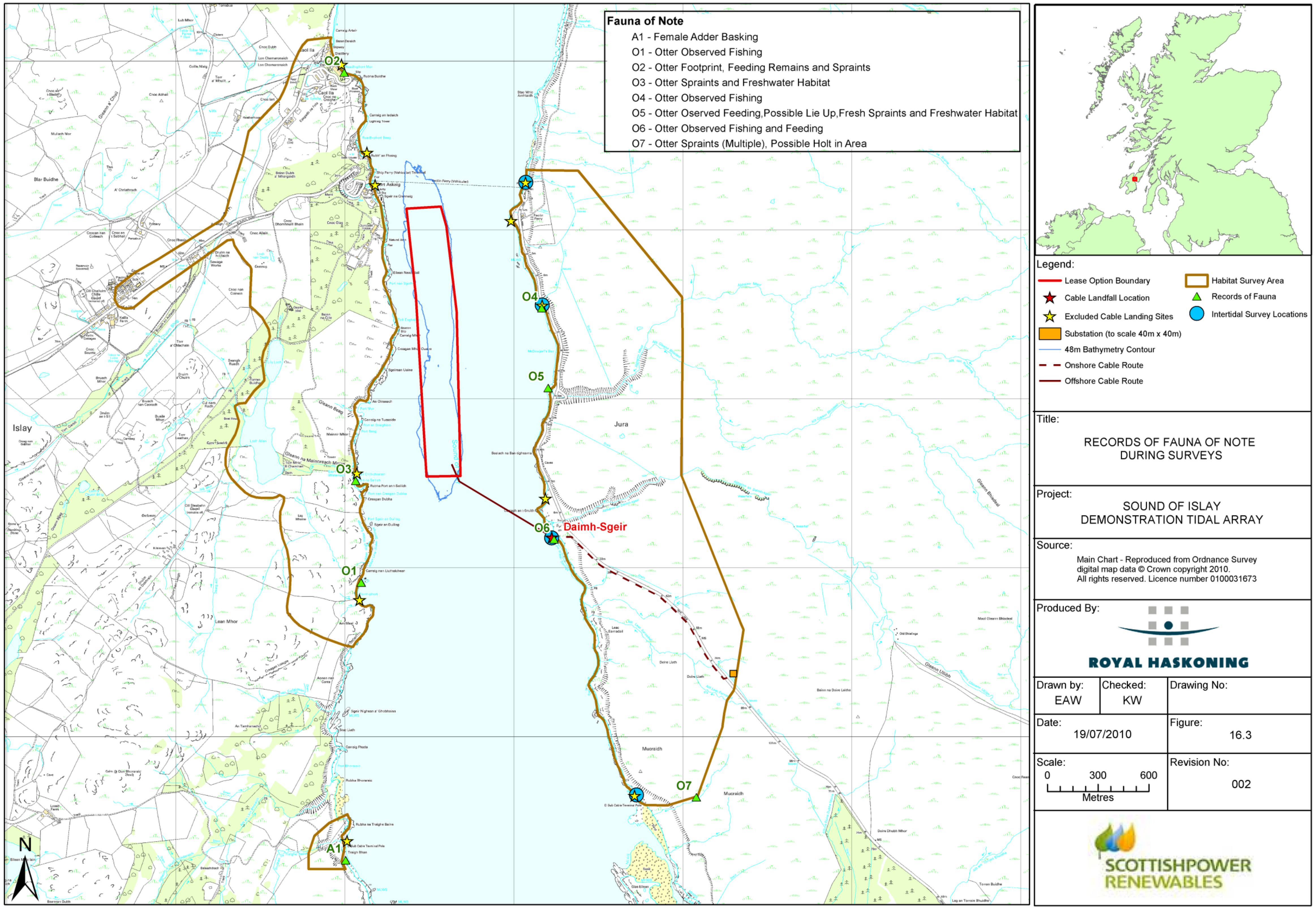

Figure 16.3 Records of Fauna of note during surveys

20. Socio-economics, Tourism and Recreation

20.1 Introduction

20.1. This chapter provides information on the potential socio-economic effects of the proposed Development. This includes possible implications of the project on existing employment, education, health, community, tourism and recreational activities on Islay and Jura and the surrounding seas.

20.2. The potential effects of the Development on these existing activities and conditions are then assessed in terms of their significance. Where required, mitigation measures are proposed in order to avoid or minimise any adverse effects.

20.3. ScottishPower Renewables (SPR) recognises the importance of the marine industry to local communities in both social and economic terms. Because of this, SPR ensured that they engaged early and actively with the Islay Energy Trust (IET), who are the local community energy organisation. This relationship, which has been formalised in a Memorandum of Understanding (MoU), has provided the Environmental Impact Assessment (EIA) process with strong links to key community stakeholders. This close relationship with the local community is an important part of the Sound of Islay Demonstration Tidal Array project.

Summary of Socio-economics, Tourism, Recreation and impacts:

The development of the array will bring with it **minor beneficial** socio-economic benefits. A small number of local jobs may be created along with a temporary increase in spend on local services during the construction of the project. There will also be ongoing spend on local services associated with operation and maintenance.

Tourism and recreation are vitally important to the economy and communities of Islay and Jura. Development of the tidal array is not expected to have any significant long term adverse effect on existing marine and coastal activities, or on visitor numbers / visitor experiences. Any negative effects will be short-term and experienced during the construction and decommissioning phases; they will be associated with the temporary displacement of activities across the array and onshore works sites. With completion of stated mitigation, the significance of effect is assessed to be at worst case **minor adverse** during construction and decommissioning and **negligible** during operation.

The proposed Development will create a new visitor attraction of Islay and Jura, increasing the islands' profiles for renewable energy with effects of **minor beneficial** significance to tourism and the local community.

The project will, on average, supply approximately the equivalent of Islay's electricity demand. SPR has an agreement with Diageo to supply electricity to three of their facilities on Islay; namely the distilleries at Caol Ila and Lagavulin and the malting at Port Ellen.

Potential Effects

20.4. The effects on landscape, seascape and visual amenity are discussed in *Chapter 17: Landscape and Visual*. The landscape, seascape and views around the Argyll and Bute coastline are intrinsic to the area's ability to attract tourists and visitors.

20.5. Installation activities (including onshore connections) may temporarily affect the general attractiveness of certain areas which could potentially affect visitor's perceptions and enjoyment of an area.

20.6. During installation of the array, access issues could arise where onshore movements of heavy construction plant may cause temporary congestion on narrow roads. Marine installation vessels could also disrupt sailing routes, fishing activities and other water sports. In the interests of efficiency and safety, installation activities may involve some restriction of public access to areas where construction is underway. Depending on location, this may affect sailing activities, diving, water sports and wildlife watching.

20.7. Visitors and local residents may be disturbed whilst participating in recreational activities (e.g. angling, walking, sailing, etc.) as a result of the noise generated during installation works.

20.8. Installation, maintenance and decommissioning of the array will make use of some local contractors based on Islay or Jura. The development is therefore likely to support local job creation.

20.9. Local businesses may benefit from increased local spend (e.g. accommodation, restaurants, shops, transport operators), particularly during the installation phase, but continuing through operation to decommissioning.

20.10. There is potential for the project to have a positive effect on tourism by becoming a tourist attraction. With increased awareness of climate change and the opportunities for gaining firsthand experience of the evolution of new technologies, the attraction of marine devices could be potentially high in the short-term.

20.11. Upgrading and strengthening of the electricity grid over Jura to the mainland may improve the security and stability of the electricity supply to Islay and Jura. However, this will depend on the work that the distribution and transmission operators require as part of the grid connection agreement.

20.12. SPR are working with IET to maximise the benefits of the project to the local community. This includes identification of opportunities for local employment as well as the options for financial benefits to the community during operation.

20.2 Methodology

20.4.1. Legislative Background

20.13. Statements of Scottish Government policy in the National Planning Framework (NPF), the Scottish Planning Policy (SPP), Designing Places and Circulars can be material considerations to be taken into account in development plans and development management decisions.

20.14. Certain elements of the SPP are particularly relevant to the proposed Development. The SPP recognises that the coast of Scotland is a major focus for economic activity, recreation and tourism, and that the sustainable development of coastal areas is an important contributor to sustainable economic growth. It also states that renewable energy generation will contribute to more secure and diverse energy supplies and support sustainable economic growth. The SPP acknowledges that there is potential for communities and small businesses to invest in ownership of renewable energy projects.

20.15. The Scottish Government Economic Strategy sees the 'green' economy as being central to the growth of Scotland's economy. This includes the start up and growth of Scottish business, encouraging and supporting key manufacturing industries and supporting innovation and technology transfer to grow high value and high skills businesses with the potential for expansion. 'Going for Green Growth: a Green Jobs Strategy for Scotland' sets out how this priority should be delivered through sustainable economic development.

20.16. The Scottish Government believe that a thriving renewables industry in Scotland has the potential to develop new indigenous industries, particularly in rural areas; to provide significant export opportunities and to enhance Scotland's manufacturing capacity. The planning system has a key role in supporting Scotland's economic competitiveness and employment market. The scope for developments to contribute to national or local economic development priorities should be a material consideration when considering policies and decisions.

20.17. This policy context indicates that the scope of socio-economic assessment for the development of the proposed tidal array should focus on the potential for the development to contribute to sustainable economic development.

20.4.2. Consultation

20.18. The Scottish Government's response to the SPR request for a Scoping Opinion stated that the Environmental Statement (ES) 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.

20.4.3. Data Sources

20.19. SPR has a collaborative agreement with IET, a local community organisation and employs a Tidal Energy Project Officer. This collaboration has enabled the project to actively engage with key stakeholders and investigate the potential impacts of the project.

20.20. In light of the nature of the Development (i.e. devices are sub-surface and at a depth that will not result in any interaction with marine vessels, onshore infrastructure is minimal) no specific surveys have been undertaken in relation to the potential effects of the development on tourism and recreation. Given the availability of published data, no specific survey was undertaken in relation to the potential effects of the Development on socio-economics.

20.21. A desk-based assessment has been carried out to establish the baseline for socio-economic, tourism and recreation for the project area, and to assess potential impacts resulting from project construction, operation, maintenance and decommissioning, using information drawn from available literature and data. Key information sources include:

- Office for National Statistics;
- Argyll Renewables Communities commissioned study relating to the socio-economic effects of proposed Argyll offshore wind farms (ARC, 2010);
- VisitScotland Research Statistics;
- Marine and Coastal Visitor Management, Public Engagement and Interpretation in Argyll and the Islands: the way forward (Benfield and McConnell, 2007);
- Review of Marine and Coastal Recreation in Scotland (Land Use Consultants, 2006); and
- Scottish Marine Renewables SEA – Tourism and Recreation (Scottish Executive, 2007).

20.22. Part of the role of the IET Project Officer has been to consult with local stakeholders including the Islay and Jura Community Councils. This work has been ongoing since April 2009.

20.3 Assessment of Significance

20.23. The broad methodology used for determining impact significance is outlined in *Chapter 2: Scoping and Assessment Methodology*. The significance of the effect is assessed on the basis of both the magnitude of the impact (Table 20.1) and the sensitivity of the receptor (Table 20.2). Also to be taken into account when making the assessment is the potential for impact occurring.

Table 20.1 Magnitude of Impact

Magnitude of Impact	Description
High	A fundamental change to the baseline condition of socio-economics and/or tourism and/or recreation.
Medium	A detectible change resulting in the non-fundamental temporary or permanent condition of socio-economics and/or tourism and/or recreation.
Low	A minor change to the baseline condition of socio-economics and/or tourism and/or recreation (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of socio-economics and/or tourism and/or recreation.

Table 20.2 Sensitivity/value of the receptor (adapted from significance criteria outlined in the Scottish Executive Marine Renewables SEA (Scottish Executive, 2007).

Receptor Sensitivity/value	Description
High	Environment is subject to major change(s) due to impact. For example the loss of an attribute(s) in its entirety or significant loss of the quality or integrity of an attribute(s) which would have a long term or lasting, damaging effects on the tourist industry and recreation. This would imply a substantial reduction in the number of people participating in an activity and have resultant effects on local business.
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. For example the loss of part of an attribute(s) or loss of the quality or integrity of an attribute(s) which would have an effect on the tourist industry and recreation. This would imply a reduction in the number of people participating in an activity and resultant effects on local business.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example a slight change to an attribute(s) or the quality or integrity of an attribute(s). Theses impacts are normally temporary or reversible and are unlikely to have effects on local businesses.
Negligible	Environment responds in minimal way to effect such that only very minor change(s) occur which may or may not be detectable, or no changes at all.

20.24. By combining the magnitude of the impact and the sensitivity of the receptor in a matrix (see Table 20.3) the final significance of the effect (prior to the implementation of mitigation measures) can be obtained. The level of significance will then be described as either 'major', 'moderate', 'minor' or 'negligible' based on the outcome of the impact matrix.

Table 20.3 Impact significance matrix

Magnitude of Impact	Receptor Sensitivity			
	Negligible	Low	Medium	High
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

20.25. As is detailed in *Chapter 2: Scoping and Assessment Methodology* and Table 20.4 below, impacts can be either adverse (causing a negative change in the baseline conditions) or can be beneficial (causing a positive change in the baseline conditions). It will be made clear in the assessment of each impact as to whether the impact has been assessed to be adverse or beneficial.

Table 20.4 Terminology for classifying environmental impacts

Significance of impact	Definition
Major adverse	The impact gives rise to serious concern and should be considered unacceptable.
Moderate adverse	The impact gives rise to some concern but is likely to be tolerable depending on scale and duration.
Minor adverse	The impact is undesirable but of limited concern.
Negligible	The impact is not of concern.
No significant effect	There is an absence of one or more of the following: impact source, pathway or receptor.
Minor beneficial	The impact is of minor significance but has some environmental benefit.
Moderate beneficial	The impact provides some gain to the environment.
Major beneficial	The impact provides a significant positive gain.

20.26. In terms of effects on socio-economic attributes, potential impacts have been quantified where possible (e.g. number of jobs to be generated). Otherwise, impacts have again been assessed subjectively.

20.27. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being of significant effect.

20.4 Existing Environment

20.4.1. Socio-economics

Local Community

20.28. Islay and Jura lie within a region classified by Highlands and Islands Enterprise (HIE) as a fragile area, characterised by a history of population loss, low incomes, limited employment opportunities, poor infrastructure and remoteness (ARC, 2010).

20.29. The population for the combined area of Islay, Jura and Colonsay was 3,822 in 2008, an increase of 1.5% since 2001 as compared to a fall of almost 1% in Argyll and Bute as a whole (Office for National Statistics). This overall increase has been driven by a 20% increase in the pension age population but there has been an 11% fall in the number of children on the islands. The working age population has also fallen slightly by 1%.

20.30. The population of Islay, Jura and Colonsay is structured differently from that of Scotland. The islands have a smaller proportion of working age people between the ages of 20 and 34 which may be explained by the need to move to the mainland to study or in search of employment opportunities. The second main difference is the higher proportion of older people within the island's population which reflects the in-migration of people moving into the area for retirement or 'lifestyle' reasons. This is an on-going trend: in 2001, those of pension age made up 21.4% but this increased to 25.4% by 2008 while the proportion of the total population made up of children has fallen from 19.6% to 17.2% across the same period. The result of this 'top heavy' population is a dependency ratio which is slightly higher than the Argyll and Bute average and much higher than the dependency ratio for Scotland.

20.31. The main settlement on Islay is Bowmore with a population of around 1,000 while the main settlement on Jura is Craighouse (approximately 160 people).

20.32. The Scottish Index of Multiple Deprivation (SIMD) is the Scottish Government's official tool for identifying small area concentrations of multiple deprivations across Scotland. The SIMD does identify that Islay, Jura and Colonsay are more deprived than the Argyll and Bute average in terms of health and education and much more deprived in terms of the housing stock. It is also clear that Islay, Jura and Colonsay face serious issues in terms of access to services which is unsurprising given their geographic isolation (ARC, 2010).

20.33. The community on Islay is generally receptive to renewable energy proposals and have formed the Islay Energy Trust (IET), a community-owned company that aims to develop and operate renewable energy projects. IET is a member of the Argyll Renewables Communities (ARC) Consortium.

Industry and Employment

20.34. The pattern of employment in Argyll and Bute is different to the Scottish average by virtue of the rural nature of the area.

20.35. The Annual Business Inquiry reports that there were a total of 236 data units[1] across Islay, Jura and Colonsay in 2007. In absolute terms, the most important sectors were distribution, hotels and restaurants (67 units), followed by the public sector (32 units) and agriculture and fishing (30 units). Compared to Argyll and Bute and Scotland, a number of sectors are over-represented on the island economies of Islay, Jura and Colonsay: agriculture and fishing, transport and communications and manufacturing (principally due to the high number of whisky distilleries on Islay) have around double the proportional representation on the islands compared to the rest of Argyll and Bute and Scotland (ARC, 2010).

20.36. In terms of employment, Islay and Jura are characterised by high levels of self employment (with 15% of all 16 - 75 year olds on Islay and Jura and 24% on Colonsay reporting that they were self-employed in the 2001 census), above average levels of part time employment and below average levels of full time employment. Unemployment in Argyll and the Islands is cyclical, with rates rising in the winter months and falling in the summer season. This seasonality reflects the relative dominance of tourism and agriculture in the local economy. Earnings on the islands in general are lower than on the mainland.

20.37. There are several small businesses in the marine service sector on Islay and Jura that have the potential to develop based on the growing marine renewables sector in Argyll. This includes CD Campbell Marine Contracts who provide commercial diving and marine survey services and StormCats, Scotland's largest GRP (glass-reinforced plastic) manufacturer.

Valuing the Output of the Local Economy

20.38. Gross Value Added (GVA) comprises the difference between the value of goods and services produced and the cost of raw materials and other inputs used in production; it represents the difference between output and immediate consumption, and is principally made up of compensation paid to employees (largely salaries and other benefits) and profit. There are no published gross value added (GVA) figures for Islay, Jura and Colonsay. Published data is available for the NUTS[2] Level 3 geography which covers Lochaber, Skye and Lochalsh, Argyll and the Islands at a sectoral level. By applying the GVA per employee values from this geography to the number of employees in each sector on Islay and Jura, it is possible to estimate the GVA generated by the two island economies. The total GVA for Islay, Jura and Colonsay in 2007 was £46.1m; of which £35.5m was accounted for by the whisky industry (ARC, 2010).

20.4.2. Tourism and Recreation

20.39. Tourism is one of Scotland's largest business sectors with an estimated value of over £4 billion per annum to the Scottish economy (Scottish Executive, 2007). Scotland's coastline and islands play an influential role in attracting tourists and recreational users to the country through the provision of stunning scenery, wildlife, cultural assets and a wide range of organisations providing a variety of sports and activities.

20.40. Argyll and Bute's proximity to the central belt of Scotland makes it accessible to both UK and overseas visitors via the motorway network and international airports. Visitors to the region often partake in coastal recreational activities; the Argyll coast and islands is the region of Scotland deemed to be of greatest importance for coastal recreation (Land Use Consultants, 2006).

20.41. There are several ways for tourists to access Islay. The island has its own airport, Glenegedale Airport, on the south east of the island, with services to and from Glasgow. In addition, there are regular ferry services to Port Ellen and Port Askaig from Kennacraig on the Kintyre Peninsula. During the summer, the ferry to Port Askaig also runs on to Scalasaig on Colonsay and on to Oban. These services are run by Caledonian MacBrayne. There is also a ferry that runs from Port Askaig to Feolin on Jura. The small road from Port Askaig forms one of the few major transport links across the island. A new passenger ferry route opened in 2008 to link Craighouse on Jura with Tayvallich on the mainland, and operates during the summer months. The locations of these access routes are shown in *Chapter 19: Traffic and Transport* (Figure 19.5).

20.42. The main attractions on Islay and Jura are the whisky distilleries and wildlife, particularly the over-wintering geese. The year round accessibility to the distilleries and the presence of the geese during the winter months means that Islay gets a significant number of visitors year-round (Benfield and McConnell, 2007).

20.43. The scenic coastlines of Islay and Jura and their natural heritage are to a large extent the foundation of the local tourism, leisure and recreation industries. Local attractions and popular recreational activities include:

- **Wildlife and Nature**: Islay is a regular destination for botanists and birdwatchers. The RSPB Nature Reserve at Loch Gruinart, Bridgend had 11,000 visitors in 2007 (VisitScotland, 2009). The RSPB run guided walks for visitors at Loch Gruinart and The Oa on Islay and the Natural History Trust on Islay run family activities such as rock pooling and seashore visits. On the coastline of the Sound there are recognised wildlife watching viewpoints near Feolin Ferry on Jura and north of Bunnahabhain on Islay.

- **Distilleries**: There is one distillery located on Jura and eight distilleries located on Islay; two of these (Bunnahabhain and Caol Ila) are located adjacent to the Sound of Islay. The creation of both these distilleries led to the development of small communities where traditionally distillery workers and their families lived. Caol Ila, built in 1846, is situated close to the proposed scheme. According to the Argyll and Bute Structure Plan (2002) the distilleries on Islay contribute most significantly to the local tourism sector.

- **Walking**: South East Islay and Jura are regularly enjoyed by walkers. The South of Jura is designated a National Scenic Area (*Chapter 17: Landscape and Visual*) and includes the Paps of Jura approximately 6km from the Sound of Islay coastline. The Paps of Jura are a small mountain range including three major peaks which rise to 728m above sea level. The Islay Community Access Group was established in 2001 to provide a link between land managers and the general public in parts of Islay where there was the possibility of conflict between the two. Several access routes have been created across Islay, with one forming a loop through woodland and on good surfaces from Ballygrant to Port Askaig via the Lily Loch (Figure 20.1). Local footpaths also exist over the cliff tops

[1] Data (or local) units do not readily correspond to the commonly used terms firms, companies or businesses by which employers are sometimes identified. They are roughly equivalent to workplaces but because of the way the data are collected two or more units can be present in the same workplace. For example, a bank may have several branches and offices in a city, each one of these would be counted as a separate data unit.

[2] In order to enable the collecting, compiling and disseminating of harmonised regional statistics, the EU has introduced the NUTS classification. The NUTS level to which an administrative unit belongs is determined on the basis of population thresholds (NUTS level 3 equates to a minimum population of 150,000 and maximum of 800,000.

between Port Askaig and Caol Ila Distillery (Figure 20.1), enabling walkers to access between the two places without having to take the long detour around the established road network. These footpaths are also popular with dog walkers and the local community. Several adventure races also take place annually on Islay and Jura, including the Isle of Jura Fell Race, the Islay Half Marathon and an ultra marathon.

- **Watersports**: Port Ellen provides 20 berths for recreational vessels, with peak activity over the summer. The islands are popular for canoeing, sea kayaking, fishing, wind surfing and surfing. The RYA has a number of identified cruising routes around Islay (including the Sound of Islay) which are popular during the summer months. The main cruising routes are shown in Figure 20.1 and there are several anchorages in the Sound (RYA, 2008). The Sound itself is classed by the RYA as being of 'light recreation use' (RYA, 2008). 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. Admiralty Chart 2481 identifies anchorages at McDougall's Bay, Whitefarland Bay and Bunnahabhain Bay within the Sound (see Figure 20.1); however these are not recommended by the RYA in their routing system (Navigation Safety Risk Assessment, Appendix 19.1).

- **Diving**: There are some interesting diving sites around Islay including the MV Wyre Majestic, close to the Bunnahabhain distillery in the Sound of Islay, with drift diving also taking place in the Sound's strong currents. A dive at 'Port Askaig Deeps' is situated within the proposed Development site (Navigational Safety Risk Assessment, Appendix 19.1). Other sites are situated around the south and west of the island (Figure 20.1).

- **Cycling**: There are a number of cycle routes which link the main settlements and distilleries, with cycle touring becoming increasingly popular. Bicycle hire is available at Port Charlotte, Port Ellen, Port Askaig and in the Bowmore post office. Routes used by cyclists are shown alongside the footpaths on Figure 20.1.

- **Stalking**: Approximately 6000 deer are present on the Isle of Jura (www.juradevelopment.co.uk) and stalking is an important activity on the island.

20.44. Several annual festivals on Islay and Jura attract visitors, especially the Islay Festival of Malt and Music, which is held annually in May and brings many people to the island (www.islayinfo.com). Further events such as the Walk Islay walking festival, the local Mod (a Gaelic festival), Beach Rugby, the Jazz Festival and the Jura Music Festival, continue throughout the year.

20.45. There are a number of marine based tourism interests in the area. Table 20.5 identifies the marine tourism related companies operating from the Isles of Colonsay, Jura and Islay. In addition several other operators based in Kerrera, Ardfern, Craobh Haven, Connel, Crinan and Oban include trips to Jura and Islay within their services.

Table 20.5 Marine tourism based on Islay and Jura (Source: Benfield and McConnell, 2007).

Island	Port	Company	Activities
Islay	Port Charlotte	Islay Birding	Wildlife and bird activities
	Port Askaig	Islay Marine Charters	Private charter vessel for sea-angling and wildlife tours
	Port Ellen	Islay Sea Safari	Marine wildlife tours
	Port Ellen	Islay Dive Centre	Diving
Mainland	Tayvallich	Venture West	Private charter vessel for scenic and wildlife tours
Isle of Jura	Ardlussa	Isle of Jura Exploration	Guided wildlife and scenic walks

20.5 Assessment of Impacts and Mitigation

20.5.1. Do Nothing Scenario

20.46. This section addresses the 'Do Nothing' scenario (i.e. what impacts and changes to these activities would be expected if the proposed scheme does not go ahead) in relation to recreation, tourism and socio-economics.

20.47. It is considered that if the array was not installed, the current economies of tourism, agriculture, fishing and whisky would remain as the main industries in Islay. These industries sustain the local population. Should the proposed scheme not go ahead it is envisaged these industries would continue to maintain the islands sustainable growth.

20.48. Similarly, if the array was not installed, there would be no anticipated change in tourism and recreational activity.

20.5.2. Potential Impacts during Construction Phase

Impact 20.1: Direct Capital Expenditure (Manufacture and Assembly)

20.49. The proposed development is a major undertaking, with substantial total capital costs expected to be in excess of £40 million. The manufacture of the sub-structures requires substantial infrastructure and many of the parts for the nacelles (turbines, gearboxes etc.) will require specialised suppliers. Argyll has been involved in the manufacture of onshore wind farms and is in the process of developing the major infrastructure for offshore wind farm manufacture. As such there are opportunities for manufacturing capital expenditure to benefit the Argyll region. Therefore the pressure of this impact can be considered to be of a medium magnitude.

20.50. Assembly of the nacelles will require substantial onshore infrastructure but the final assembly of the blades to the nacelles may be done close to the project site. Whilst this is likely to be mainly carried out by specialist contractors there may be opportunities for local businesses to be involved.

20.51. There is an opportunity for at least some of the manufacturing to be carried out in Argyll. Therefore the sensitivity of socio-economics to this impact can be considered to be medium, and an impact of long term temporary **moderate beneficial** significance is anticipated.

MITIGATION IN RELATION TO IMPACT 20.1
• No mitigation required.

Residual Impacts

20.52. As No mitigation is required, the residual impact is expected to remain **moderate beneficial** significance.

Impact 20.2: Indirect Capital Expenditure (Marine Services and Onshore Construction)

20.53. It is believed that local marine contractors could benefit from contracts worth approximately £100k during installation with a further requirement for between two and four crew for a six month period for operation on work boats and guard boats.

20.54. It is estimated that the onshore construction phase will create employment for approximately four people for a three month period. It is also likely that the marine activities will create opportunities for people with local marine knowledge.

20.55. With continued provision of local logistical support from the Islay Energy Trust combined with the onshore and offshore contract work mentioned above, it is thought that the economic contribution to Islay and Jura of the construction phase would be approximately £400k. This will result in temporary detectable change in the socio-economics of the area and therefore this impact can be considered to be of medium impact.

20.56. The indirect effects of capital Expenditure are likely to be felt by a number of local businesses, and as there are only a small number of businesses on Islay and Jura the socio-economics in the area can be considered to be of medium sensitivity.

20.57. Therefore an impact of long term **moderate beneficial** significance is anticipated.

MITIGATION IN RELATION TO IMPACT 20.2
• No mitigation required

Residual Impacts

20.58. As no mitigation is required, the residual impact is expected to remain of **moderate beneficial** significance.

Impact 20.3: Indirect Economic Benefits (Employment, Accommodation and Services)

20.59. The Development will be the first commercial tidal array in the world and therefore the first stepping stone on the road to a green economy. Scottish Government (Marine Energy Group, 2009) figures state that marine renewables could support over 12,000 jobs and be worth £2.5 billion to the economy by 2020. This Development is envisaged as the first important step to achieving that goal.

20.60. A number of specific employment opportunities will be created by the project, including:

- Project Officer - One full time local job has already been created with the appointment of the Tidal Project Development Officer at Islay Energy Trust; and
- Survey Work – Local employment has been used for seabed, ornithological and archaeological surveys. Local boats and crew are being used wherever possible and this will continue throughout the project.

20.61. Construction workers employed by the project will spend up to six months on Islay and Jura, depending on the type of vessels used for installation. These workers will use local travel facilities (e.g. hire cars), accommodation, restaurants and shops. As a result, local spend will increase on a temporary basis. The project will continue to benefit the local economy through indirect spend on accommodation, food and sundries.

- Accommodation – The project involves relatively large numbers of overnight visits from the mainland thus helping the accommodation industry on Islay. During development, it is estimated that £8,000 has been spent on accommodation and that approximately £20,000 will be spent during installation;
- Food – It is estimated that over £2,000 has been spent in local shops during development and that over £8,000 will be spent during installation; and
- Equipment – Local shops have benefited from sale of equipment and sundries to the project team and this will continue.

In total it is thought that provision of services to the construction teams would be worth approximately £50k.

20.62. Accommodation is in short supply during the summer months and it is important that a short term increase in demand from construction workers does not damage the longer term demand for holiday accommodation. Consultation with the local marketing board will be important to ensure that this opportunity is maximised.

20.63. The short term benefits to socio-economics in the area caused by the Development may therefore be neutralised by longer term adverse effects on tourism and recreation which will as a consequence have knock-on effects to socio-economics. Consequently this impact can be considered to have a low magnitude.

20.64. As employment on Islay and Jura is limited the socio-economics can be described as being of medium sensitivity.

20.65. Therefore the increased employment opportunities and the increased local spend overall will be of **minor beneficial** significance.

MITIGATION IN RELATION TO IMPACT 20.3
• No mitigation required

Residual Impacts

20.66. As no mitigation is required, impacts will remain of **minor beneficial** significance in the short term.

Impact 20.4: Disturbance to Tourism and Recreational Activity

20.67. Noise generated during the installation of the marine devices will potentially have direct and indirect effects on recreation and tourism, although the effects will only be short term. The main sources of construction noise include:

- Vessels;
- Movement of machinery/device components;
- Installation of machinery/device components; and
- Installation of onshore infrastructure e.g. the local substation.

The main direct effects of installation noise is related to general disturbance that will be experienced by visitors to coastal attractions/locations e.g. distilleries and coastal paths, and participants in key coastal and marine recreational activities. Installation noise may have adverse effects on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas. For an in-depth assessment of this topic, see *Chapter 14*: *Ornithology*. This could potentially have an indirect effect on the marine wildlife watching industry and bird watchers.

20.68. Disturbance will be short-lived and given that no particularly noisy works (e.g. piling) are to be undertaken, effects will be confined to small areas around works sites at Daimh-sgeir on Jura and along the proposed cable route, neither of which are areas specifically identified as wildlife watching locations. The storage of dumb barges at Caol Ila is not anticipated to impede industrial or tourism activities at Caol Ila Distillery. As such, the pressure of the impact is anticipated to be of a low magnitude.

20.69. There will be disruptions to tourists and visitors travelling along the A468 from / to Feolin on the Isle of Jura during construction. An impact assessment and mitigation for this is provided in *Chapter 19*: *Traffic and Transport*. As this is a lifeline road link for the island, a Traffic Management Plan will be implemented prior to and during construction to maintain access and therefore to minimise disruptions to tourists visiting Jura's attractions, such as the Jura Distillery. The Traffic Management Plan will also take account of large events on Jura including the Isle of Jura Fell Race and the Jura Music Festival.

20.70. The islands of Islay, and in particular, Jura boast a relatively undisturbed natural environment which is relatively unspoilt by anthropogenic activity. This asset brings many visitors to the area and is driving factor for the tourism and recreation industry which also provides socioeconomic benefits. Although impacts will be limited in scale (both temporal and spatial) the receptor (socio-economics, tourism and recreation) can be considered to be of medium sensitivity.

20.71. Therefore the overall impact of the disturbance to recreational activity and the knock-on effects of this are considered to be of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 20.4
• Installation will be designed to minimise unnecessary noise. • See *Chapter 10*: *Noise and Vibration Affecting Human Receptors* and *Chapter 14: Ornithology* for further details. • Adherence to Traffic Management Plan and mitigation laid out in *Chapter 19*: *Traffic and Transport*, including consideration of large Jura public events.

Residual impact

20.72. Assuming mitigation is in place, disturbance of recreational activity will be of **negligible** significant effect.

Impact 20.5: Displacement of Tourism and Recreational Activity

20.73. In the interests of efficiency and safety, installation activities may involve some restriction of public access to areas where construction is underway. This may displace sailing and activity within the footprint of the tidal array, or coastal activities (walking, wildlife watching, cycling) around landfall/onshore works.

20.74. Divers will not be able to access the deep dive at Port Askaig Deeps during construction and operation for health and safety reasons (Appendix 19.1).

20.75. There will also be temporary increases in shipping movement within the Sound of Islay associated with construction, which again may displace sailing. Any disruption to the passenger ferries, particularly those operating between Port Askaig and Feolin, and Port Askaig and Kennacraig will be an inconvenience to tourism accessing the islands and their associated tourist attractions, including local distilleries. A full assessment of the impacts to ferries and the associated mitigation is provided in *Chapter 19:* Traffic and *Transport,* with reference to the Navigational Safety Risk Assessment in Appendix 19.1. This will be a temporary change and it is only expected to create minor changes to the baseline conditions. Consequently the magnitude of this impact will be medium.

20.76. Existing activity within the direct footprint of the array and of the onshore works is limited and it is not expected that construction will entirely prevent any activity from taking place, but rather displace it temporarily (e.g. recreational vessels will still be able to transit the Sound of Islay, but may need to set a slightly different course). Furthermore, displacement will only last for the duration of works. The sensitivity of the receptor can therefore be considered to be medium. As a result of these short term temporary effects the impact is considered to be of **moderate adverse** significance.

MITIGATION IN RELATION TO IMPACT 20.5
• The array will be appropriately charted as an underwater obstruction and annotated, as discussed further in the Navigational Safety Risk Assessment. • The array will also be charted as a 'no fishing' and 'no diving' area and consultation will continue with relevant diving organisations. • During construction activities the following safety procedures will be implemented: • Notice of the activities would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Radio Navigational Warnings (NavWarns/WZs)) and will occur just prior to and during the maintenance works • Installation vessels will comply with the COLREGS in that they would display the appropriate lights and marks for vessels engaged in such activities • Presence on site of manned vessels capable of monitoring and advising the other marine traffic using the Sound of Islay, • The Navigational Safety Risk Assessment has been undertaken (Appendix 19.1) and identifies management of potential conflict with ferry routes. Further mitigation is discussed in *Chapter 19*: *Traffic and Transport.*

Residual Impacts

20.77. The level of publicity and consultation carried out to date is likely to have raised the project profile significantly around Islay and Jura; therefore it is considered that the significance of risk of negative interaction between construction vessels and tourism and recreation stakeholders is **minor adverse**.

20.5.3. Potential Impacts during Operational/Maintenance Phase

Impact 20.6: *Creation of a Visitor Attraction*

20.78. There is potential that the array could have positive effect on recreation and tourism by becoming a key visitor attraction. With increased awareness of climate change and the opportunities for gaining first hand experience of the evolution of new technologies, the attraction of marine devices could be potentially high. Interest may decrease as wave and tidal power become more commonplace.

20.79. As the first commercial tidal array in the world, the Development will be subject to significant press coverage and the profile of Islay is expected to benefit from being broadcast widely among many organisations within and beyond the UK.

20.80. Islay is already home to the world's first commercial wave generator (Wavegen's "Limpet" at Portnahaven) and the tidal project will enhance Islay's reputation as a flagship for marine energy exploitation in Scotland.

20.81. The project is expected to be the first operational tidal array site in the world but since the devices will not be visible to land-based observers, the level of attraction will depend on the provision of good quality interpretative materials in the vicinity of the site. The project's role as a tourist attraction will be of a low magnitude and the receptor (tourism and recreation) of a medium sensitivity resulting the impact being of **minor beneficial** significance.

MITIGATION IN RELATION TO IMPACT 20.6
• SPR have worked extensively, and will continue to work to raise the profile of the project and demonstrate the benefits of tidal energy. • SPR will work with the Islay Energy Trust to develop and promote good quality interpretative materials to encourage interest and understanding of tidal energy. • It is likely an onshore information centre will be provided to inform tourists, visitors and the local community on the proposed Development through interpretation boards etc.

Residual Impacts

20.82. Residual impacts will remain **minor beneficial**.

Impact 20.7: Displacement of Tourism and Recreational Activity

20.83. During operation the Development is not expected to impede tourists travelling across Islay or Jura or restrict their access to tourism facilities such as the local distilleries.

20.84. The minimum depth of the turbine tips will be 15m below the surface. This depth is well below the keel depth of any pleasure or commercial craft and is not expected to impact recreational sailing however vessels are likely to avoid passing directly above the turbines. Depths of 15m are within the average swimming depth for recreational SCUBA divers and a deep dive is currently situated within the proposed Development area. There is also potential that sea anglers may fish in the Sound, therefore there is a minor risk that angling equipment may get caught on the devices. The magnitude of this impact is considered to be low and the sensitivity of the receptor medium. Therefore operational effects on marine users are considered to be of long term **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 20.7
• Each sub-array to be charted as an "underwater obstruction" providing the least depth of each sub-array using International Symbol L21 or L24. • Application should be made for the area containing the array to be designated and charted as a "No Fishing (Int Symbol N21) and No Diving" area. • Consultation will continue with relevant diving associations. • As a safety precaution Hammerfest Strom are fitting rope cutters on the devices to prevent entanglement of fishing gear.

Residual Impacts

20.85. It is predicted that the interference with sailing, boating, and other recreational activities in the Sound, will be of **negligible** significant effect once the array is in place.

Impact 20.8: Effects on Employment

20.86. The IET Project Officer will remain in employment until the completion of the installation. During the operational phase, the IET will provide logistic and administrative support for ongoing maintenance. This is likely to be a part-time role.

20.87. There will be employment opportunities associated with maintenance of the array components, both on and offshore. In some cases local contractors may be employed to undertake non-specialist works. This is not likely to alter the base line condition dramatically (and therefore magnitude of pressure is low), however, given that there is limited employment in the area and the extra employment will be quantifiable the receptor can be considered to be of medium sensitivity.

20.88. As such, the effect on employment will be long term and of **minor beneficial** significance.

MITIGATION IN RELATION TO IMPACT 20.8
• No mitigation required

Residual Impacts

20.89. As no mitigation is required, it is predicted that any long term benefits for employment will be of **minor beneficial effect**.

Impact 20.9: Community Benefits

20.90. SPR is working with IET to maximise the potential benefits to the local community. This includes indentifying opportunities for local businesses and liaising with stakeholders to minimise the impacts.

20.91. IET currently employs a full-time Project Officer and this role would continue throughout the development and construction phases.

20.92. SPR is in discussions with the IET regarding direct financial support to a trust fund that would be invested back in the community.

20.93. The project will supply approximately the equivalent of Islay's electricity demand (on average). SPR has an agreement with Diageo to supply electricity to three of their distilleries on the island - Caol Ila, Lagavulin and Port Ellen.

20.94. Consequently, the significance of effect of community benefits is assessed to be long term **minor beneficial**.

MITIGATION IN RELATION TO IMPACT 20.9
• No mitigation required

Residual Impacts

20.95. As no mitigation is required, it is predicted that long term community benefits will be of **minor beneficial** significant effect.

20.5.4. Potential Impacts during the Decommissioning Phase

20.96. During decommissioning there will be similar impacts to those outlined during the construction phase, albeit on a smaller scale. The decommissioned project is expected to have no significant effect on tourism, recreation or socio-economic conditions following adherence to Traffic Management Plans and Navigational Safety Risk Assessments.

20.5.5. Cumulative Impacts

20.97. As no further activities are currently scheduled for the Sound of Islay there are no anticipated adverse cumulative effects.

20.98. Beneficial cumulative effects may be experienced with other renewables developments around Islay (e.g. proposed offshore wind farms and the tidal park proposed by DP Energy), with opportunities for employment and other community benefits.

20.6 Summary of effects

Table 20.6 Impact assessment summary								
Impact	Construction/Decommissioning				Operation and Maintenance			
	Magnitude	Value/ significance	Impact	Residual impact	Magnitude	Value/ significance	Impact	Residual impact
Direct capital expenditure (manufacture and assembly)	Medium	Low	Moderate beneficial	Minor beneficial				
Indirect capital expenditure (marine services and onshore construction)	Medium	Medium	Moderate beneficial	Minor beneficial				
Indirect economic benefits (employment, accommodation and services)	Low	Medium	Minor beneficial	Minor beneficial				
Disturbance to tourism and recreational activity	Low	Medium	Minor adverse	Negligible				
Displacement of tourism and recreational activity	Medium	Low	Moderate adverse	Minor adverse	Low	Medium	Minor adverse	Negligible
Creation of a tourist attraction					Low	Medium	Minor beneficial	Minor beneficial
Effects on employment					Low	Medium	Minor beneficial	Minor beneficial
Community benefits					Low	Medium	Minor beneficial	Minor beneficial

20.7 Conclusions

20.99. The development of the array will bring with it **minor beneficial** socio-economic benefits. A small number of local jobs may be created along with a temporary increase in spend on local services during the construction of the project. There will also be ongoing spend on local services associated with operation and maintenance. **beneficial**

20.100. Tourism and recreation are both vitally important to the economy and communities of Islay and Jura. Development of the tidal array is not expected to have any significant long term adverse effect on existing marine and coastal activities, or on visitor numbers / visitor experiences. Any negative effects will be short-term and experienced only during the construction phase; they will be associated with the temporary displacement of activities across the array and onshore works sites, and disturbance to access for tourists travelling along the A846 on Jura. With completion of stated mitigation, the significance of effect is assessed to be **minor adverse** during construction and **negligible** during operation.

20.101. The proposed Development will create a new visitor attraction of Islay and Jura, increasing the islands' profiles for renewable energy and wet renewables development with effects of **minor beneficial** significance to tourism and the local community.

20.102. The project will, on average, supply approximately the equivalent of Islay's electricity demand. SPR has an agreement with Diageo to supply electricity to three of their facilities on Islay; namely the distilleries at Caol Ila and Lagavulin and the maltings at Port Ellen.

20.8 References

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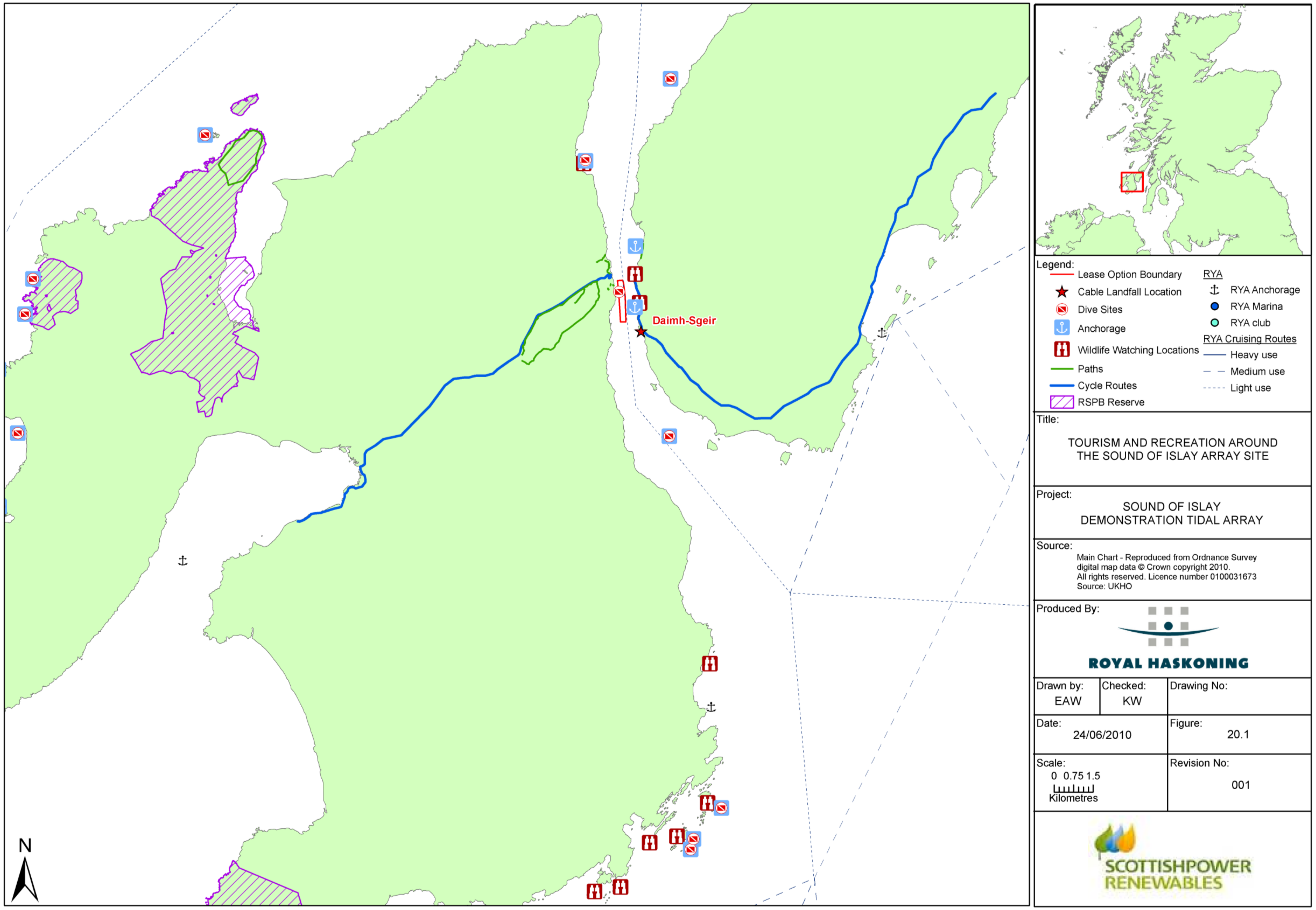

Figure 20.1 Tourism and recreation around the Sound of Islay array site.

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July 2010

24.0 Mitigation, Monitoring and Management

24.1 Introduction

24.1. The purpose of this chapter is to provide a summary of mitigation, monitoring and management measures proposed within this Environmental Statement (ES).

24.2. Table 24.1 lists the commitments made and summarises the mitigation measures proposed by ScottishPower Renewables (SPR) throughout the ES.

24.3. Environmental monitoring requirements prior to installation and post installation are discussed in more detail in Section 24.3.

24.4. Management procedures are identified in Section 24.4.

24.2 Mitigation

24.5. Mitigation measures are provided to limit, but not necessarily to eliminate, the environmental effects of the development.

24.6. If possible, prevention is the most effective form of mitigation, if it can be applied, as the potential impact is avoided. When an effect cannot be prevented, the next form of mitigation is reduction, where the environmental effect is reduced as far as reasonably practicable. If significant residual impacts remain after reduction measures have been put in place, measures delivering environmental benefits can be brought forward in order to offset them.

24.7. Mitigation measures have been outlined in each chapter of the ES in relation to each specific impact.

24.8. Table 24.1 provides a summary of all proposed mitigation measures.

TABLE 24.1 ENVIRONMENTAL STATEMENT COMMITMENTS	
Chapter	**Project Commitment**
Chapter 7: *Physical Environment and Coastal Processes*	No mitigation required.
Chapter 8: *Benthic Ecology*	No mitigation required.
Chapter 9: *Marine Mammals*	Potential impacts have been assessed as **negligible** in most instances, however, for collision risk and barrier effect assessments of **moderate** significance, before mitigation, have been made. An overall approach to mitigation, monitoring and management is proposed, which forms part of a wider deploy and monitor strategy, and should reduce the significance of effect for collision risk and barrier effect to **minor** SPR appreciates that this Development is the first tidal array and that consideration of magnitude of effects for a number of potential impacts includes consideration of elements where knowledge is incomplete. As a result, SPR commits to putting in place a programme of post installation monitoring and any mitigation considered necessary by regulators to avoid significant effects, as part of an ongoing programme of adaptive management. There is a theoretical potential to cause disturbance to marine mammals, and while our judgement is that this is of **minor** or **negligible** significance in all instances, based on industry experience gained from SeaGen and wider assessments, our knowledge is also acknowledged as incomplete. In particular effects from an array rather than a single device are unknown. A deploy and monitor strategy is proposed, with ongoing monitoring, linked to management of the Development. An important component of that strategy will be an application for a licence to disturb European Protected Species (EPS), to enable regulators to allow deployment while further knowledge regarding effects (or lack of effects) from the Development is obtained. Aspects to be monitored to address concerns regarding potential impacts on marine mammals include: • Use of impact sensors on the rotors and cameras to detect potential collisions; • Visual surveys in the first year after deployment to monitor for changes in use of the Development area and wider Sound by marine mammals; • Passive acoustic monitoring of echo-locatory species, particularly harbour porpoise within the Sound of Islay; • Development with Marine Scotland of procedure for reporting marine mammal carcass findings and carrying out post mortem, as part of wider national support to wet renewable industry by Scottish Government; and • Ongoing SMRU aerial surveys will provide approximate adult seal and pup numbers/ distribution and highlight any significant changes in the Sound of Islay. As part of a wider adaptive management and environmental monitoring strategy, SPR is committed to putting in place any appropriate mitigation indicated by monitoring.
Chapter 10: *Noise and Vibration Affecting Human Receptors*	The impacts on human receptors of noise from marine construction operations will be controlled through the application by the principal Contractor for a Section 61 ‘prior consent’ in accordance with the guidance set out in the Control of Pollution Act 1974. Additional generic mitigation against marine construction noise will incorporate conventional best practice in construction operations. Mitigation measures may (not exclusively) where necessary include: • Education and awareness-raising of construction operatives with regard to the prevention of local community noise disturbance; • Minimising the idling of vessels in proximity to the residential properties; • Avoiding excessive revving of vessel or marine plant equipment engines; • Extra care taken in handling and placing materials within vessels; • Ensuring that the most modern plant equipment is used and fitted with appropriate noise attenuation; and • Ensuring proper maintenance and operation of plant equipment and vessels.
Chapter 11: *Marine Fish and Shellfish Resources*	To mitigate against the impact of noise on shellfish and finfish SPR will adhere to best practice outlined in BS5228-2 (2009) British Standards Code of Practice for noise and vibration control on construction and open sites during all construction activities and best practice guidance in CIRIA C584 (2003) Coastal and Marine Environmental Site Guide during all construction activities.

TABLE 24.1 ENVIRONMENTAL STATEMENT COMMITMENTS	
Chapter	**Project Commitment**
Chapter 12: Anadromous Fish	No mitigation required; however, contractors will adhere to good construction practice guidance (e.g. CIRIA guidance, SEPA Pollution Prevention Guidelines). No mitigation is considered necessary for potential EMF effects on salmonids; however, the cable design will aim to minimize EMF fields through appropriate shielding to reduce potential impacts with other EMF sensitive species (see *Chapter 13: Elasmobranchs*).
Chapter 13: Elasmobranchs	Impacts on elasmobranchs were assessed as **negligible**, with the exception of collision risk, which was assessed as **minor** (after mitigation) during construction and operation. During the construction phase the proposed mitigation is as follows: • The use of vessel and / or shore based visual observers would allow teams undertaking installation works to be alerted to the presence of basking sharks in the Sound. On receiving such an alert, appropriate mitigation would be put in place, potentially including avoidance of areas where sharks are feeding and modification (e.g. slowing of vessels) or cessation of installation activity until the sharks have moved on from the installation area. Appropriate procedures would be agreed with Marine Scotland. • SPR accepts that there is some uncertainty about some potential impacts from the Development and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. • SPR is committed to putting in place measures considered necessary by the regulator to mitigate impacts
Chapter 14: Ornithology	No effects were identified as significant under the terms of the EIA Regulations. Nevertheless, it is considered good practice to implement appropriate measures to mitigate any local effects and thereby minimise potential (albeit assessed as **negligible**) adverse significant effects. Surveys to locate the nests of birds listed in Schedule 1 of the Wildlife and Countryside Act will be undertaken prior to construction (and decommissioning) works during the period March-August. These surveys will be undertaken to inform measures to safeguard any breeding attempts from disturbance. Any risk to seabirds of accidental release of marine contaminants will be minimised by adopting safe working practices and having contingency plans in place for dealing with incidents. It should be noted that: • Good practices will aim to minimise disturbance to seabirds by vessels associated with the proposed Development by avoiding, where possible, preferred feeding areas and adopting voluntary speed restrictions. • Artificial nest sites for black guillemots located away from the immediate vicinity of the proposed Development site should help reduce disturbance effects on the breeding population of this species. It could also lead to an increase in the local population size (though this is likely to be limited by food supply) and breeding success, thereby helping offset any adverse effects on this species. Artificial nest sites should take the form of specially designed nest boxes or providing suitable cavities in stone walls or quays next to the sea. It is anticipated that approximately ten such sites should be constructed given the numbers of existing nest sites that may be affected by the proposed Development and that not all artificial sites may become occupied.
Chapter 15: Commercial Fisheries	A Safety Management System (including an Emergency Response Coordination Plan (ERCoP), appropriate to the scale and nature of the risks involved by the demonstration array, should be developed and put in place prior to installation of the array. To mitigate against impacts on commercial fishing, turbines and cables should be installed during periods of least fishing activity within the Sound (creeling activity is at its lowest in the summer). Close consultation with local fishermen will help to identify potential mitigation measures. Consultation with fishermen will also ensure that they are fully aware of the locations and timings of installation. All crews operating installation vessels and any shore based workers will remain vigilant at all times, and alert fisherman to any potential dangers. Skippers of fishing vessels will be provided with accurate information on the position of the individual devices immediately after they are installed through appropriate revision of navigation advice by UK Hydrographic Office. An explanatory note will be included in navigational charts explaining the nature of the hazards caused by the turbines. Device positional data will also be provided t to Kingfisher Information Services for inclusion in their advice. To avoid entanglement resulting in possible capsize of fishing vessel, the array area will be subject to an application in order to designate it a "No Fishing" (Int. Symbol N21) area. Turbines will also be fitted with rope cutters to clear any fishing gear that may become accidentally entangled. Cable protection will be installed where appropriate and care will be taken to avoid bridging during cable installation i.e. cable should be flat on the seabed with no space underneath where fishing gear could become trapped. The reporting of any accidents or near misses should occur in a clear and concise manor. A procedure for achieving this will be decided upon which will clearly outline who is responsible for reporting and how it will occur.

TABLE 24.1 ENVIRONMENTAL STATEMENT COMMITMENTS	
Chapter	**Project Commitment**
Chapter 16: *Terrestrial and Intertidal Ecology*	Detailed otter surveys will take place prior to final cable landfall design to check the footprint for holts, couches and other otter activities in consultation with SNH. This will be used to inform the application for a licence to disturb otters if required. On final decision of cable landfall site, detailed surveys for amphibians, reptiles and invertebrates will be conducted within the footprint, and should any protected species or sign of protected species be found, the necessary mitigation will be implemented after consultation with SNH. Construction work will be undertaken during agreed daylight working hours (07:00-18:00), where practicable. Artificial light will not be used next to the coastline or rivers at night to allow otters to migrate through the area undisturbed. During summer months, construction may continue later into the evening without the need for artificial lighting. Construction areas will be left in a safe condition during periods of inactivity, with chemicals and construction materials stored safely in accordance with SEPA's Pollution Prevention and Chemical Guidelines (PPG2- Above ground oil storage tanks, and PPG5 – Works in, near or liable to affect watercourses). Key measures may include capping all pipes, covering all trenches or providing a means for otter to escape. Construction activities will maintain a strict footprint of works for the corridor of the cable trenching, and construction vehicles and equipment will not be active on, or stored by, the coastline for longer than is necessary.
Chapter 17: *Landscape and Seascape*	Mitigation will involve minimising the footprint of the proposed substation to reduce its landscape impact. Creation of an earth mound against the north western boundary of the substation to aid the integration of the substation within the open moorland context. This mound should be vegetated with reserved heather/grass turves cut from the base of the substation. All structures will be appropriately / sympathetically coloured to minimise landscape impacts.
Chapter 18: *Cultural Heritage*	To mitigate damage to or removal of unknown onshore cultural heritage assets during construction a programme of archaeological works will be implemented, the scope of which would be provided in a Written Scheme of Investigation (WSI) to be agreed by West of Scotland Archaeology Service (WoSAS) on behalf of the Planning Authority. Such a programme has the potential to completely mitigate any adverse impact and may result in positive impacts due to the recovery of information about past human activity in the area. Construction Exclusion Zones may be introduced for anomalies that are considered to be of moderate to high archaeological potential or are of medium or high sensitivity to direct impacts. There are not considered to be any such sites within the proposed offshore construction area. However, it is recommended that the site of the Glenholme (HA19) and the potential uncharted wreck (HA29) should be furnished with a 50m exclusion zone in relation to any secondary impacts such as anchoring activities associated with installation of the turbines, inter-array cables and export cable. Although this is not a legal requirement this will ensure that the development is in line with current best practice. The size of any Construction Exclusion Zone is determined on an asset by asset basis, and is dependant upon the archaeological potential and the extent of the known or suspected asset or target. It may be possible to move, reduce or remove any Construction Exclusion Zones in light of further archaeological investigation carried out prior to construction. Such work could include diver investigation, or ROV investigation in the deeper more hazardous areas of the Sound. All protocols and procedures and locational information for assets furnished with exclusion zones will be set out in a Written Scheme of Investigation (WSI) prior to installation, in consultation with Historic Scotland (Senior Inspector of Marine Archaeology) and WoSAS as part of any consent condition.
Chapter 19: *Traffic and Transport*	Construction vessels, where possible, will avoid unnecessary crossing of the ferry route. Careful timing of activities (such as deliveries to the Feolin slipway) that may impact upon the ferry service to be conducted outside of peak usage where possible. Disruption will be monitored during deployment including through contact with ferry operator. Radio communication between DP vessel, cable laying vessel and the ferries to be maintained whenever any of these vessels are on approach or operating within the Sound. Vessels will be marked with appropriate flags and lights in accordance with COLREGS to warn other users of any restricted manoeuvrability. The contractor responsible for the cable laying activity will notify the UK Hydrographic Office (UKHO) of all the activity using the maritime safety information (MSI) system for promulgation to all vessels by notices to mariners (NMs) and radio navigational warnings Onshore construction works will be carefully sited to avoid traffic access routes to the ferry terminals on both Islay and Jura. Staff travelling on the Islay to the Jura ferry service during construction of the substation should use the minimum number of vehicles as is practical (car sharing when

TABLE 24.1 ENVIRONMENTAL STATEMENT COMMITMENTS	
Chapter	**Project Commitment**
	possible). Use of suitable methodology to ensure road disruption is minimised, such as half road closure or use of passing places whilst construction will be undertaken. The contractor will provide a traffic management plan which will reduce effect to that of normal A846 traffic.
Chapter 20: Socio Economics, Tourism and Recreation	SPR will continue to work with the Islay Energy Trust (IET), Argyll and Bute Council and Highlands and Islands Enterprise (HIE) to fully develop the local supply chain. Where possible, and economically viable contractors and other services will be sourced locally. Consultation will take place with the Islay and Jura Marketing board to identify the most effective solutions for accommodation provision, particularly during summer months. SPR have worked extensively, and will continue to work to raise the profile of the project and demonstrate the benefits of tidal energy. SPR will work with the Islay Energy Trust (IET) to develop and promote good quality interpretative materials to encourage interest and understanding of tidal energy which may provide a benefit to tourism in the area. Construction activities will be clearly advertised locally. Adherence to a Traffic Management Plan and the mitigation laid out in *Chapter 19: Traffic and Transport*, including consideration of large Jura public events will minimise disruption. Installation will be designed to minimise unnecessary noise, discussed further in *Chapter 10: Noise and Vibration Affecting Human Receptors*. . A Notice to Mariners will be issued in advance of marine works. The array will be appropriately charted as an underwater obstruction and annotated, as discussed further in the Navigational Safety Risk Assessment (Appendix 19.1). The array will also be charted as a 'no diving' area and consultation will continue with relevant diving organisations. During construction activities the following safety procedures will be implemented: • Notice of the activities would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Radio Navigational Warnings (NavWarns/WZs)) and will occur just prior to and during the maintenance works; • Installation vessels will comply with the COLREGS in that they would display the appropriate lights and marks for vessels engaged in such activities; and • Presence on site of manned vessels capable of monitoring and advising the other marine traffic using the Sound of Islay. The Navigational Safety Risk Assessment has been undertaken (Appendix 19.1) and identifies management of potential conflict with ferry routes, discussed in *Chapter 19: Traffic and Transport.*
Chapter 21: Water and Sediment Quality	No mitigation required.
Chapter 22: Military and Munitions	Through consultation with the Defence Estates it was identified that there were no concerns with regard to military activities and the Development. Consultation with the Defence Estates will be continued throughout consenting and site development, allowing any future concerns to be addressed should they arise. The Defence Estates will be informed in advance of intended works dates and any potentially conflicting activities will be coordinated to minimise disturbance. The Development will adhere to the safety measures identified in the Navigational Safety Risk Assessment (Appendix 19.1), with particular reference to the following points: • 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)) and will occur just prior to and during the construction works. Installation vessels will comply with the COLREGS in that they would display the appropriate lights and marks for vessels engaged in such activities and manned vessels will be on site which can monitor and advise other marine traffic using the Sound of Islay. • The array will be appropriately charted as an underwater obstruction and annotated, as discussed further in the Navigational Safety Risk Assessment (Appendix 19.1). • The Principal Contractor will liaise with local organisations including the Defence Estates to ensure that suitable working channels are selected to avoid compromising authorised communications • Should suspected items of UXO be discovered during any project phase, their location will be recorded and immediate advice will be sought from the relevant authorities. If a UXO is identified during the construction phase then works will cease immediately until advice and remediative actions are implemented. In addition munitions awareness briefings will be given to contractor's and ship staff prior to and during the construction phases. The MoD and emergency services will be consulted as appropriate.
Chapter 23: Air Quality	No mitigation required.

24.3 Monitoring

24.9. SPR will develop an appropriate monitoring and reporting programme to cover the construction and operational phases of the array as identified for key receptors in relevant ES chapters.

24.10. An effective monitoring programme will give the opportunity to re-address mitigation measures where they have been more or less successful than anticipated. Pre-installation monitoring and Deploy and Monitor strategy are each considered in turn below.

24.4 Pre-installation Monitoring

24.11. The monitoring strategy prior to installation of the Development will be established through consultation with SNH. A number of elements of pre-installation monitoring are already in place, for example, vantage point monitoring of the area of the Sound for marine mammals and birds, as well as incidental basking shark sightings.

24.4.1. Terrestrial ecology

24.12. Otter surveys will be undertaken in advance of onshore construction works to identify areas being actively used and works planned in such a way as to avoid or minimise disturbance to those areas.

24.13. Amphibians, reptiles and invertebrate detailed survey will be undertaken within footprint in advance of construction to inform management of the construction site.

24.4.2. Ornithology

24.14. The potential impacts of the proposed Development on birds are not deemed to be significant. However, best practice dictates that an appropriately detailed monitoring programme should be agreed and implemented. The value of monitoring the Sound of Islay Demonstration Tidal Array to the wider tidal renewables industry is likely to be particularly high given that this would be the first tidal array, the geography of the site facilitates survey work (as much can be done from the land) and there is a relatively high level of pre-construction baseline survey data for comparison.

24.15. Under the Breeding Bird Protection Plan (BBPP) surveys to locate the nests of birds listed in Schedule 1 of the WCA will be undertaken prior to construction (and decommissioning) works during the period March-August. These surveys will be undertaken to inform measures to safeguard any breeding attempts from disturbance.

24.4.3. Marine mammal and basking sharks

24.16. Baseline vantage point data have already been collected for the Sound.

24.17. The establishment of a system for recording of marine mammal stranding would allow potential direct collision impacts to be assessed against a baseline. Marine Scotland is establishing a process for assessment of any stranding reported. This system could be supplemented by work to increase local awareness and establishment of a local (Islay and Jura) reporting system. Any reporting system could be easily expanded to encompass basking sharks if considered appropriate.

24.18. Modelling as well as consultation with local vessel users and RNLI could be used to indicate areas if the Sound where stranding potential is greatest, allowing recording effort to be focussed there.

24.5 ‘Deploy and Monitor’ Strategy

24.19. Open stream tidal turbine technology is an emerging technology, with limited currently operational commercial scale developments upon which to base aspects of assessment. Where devices have been both operating at a commercial scale and potential environmental interactions have been monitored, the results to date indicate no significant adverse environmental impacts (for example, SeaGen, Northern Ireland). However, SPR appreciates that the potential interactions of an array of turbines is to some extent unknown, and assessments must be necessarily based on data for single devices from expert judgement based on knowledge of potential receptors and current understanding of the potential effects of single devices extrapolated to encompass an array.

24.20. The ‘deploy and monitor’ strategy for the Development will be established through consultation with Marine Scotland and SNH with the aim of providing sufficient comfort to regulators to allow licensing of installation of the array against a background of uncertain environmental effects. Key elements of the strategy are detailed in the ES and can be summarised as follows:

- Uncertainly regarding effects of an array of devices must be balanced against the desire to develop wet renewable energy. A risk management based approach to deployment, combined with detailed monitoring and mitigation if required is proposed;
- Application to (potentially) disturb European Protected Species (EPS);
- Monitoring of key receptors;
- Commitment by developer to put in place any mitigation indicated.

24.5.1. Ornithology

24.21. The potential impacts of the proposed Development on birds are not deemed to be significant. However, best practice dictates that an appropriately detailed monitoring programme should be agreed and implemented. The value of monitoring the Development to the wider tidal renewables industry is likely to be particularly high given that this would be the first tidal array, the geography of the site facilitates survey work (as much can be done from the land) and there is a relatively high level of pre-construction baseline survey data for comparison.

24.22. Post installation monitoring studies of greatest value will continue baseline studies, including:

- Pre-breeding surveys of black guillemot in the Sound of Islay, including the monitoring of any nest boxes provided;
- Surveys to quantify the distribution, abundance and behaviour of diving seabirds using the Development site and other parts of the Sound of Islay. The behavioural surveys should collect evidence of changes in behaviour in response to the proposed Development including disturbance, displacement, attraction and habituation; and
- Surveys to quantify the level of human activity, in particular vessel movements, associated with the construction and operation phases of the proposed Development.

24.23. The surveys noted above should be conducted during construction and in years 1 – 3, 5 and 10 of the proposed Development's 7-year operation period (with possible extension to 14 years). However, flexibility will be retained to cancel this monitoring programme if it is clear that beneficial information is not being collected.

24.24. Given the Development's novelty, an appropriately detailed bird monitoring programme should be agreed, with an Ornithological Steering Group for the Development to establish protocols and review results on a suitably frequent basis. If distribution and abundance surveys indicate a high likelihood of interaction it would be beneficial to attempt to monitor any mortality which results from collision with the turbines. The need for and methods used to monitor collisions would be considered by the Ornithological Steering Group.

24.5.2. Marine mammals and basking sharks

24.25. Due to the high conservational importance of marine mammals and basking sharks any impact of low to high magnitude is deemed to be significant.

24.26. The primary aim of post installation monitoring is to assess the potential impacts of the development on EPS and on the seals associated with the South East Islay Skerries. The data collected during this phase of monitoring should contribute to an assessment of whether the development is having a significant impact that is likely to affect the Favourable Conservation Status (FCS) of relevant populations.

24.27. The post installation monitoring studies which will provide most useful information in the context of this development include:

- Land based observations from a vantage point overseeing the Development site should be undertaken by an observer with suitable experience. Marine mammals and basking shark surveys will be undertaken in the first year after deployment in combination with diving bird surveys. This should be designed in consultation with SNH, SMRU and HWDT to ensure data collected are comparable with available baseline data;
- Use of strain gauge sensors on the rotors. SPR will establish a methodology for detecting an impact on the turbine rotors equivalent to the weight of a juvenile seal. The impact will be detected in real time and a protocol will be established and agreed through consultation with SNH;
- Ongoing SMRU aerial surveys will provide approximate adult seal and pup numbers/ distribution and highlight any significant changes in the Sound of Islay.

24.6 Management

24.28. A number of management protocols will be implemented during the construction, operation and decommissioning of the Development to ensure suitable actions are taken in the prevention, reduction and offsetting of any impacts.

24.29. A full Environmental Management Plan (EMP) for the operational phase of the Development will be implemented in agreement with the relevant regulators following submission of this ES. The EMP will consist of a working document which details the environmental actions highlighted in the ES, providing a framework for addressing these environmental risks and outlining the mitigation required and the responsibilities of all involved parties.

24.30. The EMP will include details of the post-installation monitoring programme agreed with Marine Scotland, and detail agreed reporting and decision making protocols. A system similar to that used for oil spill response planning, though much simplified, is proposed.

24.31. A detailed Construction Method Statement (CMS) and a Pollution Incident Response Plan (PIRP) will be prepared and agreed with SEPA, SNH and Marine Scotland prior to commencement of construction.

24.32. All work will be undertaken to an overarching Health, Safety and Environmental Management System, which will include the CMS, the PIRP and the EMP. The project will be supervised in accordance with the Construction Design and Management Regulations (2007)

24.33. All wastes activities will be undertaken in accordance with the Waste Management Licensing Regulations 1994 (as amended for Scotland), the Landfill (Scotland) Regulations 2003 (as amended) and the Special Waste Amendment (Scotland) Regulations 2004 (as amended). In addition, the volume of materials excavated and stored will be minimised.

24.34. The appointment of an environmental clerk of works, to be present on site and oversee the construction phase is proposed. The clerk of works would have responsibility for overseeing the implementation of mitigation measures agreed with Marine Scotland during licensing.

24.7 Conclusions

24.35. Measures are proposed to establish a programme of mitigation and monitoring.

24.36. The measures include a number of 'traditional' mitigation measures, of known effect, including careful management of working practices in the marine and terrestrial environments.

24.37. In the marine environment the potential effects of the proposed Development are thought to be limited; however, there are gaps in the knowledge available to inform some assessments. In particular the potential for effects on marine mammals and basking sharks requires ongoing careful investigation. An adaptive approach to management is proposed, with the deployment of the array, combined with a series of focussed monitoring measures and a commitment to establish mitigation as indicated by the results of monitoring. This approach is summarised as deploy and monitor.

24.38. In order to implement deploy and monitor strategy, the potential to damage or disturb marine mammals must be addressed. An application for an appropriate licence, linked closely with the monitoring proposed and a clear mitigation commitment, will be made.

24.39. SPR is committed to the establishment of an appropriate monitoring programme as part of a wider deploy and monitor strategy. Where monitoring indicates that specific mitigation may be reasonably required, SPR is committed to putting this mitigation in place.

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 8 – Benthic Ecology.

Appendix 8.1: “SeaStar Drop Down Camera Survey Report ”

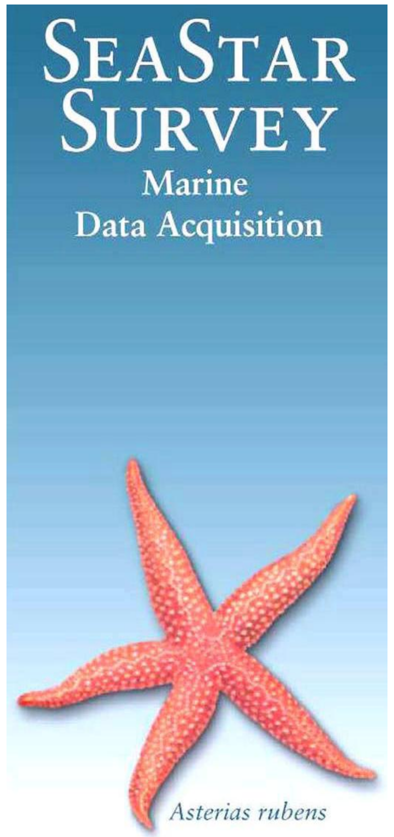
Scottish Power Renewables

Islay Demonstration Tidal Array - Site Surveys 2009

Drop-down camera survey report

Axelsson, M.B.

August 2009



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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.

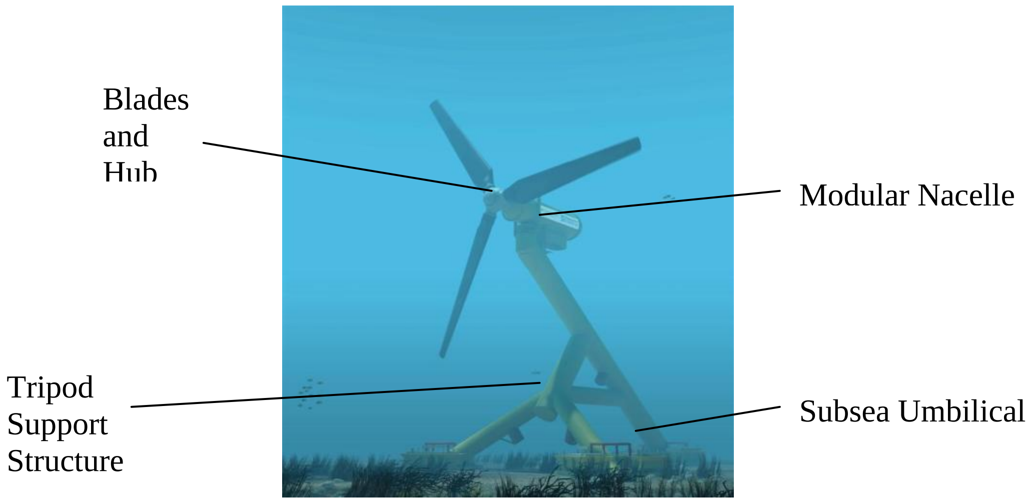

Figure 1. Graphical representation of the 300kW tidal device developed by Hammerfest Strøm, installed in Kvalsund in Finnmark, Norway (SPR, 2008).

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.

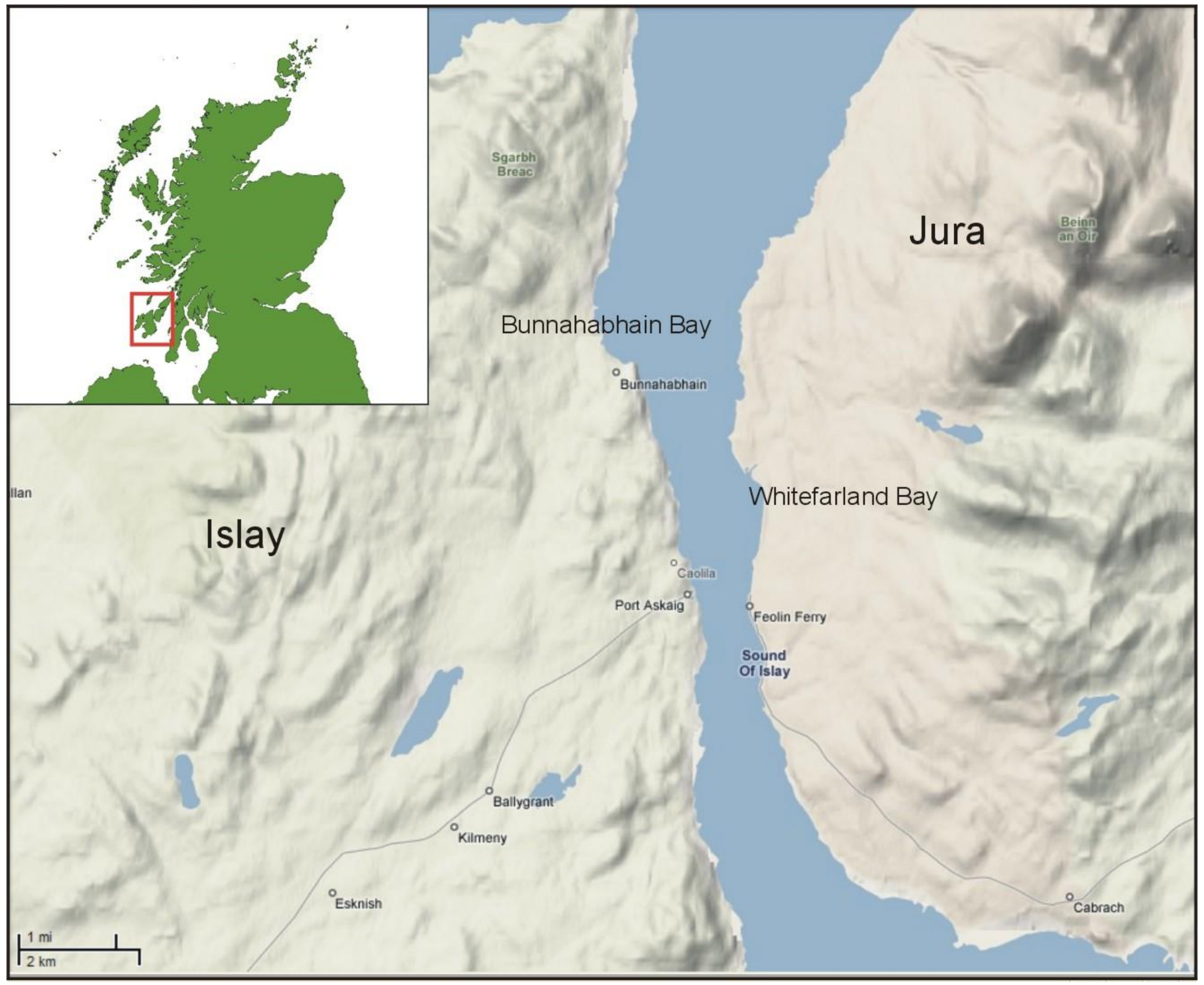

Figure 2. The Sound of Islay between the islands of Islay and Jura (courtesy of Google Maps ©).

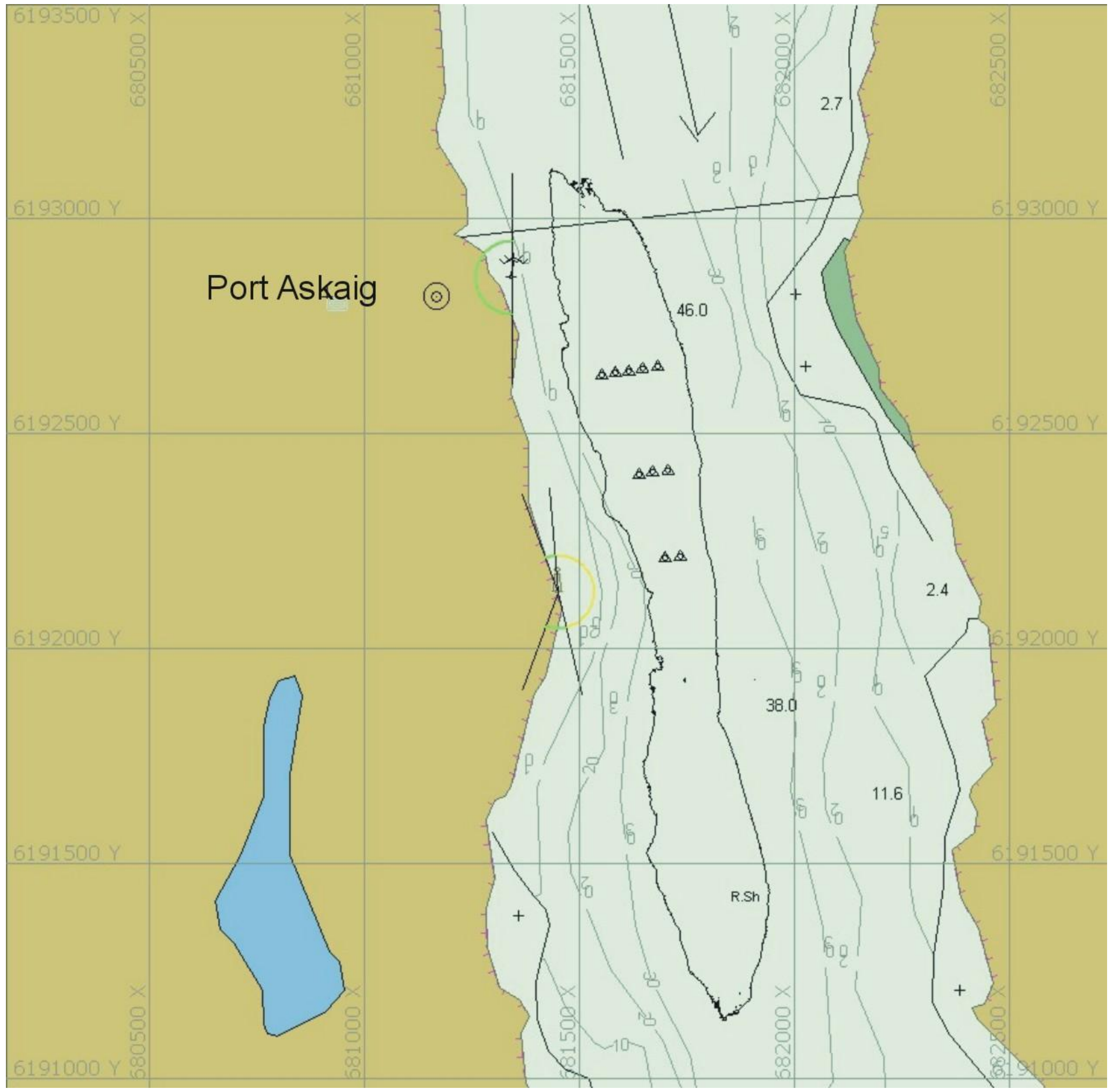

Figure 3. Proposed location for the tidal devices in the Sound of Islay (the 48 m contour shown in black and the proposed turbine sites (black triangles) within the 48 m contour).

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).

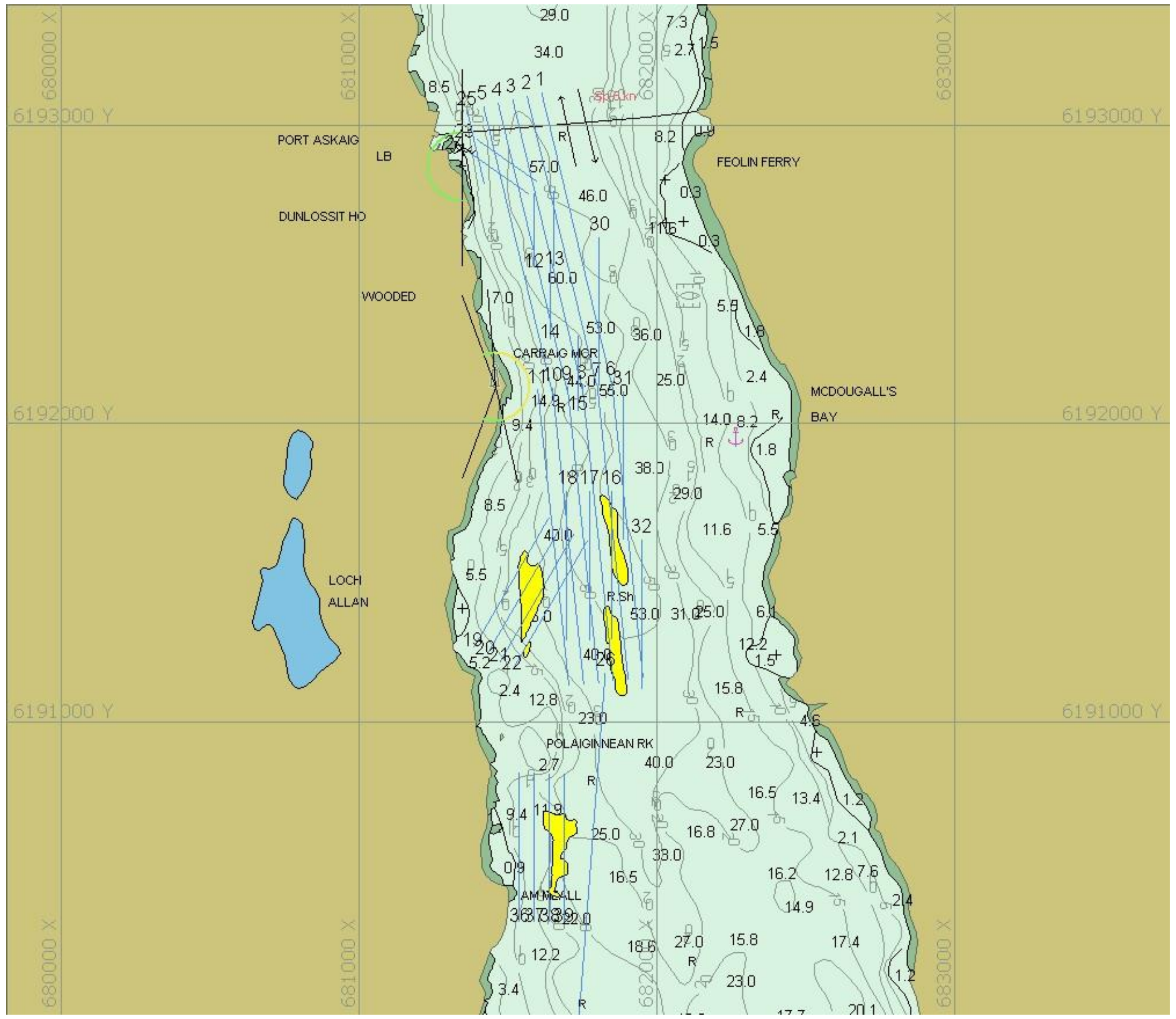

Figure 4. Planned drop-down camera survey transects in the Sound of Islay (planned survey transects together with potential ‘megaripples’ (highlighted in yellow) as identified on sidescan sonar imagery by iX Survey).

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.

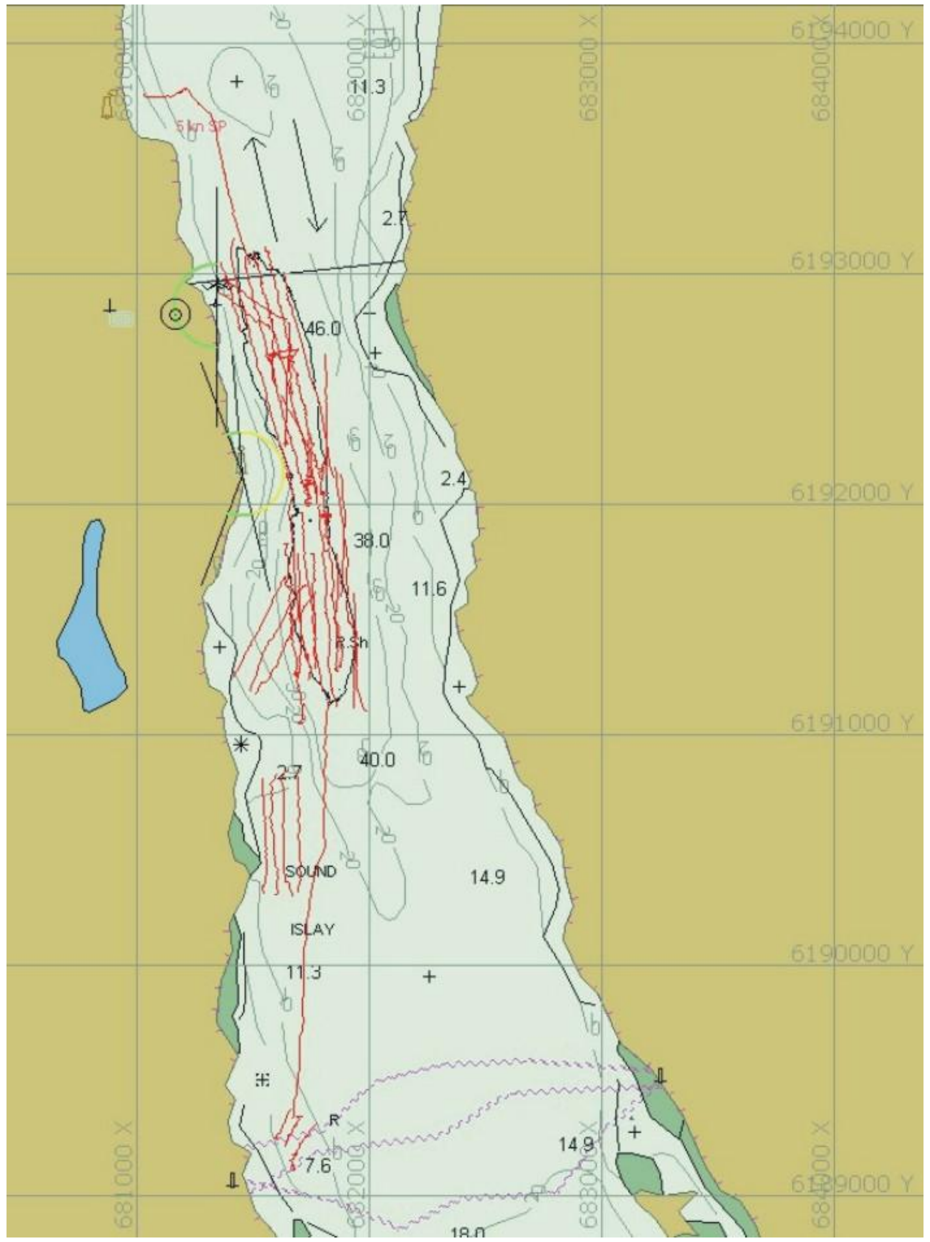

Figure 6. Track plot for the 2009 Sound of Islay drop-down video survey.

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.

Islay Demonstration Tidal Array - Site Surveys 2009
Photograph Substrata

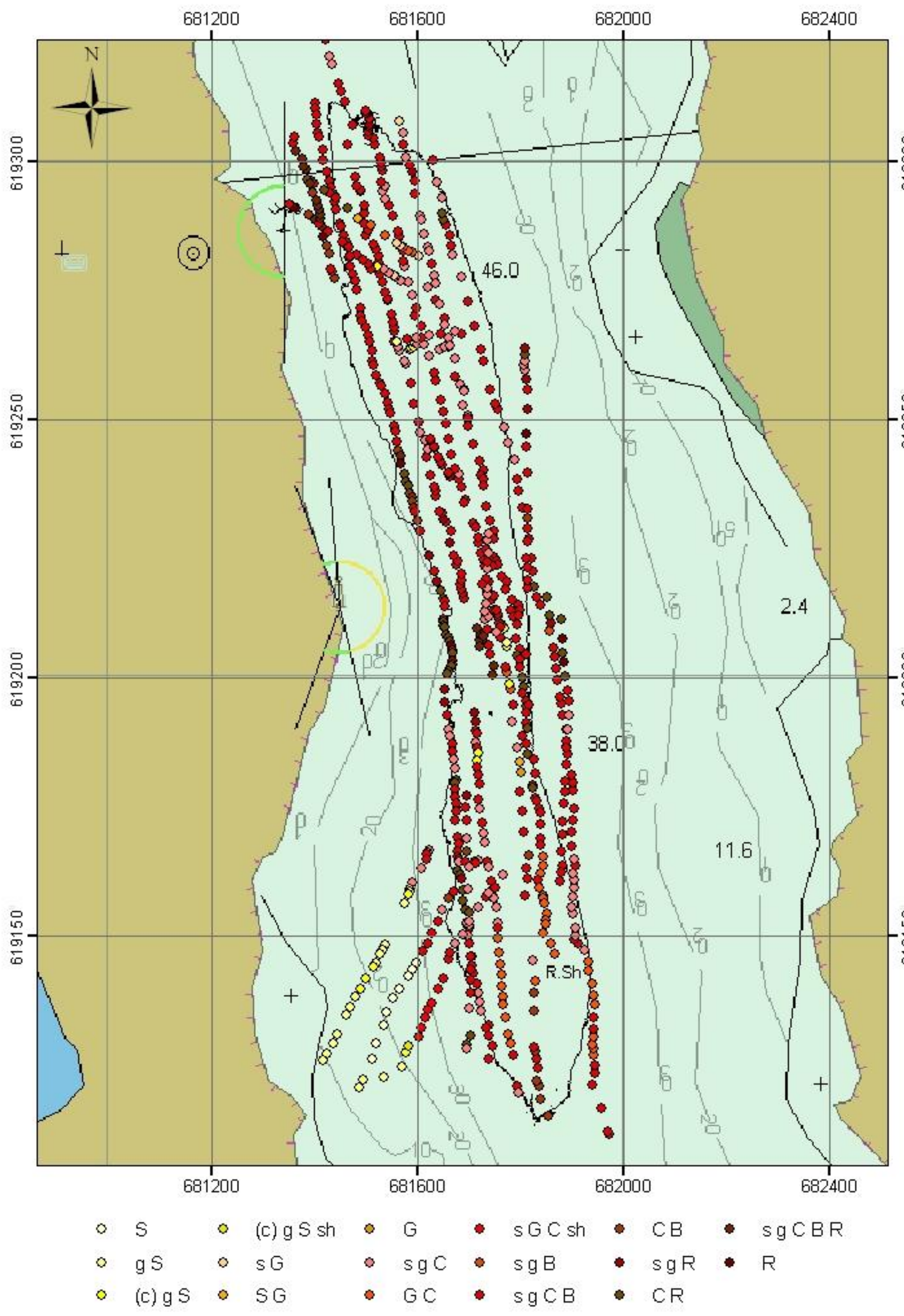

Figure 7. A summary of the substrata identified in the still photographs part of the Islay drop-down camera survey (S: Sand; g S: gravely sand; (c) g S: slightly cobbled gravely sand; (c) g S sh: slightly cobbled gravely sand and shell material; s G: sandy gravel; G C: gravel and cobbles; sandy gravel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

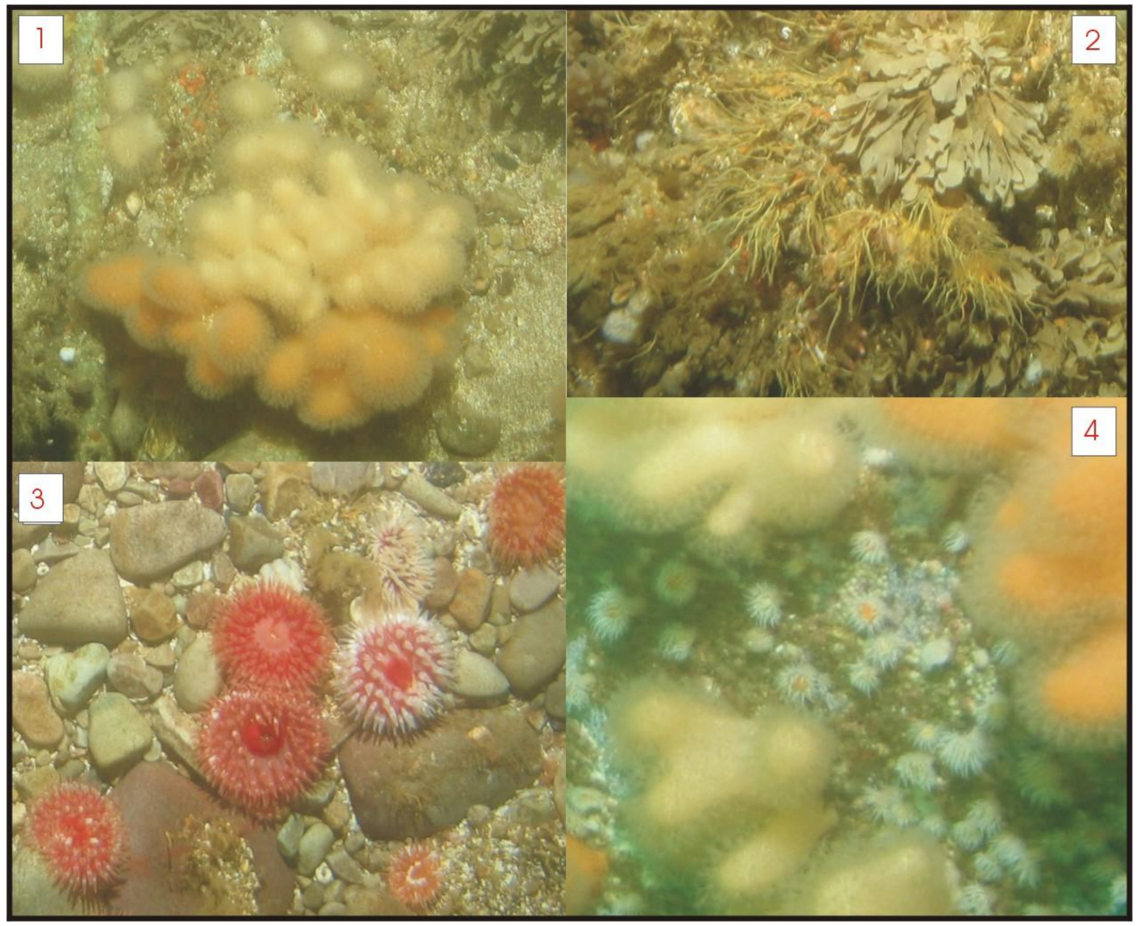

Figure 8. Examples of the dominant taxa identified in the deep water of the Islay Demonstration Tidal Array project with 1) Alcyonium digitatum, 2) Tubularia indivisa and Flustra foliacea, 3) Urticina sp., and 4) Actinothoe sphyrodeta and A. digitatum.

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.

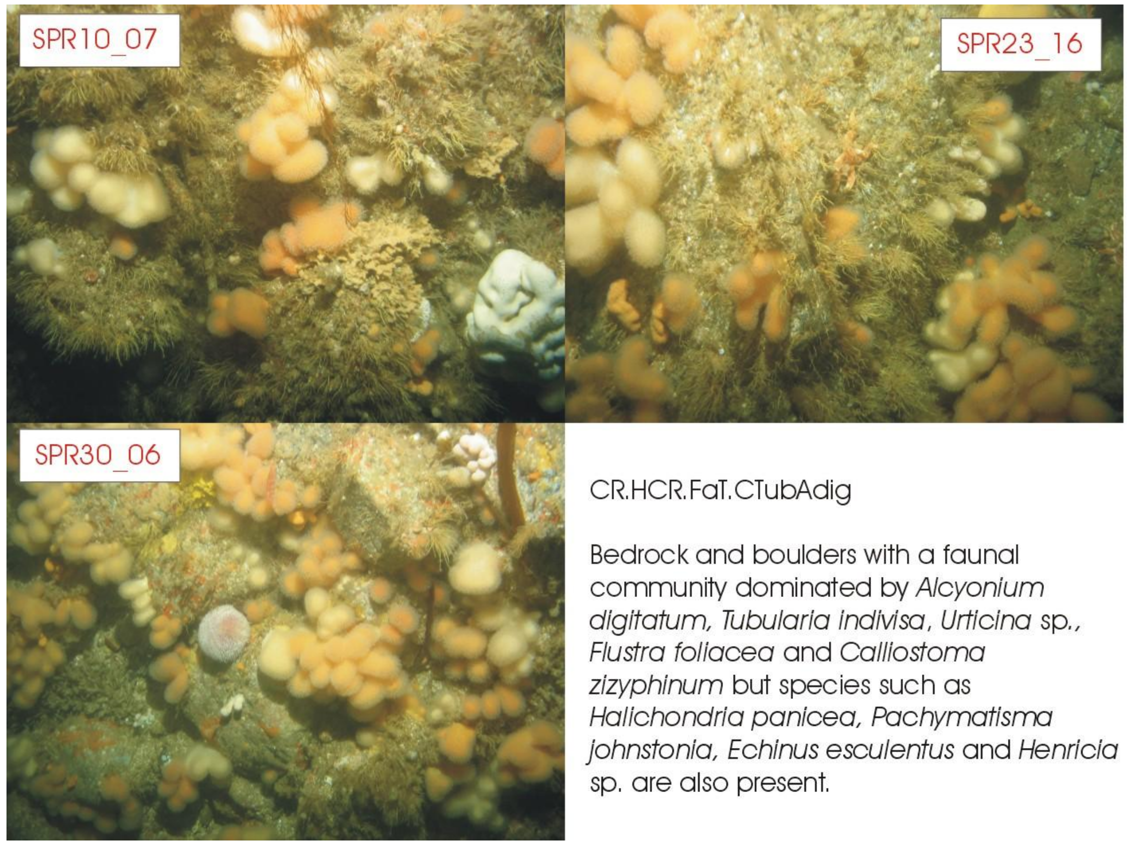

Figure 9. Photographs classified as CR.HCR.FaT.CTubAdig from the Islay drop-down camera survey in 2009.

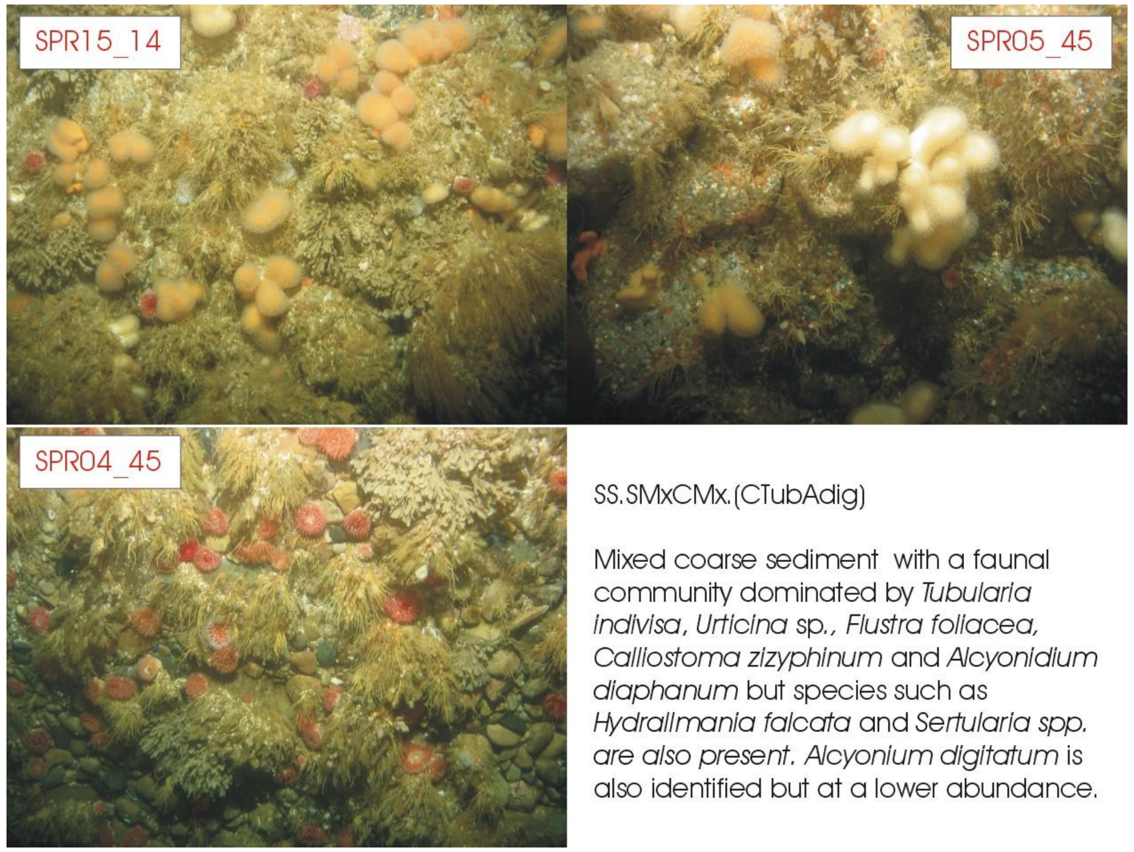

Figure 10. Photographs classified as SS.SMx.CMx.(CTubAdig) in the Islay drop-down camera survey in 2009.

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.

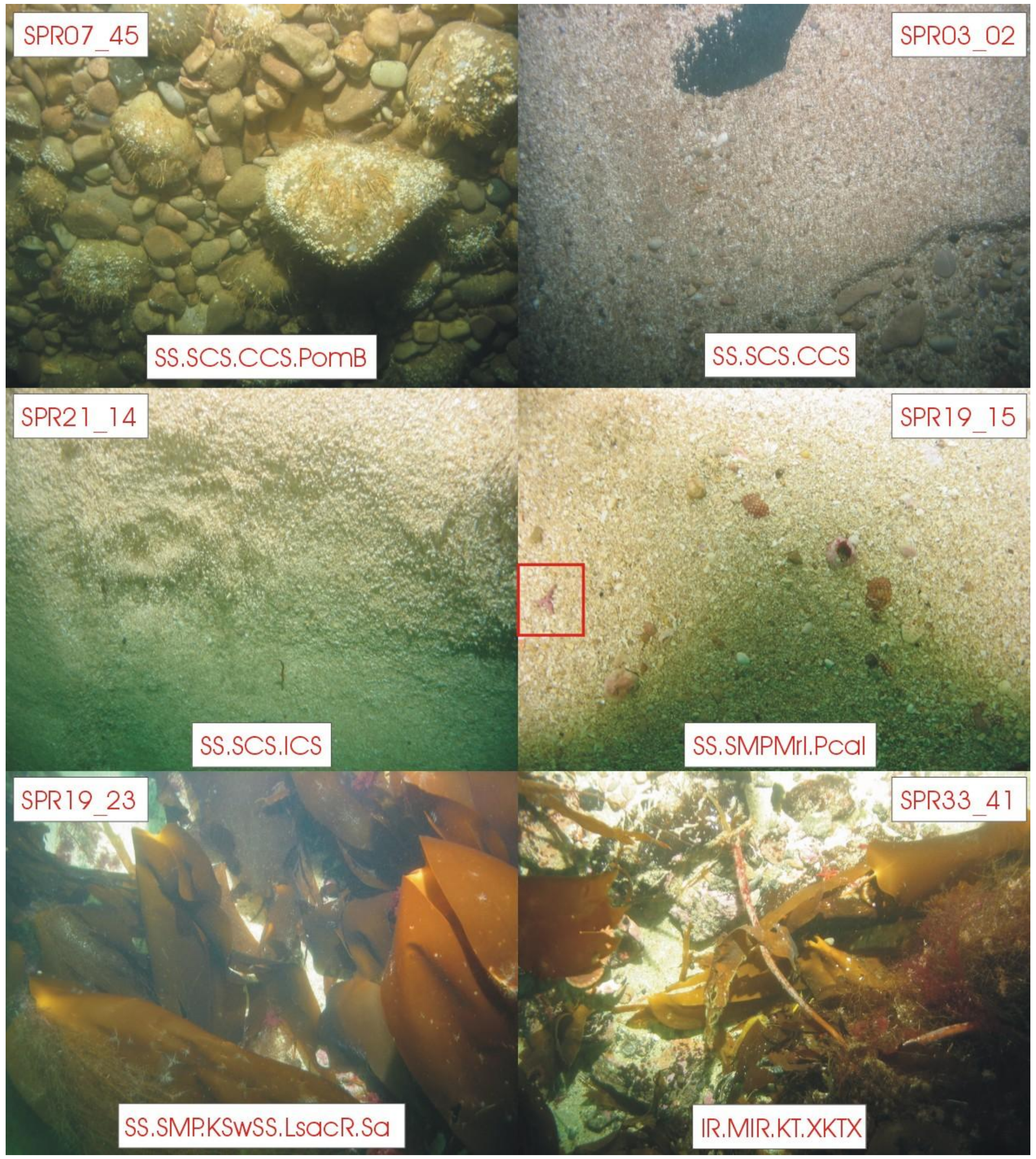

Figure 11. Photographs exemplifying the different biotopes identified in the Islay Demonstration Tidal Array survey 2009.

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.

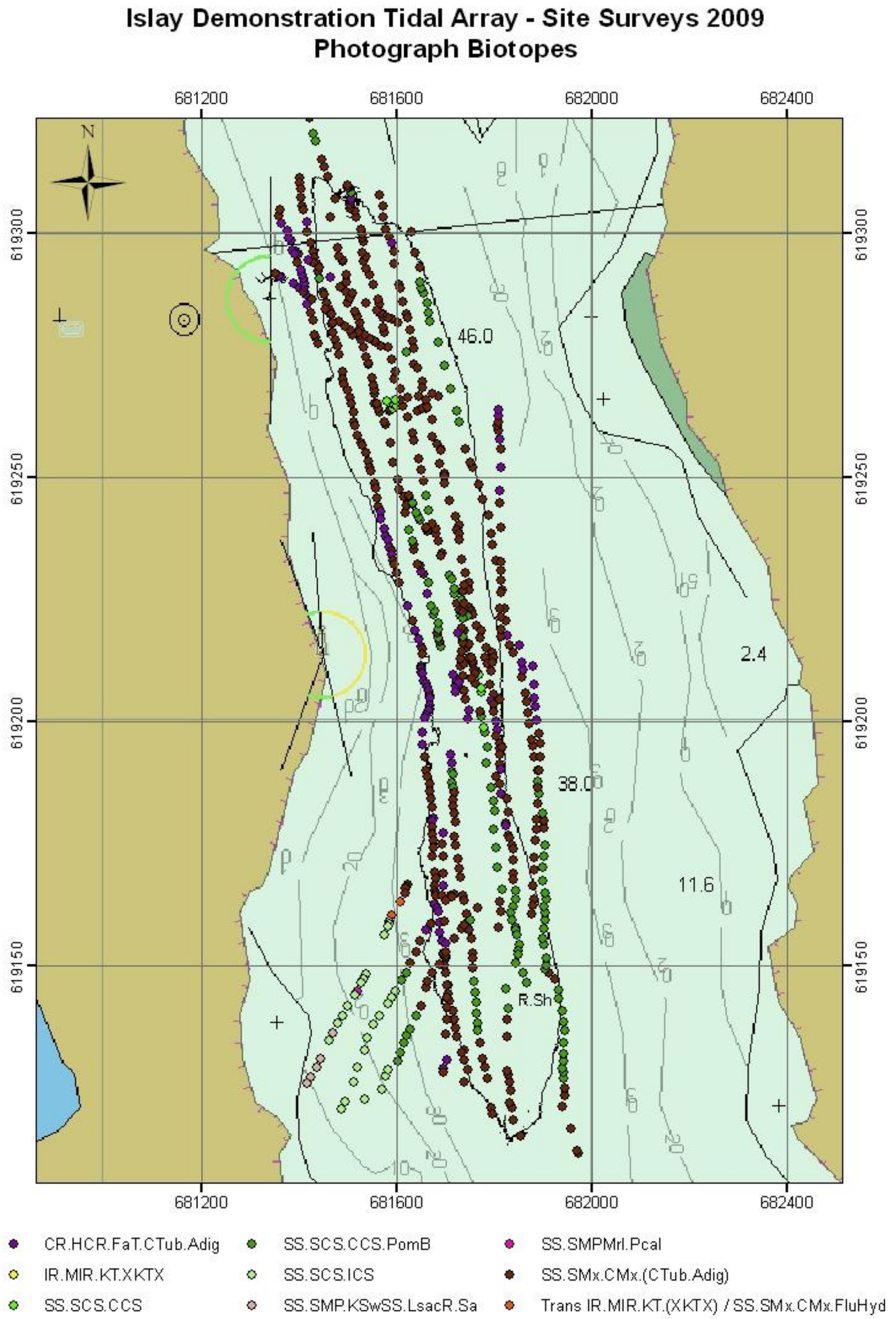

Figure 12. Biotope distribution derived from still photography analysis of the 2009 Islay drop-down camera survey.

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.

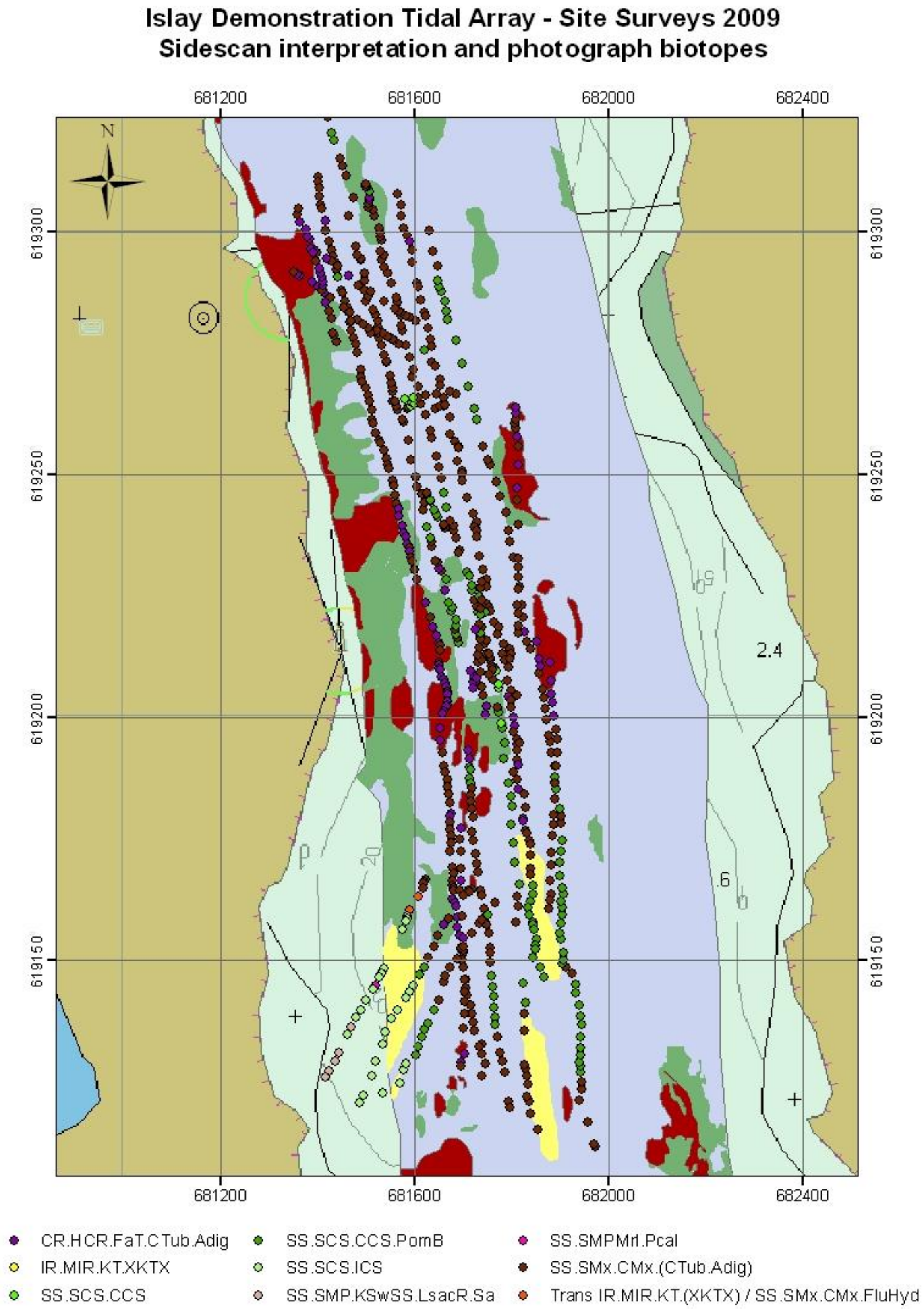

Figure 13. The biotope distribution (derived from still photography analysis of the 2009 Islay drop-down camera survey) overlying the iX Survey sidescan sonar interpretation.

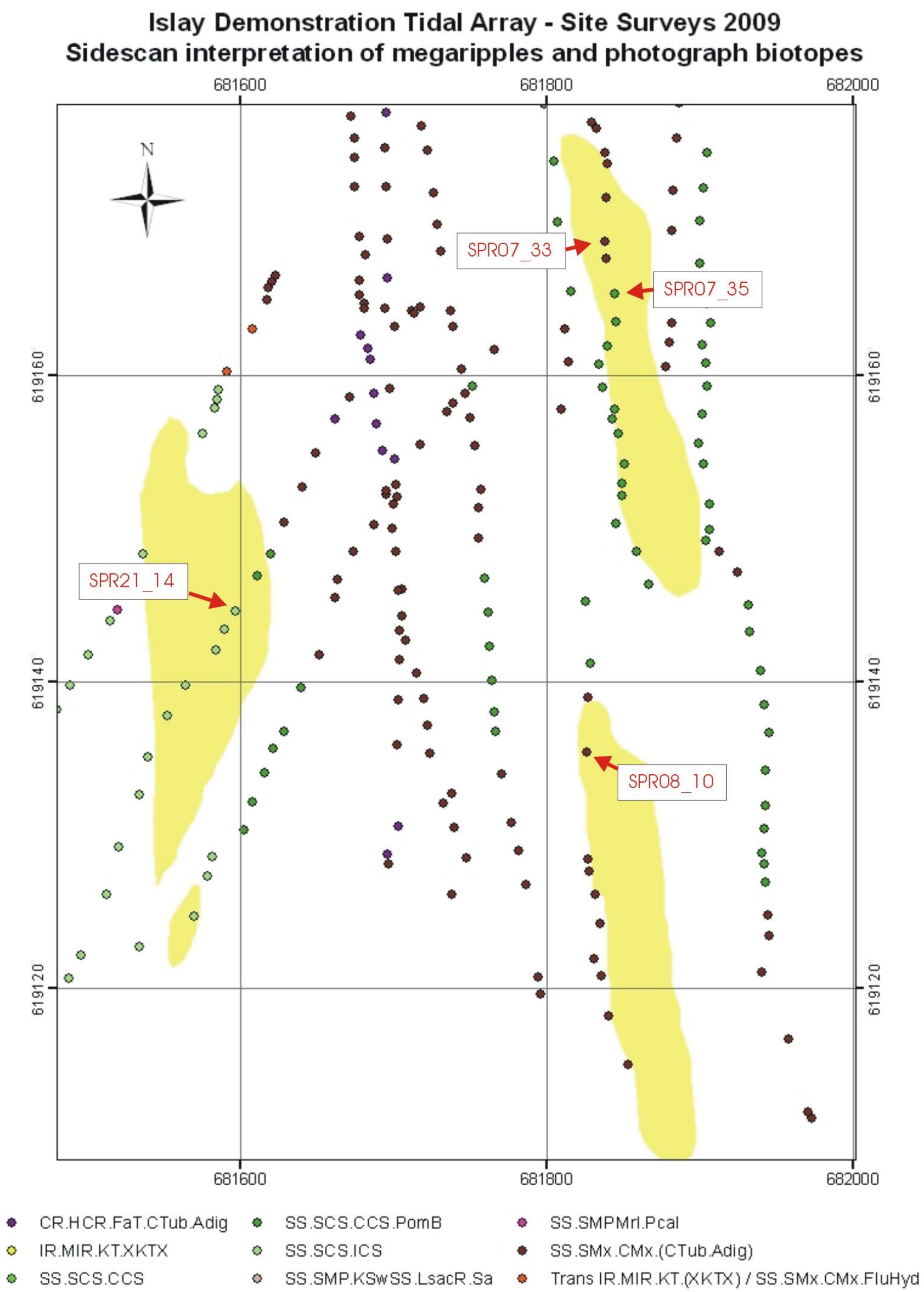

Figure 14. Close-up of features classified as ‘megaripples’ (from iX Survey sidescan interpretation) with 2009 ground-truth survey photographs.

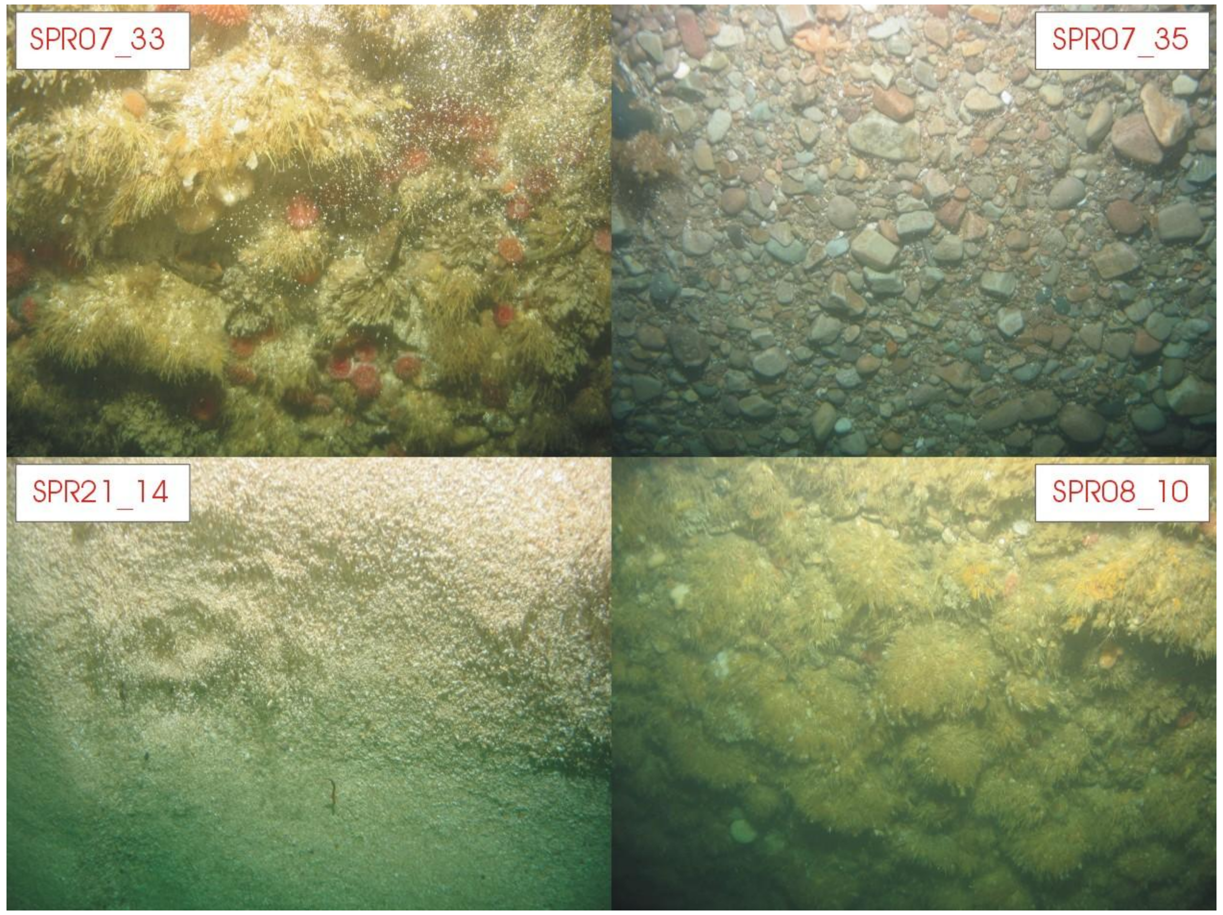

Figure 15. Photographs from the areas classified as ‘megaripples’.

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.

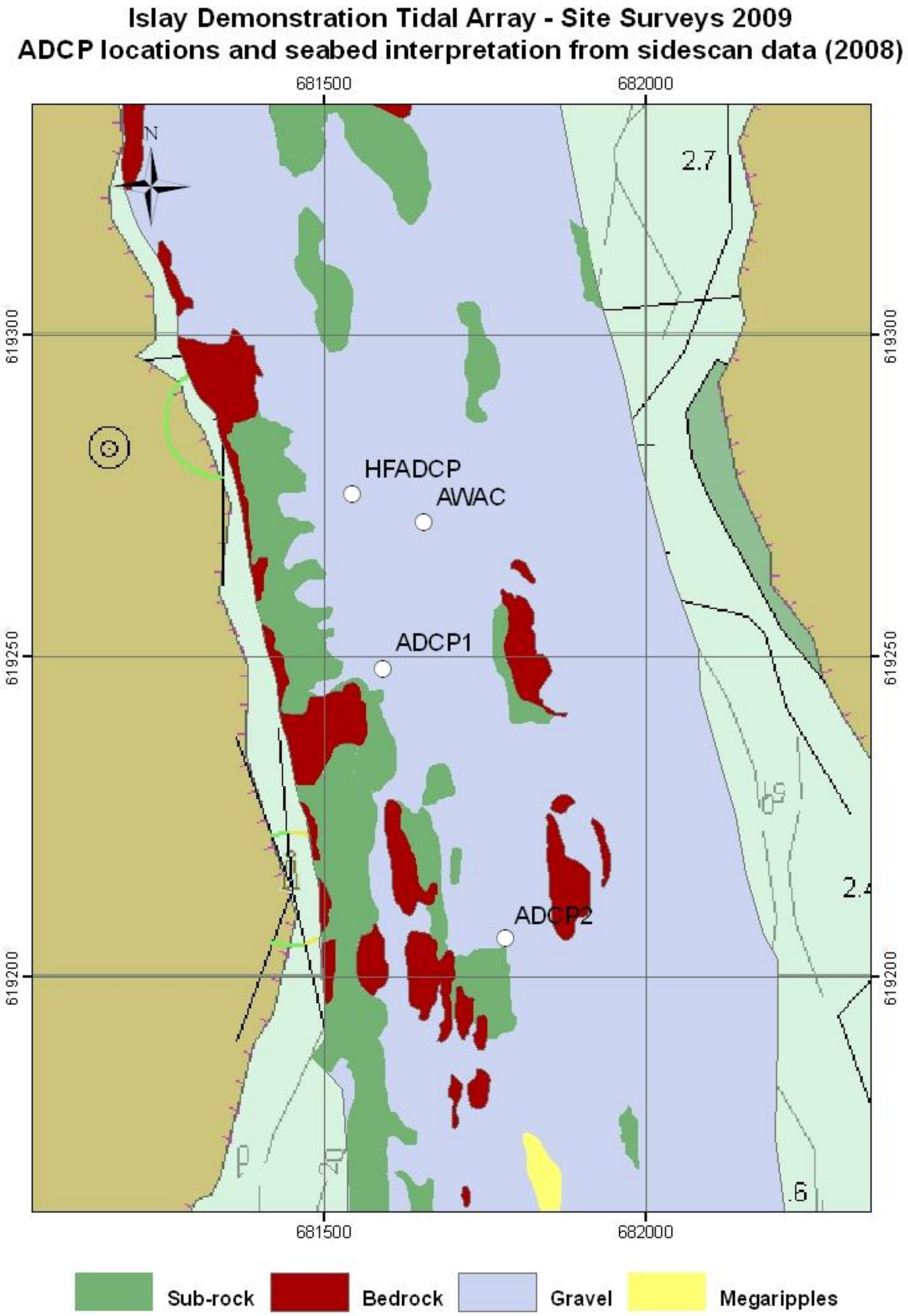

Figure 16. ADCP, HFADCP and AWAC locations within the 2009 Islay survey.

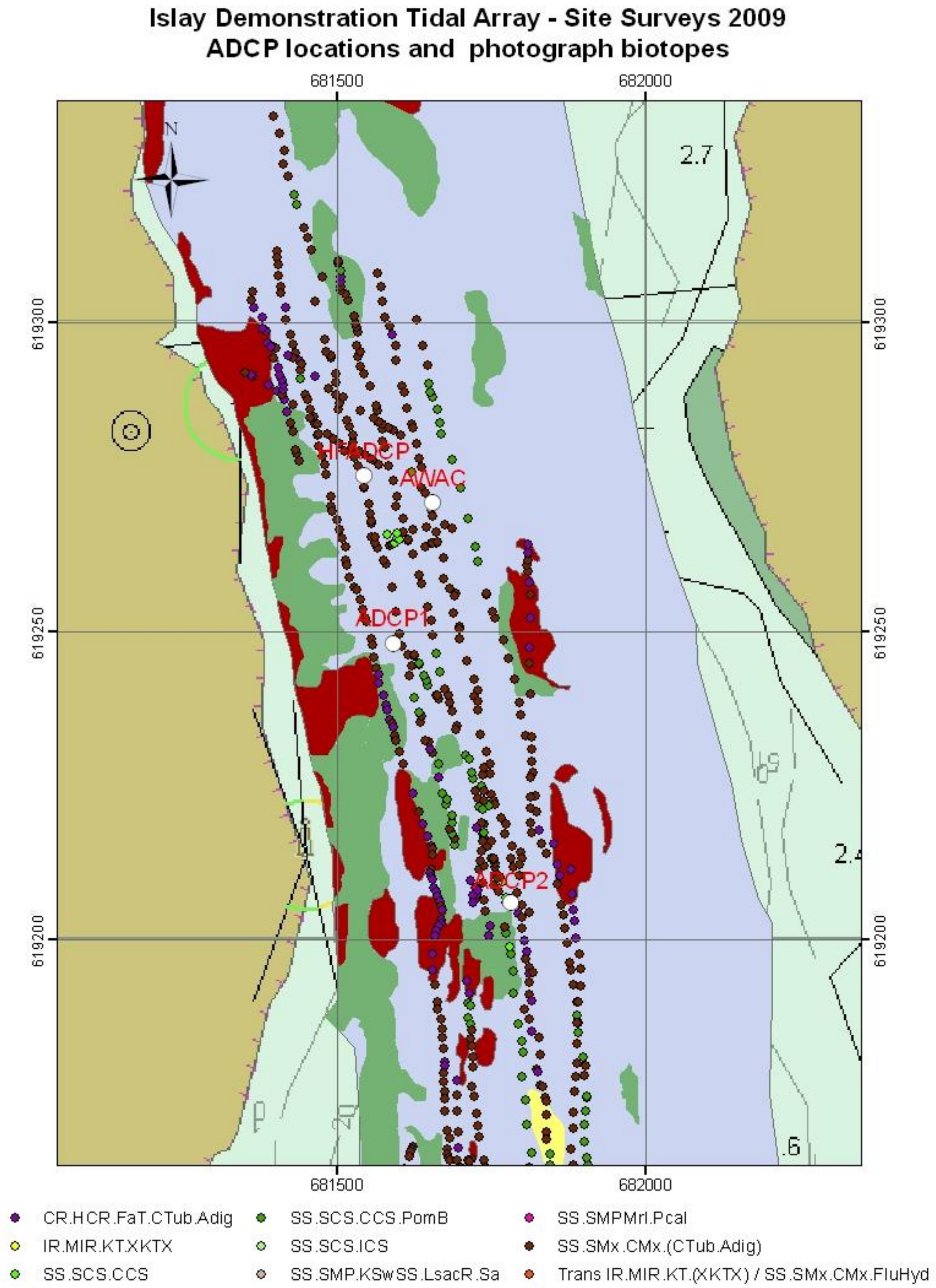

Figure 17. *ADCP, HFADCP and AWAC locations with still photography biotope classifications within the 2009 Islay survey.*

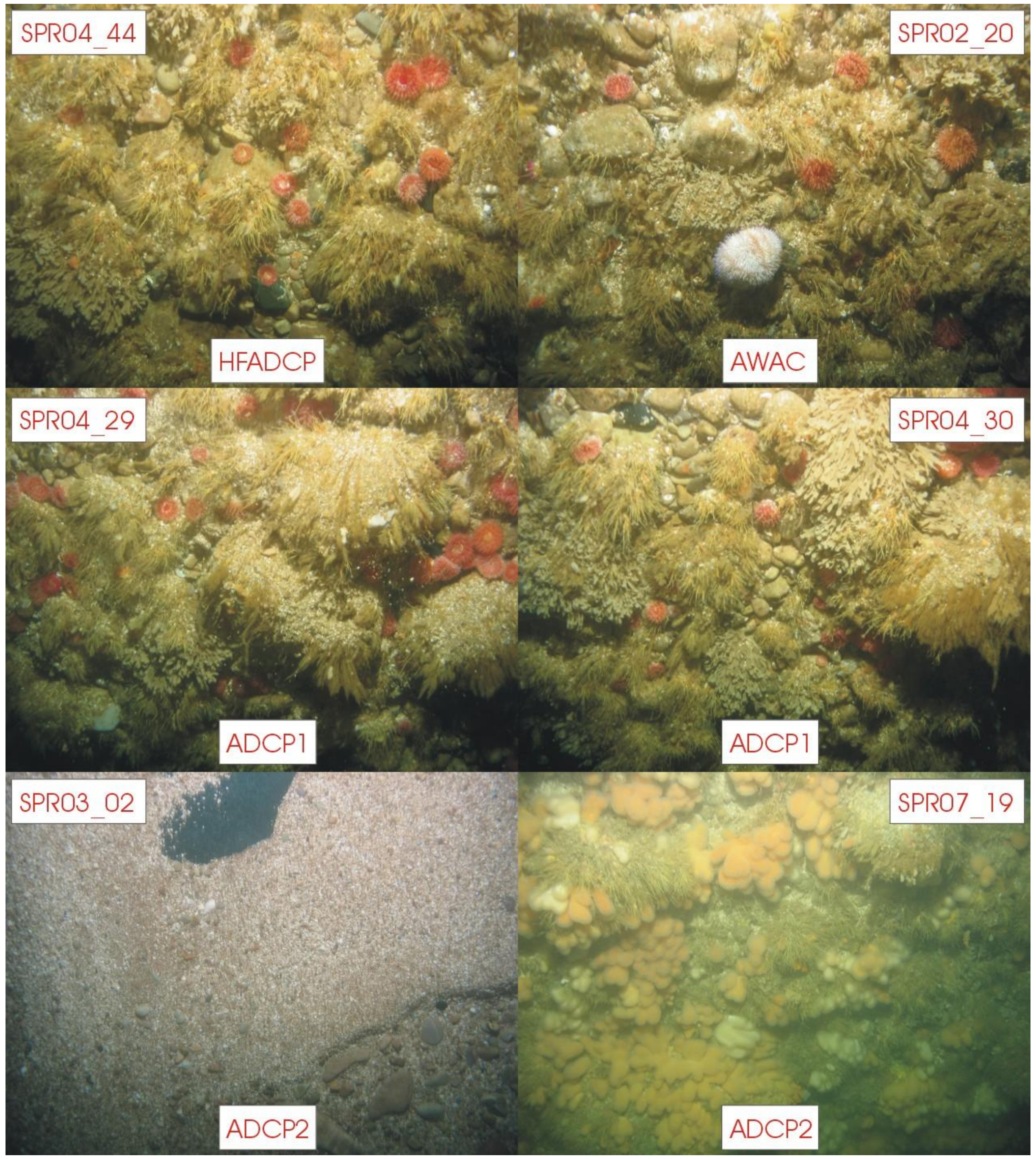

Figure 18. Photographs from the current profiler locations.

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*).

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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.

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

Sound of Islay Proposed Tidal Array Cable Route

Drop Down Video Survey

Scottish Power Renewables

12th April 2010

Final Report

9T3474

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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

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Approved by	Frank Fortune	
Date/initials approval	………………….	………………….

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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.

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.

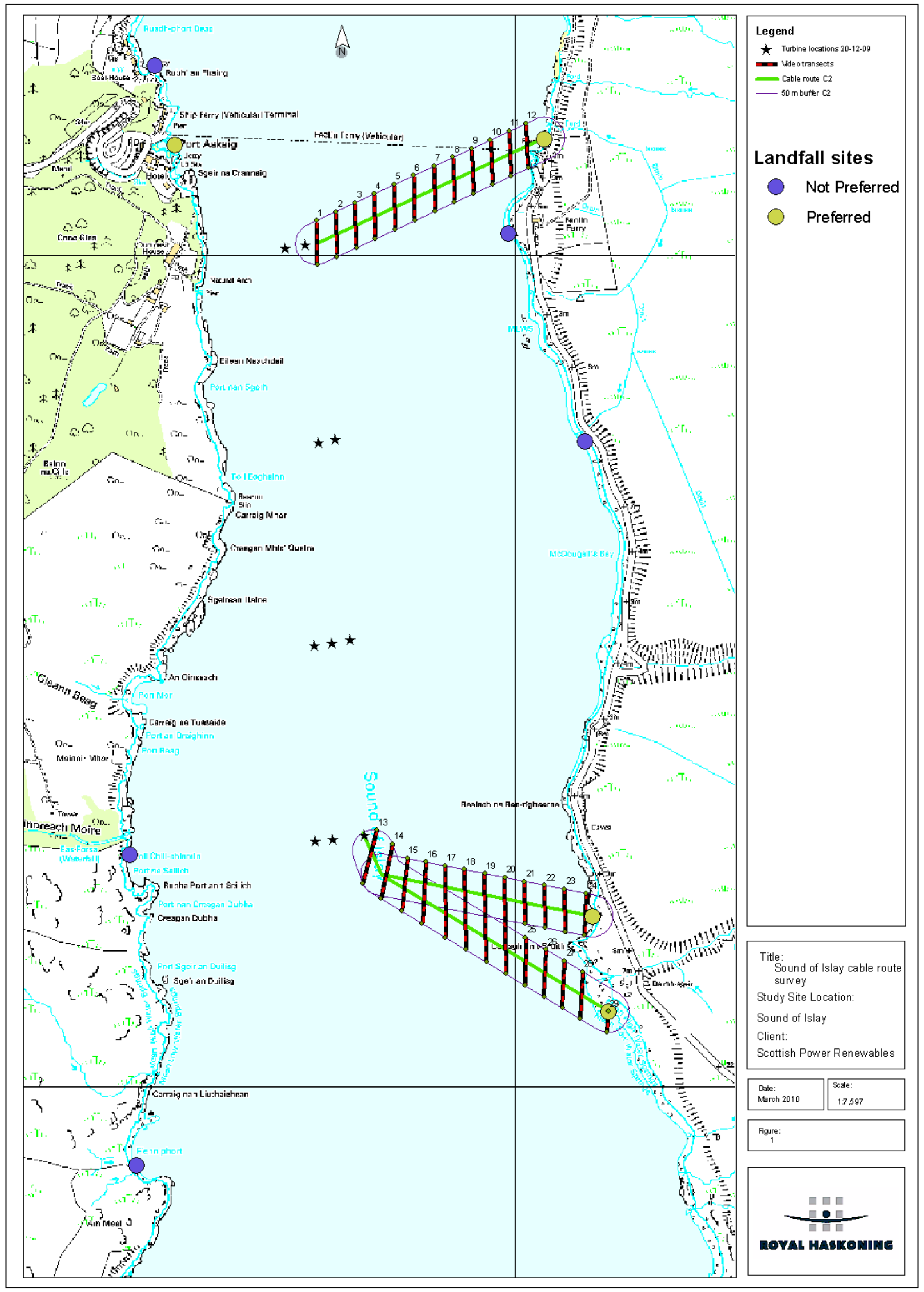


Figure 2.1 Location of proposed cable routes and drop video transects

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.

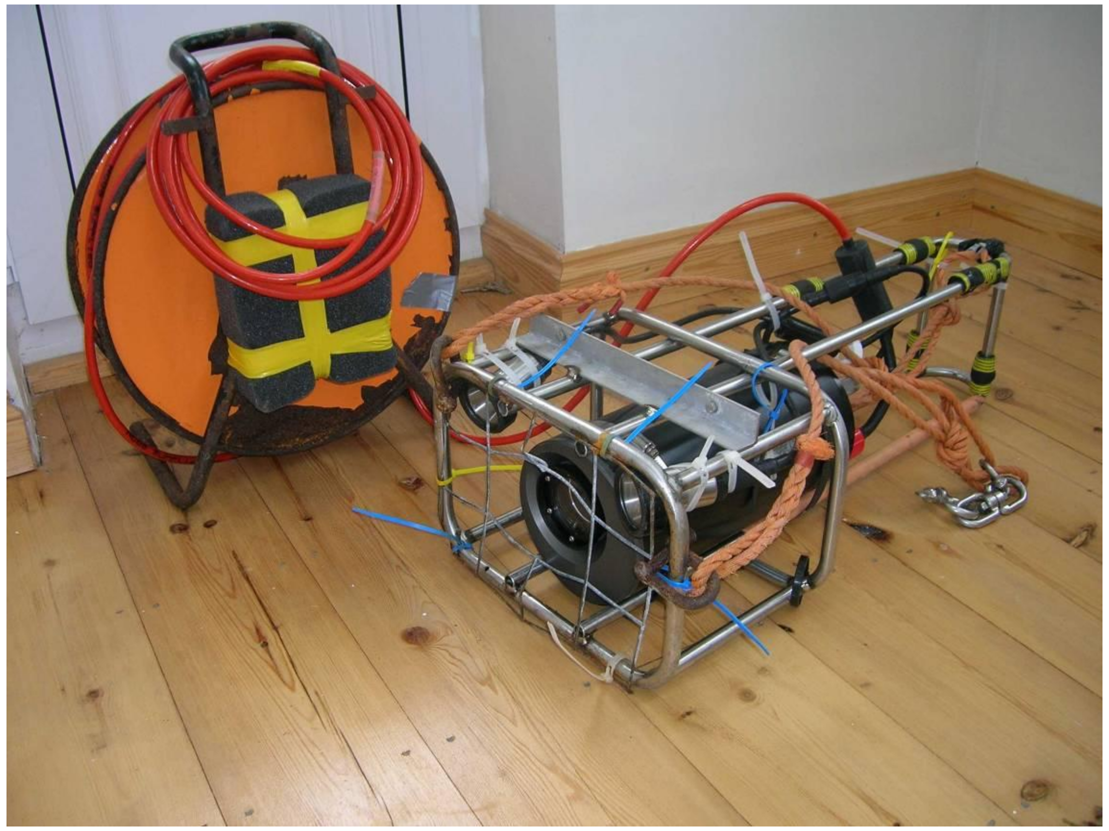


Figure 2.2 Drop down camera equipment

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

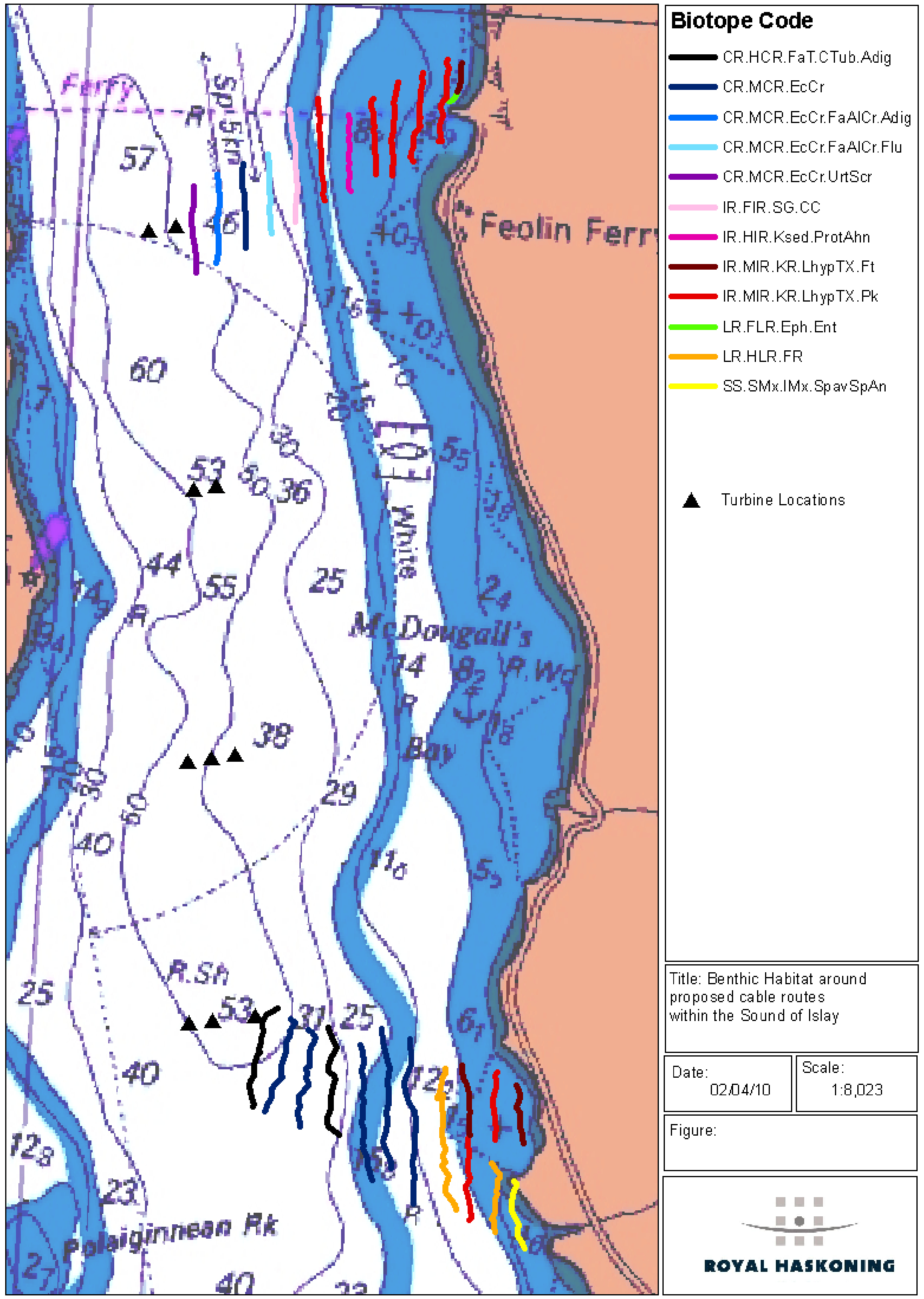
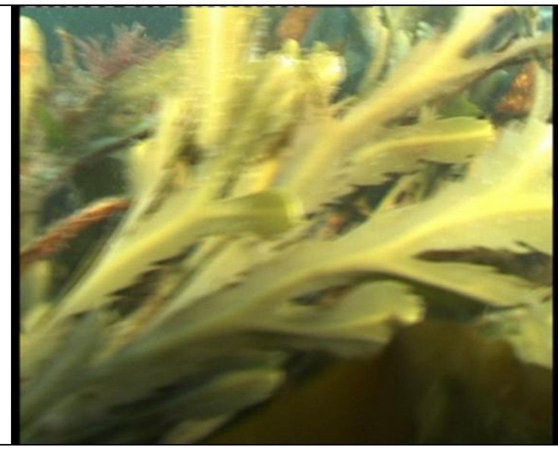
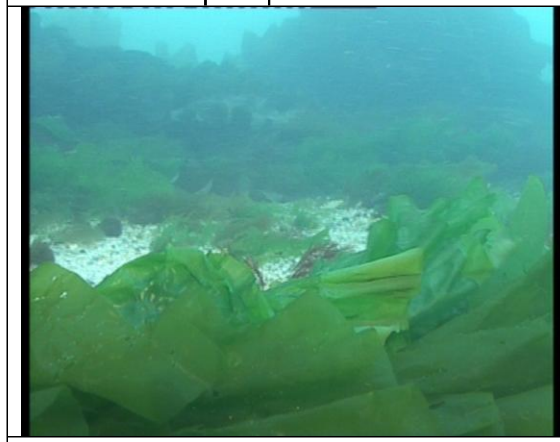
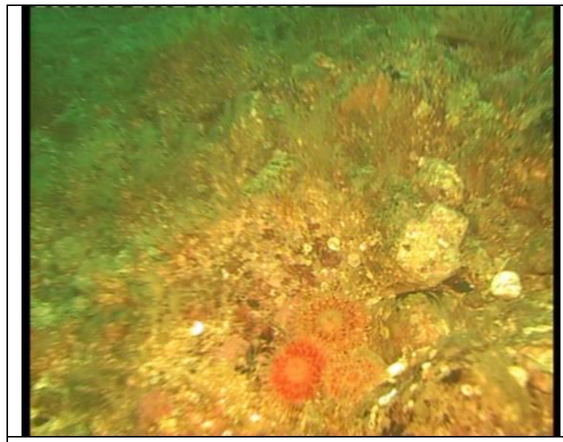


Table 3.2 Biotope pictures

	
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

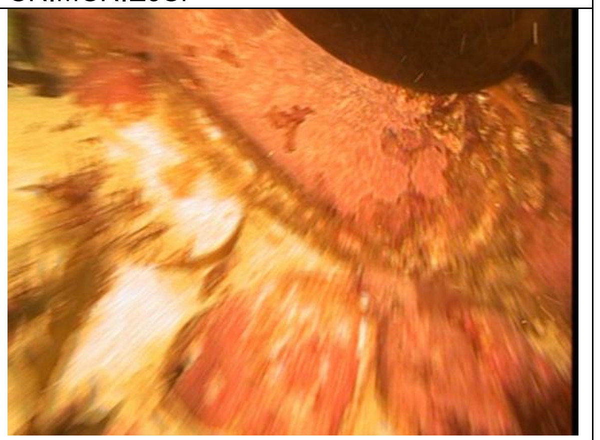

CR.MCR.EcCr.UrtScr


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

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.

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.

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.

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

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

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**).

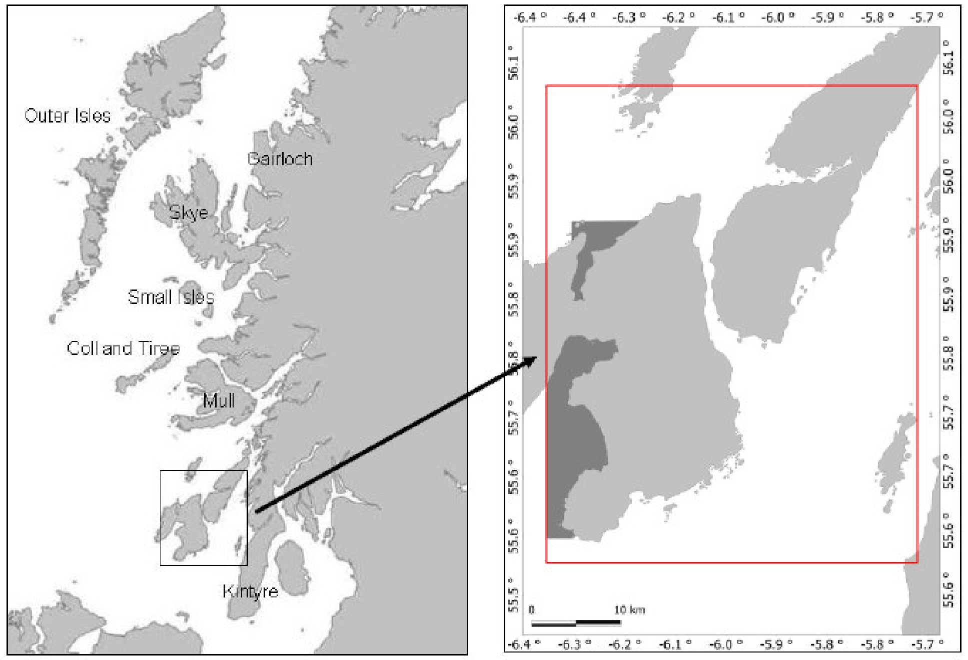


Figure 1: Map of west coast of Scotland and survey area for HWDT visual and acoustic surveys. The region included in the analysis presented here is outlined in red. The dark grey area was not surveyed.

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).

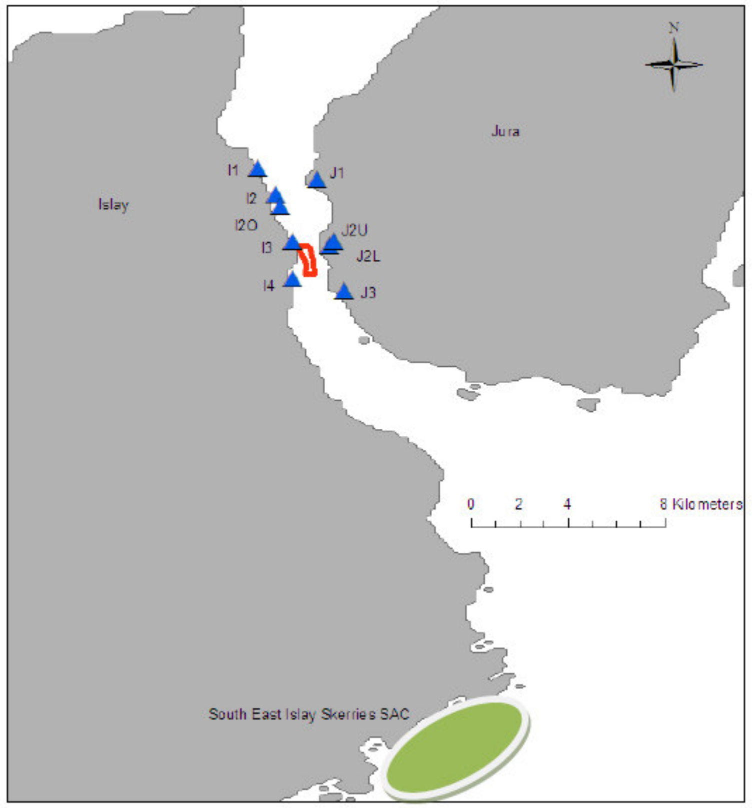


Figure 2: Position of land based observation sites (blue triangles), the proposed development site (outlined in red) and the South East Islay Skerries SAC (green).

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.

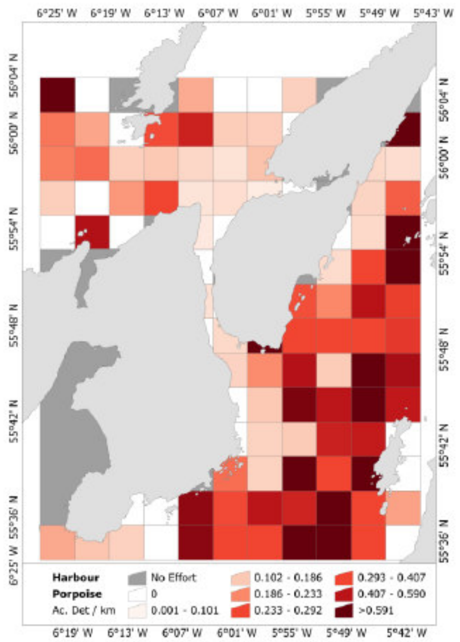


Figure 3: Harbour porpoise acoustic detections per unit effort in the Sound of Islay region (shown in shades of red – darker shades indicate higher detection rates). Grid cells not surveyed shown in dark grey (HWDT).

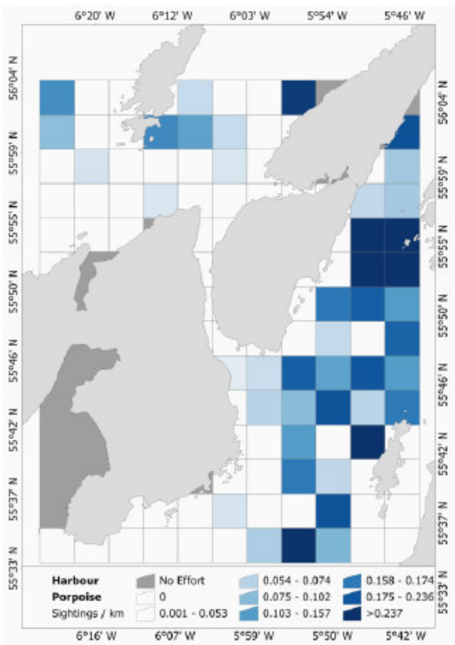


Figure 4: Sightings per unit effort of harbour porpoises in the Sound of Islay region (shown in shades of blue – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey.

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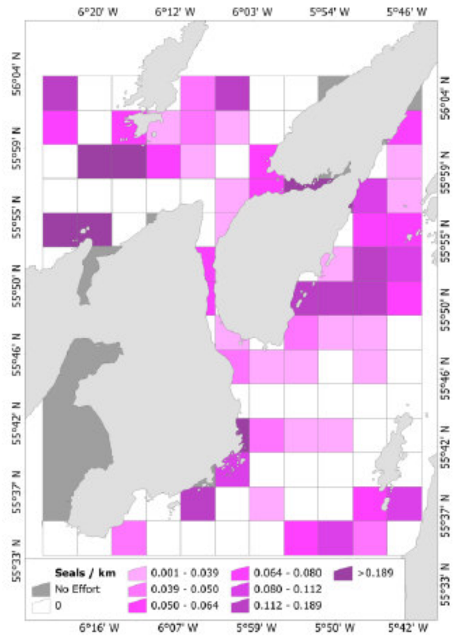

Figure 5: Sightings per unit effort of grey, harbour and unidentified seals in the Sound of Islay region (shown in shades of purple – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (HWDT).

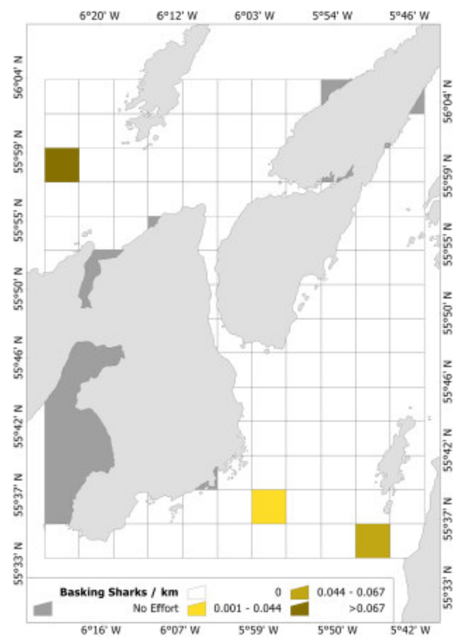

Figure 6: Sightings per unit effort of basking sharks in the Sound of Islay region (shown in shades of yellow – darker shades indicate higher sighting rates). Grid cells not surveyed is shown in dark grey.

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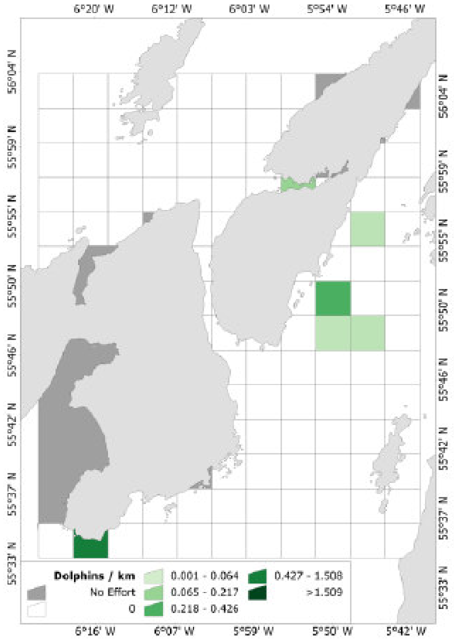

Figure 7; Sightings per unit effort of dolphin species in the Sound of Islay region (shown in shades of green – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (HWDT).

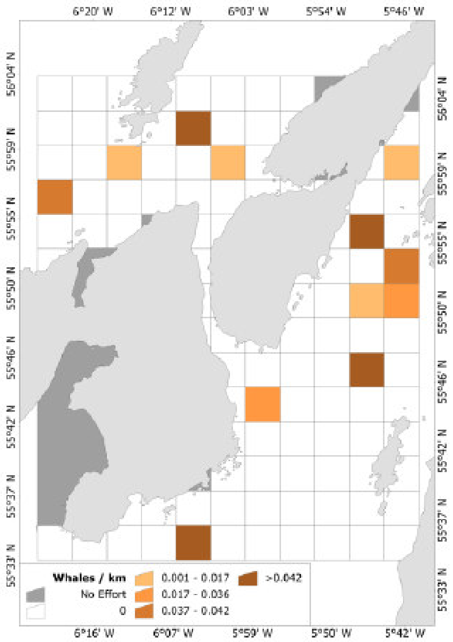

Figure 8: Sightings per unit effort of whale species in the Sound of Islay region (shown in shades of orange – darker shades indicate higher sighting rates). Grid cells not surveyed shown in dark grey (HWDT).

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.

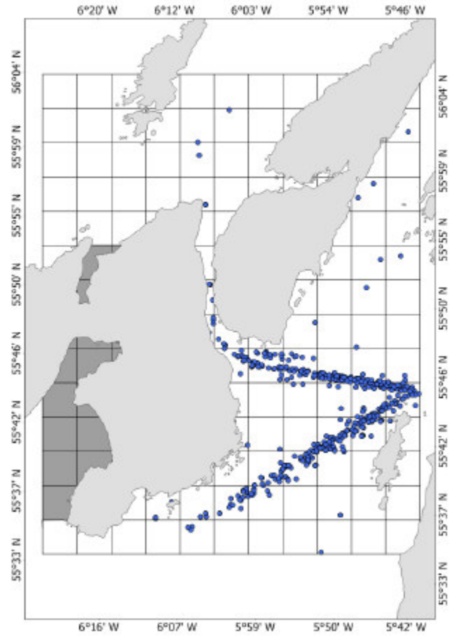

Figure 9: Harbour Porpoise public sightings 2000-2008 (blue dots) in the Sound of Islay region (HWDT)

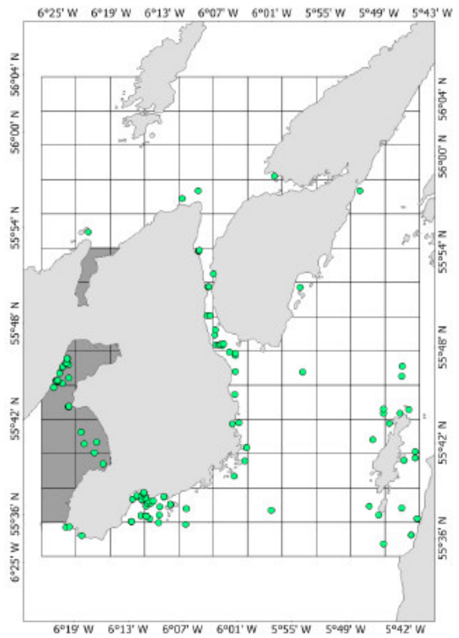

Figure 10: Bottlenose dolphin public sightings 2000-2008 (light green dots) in the Sound of Islay region (HWDT)

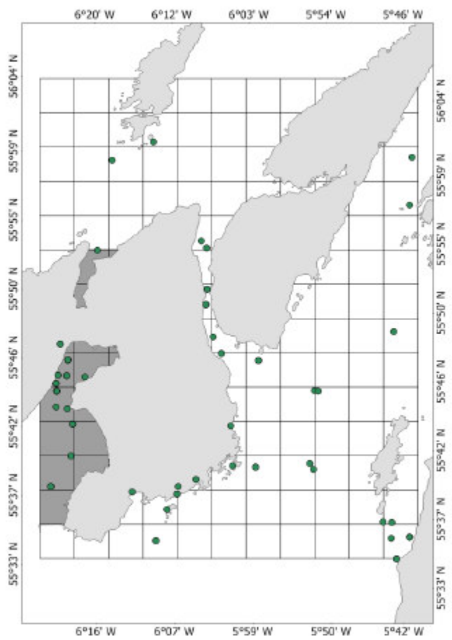

Figure 11: Dolphin public sightings 2000-2008 (dark green dots) in the Sound of Islay region (HWDT)

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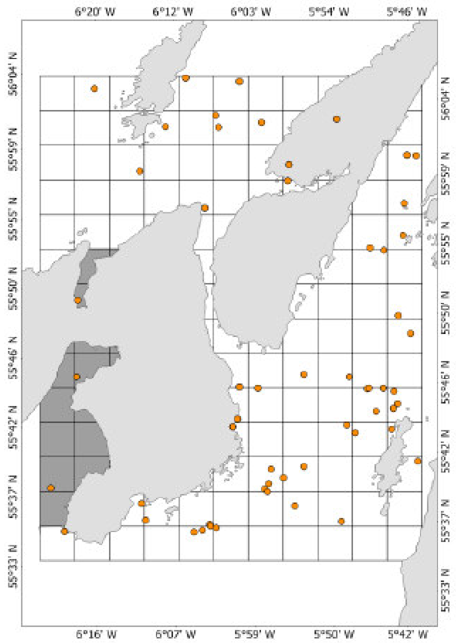

Figure 12: Whale public sightings 2000-2008 (orange dots) in the Sound of Islay region (HWDT)

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**

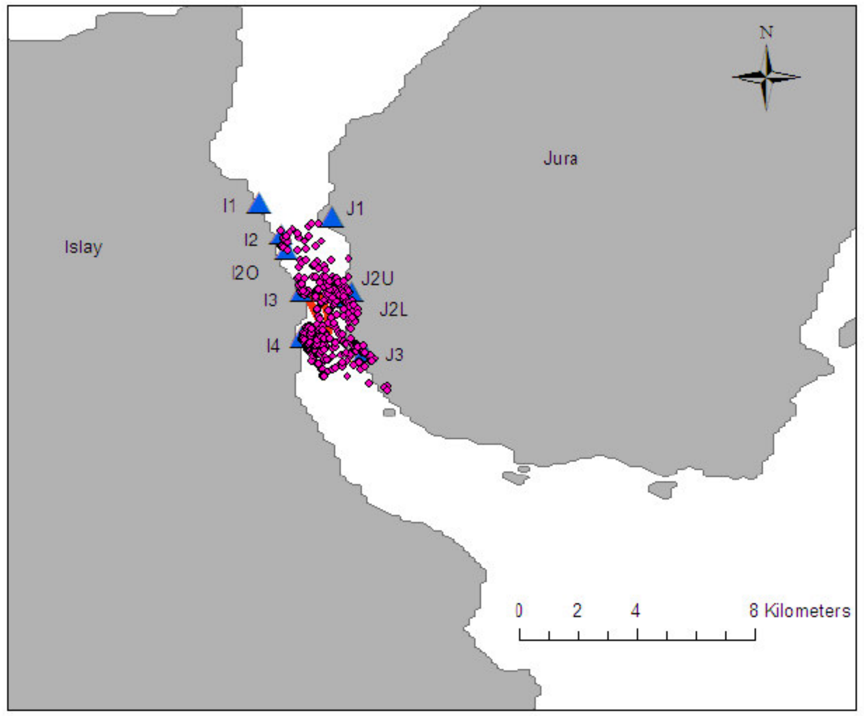

Figure 13: Seal positional data –care must be taken when interpreting this map as effort is not taken onto account. Blue triangles indicate the observation sites and red outlines the proposed development area.

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

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).

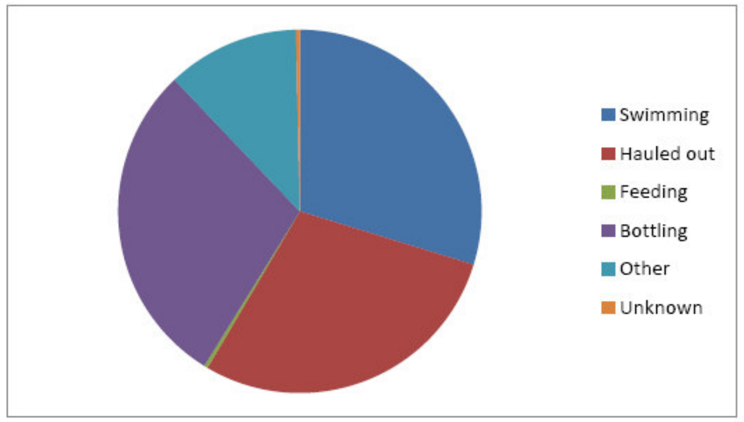

Figure 14: Seal behaviour (harbour and grey seals combined) recorded in Sound Of Islay April-November 2009 (marine mammal scans only).

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**

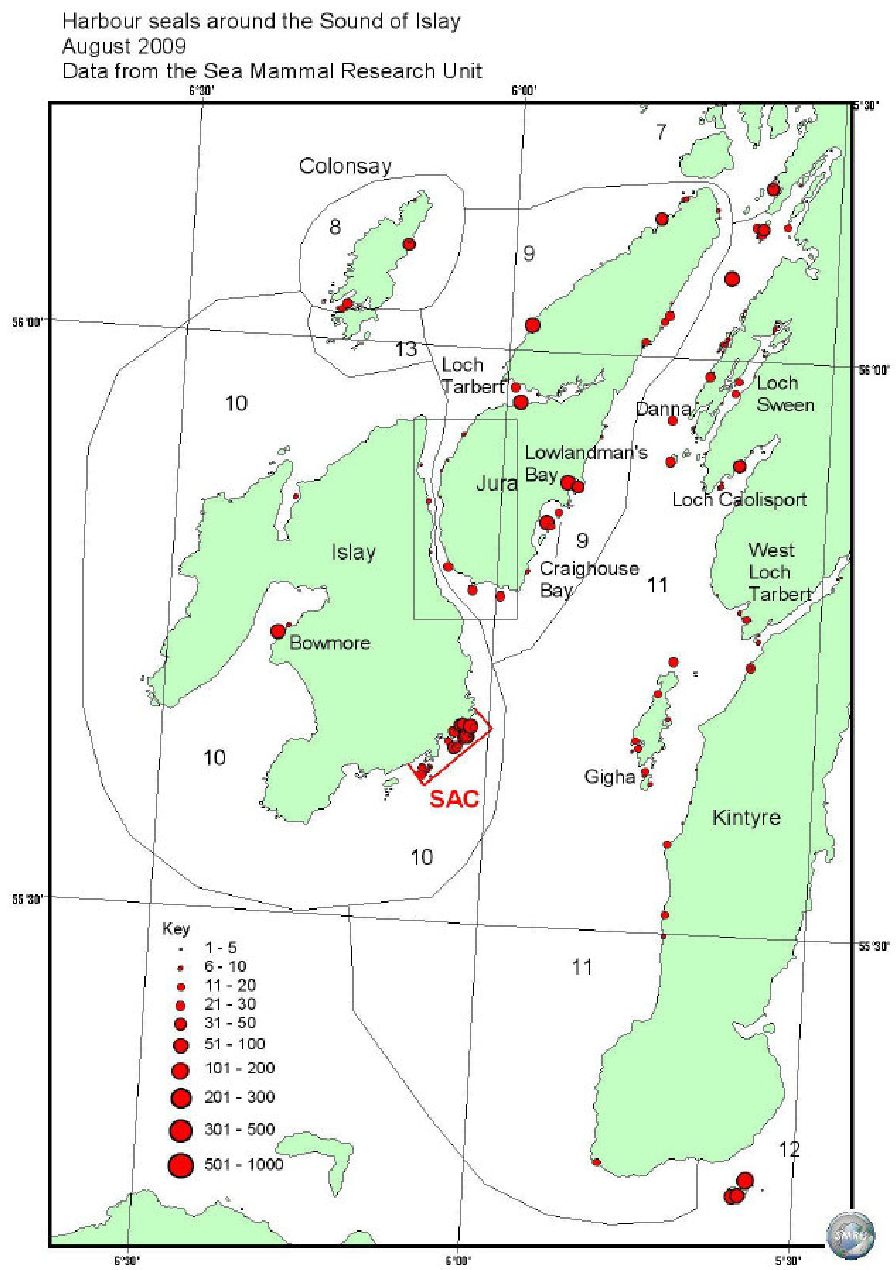

Figure 15: The distribution of harbour seals around the Sound of Islay from a survey carried out in August 2009. Counts of seals in the numbered sub-regions are provided in Table 12. The Sound of Islay is outlined in black and the designated Special Area of Conservation for harbour seals is outlined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

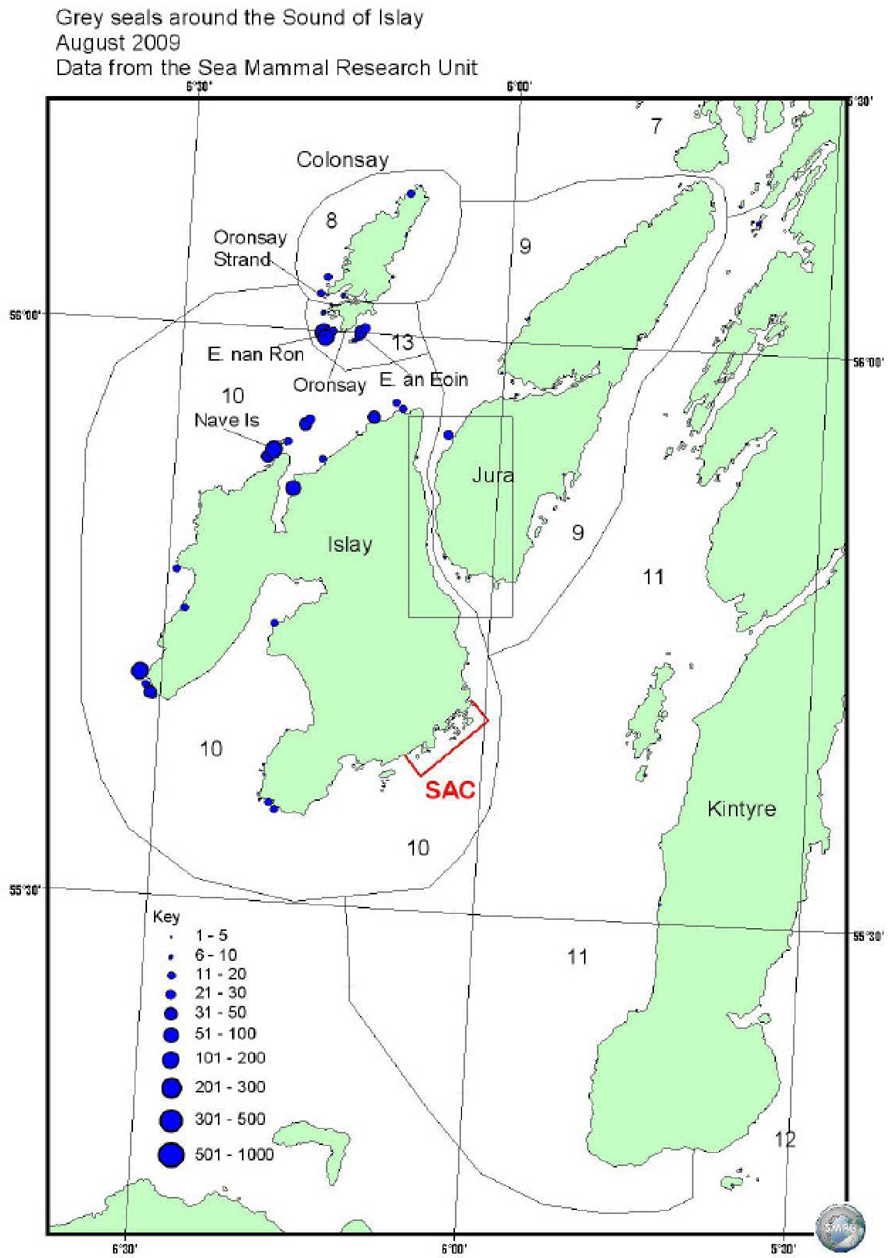

Figure 16: The distribution of grey seals around the Sound of Islay from a survey carried out in August 2009. Counts of seals in the numbered sub-regions are provided in Table 13. The Sound of Islay is outlined in black and the designated Special Area of Conservation for harbour seals is outlined in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

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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

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 Community 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.

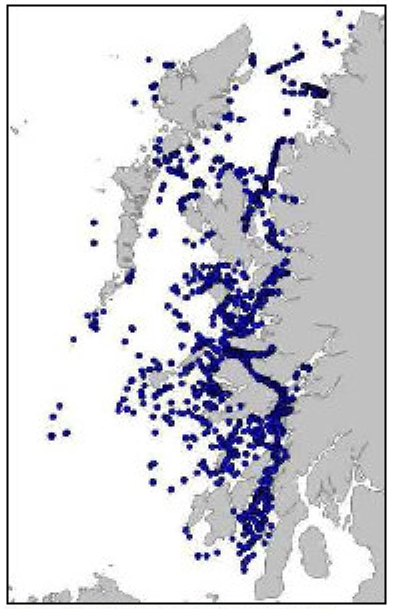

Figure 1a Harbour porpoise sightings data collected during *Silurian* surveys 2003-2007 (blue dots - not corrected for effort)

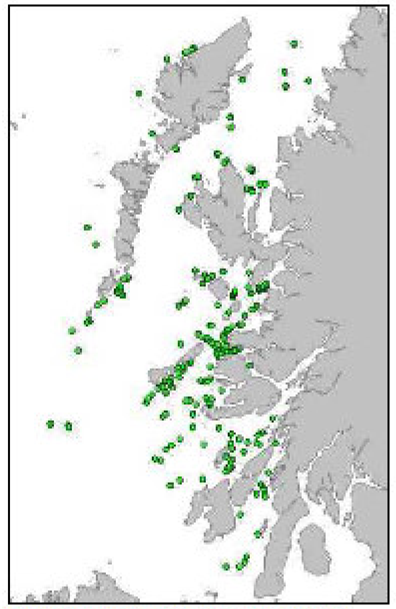

Figure 1b. Visual sightings data for all whale species collected during *Silurian* surveys 2003-2007 (green dots - not corrected for effort)

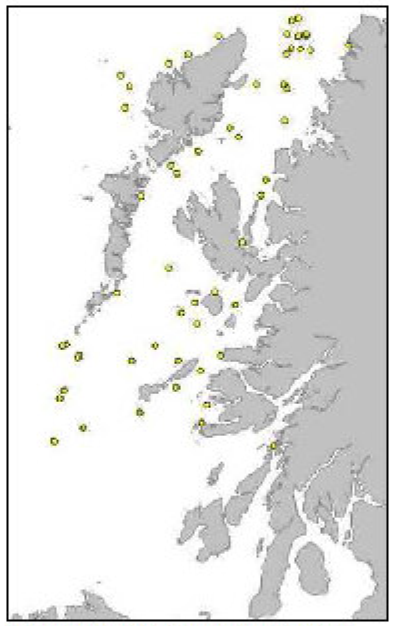

Figure 1c. Visual sightings data for all dolphin species collected during *Silurian* surveys 2003-2007 (yellow dots - not corrected for effort)

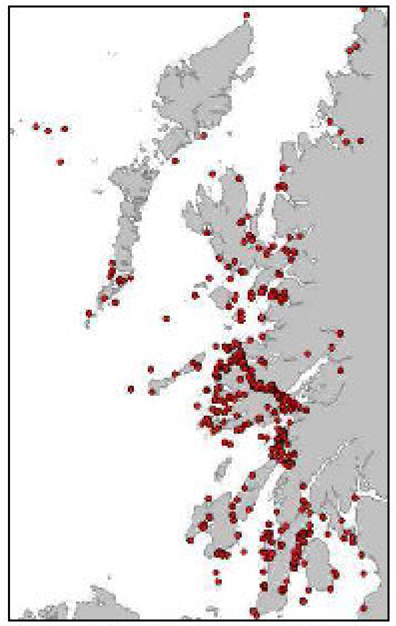

Figure 1d. Public sightings data for bottlenose dolphins 2003-2007 (red dots)

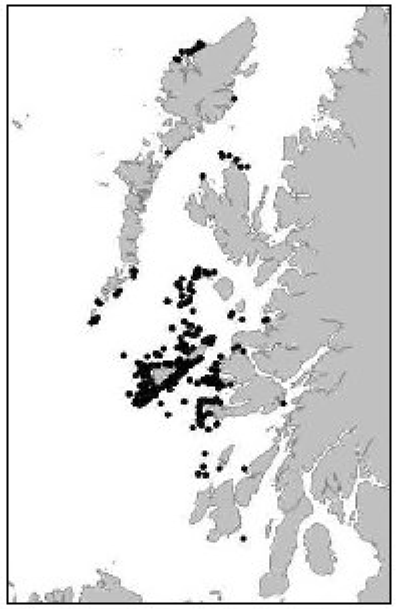

Figure 1e. Sightings data for basking sharks collected during *Silurian* surveys 2003-2007 (black dots - not corrected for effort)

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),

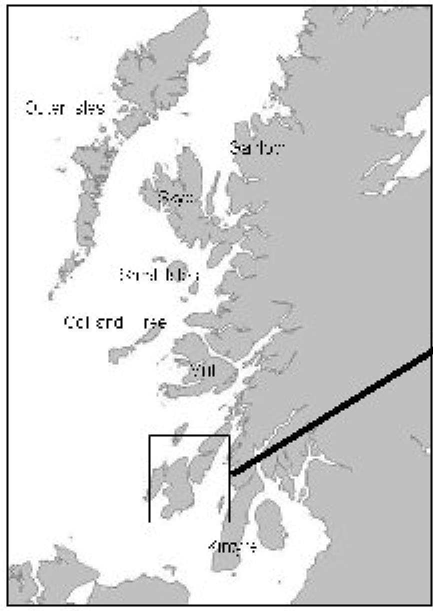

Figure 2a Map of west coast and survey area for HWDT visual and acoustic surveys.

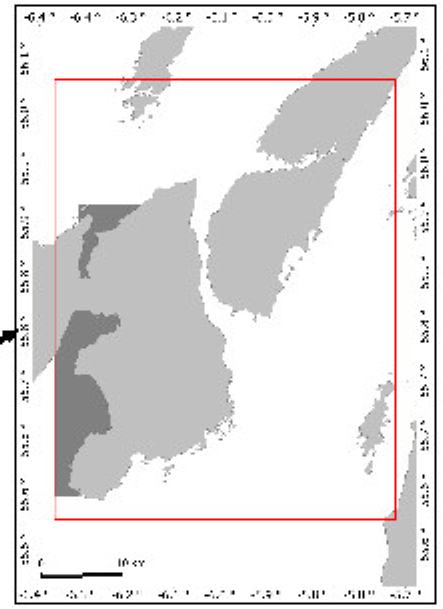

Figure 2b Study region for the Sound of Islay analysis (red line). Area not surveyed is shown in dark grey. Scale is shown in the bottom left corner.

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).

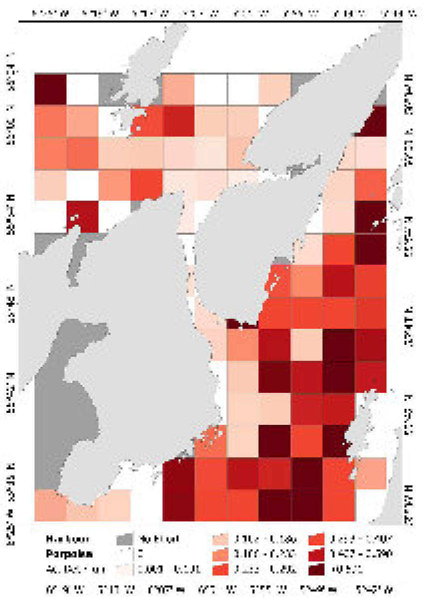

Figure 3a. Harbour porpoise acoustic detections per unit effort in the Sound of Islay region (shown in shades of red). Grid cells not surveyed shown in dark grey.

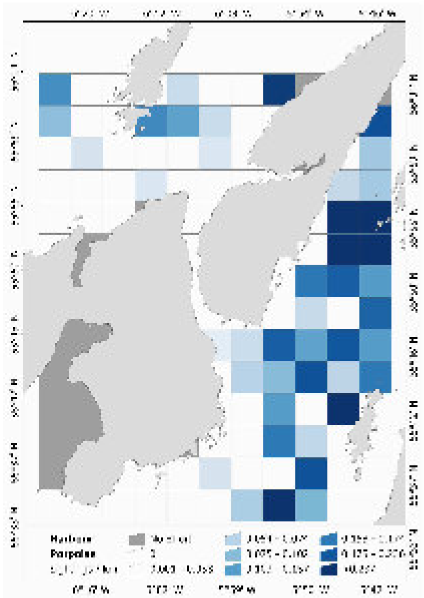

Figure 3b. Sightings per unit effort of harbour porpoise in the Sound of Islay region (shown in shades of blue). Grid cells not surveyed shown in dark grey.

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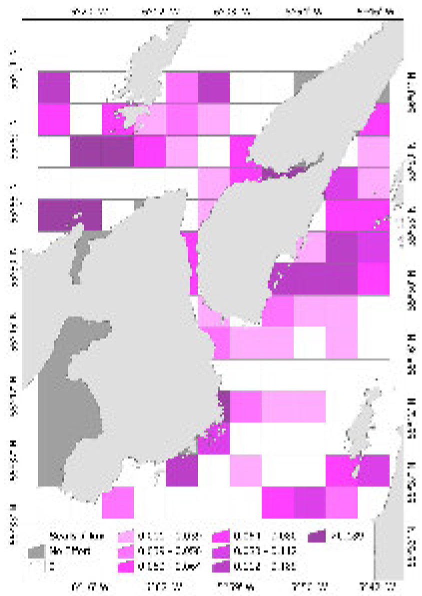

Figure 3c Sightings per unit effort of grey, common and unidentified seals in the Sound of Islay region (shown in shades of purple). Grid cells not surveyed shown in dark grey.

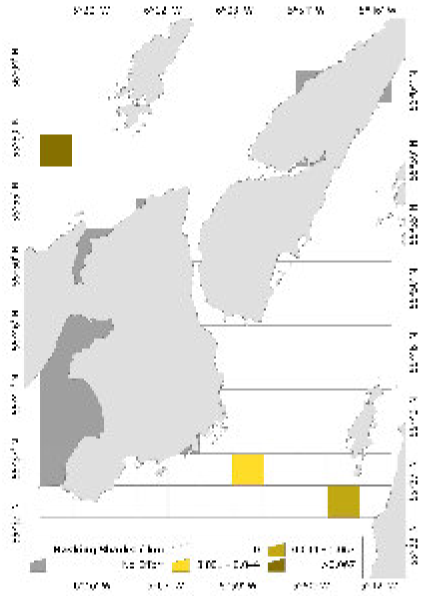

Figure 3d Sightings per unit effort of basking sharks in the Sound of Islay region (shown in shades of yellow). Grid cells not surveyed is shown in dark grey.

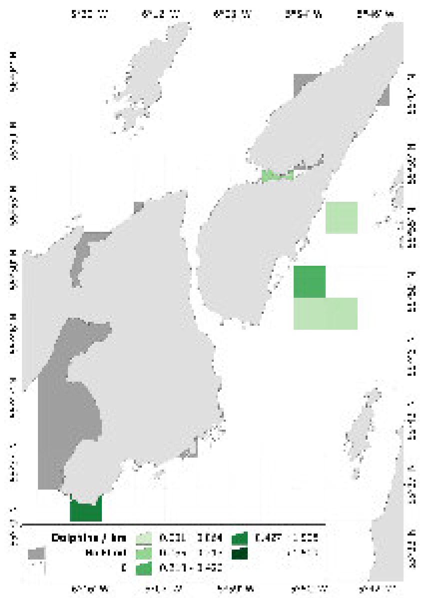

Figure 3e Sightings per unit effort of dolphin species in the Sound of Islay region (shown in shades of green). Grid cells not surveyed shown in dark grey.

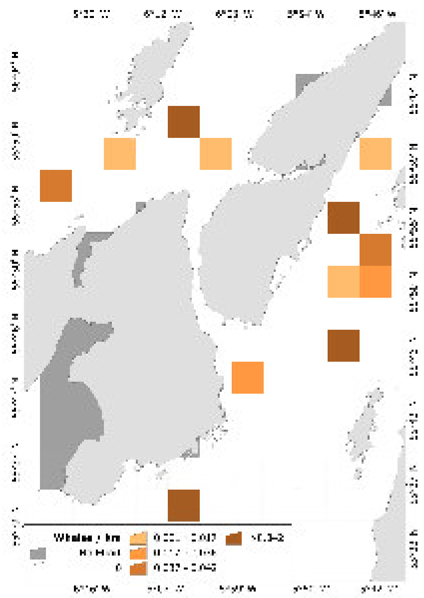

Figure 3f Sightings per unit effort of whale species in the Sound of Islay region (shown in shades of orange). Grid cells not surveyed shown in dark grey.

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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.

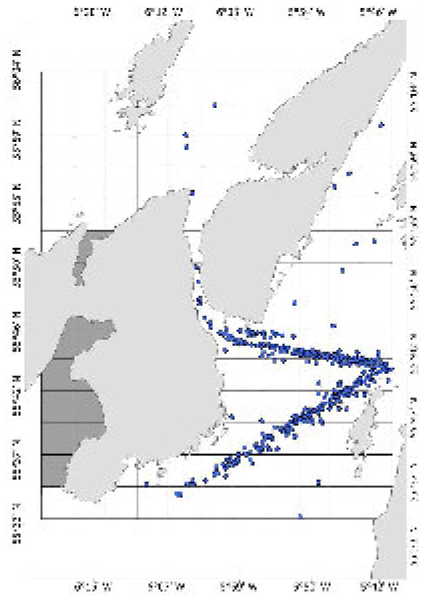

Fig 4a Harbour Porpoise public sightings 2000-2008 (blue dots) in the Sound of Islay region

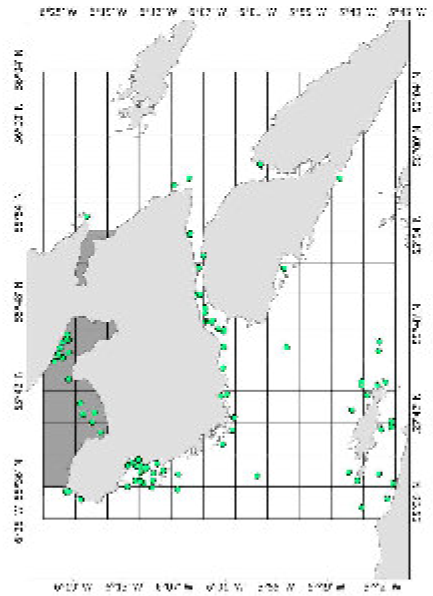

Fig 4b Bottlenose dolphin public sightings 2000-2008 (light green dots) in the Sound of Islay region

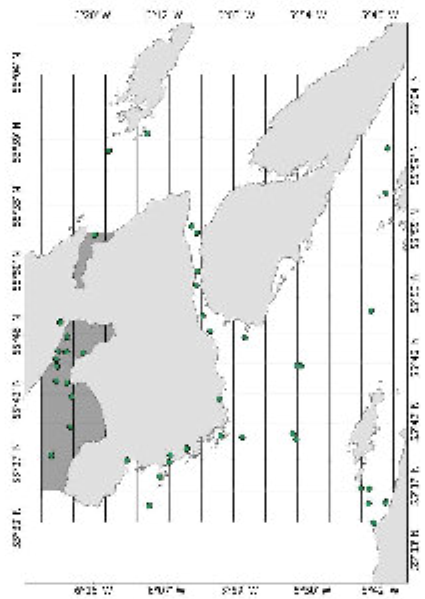

Fig 4c Dolphin public sightings 2000-2008 (dark green dots) in the Sound of Islay region

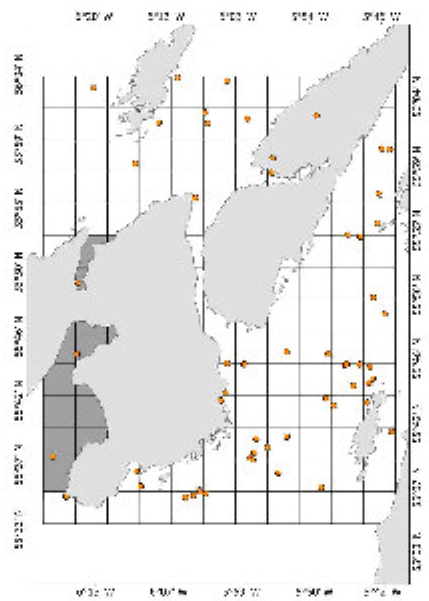

Fig 4d Whale public sightings 2000-2008 (orange dots) in the Sound of Islay region

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.

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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

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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

HWDT would like to thank our funders and supporters; Scottish Natural Heritage (SNH), Heritage Lottery Fund (HLF), Highlands and Islands Enterprise (HIE), Argyll and Bute Council, WWF, the Earthwatch Institute and all the students and volunteers that have contributed towards our research over the years. HWDT would also like to thank the Sea Mammal Research Unit (SMRU) for their scientific support and advice and all the members of the public who have contributed reports to the Community Sightings Programme.

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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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A report prepared for Scottish Power Renewables

April 2010

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).

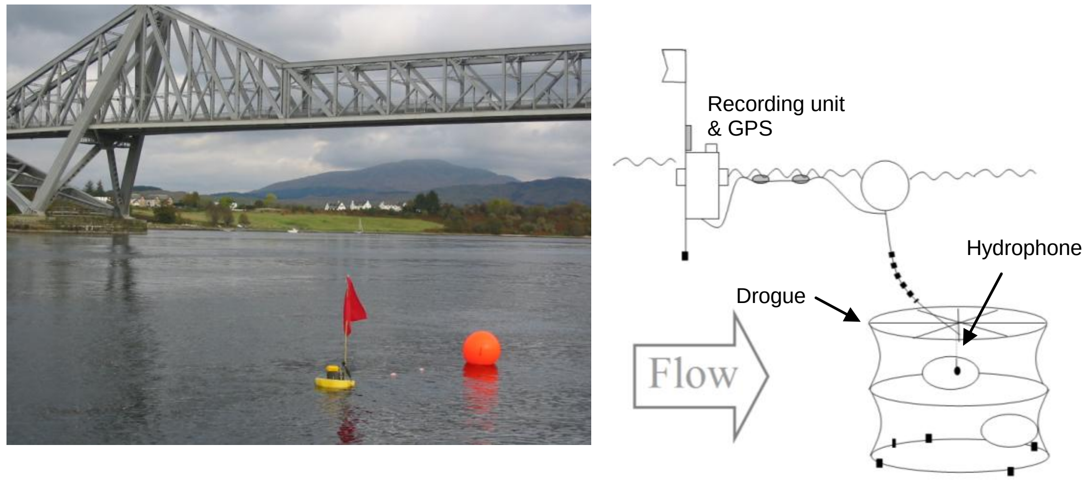

Figure 1. Deployment and structure of the "Drifting Ears" recorders developed by SAMS in collaboration with EMEC. These devices were built to measure ambient sound in areas of strong tidal flow where conventional methods of sound recording have proved inappropriate.

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.

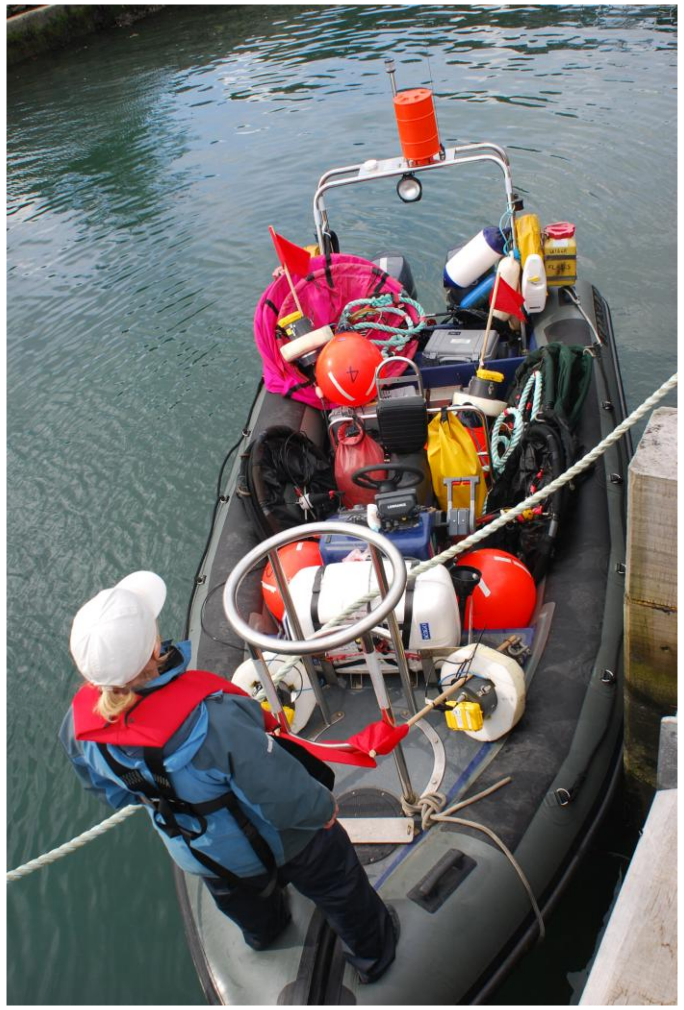

Figure 2. The low-noise RIB *Uisge* tied up in Port Askaig harbour and used to deploy and retrieve drifters (seen here stowed).

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) $>2m.s^{-1}$ flood b) $<2m.s^{-1}$ flood c) $>2m.s^{-1}$ ebb d) $<2m.s^{-1}$ 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.

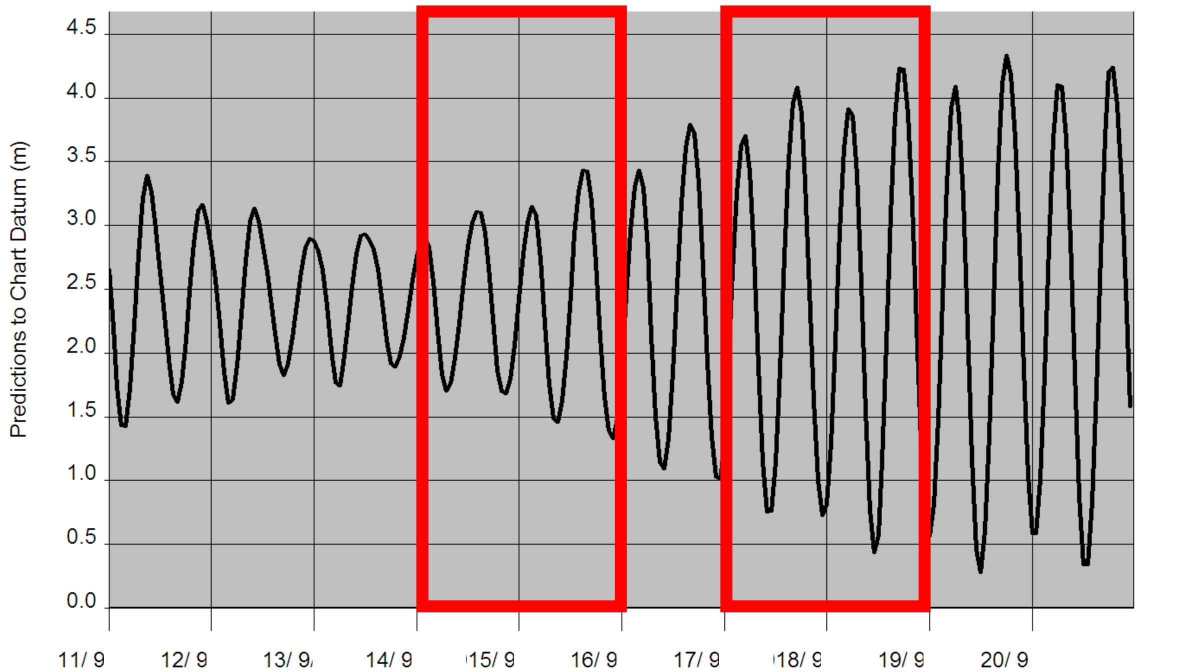

Figure 3. Boxes shows the days in the neap to spring cycle that were sampled during this study in 2009. Tidal heights are referenced to Oban.

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.

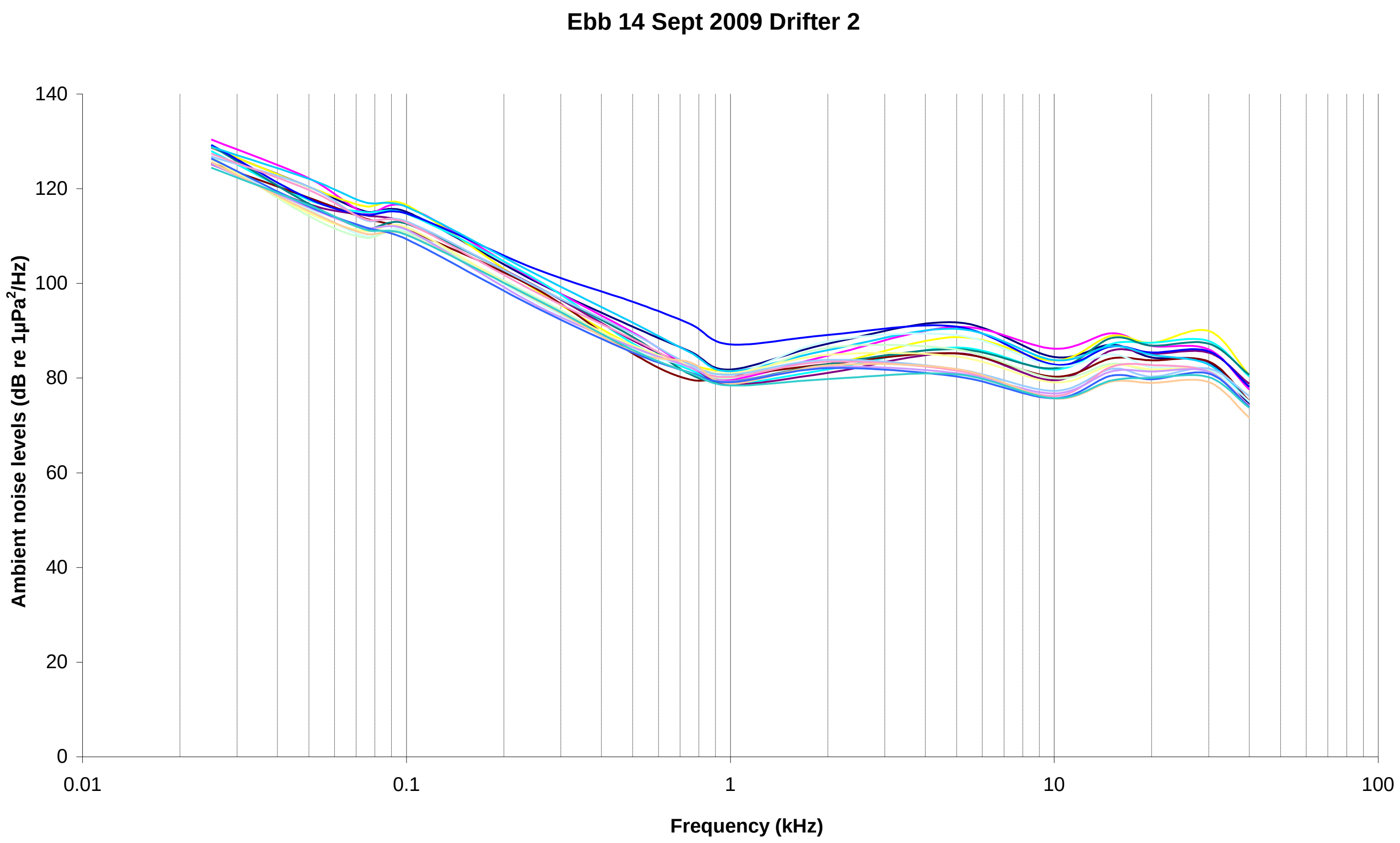

Figure 4. Example sound spectrum data from multiple sampling stations over the study area from a single drifter run on the ebb tide.

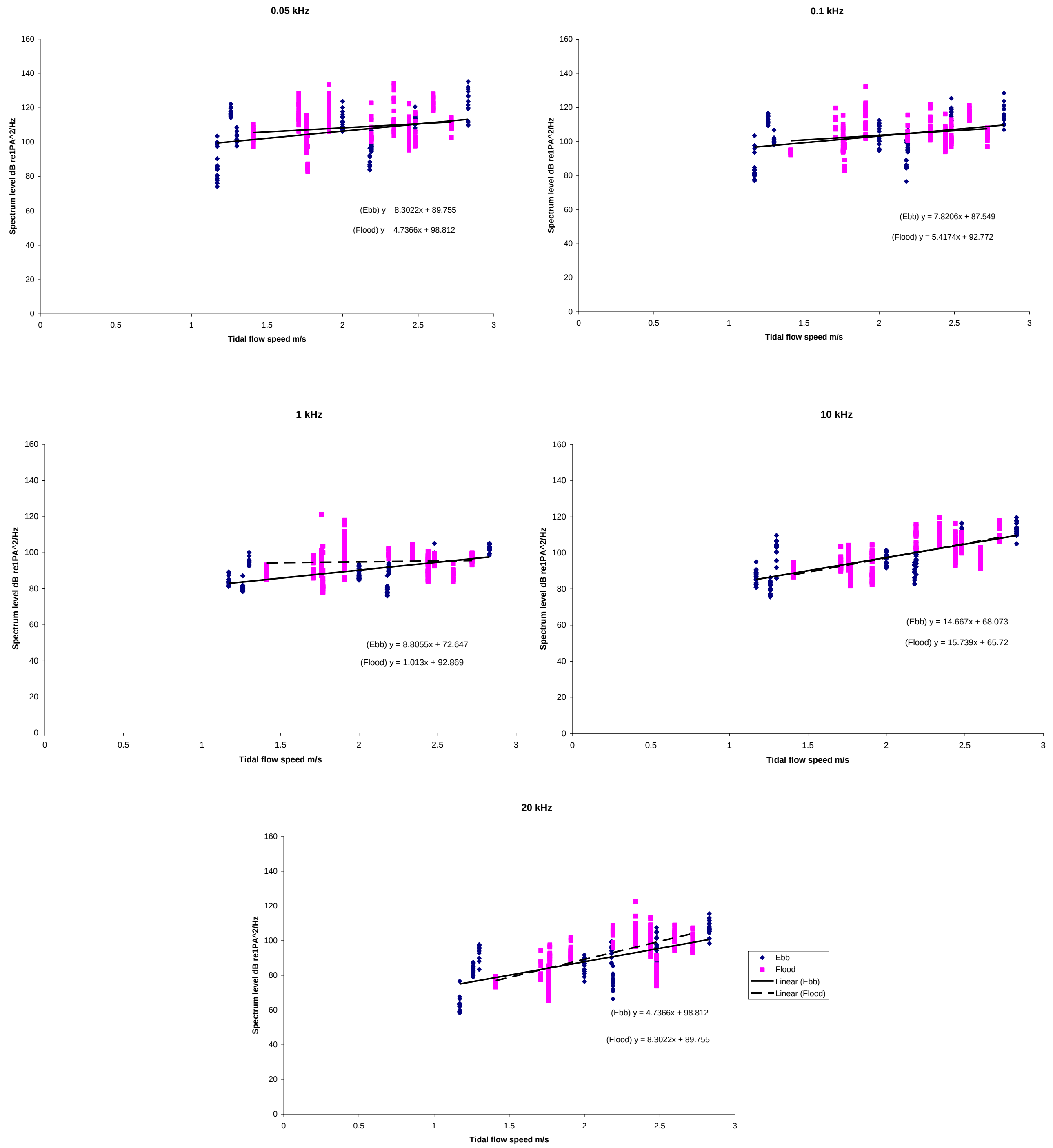

Figure 5a-e. Ambient sound level in each 60 s sample plotted against flow speed.

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.

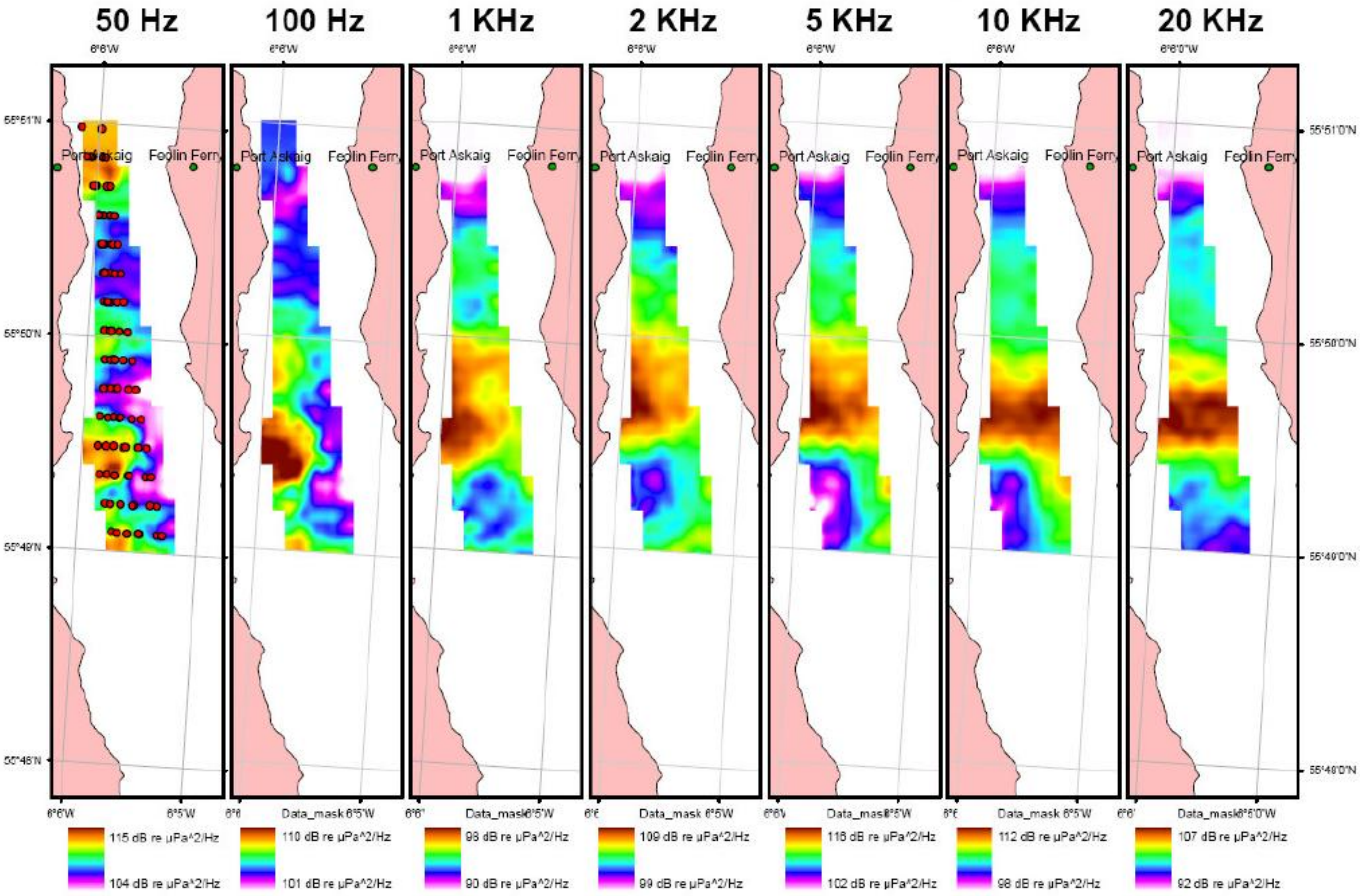

Figure 6. Flood Fast – Individually scaled per frequency

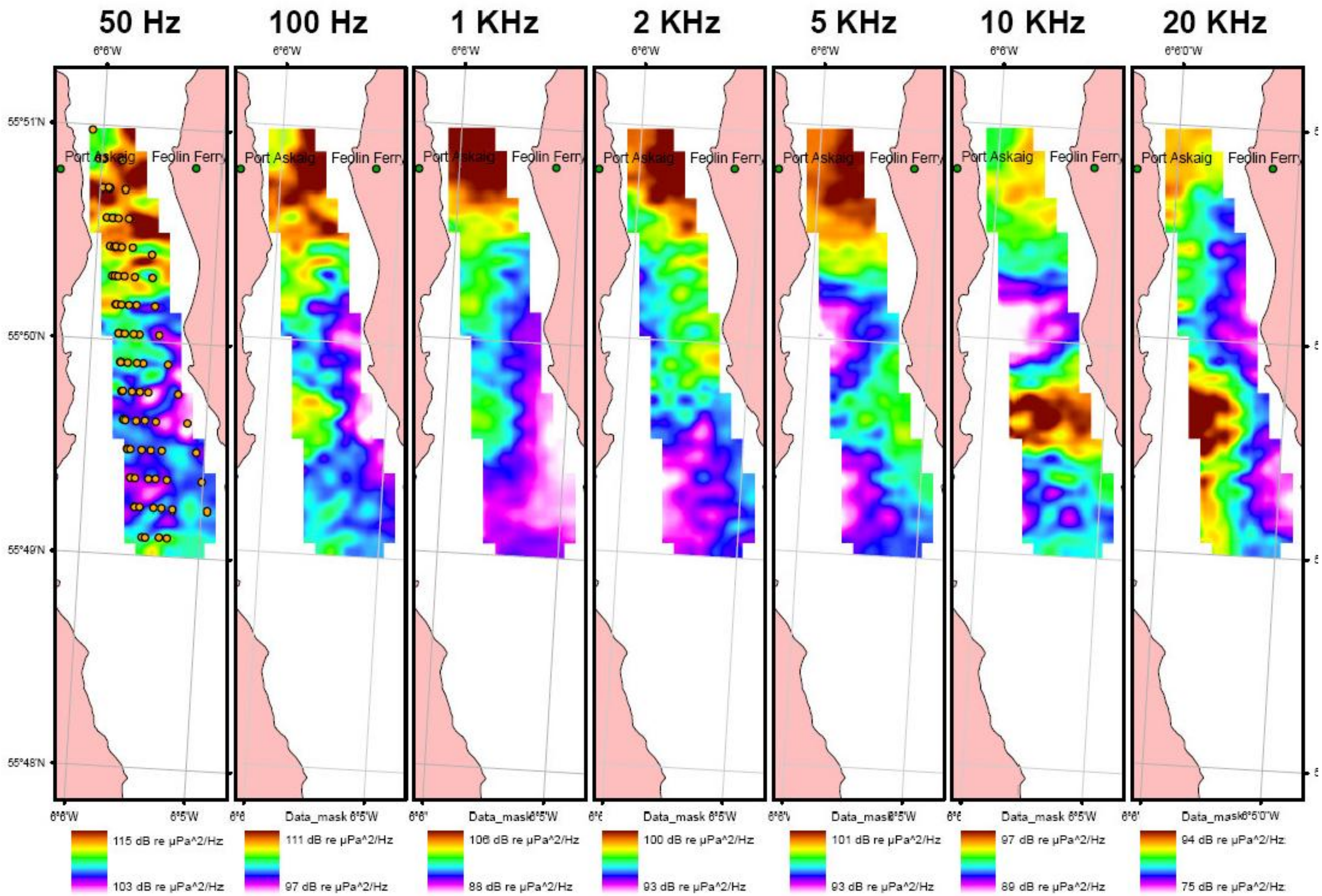

Figure 7. Flood Slow – Individually scaled per frequency

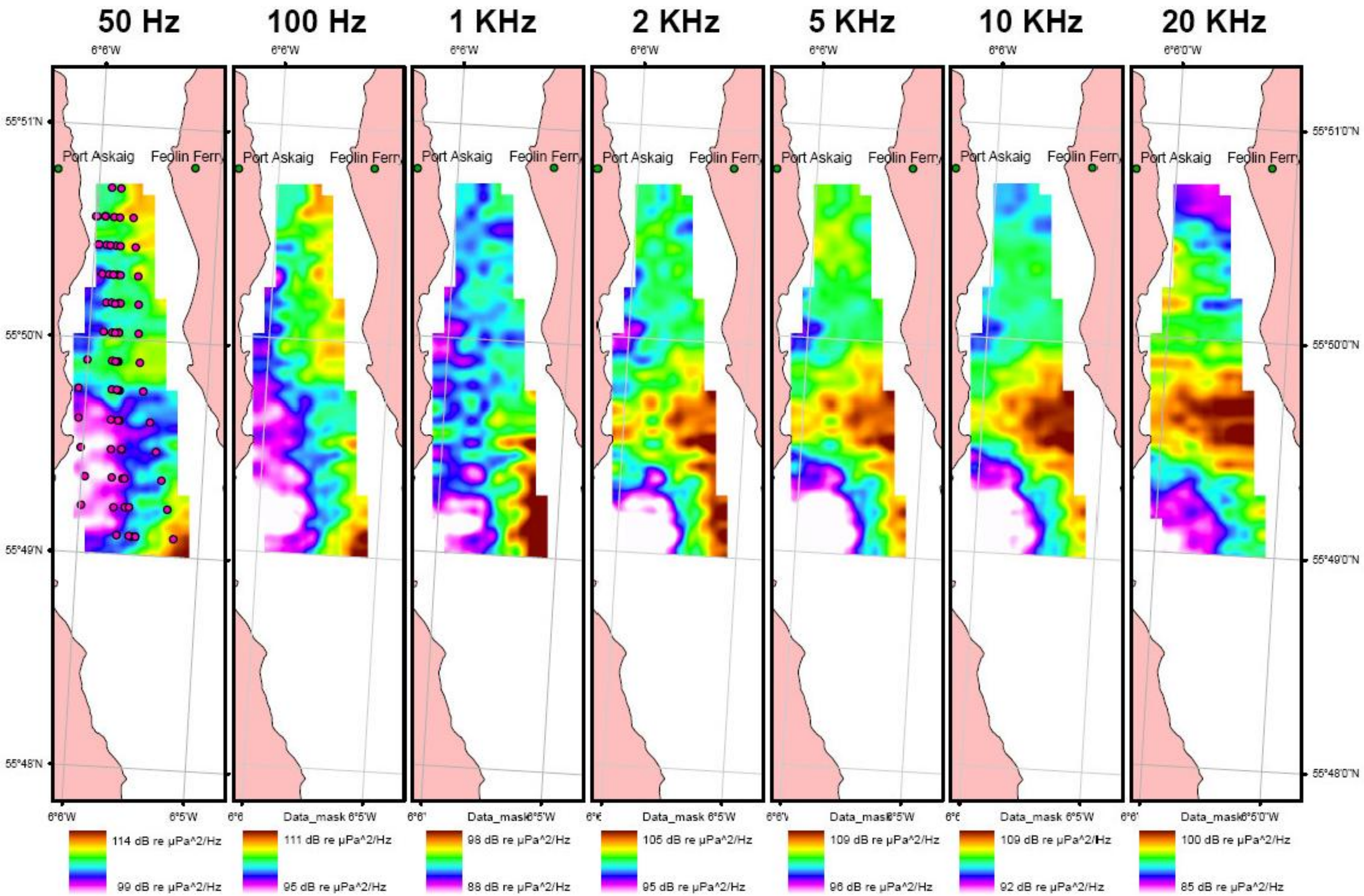

Figure 8. Ebb Fast – Individually scaled per frequency

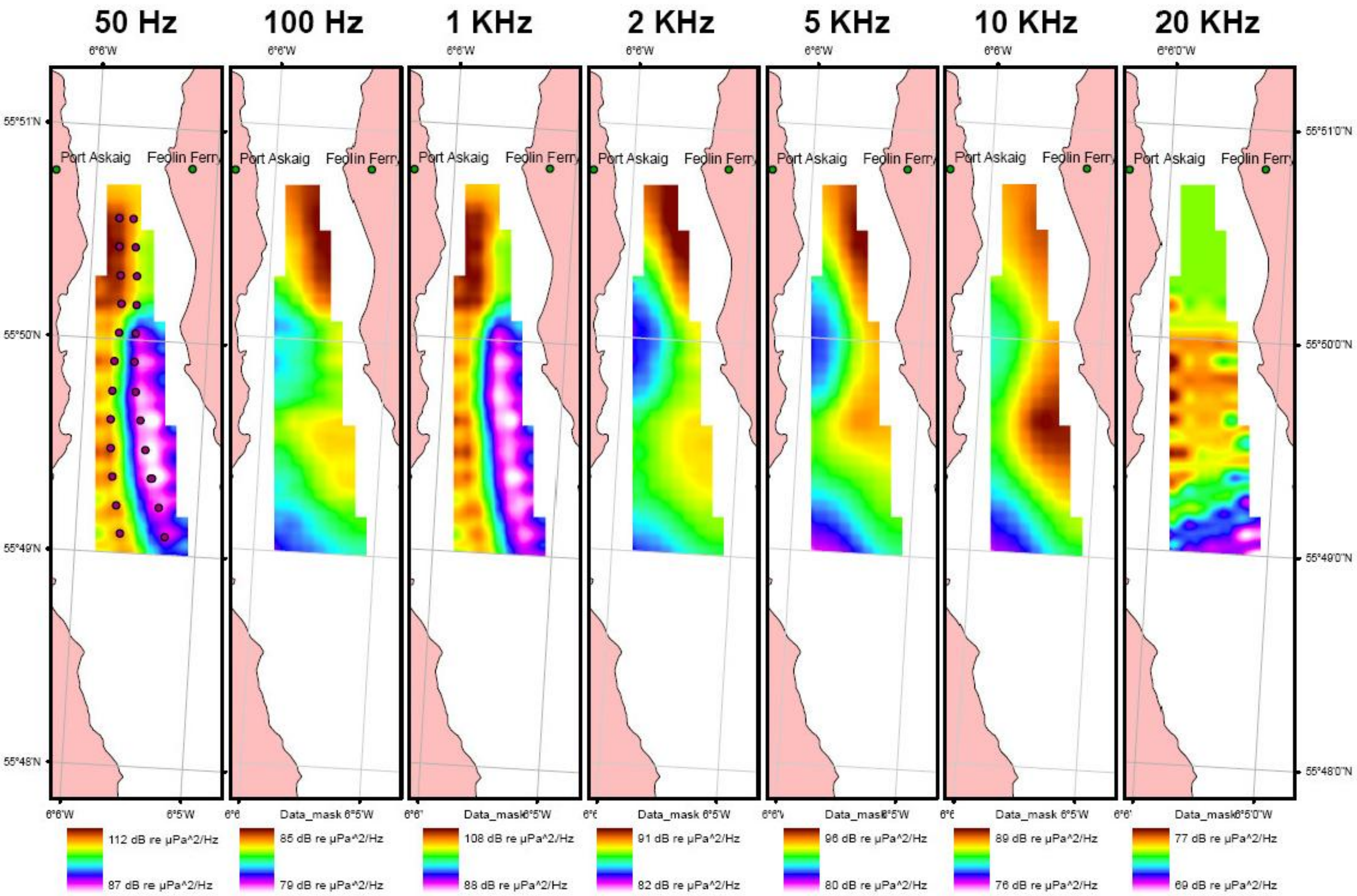

Figure 9. Ebb Slow – Individually scaled per frequency

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.

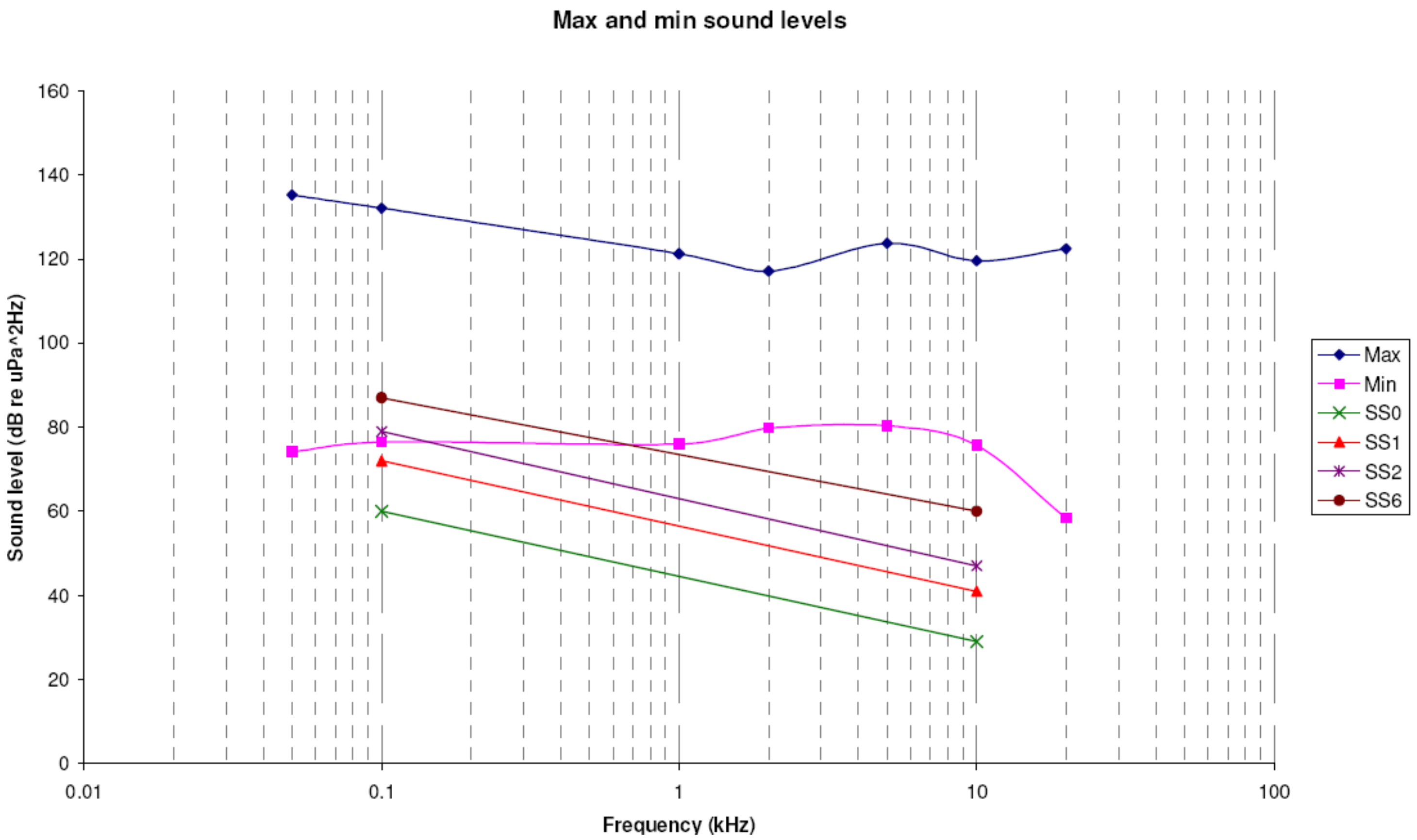

Figure 10. A comparison of sound levels from the open ocean (~200m depth) at Beaufort sea states ranging from 0 to 6 (straight lines) plotted against the minimum and maximum values observed in this study (curved lines). Oceanic values drawn from Richardson *et al*'s adaptation of the Knudsen curves.

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.

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Sound of Islay Demonstration Tidal Array

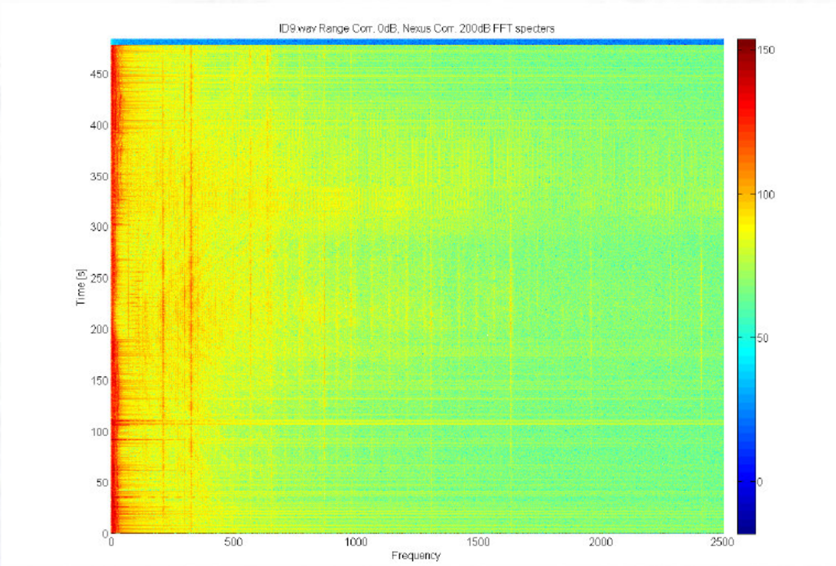
Environmental Statement: Chapter 9 – Marine Mammals

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

Akvaplan-niva

Rapport Report

Tidal turbine in Kvalsund, western Finnmark - underwater sound measurements



Akvaplan-niva AS Report: 4302 - 04

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

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.

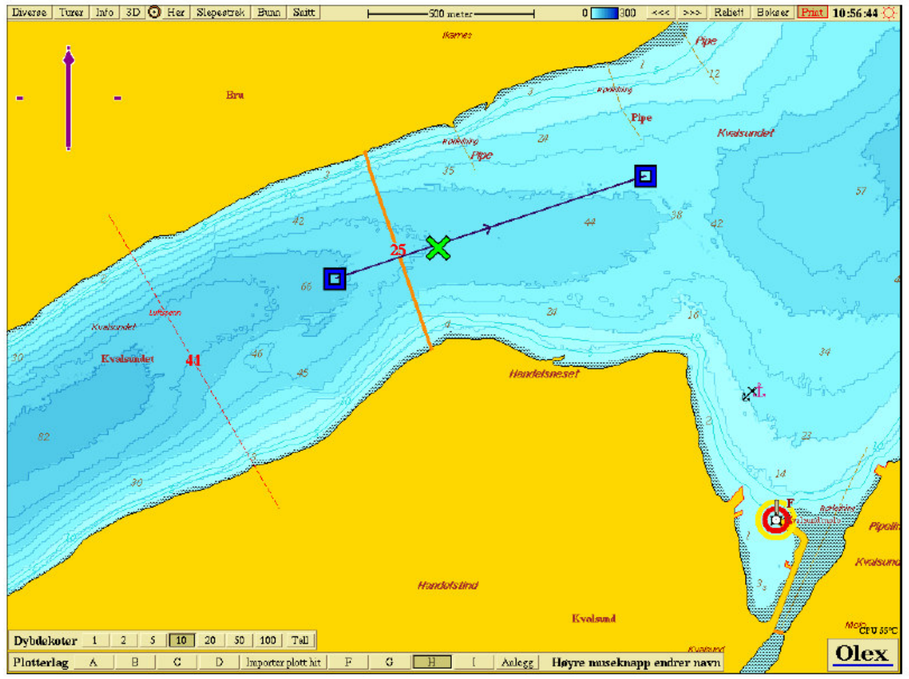

Figure 1 Map of the area of study, the location of the tidal turbine (green) and an approximate trajectory followed when drifting over the tidal turbine (blue line between squares, ID9). The map is drawn with the Olex software (www.olex.no).

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).

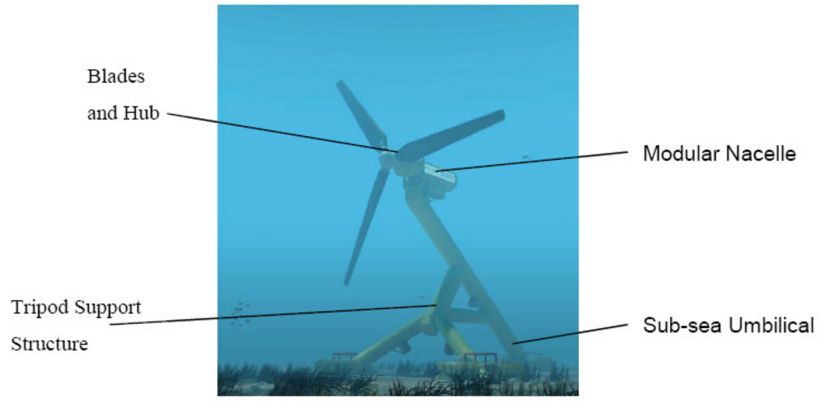

Figure 2 Illustration of the tidal turbine (Hammerfest Strøm).

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.

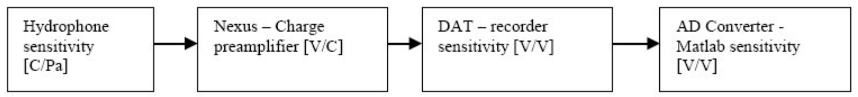

Figure 3 Elements in the measurement chain.

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

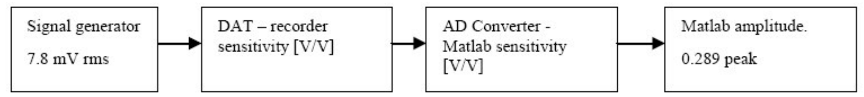

Figure 4 Calibration of DAT recorder and AD converter

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.

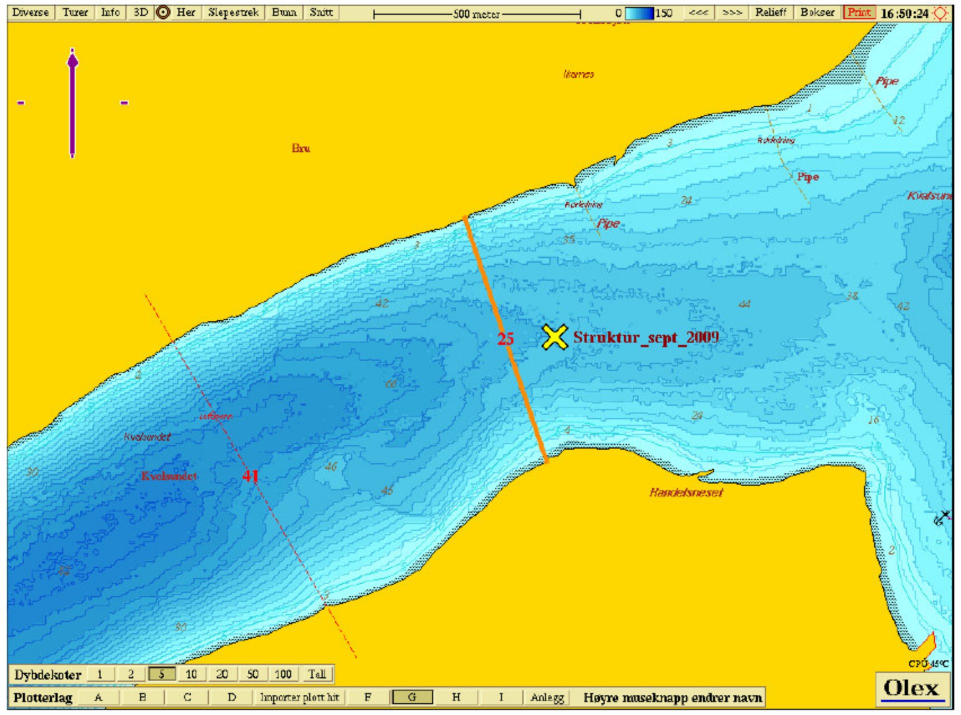

Figure 6 The bottom topography (equidistance 5 m) near the tidal turbine (marked with yellow cross) in Kvalsund. The map is drawn with the Olex software (www.olex.no).

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.

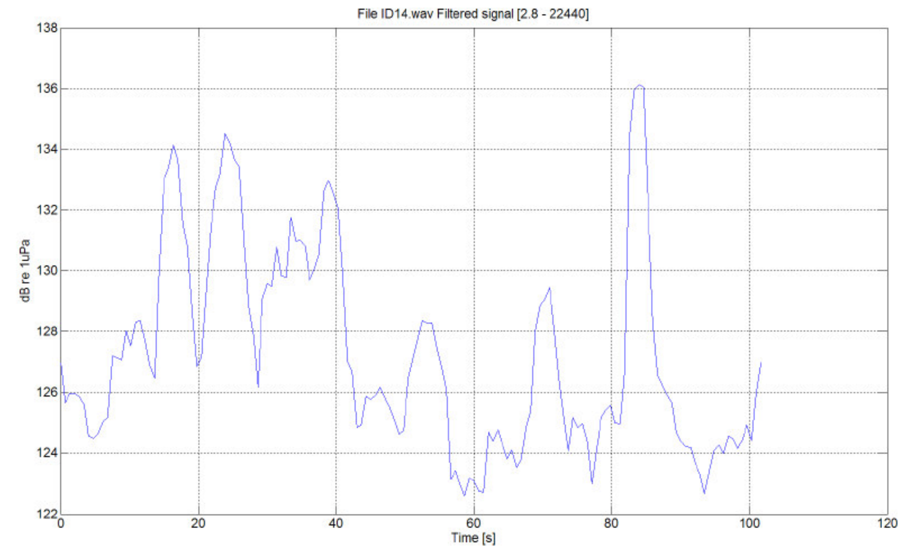

Figure 8 *ID 14 ambient noise in the frequency range from 2.8 Hz to 22440 Hz*

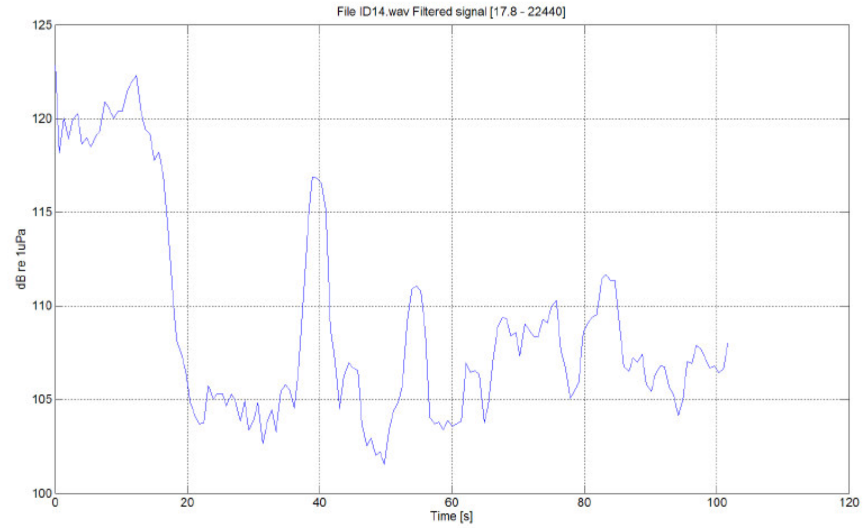

Figure 9 *ID 14 ambient noise in the frequency range from 17.8 Hz to 22440 Hz*

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.

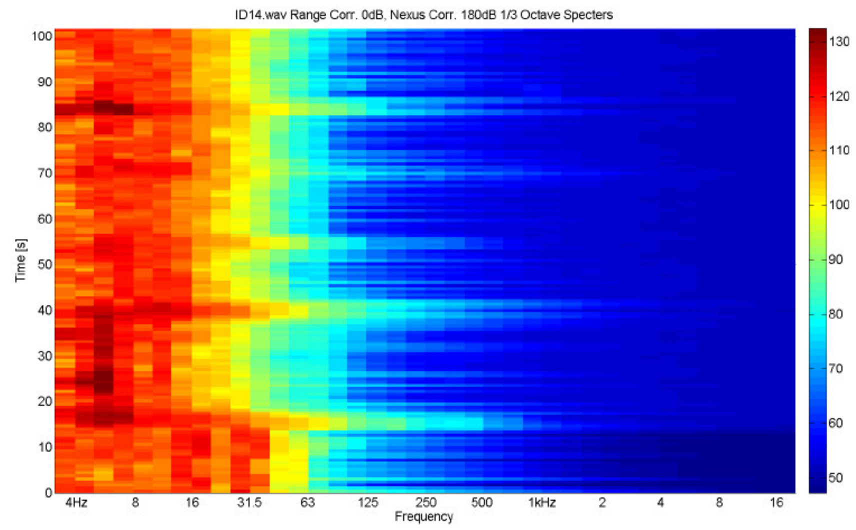

Figure 10 ID 14 – Ambient noise 1/3-octave levels versus time. The colors denote the sound intensity, dB re 1 μPa.

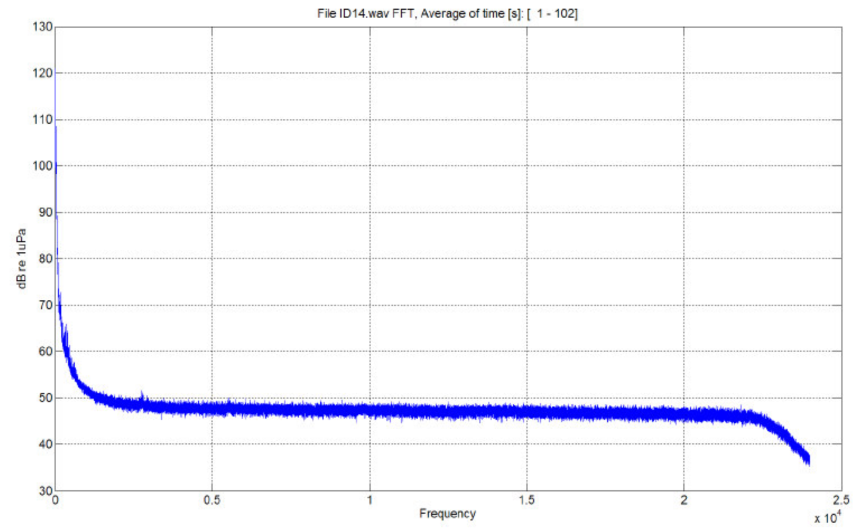

Figure 11 ID14 – Ambient noise, FFT analysis for frequencies up to 24 kHz.

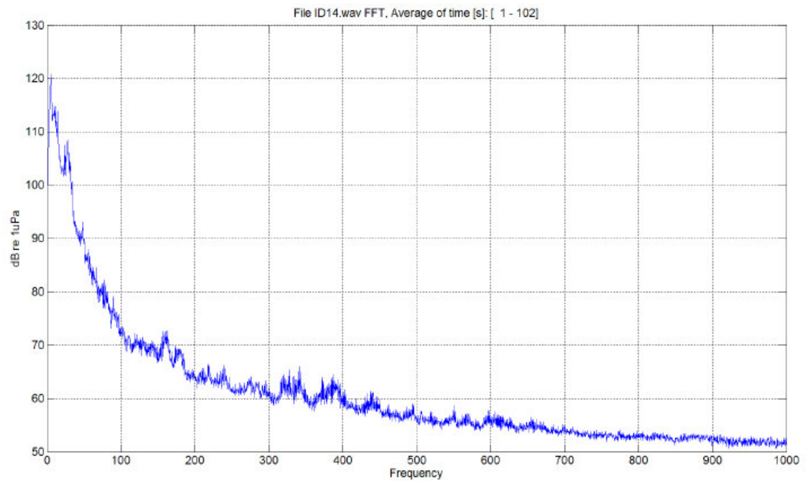

Figure 12 ID14 - Ambient noise, FFT analysis for frequencies up to 1000 Hz

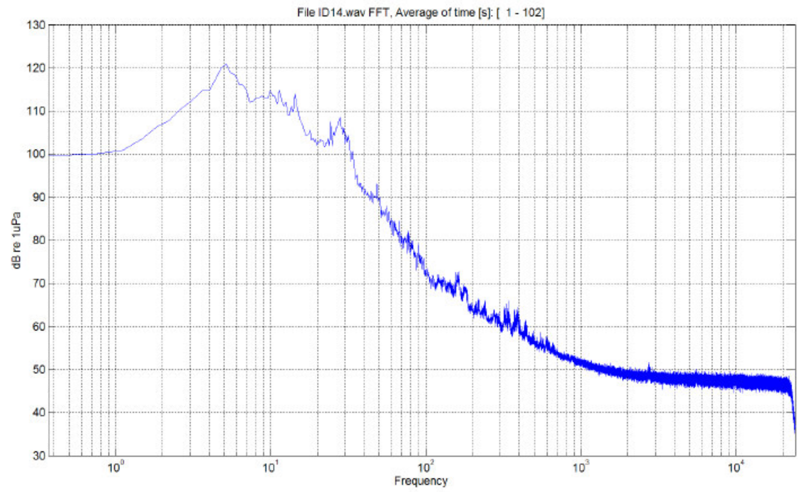

Figure 13 ID14 - Ambient noise, FFT analysis of frequencies up to 24000 Hz – log frequency scale.

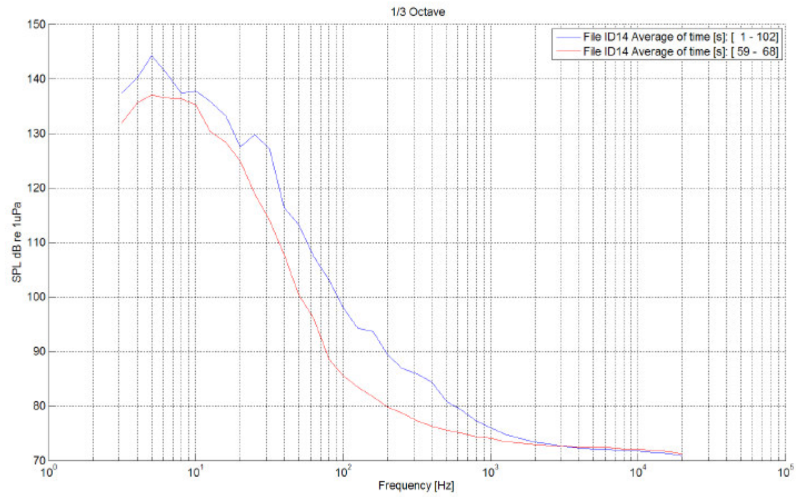

Figure 14 Ambient noise, 1/3-octave spectra - average of the complete recording compared to a "silent" period.

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.

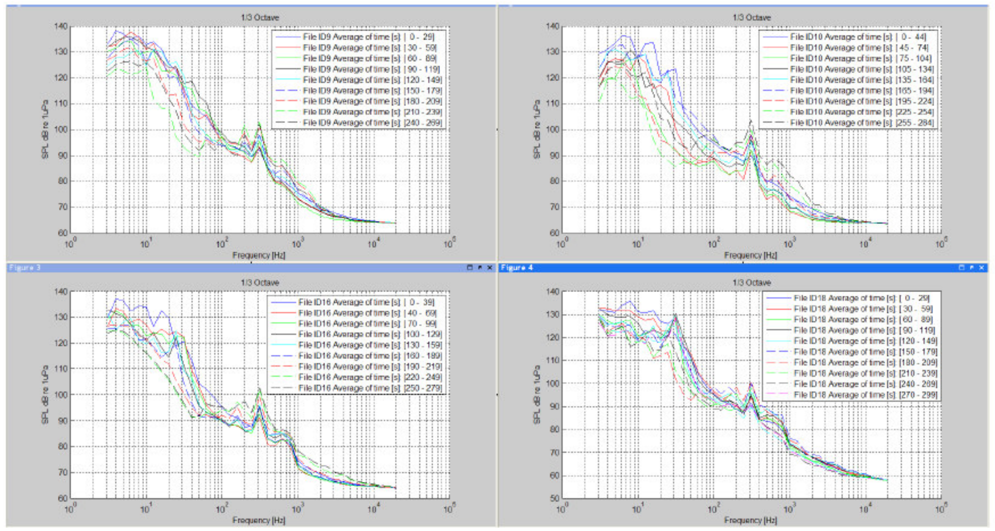

Figure 15a-d 1/3 Octave, spectral levels. Analysis of all 4 drifting runs. Average of selected 30s intervals.

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.

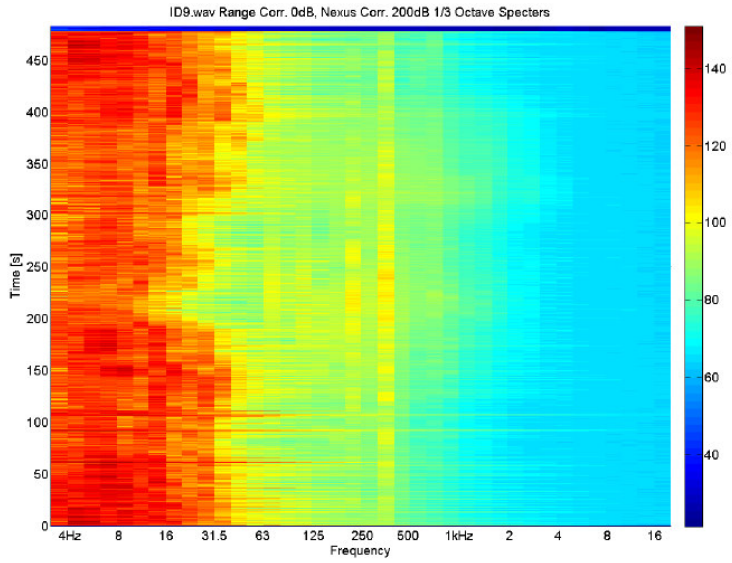

Figure 16 ID 9 – 1/3-octave spectra as function of time. The colors denote the sound intensity, dB re 1 µPa

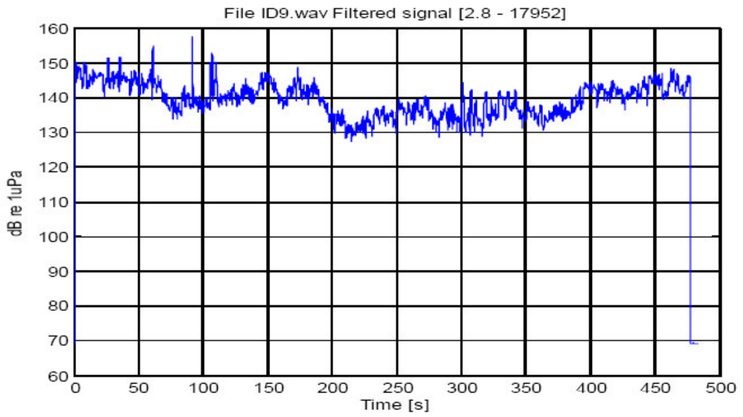

Figure 17 ID 9 – SPL as a function of time, integrated over all 1/3-octave filters.

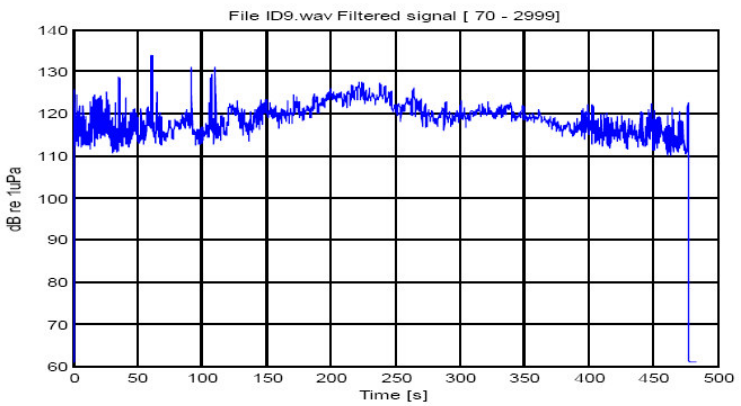

Figure 18 ID 9 – SPL as function of time, integration over frequency [70 Hz – 3 kHz].

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.

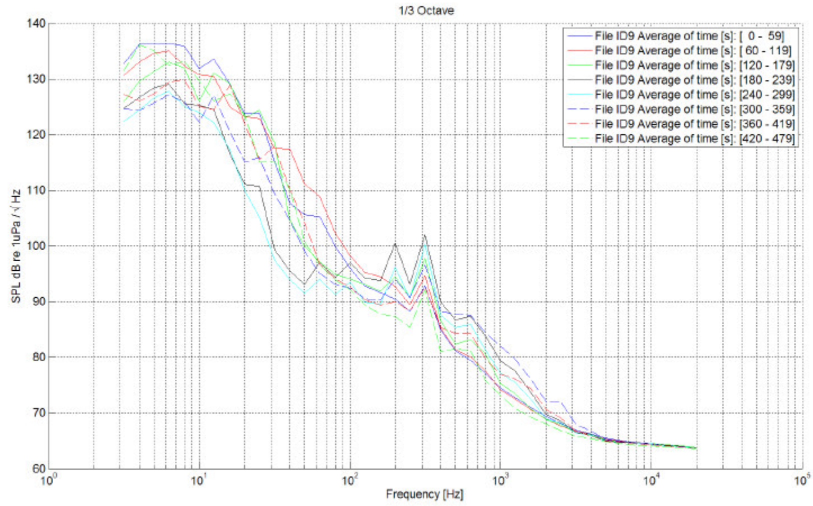

Figure 19: ID9 (Drift 1) - 1/3-octave spectra, averaged over 60 seconds for 8 different time intervals.

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.

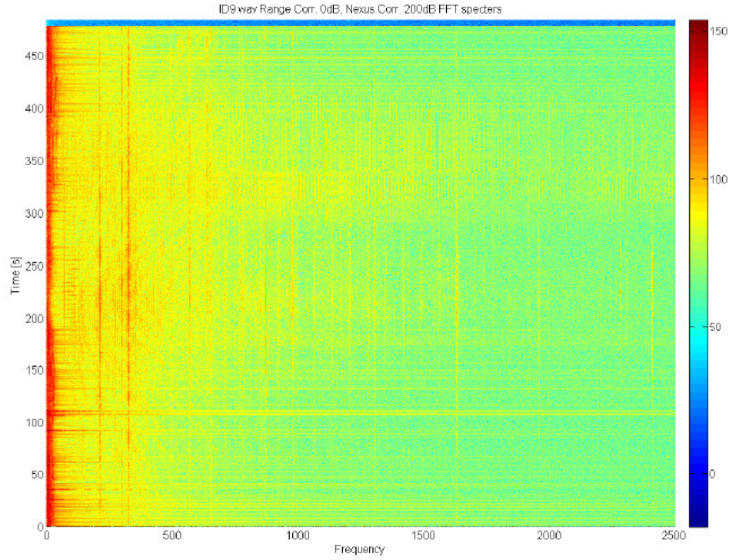

Figure 20 ID 9 – FFT spectra [0 -2500Hz] versus time, frequency resolution 1.46Hz. The colors denote the sound intensity, dB re 1 µPa

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.

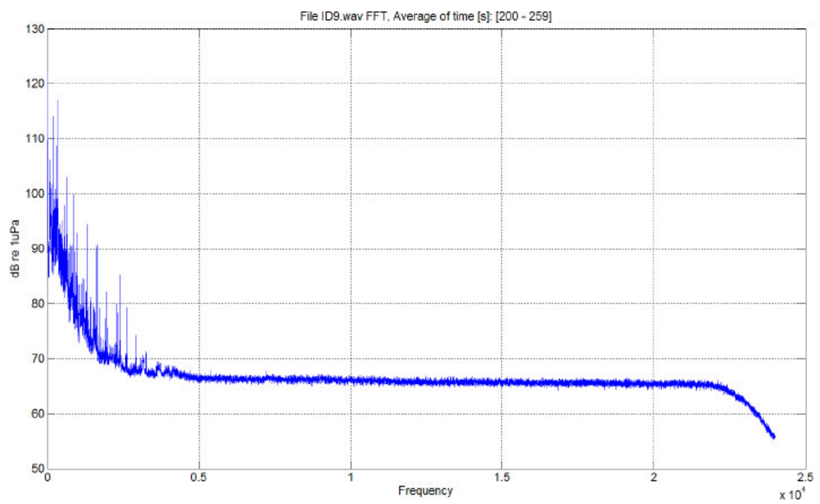

Figure 21 ID 9 – Time averaged narrow band spectrum (0 to 25 kHz)

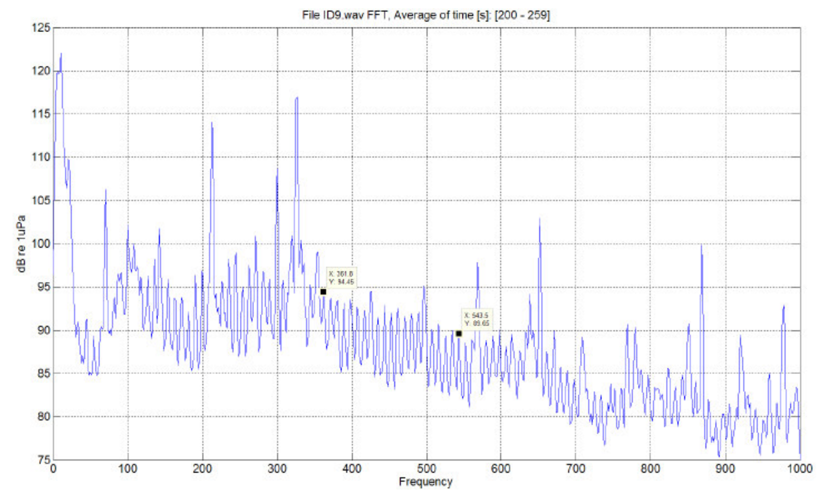

Figure 22 ID 9 – Time averaged narrow band spectrum (0 to 1000 Hz).

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).

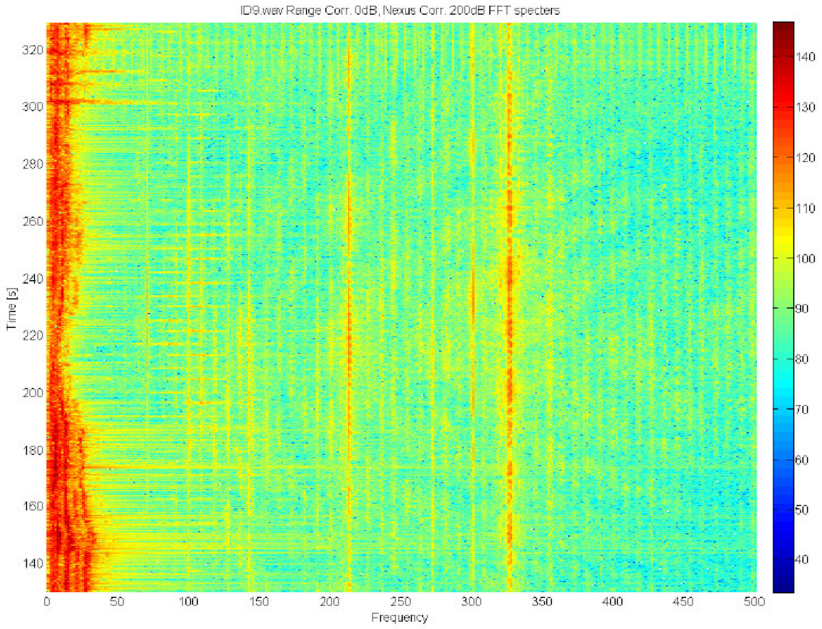

Figure 23 ID 9 - FFT spectra [0 -500 Hz] versus time, frequency resolution 1.46Hz. The colors denote the sound intensity, dB re 1 µPa.

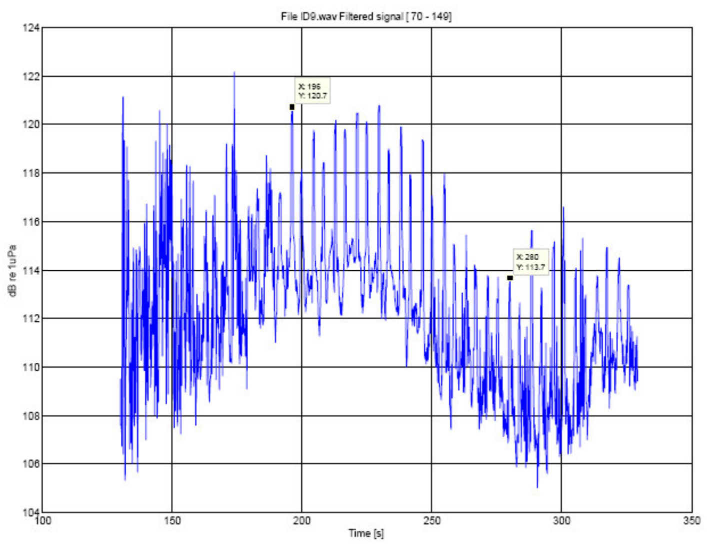

Figure 24 ID 9 – SPL as function of time, integrated over the frequency band 70 Hz – 3 kHz.

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.

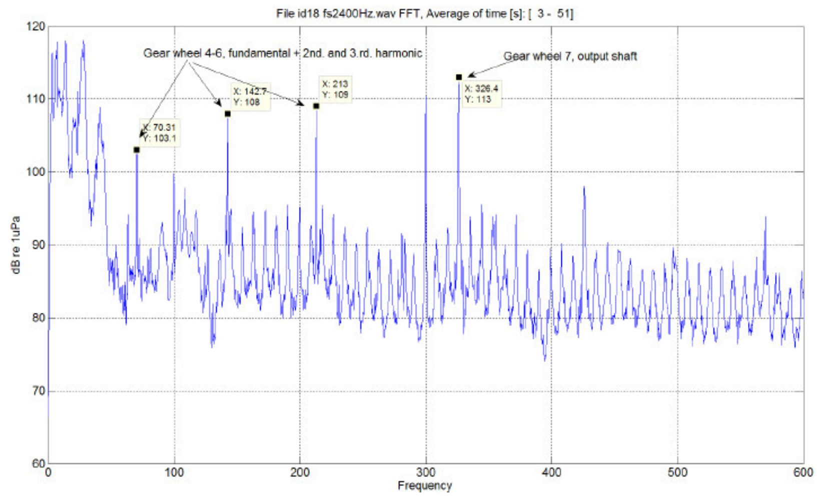

Figure 25 Turbine gear lines

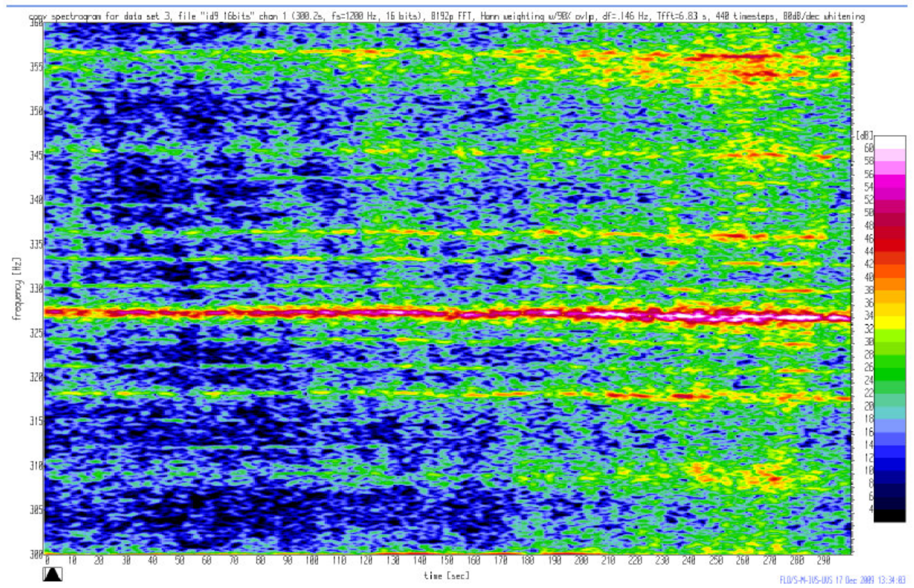

Figure 26 ID9 Frequency versus time. Frequency lines.

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.

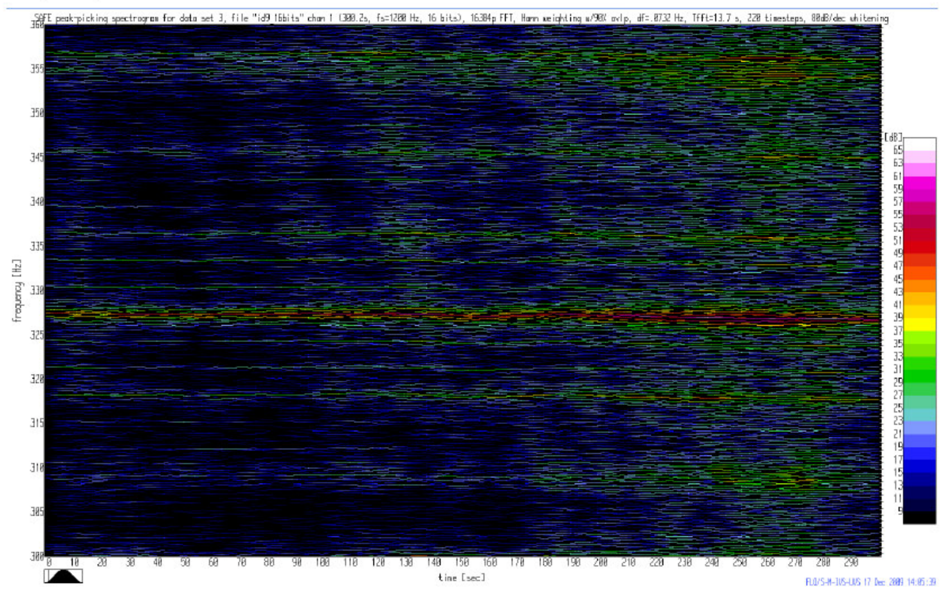

Figure 27 Frequency versus time, FFT phase corrected.

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.

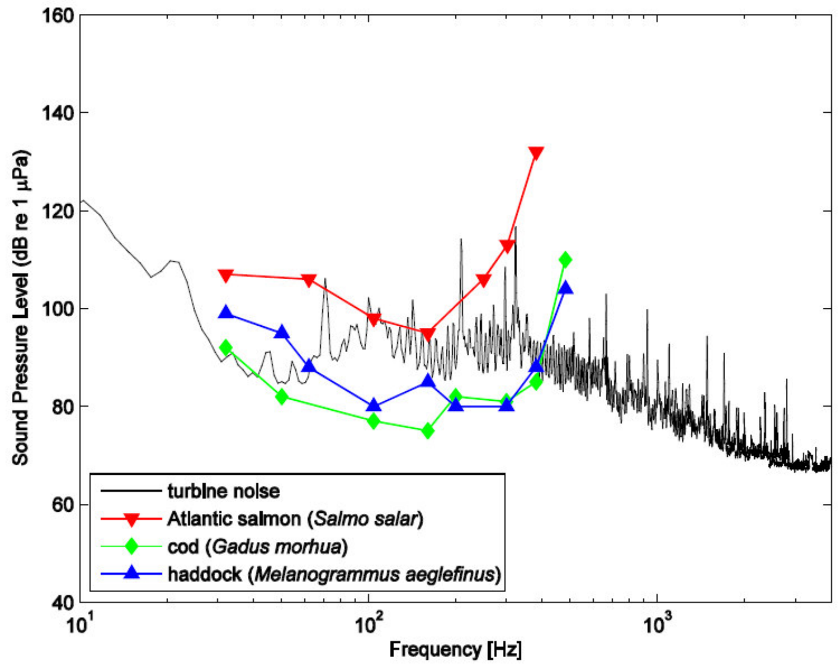

Figure 28 Hearing thresholds for a select group of fish species to illustrate fish hearing capabilities plotted together with the noise of the tidal turbine. These specific hearing thresholds are redrawn from Popper and Hastings (2009). The turbine noise is a time average corresponding to that of Figure 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.

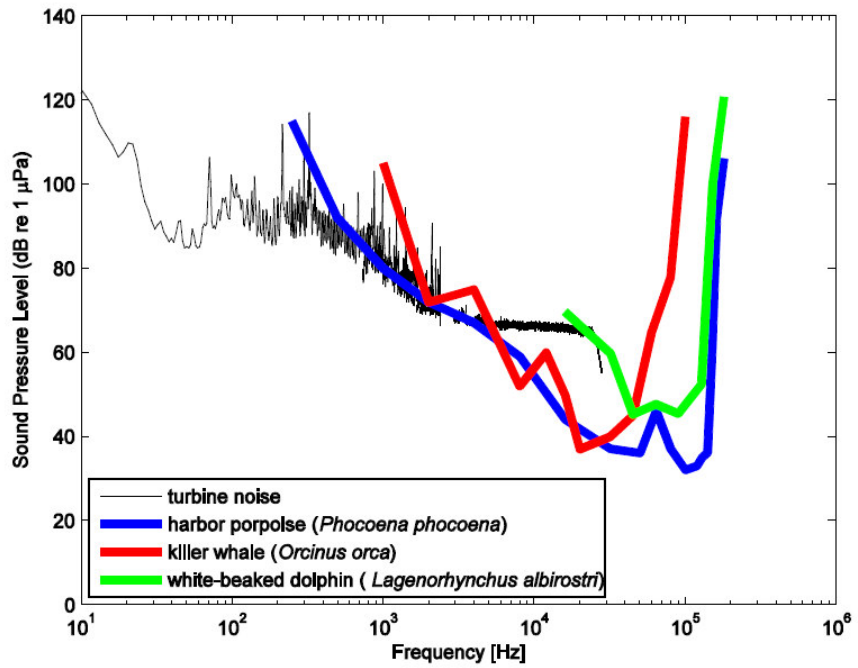

Figure 29 Audiograms for harbor porpoise (blue) (Kastelein et al., 2002), killer whale (red) (Szymanski et al., 1999) and white-beaked dolphin (green) (Nachtigall et al., 2008), displayed together with the noise of the tidal turbine. The noise is a time average corresponding to that of Figure 21, (but 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.

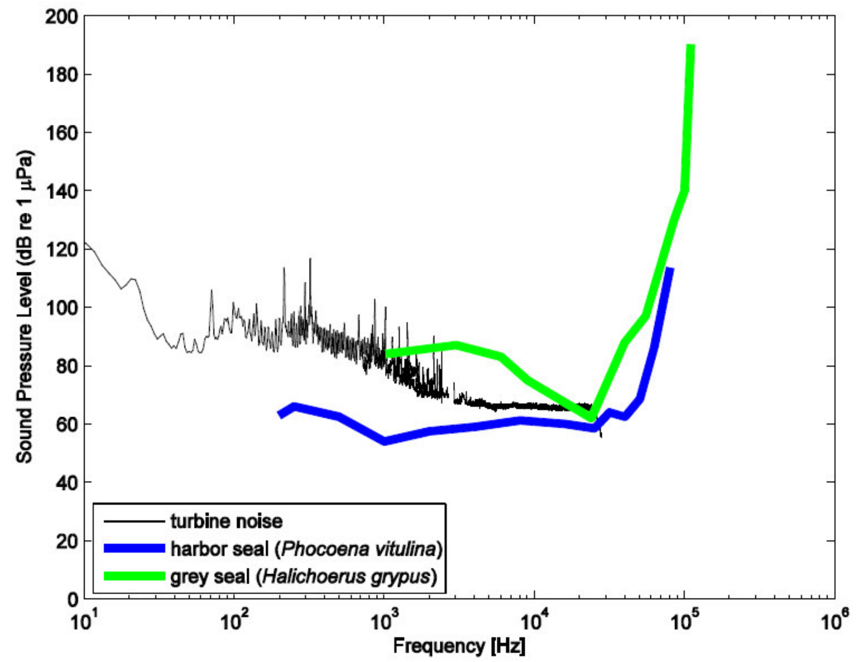

Figure 30 Audiograms for harbor seal (blue) (Kastelein et al., 2009) and grey seal (green) (Ridgeway and Joyce, 1975; redrawn from Nedwell and Brooker, 2008). displayed together with the noise of the tidal turbine. The noise is a time average corresponding to that of Figure 21, (but here with logarithmic 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.

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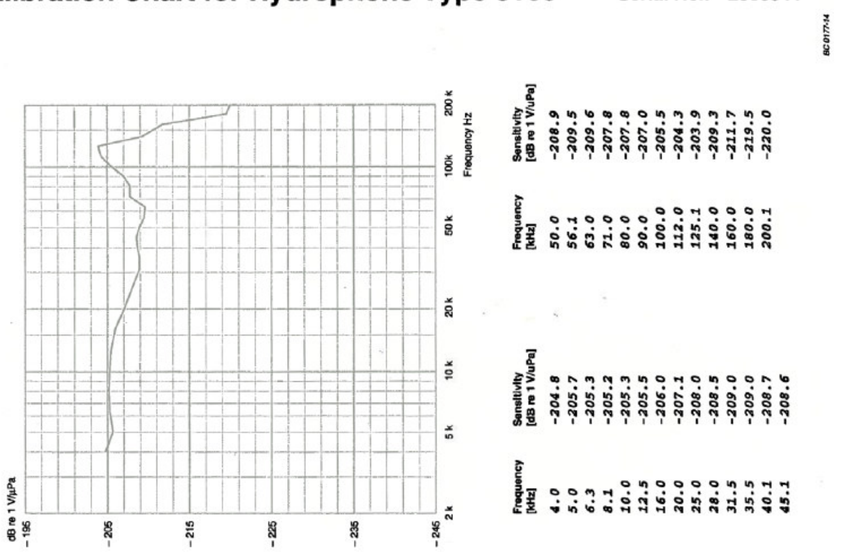
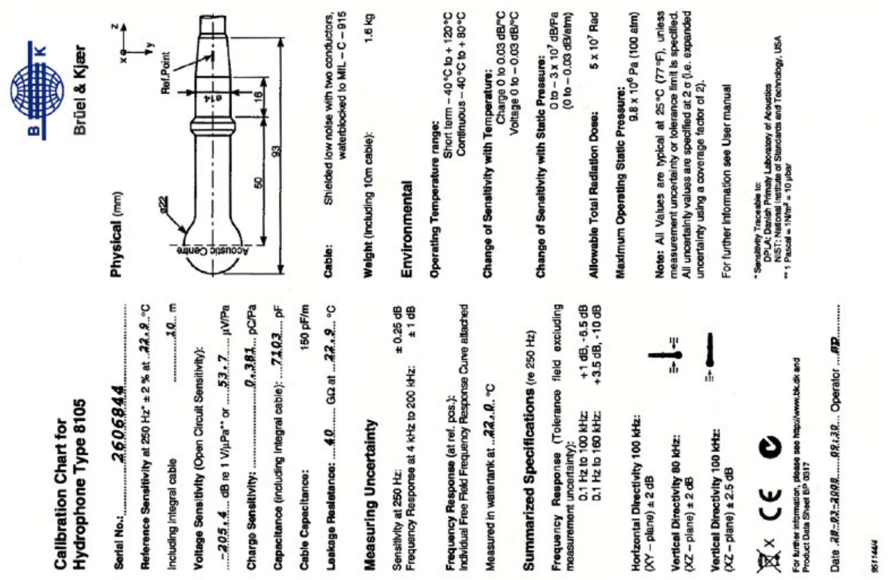
Appendix

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.

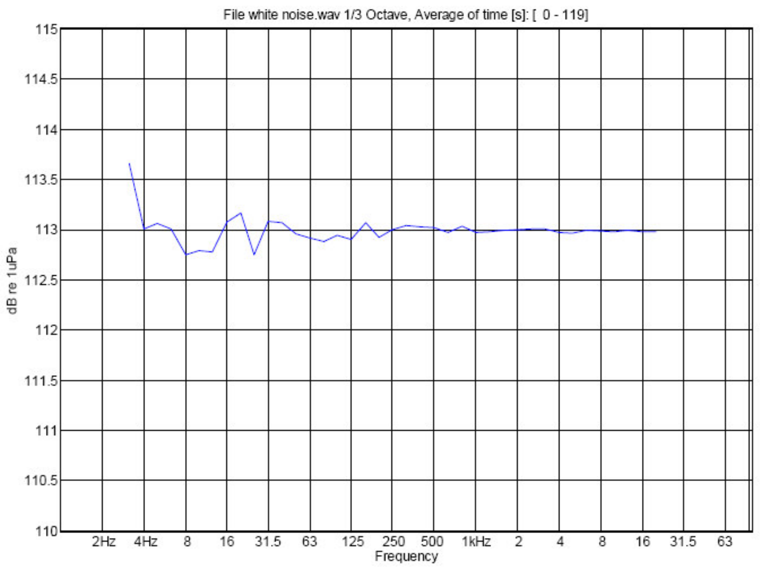


Figure 31: 1/3-octave test, Gaussian white noise

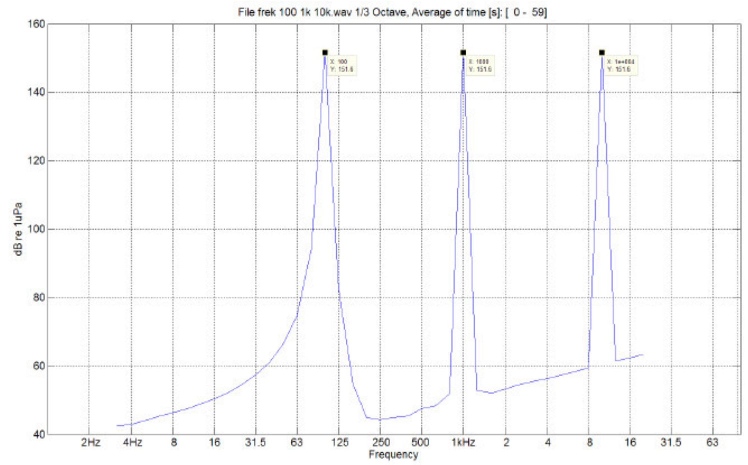


Figure 32: 1/3-octave analysis of a 100 Hz+1 kHz+10 kHz test signal

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.

$SPL = Signal\ level - TF - Nexus\ gain$

$SPL = 20 \bullet log\mathbf{10(0.1)} - 28.37 - (-200) = 151.\mathbf{6}dB$

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.

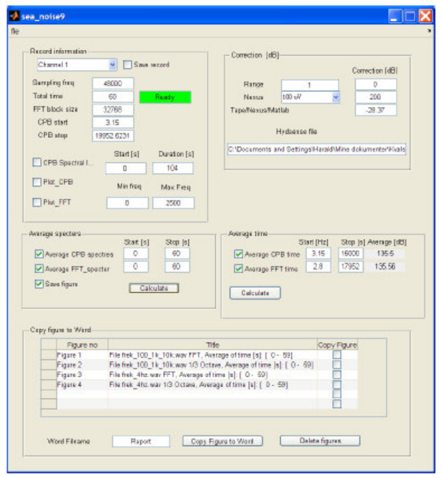


Figure 33: Sea_Noise9 GUI

Sound of Islay Demonstration Tidal Array

Environmental Statement: Chapter 12 – Anadromous Fish

<u>Appendix 12.1: “Salmonid Habitat Survey”</u>

Sound of Islay Demonstration Tidal Array

Salmonid Habitat Survey

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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

ScottishPower Renewables

Technical Report
9T3474

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.

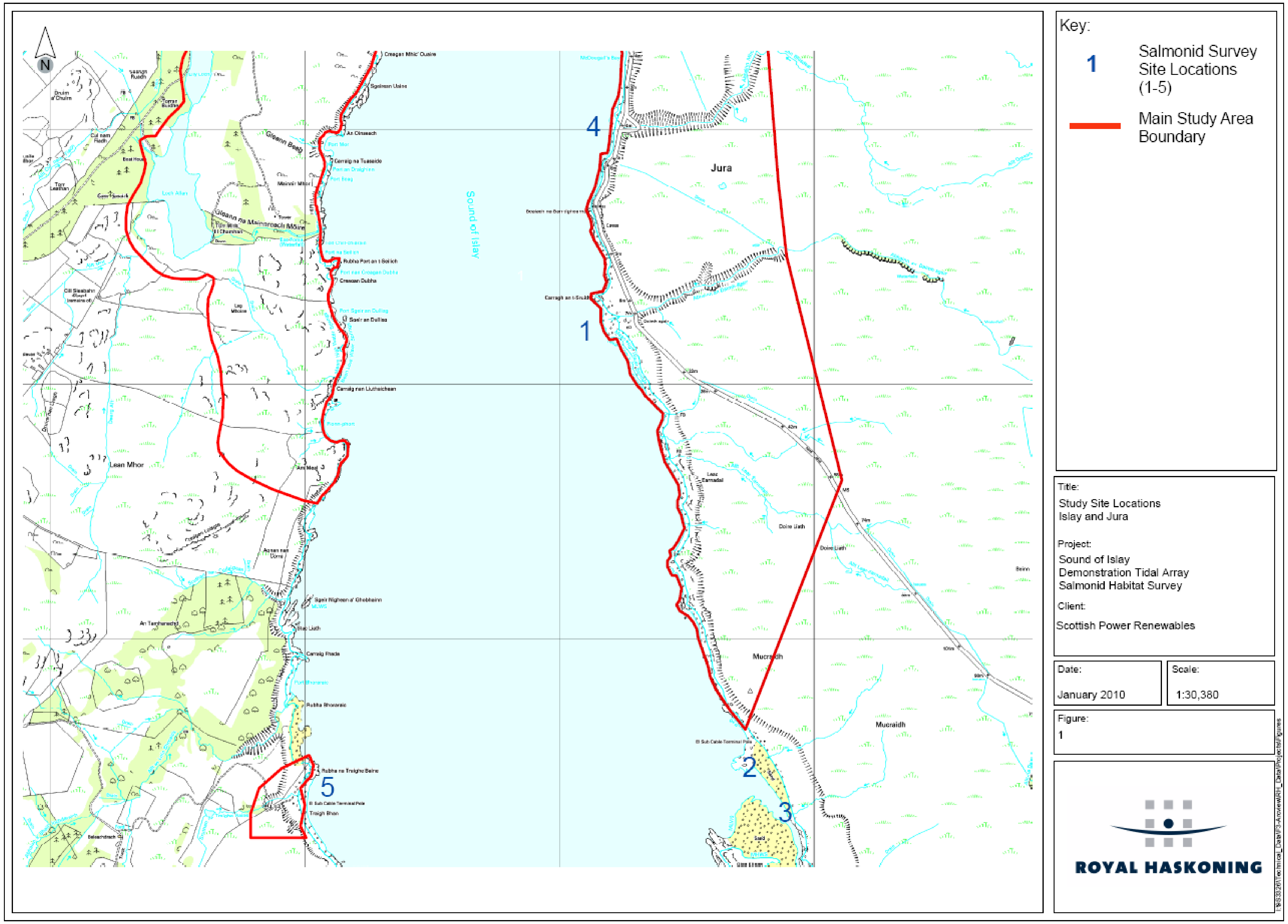
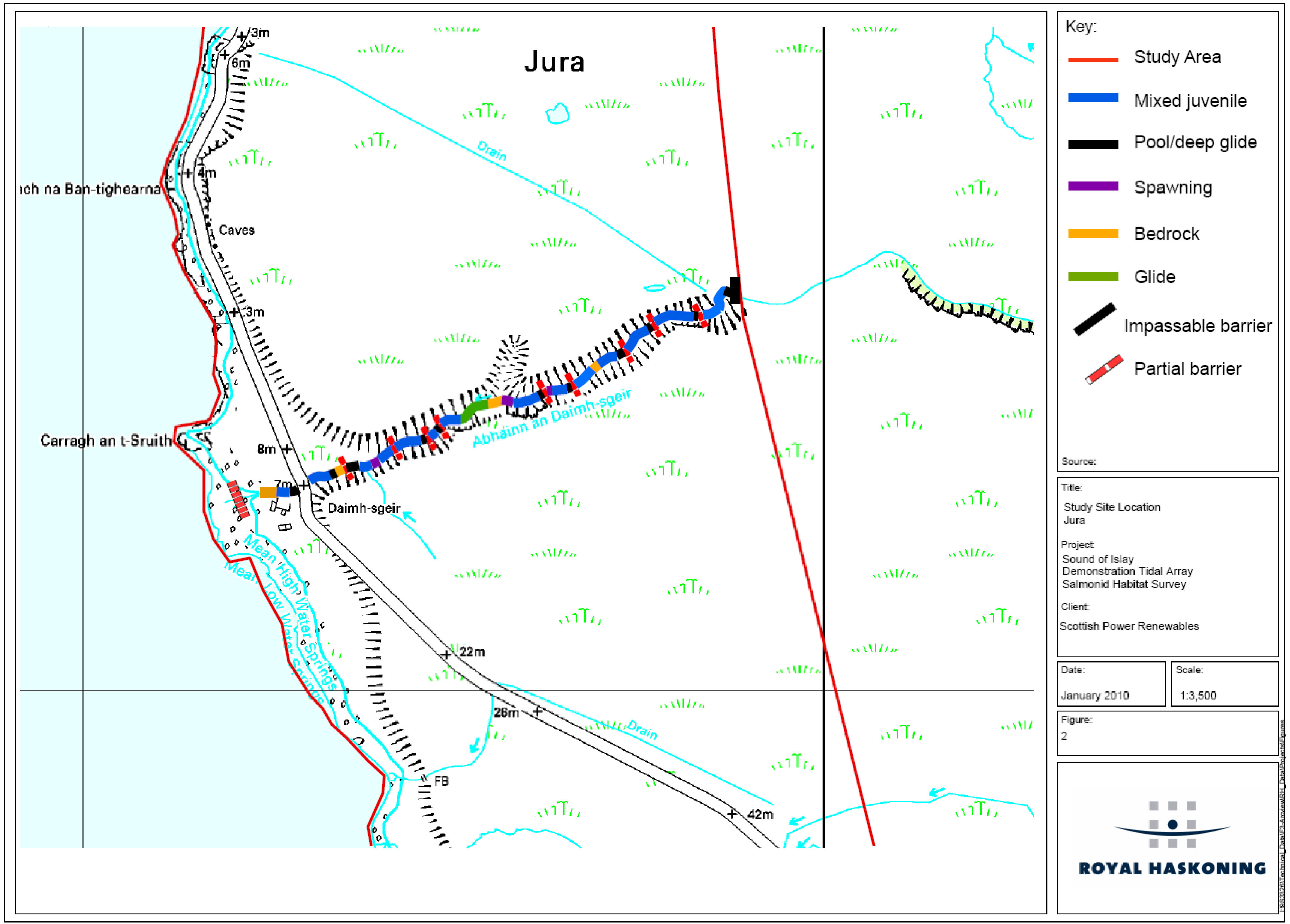
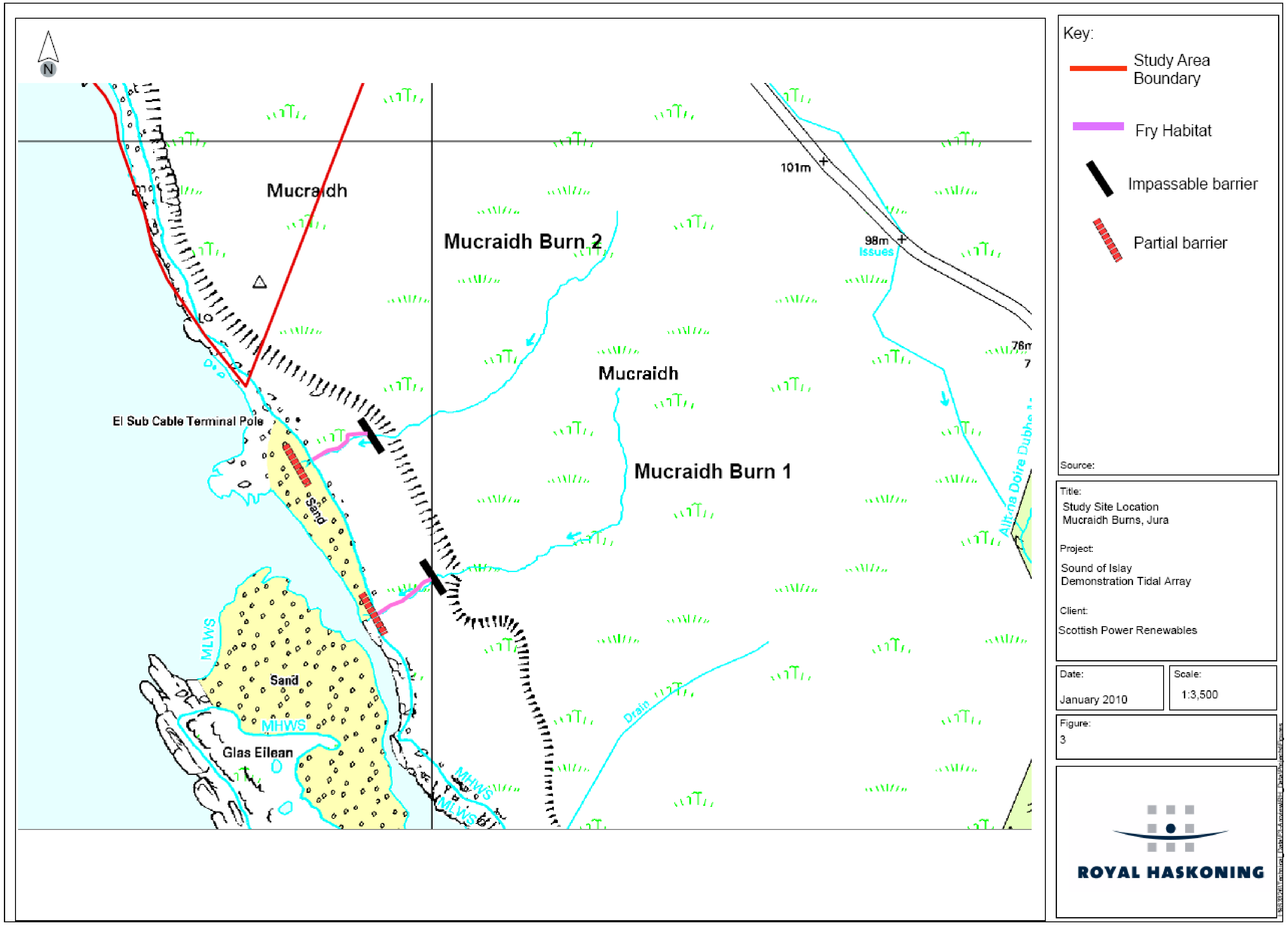


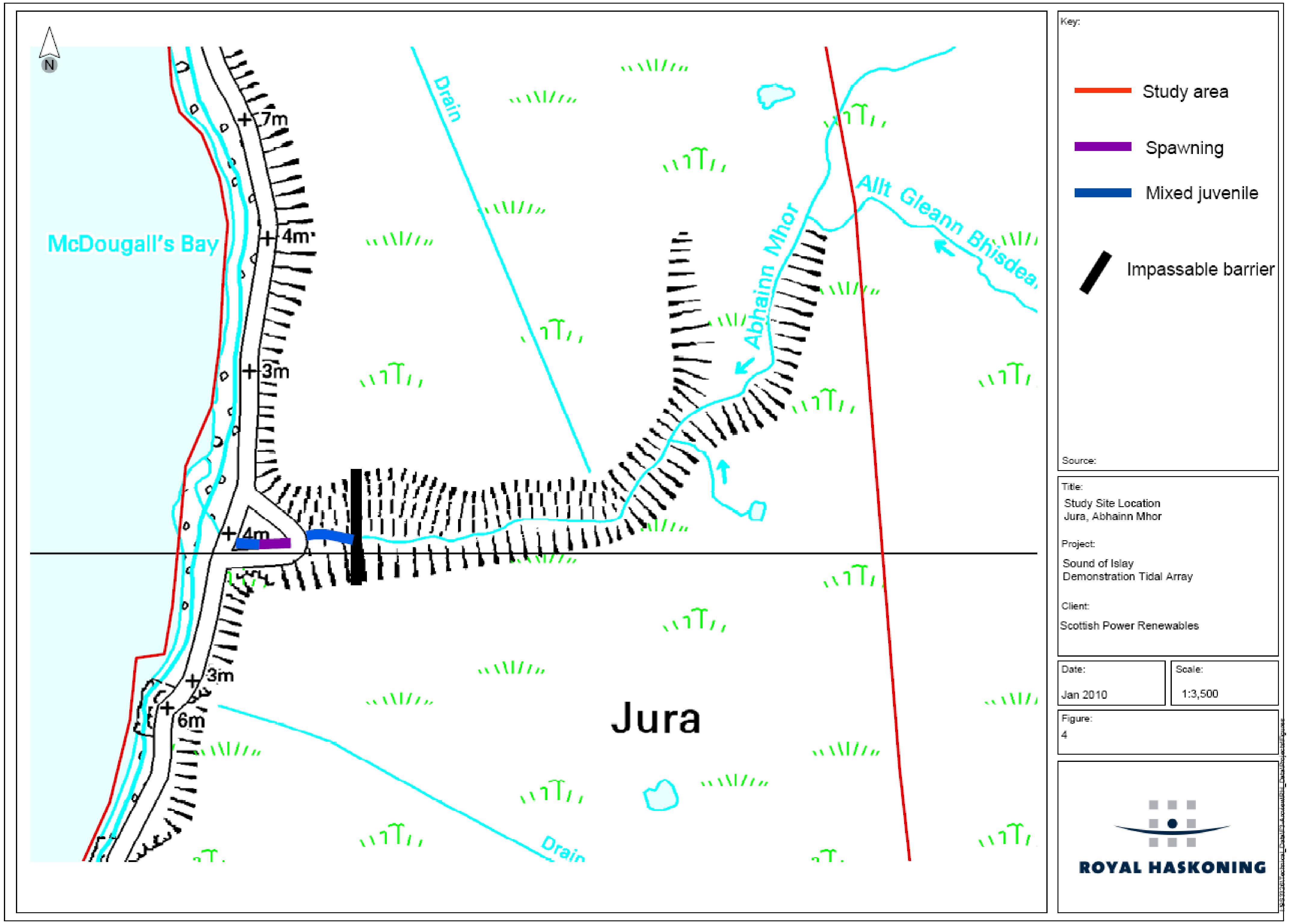
Figure 1 Locations of survey sites



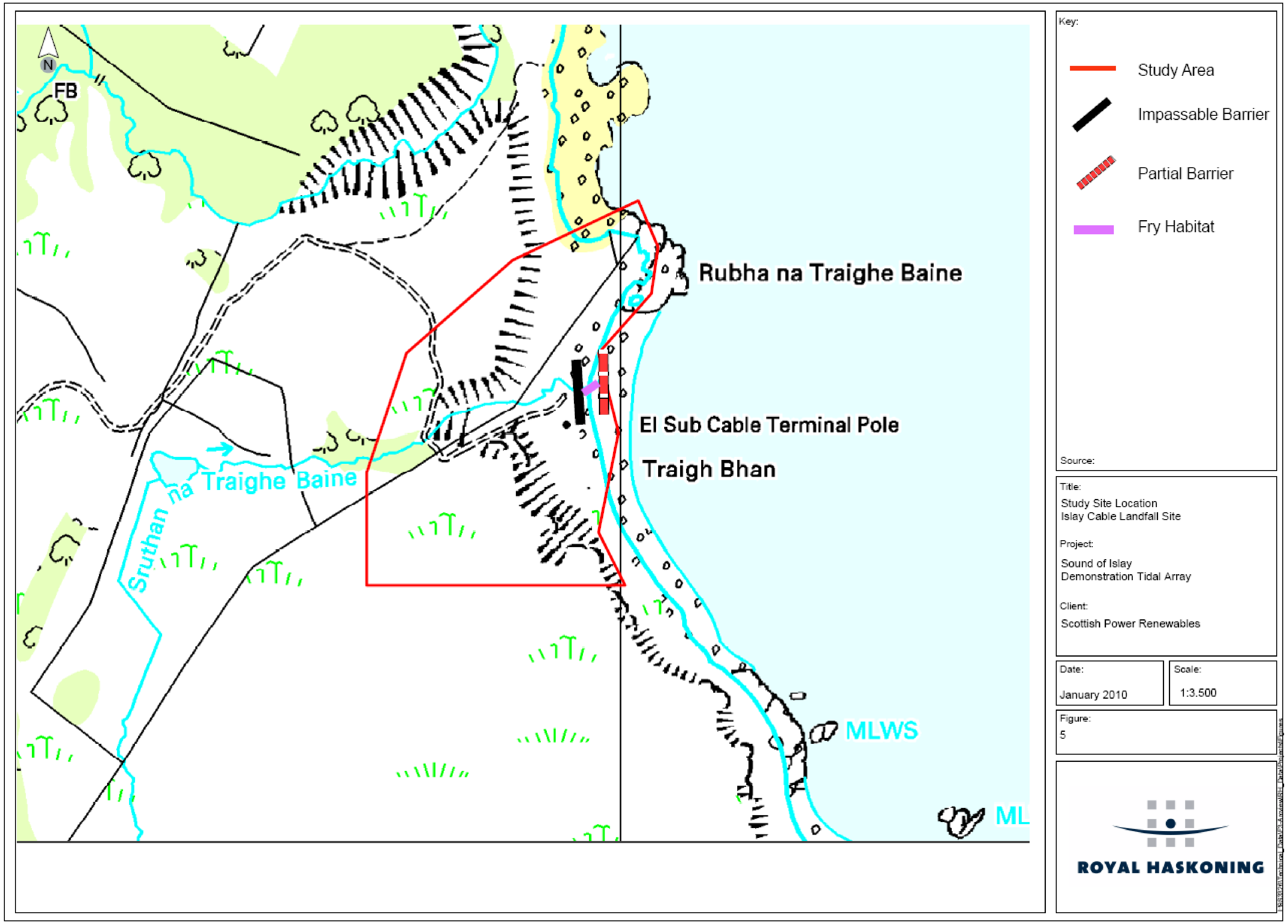
Figures 2 Distribution of habitat types within target watercourses



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 l. 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.

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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

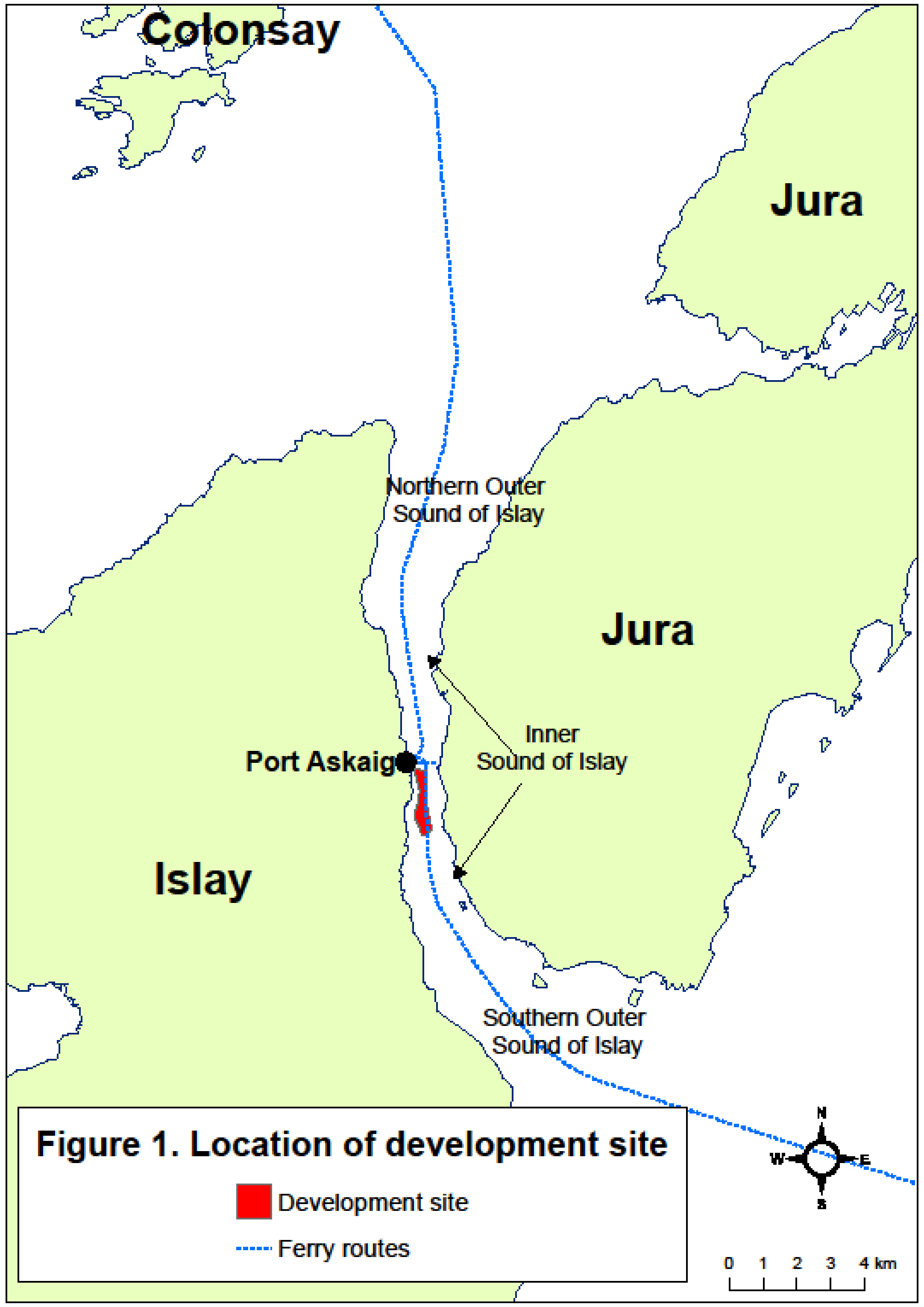


Figure 1. Location of development site

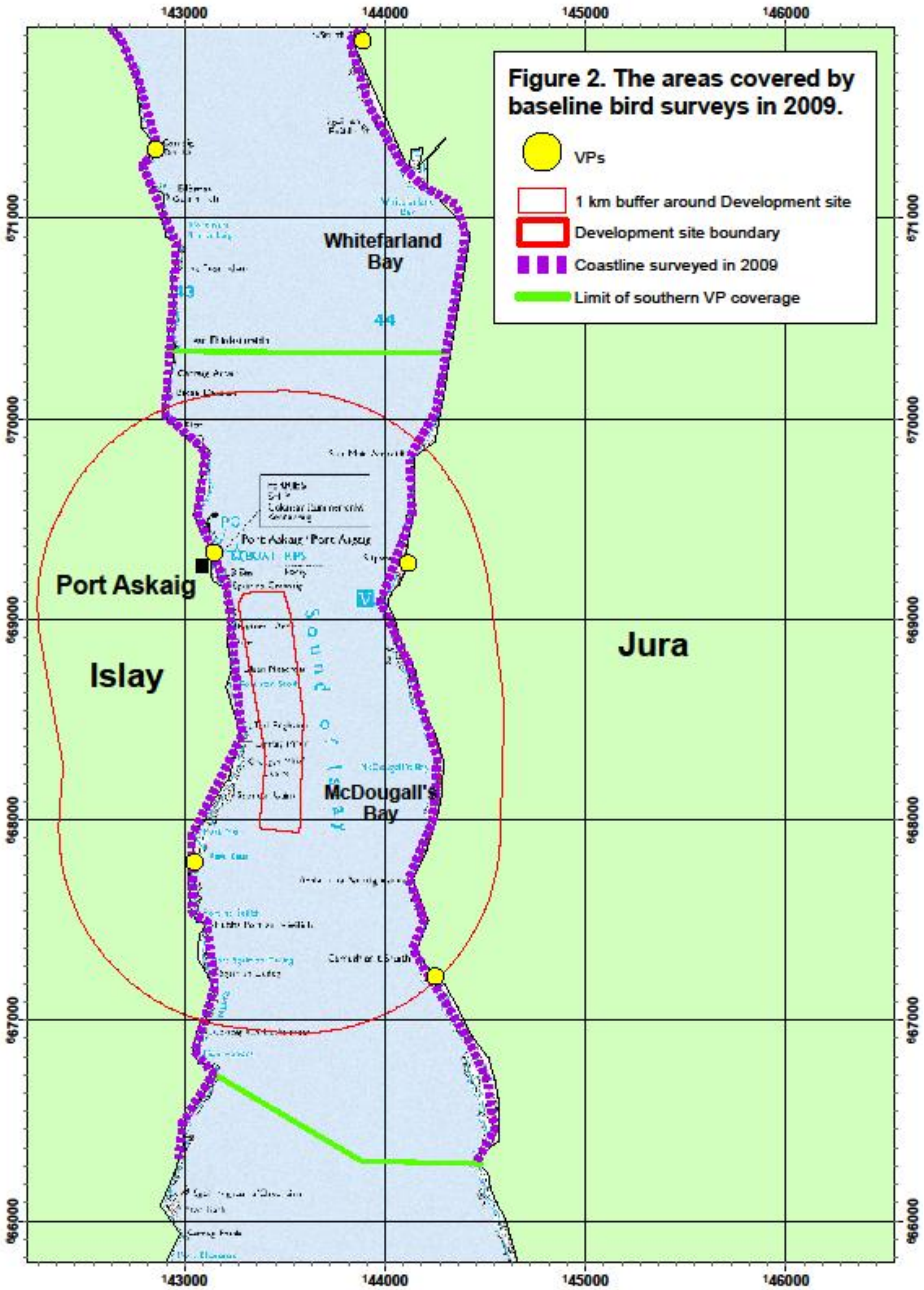


Figure 2. The areas covered by baseline bird surveys in 2009.

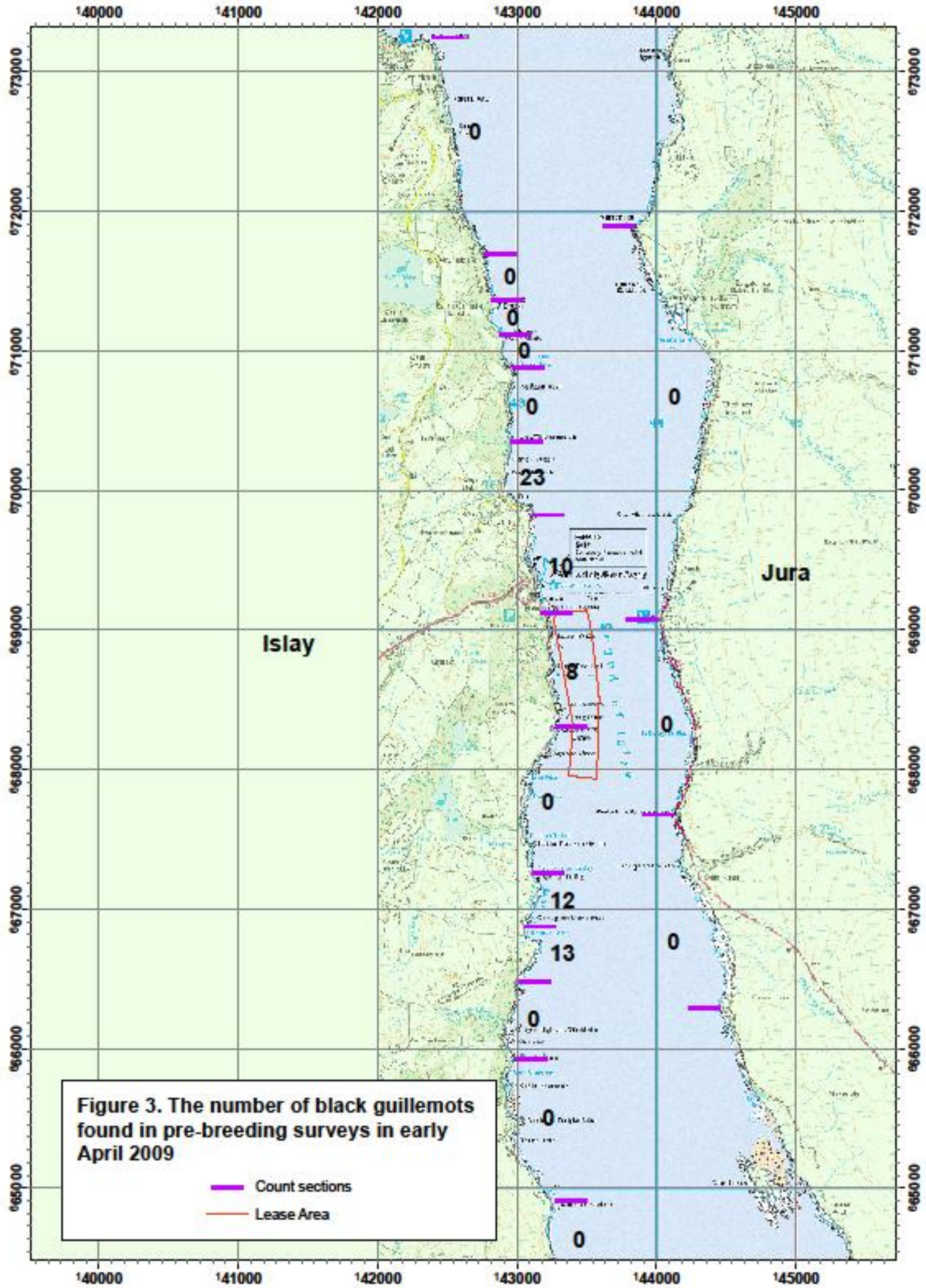


Figure 3. The number of black guillemots found in pre-breeding surveys in early April 2009

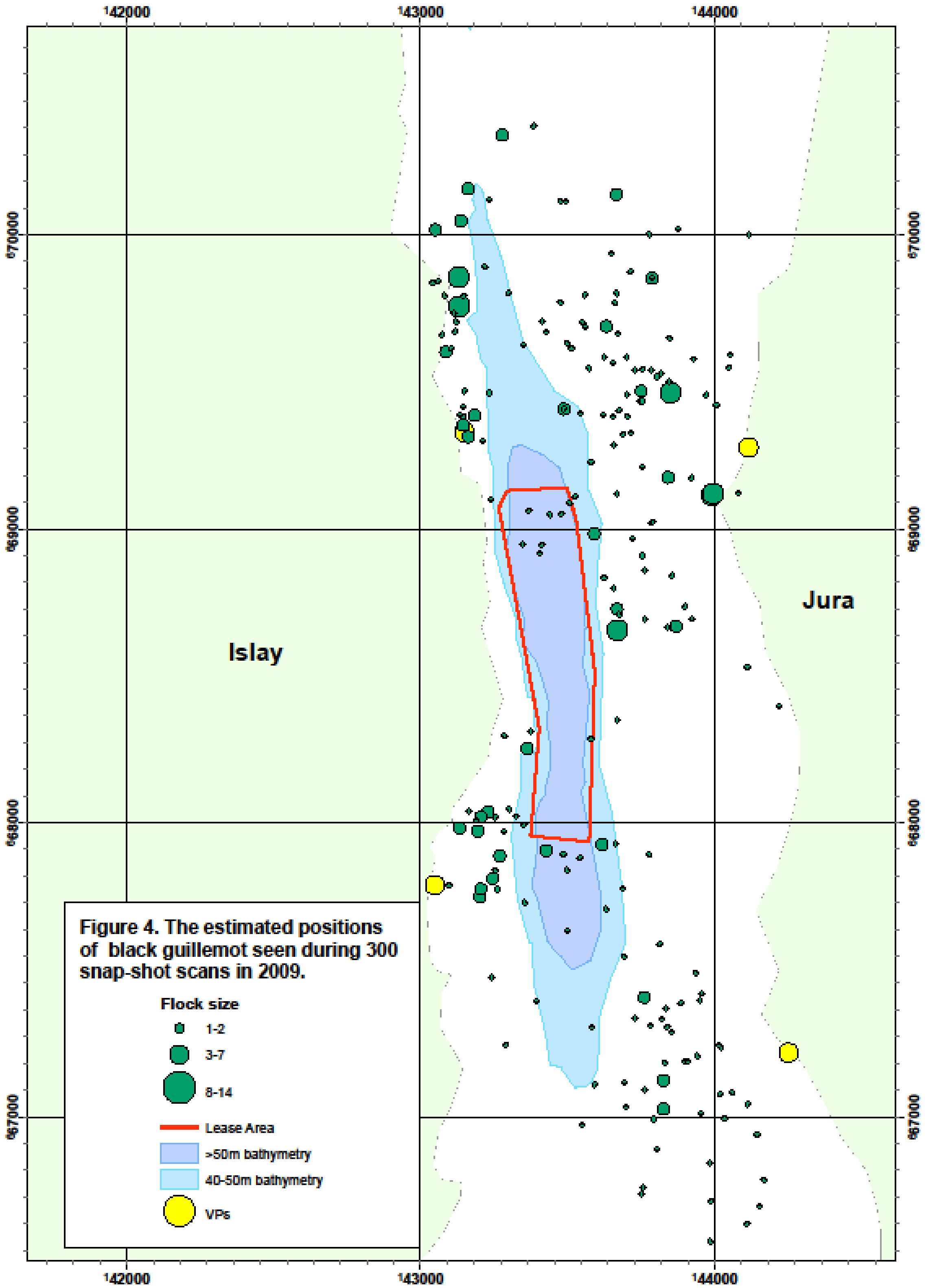


Figure 4. The estimated positions of black guillemot seen during 300 snap-shot scans in 2009.

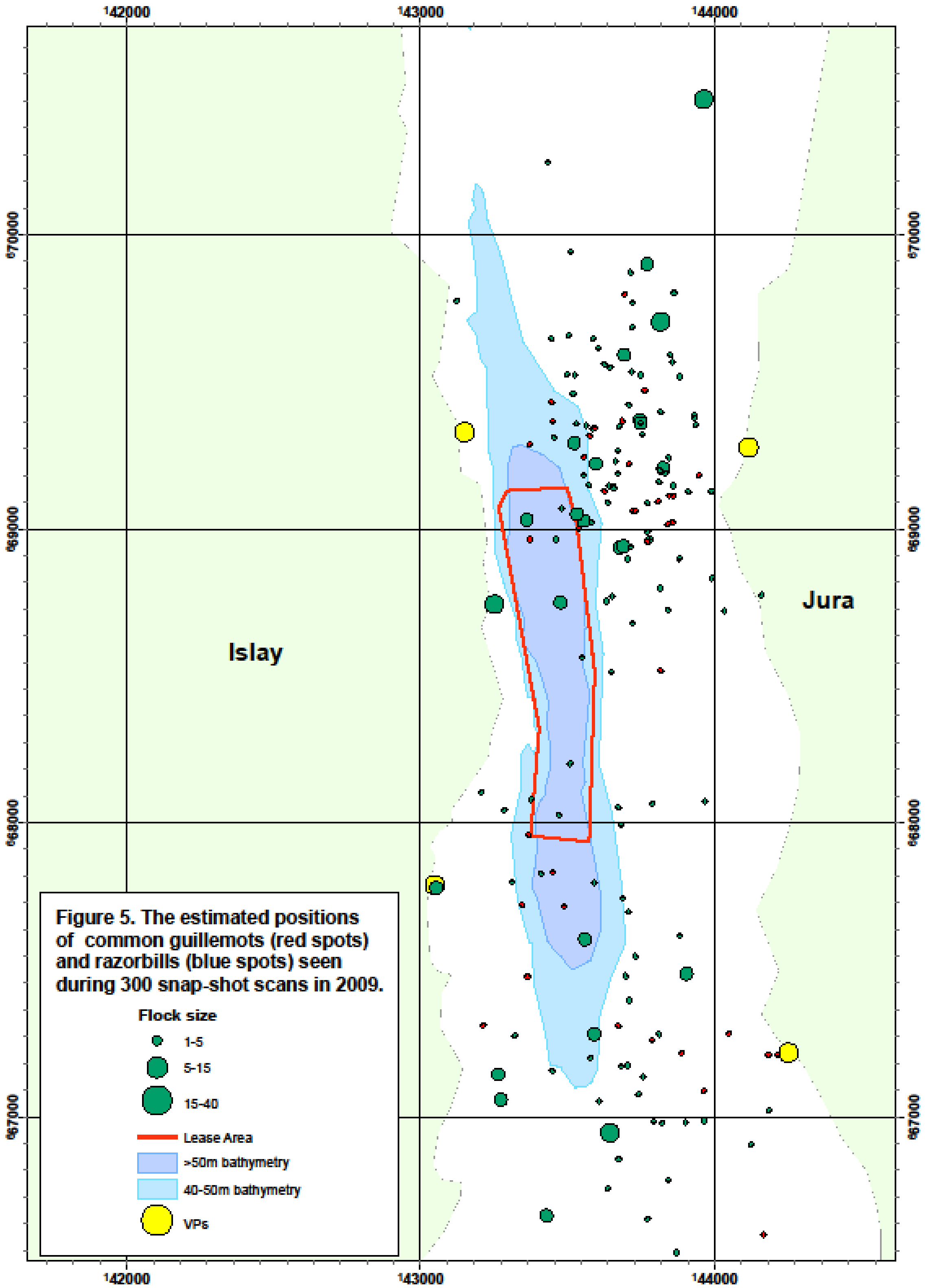


Figure 5. The estimated positions of common guillemots (red spots) and razorbills (blue spots) seen during 300 snap-shot scans in 2009.

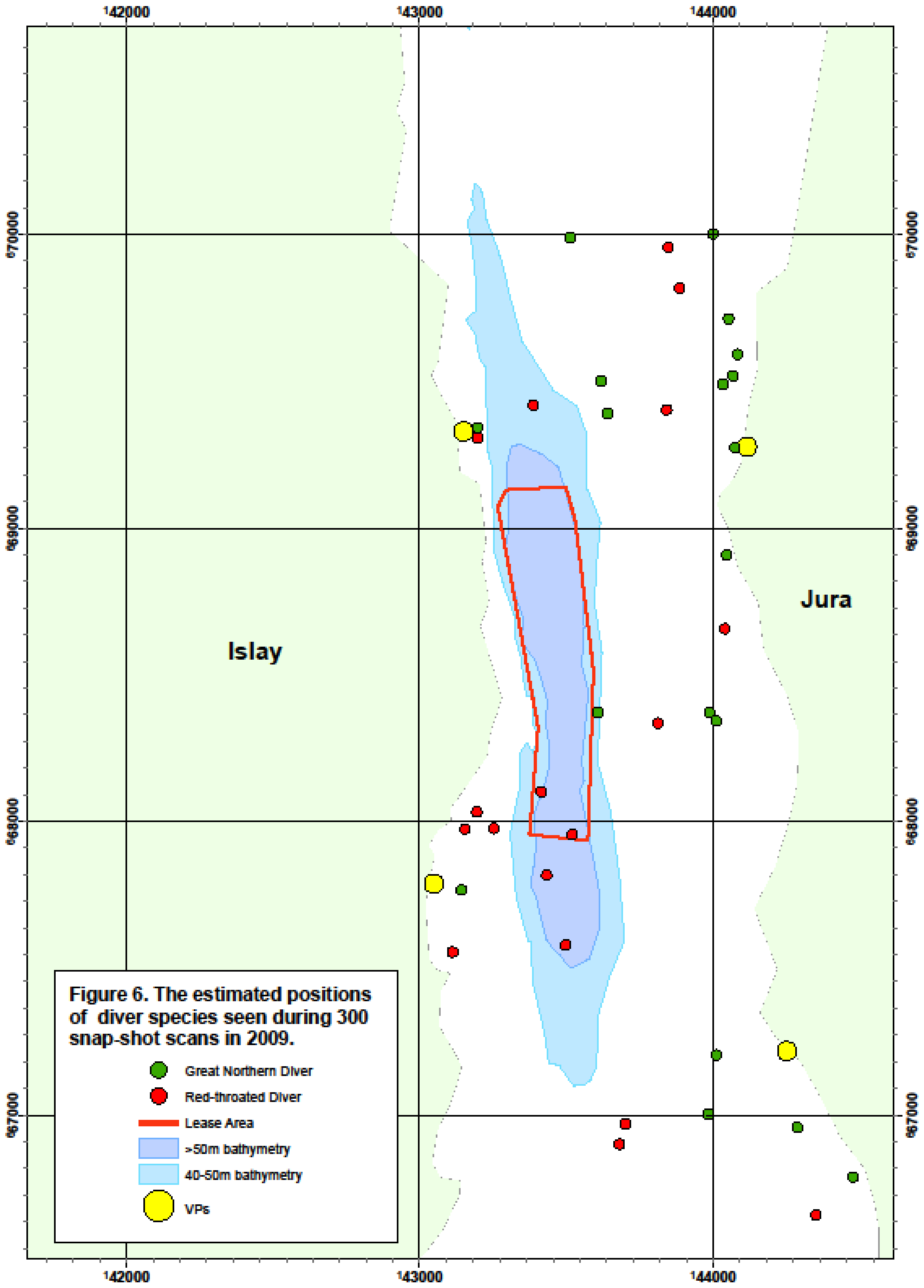


Figure 6. The estimated positions of diver species seen during 300 snap-shot scans in 2009.

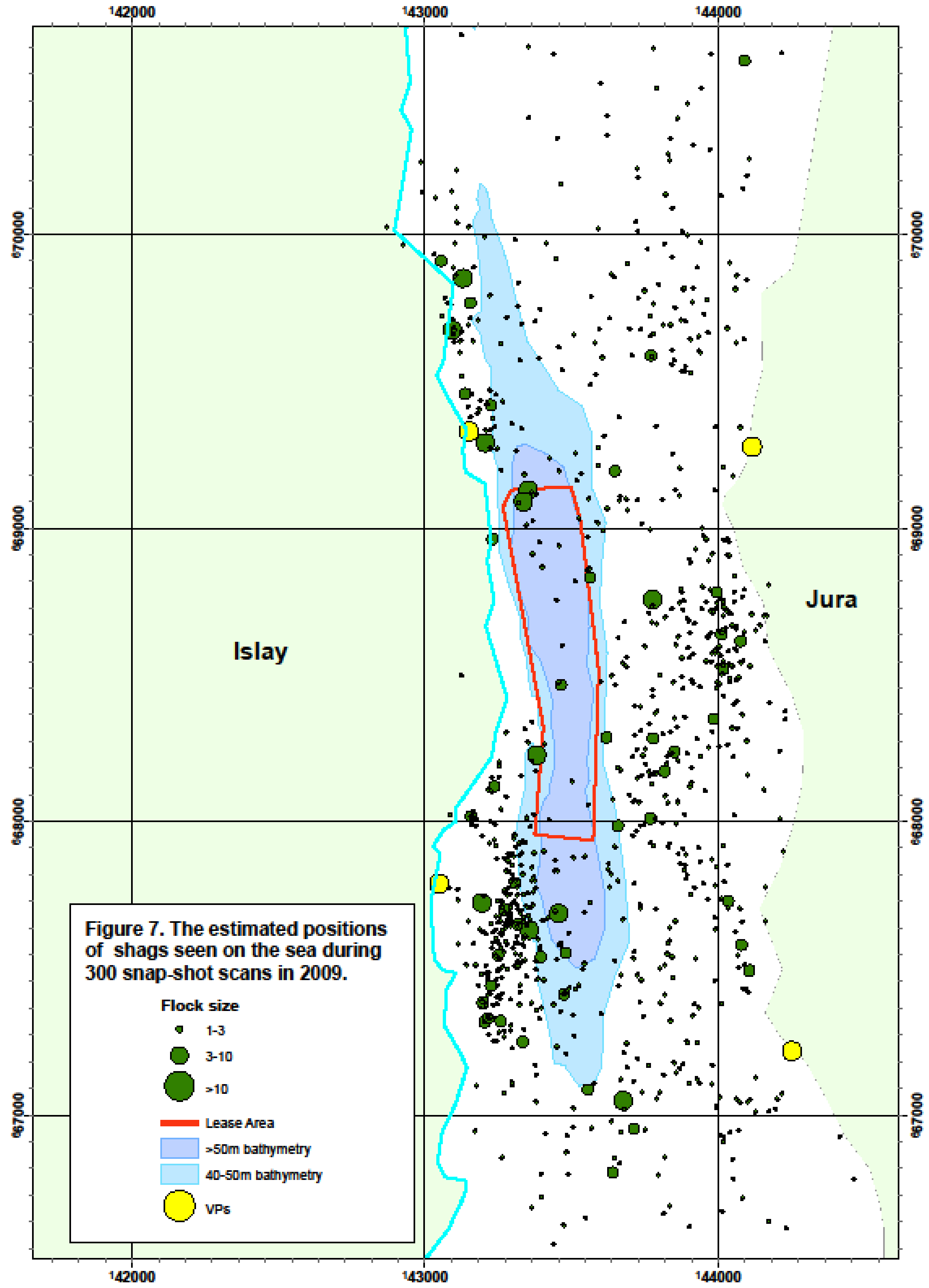


Figure 7. The estimated positions of shags seen on the sea during 300 snap-shot scans in 2009.

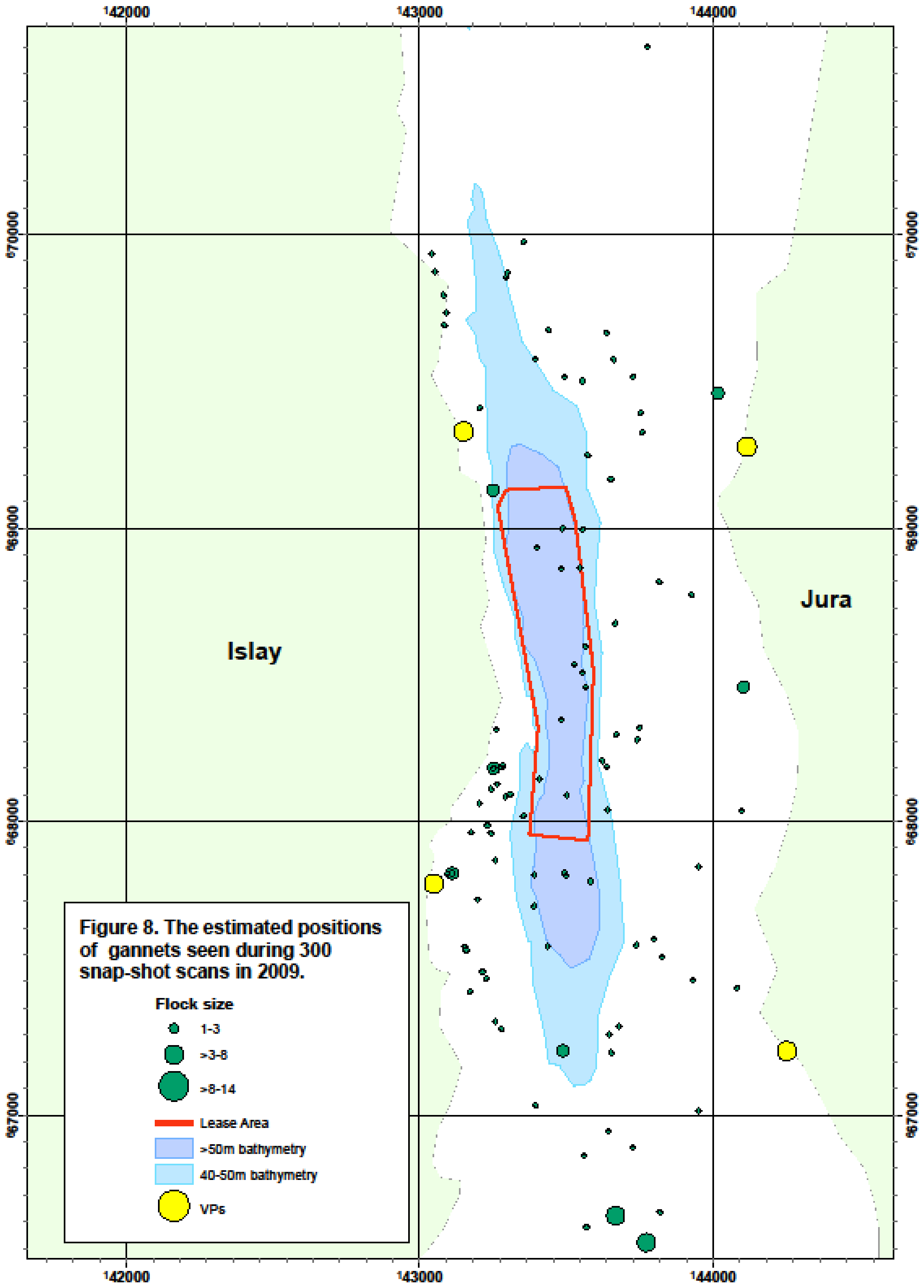


Figure 8. The estimated positions of gannets seen during 300 snap-shot scans in 2009.

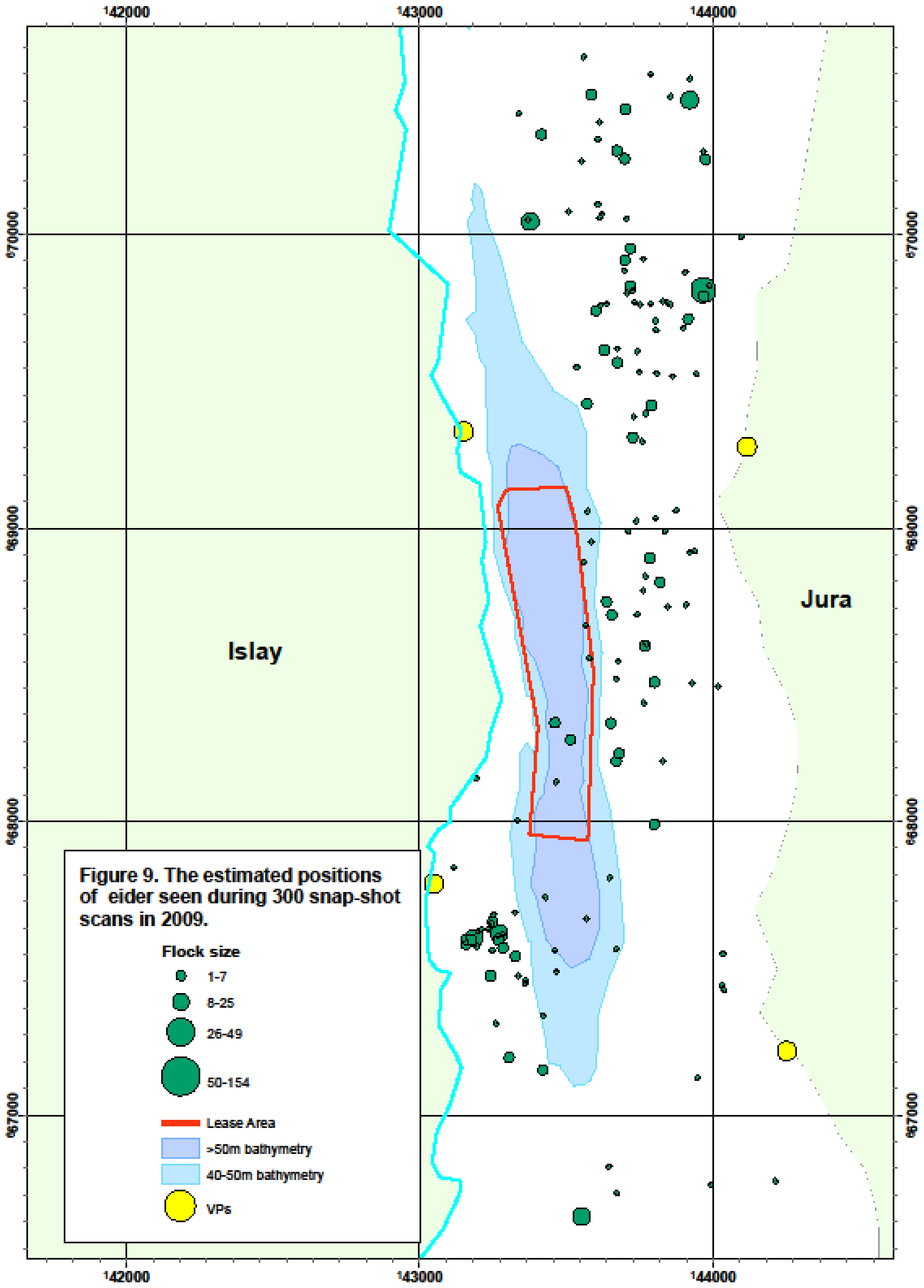


Figure 9. The estimated positions of eider seen during 300 snap-shot scans in 2009.

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

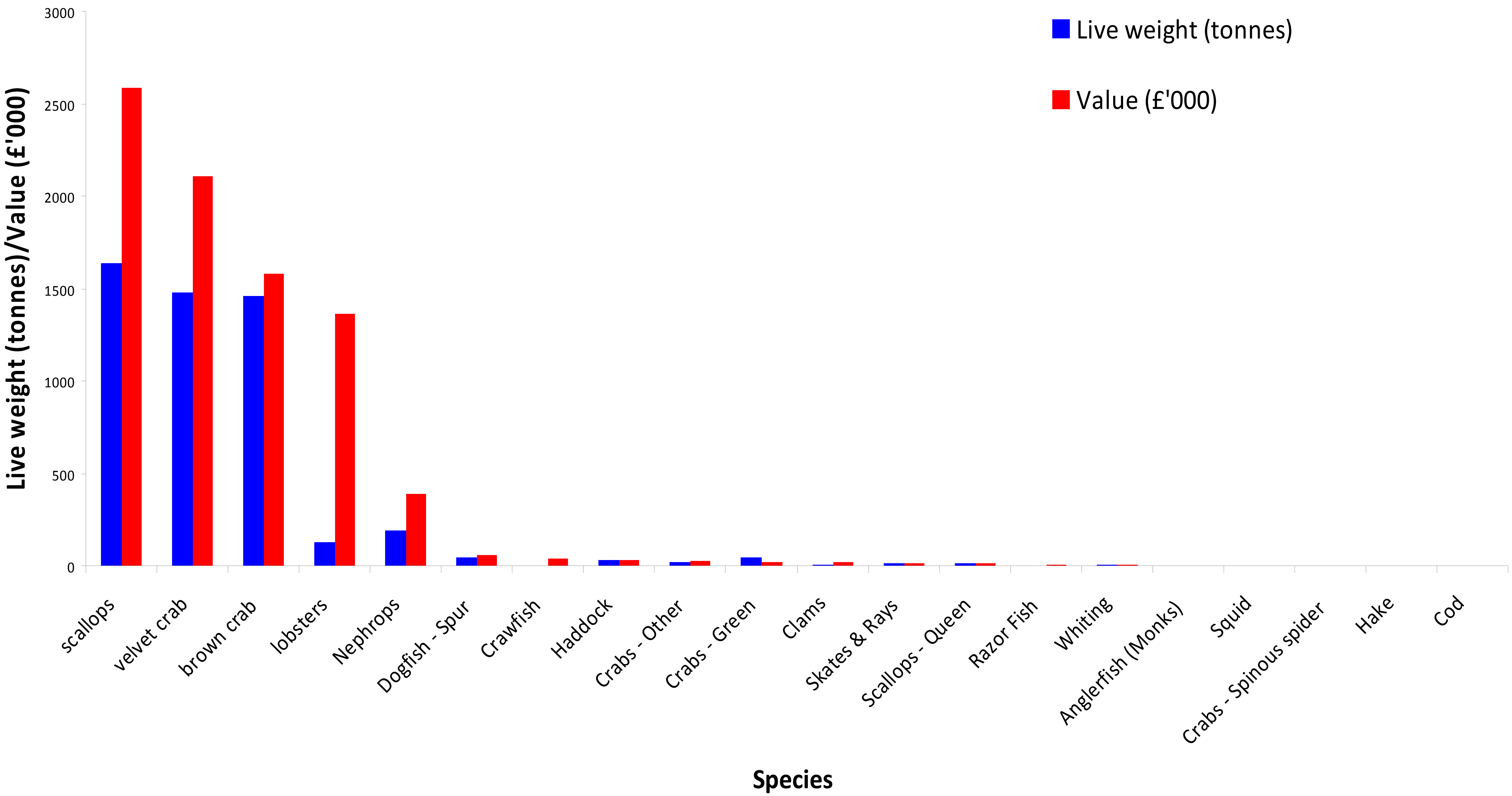
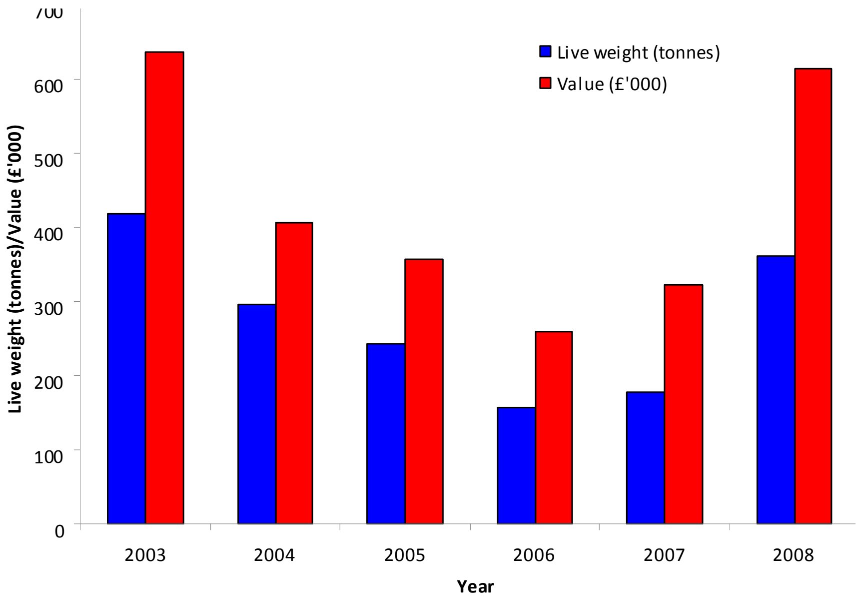
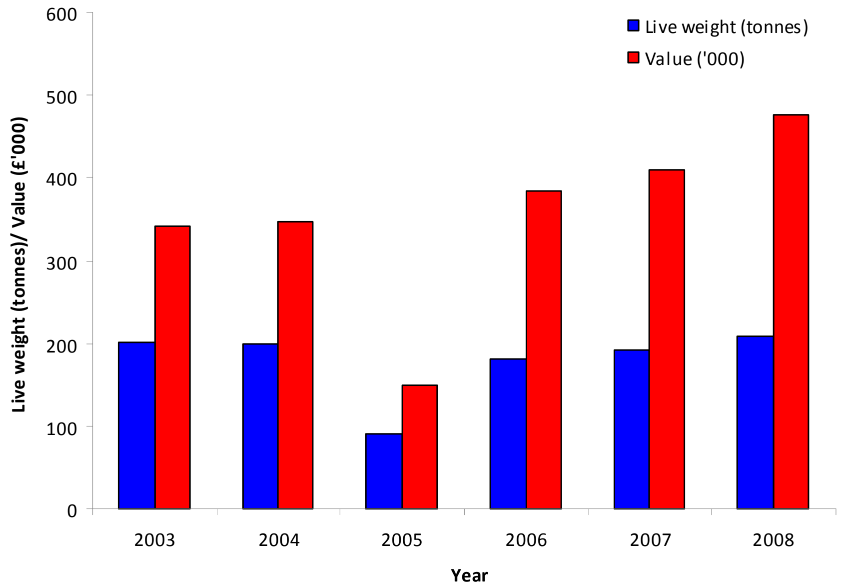


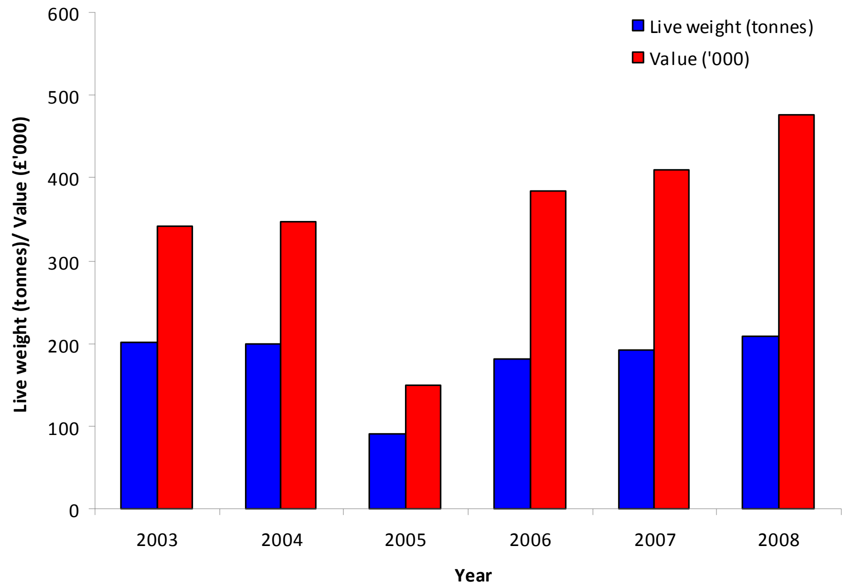
Figure. 1: Live weight and value of the landings from ICES rectangle 40E3 for each species for the period 2003 and 2008 (inclusive) showing the top 20 species by value.



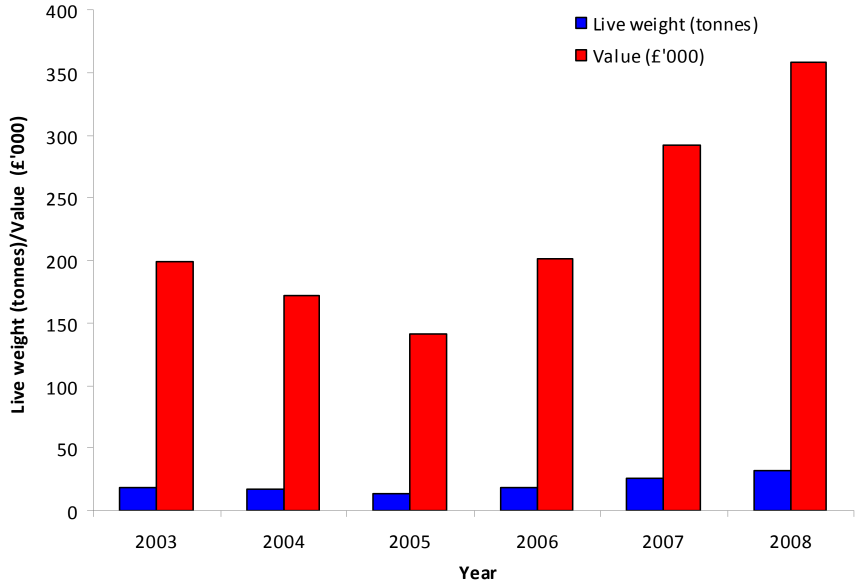
(a) Great Scallop



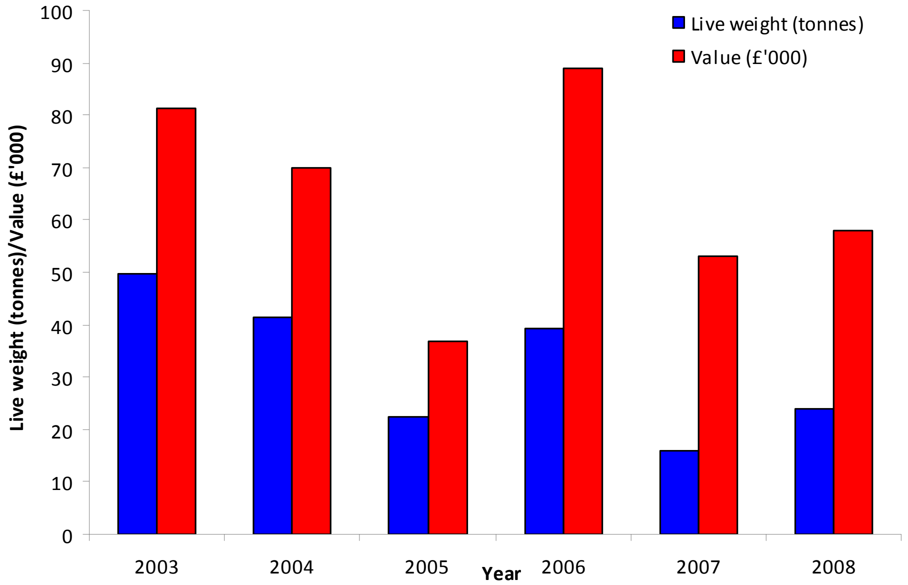
(b) Velvet Swimming Crab



(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*

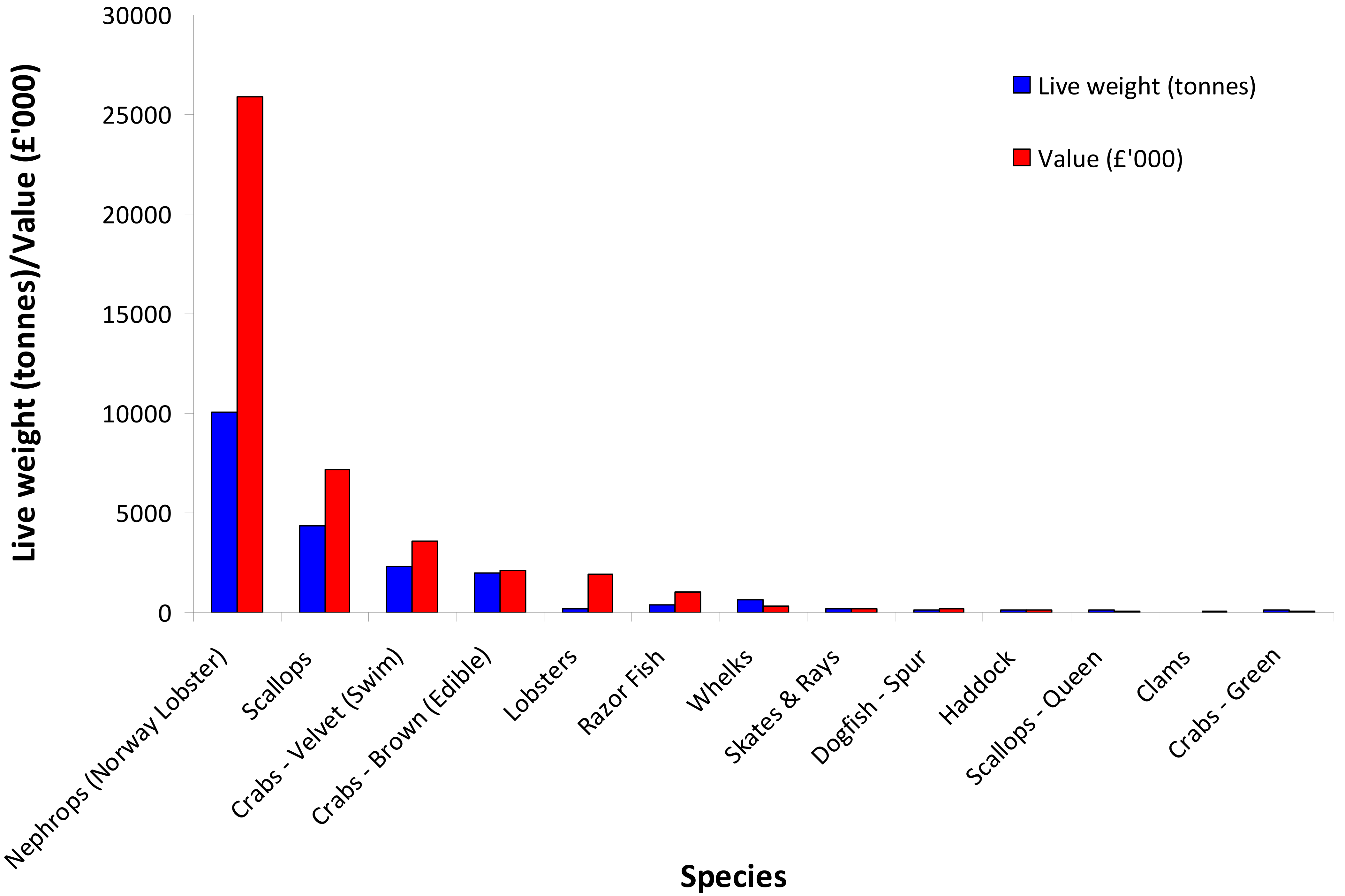


Figure 3: Live weight and value of the landings from ICES rectangle 40E3 and 40E4 combined by species for the period 2003 and 2008 (inclusive) showing the top 20 species by value.

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.

Vessel Sizes

<10m	>10m and <12m	>12m	Actual (average) m
5	1	-	7

Crew Number (including skipper)

1	2	3	4
4	2	-	-

Full-time/Part-time vessels

Full-Time	Part-Time
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

ROYAL HASKONING

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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.

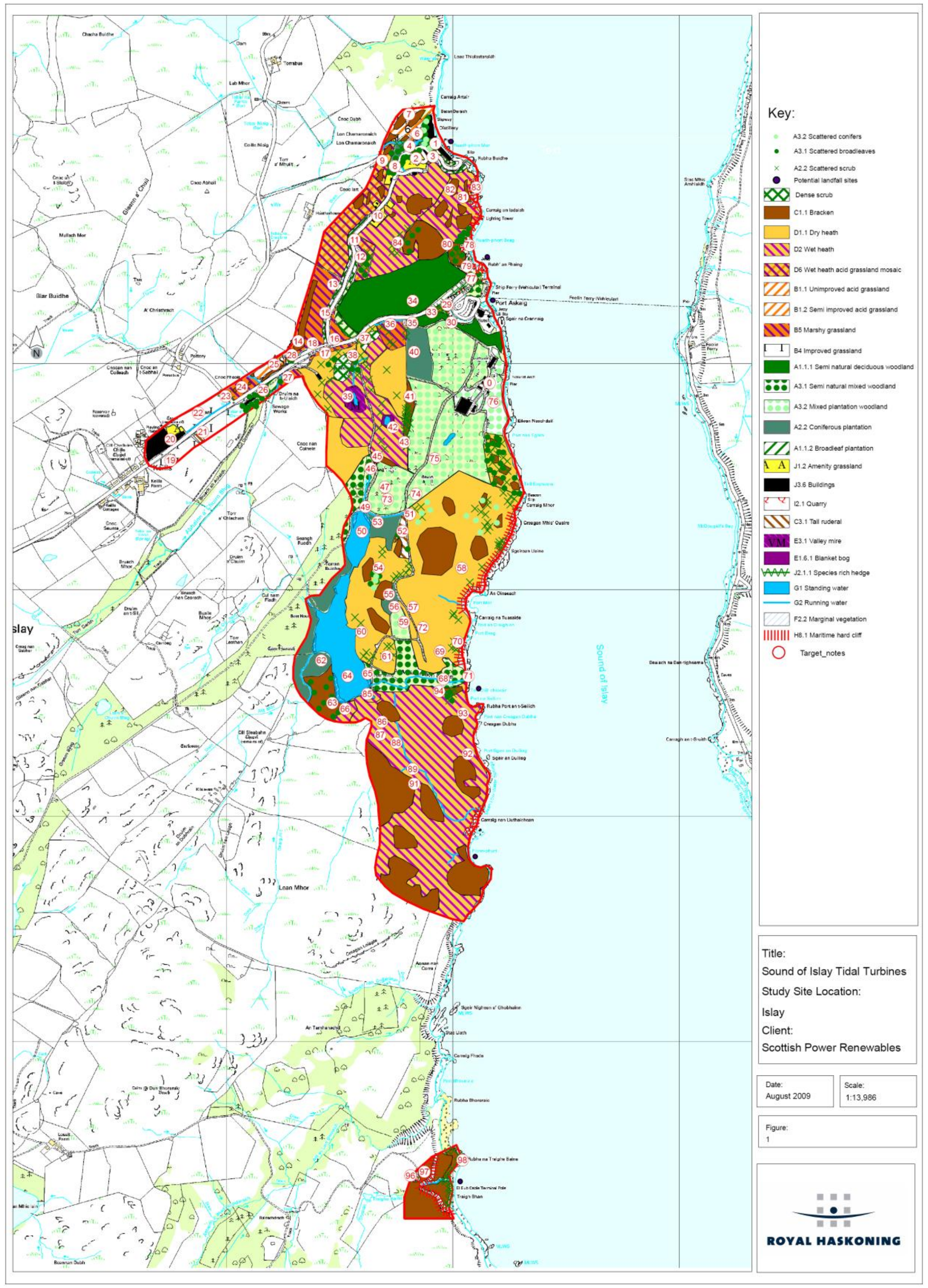

Figure 1 Footprint boundary (red line), potential cable access points (A-F) and habitat codes.

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.

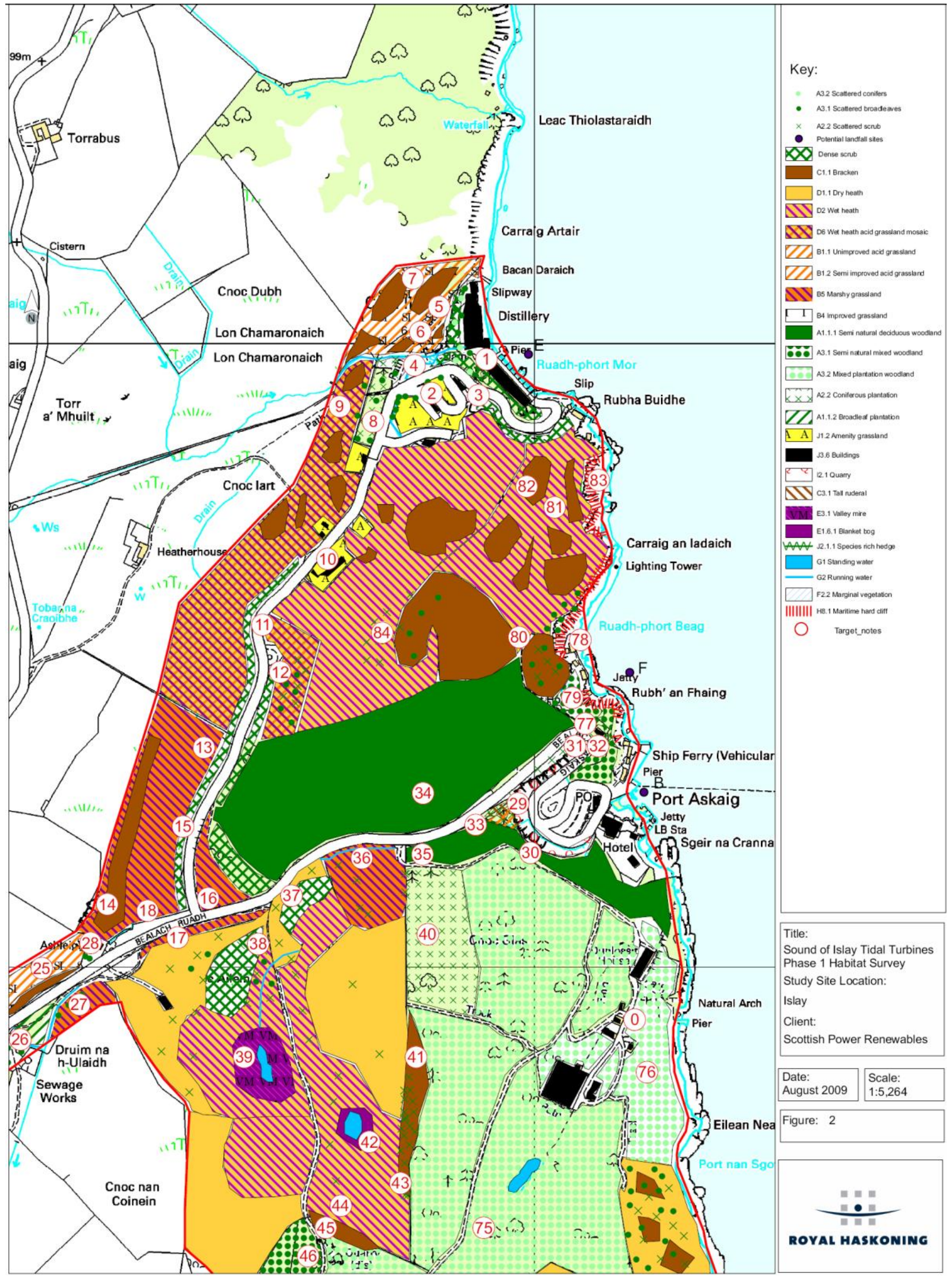

Figure 2 Habitats in the north of the footprint (Sites E, F and B)

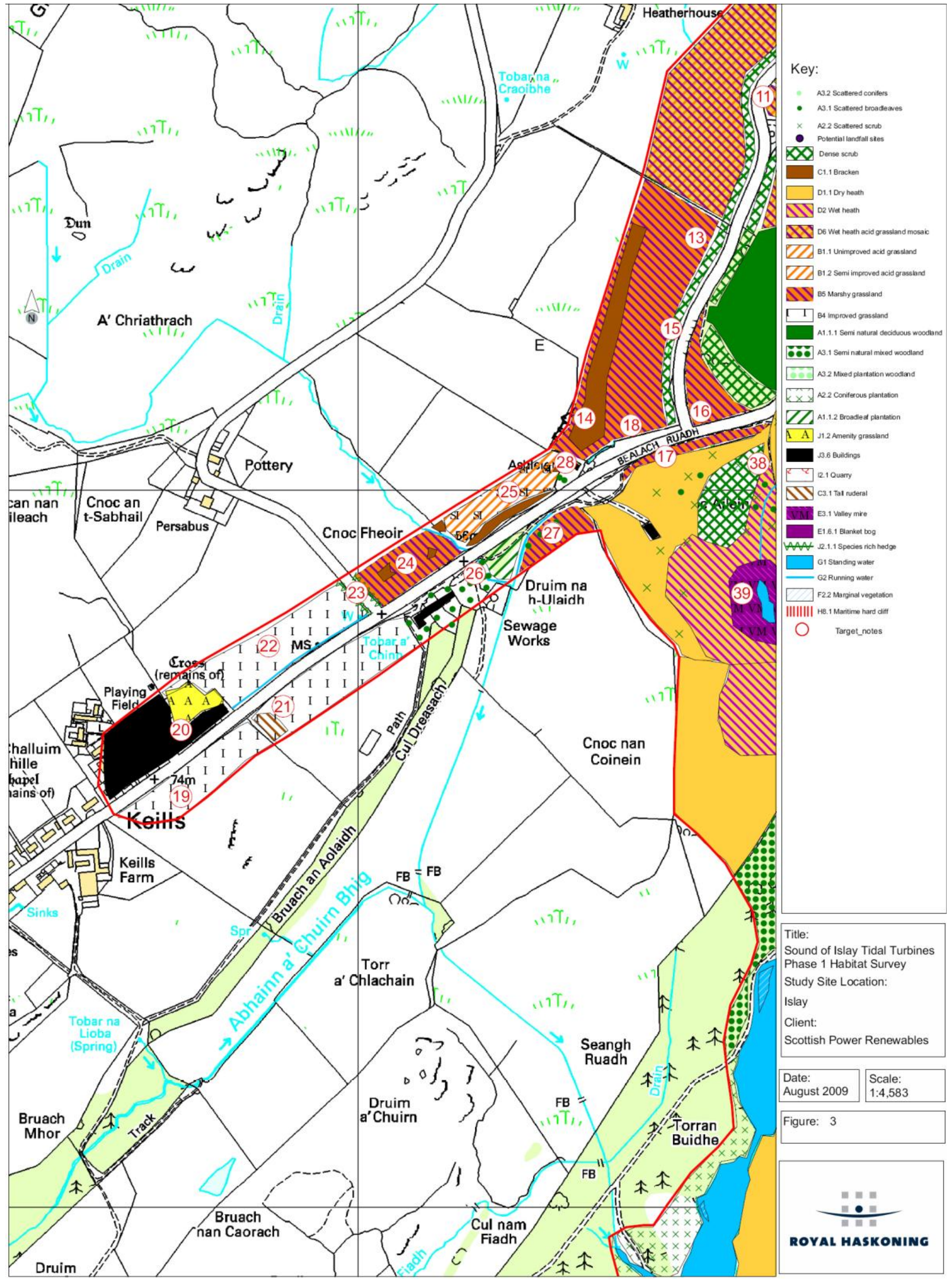

Figure 3 Habitats along route to Keills

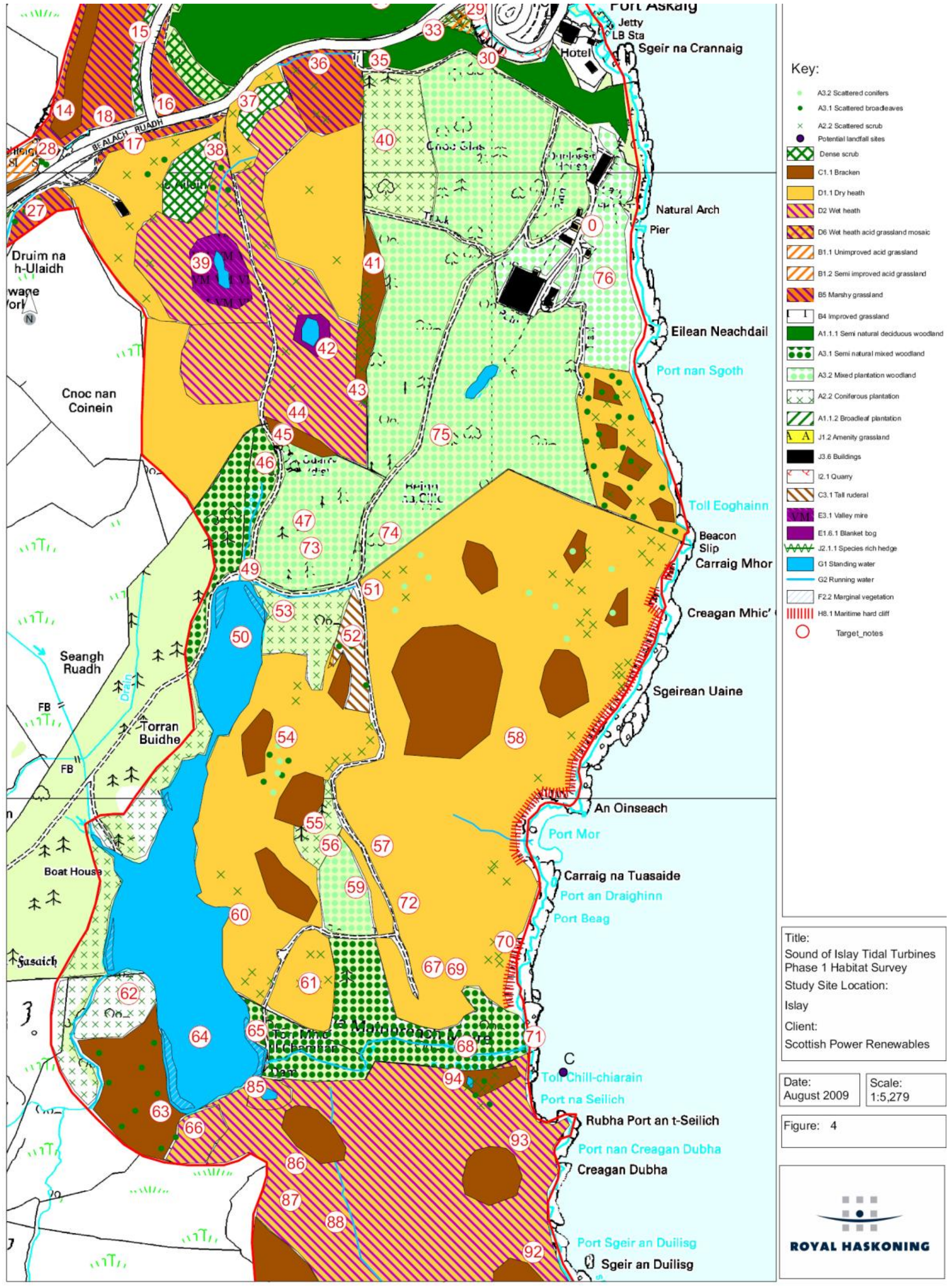

Figure 4 Habitats in the middle of the main footprint (Site C)

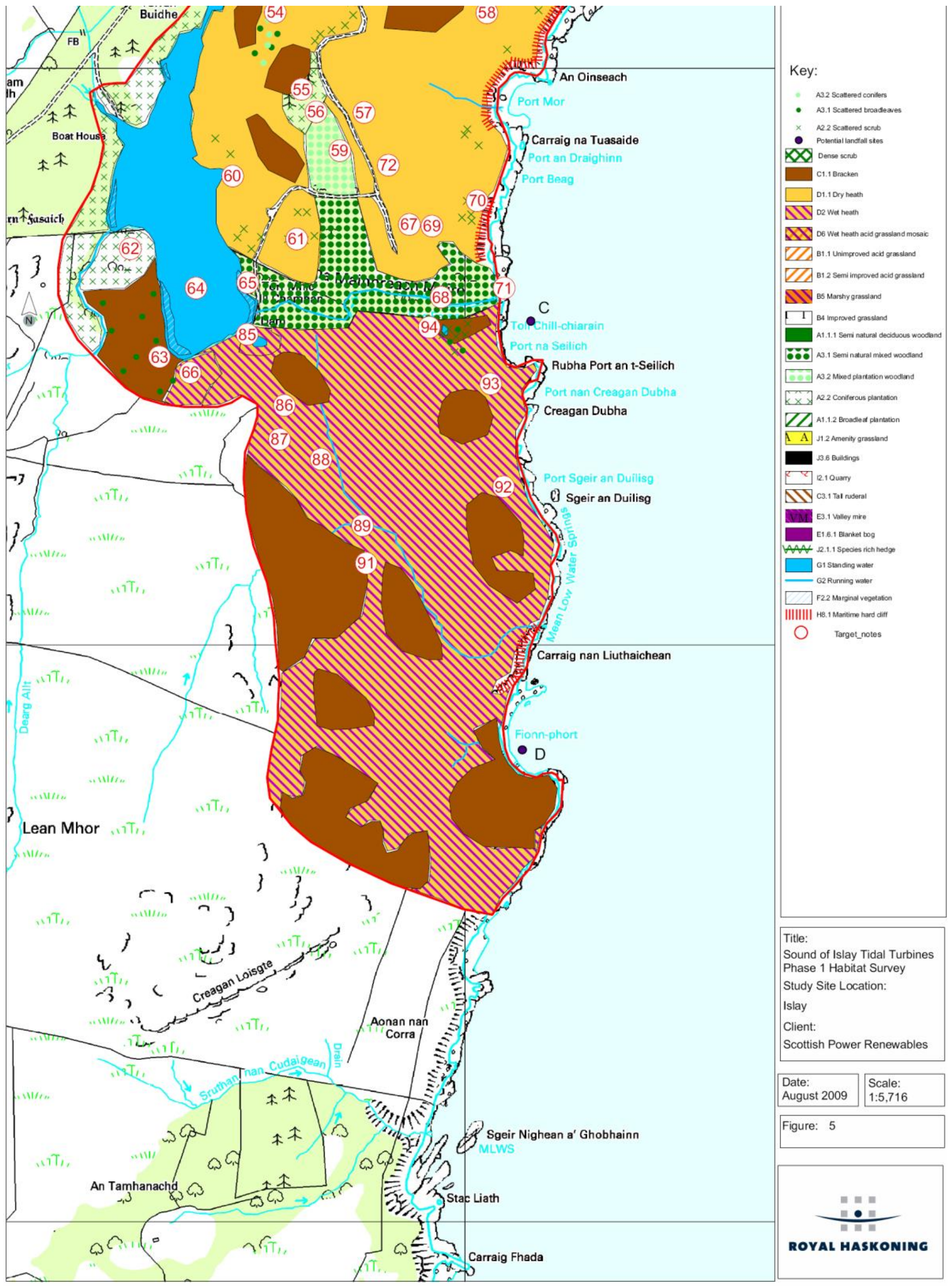

Figure 5 habitats in the south of the main footprint (Sites C and D)

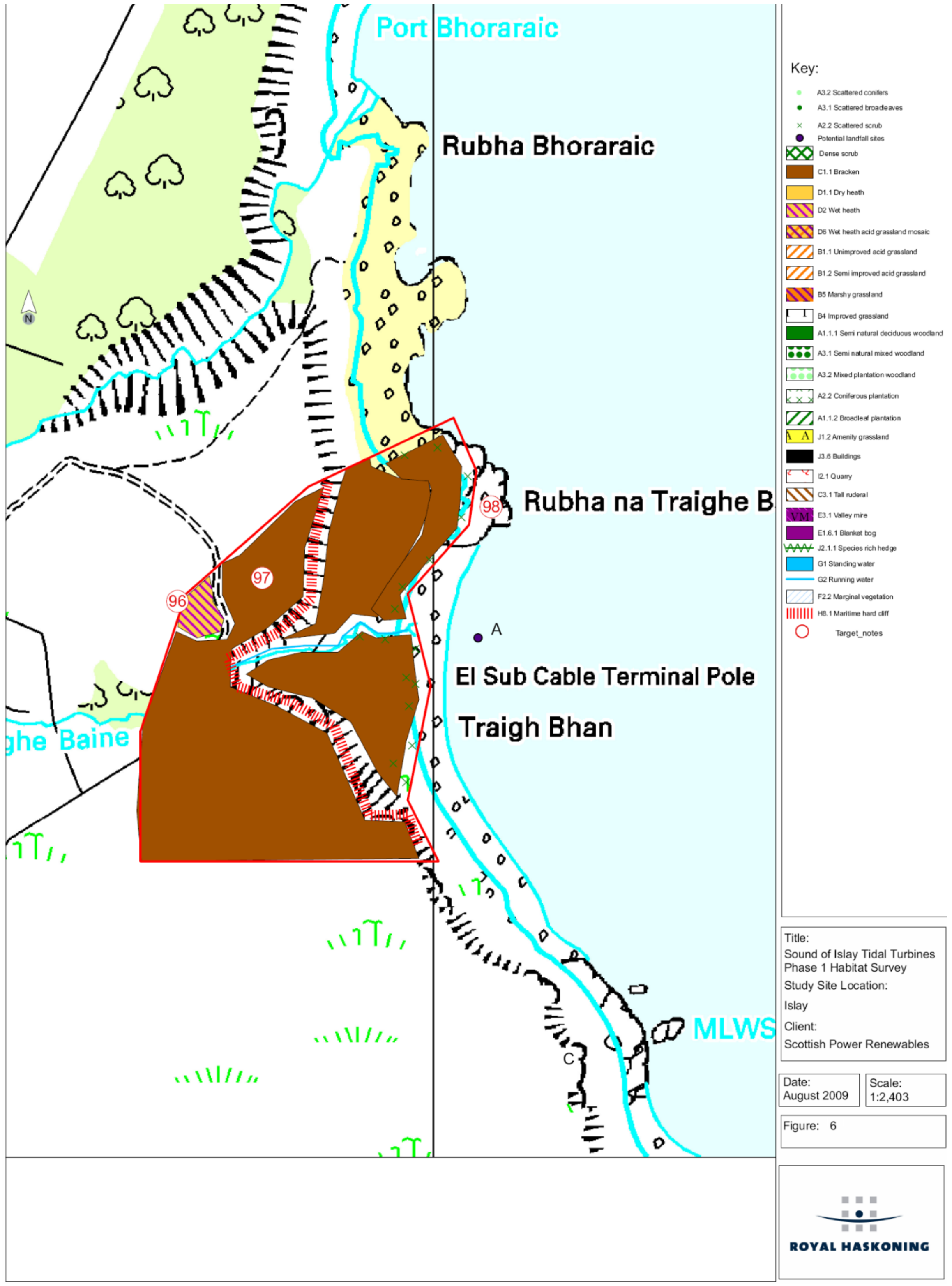

Figure 6 Habitats south of the main footprint (Site A)

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

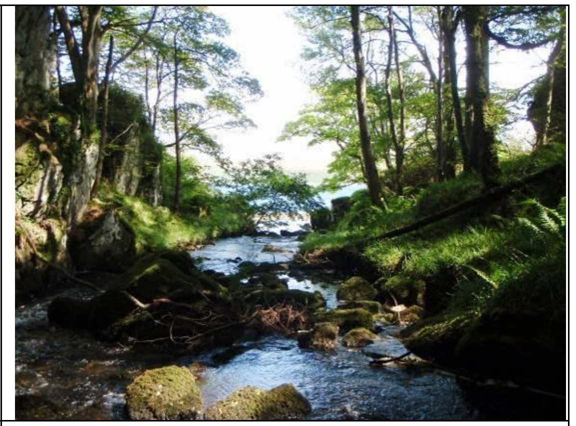

Plate 3.18 Downstream of waterfall

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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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

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Document title	Sound of Islay Demonstration Tidal Array Inter-tidal survey of potential cable routes
Document short title	
Status	Final Report
Date	31 August 2009
Project name	
Project number	9T3474
Client	Scottish Power Renewables
Reference	9T3474/R/303352/Edin

Scottish Power Renewables

31st August 2009
Final Report
9T3474

Drafted by	Jen Trendall	
Checked by	Frank Fortune and Fiona Nimmo	
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.

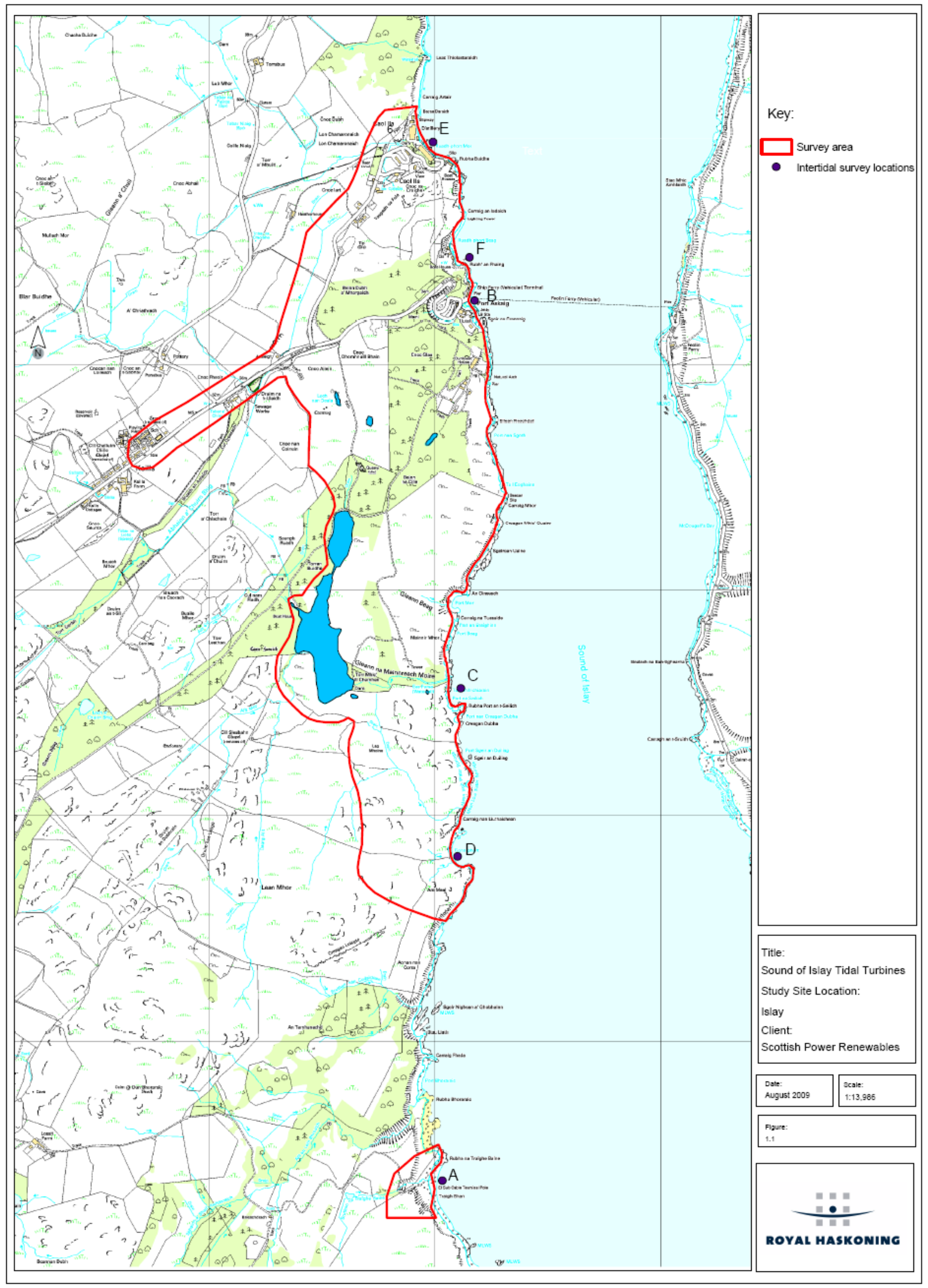

Figure 1.1 Locations of intertidal survey sites A – F.

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

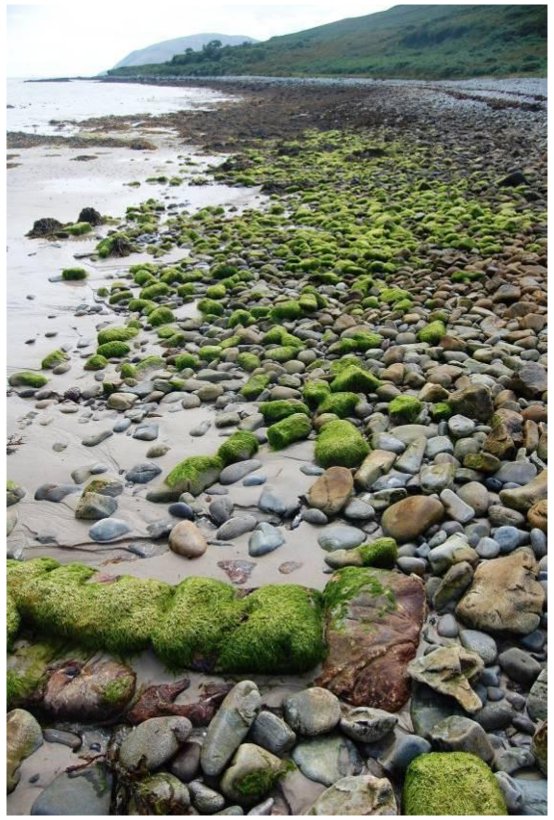

Plate 3.4 Transect A1 top of existing cable facing south

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*

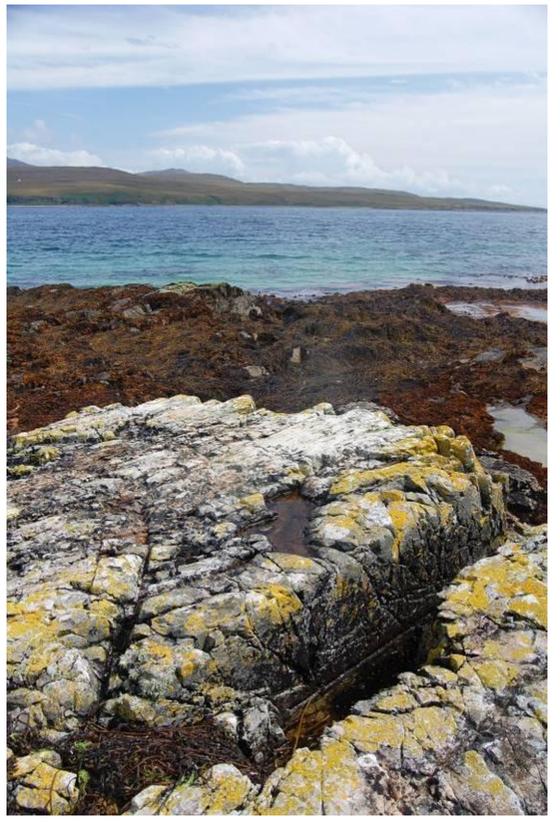

Plate 3.6 Transect A2 view down shore from upper shore. Upper shore bedrock supporting yellow and grey lichens

Plate 3.7 *Dilsea carnosa* and *Corallina officinalis* in rockpools

Plate 3.8 *Halichondria panicea* and orange sponge indet. (possibly *Myxilla* sp.)

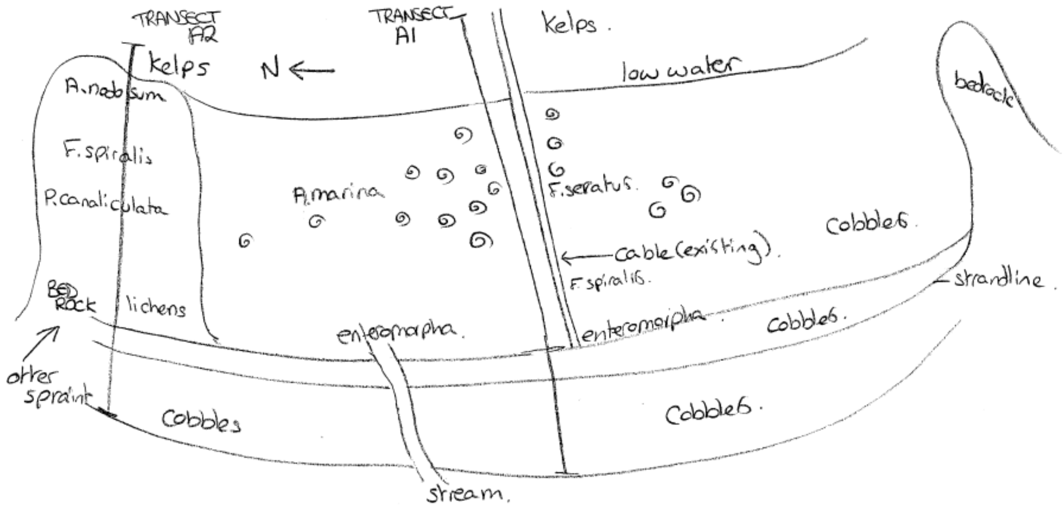

Figure 3.1 Map of Site A

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

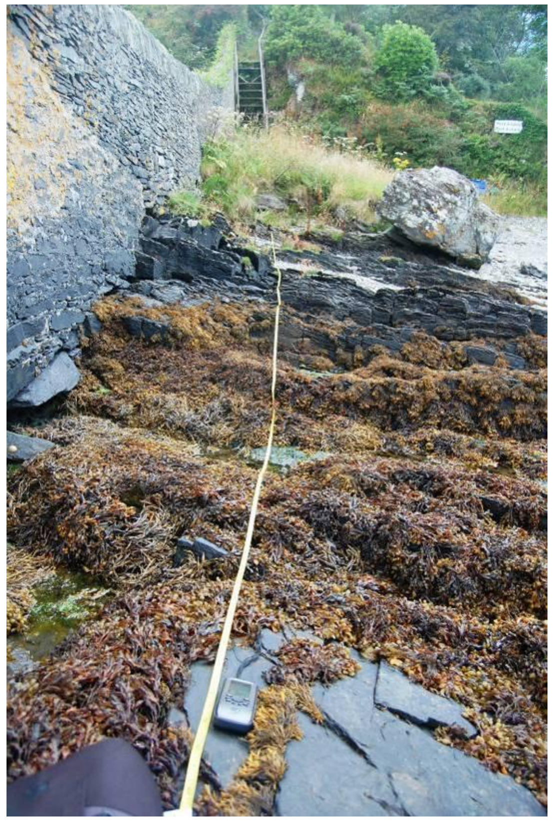

Plate 3.10 Transect B facing up the shore

Plate 3.11 *Calliostoma zizyphinum*

Plate 3.12 view north from the wall

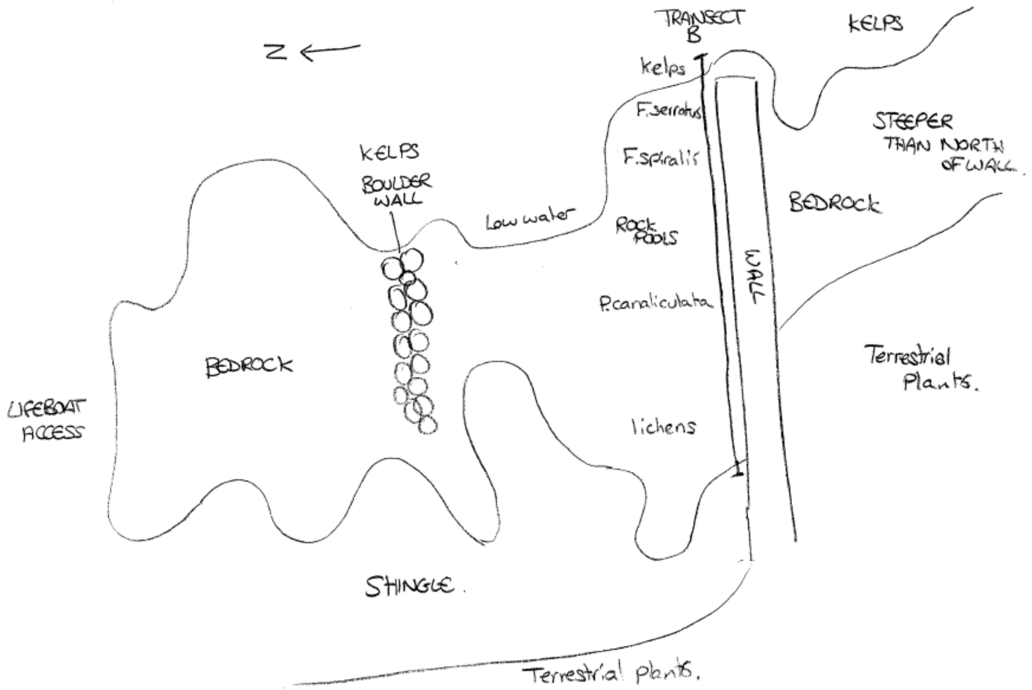

Figure 3.2 Map of Site B

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

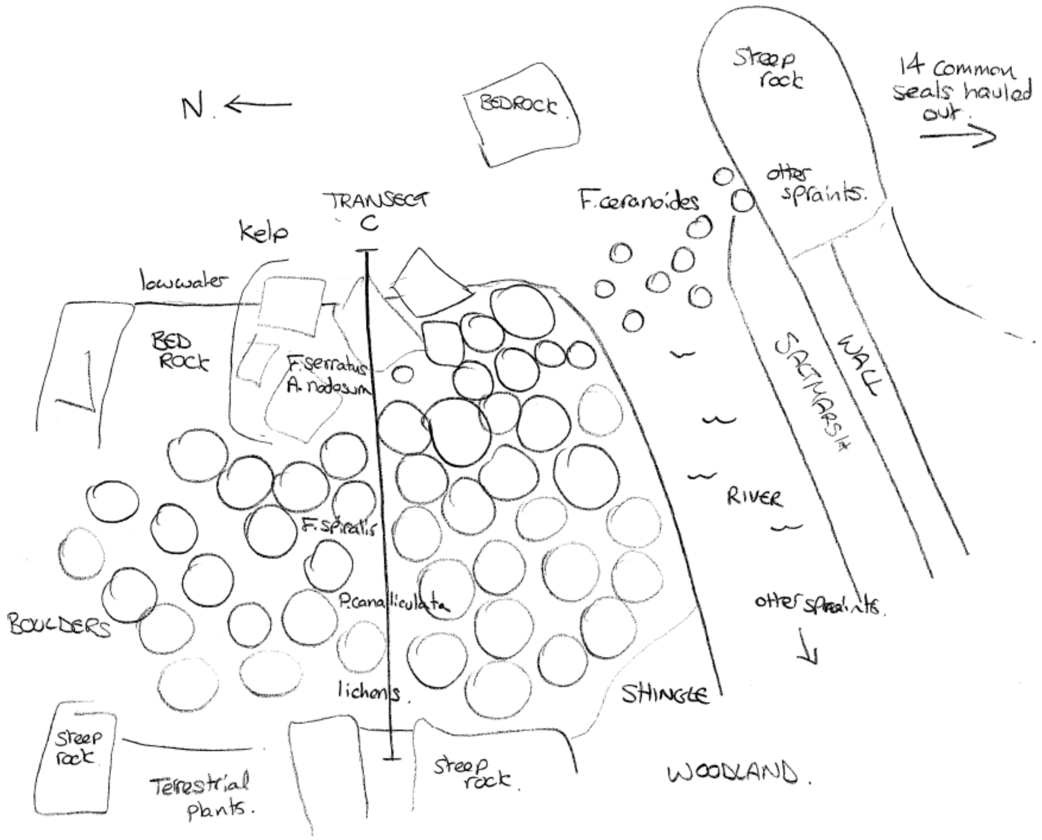

Figure 3.3 Map of Site C

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 3.20 south of transect

Plate 3.19 Site E transect up the shore

Plate 3.21 Site E north of transect

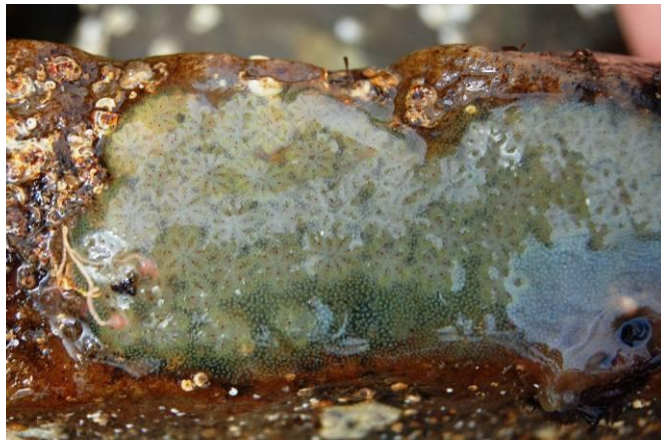

Plate 3.22 *Botryllus schlosseri*

Plate 3.23 *Anemonia viridis*

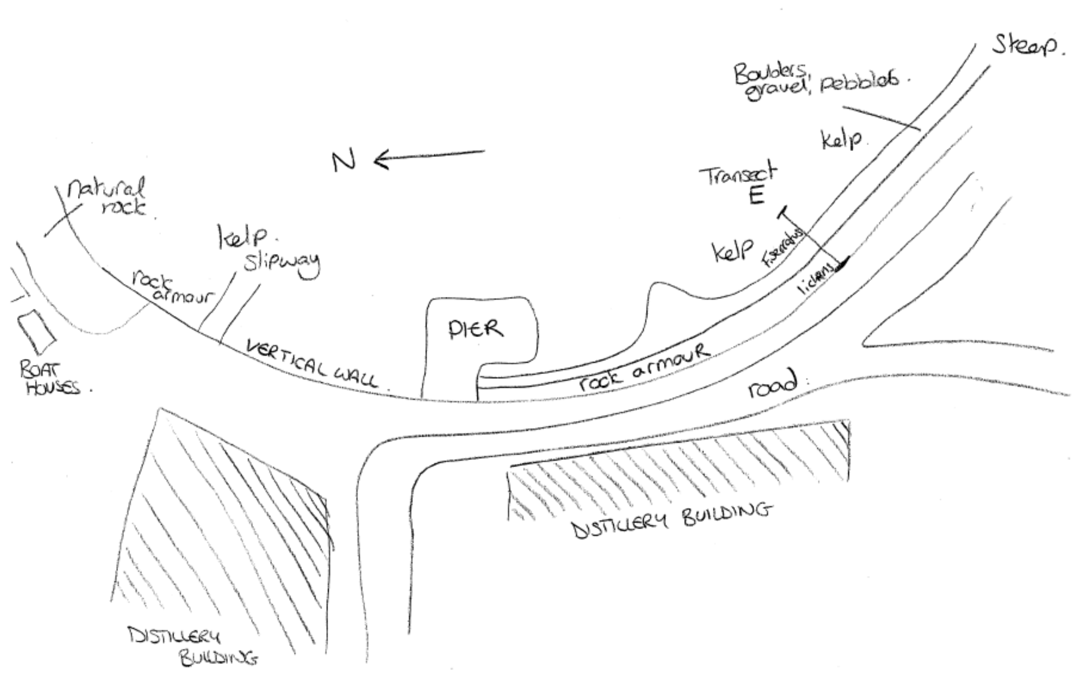

Figure 3.4 Map of Site E

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

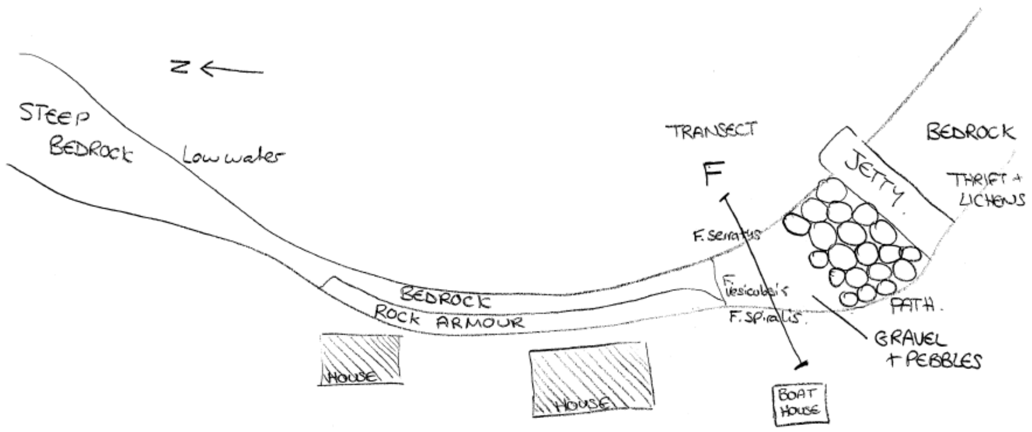

Figure 3.5 Map of Site F

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

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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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Document title	Sound of Islay Demonstration Tidal Array Phase 1 Habitat survey of the Isle of Jura
Document short title	
Status	Final Report
Date	23 February 2010
Project name	Sound of Islay Tidal Turbines
Project number	9T3474
Client	ScottishPower Renewables
Reference	9T3474/R/303352/Edin

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Date/initials approval	…………………	……….

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.

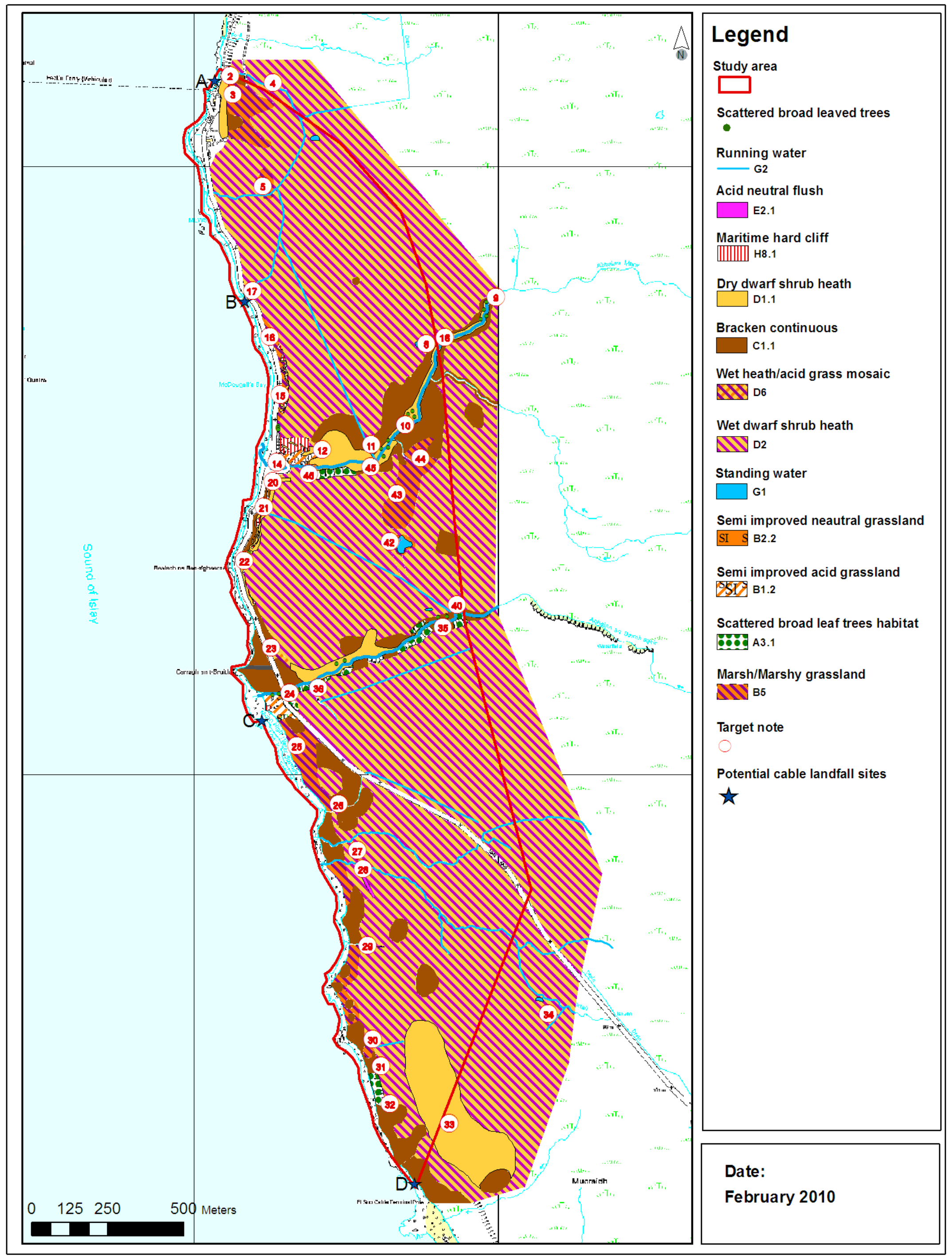


Figure 1 Study Area (red line), potential cable access points (A-D) and habitat codes. Feolin Ferry slip is at Site A, in the north of the footprint

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

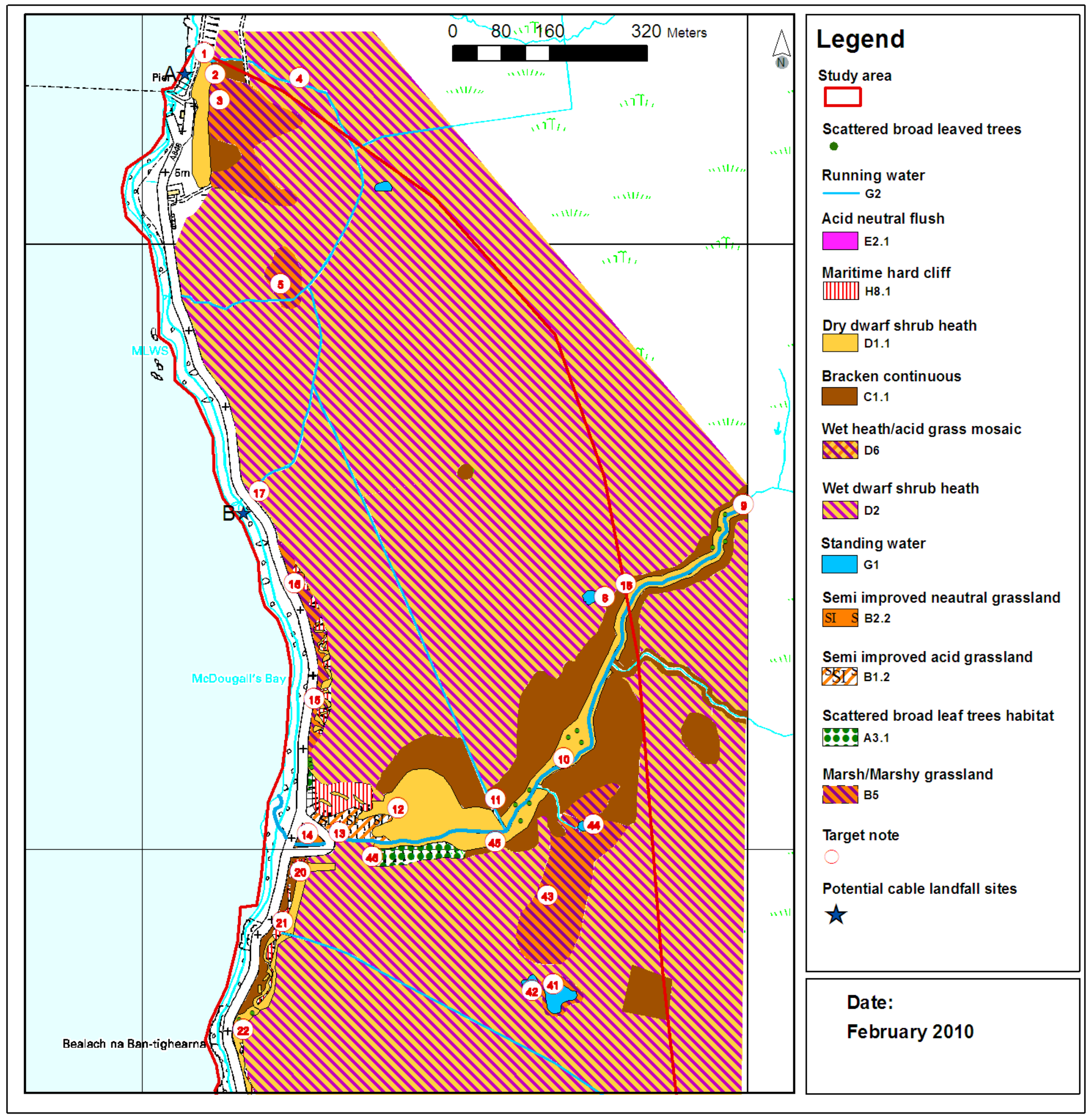


Figure 2: Northern section of study area

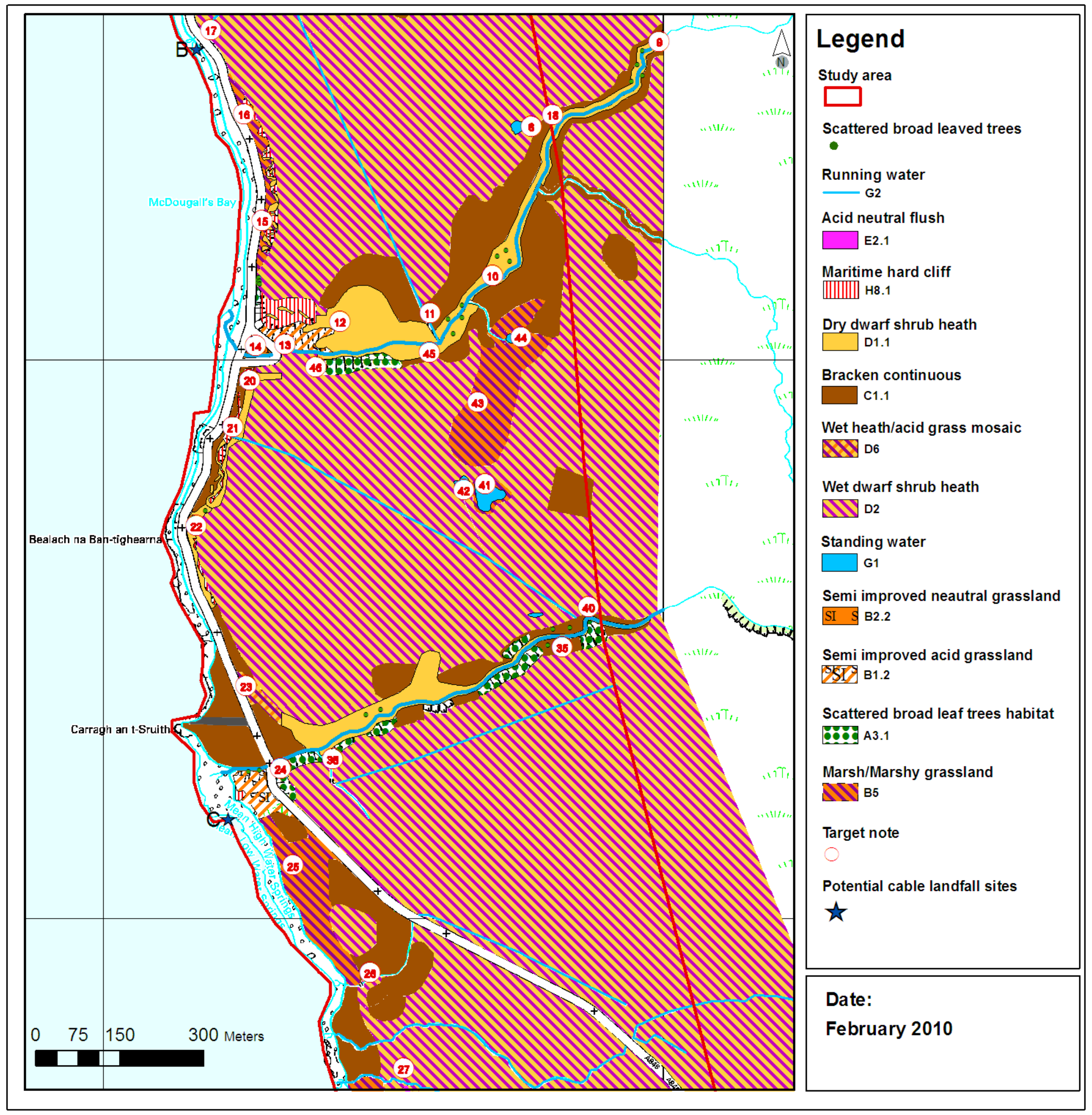


Figure 3: Central section of study area

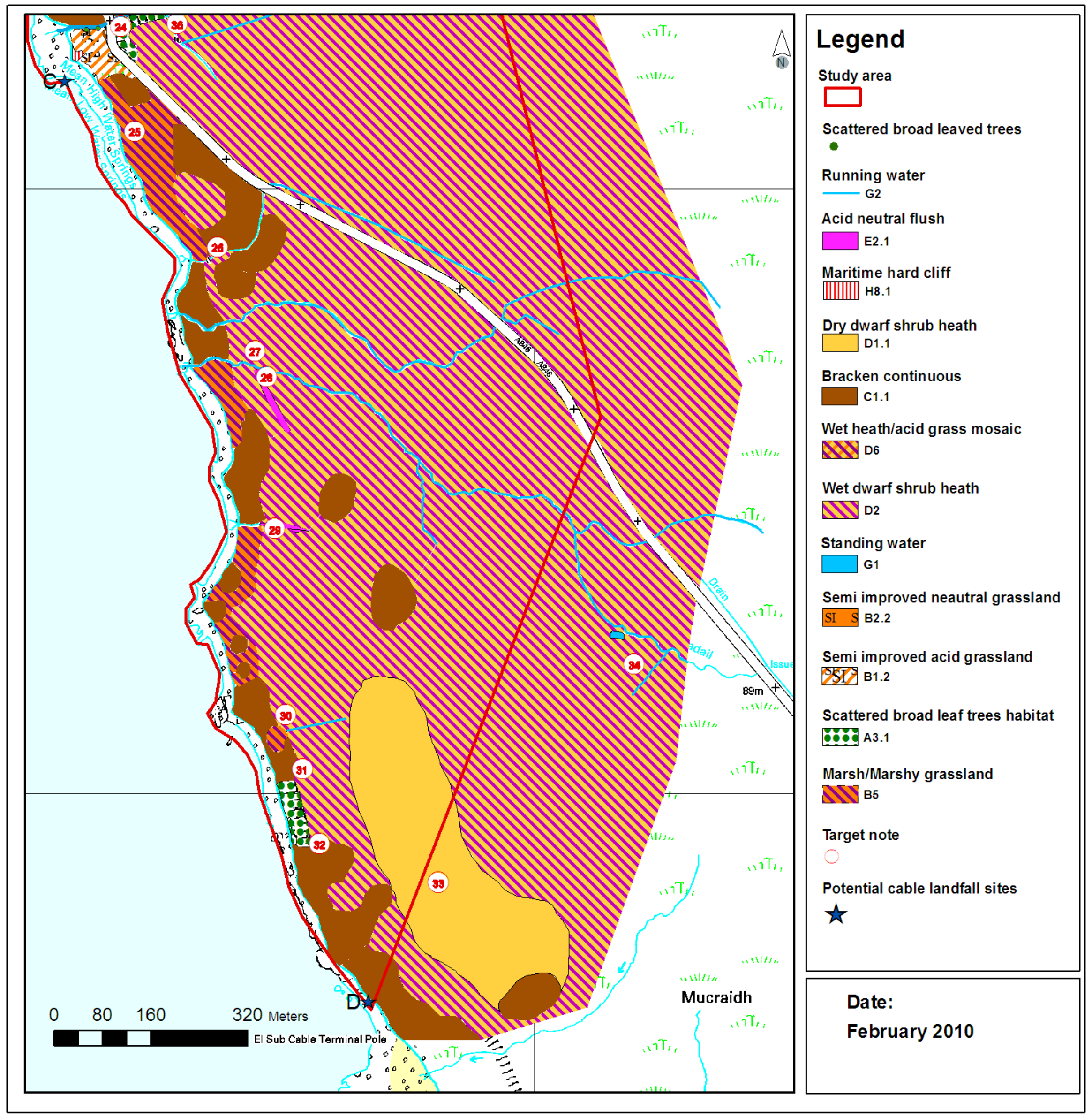


Figure 4: Southern section of the study area

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*)

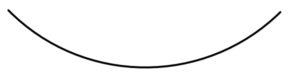
Target Note 14
B2 semi improved neutral grassland
NR 4427 6803:
Neutral grassland in between the old and new bridges, including crested dog tail (*Cynosurus cristatus*) and soft rush.

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.

[*] Guidance is available from www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

- 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 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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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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Document title	Sound of Islay Demonstration Tidal Array Inter-tidal survey of potential cable routes on the Isle of Jura
Document short title	
Status	Final Report
Date	14th December 2009
Project name	
Project number	9T3474
Client	Scottish Power Renewables
Reference	9T3474/R/303352/Edin

Drafted by	David Tarrant and Jennifer Trendall	
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Date/initials check	…………………	14/12/09……….
Approved by	Frank Fortune	
Date/initials approval	…………………	14/12/09……….

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 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.

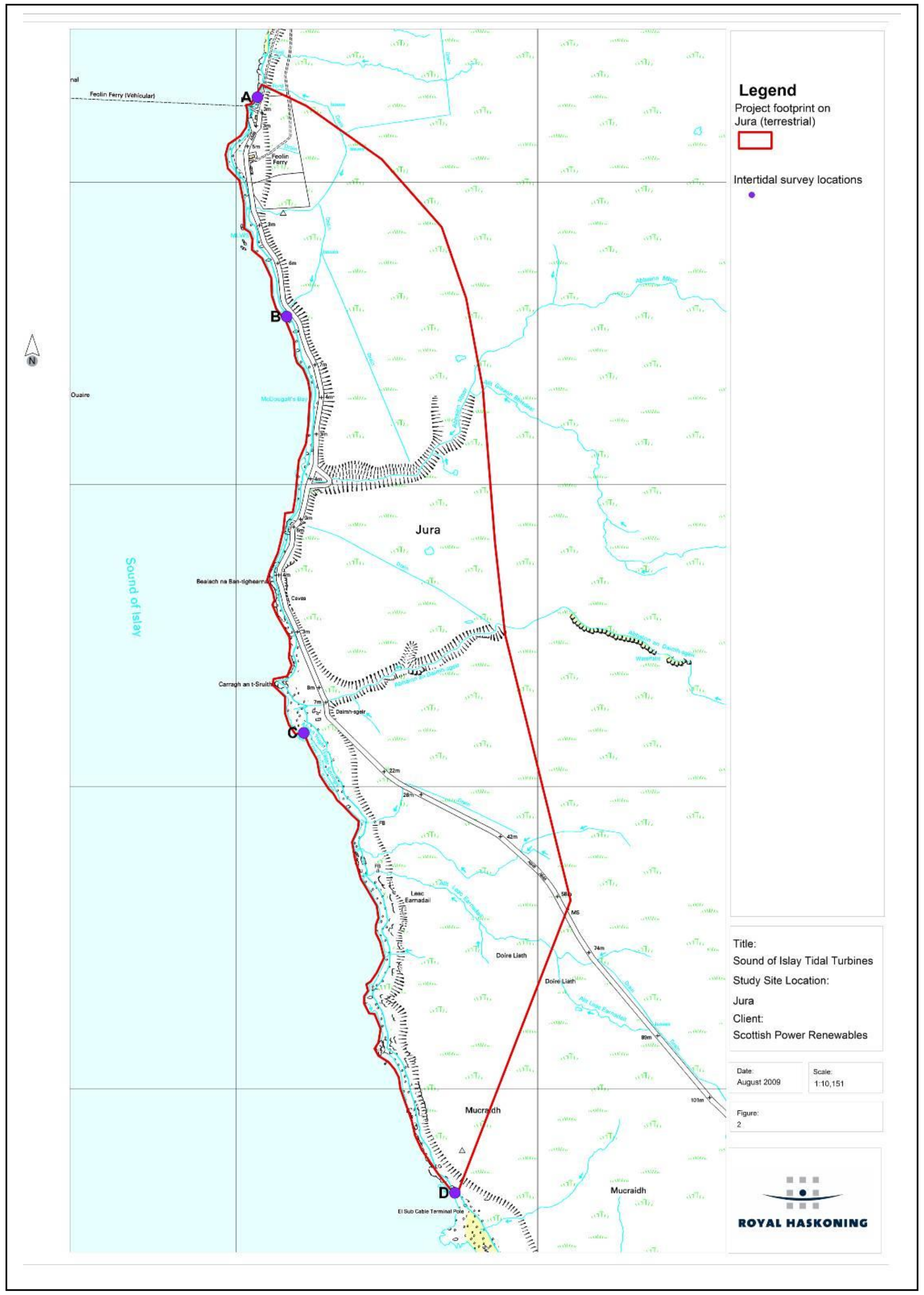

Figure 1.1. Locations of intertidal survey sites A – D.

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°, 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°, 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

Location on tape measure (m)	Description	Biotope
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

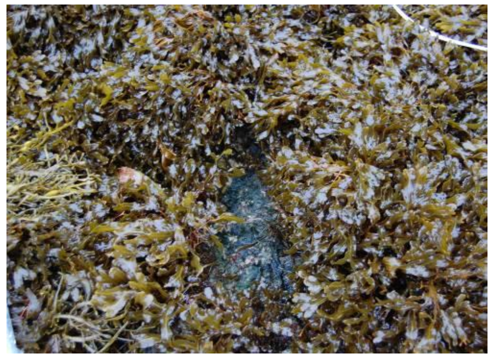

Plate 3.6. Transect A2: Mid shore dominated by *Fucus spiralis*, especially on the higher ground

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

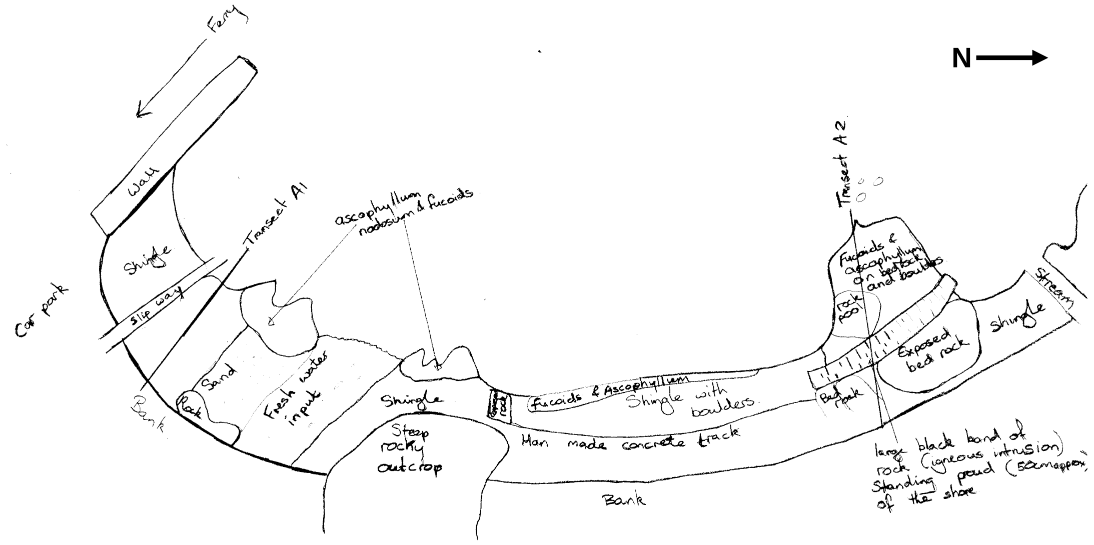

Figure 3.1. Sketch Map of Site A - showing target notes and distribution of species and habitats

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.

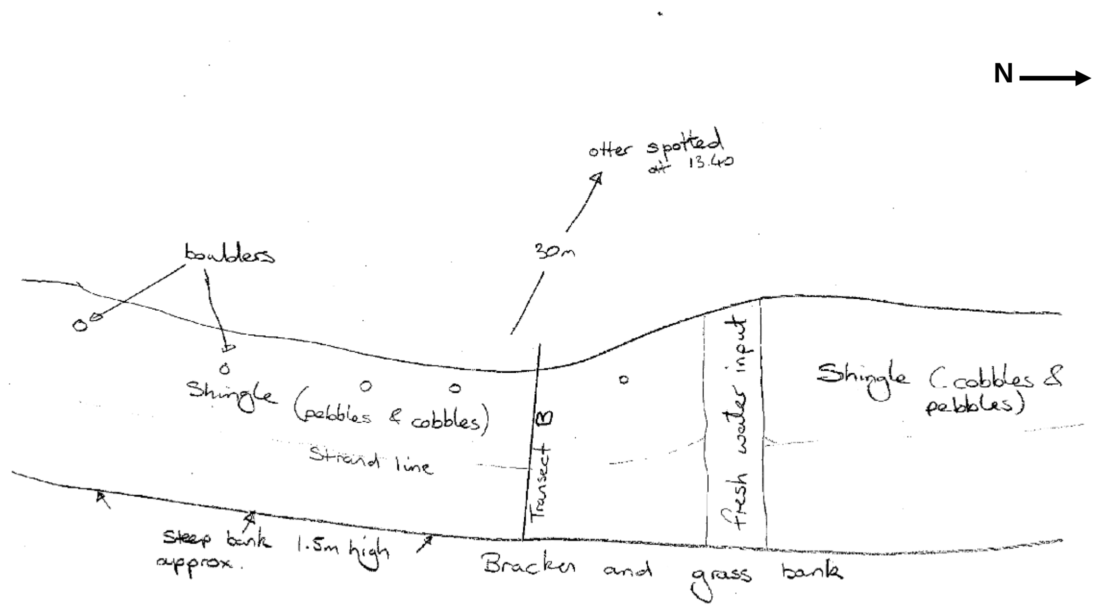

Figure 3.2. Sketch Map of Site B- showing target notes and distribution of species and habitats

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

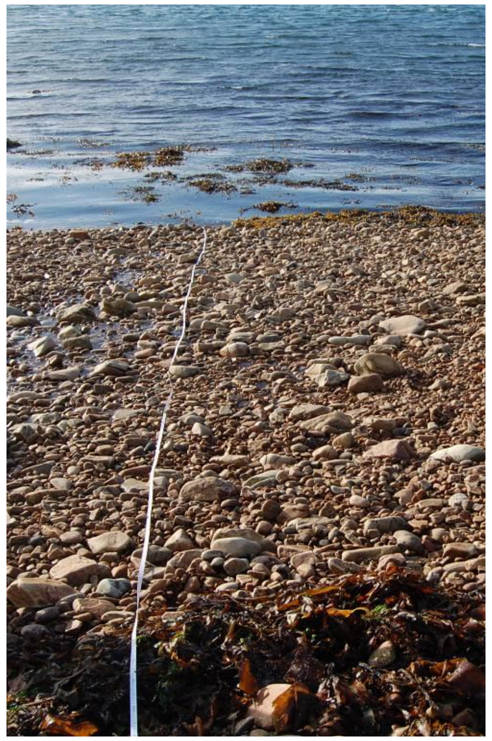

Plate 3.18. Transect C.2: Strandline on cobbles and cobbles with no algae. Small diffuse stream on left of picture

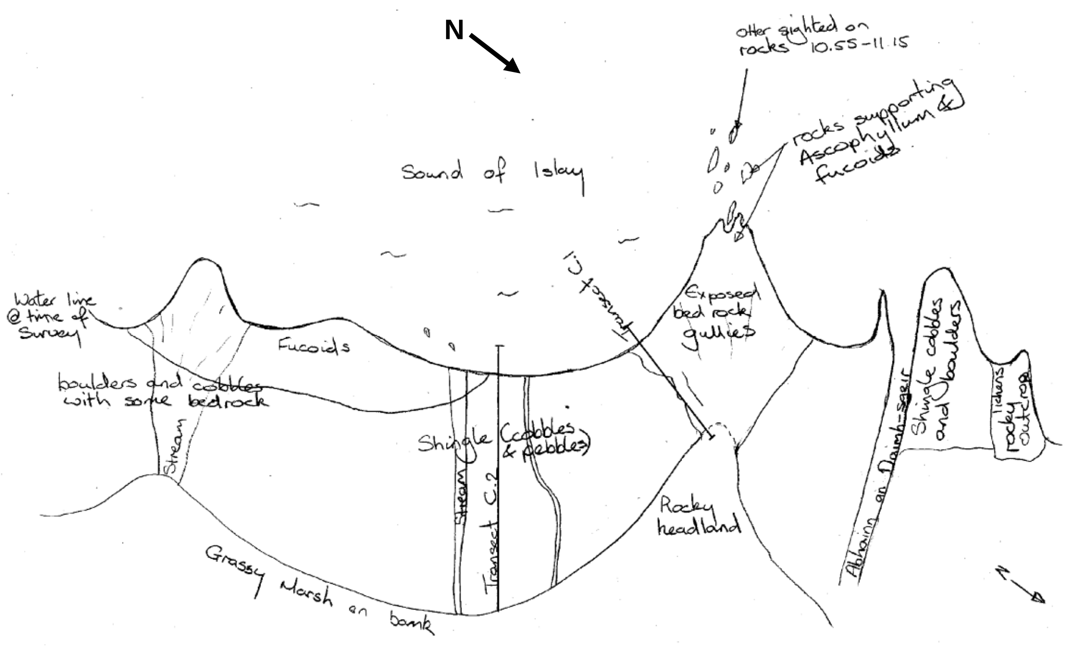

Figure 3.3. Sketch Map of Site C- showing target notes and distribution of species and habitats

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) Chondrus 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

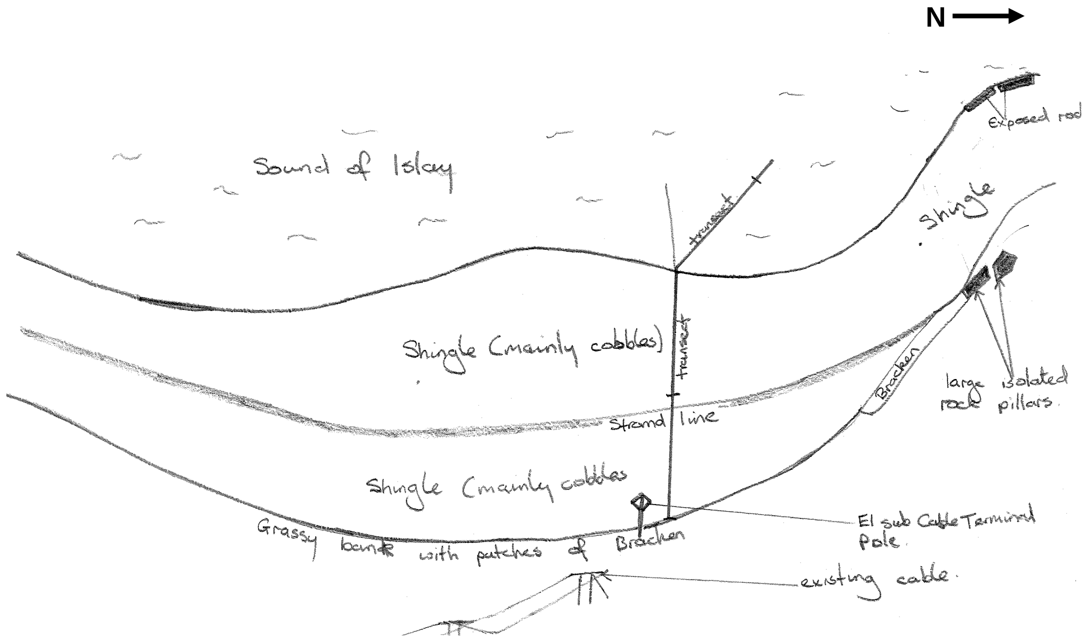

Figure 3.4 Sketch map of site D- showing target notes and distribution of species and habitats

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

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