Development and demonstration of an automated, modular and environmentally friendly multi-functional platform for open sea farm installations of the Blue Growth Industry

D4.1 – Environmental impact assessment for the representative sites report

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LIST OF ACRONIMS AND ABBREVIATIONS

ADD	Acoustic Deterrent Devices
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BGF	Blue Growth Farm
CAR	Controlled Activity Regulations
CDOM	Coloured Dissolved Organic Matter
CEC	Crown Estate Commissioners
CFP	Common Fishery Policy
cSACs	Candidate SACs
EIA	Environmental Impact Assessment
ELC	European Landscape Convention
EPS	European Protected Species
EUNIS	European Nature Information Systems
FEAP	Fedreation of European Aquaculture Producers
FHI	Fish Health Inspectorate
GES	Good Ecological Status
HES	Historic Environment Scotland
HLA	Historic Land-use Assessment
HRA	Habitat Regulation Appraisal
ICZM	Integrated Coastal Zone Management
IUCN	Internation Union for the Conservation of Nature
JNCC	Joint Nature Conservation Committee
LBAP	Local Biodiversity Action Plan
LCA	Landscape Character Assessments
LCT	Landscape Character Types
LDP	Local Development Plan
LSE	Likely Significant Effects
LVIA	Visual Impact Assessment
MARG	Marine Assessment and Reporting Group
MMO	Marine Management Organisation
MPAs	Marine Protected Areas
MPS	Marine Policy Statement
MSFD	Marine Strategy Framwork Directive
N-RIP	National Renewables Infrastructure Plan
NE	Natural England
NMP	National Marine Plan
NPF 3	National Planning Framework 3
NTS	National Trust for Scotland
O&G	Oil and Gas
OREI	Offshore Renewable Energy
PBR	Potential Biological Removal
PMF	Priority Marine Features
pSACs	proposed SACs
pSPA	Proposed Special Protection Area
REAP	Renewable Energy Action Plan
SAC	Special Areas for Conservation
SCIs	Sites of Community Importance

SEA	Strategic Environmental Assessement
SEERAD	Scottish Executive Environment and Rural Affairs Department
SEPA	Scottish Environment Protection Agency
SMAs	Seal Management Areas
SMRU	Sea Mammals Research Unit
SNH	Scottish Natural Heritage
SPA	Special Protection Areas
SPP	Scottish Planning Policy
SSSI	Sites of Special Scientific Interest
TCE	The Crown Estate
UK	United Kingdom
UKMMAS	Marine Monitoring and Assessment Strategy
WCA	Wildlife and Countryside Act
WFD	Water Framework Directive
WLAs	Wild Land Areas
ZTV	Zone of Theoretical Visibility

CHAPTER 1: INTRODUCTION

The aim of the **Blue Growth Farm project** is to develop and demonstrate an automated, modular and environmentally friendly multi-functional platform for open sea farm installations of the Blue Growth Industry. Therefore, this project can be a driver on designs a system to produce food and energy at the least environmental load.

The BGF platform design is based has the following aims:

- Ensuring a nominal 2.000t/y fish production, operating with advanced automation and remote control capabilities;
- Avoid or minimize the pollution to the surrounding marine ecosystem, at the same time exploiting the marine natural resources in a sustainable way;
- Maximize the electricity production in the BGF potential installation area, dispatching produced electric energy to the grid and providing a maritime electric station service to shipping.

In particular, WP4 aims to carry out the Environmental Impact Assessment studies for the Blue Growth Farm concept and potential exploitation. In this respect, the present report of the Task 4.1 performs an assessment of all the main environmental components possibly impacted by the BGF installation, as a farm located in open sea. The outcome of this study has to be intended as a decision-making support tool for the development, designing and exploitable phases of the project, aiming at avoiding/reducing/compensating any likely environmental negative effect.

IDENTIFICATION OF THE DOCUMENT AND ITS STRUCTURE

The present document is a WP4 deliverable of the European Commission funded project "The Blue Growth Farm" (under Grant Agreement no.774426, in the framework of H2020 programme). The deliverable D4.1 "Environmental Impact Assessment" is the first step to the assessment of the overall environmental sustainability of the BGF system.

The document is organised in the following chapters:

- Chapter 1 introduce and specifies the structure of the document;
- Chapter 2 describes programmatic framework, starting form the international legal context to the local;
- Chapter 3 describes the environmental characteristic of the selected site;
- Chapter 4 outline the Project and the features of its main operational life;
- Chapter 5 provides the assessment of the impacts on the main components, taking into account the sensitive receptors, and including mitigation measures;
- Chapter 6 reports the final recommendations
- Chapter 7 is the conclusions of the document;
- Chapter 8 lists the quoted references.

Within this part of the document, the international legal framework and all the methods used to assess the environmental impacts are not described, as well detailed informations on generic impact on main group of receptors as mammals, birds, fish etc. The reader is thus diverted to the D 4.1 – France document for all informations.

CHAPTER 2: PROGRAMMATIC FRAMEWORK

2.1 INTERNATIONAL ENVIRONMENTAL POLICY

2.2 ENVIRONMENTAL LEGAL FRAMEWORK

2.2.1 The MSFD application

A key requirement of the Directive is that Member States work together to implement each stage of the Directive in a coherent and coordinated way, in order to ensure comparability across Europe. For the UK, regional coordination is focused on other Member States in the North East Atlantic region and the OSPAR Regional Sea Convention has been the key forum for the coordination process.

The Directive covers the extent of the marine waters over which the UK exercises jurisdiction. This area extends from the landward boundary of coastal waters as defined by the WFD (which is equivalent to Mean High Water Springs) to the outer limit of the UK Renewable Energy Zone. It also includes the seabed in the area of the continental shelf beyond the renewable energy zone over which the UK exercises jurisdiction on the basis of a submission to the Commission on the limits of the continental shelf. The area of UK waters over which the MSFD applies is shown below in Figure 1.

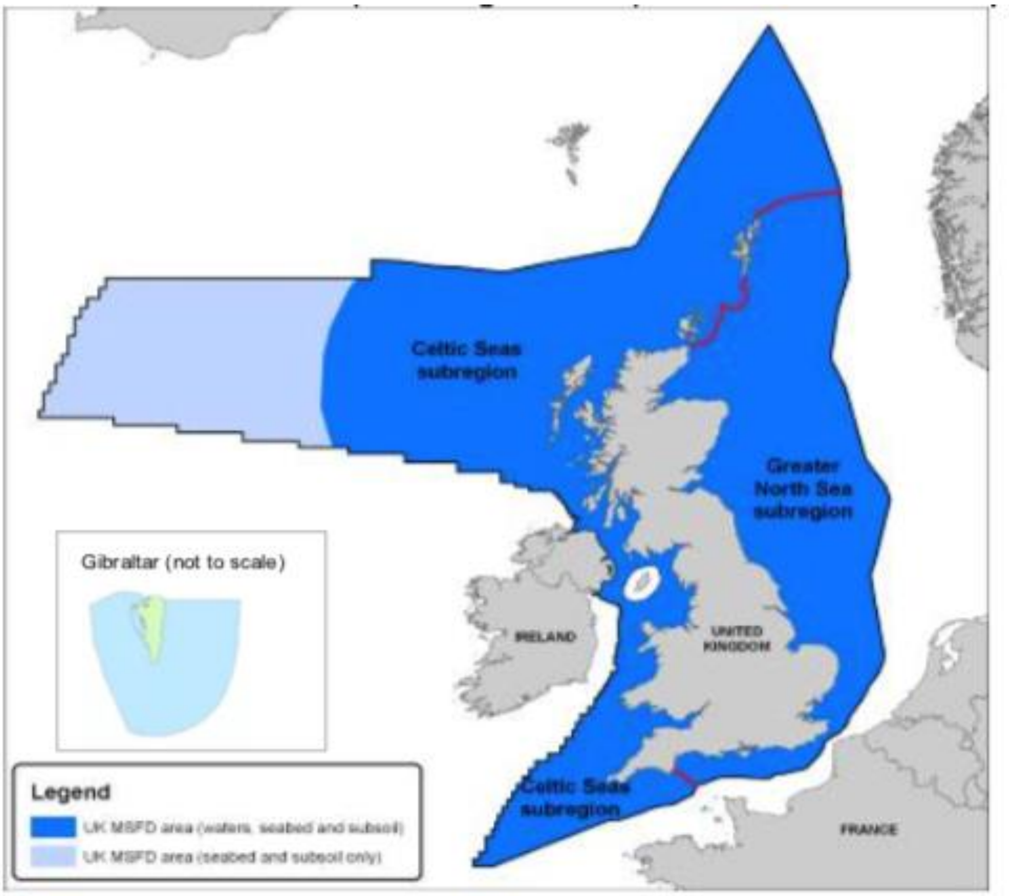


Figure 1: Area of UK marine waters (including Gibraltar) over which the MSFD applies
(Source: www.gov.scot)

There is some overlap between the waters covered by the WFD and the MSFD. The WFD relates to improving and protecting the chemical and biological status of surface waters throughout River Basin Catchments from rivers, lakes and groundwaters through to estuaries (transitional) and coastal waters to 1 nautical mile (nm) out to sea (3nm in Scotland) and overlaps with MSFD in coastal waters (12nm for chemical status). The MSFD includes coastal waters (as defined by the WFD) but does not include WFD transitional waters (e.g. estuaries, sea lochs, coastal lagoons). For estuaries, the boundary between the two directives is the “bay closing line” which is the seaward limit of “Transitional Waters” as defined under the WFD (Figure 2).

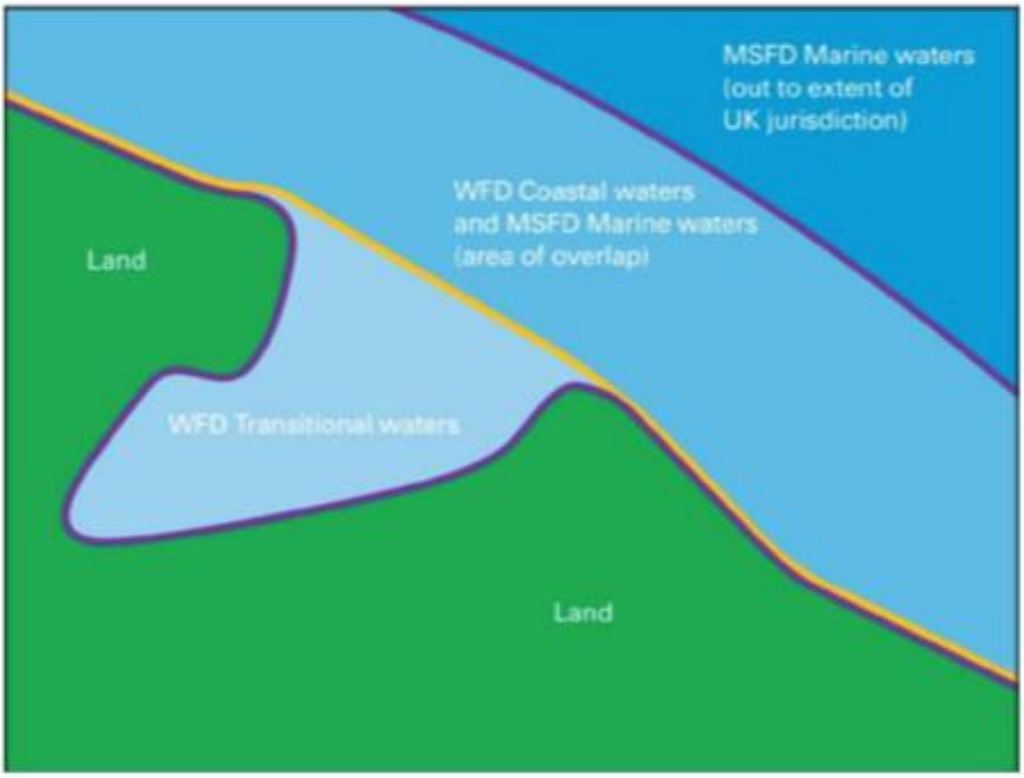


Figure 2: MSDF/WFD boundaries *(Source: www.gov.scot)*

The Directive has been transposed into UK legislation via the Marine Strategy Regulations 2010, which apply to the whole of the UK – including the Administrations in Scotland, Wales and Northern Ireland. Gibraltar has transposed the Directive via the Marine Strategy Regulations (Gibraltar) (2011). The Directive is being implemented in a coordinated way across the UK Administrations and part 1 of the UK Marine Strategy has been developed at a UK-wide scale with input from experts and policy-makers across the UK Administrations. The Devolved Administrations will lead the development of GES monitoring programmes and programmes of measures for their marine waters, working in coordination with one another. Gibraltar has a separate implementation process and is developing an Initial Assessment and GES characteristics, targets and indicators for British Gibraltar Territorial Waters.

The Directive splits Europe’s waters into four marine regions and associated Subregions.

The UK's marine waters are in the North East Atlantic Ocean marine region, with waters to the west of the UK comprising part of the Celtic Seas Subregion, and waters to the east of the UK, including the Channel, forming part of the Greater North Sea Subregion. The UK shares the Celtic Seas Subregion with Ireland and France, and the Greater North Sea Subregion with France, Belgium, the Netherlands, Germany, Denmark, Sweden and Norway. All these countries are contracting parties to the OSPAR Convention19 for the protection of the marine environment of North East Atlantic and OSPAR has played the primary role in coordinating the implementation of the Directive in this marine region. British Gibraltar Territorial Waters are located in the Mediterranean region, and separate arrangements for coordination with other Mediterranean countries will be put in place.

The UK has one marine strategy covering the whole of its marine waters and the UK initial assessment, characteristics of GES and associated targets and indicators set out in our Marine Strategy Part One were developed at this scale, in coordination with other countries in the North East Atlantic Region. However, where there are significant biogeographical differences between the Greater North Sea and the Celtic Seas subregions these were taken into account.

The three key elements:

- **The Initial Assessment of the State of the UK's seas Cover Paper** – This provides an analysis of the essential features, characteristics and environmental status of UK marine waters, together with an analysis of economic and social use of UK marine waters and predominant pressures and their impacts. The evidence base for the UK Initial Assessment was developed by a wide range of UK experts working in the UK Marine Monitoring and Assessment Strategy (UKMMAS) framework. An initial assessment for British Gibraltar Territorial Waters is being prepared separately.
- **Characteristics of GES for the UK's seas** – these provide a high-level, qualitative description of what the UK marine environment will look like when GES is achieved. The GES characteristics have been developed by policy makers in consultation with experts and key stakeholders.
- **GES targets and indicators of GES** - these build on the high-level characteristics described above, providing a more detailed, quantitative assessment framework for guiding progress towards GES. The GES targets and indicators have been developed on the basis of scientific advice provided by the Centre for Environment, Fisheries and Aquaculture Science (Cefas), the Joint Nature Conservation Committee (JNCC) and a large range of experts, including those involved in the UK Marine Monitoring and Assessment Strategy.

The UK Marine Strategy Part Two provides summaries of the UK Monitoring programmes. This meets the requirements of the second stage of the MSFD which is to establish and implement a monitoring programme to measure progress towards achieving GES. The relevant Articles in the Directive are set out below:

According to **Article 5 (2) (a iv)** of Directive 2008/56/EC, an essential element for the preparation of marine strategies is the "establishment and implementation, by 15 July 2014 except where otherwise specified in the relevant Community legislation, of a monitoring programme for ongoing assessment and regular updating of targets, in accordance with Article 11(1)".

Article 11 (1) then specifies that: "on the basis of the initial assessment made pursuant to Article 8(1), Member States shall establish and implement coordinated monitoring programmes for the ongoing assessment of the environmental status of their marine waters on the basis of the indicative lists of elements set out in Annex III and the list set out in Annex V, and by reference to the environmental targets established pursuant to Article 10. Monitoring programmes shall be compatible within marine regions or subregions and shall build upon, and be compatible with, relevant provisions for assessment and monitoring laid down by Community legislation, including the Habitats and Birds Directives, or under international agreements."

In addition, **Article 11 (2)** provides that "Member States sharing a marine region or subregion shall draw up monitoring programmes in accordance with paragraph 1 and shall, in the interest of coherence and coordination, endeavour to ensure that: (a) monitoring methods are consistent across the marine region or subregion so as to facilitate comparability of monitoring results; (b) relevant transboundary impacts and transboundary features are taken into account."

Also, **Annex V** sets out a list of needs for monitoring programmes. Before the monitoring programmes are finalised and notified to the Commission, Member States must publish and consult the public on summaries of the programmes (**Article 19 (2) (c)**). Then, Member States have to notify (report) their monitoring programmes to the European Commission by 15 October 2014 (**Article 11 (3)**) and the European Commission has to assess these programmes within six months of receiving all those notifications (**Article 12**). An update of the monitoring programmes is required every six years, i.e. by 15 July 2020 at the latest (**Article 17 (2) (c)**). Finally, the Commission and the EEA must receive access and use rights in respect of data and information resulting from the monitoring programmes (**Article 19 (3)**).

The framework used for monitoring the marine environment in the UK

The scientists working in the four evidence groups of the UKMMAS community develop the methods and carry out the monitoring programmes required to assess the state of the UK Seas. The evidence groups are overseen by a science/policy committee called the Marine Assessment and Reporting Group (MARG) (Figure 3). UKMMAS was set up in 2006 to achieve a more coordinated and systematic approach to marine monitoring, assessment and data collection across the UK. It brings together all of the UK and Devolved Administration Departments with interests in the marine environment, the environment agencies, nature conservation agencies and marine laboratories, and representatives from marine institutes and the research communities.

UKMMAS currently sits under the Marine Science Coordination Committee (Figure 3).

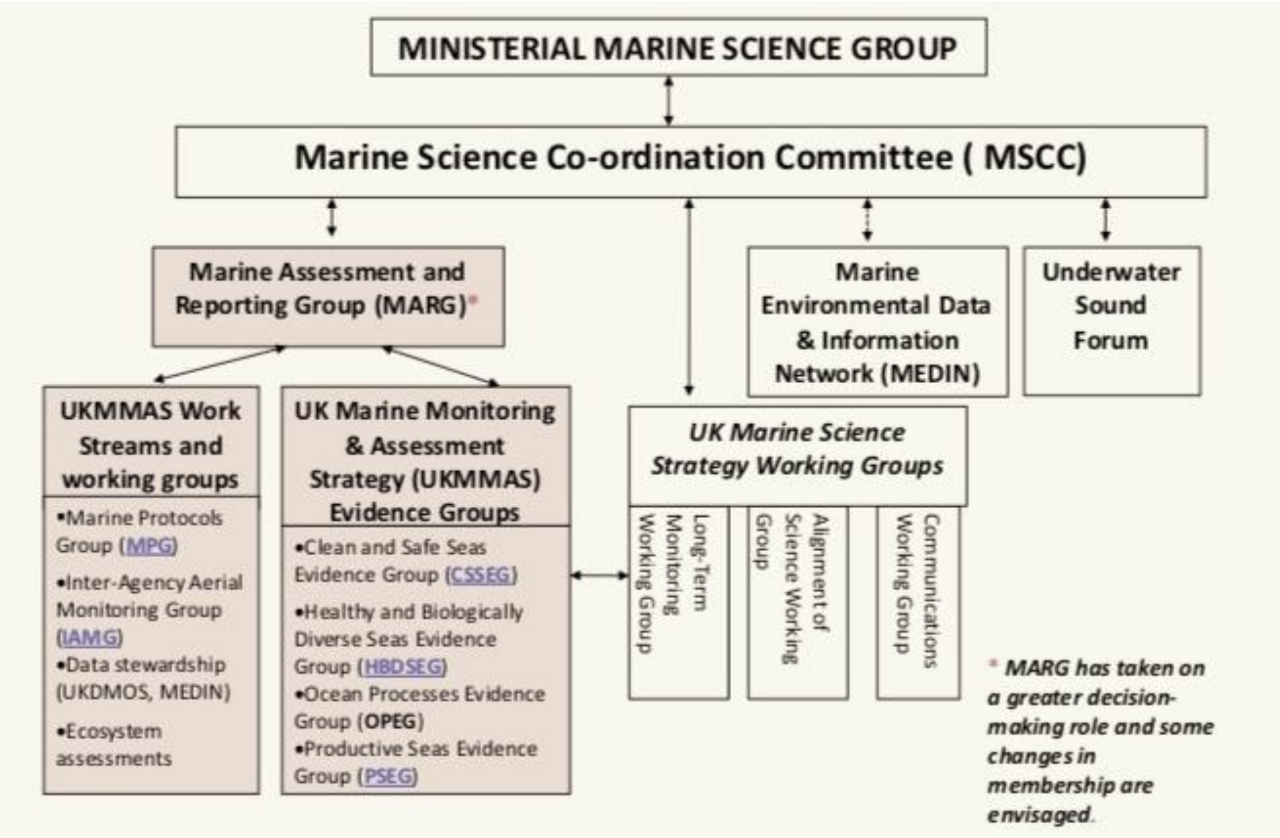


Figure 3: Structure of the Marine Science Coordination Committee

2.2.2 The Strategic Environmental Assessement

The Environmental Assessment (Scotland) Act 2005 (2005 Act) came fully into force on 20 February 2006. The 2005 Act ensures that the environmental effects of public plans that fall within its scope are properly assessed and are outlined in an Environmental Report. The Environmental Report and the plan to which it relates must be then open to a meaningful public consultation. This must be undertaken at an early stage in the preparation process, to give interested parties an opportunity to comment and help shape the content of the plan, prior to its adoption.

The 2005 Act implements the EU Directive 2001/42/EC, 'on the assessment of the effects of certain plans and programs on the environment' which was the original driver for SEA within Scotland.

The 2005 Act requires Scottish public bodies or those exercising functions of a public character (Responsible Authorities) to undertake a SEA when preparing plans, if it is likely to have significant environmental effects. This applies to plans with significant positive or negative environmental effects.

Some plans are automatically exempt from the 2005 Act:

- National defense or civil emergency plans; financial or budgetary plans; and plans relating to individual schools.

The plans that fit the following criteria are likely to be subject to SEA:

- Are prepared and/or adopted at the national, regional or local level;
- Relate to matters of public character (this can be a public sector body or a private sector or voluntary body undertaking work of a public character);
- Relate solely to Scotland.

Involved Authorities

The Scottish statutory Consultation Authorities are:

- Scottish Environment Protection Agency (SEPA),
- Scottish Natural Heritage (SNH), and
- The Scottish Ministers (Historic Scotland).

The role of the statutory Consultation Authorities within SEA is to bring their individual environmental expertise to the assessment process. This can help to ensure that the future consultation process undertaken by a Responsible Authority is more robust. This in turn means that the public can gain a better understanding of the likely effect of a plan on the environment and meaningfully contribute to the plan's preparation process by offering an informed view.

The UK legislation

A plan could fall within the scope of the Environmental Assessment of plans and programmes Regulations 2004 (the UK Regulations), if its geographical coverage extends beyond Scotland. If a plan or part of a plan extends into another part of the UK, it has to be considered under the requirements of the UK Regulations.

Plans those are limited to Scotland, but which could have environmental effects on another part of the UK, are subject to the 2005 Act rather than the UK Regulations. In such cases it may be necessary to ensure that the relevant UK Consultation Bodies are consulted on potential cross border environmental effects. As with Scottish submissions, the SEA Gateway teams can co-ordinate UK consultation correspondence.

In addition to the Scottish SEA Consultation Authorities, the UK Consultation Bodies are:

- England: English Heritage, Environment Agency and Natural England
- Wales: Cadw (Welsh Historic Monuments) and Natural Resources Wales
- Northern Ireland: Department of the Environment

The ecosystem approach to SEA

The Convention on Biological Diversity describes an ecosystems approach as a "strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". Given the wide coverage of environmental topics that the 2005 Act requires a SEA to consider, there are strong synergies with an ecosystem approach.

The Scottish Government publication "Applying an ecosystems approach to land use: information note" highlights the importance of protecting the natural environment, not only from a custodian perspective, but also on the basis that the natural environment provides services that contribute to human wellbeing and community health. These services also have real economic value, both directly and indirectly through the economic activities they underpin or protect.

The note sets out three key principles for applying an ecosystems approach:

a) **Consider natural systems** - this promotes the use of knowledge of environmental interactions and how these affect the way ecosystem function. This includes concepts of ecosystems capacity for change and how this may occur spatially and temporally.

b) **Take account of the services that ecosystems provide** - this includes identifying and accounting for relevant ecosystem services that could be affected by strategic actions.

c) **Involve people** - this seeks to ensure that those who benefit from the ecosystem services and those managing them are involved in decision making.

An ecosystems approach aims to change the way of considering and analyse the use of natural resources. An SEA provides a means to consider how certain actions within a plan are likely to impact on a range of environmental receptors. An ecosystems approach, when integrated into an SEA, can help decision makers to look at the wider linkages between the plan's actions and its impact on the environment, including how we value and use that environment.

2.2.3 The Environmental Impact Assessment (EIA) Application

The main aim of the Environmental Impact Assessment Directive ("the EIA Directive") (2011/92/EU) as amended by (2014/52/EU) is to ensure that the authority granting consent the 'competent authority' (Scottish Ministers in this context) for a particular project makes its decision in full knowledge of any likely significant effects ("LSE") on the environment. The Directive therefore sets out a procedure that must be followed for certain types of projects before they can be given 'consent'. This procedure is a means of drawing together, in a systematic way, an assessment of a project's likely significant environmental effects. This helps to ensure that the importance of the predicted effects, and the scope for reducing any adverse effects, are properly understood by the public and Scottish Ministers before a decision is made.

Any EIA must take account of the OSPAR List of threatened and/or declining species and habitats. EIA includes the following broad stages:

Pre-application

- Screening - determines whether an EIA is required.
- Scoping - identifies the issues which must be addressed in the EIA Report.

Application

- EIA Report: assesses the likely significant effects of a project
- Consultation/public participation by Scottish Ministers: to gather views from stakeholders on the likely effects of the project.
- Determination: made by the Scottish Ministers having considered the environmental information, mitigation and consultation responses. Post-consent
- Multi-stage consent / regulatory approval: will apply following consent.

The EIA Directive has been transposed into Scottish and UK legislation. The following regulations may apply to offshore renewable energy projects:

The *Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017* as amended by *The Environmental Impact Assessment (Miscellaneous Amendments) (Scotland) Regulations 2017* apply to all applications for s.36 consent in Scottish waters out to 200 nm.

The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended by *The Environmental Impact Assessment (Miscellaneous Amendments) (Scotland) Regulations 2017* apply to applications that require an EIA (as defined in schedule 2 of the 2017 Marine Works Regulations) for a marine licence from 0-12 nm.

The Marine Works (Environmental Impact Assessment) Regulations 2007 as amended by *The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011*, *The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2015* and *The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017* apply to applications that require an EIA, for a marine licence from 12-200 nm.

For applicants, EIA can help to identify the likely significant environmental effects of a particular development at an early stage. This can produce improvements in the planning and design of the development and in decision making by both the developer and Scottish Ministers. In addition, applicants may find EIA a useful tool for considering alternative approaches to a development. This can result in a final proposal that is more environmentally acceptable, and can form the basis for a more robust application for consent. The presentation of environmental information in a more systematic way may also simplify Scottish Ministers' task of appraising the application and drawing up appropriate conditions, lead to more meaningful consultations, and can help enable swifter decisions to be reached.

2.2.4 The Habitats Directive

The Habitats Directive is the short name for European Union Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

The Habitats Directive:
- was adopted in 1992
- is part of EU nature legislation
- adds to and amends the Birds Directive

As well as establishing Natura 2000 sites and setting out how they should be protected, the Directive extends to European protected species and other issues. It is a major contribution by the European Community towards realising the Convention on Biological Diversity, agreed at the 1992 Rio Earth Summit.

In Scotland, the Habitats Directive is translated into specific legal obligations by the Conservation (Natural Habitats, &c.) Regulations 1994. This piece of legislation is usually known as the Habitats Regulations.

The Habitats Regulations cover the requirements for:

- sites that are internationally important for threatened habitats and species – i.e. Natura sites
- species requiring strict protection – i.e. European protected species
- other aspects of the Habitats Directive

The Habitats Regulations have been amended in Scotland, most recently in 2012. Amendments have also been made to the legislation in England and Wales in the Conservation of Habitats and Species Regulations 2017.

Despite this variation, development proposals affecting Natura sites are assessed the same way across Great Britain – uing Habitat Regulation Appraisal (HRA).

The HRA process relates specifically to the consideration of habitats or species under the EU Habitats and Birds Directives and associated transposing regulations. The process considers the potential effects of the development on internationally important habitats and/or species for which the sites are designated. The assessment includes consideration of direct and indirect effects on these interests and must also consider cumulative and in-combination effects from other proposed plans or projects.

A HRA is required under the Conservation Regulations 1994 (as amended). The HRA is an assessment impact of the plans and projects to impact on sites designated under the European Habitats or Birds Directives as Special Areas for Conservation (SAC) or Special Protection Areas (SPA). The process has identified whether the Draft Plan Options have the potential for likely significant effects on European sites, either alone or in-combination. Areas of search which were found to have the potential for likely significant effects were then subject to an 'appropriate assessment' which considered the draft plans' implications for the European sites in view of the sites' conservation objectives. A view was then taken on whether the draft plans will avoid adverse effects on the integrity of European sites.

The HRA process can be summarised as three steps:

- Step 1: Is the proposal directly connected with or necessary for site management for nature conservation?
- Step 2: Is the proposal likely to have a significant effect on the site either alone or in-combination with other plans or projects?

- Step 3: Can it be ascertained that the proposal will not adversely affect the integrity of the site either alone or in-combination with other plans or projects (the AA).

If the HRA screening process concludes that the potential for LSE cannot be excluded then its scope should include the collation, and presentation, of information to enable an AA to be undertaken. The AA that is undertaken by Scottish Ministers must ascertain whether the proposed project will or will not adversely affect the integrity of the European site(s) concerned. In cases where there is doubt about the presence or absence of adverse effects on integrity, the proposal may not proceed unless there are no alternative solutions and there are imperative reasons of over- riding public interest. The HRA is an integral document to the consent and licence applications and should be submitted as part of the application package of documents required under the EIA process.

Under the Habitats Regulations the follow sites types have full legal protection:

- SAC - a site formally designated by a member state
- SPA - a site formally classified by a member state
- Sites of Community Importance (SCIs) – a site adopted by the European Commission but not formally designated.
- Candidate SACs (cSACs) – a site proposed by a member state but not yet adopted by European Commission

Under Scottish Government policy Ramsar sites are also protected under the same statutory regimes. There is no need to consider Ramsar sites separately if they overlap with SACs and/or SPAs.

Under Scottish Planning Policy the follow site types should be treated as if fully designated, Sites which have been approved by Scottish ministers for public consultation.

- Proposed Special Protection Area (pSPA)
- proposed SACs (pSACs)

The following have no legal status but should be given appropriate consideration: Draft SPAs (dSPAs) and draft SACs (dSACs) – Sites that the statutory nature conservation advisor has provided advice that the area is suitable for designation.

Relationship between HRA and EIA

HRA is undertaken by the developer and should provide Scottish Ministers with the information required for them to either complete an AA or to rule out the potential for LSE on the qualifying interests of European sites. It is a separate requirement from EIA, due to the specific assessment and legislative requirements for projects that may affect European sites, although both often need to be informed by the same information. It is also necessary for projects, which do not require EIA to undergo HRA if there is a LSE. In these cases, full presentation of a HRA assessment and evidence will be required out with the EIA process. Additionally, the terms ‘significant’, ‘compensation’ and ‘mitigation’ have different definitions/implications under the EIA and HRA legislation and these needs to be clearly understood at the outset.

Where an appropriate assessment is required, the competent authority must consult SNH. As with EIA, applicants should be aware of timescales for obtaining the necessary data.

The Conservation of Habitats and Species Regulations 2017 apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36 and 37 of the Electricity Act 1989. The Offshore Marine Regulations 2017 apply in Scottish waters more than 12 nautical miles from land.

The Conservation of Habitats and Species Regulations 2017 consolidate the Conservation of Habitats and Species Regulations 2010 with subsequent amendments. The Regulations transpose Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive), into national law. They also transpose elements of the EU Wild Birds Directive in England and Wales. The Regulations came into force on 30th November 2017, and extend to England and Wales (including the adjacent territorial sea) and to a limited extent in Scotland (reserved matters) and Northern Ireland (excepted matters). In Scotland, the Habitats Directive is transposed through a combination of the Habitats Regulations 2010 (in relation to reserved matters) and the Conservation (Natural Habitats &c.) Regulations 1994.

The Regulations provide for the designation and protection of 'European sites', the protection of 'European protected species', and the adaptation of planning and other controls for the protection of European Sites.

Under the Regulations, competent authorities i.e. any Minister, government department, public body, or person holding public office, have a general duty, in the exercise of any of their functions, to have regard to the EC Habitats Directive and Wild Birds Directive.

Certain provisions implement aspects of the Marine and Coastal Access Act 2009 (the “Marine Act”), such as the transfer of certain licensing functions from Natural England (NE) to the Marine Management Organisation (MMO); and for Marine Enforcement Officers to use powers under the Marine Act to enforce certain offences under the Habitats Regulations.

The Habitats Regulations apply only as far as the limit of territorial waters (12 nautical miles from baseline). The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 apply the Habitats Directive and the Birds Directive in relation to oil and gas plans or projects wholly or partly on the United Kingdom's continental shelf and superjacent waters outside territorial waters.

2.2.5 The Birds Directive

Directive on the Conservation of Wild Birds (EU Birds Directive) Marine Scotland leads on the implementation of the EU Birds Directive in Scottish territorial waters and the Scottish offshore region. This includes designation and management of SPAs, establishing and operating a system of

strict protection for particular species that are listed in the Directive, and responsibility for surveillance and monitoring of the species and habitats protected by the Directive.
The Wildlife and Countryside Act 1981 was enacted to implement the Birds Directive (and also the Bern Convention) in Great Britain. Therefore, all wild birds in Great Britain are protected today under the Wildlife and Countryside Act 1981 (as amended).

2.2.6 Marine Protected Areas

A network of Nature Conservation MPAs have been designated in Scottish waters under the Marine (Scotland) Act 2010 or the Marine and Coastal Access Act 2009 since 2014, protecting habitats and species such as maerl beds, flame shell beds, and common skate. Eight Historic MPAs have been designated to preserve sites of historical importance around the Scottish coast.

Under section 83 of the Marine (Scotland) Act 2010 / section 126 of the Marine and Coastal Access Act 2009 Public Authorities (including the Scottish Ministers) are required to consider whether a project is capable of affecting (other than insignificantly) a protected feature in an MPA. The Public Authority must not grant authorisation to the activity unless satisfied that there is no significant risk of the activity hindering the achievement of the objectives of the site. A similar provision requires consideration of the stated purpose of a demonstration and research MPA, or the stated preservation objective of a Historic MPA.

It is Scottish Government policy that proposed MPAs (pMPAs), which are sites approved by Scottish Ministers for public consultation but not yet designated, should be treated for assessment purposes as if they were designated.

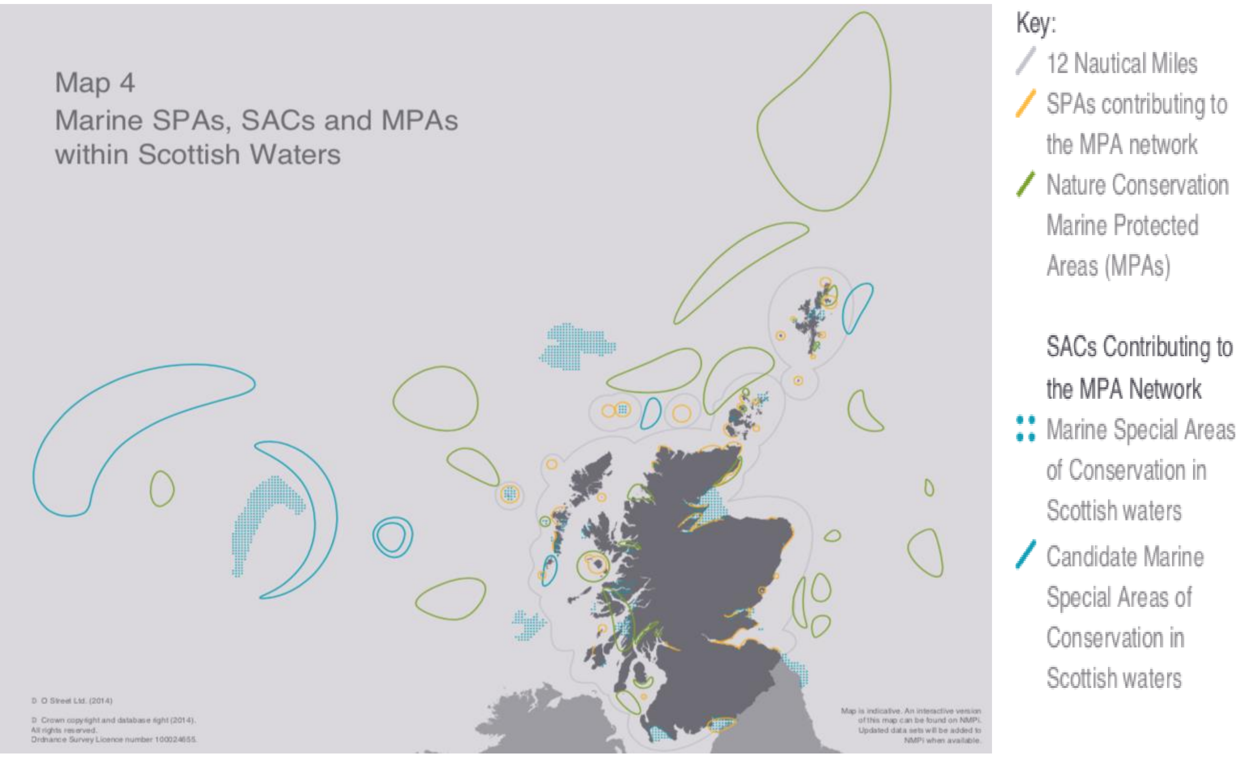


Figure 4: Marine SPAs, SACs and MPAs within Scottish Waters *(Source: www.gov.scot)*

Scotland has some of the most beautiful and diverse marine ecosystems in the world. Marine Scotland is committed to protecting and enhancing these amazing ecosystems to ensure they are safeguarded for future generations to enjoy. Protected areas are used to ensure protection of some of the most vulnerable species and habitats.

The Scottish MPA network (see figure 5) includes sites for nature conservation, protection of biodiversity, demonstrating sustainable management, and protecting our heritage. In total the network covers approximately 22% of our seas and comprises:

- 217 sites for nature conservation protecting a broad range of habitats and species that are found in our seas. Habitats range from rocky shores and sea caves at the coastline to deep-sea habitats such as coral gardens and *Lophelia pertusa*. Species range from harbour porpoise to common skate to puffins.
- 5 other area based measures, which protect species such as sandeels and blue ling, as well as vulnerable marine ecosystems.
- 1 Demonstration and Research MPA around Fair Isle to investigate the factors affecting seabird populations demonstrate the socio-economic benefits of the marine environment.
- 8 Historic MPAs to preserve sites of historical importance around the Scottish coast.

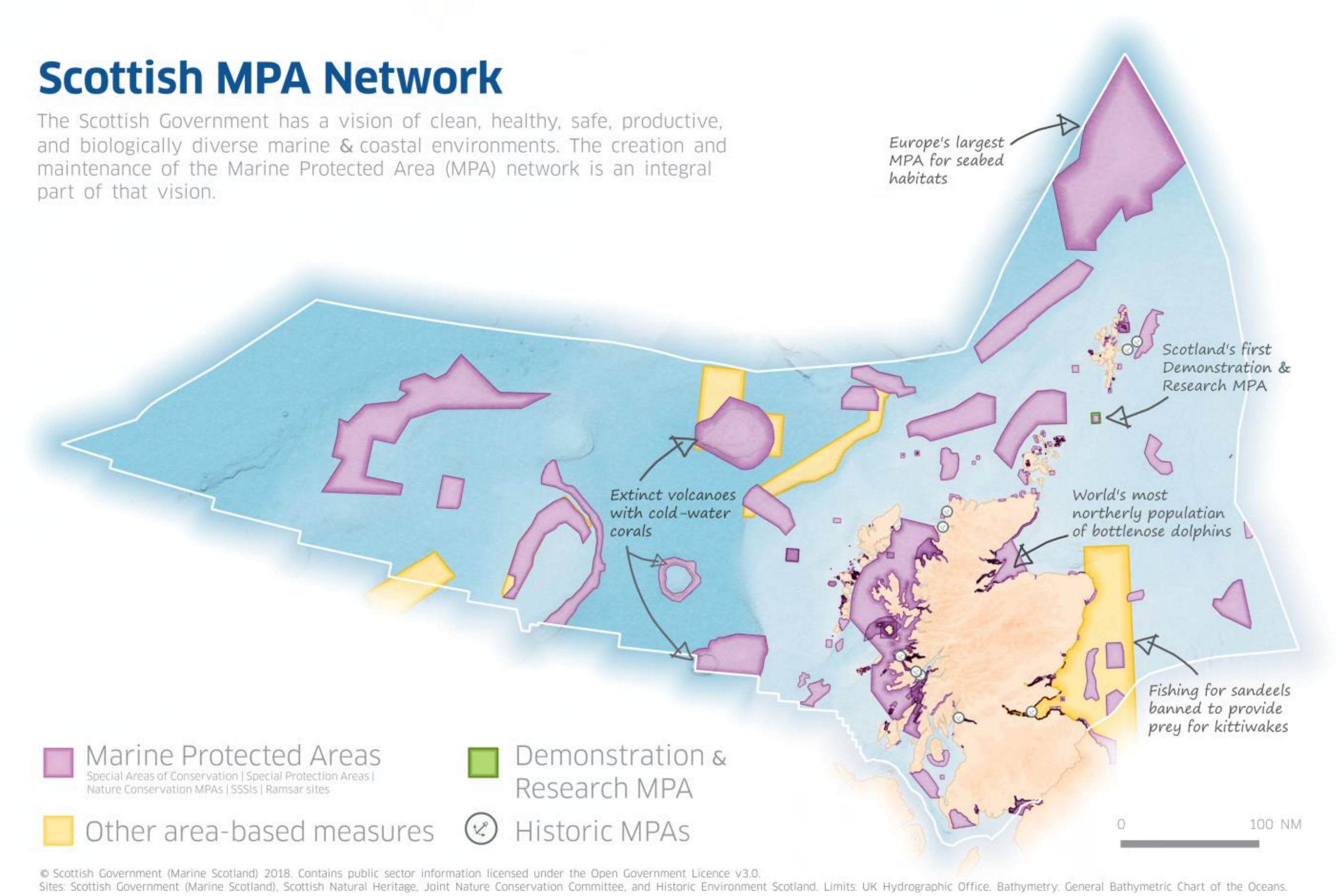


Figure 5: Scottish MPA Network *(Source: www.gov.scot)*

Scotland has made international commitments to establish an ecologically coherent network of MPAs using powers established within the Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009.

Existing protected areas (SACs, SPAs, Ramsar sites, and Sites of Special Scientific Interest (SSSI)) will make a significant contribution to the MPA network. Three different types of MPAs will be set up: Nature Conservation MPAs, Demonstration and Research MPAs and Historic MPAs. The MPAs will protect important marine habitats and wildlife, geology and geomorphology, as well as features of cultural importance such as shipwrecks and submerged landscapes.

The Wildlife and Countryside Act 1981 applies to the terrestrial environment and territorial waters (within 12 nautical miles of land). Part 1 of the Act details a large number of offences in relation to the killing and taking of wild birds, other animals and plants. Schedules attached to the Act categories species. The level of protection given to a species depends on the schedule it’s listed on.

The main schedules are:

- Wildlife and Countryside Act 1981 Schedules 1, 1A, A1, 2, 3 and 4 – birds
- Wildlife and Countryside Act 1981 Schedules 5 and 6 – animals
- Wildlife and Countryside Act 1981 Schedule 8 – plants

Scottish Natural Heritage and the other country agencies must review Schedules 5 and 8 every five years.

2.2.7 Protection of wildlife

Part 3 and Schedule 6 of the Act make amendments to the Wildlife and Countryside Act 1981, strengthening the legal protection for threatened species. The species protection afforded to wild birds, animals and plants is extended to include 'reckless' acts. The protection afforded to the nests of certain, threatened, bird species is extended to all times of the year, and the disturbance of certain bird species at their lek sites is prohibited. The Act makes it an offence to intentionally or recklessly disturb a dolphin, whale or basking shark, and also to sell a self-locking snare, or to possess one without reasonable excuse. Powers are provided to Scottish Ministers to prohibit the sale of certain non-native species. The Act amends and enhances the provisions for enforcement. The Protection of Badgers Act 1992 is also amended.

2.2.8 Coastal law

Scotland’s coastal zone is notable in both a UK and a European context for its scale and variety. At more than 11,000 km the coastline is long relative to the country’s size and it is often highly indented, with island archipelagos to both the north and west. The distribution of these islands gives Scotland one of the largest inshore areas (within 12 nautical miles of the coast) of any country in the EU.

The measures contained within the Directive 2000/60/EC on establishing a framework for Community action in the field of water policy, or the Water Framework Directive (WFD), are implemented to 3 nautical miles.

The Marine (Scotland) Act created a new legislative and management framework for the marine environment to manage the competing demands of the use of the sea whilst protecting the marine environment. It provides for the preparation and adoption of a National Marine Plan (NMP) and for the delegation of marine planning functions to a regional level.

The NMP sets out the strategic objectives for the Scottish marine area including important marine activities such as aquaculture, conservation, recreation and tourism ports, harbours and shipping, alongside renewable energy. It therefore provides the over-arching policy framework for the review of Blue Seas Green Energy as well as the Sectoral Marine Plans for wave and tidal energy in Scotland's Territorial Waters.

Figure 6: Inshore and offshore limits of Scottish territorial waters *(Source: www.gov.scot)*

<u>Argyll and Bute development plan</u>

The approval of the Marine (Scotland) Act in March 2010 introduced a new statutory marine planning framework to manage competing demands for the use of the sea whilst protecting the marine environment. Land based development proposals on the coast will need to consider their effects on the marine environment and its users and in addition to being consistent with LDP policies they will need to consider national and regional marine planning policy. In reaching planning decisions, Argyll and Bute Council will therefore have regard to the National Marine Plan and subsequent Regional Marine Spatial Plans in so far as they impact within the inter-tidal zone and on the wider coastal zone.

To protect the character of the Argyll and Bute coast from inappropriate development, this is directed in the first instance to areas where development has already taken place. The existing Spatial Strategy aims to direct development requiring a coastal location to areas with existing development, or sites where the character of the coastal zone could accommodate such development.

The 'Very Sensitive Countryside Zone', relates to Isolated Coast where it abuts the coastline and has extremely limited capacity to successfully absorb development. Only limited categories of natural resource based development will be supported in these areas.

The foreshore is the sensitive interface between land and sea. The natural foreshore corresponds to the area of land between mean low-water and high-water springs, which has been largely unaltered by human activity. This therefore excludes substantial areas of made up land within the original foreshore, which are now above current high water levels. The policy identifies environmental sensitivities and planning issues that impose severe limits on the acceptability of development on the natural foreshore.

Coastal waters can be affected directly by engineering works and indirectly through pollution from surface water run-off and industrial processes. Coastal development should not result in the deterioration of the overall ecological status of these water bodies or protected areas such Shellfish Waters and Bathing Waters. Nature Conservation Marine Protected Areas (MPA) are designed to conserve a selection of marine biodiversity (species and habitats) and geodiversity (the variety of landforms and natural processes that underpin the marine landscapes), offering long-term support for the services that seas provide to society.

Development proposals, which have the potential to affect a MPA, will only be permitted where it can be demonstrated that there is no significant risk of the proposal hindering the achievement of the conservation objectives of the MPA. Priority Marine Features (PMF) are species and habitats which have been identified as being of conservation importance to Scotland and provide a new focus for marine conservation in Scotland. Impacts of development on the national status of PMFs must be considered and where proposals have potential to impact PMFs, mitigation, including alternative locations, should be considered.

2.2.9 Renewable energy

Scotland is a world leader in the development and deployment of renewable energy technologies. The offshore potential is enormous – with an estimated 206 gigawatts (GW) of offshore wind, wave and tidal resource in Scottish waters; almost 40% of the UK total. These resources will play a major part in meeting the renewable electricity target of 80% of gross Scottish consumption by 2020.

The Scottish Government has used a marine planning approach to develop *Blue Seas Green Energy – A Sectoral Marine Plan for Offshore Wind in Scottish Territorial Waters* (the Plan). This process was started through the application of Strategic Environmental Assessment (SEA) to produce a draft Plan. The SEA Environmental Report and draft Plan were consulted upon before Habitats Regulations Appraisal (HRA) and Socio-economic Assessment were applied to inform the contents of the final Plan.

The draft Plan contained 10 short-term options. The sites were selected by developers and The Crown Estate Commissioners (CEC) and awarded Exclusivity Agreements. The 10 sites, reduced to 9 due to the Bell Rock site being withdrawn by the developer, were included in the draft Plan as the short-term options to be developed by 2020. The planning and SEA processes identified a further 25 medium term areas of search within the plan regions for development between 2020 and 2030. The medium areas of search will be subject to further assessment.

It should be noted that in addition to the short-term sites and medium-term areas of search contained within the Plan, there are 2 sites within Scottish Offshore Waters as a result of the CEC third leasing round (Round 3) for offshore wind development. These sites were considered as part of the UK Government Department for Energy and Climate Change Offshore Wind SEA.

Progress

The Scottish Government will consider the opportunity for further developments in the short and medium term both in Scottish Territorial and Offshore Waters.

The Plan will be subject to monitoring on a variety of environmental and social receptors. It will be reviewed on a 2-year cycle. This will be informed by monitoring and research work as a result of SEA, HRA and Socio-economic assessments, as well as views expressed in future consultation and by any steering or advisory groups. The SEA contains recommendations for monitoring, research and further assessment, as does the Habitats Regulation Appraisal. It is recognised that the Socio-economic Assessment is strategic and high level and as such will require a more regional focus to address fishing, shipping, recreation, sport and tourism sectors. It is also recognised that potential development strategies including those for other marine renewables (wave and tidal), further offshore wind development and other marine sector activities will emerge and that potential cumulative and in- combination effects must be addressed in the appropriate manner to properly consider existing sectors such as fishing and shipping and our unique natural environment.

Overseen by The Scottish Government, it is envisaged that the Marine Strategy Forum will provide high level steering for the Plan review and research agenda. The SEA and HRA steering groups and Socio-economics advisory group will inform the development of assessment processes and as regional marine planning is rolled out around Scotland there is growing potential for more structured regional policy development and consultation engagement.

Strategic aims

The Plan is based on strategic aims that are applicable across its geographical scope. These are:

- Maximise the contribution that offshore wind energy makes to renewable energy generation in Scotland;
- Maximise opportunities for economic development, investment and employment;
- Minimise adverse effects on people, other economic sectors and the environment;

- Deliver offshore wind while complementing other forms of marine energy generation.

This Plan is an integral part of a series of initiatives, which include:

- Scotland's Offshore Wind Industry Route Map,
- The National Renewables Infrastructure Plan (N-RIP)
- Securing the Benefits from Scotland's Next Energy Revolution

Key Legislative and Regulatory Drivers

The key legislative and regulatory drivers for the development of offshore wind in Scotland are associated with:

Marine planning: A regulatory system for Marine Planning was introduced at the UK level through the Marine and Coastal Access Act 2009. This requires that marine plans are prepared for the UK marine area (0 to 200 nautical miles). The devolved administrations (the Scottish Government, the Welsh Assembly Government and the Northern Ireland Executive) have jurisdiction over marine planning matters from 0 to 12 nautical miles. In accordance with the 2009 Act, the UK Government and devolved administrations have prepared a joint Marine Policy Statement (MPS). The MPS provides the framework for preparing Marine Plans and decision-making in relation to the marine environment, and establishes policies and objectives for specific sectors and activities.

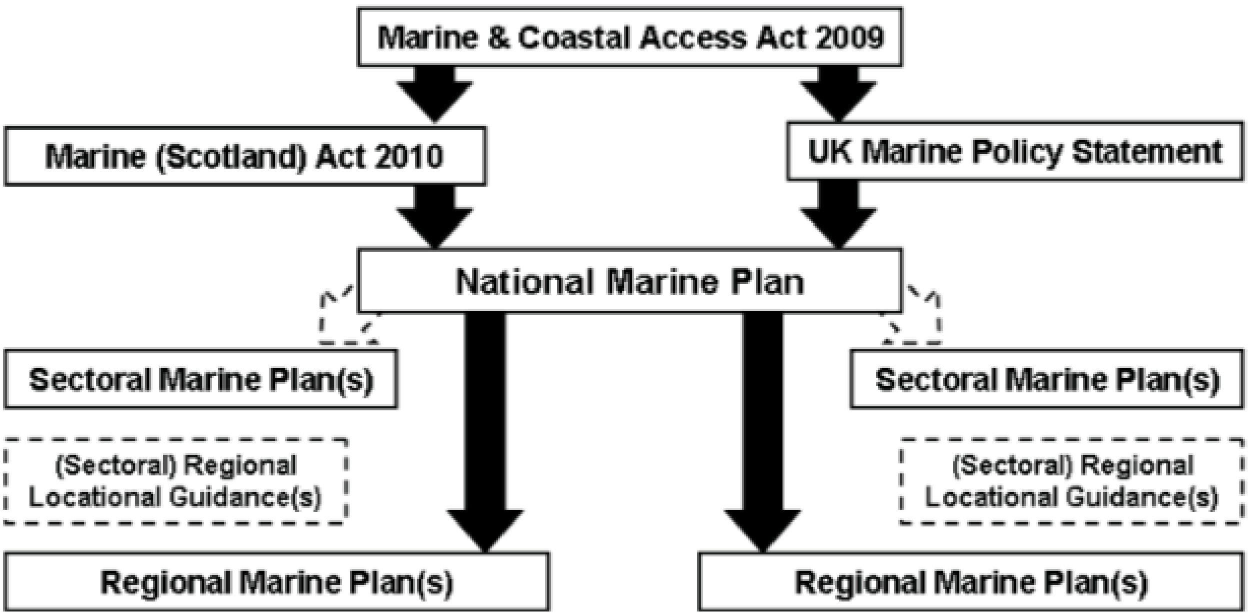


Figure 7: Marine Planning Legislative and Policy Framework

In Scotland, the new legislative and management framework for marine environment is established by the Marine (Scotland) Act 2010. As previously noted, the Scottish Government has jurisdiction over marine planning matters from 0 to 12 miles from the coast. For the purposes of marine planning, the marine area from 12 to 200 miles from the coast (Scottish Offshore Waters) is executively devolved to the Scottish Ministers. The Marine (Scotland) Act 2010 allows for a system of regional marine planning to be developed for Scottish waters. The Regional Plans will be directed by the objectives and policies of the National Marine Plan.

The Sectoral Marine Plan for Offshore Wind in Scottish Territorial Waters will be integrated into and inform this emerging marine planning framework. The requirement to develop the Plan is not a statutory provision of related marine legislation. The Plan is intended to complement both the National and Regional Marine Plans through the provision of relevant information and assessment for specific areas of marine planning. It will also be complemented by Regional Locational Guidance, which will provide more prescriptive information for developments in relation to the potential for development in marine areas of resource acknowledging environmental and sectoral constraints.

Climate change and energy: Climate change and the requirement for alternative sources of energy are important drivers for the Plan. The Climate Change (Scotland) Act 2010 establishes a long-term framework to cut greenhouse gas emissions by at least 80% below 1990 levels by 2050, with an interim target of 42% by 2020. In addition, the Scottish Government has made a commitment to generating 20% of energy demand, incorporating 80% of electricity consumption from renewable sources, by 2020.

Strategic Environmental assessment: The Offshore Wind Plan was subject to the requirements of the Environmental Assessment (Scotland) Act 2005 "*The 10 short tem sites with Exclusivity Agreements for offshore wind development in Scottish Territorial Waters, announced by The Crown Estate in February 2009, were considered to constitute a 'plan' in terms of the Environmental Assessment (Scotland) Act 2005''.*

This legislation requires the Scottish Government to carry out Strategic Environmental Assessment (SEA) of its Plans, Programmes and Strategies that could generate potential significant environmental effects. The SEA has played a prominent role in the development of the Plan by identifying key environmental receptors, mitigation measures and providing an early indication of issues to be addressed at the project level.

Options for wind Sectorial Marine Plan

The Offshore Wind Sectoral Marine Plan contains options for development at the regional level to 2020 and beyond. These options are classed as:

Short-term Sites – up to 2020: The seabed within Scottish Territorial Waters is part of the Crown Estate. The Crown Estate Commissioners (CEC) is the commercial manager of the seabed within UK and Scottish Territorial Waters. CEC has the responsibility for awarding seabed leases and Exclusivity Agreements for offshore wind sites. Developers proposing to take forward offshore wind development have to secure a seabed lease. In 2009, CEC undertook the first stage of lease bidding and awarded Exclusivity Agreement awards for 10 sites (Solway Firth, Wigtown Bay, Kintyre, Islay, Argyll Array, Beatrice, Inch Cape, Neart Na Gaoithe, Forth Array and Bell Rock).

Medium-term Areas – up to 2030: In response to the CEC leasing round and to support the sustainable delivery of the potential for offshore wind around Scotland, the Scottish Government made a commitment to produce a Strategic Environmental Assessment (SEA) of the potential for offshore wind development in Scottish Territorial Waters, to include the 10 site options. The draft Plan was developed to accompany the Environmental Report, and thereby ensure that those reviewing the assessment findings were clear about the emerging proposals.

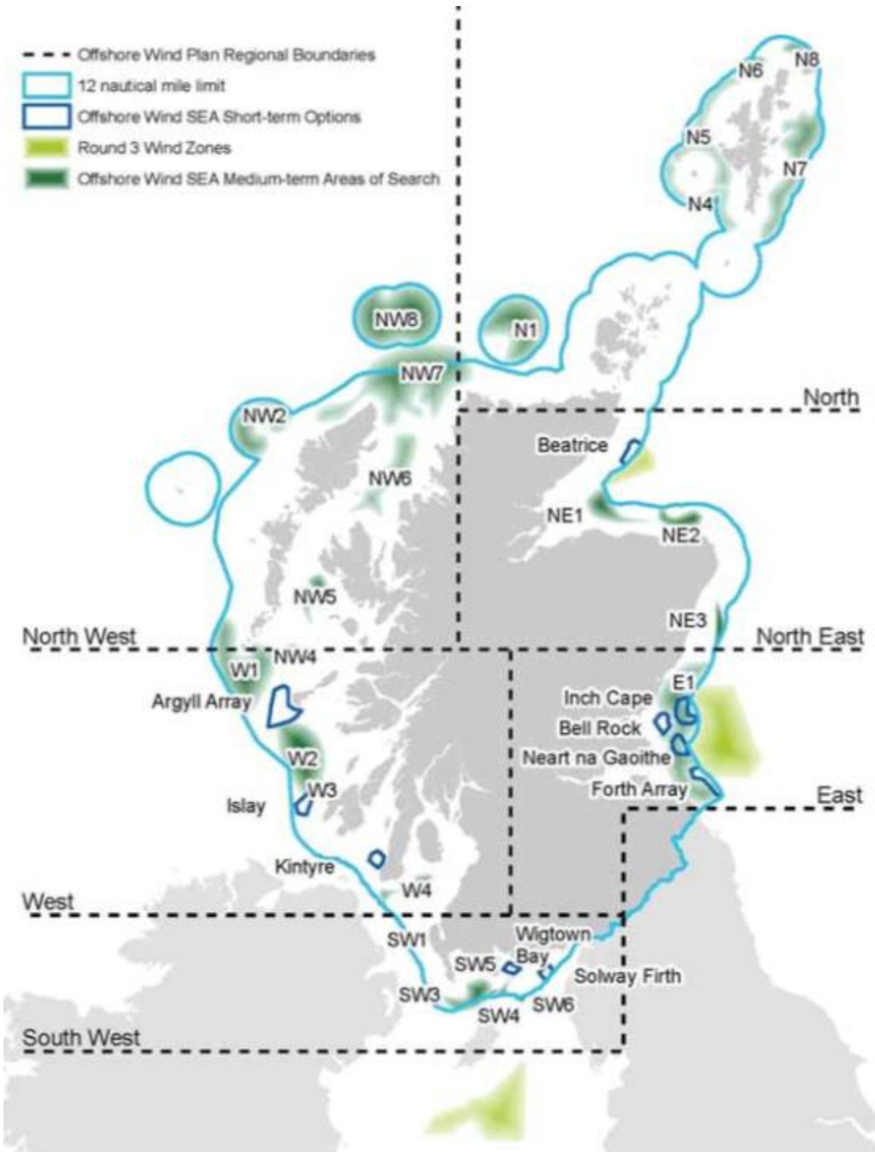


Figure 8: Short-term Sites and Medium -term Areas of Search
(*Source: Marine Scotland, 2010*)

The following figure demonstrated the short-term sites and medium term areas of search identified on a regional basis within Scottish Territorial Waters.

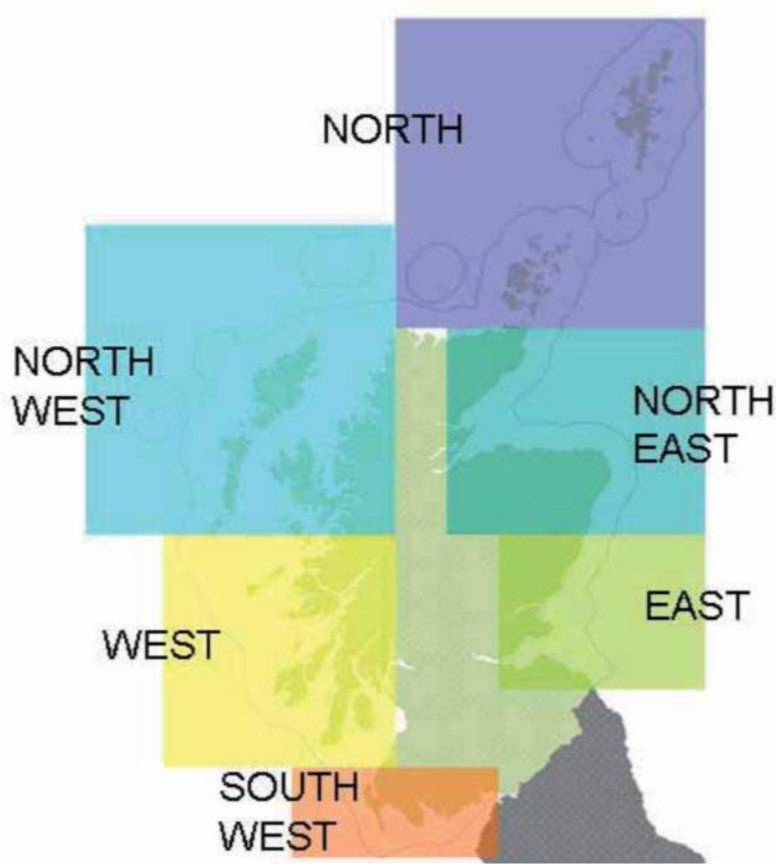


Figure 9: Offshore Wind Plan Regions (*Source: Marine Scotland, 2010*)

The **West Region** (as Port Ellen is included in this area) has three short-term sites and four medium term areas of search. The short-term sites are:

- Argyll Array
- Islay
- Kintyre

There is considerable resource potential in this region. At the same time, the region have particular environmental sensitivities, remote community identity and special coastal and island qualities which must be taken very carefully into account.

2.2.10 Aquaculture development

Commercial aquaculture began in Scotland in the 1970s, although research and small-scale fish and shellfish production had by then been under way for some years. Since the 1970s, the industry has developed into a major employer in rural Scotland, with just under 2,000 direct jobs and between 4,000 and 5,000 in the supporting sectors. Around 75% of these jobs are in the Highlands and Islands. The industry, which includes a significant, and growing, organic sector, generates annually more than £500m of turnover at "farm gate" and through secondary processing, and now accounts for around 50% by value of all Scottish food exports. Production in 2001 was some

139,000 tonnes of salmon, almost 5,500 tonnes of rainbow trout, and 3,000 tonnes of cultivated shellfish. Techniques to farm alternative species such as halibut and cod are now reaching commercial fruition and the industry is keen to diversify. While much of its production arises from activities in marine waters, the trout sector and early stages of salmon rearing rely on Scotland's high quality freshwater resources.

The Town and Country Planning (Scotland) Act 1997 ("the 1997 Act") defines fish farming as the breeding, rearing or keeping of fish or shellfish. Since 2007 marine fish farming has required planning permission from Local Authorities in accordance with the 1997 Act. This applies to all new fish farms out to 12 nautical miles including modifications to existing ones (although the role of planning authorities currently only extends to 3 nautical miles). Fish farming is therefore unique amongst marine activities in that it requires consent from a terrestrial planning authority. Aquaculture other than fish farming, such as seaweed cultivation, requires a marine licence from Marine Scotland and a works licence in Shetland and certain parts of Orkney. In the future, should fish farming extend beyond 12 nautical miles a marine licence from Marine Scotland would be required as the primary consent to develop.

Prior to 2007 marine fish farming development was leased and consented either by the Crown Estate or, in their respective areas, by Orkney Islands Council and Shetland Islands Council. Marine Scotland is undertaking a process (the Audit and Review process) to determine whether certain fish farms (typically farms granted consented by the Crown Estate or by the Orkney and Shetland Islands Councils prior to 1 April 2007) should be granted permission to operate under section 31A of the 1997 Act.

In 2009 the Scottish Government in conjunction with the aquaculture industry launched 'A Fresh Start – The Renewed Framework for Scottish Aquaculture'. The Framework set out the shared vision of the Scottish Government and the industry for the future development of the sector:

The National Marine Plan sets out objectives for Aquaculture in Scotland including; 'An aquaculture industry that is sustainable, diverse, competitive, economically viable and which contributes to food security whilst minimising environmental impact; and support for industry targets for sustainable growth in production of finfish and shellfish to 210,000 and 13,000 tonnes respectively by 2020, from a 2011/12 baseline of 159,269 and 6525 tonnes.

The Scottish Planning Policy (SPP) is a statement of Scottish Government policy on land use planning and identifies aquaculture as making a significant contribution to the Scottish economy, particularly for coastal and island communities. SPP identifies that the planning system should:

- play a supporting role in the sustainable growth of the finfish and shellfish sectors to ensure the aquaculture industry is diverse, competitive and economically viable;
- guide development to coastal locations that best suit industry needs with due regard to the marine environment;
- maintain a presumption against further marine finfish farm developments on the north and east coasts to safeguard migratory fish species.

The regulatory framework

The main regulatory and advisory bodies involved in aquaculture are:

- the Scottish Executive Environment and Rural Affairs Department (SEERAD);
- the Crown Estate;
- local authorities;
- the Scottish Environment Protection Agency (SEPA);
- Scottish Natural Heritage (SNH).

As well as planning permission, all fish farms need a number of additional consents to operate. These include:

- an Aquaculture Production Business Authorisation by Marine Scotland"s Fish Health Inspectorate (FHI)
- a licence from Marine Scotland in relation to navigational aspects such as fish farm cages and barges.
- a Controlled Activity Regulations (CAR) licence from SEPA under The Water Environment (Controlled Activities) (Scotland) Regulations 2005.
- a licence from Marine Scotland in relation to discharges from wellboats.
- Seabed lease from The Crown Estate.

In accordance with the Act, Scottish Ministers can, by Order, provide for fish farming in a specified area not to be development under the terrestrial planning system and to be regulated by marine licence instead. An Order can only be made with the consent of the affected planning authority. In effect, this means that new fish farm development would no longer require planning permission but would be regulated by Marine Scotland marine licensing procedures. Unless an Order is made, fish farm development consents will remain a function of planning authorities throughout Scotland.

Marine planning for aquaculture

Marine plans apply to all marine aquaculture, including fish farming as defined by the Town and Country Planning Act, and other marine aquaculture such as seaweed cultivation. The National Marine Plan sets out high-level objectives for the aquaculture industry. It also contains policies on the sectors sustainable growth, including where new aquaculture development should be permitted and its interaction with other sectors. These policies largely reflect the same principles upon which development plans and consenting decisions by terrestrial planning authorities are based.

As regional marine plans are developed it will be important for them to conform with the National Marine Plan on aquaculture, and to be compatible with development plans. Planning consent for fish farm proposals within 12 nautical miles is a function of terrestrial planning authorities and decisions will be made in accordance with development plans. Terrestrial planning authorities are also required to accord with marine plans in decision making unless relevant considerations indicate otherwise, and to have regard to marine plans in preparing development plans. Development plans and marine plans will direct decision making based on common evidence and policy, minimising the potential for ambiguity.

Planning permission and consents

Terrestrial planning authorities must determine applications for planning permission in accordance with terrestrial development plans. Development plans provide locational guidance for new development, and may identify where new fish farms are likely to be acceptable. Development plans, and in some cases associated supplementary guidance, also provide the policy context for fish farm development. Non-statutory planning guidance for fish farming which a planning authority might have prepared and any guidance issued by statutory consultees may support decision-making. The latter includes Marine Scotlands Locational Guidance and Scottish Natural Heritages Marine Aquaculture and the Landscape, which are referenced within National Marine Plan policies.

Table 1: Competences on aquaculture development (*Source: Argyll and Bute Local Development Plan, 2016*)

Argyll and Bute Council	- Prepare planning and guidance for aquaculture development in Argyll and Bute. - Process and determine planning applications for new or modifications to existing marine and fresh water fish farms. Prelevant Authority under the BA (Fish Farming in Marine Waters) Regulations 1999. - Informally consulted by SEPA and Marine Scotland on CAR licences for fish farms and marine licences for aquaculture development.
Marine Scotland	- Under the Aquaculture and Fisheries (Scotland) Act 2007, Marine Scotland enforces provisions on containment and parasite control through information gat hering, inspections and enforcement measures aimed at controlling and improving containment and parasites. Marine Scotland also implements measures that regulate the movement of live fish with a view to preventing the spread of fish diseases. - Marine Scotland issues the single marine license coveing navigation issues and deposits in the marine environment including discharges from wll boats. - When a commercial activity could cause disturbance to European Protected Species such as cetaceans, Marine Scotland issues a licence for the activity. Strict legal test are required to be satisfied. - Marine Scotland in the licensing authority for seals under the Marine (Scotland) Act 2010 and can issue licences for the killing or removal of seals for activities such as research or to protect the welfare of farmed fish to prevent serious damage.
Scottish Environment Protection	- Under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) SEPA has powers to ensure that activities which may pose a risk to the water environment are controlled. With regard to finfish farming, SEPA sets

Agency (SEPA)	limits on the types and amount of fish that can be held in the cage (known as maximum biomass) and the amount of certain medicines that can be administered and discharged from cages. The CAR licensing process takes account of the likely effects of discharges from the proposed development on both the water column and benthic environments. Shellfish farms are not currently regulated by SEPA.
Scottish Natural Heritage (SNH)	- Provide advice on natural heritage matters. In particular with respect to aquaculture, SNH is a statuary adviser to the council, as the Competent Authority, under the Conservation (Natural Habitats) Regulations 1994 with regard to Natura Sites (Special Areas of Conservation and Special Protection Areas) and European Protected Species (EPS). - SNH also advises Marine Scotland with respect to EPS licensing and sean licensing under the Marine (Scotland) Act 2010. SEPA are advised by SNH with respect to CAR applications. SNH welcomes pre-application consultation with developers.
The Crown Estate (TCE)	- The Crown Estate is the public body in Scotland that owns and manges approximately 50% of the foreshore, the beds of tidal rivers and territorial seabed out to 12 nautical miles, with renewable energy and (non-hydrocarbon) mineral rights out to 200 nautical miles. - The Crown Estate's management of the territorial seabed means that any developer acquiring the necessary permissions to implement an aquaculture development will require rights to the area of seabed to which those continuation permissions apply, in the form of lease of seabed fron The Crown Estate, in order to excercise those permissions. - Planning permission for an aquaculture development granted by the Council attaches to the land (seabed in this case) and not the applicant, and therfore securing the necessary seabed rights is part and parcel of ensuring a successful outcome to any development proposal.

2.3 LANDSCAPE FRAMEWORK

Scotland's landscape policy is framed by the European Landscape Convention (ELC). It was ratified by the UK in 2006. The ELC is a series of principles to be interpreted and applied through each country's own legal and policy arrangements.

The Scottish approach to implementation of the ELC can be understood with reference to Scottish Natural Heritage's Landscape Policy Framework 2 and to Landscape and the Historic Environment – A Common Statement, which was prepared by SNH, Historic Environment Scotland (HES) and the National Trust for Scotland (NTS) and published by the Scottish Historic Environment Forum.

SNH is the Scottish Government's statutory advisor on landscape matters and HES is the lead national body on the historic environment.

Also relevant is the Scotland's Landscape Charter. This is not the policy of government nor of any particular public body, but it has relevance as a vision and set of principles developed by the Scottish Landscape Forum. The Forum included SNH and other public sector organisations alongside associations of community organisations, NGOs, businesses and professionals.

As defined in the ELC, a landscape is "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". SNH interpret this rather convoluted sentence as meaning that 'landscape' refers to "our experience and perception of all the elements of the physical environment that surrounds us".

At the general level, then, Scottish landscape policy promotes a holistic approach to the local environment that includes all aspects of the surroundings and that recognises that both people and nature have played a role in shaping these surroundings. In Scotland the tradition has been to recognise both the natural and the human aspects of landscape, but to divide these for separate treatment into the domains of 'natural heritage' or 'natural environment' on the one hand and 'cultural heritage', 'historic environment' and, more broadly, 'built environment', on the other. Two public bodies – SNH and HES – have an interest in landscape management.

SNH's remit is to secure the conservation and enhancement of Scotland's natural heritage, and to promote understanding and enjoyment of it. Natural heritage includes 'natural beauty and amenity', which SNH understands to refer to "what people see, experience and enjoy as they react to their surroundings". SNH use 'landscape' as a descriptive and analytical term for 'natural beauty and amenity', and – as outlined in the SNH Landscape Policy Framework – their main concern is "with the aesthetic and more natural qualities of the landscape, and the enjoyment people derive from this". SNH recognises that the landscape is valued in other ways too but, in light of its particular remit, the organisation considers these other values primarily to be the responsibility of others.

HES' remit is to investigate, care for and promote Scotland's historic environment. The historic environment is "the physical evidence for [historic] human activity that connects people with place, linked with the associations we can see, feel and understand". The SNH, HES and NTS Common Statement on landscape notes that scenic value and biodiversity have traditionally been the primary considerations in landscape policy, and that there is a need for policy and guidance better to reflect the 'historic environment' aspects of landscape. The vision in the Common Statement is that the historic dimension of landscape will be fully acknowledged and valued as part of a "holistic and placed-based definition of landscape" that encompasses both nature and people, and the ways in which they have interacted – and continue to interact – to create distinct places.

The ELC and SNH's Landscape Policy Framework recognise that landscapes are dynamic. The ELC aims to promote the 'protection, management and planning' of landscapes.

The ELC requires states to establish procedures for public participation in the definition and implementation of landscape policies. States that have ratified the ELC undertake to enable the public actively to take part in the identification of landscapes, and in the analysis of their characteristics and of the forces and pressures transforming them. The ELC also requires public authorities to develop 'landscape quality objectives', and to do so with the active participation of the people concerned.

The principle of participation is explicit in SNH's Landscape Policy Framework. This Framework advocates the closer involvement in landscape management of a range of stakeholders including landowners and managers, individuals and communities, NGOs, government departments and public bodies.

At local level, SNH commits to stimulating debate about the future evolution of the landscape and to working with others to develop "agreed landscape objectives", which "requires debate amongst the community of interests".

Similarly, Scotland's Landscape Charter advocates "a forward-looking approach to national and local policy that involves people in decisions about change to the character and quality of their surroundings".

Scotland's landscape policy is interpreted and implemented through a range of measures.

Table 2: Indicative list of potentially relevant qualifying plans and programmes

International	National	Regional / Local
The European Landscape Convention	The National Planning Framework Scotland's Scenic Heritage	National Park Management Plans National Scenic Area Management Strategies and Plans
UNESCO World Heritage Sites	SPP Parts 1 - 3	Strategic Development Plans
		Local Development Plans
	SNH Landscape Policy Framework	Landscape Character Assessments
	Scottish Foresty Strategy	Foresty and woodland management plans and Indicative Foresty Strategies
	A Forward Startegy for Scottish Agriculture – Next Steps?	
	Scottish Biodiversity Strategy	Biodiversity Plans and Strategies which address landscape scale habitat actions / objectives
	Scottish Rural Development Programme 2007 - 13	Local Landscape plans and initiatives including landscape

		sensitivity and capacity studies etc.
	SNH Natural Heritage Futures national prospectuses	SNH Natural Heritage Futures prospectuses
	Scottish Landscape Forum "places for people"	

In the 1990s, SNH and its partners commissioned a suite of 30 regional Landscape Character Assessments (LCAs) that, taken together, cover all of Scotland. This body of work is currently being reviewed, in light of advances in digital technology and in the available data, and of changes in development patterns and pressures. The aim of the review is to create a single national dataset, to be hosted on the SNH website. SNH consider that much of the information in the original studies remains valid. These LCAs have mostly been undertaken at the relatively broad scale of 1:50,000, providing a national framework of landscape character information at that scale. Finer resolution studies have subsequently been undertaken in a number of places.

The national programme has divided Scotland into more than 3900 distinct character units, each one of which has been assigned one of 275 Landscape Character Types (LCT), that are "distinctive types of landscape that share broadly similar combinations of geology, topography, drainage patterns, vegetation and historical land use and settlement pattern".

Complementary information is also available for the whole of Scotland in the form of the Historic Land-use Assessment (HLA), undertaken between 1997 and 2015 by the predecessor bodies to Historic Environment Scotland

The national LCA and HLA programmes were carried out separately. As noted above, the SNH, HES and NTS *Common Statement* on landscape calls for the 'historic environment' aspects of landscape to be integrated more fully with the 'natural heritage' aspects.

National Scenic Areas were designated in 1980, and each of the forty NSAs was originally only described in a short statement. Between 2007 and 2009, SNH therefore conducted a new assessment to identify and describe the special qualities that give rise to the 'outstanding scenery' of each NSA.

SNH have also recently undertaken a programme of work to identify Wild Land Areas. Here, 'wildness' is defined as a quality that people perceive in the landscape. A total of 42 Wild Land Areas have been defined, and the map of these areas was published in 2014, together with descriptions of each WLA. The purpose of mapping WLAs was to provide "locational guidance" for the implementation of planning policies relating to wildness and Wild Land.

Assessments of landscape characteristics and qualities are used to inform decisions and shape change. LCA data can be used in producing development plans, in designing particular development proposals and assessing their potential effects, and in taking decisions on development proposals. It can be used in producing land management plans and forestry strategies and in operating agri-environment funding programmes. It can form a basis for landscape capacity studies that assess the extent to which a particular landscape type is able to absorb a specific kind of change without significant effects on its character. Landscape character and quality assessments are also used to identify areas that are to be afforded special attention and treatment, either through the protections afforded by designation or by being made the subject of particular policies (e.g. in the planning system).

2.3.1 Landscape & Aquaculture

Argyll and Bute has a diverse range of landscapes each with a different capacity to accommodate new development. The siting and design of new development should be informed by national considerations and local landscape character.

Argyll and Bute Council has identified Areas of Panoramic Quality, which are areas of regional importance in terms of their landscape quality. Within these areas the impact on the landscape is a major consideration when new development is proposed and will need to be consistent with Policy **SG LDP ENV 11 - Development Impact on Areas of Panoramic Quality.**

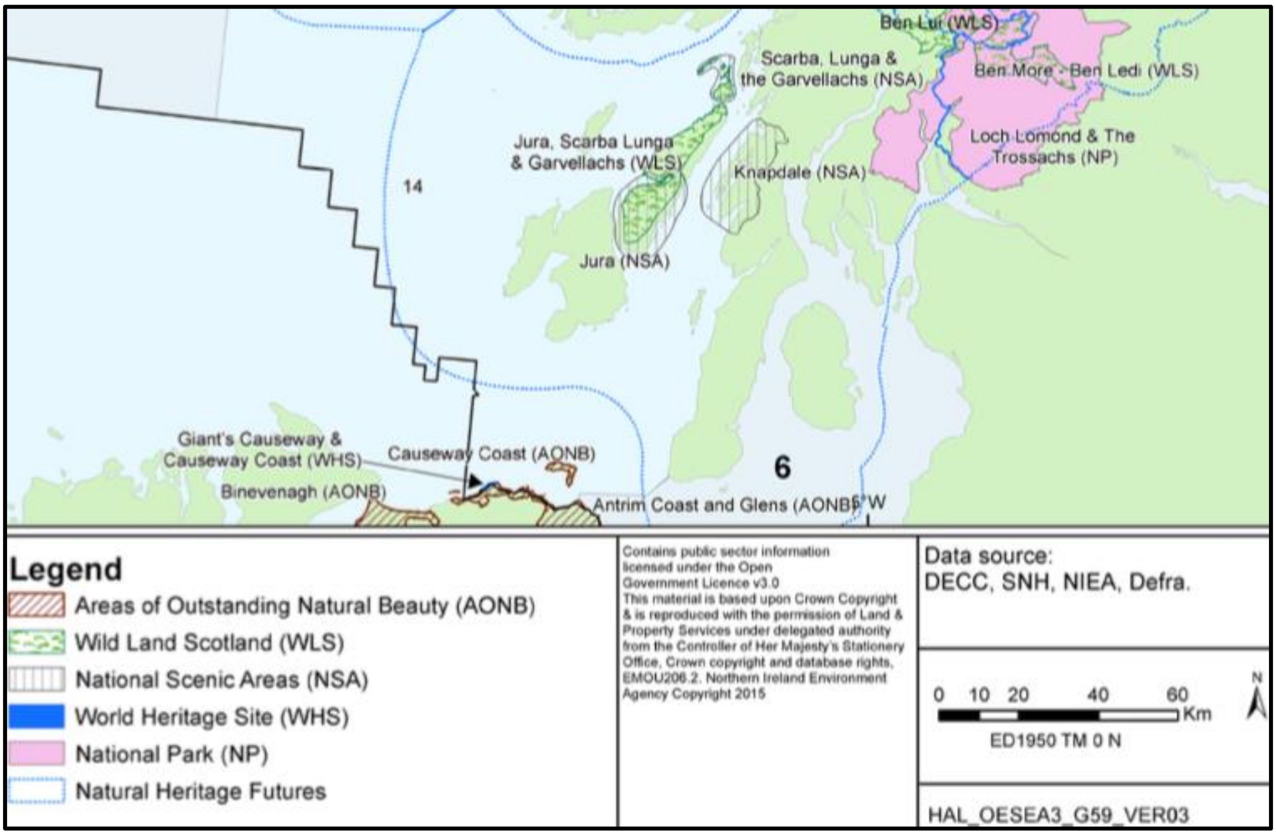


Figure 10: Areas of Panoramic Quality (*Source: Marine Scotland, 2010*)

Physical character, human activity, visual qualities and experience of place combine to create a landscape character, which is distinct across a geographic area. One of the aims of locating and designing a development with care is to ensure that the proposal does not undermine characteristics, which most significantly contribute to the landscape character of an area. Where possible, new developments should relate to the key characteristics of an area. The Argyll and Firth of Clyde Landscape Character Assessment provides detailed information on landscape character in Argyll and Bute and a Landscape/Seascape Assessment of the Firth of Clyde provides a strategic assessment of the coastal landscape and seascape of the Firth of Clyde.

Coastal landscape character is made up of many elements and a table identifies the likely opportunities for siting aquaculture in the landscape in relation to generic coastal landscape characteristics.

Table 3: Coastal landscape character of Jura Sound

Openness and expansiveness of the coast and sea	Expansive stretches of sea along the horizon, creating a sense of big space and openness will often diminish the relative size of a structure. Smaller and lower structures, including shellfish lines, are likely to fit in more easily to smaller spaces, but even then, the size and extent of the structure as a whole should aim to avoid dominationg the size of the space.

The developer will be required to submit information, which demonstrates that the proposal can be satisfactorily integrated with the landscape through appropriate siting and design. For larger scale developments or development in sensitive landscape areas, planning applications should be supported, as appropriate, by a Landscape and Visual Impact Assessment (LVIA) in line with current best practice and guidance from Scottish Natural Heritage and Argyll and Bute Council.

VIAs should be undertaken in accordance with a methodology acceptable to Scottish Natural Heritage, which may require the preparation of a Zone of Theoretical Visibility (ZTV) to inform the selection of representative viewpoints, which will be the subject of photomontages. Information should also be provided on details of alternative locations considered by the applicant and scaled diagrams of all surface equipment including, top nets cages, feed barges and other ancillary equipment.

Heritage assets are a finite and often irreplaceable resource and can be vulnerable to a wide range of human activities. Listed buildings, scheduled ancient monuments and their surroundings, historic gardens and designed landscapes and conservation areas are all subject to special protection measures to ensure that inappropriate or unsympathetic development does not damage the property or its setting. Development proposals which could affect historic interests will need to be consistent with **Policy LDP – Supporting the Protection, Conservation and Enhancement of our Environment and supporting SG**, which will not permit development in locations where they would have an unacceptable adverse impact on the historic environment.

Marine aquaculture development has the potential to impact on the setting of onshore historic interests and affect wrecks of historic importance. Planning authorities have a responsibility to protect and support the retention of features or sites of archaeological and historical importance and will expect developers to take account of these interests when submitting planning applications for aquaculture.

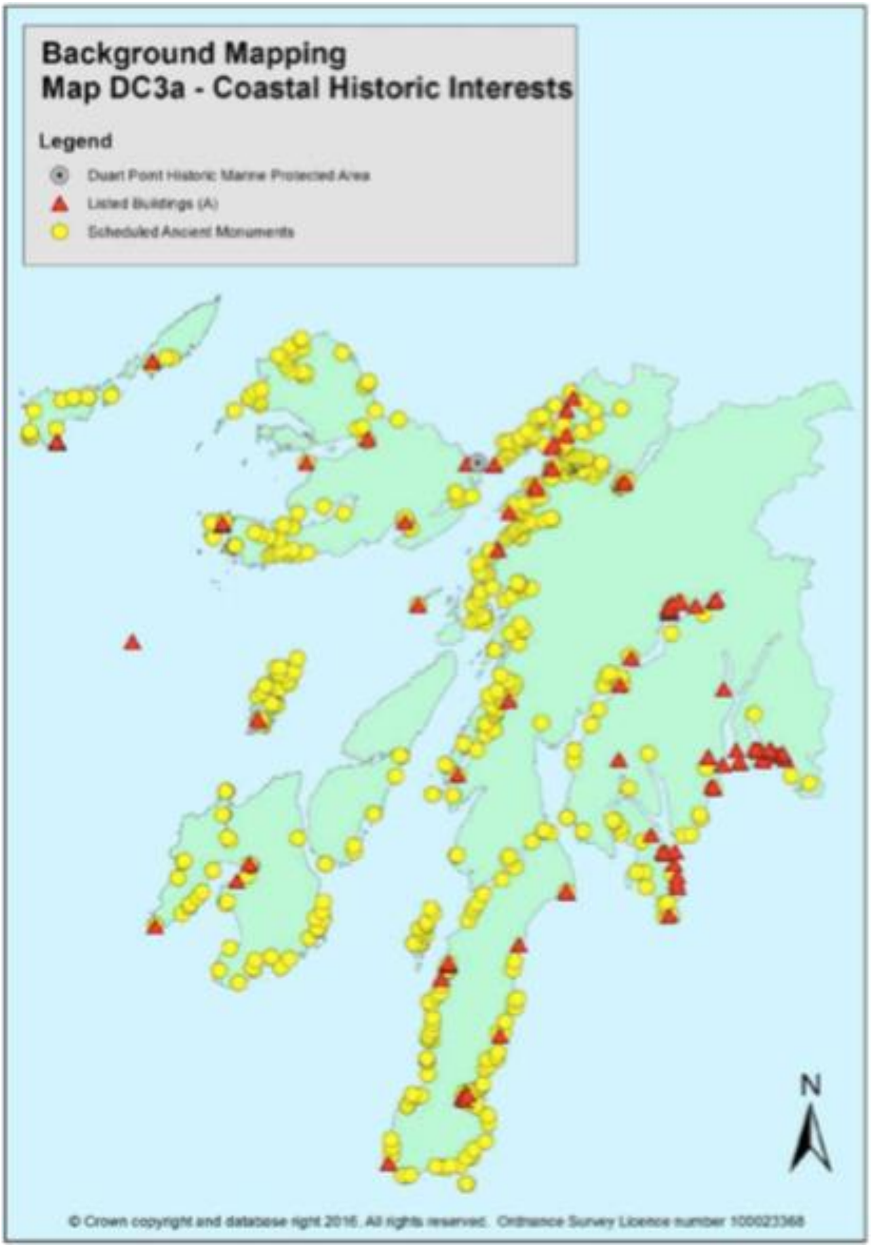


Figure 11: Coastal Historic Interests sites
(*Source: Argyll and Bute Local Development Plan, 2016*)

Argyll and Bute has a wealth of natural heritage and biodiversity resources and its coastal waters are both physically and ecologically diverse, ranging from very exposed waters bounded by rocky coastline to extremely sheltered sealochs. Within and between these extremes, this area supports a diversity of seabed habitats and associated flora and fauna. Those of particular ecological and conservation interest include rocky reefs, biogenic habitats (e.g. maerl, mussel and seagrass beds), burrowed mud and intertidal sediment flats. Much important flora and fauna is contained within these areas, but they also provide foraging areas for various fish and birds, as well as supporting broader ecological functioning of the marine environment. Marine mammals are also an important feature of the natural heritage of this area. Argyll and Bute's marine and coastal environment is recognised as being truly outstanding with many areas protected by International, European and UK designations and legislation. It is also increasingly recognised as a significant economic and social asset for local communities.

Scottish Planning Policy states that when determining planning applications, authorities should take into account the effects of the proposed development on the environment, including effects on the seabed. Protected or important marine habitats and species both within and out with designated sites can be affected by aquaculture development through the deposition and accumulation of waste on the seabed, interactions with wildlife from the operation of the site and the control of predators. The following natural heritage interests are considered of relevance to marine aquaculture development. It should be noted that this section will not necessarily include all potential natural heritage interests relevant to every aquaculture proposal and therefore applicants should seek pre-application advice from the Council and/or SNH.

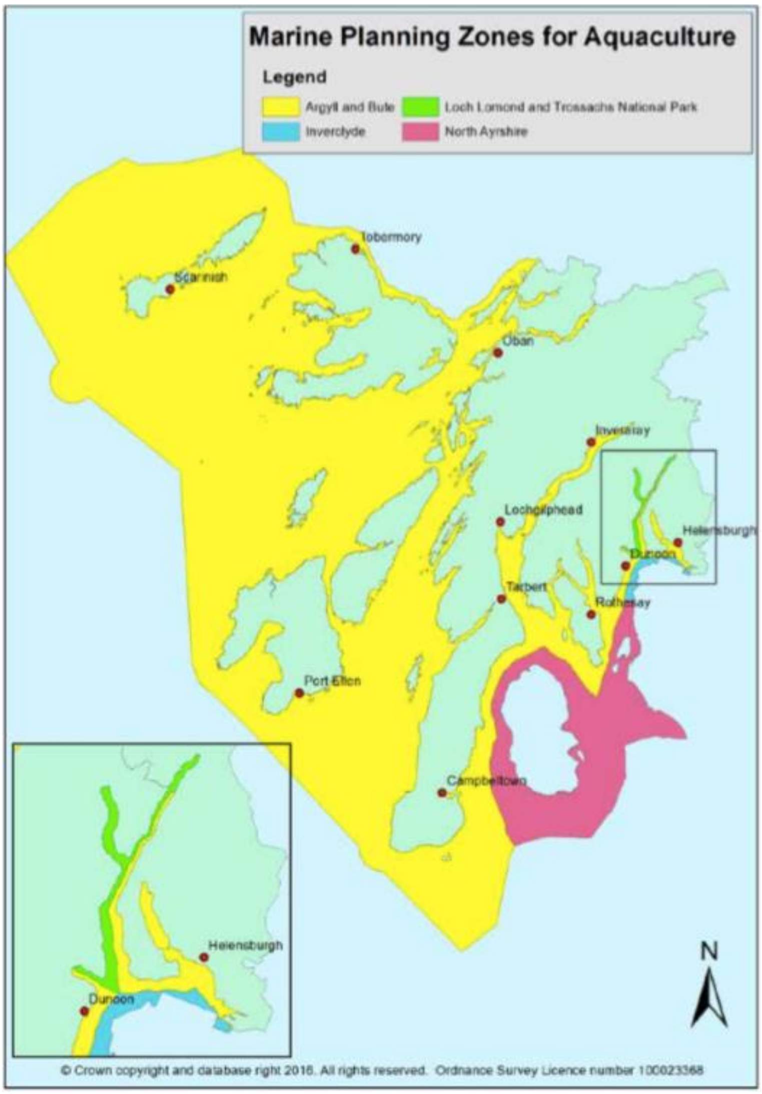


Figure 12: Marine Planning Zones for Aquaculture
(*Source: Argyll and Bute Local Development Plan, 2016*)

2.3.2 Landscape & Renewable Energy

In June 2014, the Scottish Government published the National Planning Framework 3 and an updated Scottish Planning Policy. The NPF 3 states that the government wants to continue to capitalise on our wind resource and for the country to be a world leader in offshore renewable energy, with onshore wind energy development being overtaken by marine energy including wind wave and tidal. NPF3 recognises that planning has a key role in reaching the ambitious targets for renewables by facilitating development, linking generation with consumers and guiding new infrastructure in to appropriate locations. Development must work with and sustain our environmental assets, and provide opportunities for communities.

Scottish Planning Policy 2014

Paragraph 155 of SPP states - "Development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved, in line with national climate change targets, giving due regard to relevant environmental, community and cumulative impact considerations." In order to deliver national consistency, SPP Paragraph 163 advises of the approach to be used when preparing spatial frameworks for onshore wind farms, using the following Groups:

- **Group 1:** Areas where wind farms will not be acceptable - National Parks and National Scenic Areas.
- **Group 2:** Areas of significant protection – Recognising the need for significant protection, in these areas wind farms may be appropriate in some circumstances. Further consideration will be required to demonstrate that any significant effects on the qualities of these areas can be substantially overcome by siting, design, or other mitigation. These include :
  - National and international designations:
  - World Heritage Sites;
  - Natura 2000 and Ramsar sites;
  - Sites of Special Scientific Interest;
  - National Nature Reserves;
  - Sites identified in the Inventory of Gardens and Designed Landscapes;
  - Sites identified in the Inventory of Historic Battlefields.
  - Other nationally important mapped environmental interests:
  - areas of wild land as shown on the 2014 SNH map of wild land areas;
  - carbon rich soils, deep peat and priority peatland habitat.
- **Group 3:** Areas with potential for wind farm development - Beyond Groups 1 and 2, wind farms are likely to be acceptable, subject to detailed consideration against identified policy criteria.

Argyll and Bute Local Development Plan Policy

The Council will support renewable energy developments where these are consistent with the principles of sustainable development and it can be adequately demonstrated that there would be no unacceptable significant adverse effects, whether individual or cumulative, including on local communities, natural and historic environments, landscape character and visual amenity, and that the proposals would be compatible with adjacent land uses. A spatial framework for wind farms and wind turbine developments over 50 metres high in line with Scottish Planning Policy has been issued as Supplementary Guidance. This will identify:

- Areas where wind farms will not be acceptable
- Areas of significant protection
- Areas which may have potential for wind farms development

The Council recognises the important role which the renewable energy industry can play in developing our local economy, as encouraged by the Council's Renewable Energy Action Plan (REAP).

Argyll and Bute Renewable Energy Action Plan

The Renewable Energy Action Plan of 2010 has set out its vision that:

"Argyll and Bute will be at the heart of renewable energy development in Scotland by taking full advantage of its unique and significant mix of indigenous renewable resources and maximising the opportunities for sustainable economic growth for the benefit of its communities and Scotland."

The co-ordinating framework for action is based on three themes of a connected, competitive and collaborative Argyll and Bute. In this respect there are a number of priorities for the REAP to deliver:

- Optimise the development of the Renewable Energy Sector in Argyll and Bute in a manner that promotes sustainable economic development and recognises the need for co-existence with other economic activities, our environment and our communities.

- Work with partners to secure capacity within the transmission network in order to unlock the future potential of our considerable renewable energy assets and provide confidence to investors.

- Assist in the prioritisation and promotion of supporting physical and transport infrastructure investment to enable the growth of the Renewable Energy Sector.

- Foster a partnership approach to securing local socio-economic and community benefit for the communities across Argyll and Bute.

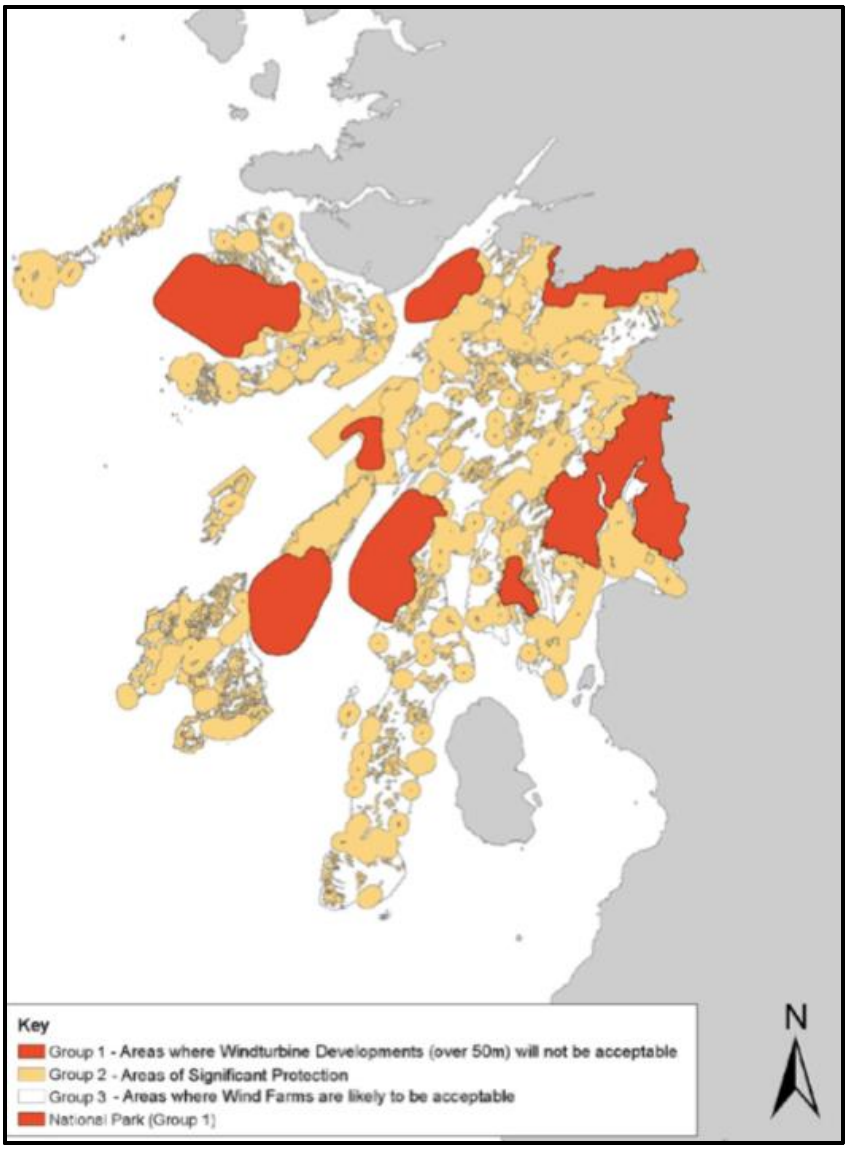


Figure 13: Spatial Framework for Wind turbines over 50 m to blade tip
(*Source: Argyll and Bute Local Development Plan, 2016*)

The Argyll and Bute Spatial Framework for ***onshore*** wind energy developments has been produced in accordance with the Groups 1 to 3 approach outlined in Scottish Planning Policy. This framework applies to all wind turbines over 50 meters high as outlined in Policy LDP 6 of the Local Development Plan. The Spatial Framework identifies the 7 National Scenic Areas which occur within the development plan area, and shows the adjoining Loch Lomond and Trossachs National Park which comprise Group 1 areas where wind turbine developments will not be acceptable. The Group 2 areas in Argyll and Bute comprise, Natura 2000 and Ramsar Sites; Sites of Special Scientific Interest; National Nature Reserves; and sites on the Inventory of Gardens and Designed Landscapes. There are also several areas of wild land as mapped by SNH. The Carbon Rich soils, deep peat and priority peatland habitat as identified by SNH have also been mapped, as have community separation distances of 2km around those settlements identified in the Local Development Plan. These Group 2 areas are Areas of Significant Protection where any development would be required to demonstrate that any significant effects on the qualities of these areas could be substantially overcome by siting, design or other mitigation. For Natura 2000 sites this will require any proposal not directly connected with, or necessary to their conservation management to be subject to an "appropriate assessment" of the implications for the conservation objectives. Such plans or proposals may only be approved if the competent authority has ascertained by means of an "appropriate assessment" that there will be no adverse effects on the integrity of the site.

Within the Group 2 areas these include areas of wild land; and carbon rich soils, deep peat and priority peatland habitat. These areas have only recently been mapped by SNH, and as such the policy position regarding the appropriate level of protection from development in these locations is emerging. Land with "wild land" qualities is a relatively scarce resource in Britain; and in Argyll, wild land has been identified in 4 locations. These areas are very sensitive to any form of intrusive human activity and have little or no capacity to accept new development. Accordingly, a significant level of protection should be afforded to areas of wild land from all forms of development, including wind turbine developments. This level of protection may extend to wind turbine developments outwith the wild land area, but where impacts of the development could be significant due to proximity to, and effect on, the wild land area.

Other national and international designations within the Group 2 areas include: World Heritage Sites; Natura 2000 and Ramsar sites; Sites of Special Scientific Interest; National Nature Reserves; Sites identified in the Inventory of Gardens and Designed Landscapes; and Sites identified in the Inventory of Historic Battlefields. These are all afforded a significant level of protection by policy LDP 3 of the Adopted Local Development Plan and relevant associated supplementary guidance.

Outwith Group 1 and 2 areas are the Group 3 areas, which is where SPP 2014 states wind farms are likely to be acceptable, subject to detailed consideration against identified policy criteria. This includes all other appropriate local development plan policy together with relevant supplementary guidance policies. Included amongst these are local landscape designations, and Tourism Development Areas where the effect of wind farm and wind turbine developments will require careful consideration, with particular regard to cumulative visual impacts. In order to assist and guide wind turbine developments to the most appropriate locations the council will publish further technical notes indicating areas where landscape and cumulative issues may arise, and those where capacity for additional wind turbine developments may exist.

The Argyll and Bute Landscape Wind Energy Capacity Study (2012)

This paper provides further background and technical information in relation to landscape capacity to accommodate wind turbines. As a technical study it does not form part of the spatial framework for wind farms, it does however provide information on the sensitivity of the various landscape character areas in Argyll and Bute to accommodate four different typologies of wind turbines from small scale 20 - 35m to large scale 80 - 130m in height to blade tip. The information contained should be taken into account when formulating and assessing development proposals.

Findings are presented for each landscape typology, in terms of the opportunities, landscape, visual and cumulative issues, which wind turbine development, may present in these areas. In particular, the study provides a summary of the sensitivity assessment of landscape character types with more detailed guidance on the relative sensitivities of each of the landscape typologies to accommodate various scales of wind turbine development

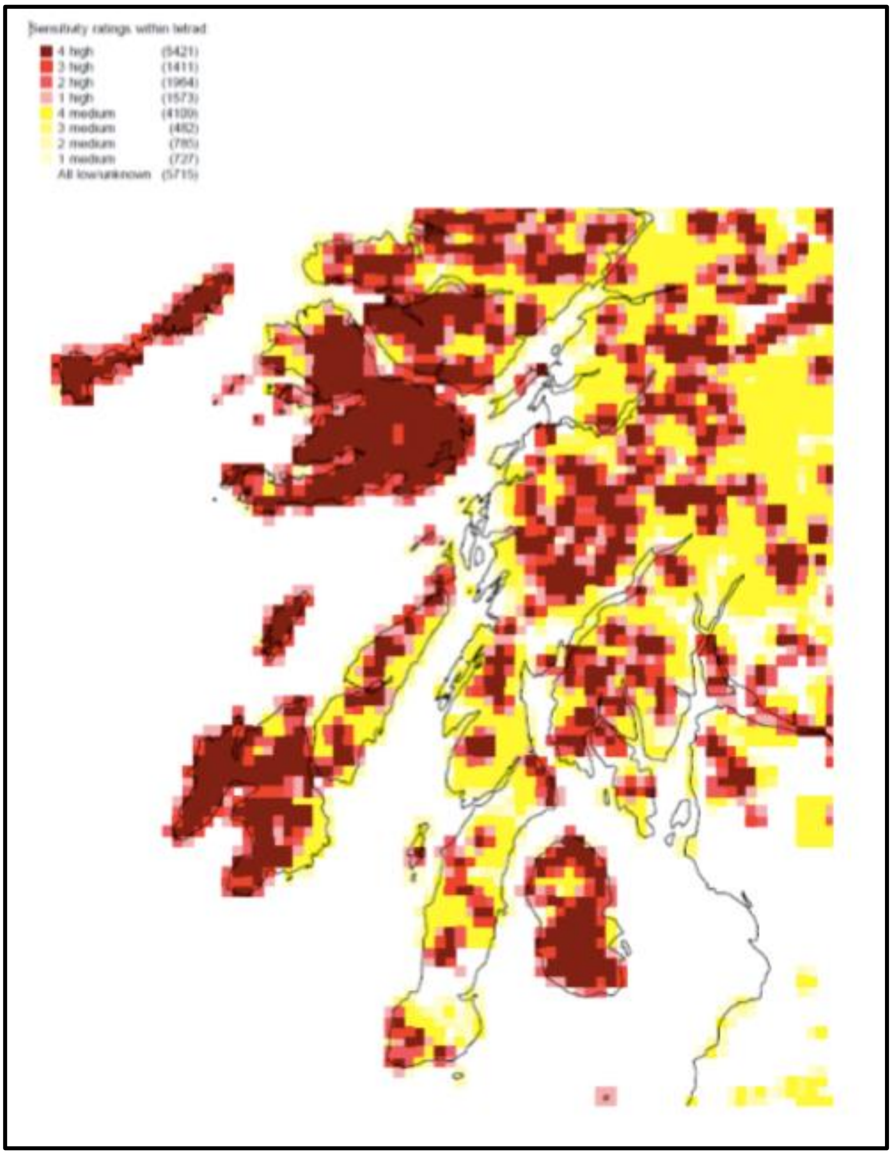


Figure 14: Sensitive Bird Species (*Source: Argyll and Bute Local Development Plan, 2016*)

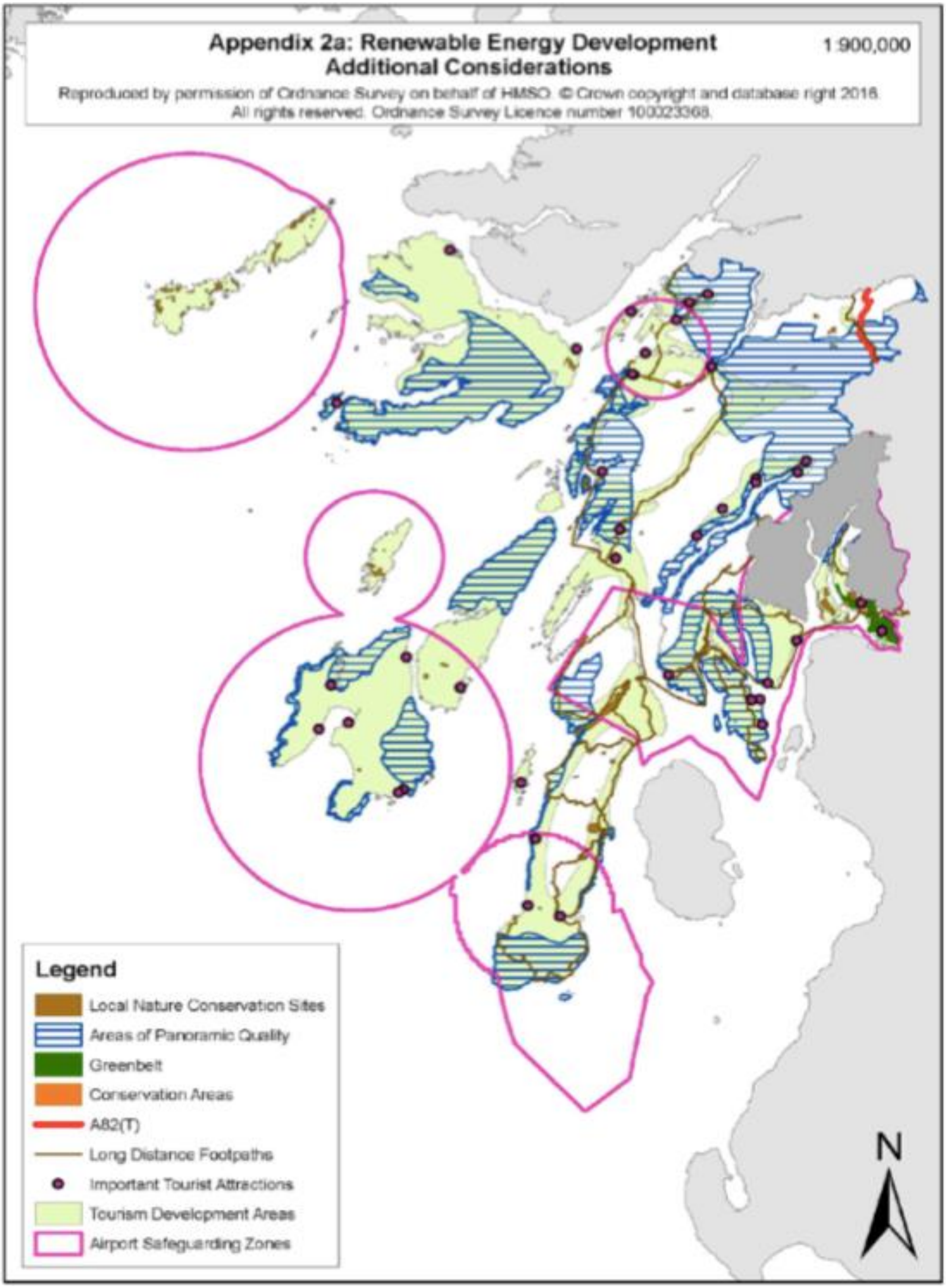


Figure 15: Renewable Energy Development
(*Source: Argyll and Bute Local Development Plan, 2016*)

CHAPTER 3: ENVIRONMENTAL BASELINE
Site 3 – Scotland: Port Ellen

On the Atlantic side of Scotland, the Sound of Jura, beside the island of Islay, has a deep seabottom with a moderate shelter for oceanic waves, together with major exposure to wind. Moreover, the area is characterized by the lowest tide oscillation around the UK, and water temperatures are subject to the beneficial influence of the Gulf Stream. The UK's Navy uses all the surrounding areas for exercises so any infrastructure development would have to be discussed with the Ministry of Defence at early stages. Nevertheless, an offshore wind farm located opposite Islay is also in adjacent waters with the same kind of possible restriction.

The sound remains outside from the great shipping lanes that run offshore, and has only a moderate local ferry passing through.

The North Channel is widely integrated within the Natura 2000 network, but the Sound mouth is free, through its extensive width, from protected areas. Two Natura 2000 sites of limited size are on the coast of the Islay Island.

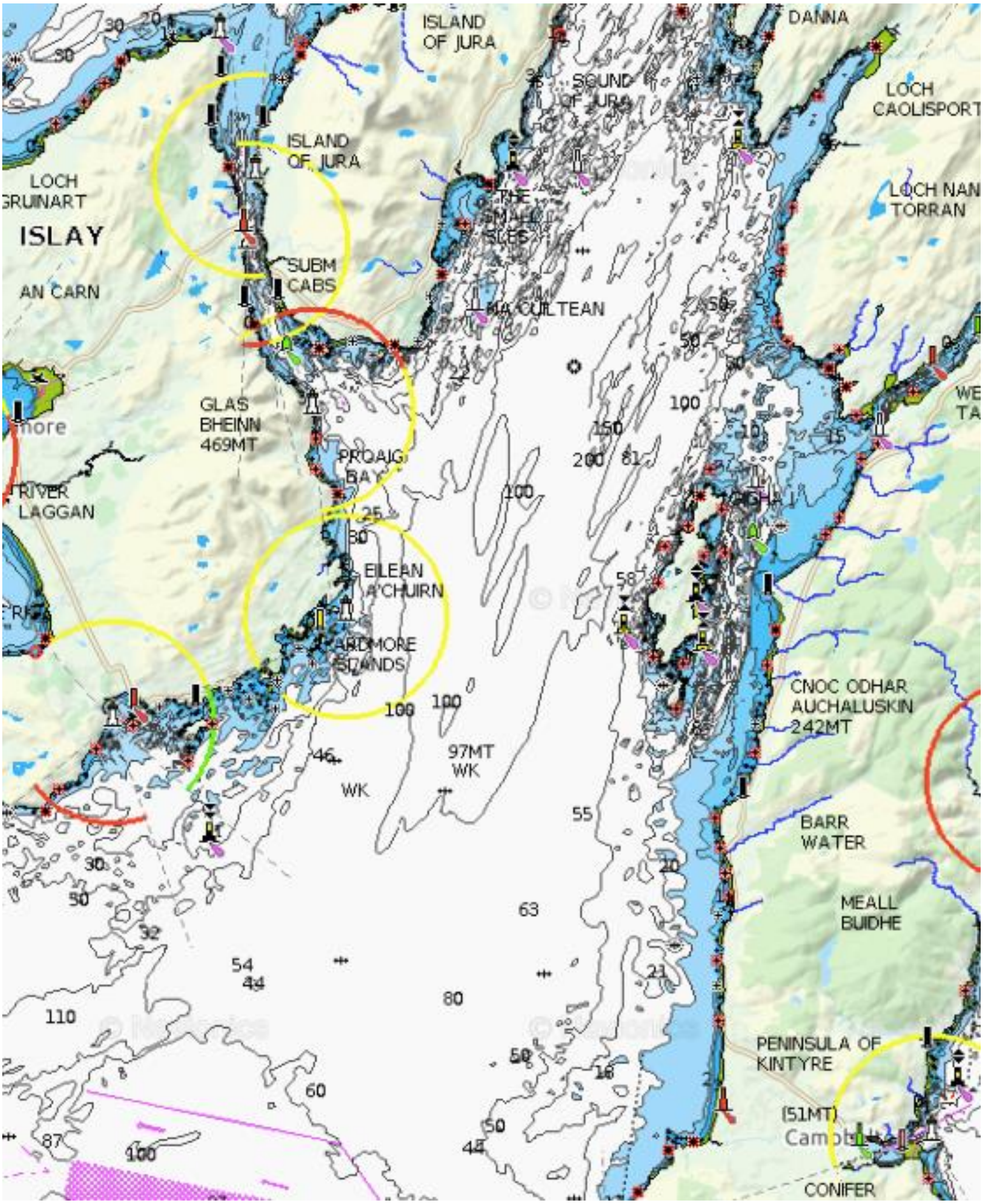


Figure 16: Sound of Jura nautical chart (*Source: www.navionics.com*)

Table 4: Port Ellen site characteristics

Site name: Port Ellen	Position: λ 55,555297° φ -6,019110°
Port distance	7,1 nm
Land distance	5,7 nm
Depth	80 m
Seabottom	Sand
Protected areas distance	5,7 nm
Minimum temperature	6,1
Maximum temperature	15,6
Tide amplitude	1,2 m
Annual wave power	11,9 kW/m
Annual wind power	0,892 kW/m^2
Maximum Hs 2016-2018	6,2 m

The species selected for fish farming within the Blue Growth platform facilities located within the North Atlantic Sea is the Atlantic salmon *Salmo salar* (Linnaeus, 1758). This species is one of the most farmed in temperate waters around the world, with an annual gross production of 1.488.434 tons in year 2016 (FEAP, 2017).

Atlantic Salmon has a singular life cycle, consisting of fresh water egg to juvenile "parr" stage at the end of which the fish undergoes a metabolic adaptation to the seawater environment; is then termed a "smolt"at which point in nature migrates to sea. In farming practice, smolts can be transferred to sea cages, where they enter the growing phase experiencing fully marine conditions. Atlantic salmon are ususlly grown to sizes of 0,5 – 0,8 m, for a weight up to 5 kg. While Atlantic salmon is spread from nearly arctic waters down to Britain on the European coast (FAO, 2018; Fishbase.org, 2018), its temperature range lies between 8 and 18 °C, with suboptimal temperature from 4° C up to 20° C, tolerable for short periods

3.1 PHYSICAL ENVIRONMENT

The waters around Scotland are diverse in their physical characteristics. In the coastal zone the coastline varies between deep and narrow sheltered sea lochs on the west coast, shallow bays and estuaries, and long straight stretches of coastline that have little shelter from waves and storms. The major Scottish estuaries are the Solway Firth, the Clyde Sea, the Moray Firth, the Firth of Tay and the Firth of Forth. The offshore environment in Scottish waters ranges from shelf sea areas, which are generally shallower than 250 m (average ~100 m) and deep ocean regions with depths greater than 2,000 m. The continental shelf includes the Malin and Hebrides Shelf Seas, Orkney and Shetland Shelf Seas, and the North Sea. The shelf seas are marked by notable features such as banks (e.g. Stanton Banks, Viking Bank) and deep channels (e.g. Beauforts Dyke).

The western margin of the continental shelf is marked by a sharp change in the depth of the seabed. From less than 250 m, the continental slope drops rapidly into water deeper than 2,000 m.

The continental slope is a transition area between two systems; the deeper oceanic waters and the shelf seawaters. The deep ocean areas have a complex bathymetry that is broken up by steep ridges (e.g. Wyville-Thomson Ridge), seamounts (e.g. Anton Dohrn) and banks (e.g. Rockall Bank).

Sedimentary process

In general, the sediments around Scotland are sandy or gravelly and originate from deposits during the Quaternary glaciation. Strong currents and wave action may also have prevented deposition of recent muddy sediment or have washed it to leave a coarse-grained lag deposit. Muddy sediments occur principally nearshore, for example in estuaries where the sediment is supplied from the main rivers such as the Forth and Clyde. Further offshore, muddy sediments occur in depressions on the sea floor, where currents may be relatively weak, such as the Witch Ground and Fladen basins and in The Minch. They also occur beyond the shelf break (200 m water depth) to the west of Scotland, in the Faroe-Shetland Channel and the Rockall Trough. The concentration of calcareous material varies greatly in seabed sediments reflecting the amount of shell material in different areas; locally, they can be very high (over 75%) in areas such as the seabed around Orkney and Shetland.

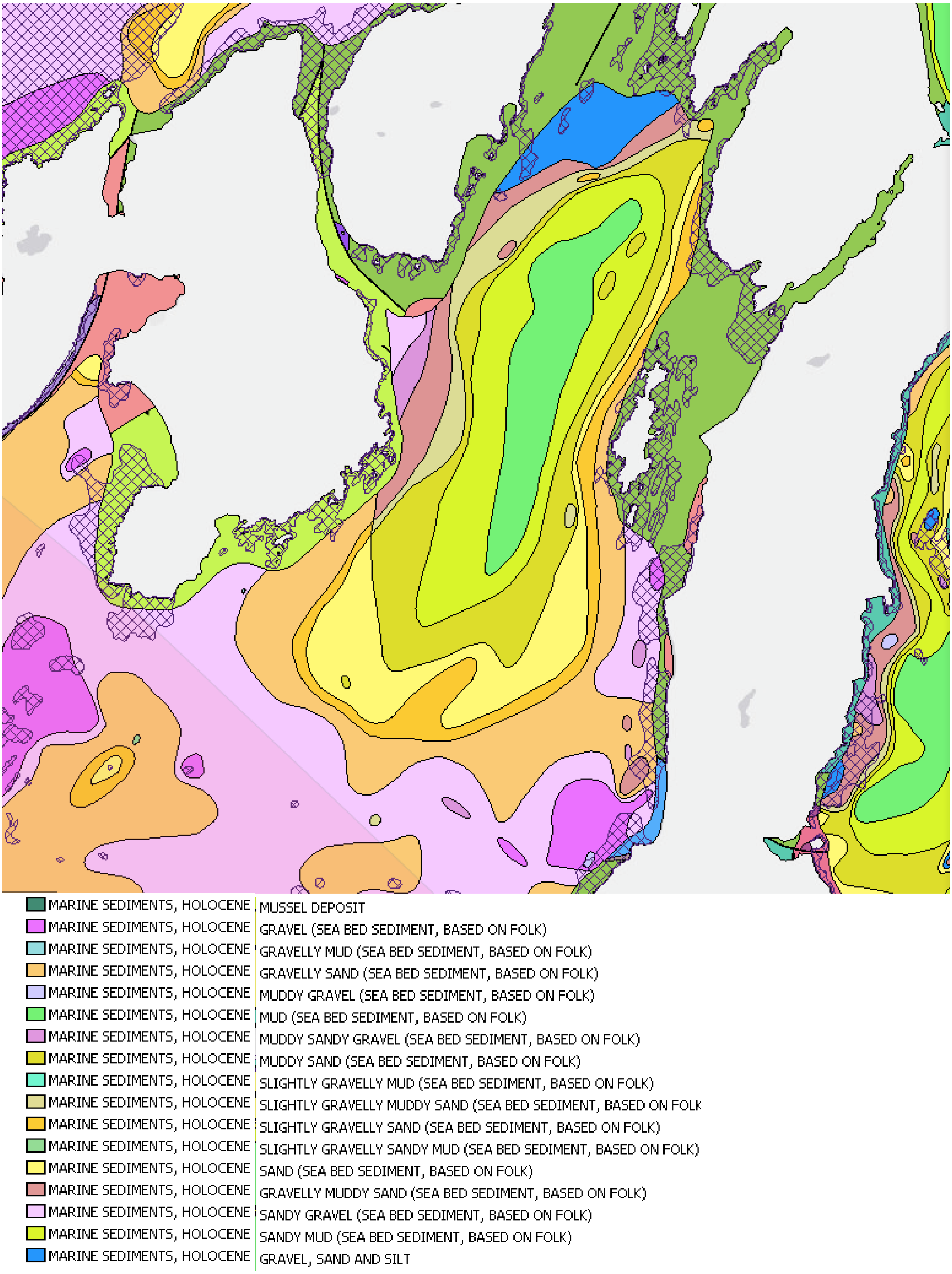


Figure 17: Seabed sediments, Islay area (*Source:UK Geological Service, in: Marine Scotland*)

3.1.1 Currents

Due to Scotland's position on the UK continental shelf, the seas around are directly affected by oceanic circulation. The ocean circulation in the North Atlantic is dominated by two gyres, the southernmost of this is called the sub-tropical gyre. Although it is often stated that the Gulf Stream, as part of the sub-tropical gyre circulation, brings warmth and milder conditions to Scotland's shores it is more correct to refer to the North Atlantic Current. This current is partly wind driven and partly driven by the density differences between the warmer, southern water and the cooler, northern water.

Despite the significance of this circulation, current speeds and depth-averaged tidal velocities are relatively low. Currents speeds can be enhanced around topographic features, so areas such as the Rockall Bank and the edge of the continental shelf can have strong currents associated with them. The map (Figure 18) gives an outline of the general pattern of currents and does not show the detail associated with the complex circulation of water. Background current speeds can also be enhanced over shorter timescales by complex effects such as mesoscale meanders and eddies, internal tides, internal waves and storm surges.

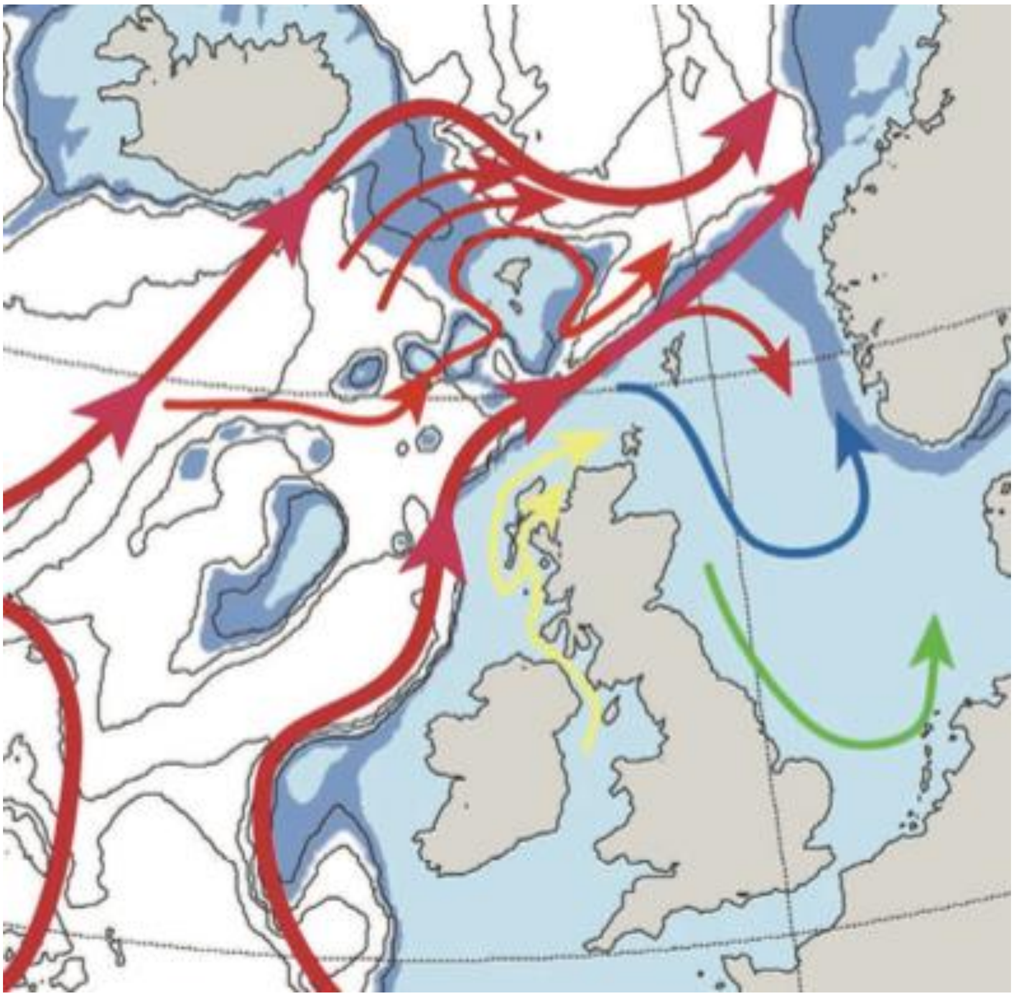


Figure 18: Ocean circulation around Scotland (*Source: Baxter et al., 2008*)

As well as the surface circulation, there is a flow of deep water returning at depth from the Arctic. This is evident from the presence of cold water at depth in the Faroe-Shetland Channel (below 400-600 m) that has its origin in the Iceland, Greenland and Norwegian Seas. Two technical terms often associated with this circulation are the Thermohaline Circulation and, more recently, the Meridional Overturning Circulation (MOC). The MOC has been the subject of intense study in recent years, because of its significant contribution to climate variability and the possibility that the effects of global climate change will weaken the MOC. The deep waters from the Arctic, which travel in a south-eastward direction through the Faroe-Shetland Channel, are diverted westward by the Wyville-Thomson Ridge and eventually spill over into the deep basin of the Rockall Trough. There are also intermittent overflows through deep channels in the Wyville-Thomson Ridge that are as yet unquantified. Changes in the properties of the deep water are thought to be indicative of changes in the surface circulation and the wider scale climatic changes.

In addition to the North Atlantic Current, a jet-like current, known as the Slope Current, flows in a poleward direction along the edge of the continental slope as a persistent slope current with speeds in the range of 15 to 30 cm/s, and centered approximately over the 400-500 m isobaths. The waters in the Slope Current originate from the Iberian region and some of the North Atlantic Water that reaches the Bay of Biscay joins the Slope Current. The Slope Current is an important source of heat, nutrients and plankton to the waters around Scotland. It appears to vary with the seasons, and can be stronger in winter than in summer. Its strength and direction can also be affected by local winds.

The steep bathymetry of the continental slope acts as a barrier between oceanic regions and the shelf sea systems, reducing the amount of water that can travel from the deeper waters of the North Atlantic into the shallower waters on the continental shelf. Processes that cause mixing of oceanic waters and shelf seawaters are complex but have a significant impact on conditions in Scottish waters. Waters from the North Atlantic enter the North Sea between Orkney and Shetland and around the north-east of Shetland as well as through the deep Norwegian Trench.

The residual circulation in the North Sea is predominantly anti-clockwise and circulation on the shelf west of Scotland (the Scottish Coastal Current) is mainly northwards. However, this circulation is strongly affected by winds and density-driven coastal currents and jets, which can lead to significant changes and even a reversal of this general pattern for short periods.

Tidal currents are predictable and stronger than the residual current in many areas. Tidal currents cause mixing in the water column and therefore often determine the location and extent to which the water column is stratified into different distinct layers. Tidal currents are intensified in localised areas, usually where the flow is constrained by topography. This includes areas such as between Orkney and Shetland, the Pentland Firth, off the Mull of Kintyre and Hebrides where tidal streams can be as high as 3.5-4.5 m/s. However, when the transport of water around Scotland is considered, the overall effect of the tides is quite small as tidal currents mainly move water back and forth. The principal tidal components are the semi-diurnal (twice daily) tides although in some limited regions the diurnal (daily) tides are significant. The UK National Tide Gauge Network, run by the Tide Gauge Inspectorate, records tidal elevations at a number of locations around the UK coast of which

11 are located in Scotland. These measurements, together with those provided by the SEPA Tide Gauge Network, provide a long time series of reliable and accurate sea-level data. Tidal range is generally between 4 and 5 m; highest tidal ranges are found in the inner Solway Firth where the mean spring tidal range can be between 7 and 8 m. Tidal range is at a minimum in areas known as amphidromic points. One of these points occurs in Scottish waters between Islay and the Mull of Kintyre; another amphidromic point can be found in the north-east of the North Sea. Tidal range decreases with distance offshore from the north-east coast.

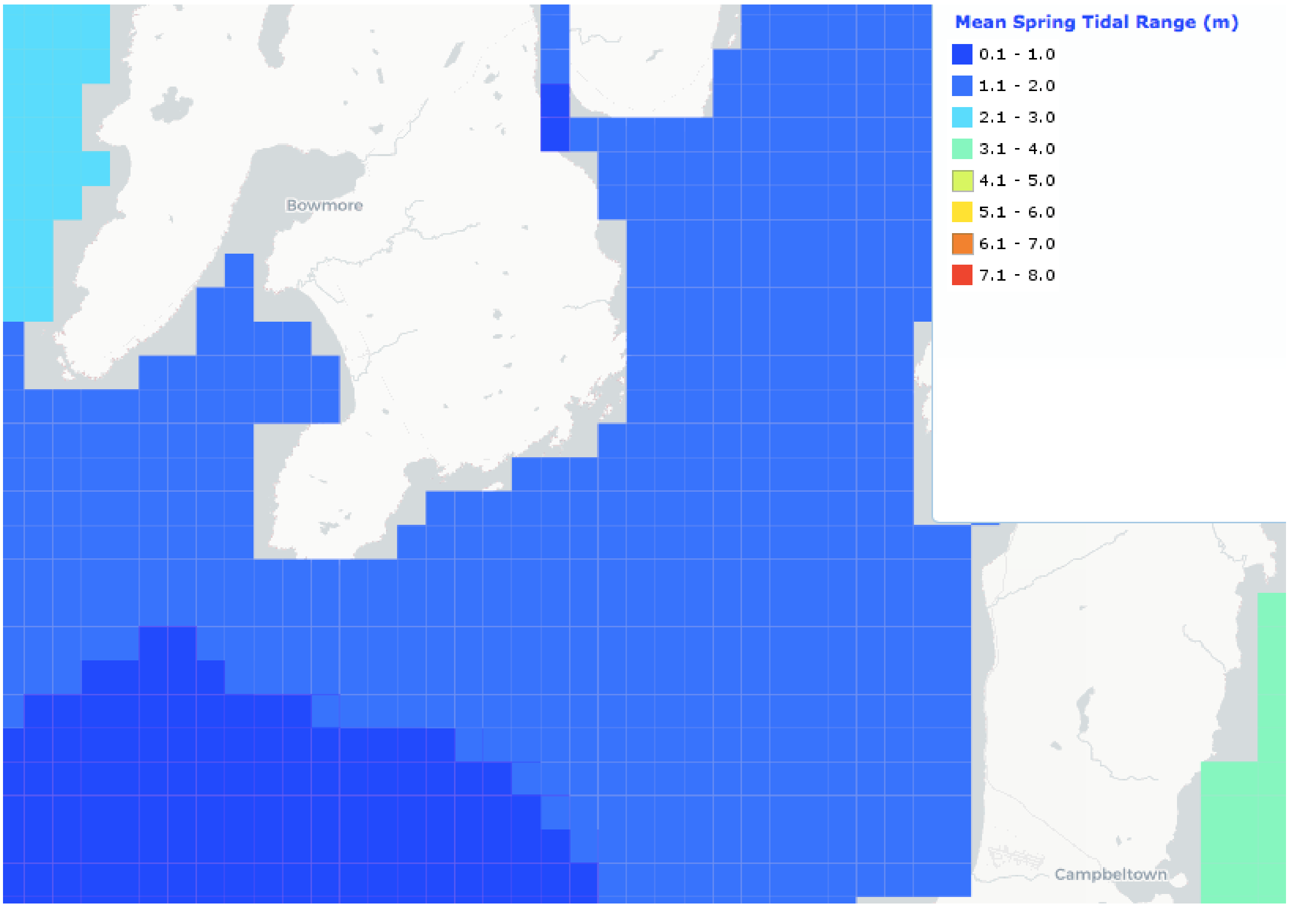


Figure 19: Mean Spring Tidal Range (m) (*Source: Marine Scotland*)

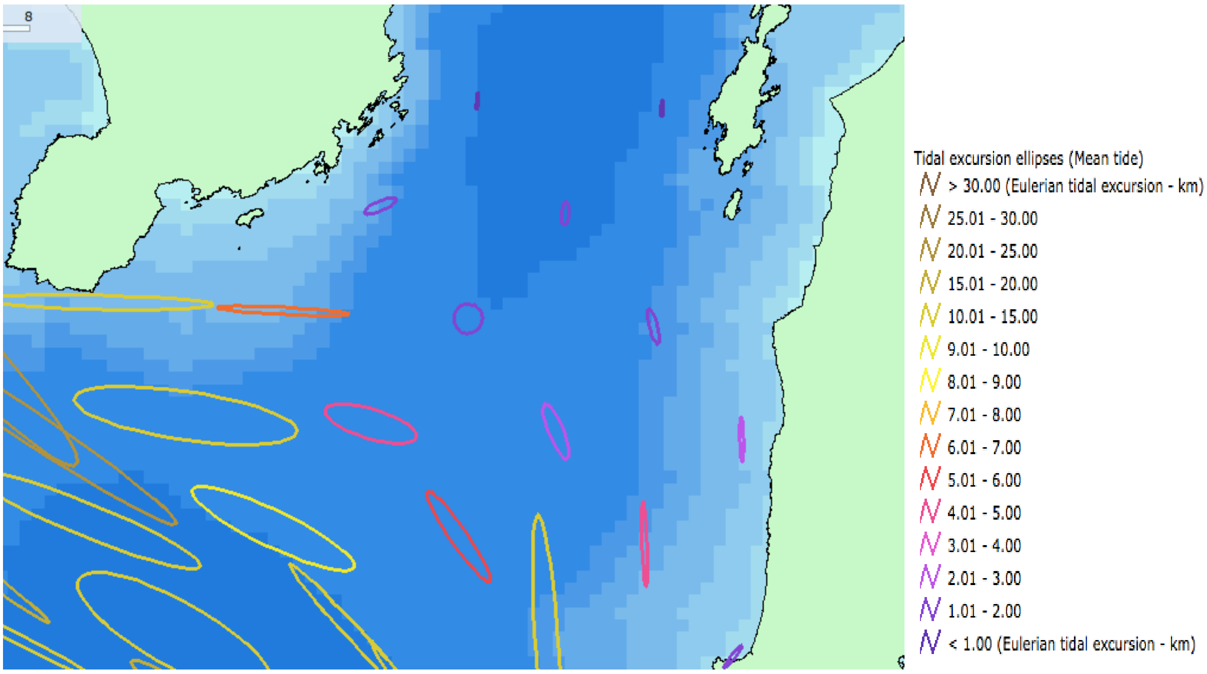


Figure 20: Ellipses of tidal current (*Source: UK Renewables Atlas*)

3.1.2 Waves

Within Scottish waters, the wave climate is mainly influenced by conditions in the North Atlantic Ocean, where the fetch is long enough to establish large swell waves. The north and west of Scotland (Hebrides, Orkney and Shetland) are most exposed to these conditions. Waves on the east coast of these islands are smaller due to their comparatively sheltered nature. On the east coast of Scotland, conditions in autumn and winter may also be rough in the North Sea due to the wind direction being such that there is a large fetch. Moreover, the Moray Firth is also relatively exposed because of its shoaling bathymetry and exposure to the North Sea.

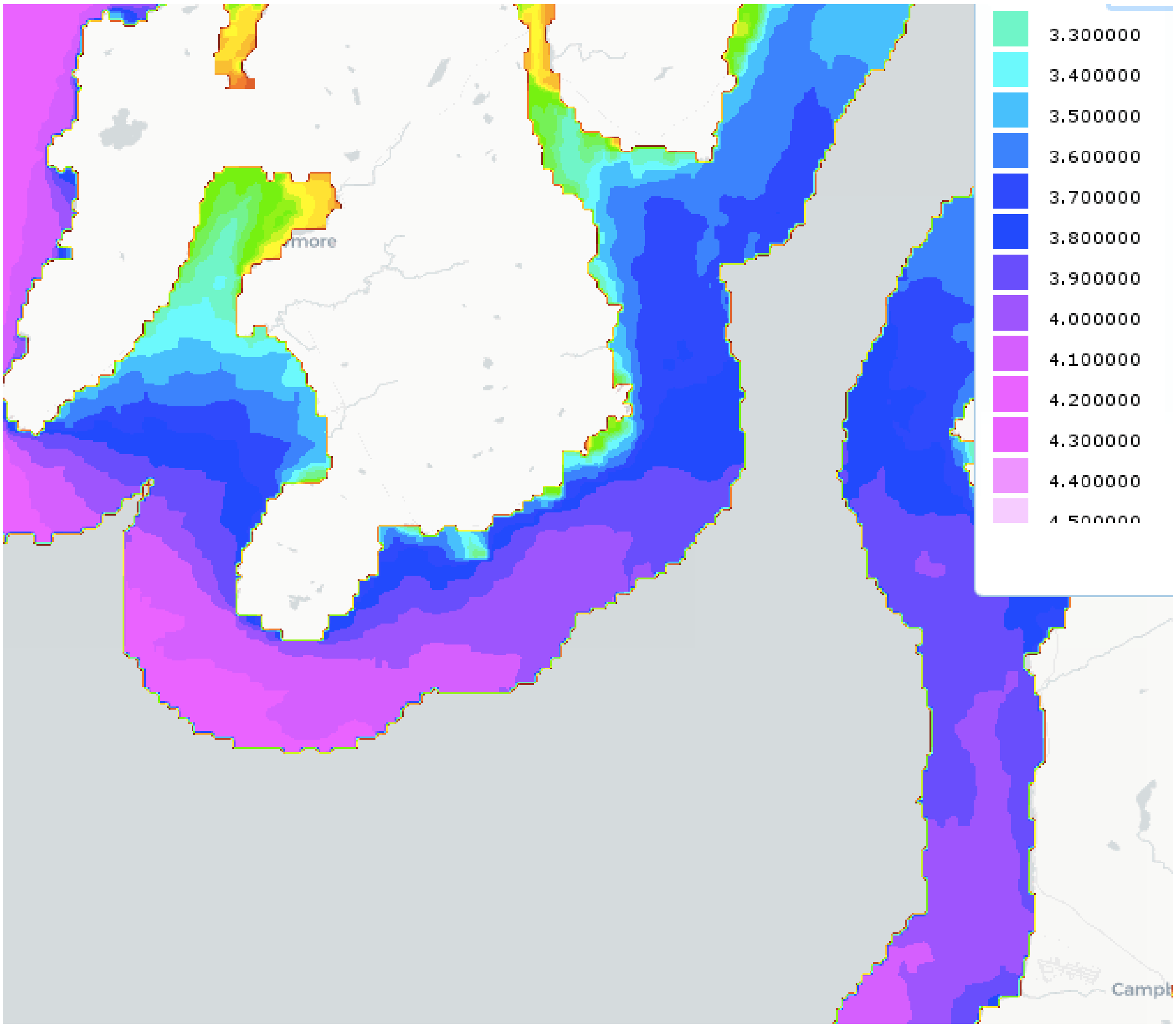


Figure 21: Wave exposure index, Islay area (*Source: Marine Scotland*)

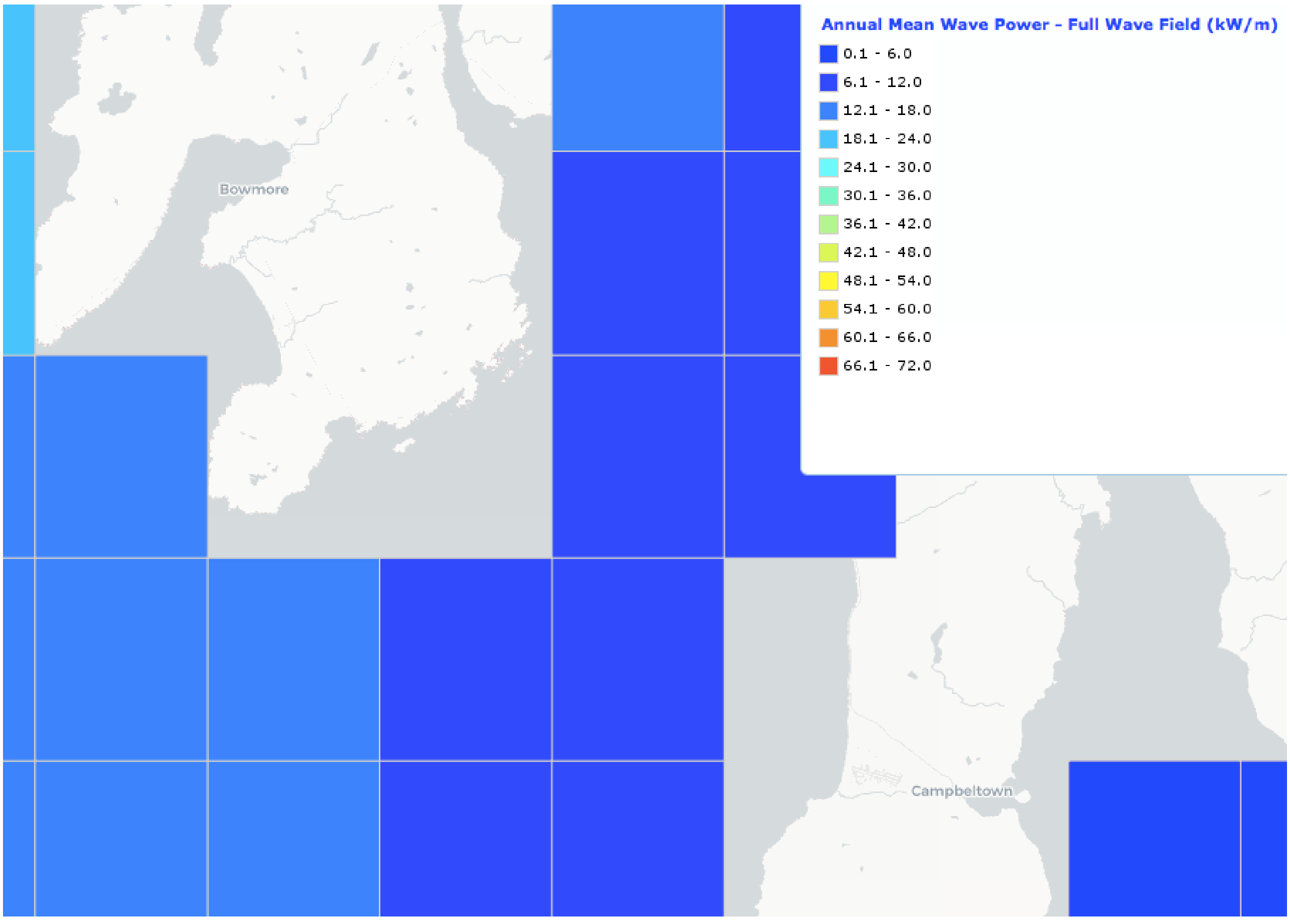


Figure 22: Annual Mean Wave Power (kW/m) (*Source: Marine Scotland*)

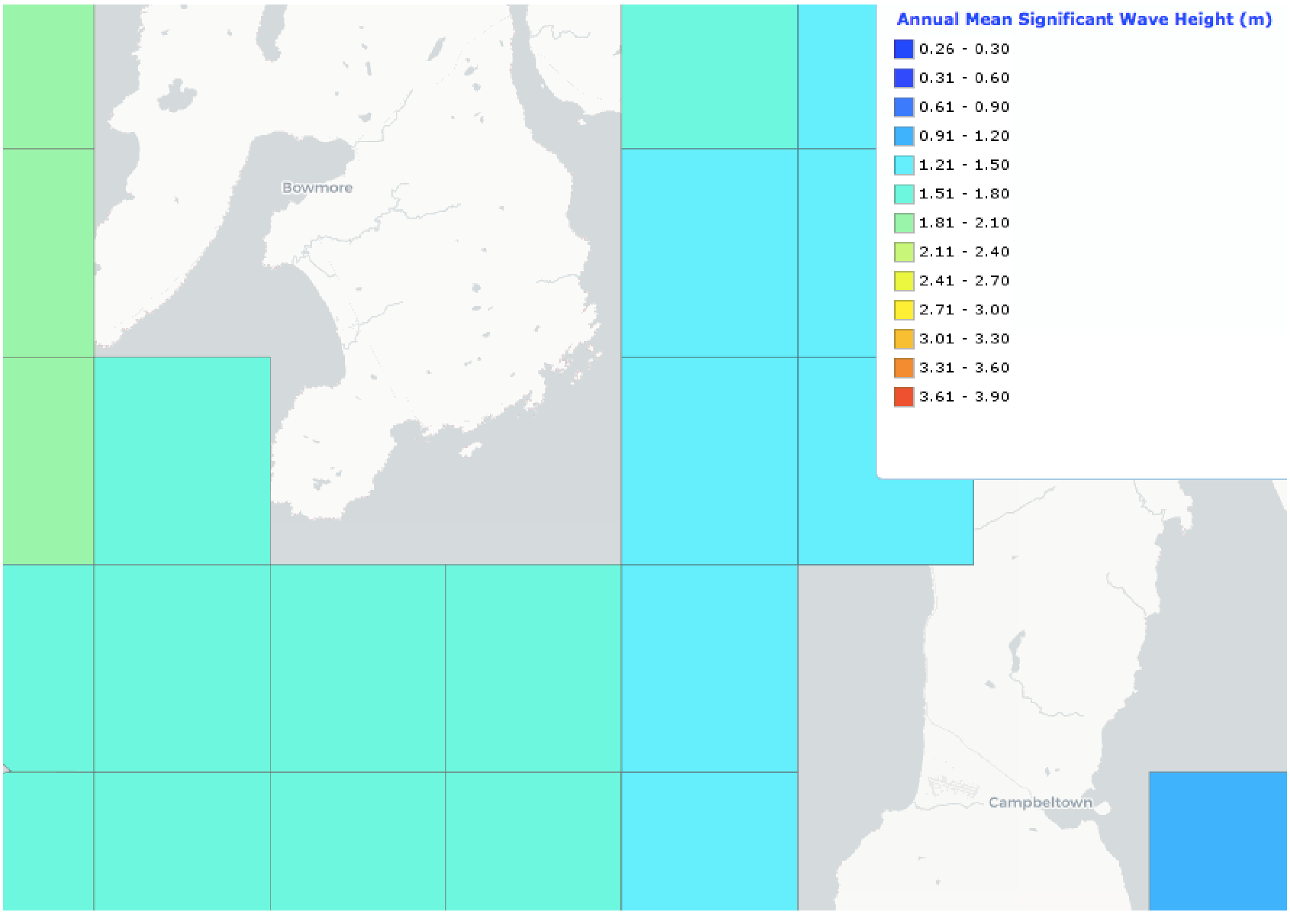


Figure 23: Annual Mean Significant Wave Height (m) (*Source: Marine Scotland*)

Tidal surges caused by storms do occur in Scotland, and mainly affect the east coast. However, storm surges are less significant around Scotland than in regions further south because of the way that the surges grow as they propagate southward. For example, the most significant storm surge ever recorded over the last 100 years occurred in 1953. During that event surge levels of 0.6 m and 0.83 m were recorded at Aberdeen and Leith respectively, but reached 2.97 m in southern England (King’s Lynn) and 3.36 m in the Netherlands. The 1 in 50 year storm surge predictions for Scotland are around 1.25 m.

3.1.3 Wind

Scotland has a maritime climate strongly influenced by the oceanic waters of the North Atlantic and prevailing south- westerly winds. As these winds blow over the regions of the North Atlantic warmed by the North Atlantic current, they pick up heat, which is delivered to Scotland, giving Scotland a relatively mild, wet climate considering its latitude. As such, changes in the strength of the Atlantic Ocean circulation have a significant effect on the climate of Scotland. Normally in the atmosphere over the North Atlantic, a low-pressure area is situated in the north, near Iceland, and a high-pressure area is situated in the south of the region near the Azores. This pattern of sea-level pressure results in a stream of smaller, secondary depressions, travelling in a north-eastward direction between these two regions. The passage of these depressions account for the variable weather experienced in Scotland and although the predominant wind direction is from the south-west, wind direction varies as depressions pass. The depressions are often more intense during winter months bringing with them gales, which in the windiest places (Western Isles, Orkney and Shetland) can occur up to 30 days per year.

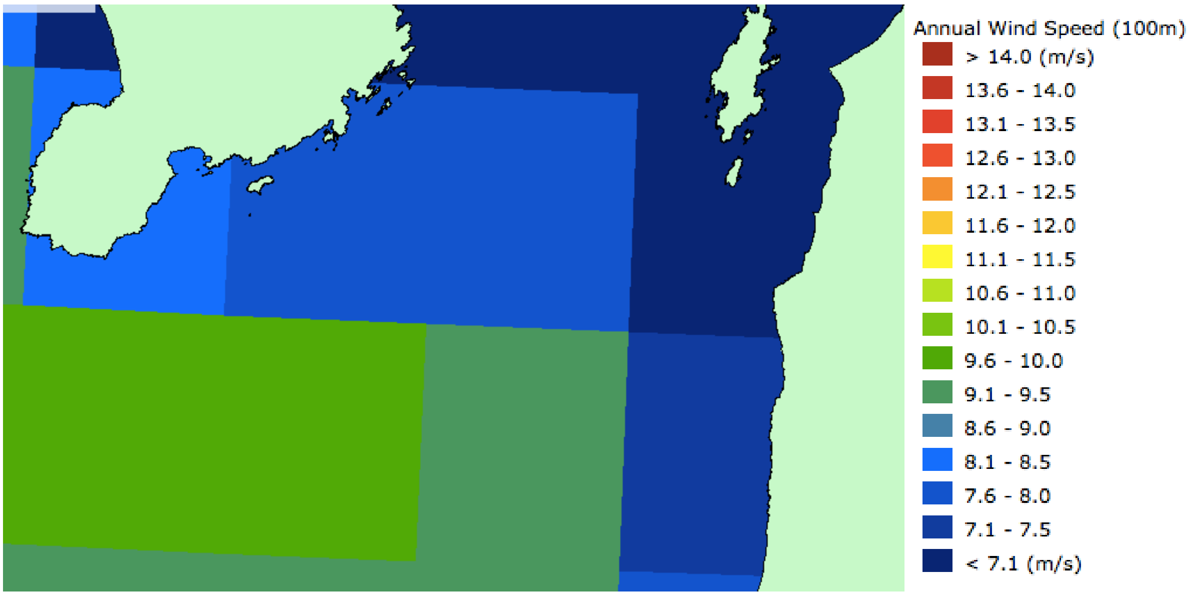


Figure 24: Annual Mean Wind Speed at 100 m above sea level (*Source: UK Renewables Atlas*)

The low-lying areas on the west coast of Scotland that are exposed to the Atlantic Ocean tend to have more cloud, less sunshine and be slightly warmer and wetter than the east of Scotland (Figure 2.3). Mean annual air temperatures in low-lying areas are between 7-9°C. However, sea fog (haar) from the North Sea is common in the spring and summer, particularly in the Northern Isles and on the east coast.

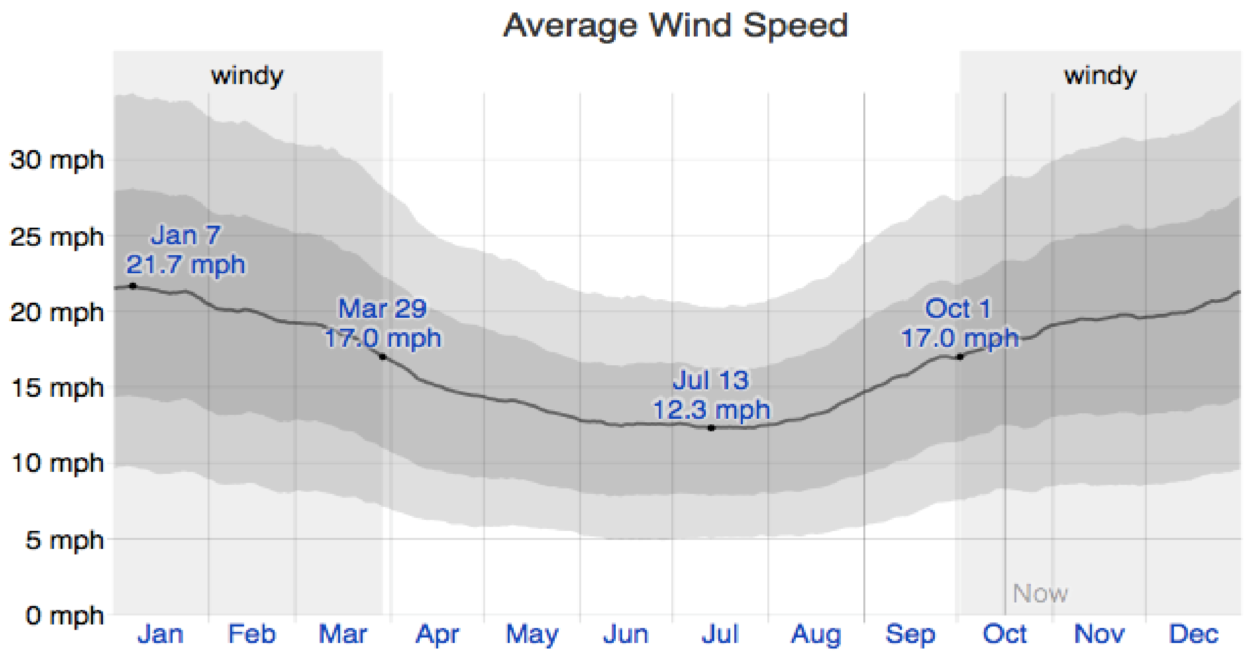


Figure 25: Average wind speed at ground in Islay. 95 and 75 percentiles in grey (Source: www.weatherspark.com)

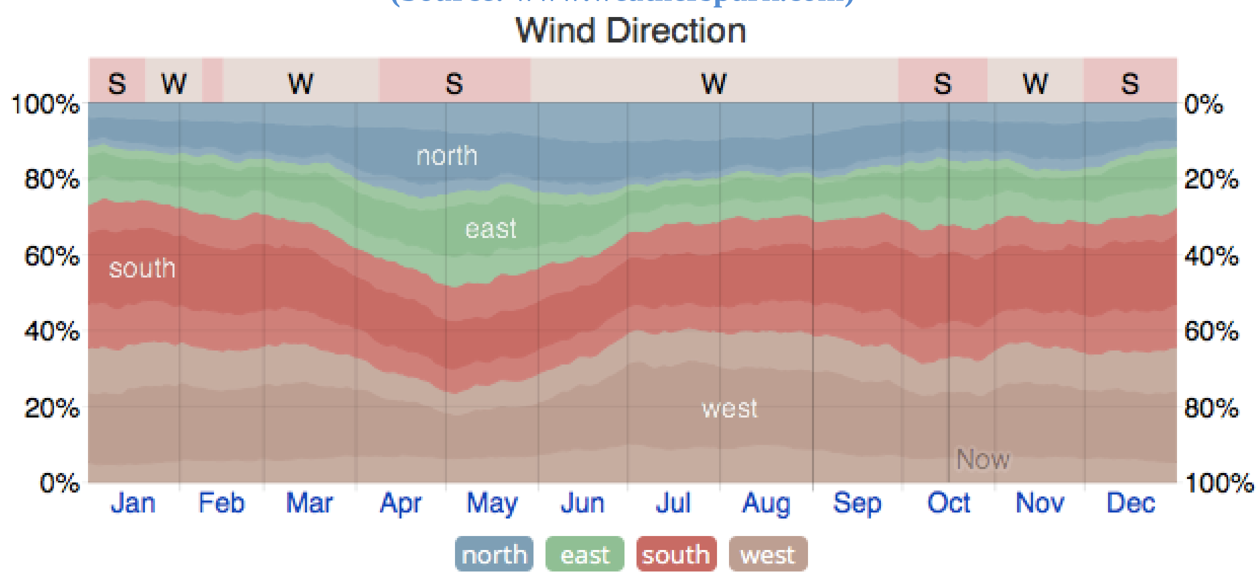


Figure 26: Average wind direction at ground in Islay (*Source: www.weatherspark.com*)

3.1.4 Sea water temperature

Sea temperatures around Scotland are affected by local climatic conditions (heat flux with atmosphere) and the heat transferred to the shores of Scotland by ocean currents (advective effects). Sea surface temperatures vary with an annual cycle, lagging behind the cycle of atmospheric temperature by around one month.

Average sea temperatures around Scotland reflect the influence of heat transported from oceanic waters. On average, the winter temperatures on the west coast of Scotland are higher than those on the east coast. In the summer this situation is reversed as waters in the shallower North Sea warm up more quickly and so summer temperatures on the east coast are higher than on the west coast. The influence of the North Atlantic Current and climate system can also be observed in the long-term variability of sea surface temperatures.

In deeper waters, the circulation patterns strongly influence temperatures, with returning cold water of Arctic origin filling the deep basins below about 800 m and intermediate waters lying between this and the warmer Atlantic waters above.

3.1.5 Salinity

Salinity in the open ocean is controlled by the balance between evaporation (freshwater out) and precipitation (freshwater in). In coastal waters the direct input of freshwater from land run-off and rivers dominates the changes in salinity. Many shelf areas are affected by freshwater inputs. Areas of high freshwater influence are the large estuaries and adjacent coastal waters of the Clyde, Solway Firth, Moray Firth, Firth of Tay and Firth of Forth as well as coastal areas on the west coast that receive a lot of freshwater from land runoff and numerous small rivers.

The physical characteristics of the waters in the shelf seas off Scotland are important because of their effect on the marine ecosystem. These characteristics are largely determined by a balance between the surface heating from the sun and freshwater run-off from the land, and the mixing influences of the strong tidally and wind driven flows, themselves shaped by the intricate and irregular bathymetry and coastline. The combination of these factors results in regions that are stratified and regions that are well mixed, with complex frontal systems between them (Figure 27).

It is also important to note the particular characteristics of sea lochs. Many west coast Scottish sea lochs have restricted water exchange with the surrounding seas, particularly those with a sill at the mouth of the loch.

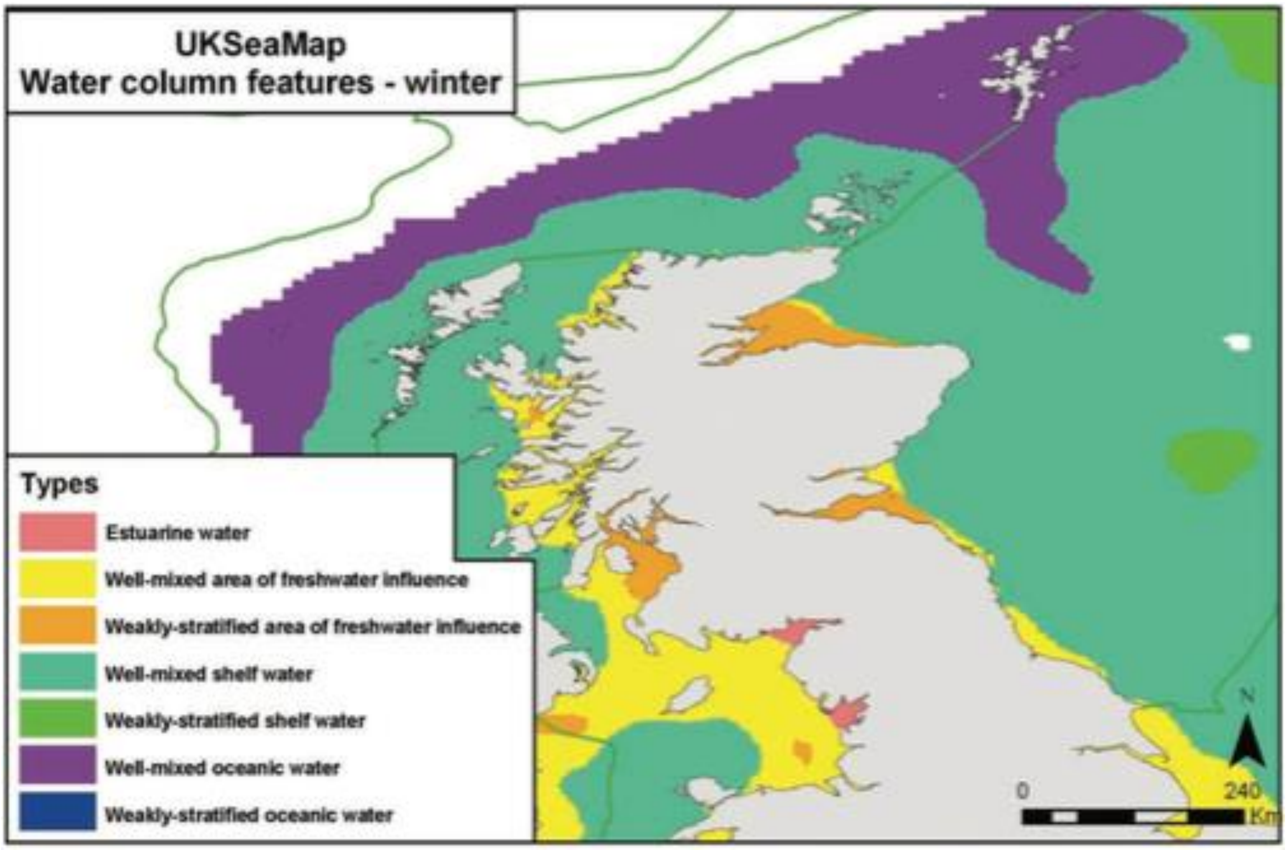


Figure 27: Water column features (*Source: Baxter et al., 2008*)

3.1.6 Rain

Rainfall over Scotland is high compared to the UK as a whole. Total rainfall is 113,150 million cubic meters *per* year of which 73% is estimated to runoff into the sea. This equates to approximately 1 million cubic meters runoff per square km of land.

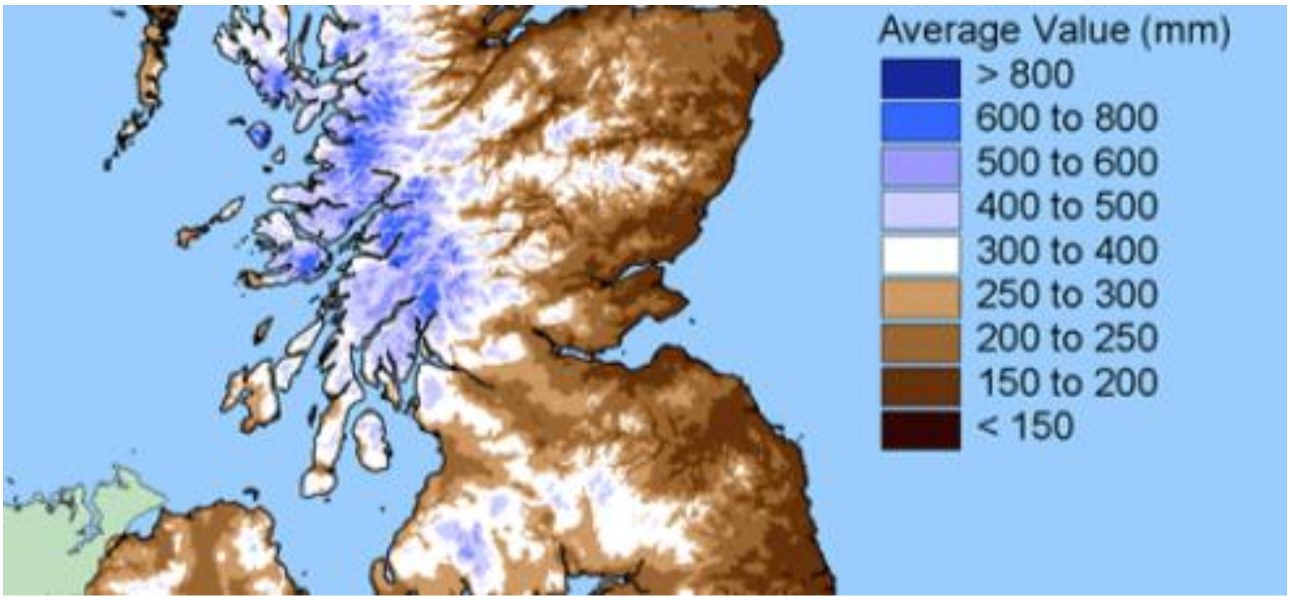


Figure 28: Rainfall in summer (*Source: UK Metereological Office*)

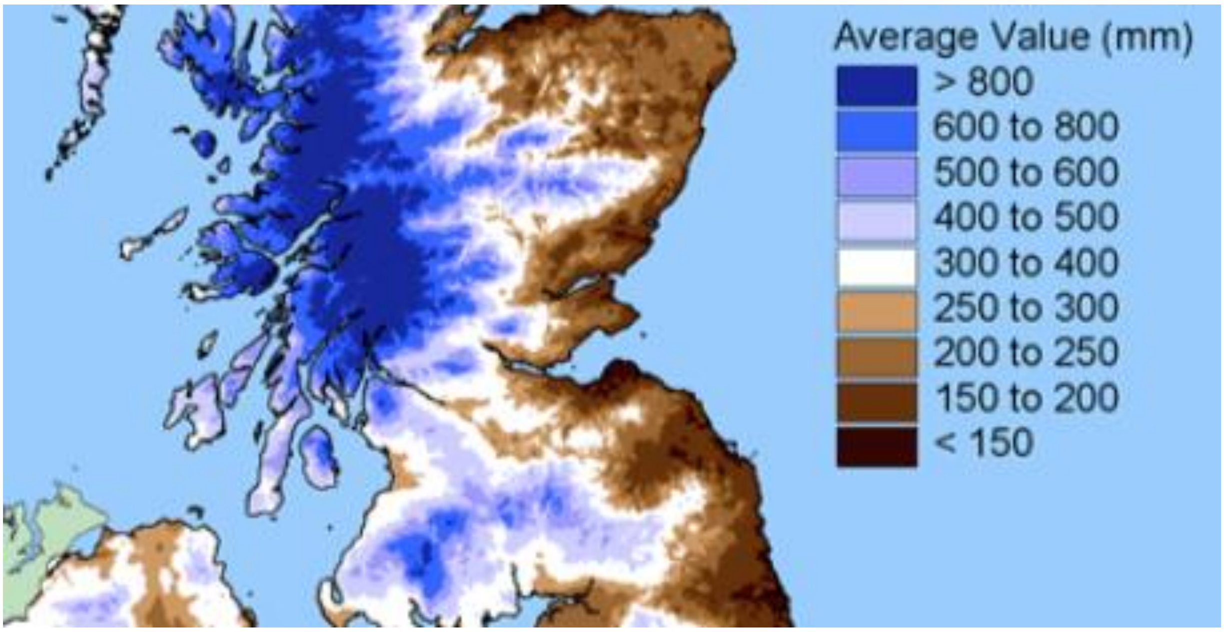


Figure 29: Rainfall in winter (*Source: UK Metereological Office*)

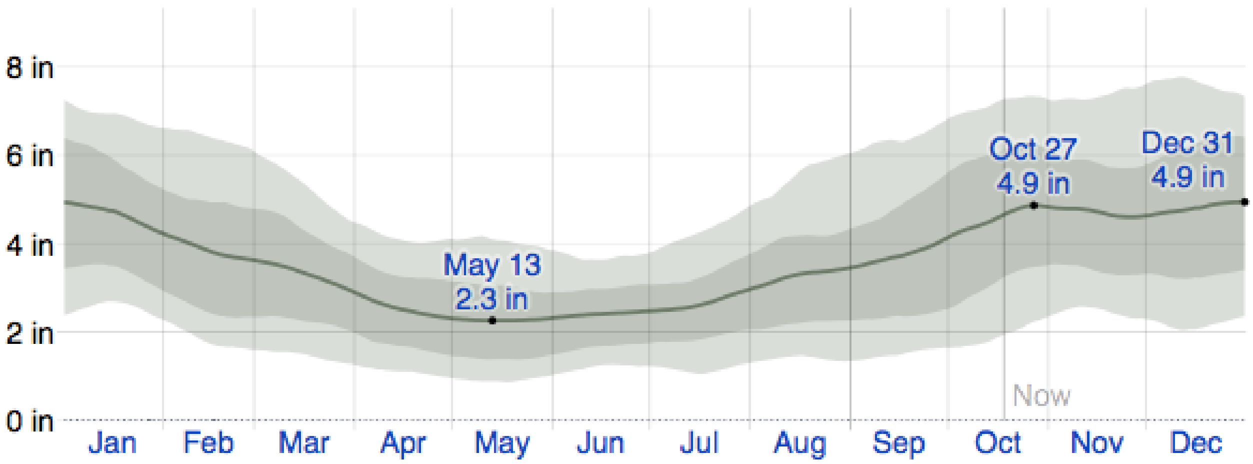


Figure 30: Average monthly rainfall in Islay. 95 and 75 percentile bands in grey (*Source: www.weatherspark.com*)

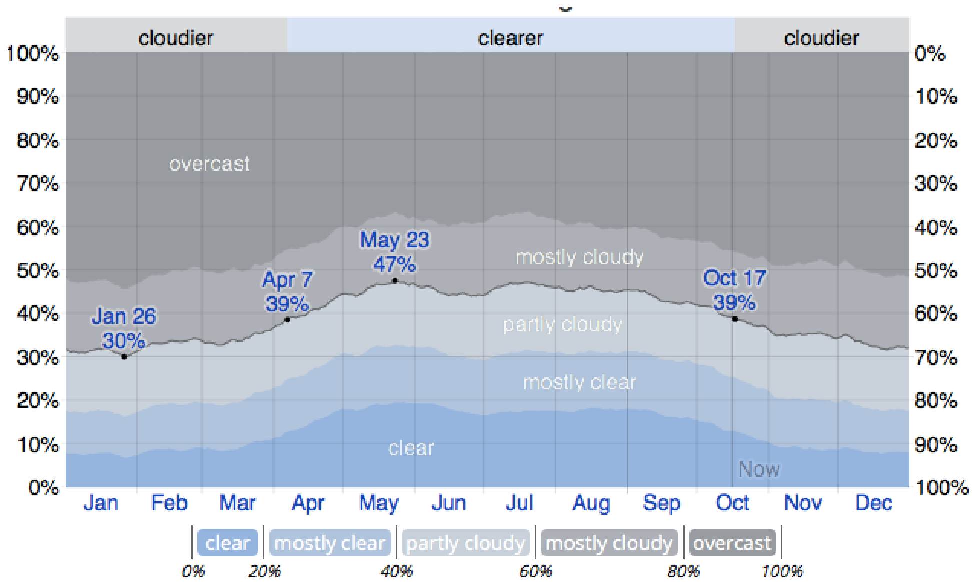


Figure 31: Cloud coverage in Islay (*Source: www.weatherspark.com*)

3.1.7 Photosynthetic active radiation

At the latitude of Scotland there are large variations in day length throughout the year with some northern areas receiving almost 24 hours daylight in midsummer and just a few hours of daylight at midwinter. The duration of light availability is known to produce a varied response in different phytoplankton species. The short, dark winter days that are typical of the north of Scotland mean that phytoplankton growth is considerably reduced between the months of November and February and very low cell abundances are observed in the water column. In contrast, some phytoplankton growth is observed in more southerly latitudes of the UK during the winter period. Turbidity, a measure of how clear the water is, is generally determined by which particles are suspended in the water column, and their concentration. Suspended solids are generally highest in areas close to land (due to run-off) and in shallow regions where currents and waves are sufficiently strong to resuspend bottom sediments. Other than biological (e.g. phytoplankton cells) and mineral (sediment) particles, the water colour may also be influenced by Coloured Dissolved Organic Matter (CDOM), that is released by decaying terrestrial and marine plants. Due to the relatively larger release from terrestrial plants, the input of significant concentrations of CDOM is mainly confined to coastal areas with a large freshwater input.

Turbidity is highest in coastal areas with a large fresh water input, such as the Clyde Sea, Firth of Lorn and the Forth/Tay river plume. Compared to the southern North Sea, the Scottish North Sea has much lower concentrations of suspended sediment. The turbidity of the water influences the productivity, as cloudy waters limit the penetration of light and can inhibit photosynthesis.

3.2 NATURAL ENVIRONMENT

3.2.1 Protected areas

Argyll and Bute has a wealth of natural heritage and biodiversity resources and its coastal waters are both physically and ecologically diverse, ranging from very exposed waters bounded by rocky coastline to extremely sheltered sealochs. Within and between these extremes, this area supports a diversity of seabed habitats and associated flora and fauna. Those of particular ecological and conservation interest include rocky reefs, biogenic habitats (e.g. maerl, mussel and seagrass beds), burrowed mud and intertidal sediment flats. Much important flora and fauna is contained within these areas, but they also provide foraging areas for various fish and birds, as well as supporting broader ecological functioning of the marine environment. Marine mammals are also an important feature of the natural heritage of this area.

Argyll and Bute's marine and coastal environment is recognised as being truly outstanding with many areas protected by International, European and UK designations and legislation. It is also increasingly recognised as a significant economic and social asset for local communities.

International designations

There are 8 Ramsar sites in Argyll and Bute. Meeting UK commitments under the Ramsar Convention, these sites are recognised as wetlands of international importance. Four of these sites (Table 5) are considered to either extend into the marine environment or support features, which may interact with marine aquaculture development.

Table 5: Ramsar sites with relevance to marine aquaculture development (*Source: Argyll and Bute Local Development Plan, 2016*)

Ramsar Site	Designated Features	Relevant to finfish development	Relevant to shellfish development
Bridgend Flats, Islay	Greenland Barnacle goose	No	Yes (Oyster only)
Gruinart Flats, Islay	Greenland Barnacle, Greenland white-fronted and Light-bellied Brent geese	No	Yes (Oyster only)
Sleibhtean agus Cladach Thiriodh	Greenland Barnacle and Greenland white-fronted geese, Breeding dunlin, oystercatcher redshank, ringed plover. Non-breeding ringed plover and turnstone.	No	Yes (Oyster only)
Inner Clyde	Non-breeding birds (redshanks)	No	Yes (Oyster only)

The Special Areas of Conservation (SACs), designated by Scottish Ministers under the EC Habitats Directive, represent the range and variety of habitats and (non-bird) species within the EU, as listed in Annexes I & II of the Directive. Thirteen of these sites (Table 6) are considered to either extend into the marine environment or support features, which may interact with marine aquaculture development.

Table 6: Scottish Special Areas of Conservation (SACs)
(*Source: Argyll and Bute Local Development Plan, 2016*)

Special Area of Conservation (SAC)	Relevant Qualifying Features	Relevant to finfish development	Relevant to shellfish development
Loch Oreran	Reefs	Yes	Yes
Firth of Lorn	Reefs	Yes	Yes
Treshnish Isles	Grey seal, reefs	Yes	Yes (Reef feature)
Moine Mhor	Intertidal mudflats and sandflats, Otter (*Lutra lutra*)	No	Yes (Oyster only)
Eileanan agus Sgeiran Lios mor	Common seal	Yes	Yes
South-east Islay Skerries	Common seal	Yes	Yes
Coll Machair	Machair	No	Yes (Oyster only)
Oronsay	Machair	No	Yes (Oyster only)
Tiree Machair	Machair	No	Yes (Oyster only)
Loch Etive Woods	Otter	Yes	Yes
Glen Oreran Woods	Otter	Yes	Yes
Taynish and Knapdale Woods	Otter	Yes	Yes
Tayvallich Juniper and Coast	Otter	Yes	Yes
Mingarry Burn	Freshwater pearl mussel	Yes	No
Inner Hebrides and the Minches	Harbour Porpoise	Yes	No

Special Protection Areas (SPAs), established by Scottish Ministers under the EC Birds Directive, are identified as the most important for rare and regularly occurring migratory birds in the EU. Ten of these sites (Table 7) are considered to either extend into the marine environment or support features, which may interact with marine aquaculture development. Scientific advice from SNH and JNCC has recommended additional marine SPAs including two draft SPAs in Argyll and Bute.

Table 7: Special Protection Areas (SPAs)
(*Source: Argyll and Bute Local Development Plan, 2016*)

Special Protection Area (SPA)	Relevant Qualifying Features	Relevant to finfish development	Relevant to shellfish development
Bridgend Flats, Islay	Greenland Barnacle goose	No	Yes (oyster only)
Gruinart Flats, Islay	Geenland Barnacle, Greenland White- fronted and Light- bellied Brent geese	No	Yes (oyster only)

Coll	Geenland Barnacle, Greenland White- fronted geese	No	Yes (oyster only)
Inner Clyde	Non-breeding birds (redshanks)	No	Yes (oyster only)
Laggan, Islay	Geenland Barnacle, Greenland White- fronted geese	No	Yes (oyster only)
Treshnish Isles	Breeding storm petrel	Yes	Yes
Sleibhtean aggus Cladach Thiriodh	Geenland Barnacle, Greenland White- fronted and Light- bellied Brent geese, Breeding dunlin, oystercatcher, redshank, ringed plover. Non-breeding ringed plover and turnstone	No	Yes (oyster only)
Oronsay and South Colonsay	Corncrake and Chrough	No	Yes (oyster only)
North Colonsay and Western Cliffs	Breeding seabird assemblage. Breeding guillemot and kittiwake.	Yes	Yes
Glas Eileanan (Sound of Mull)	Common tern	Yes	Yes

Nature Conservation Marine Protected Areas (MPAs) are designed to preserve a number of marine biodiversity features (species and habitats) and geodiversity features (the variety of landforms and natural processes that underpin the marine landscapes), offering long-term support for the services our seas provide to society. 30 Nature Conservation MPAs have been designated in Scotland with 5 of these sites (Table 8) within Argyll and Bute inshore waters.

Table 8: Nature Conservation Marine Protected Areas (MPAs)
(*Source: Argyll and Bute Local Development Plan, 2016*)

Nature Conservation Marine Protected Areas (MPA)	Relevant Designated Features	Relevant to finfish development	Relevant to shellfish development
Clyde Sea Sill	Biodiversity: black guillemot; circalittoral sand and coarse sediment communities; fronts. Geodiversity: Marine Geomorphology of the Scottish Shelf Seabed	Yes	Yes
Loch Oreran	Biodiversity: flame shell beds. Geodiversity: Quaternaty of Scotland.	Yes	Yes
Loch Sunart to the Sound of Jura	Biodiversity: common skate. Geodiversity: Quaternary of Scotland	Yes	Yes

Loch Sween	Biodiversity: burrowed mud; maerl beds; native oysters; sublittoral mud and mixed sediment communities	Yes	Yes
Upper Loch Fyne and Loch Goil	Biodiversity: burrowed mud; flame shell beds; horse mussel beds; ocean quahog; sublittoral mud and mixed sediment communities.	Yes	Yes

Sites of Special Scientific Interest (SSSIs) provide protection for the best examples of the UK's biological, geological or physiographical features, down to mean low water of spring tides. Many SSSIs overlap with SACs and SPAs. Twenty-one of these sites (Table 9) are considered to either extend into the marine environment or support features which may interact with marine aquaculture development.

Table 9: Sites of Special Scientific Interest (SSSIs)
(*Source: Argyll and Bute Local Development Plan, 2016*)

Sites of Special Scientific Interest (SSSIs)	Relevant Designated Features	Relevant to finfish development	Relevant to shellfish development
Oronsay and South Colonsay	Grey seal, Chough	Yes	Yes
Moine Mhor	Saltmarsh	No	Yes (oyster only)
Taynish Wood	Rocky shore	No	Yes (oyster only)
Ulva, Danna and the McOormaing Isles	Mudflats	Yes	Yes
Gruinart flats	Mudflats, goose features, Chough	No	Yes (oyster only)
Bridgend flats	Saltmarsh, sandflats, goose features	No	Yes (oyster only)
West Colonsay seabird cliffs	Breeding guillemot, kittiwake, razor bill and seabird colony	Yes	Yes
Sanda Island	Cormorant, guillemot, shag, storm petrel, fulmar, great black-backed gull, kittiwake, manx shearwater, puffin and razorbill	Yes	Yes
Ruel estuary	Saltmarsh	No	Yes (oyster only)
Linne Mhuirich	Saltmarsh	No	Yes (oyster only)
Sleibhtean agus Cladach Thiriodh	Breeding bird assemblage. Breeding dunlin, oystercatcher, redshank, and ringed plover. Non-breeding purple sandpiper, sanderling, ringed plover and turnstone, goose features	No	Yes (oyster only)
Treshnish	Breeding seabird colony, grey seal	Yes	Yes

Staffa	Breeding fulmar, puffin and shag	Yes	Yes
Inner Clyde-Ardmore Point	Saltmarsh; non-breeding birds (cormorant, eider, goldeneye, oystercatcher, red-breasted merganser, red-throated diver, redshank)	No	Yes (oyster only)

Habitats and species of conservation interest

Wildlife & Countryside Act, 1981 (as amended) reports Marine species with special protection under schedules 5 and 8, including basking shark, otters and all cetaceans and marine turtles. The waters surrounding the island of Coll are important for basking sharks and as a result form part of a larger search area for a potential Marine Protected Area. Marine turtles are rare in Scotland but it is likely that they are annual visitors to the west coast of Scotland. Most Scottish records have been of leatherback turtles, the largest and most cold-tolerant species.

Where aquaculture development is proposed in close proximity to known coastal nesting sites for seabirds and raptors the protection afforded to relevant wild bird species under the Act will need to be considered.

Other species and habitats of conservation interest present in Argyll and Bute, which do not receive explicit protection, but are particularly important in the context of biodiversity conservation and/or ecosystem function, are listed under the Scottish Biodiversity List, UK Biodiversity Action Plan and OSPAR lists.

Under the Nature Conservation (Scotland) Act 2004, all public bodies have a duty to further the conservation of biodiversity and the Scottish Biodiversity Strategy. When considering aquaculture development proposals the Council will seek to contribute to the delivery of the objectives and targets set by the Local Biodiversity Action Plan (LBAP) and the Scottish Biodiversity Strategy.

The Argyll and Bute Local Biodiversity Action Plan (LBAP) was renewed in 2010 and identifies habitats and species important in the local context and includes Action Plans for their conservation and enhancement.

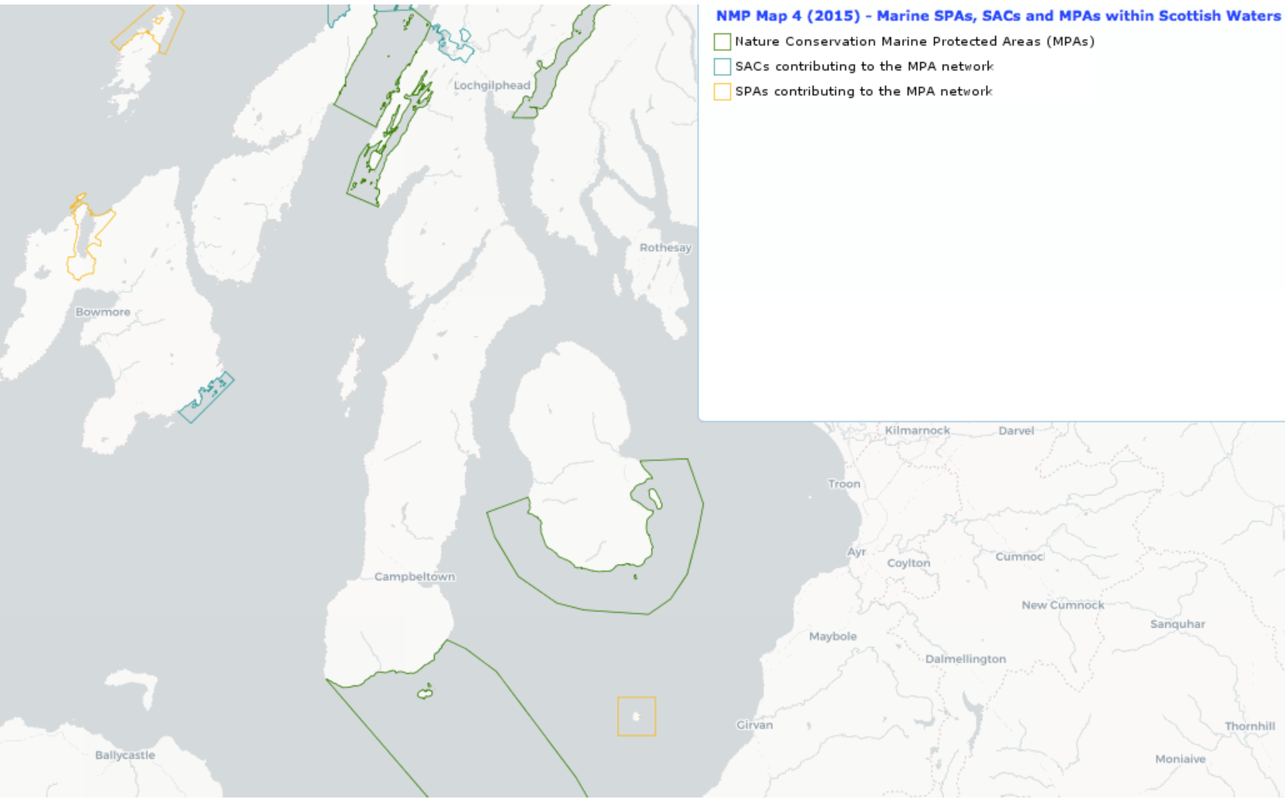


Figure 32: Marine SPAs, SACs and MPAs within Scottish Waters (*Source: Marine Scotland*)

Priority Marine Features

Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) have developed a prioritised list of marine features in Scotland to underpin conservation action. The recommended list contains 81 habitats and species, termed Priority Marine Features (PMFs), which are considered to be of particular importance in Scotland's seas. This list will help deliver Marine Scotland's vision for marine nature conservation outlined in the Marine Nature Conservation Strategy. Approximately 50 of the 81 Priority Marine Features are represented in Argyll and Bute inshore waters and these features will be the main focus for protection of marine biodiversity outside designated sites and protected species.

Table 10: Communities Priority Marine Features of Scotland
(*Source: Tyler-Walters et al., 2016*)

Priority Marine Features	Biotope/species
Inshore deep mud with burrowing heart urchins	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud
Intertidal mudflats	Littoral mud
Kelp and seaweed communities on sublittoral sediment	Kelp and seaweed communities on sublittoral sediment[1]
Kelp beds	*Laminaria hyperborea* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock
	Laminaria hyperborea with dense foliose red seaweeds on exposed infralittoral rock[2]
	Laminaria hyperborea on tide-swept, infralittoral rock
	Laminaria hyperborea on tide-swept infralittoral mixed substrata[3]
	Laminaria hyperborea and foliose red seaweeds on moderately exposed infralittoral rock[4]
Low or variable salinity habitats	Faunal communities on variable or reduced salinity infralittoral rock
	Kelp in variable or reduced salinity
	Submerged fucoids, green or red seaweeds (low salinity infralittoral rock)
	Sublittoral mud in low or reduced salinity (lagoons)
	Bird's nest stonewort
	Baltic stonewort
	Foxtail stonewort
	Small brackish water snail
Maerl beds	Maerl beds

Priority Marine Features	Biotope/species
Maerl or coarse shell gravel with burrowing sea cucumbers	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand
Native oysters	*Ostrea edulis* beds on shallow sublittoral muddy mixed sediment
	Native oyster
Northern sea fan and sponge communities	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock
	Mixed turf of hydroids and large ascidians with *Swiftia pallida* and *Caryophyllia smithii* on weakly tide-swept circalittoral rock
	Deep sponge communities (circalittoral)
	Northern sea fan
Offshore deep sea muds[5 & 6]	*Ampharete falcata* turf with *Parvicardium ovale* on cohesive muddy sediment near margins of deep stratified seas
	Foraminiferans and *Thyasira* sp. in deep circalittoral fine mud
	Levinsenia gracilis and *Heteromastus filifirmis* in offshore circalittoral mud and sandy mud
	Paramphinome jeffreysii, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud
	Myrtea spinifera and polychaetes in offshore circalittoral sandy mud
Offshore subtidal sands and gravels[7]	*Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand
	Hesionura elongata and *Protodorvillea kefersteini* in offshore coarse sand
	Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand

Priority Marine Features	Biotope/species
Offshore subtidal sands and gravels *cont.*	*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand
	Maldanid polychaetes and *Eudorellopsis deformis* in offshore circalittoral sand or muddy sand
	Owenia fusiformis and *Amphiura filiformis* in offshore circalittoral sand or muddy sand
Seagrass beds	*Zostera noltii* beds in littoral muddy sand
	Zostera marina/angustifolia beds on lower shore or infralittoral clean or muddy sand
	Ruppia maritima in reduced salinity infralittoral muddy sand
Sea loch egg wrack beds	*Ascophyllum nodosum* ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata
Seamount communities	Seamount communities
Serpulid aggregations	*Serpula vermicularis* reefs on very sheltered circalittoral muddy sand[8]
Submarine structures made by leaking gases	Submarine structures made by leaking gases
Tide-swept algal communities	Fucoids in tide-swept conditions
	Halidrys siliquosa and mixed kelps on tide-swept infralittoral rock with coarse sediment
	Kelp and seaweed communities in tide-swept sheltered conditions[9]
	Laminaria hyperborea on tide-swept infralittoral mixed substrata[10]
Tide-swept coarse sands with burrowing bivalves	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand[11]

3.2.2 Birds

Scotland holds relevant numbers of 24 species of breeding seabirds that are an important indicator of the state of the marine environment. Seabirds respond to a range of factors, such as changes in food availability, weather, predation and pollution. Their abundance is determined by how many adults survive from the previous year and how many young birds successfully reach maturity. The productivity (i.e. number of chicks produced) can provide a good indication of food availability as well as levels of predation. Productivity typically changes more quickly than abundance.

Seabird abundance has been declining since the early 1990s, the lowest abundance (70% of 1986 level) was reached in 2004 and has subsequently increased slightly. The abundance declines were driven by those of black-legged kittiwake, Arctic skua, Arctic tern, herring gull, European shag, great black-backed gull and Sandwich tern and latterly by those of northern fulmar and common guillemot. Seabird productivity has fluctuated over the period but has declined to a low of 57% in 2007, since when there has been a very slight increase.

In the following pages the most common species of seabird found along Scottish coast are described. Descriptions are based on IUCN Red list factsheet, and on Pollock et *al*. (2000) and Barton & Pollock, (2005).

- **Red-throated diver *Gavia stellata***

This species breeds on fresh-water lochs and moves to coastal waters outside the breeding season. Approximately 60% of the British population breeds in the Northern Isles (Gibbons et *al.*, 1997). Red-throated divers prefer relatively sheltered shallow waters and sandy bays along North Sea coasts in winter and have a patchy distribution around the west coast of Britain, with the main concentrations located along the west coast of Scotland, and the north-west coast of Wales. Numbers may fluctuate widely in response to weather and other factors affecting the food supply of sandeels, small crustaceans, sprat and herring (Lack, 1986). Although they nest in freshwater lochs, breeding red-throated divers make use of sheltered inshore waters close to their nest sites (Pennington et *al*., 2004).

January to December: Red-throated divers were recorded in inshore waters, in all months except December, with 74% of red-throated divers recorded between May and September. In autumn, migrant birds arrive from Scandinavia, Faroes, Iceland, and Greenland (Cramp & Simmons, 1977). In late September, red- throated divers moult and are flightless for about a month (Ginn & Melville, 1983), during which time they are very susceptible to surface pollution.

- **Black-throated diver *Gavia arctica***

Black-throated divers tend to occur in sandy bays in winter, feeding on sandeels, crustaceans and flatfish although herring and sprats are also taken (Lack, 1986). Danielsen et *al*. (1990) estimated that there might be approximately 150 black-throated divers wintering along the south coast, 450 wintering along the west coast of Britain, with a combined wintering population of 800 birds in Britain and Ireland. In the non-breeding season, the biogeographic population for north-west Europe has been estimated to be between 100,000 and 1,000,000 birds (Delaney & Scott, 2002).

Black-throated divers are a rare breeding species in Britain with a breeding population of 155 - 189 pairs, although there appears to have been a recent decline (Stone et *al*., 1997).

- **Great northern diver *Gavia immer***

Great northern divers spend the winter at sea, off rocky headlands, coves and sandy beaches. They feed primarily on fish such as herring and codling, but also take crustaceans and flatfish in shallower waters (Lack, 1986). Great northern divers tend to occur further offshore than other diver species, but still within 10km of the shore (Mudge & Cadbury, 1987).

The UK winter population of great northern divers has been estimated to be in the region of 3,000 birds, approximately 75% of the western Palaearctic wintering population of 5,000 (Lack, 1986). This figure is still quoted as the best winter estimate for the northern Europe non- breeding population (Delaney & Scott, 2002). Known key wintering areas for the species are western

Scotland, including the Outer Hebrides, and the north and west coasts of Ireland, with low numbers elsewhere. The main winter influx tends to occur in October/November with numbers remaining stable until April/May.

As great northern divers show a preference for deeper water, it is likely that this species is under-recorded by land-based surveys. The species does not breed in the UK or Ireland.

The great northern diver is primarily a winter visitor to Scotland (Cramp & Simmons, 1977). It is estimated that 75% of the Western Palearctic wintering population are found in British waters.

Most sightings were located around the Northern and Western Isles as well as inshore waters west of Scotland. Almost half the birds were recorded in December and January. Sightings in the Atlantic Frontier (>200 m) were mostly in October and November and were possibly migrating birds from colonies in Greenland, Canada and Iceland (Weir et *al.*, 1996).

Great northern divers moult between late March and early May (Ginn & Melville, 1983), during which time they are flightless and are especially vulnerable to surface pollution.

- **Fulmar *Fulmarus glacialis***

This species typically breeds on cliffs and rock faces, but also occasionally on flatter ground sometimes up to 1 km inland. It will also breed near human habitation, sometimes even on occupied houses along the seafront of towns. Its diet comprises of variable quantities of fish, squid and zooplankton (especially amphipods), and it will also feed on fish offal and carrion (e.g. whale blubber). Most of its food is obtained by surface seizing but it will also plunge (del Hoyo et *al.*, 1992). Tracking revealed breeders foraging close to the colony, preferring the continental shelf. As chicks became older, parents foraged further from the colony, eventually regularly embarking on long trips (Weimerskirch et *al.*, 2001).

This species is found breeding throughout the north Atlantic and north Pacific, ranging from **Japan** and the **United Kingdom** in the south, to the high Arctic in the north. Northern populations are migratory, travelling south as the sea freezes over. Southern populations are more dispersive, but do not usually reach zones of warm water. Young birds may undertake transoceanic crossings and general wander further than the less mobile adults (del Hoyo et *al.*, 1992).

January to April: From January to April, prior to the breeding season, highest densities of fulmars were concentrated along the continental slope south of 60°N and around Shetland. This was most pronounced in April when they leave their colonies on a “pre-laying exodus” (Macdonald, 1977). Many fulmars encountered along the continental slope were associated with fishing vessels, particularly in April. Fulmars regularly follow fishing vessels, scavenging on discards (e.g. Camphuysen et *al.*, 1993), although the overall distribution of fulmars at sea is thought not to be influenced by the availability of discards (Camphuysen & Garthe, 1997). On the shelf, densities were generally low to moderate except around and to the north-west of Shetland.

May to July: During the breeding season, from May to July, higher densities occurred over the continental shelf, mostly in the vicinity of Shetland and Orkney, with generally moderate densities of fulmars widespread over the remaining areas of the continental shelf. Beyond the continental shelf moderate to high densities of fulmars were recorded over the deep waters of the Norwegian Sea and following the continental break north and west of Scotland. Fulmars are associated with fishing boats along the slope north-west of the Western Isles and the waters around Orkney. Fulmars range widely when feeding even during the breeding season, and have been recorded up to 466 km away from their colonies (Dunnet & Ollason, 1982). Fulmars leave their colonies to moult in late summer.

August to October: Between August and October, relatively lower densities of fulmars were present in waters deeper than 200 m except for areas of high density over the Wyville-Thomson Ridge and over the shelf-break to the north-west of the Western Isles. Over shelf waters, there were high-density areas north of Scotland and around Shetland, possibly reflecting the presence of recently fledged birds during late August and September, although high densities were associated with fishing vessels in these waters.

November and December: By November and December, recorded average densities were considerably lower. Ringing recoveries suggest much of the breeding population remains within a few hundred kilometres of breeding colonies in winter, while young disperse over large distances travelling as far as Newfoundland (MacDonald, 1977b). All sightings in the study area were less than 200 km from the nearest colony suggesting low densities of juvenile birds. Very few birds were recorded associating with fishing vessels.

In the Atlantic the species has undergone a large range expansion over the last two centuries whilst Arctic populations have remained relatively stable over the last four centuries (Carboneras et *al*., 2016). In Europe since declines began in the mid-1980s (c. one generation) the population size is estimated to have declined by more than 40%. Although there is uncertainty in the projected magnitude of the decline owing to the long generation length of the species, the population size in Europe is estimated to be decreasing by 50-79% in the period 1985-2077 (three generations) (BirdLife International 2015).

In some breeding colonies, the species is susceptible to low level predation from invasive mammals such as rats Rattus spp., cats Felis catus and Red Fox Vulpes vulpes (Mendel et *al*., 2008). Bycatch in fisheries is also a significant threat, with large numbers recorded as caught in longline fisheries in the North East Atlantic and in trawl fisheries (Anderson et *al*., 2011) as well as in gill-net fisheries (Žydelis et *al*., 2013). However, bycatch is not believed to be causing significant population decline. The species is susceptible to oil spills throughout North Sea with chronic pollution recorded in many individuals, yet with apparently minor impacts on reproductive rates.

Plastic ingestion also represents a threat across much of the Northern Fulmar's range, with around 95% of beached birds in the North Sea containing plastic, more than 40% in the eastern Canadian Arctic and 87% in Svalbard (Trevail et *al*., 2015). The majority of these contained more than the 0.1g per individual deemed acceptable under the OSPAR agreement; however, there is evidence that relatively large loads of ingested plastic may be processed through a bird relatively rapidly (van Franeker et *al*., 2011). Plastic loads are higher in juvenile birds and there is some evidence that adults pass on plastic to chicks. The effect of plastic ingestion on the population is unknown.

The species was subject to intensive exploitation for food in the past, and hunting continues in Alaska, Greenland, Iceland, Svalbard and the Faroe Islands (Carboneras et *al*., 2016). However, this is not thought to have a significant impact on the population.

The species is covered by the EU Birds Directive as a migratory species. In Europe it occurs within 29 marine Important Bird Areas, including in the Faroe Islands, France, Germany, Iceland, Svalbard (Norway) and the United Kingdom. Within the EU it is listed within 46 Special Protection Areas. Under the EU Marine Strategy Framework Directive it will be monitored for plastic ingestion.

- **Great shearwater *Puffinus gravis***

After breeding on islands in the South Atlantic, Great shearwaters are thought to complete a clockwise migration circuit of the Atlantic Ocean (Bourne, 1995; Voous & Wattel, 1963). The majority was recorded between August and October, with peak numbers in August. The species had an offshore distribution. Sightings were spread along the continental slope north and west of Scotland and over the Wyville-Thomson and Ymir Ridges.

November to February: Single birds were seen in January and February to the west of the Western Isles close to the shelf break.

- **Common scoter *Melanitta nigra***

Common scoters are usually found in shallow waters associated with sandy substrates. They feed actively during day mainly on blue mussels, crustaceans and small fish such as sandeels. Most of the UK winter population tends to be found in a few large flocks off the mouths of major estuaries around the coast of Britain. A recent review of numbers for the UK and recent survey at key sites suggested that the number of wintering common scoter is likely to be in the region of 50,000 birds (Kershaw & Cranswick, 2003). Most wintering birds are thought to come from Fennoscandia and western Siberia, while he main influx of scoter occurs in October & November with a peak between December and early February (Lack, 1986). The biogeographic population is currently estimated at 1,600,000 individuals (Delany & Scott, 2002).

- **Manx shearwater *Puffinus puffinus***

Manx shearwaters are migratory and are generally found in British and Irish waters between March and October, travelling to wintering areas off the east coast of South America from November to February. Birds return to their breeding colonies in March, with the young fledging in September (Webb et *al*., 1990).

Breeding starts in March, and the species forms colonies on coastal or offshore islands, nesting in burrows (Carboneras et *al*., 2014). At sea this species is mainly found on waters over the continental shelf, feeding predominantly on small shoaling fish (*Clupea harengus, Sprattus sprattus, Ammodytes marinus*) but also on some squid, crustaceans and offal. It feeds mainly by pursuit plunging and pursuit-diving; also by surface-seizing and pattering either alone or in small flocks (Carboneras et *al*., 2014).

The European population is estimated at 342,000-393,000 pairs, which equates to 684,000-785,000 mature individuals. The population in the EU27 is estimated at 314,000-359,000 pairs, which equates to 629,000-718,000 mature individuals.

March to May: Manx shearwaters begin returning to the breeding colonies in March (Brooke 1990). Low densities were recorded between March and May, mostly to the south of 60°N and west of 4°W, with high densities encountered near Rum. This island holds one of the largest Manx shearwater colonies in the world with an estimated population of 61,300 pairs (Furness, 1997). Low densities recorded over the shelf-break to the south-east of the Wyville-Thomson Ridge may be accounted for by birds returning to more northerly colonies in the Faroes and Iceland.

June to August: Between June and August, Manx shearwaters were widespread at low densities over the continental shelf edge with the highest densities once again around the main west coast colonies. Low densities were also widely distributed over the Rockall Trough and Wyville-Thomson Ridge as far west as the Lousy Bank. Birds had also penetrated north-eastwards along the Faroe-Shetland Channel and east towards Shetland and Orkney. Sightings in these two areas may relate to immature non-breeding birds, which visit the breeding grounds from their second summer onwards (Brooke, 1990). Also, Brooke (1990) estimated that breeding birds are able to commute 360 km each way on a day feeding trip so these birds may be from colonies in the Western Isles or Faroes.

September and October: In September and October Manx shearwater distribution had contracted and densities reduced as birds began to move southward. Despite adequate coverage over most of the study area the species was found to be restricted to inshore waters south along the west coast, with areas around North Uist and Jura holding high densities. Numbers at this time comprise adults that have finished breeding and left the colonies and chicks, which fledge in mid-September (Brooke, 1990).

November to February: Manx shearwaters were rarely recorded in the Atlantic Frontier between November and February. Two birds in December and one in January were the only records. Most Manx shearwaters have migrated southwards by this time, spending the winter off the east coast of South America (Brooke, 1990).

Considerable human exploitation continues in the Azores and in Islands of Madeira (Carboneras et *al*., 2014) and legal harvesting (1,000–5,000 chicks per annum) also continues on the Faeroe Islands (Thorup et *al*., 2014). The species suffers predation by rats and feral cats at many of its breeding colonies. Light pollution causing mortality has been recorded at some sites (e.g., Canary Islands) (Carboneras et *al*., 2014) and the species may also be displaced from foraging areas by shipping lanes. Habitat destruction and fire induced damage to breeding colonies within the Canary Islands is believed to impact on the species. The species is vulnerable to oil spills and to other types of marine water pollution (Camphuysen et *al*., 2010). The species is vulnerable to being caught as fisheries bycatch, including in longlines and gillnets (Žydelis et *al*., 2013). While the increasing number of wind farms may cause collisions or displacement, it is currently considered a very low risk for this species (Bradbury et *al*., 2014). The species is listed on Appendix II of the Bern Convention. It is covered by the EU Birds Directive as a migratory species. It occurs in 20 marine Important Bird Areas including in the Faroe Islands, Iceland, Ireland, the U.K. and Spain. Within the EU it is listed in 53 Special Protection Areas in France, the United Kingdom, Ireland, Italy, Portugal and Spain.

- **European storm-petrel *Hydrobates pelagicus***

This is a marine species feeding mainly on small fish, squid and crustaceans, but it will also feed on medusae and offal. It feeds mainly on the wing by pattering and fishing, and will occasionally follow ships and attend trawlers. Breeding starts in May and June, resulting in the formation of colonies on rocky ground on offshore islands and stacks that are free of mammalian predators (Carboneras et *al*., 2014).

April and May: European storm-petrels were recorded in the region between April and November. In April and May low numbers were recorded as they began to return from wintering grounds off Africa (Cramp & Simmons, 1977). None were recorded associating with fishing vessels in April. During May, low densities were associated with fishing vessels only in two areas, over the shelf and continental slope respectively.

June and July: In June and July, European storm-petrels were widespread. The most important colonies are located at Sule Skerry and Shetland, and the deep water of the shelf edge is within the feeding range of breeding adults. Many non-breeders, numbering tens of thousands, may be present from the end of June. European storm-petrels were associated with fishing vessels in both these months. The highest densities were recorded over the shelf edge to the west and north-west of the Western Isles, especially during July. Over the shelf low densities were widespread around Lewis, Orkney and Shetland.

August: Highest concentrations were located in deep waters around the south of the Faroe-Shetland Channel. Densities were lower in shelf waters north of Scotland. An area of high density was observed in the Sea of Hebrides. Associations with fishing vessels were recorded only in the Minch.

September to November: Lower numbers of European storm-petrels were recorded in September which may indicate the departure of the large non-breeding population, as many birds from Shetland and more northern colonies are still breeding during September (Cramp & Simmons, 1977). Even fewer were observed in October and November and no birds were sighted between December and March.

The European population is estimated at 438,000-514,000 pairs, which equates to 876,000-1,030,000 mature individuals. The population in the EU27 is estimated at 137,000-154,000 pairs, which equates to 274,000-308,000 mature individuals. For details of national estimates, see the supplementary material. In Europe and the EU27 the population size trend is unknown.

The accidental introduction of predators, such as rats and cats to breeding colonies is a major threat to this species, particularly in southern Europe and the Mediterranean (Carboneras et *al*., 2014). In some areas, increases in numbers of skuas and large gulls appear to have increased the rate of predation. Reduction of prey, caused by unsustainable fisheries may also impact this species. There may be some risk from eating contaminated food items or taking indigestible matter but, by feeding in flight, the species is less vulnerable to oil spills than some other seabirds (Newbury et *al*., 1998). Coastal development, particularly in the Mediterranean region has caused habitat destruction and disturbance (Carboneras et *al*., 2014). The species is also vulnerable to the impacts of climate change, including shifts in prey availability, and storms and extreme weather events. Light pollution from ships and coastal developments may also create a problem at night for this species (Sultana et *al*., 2011). In Molène archipelago, France, population has declined over last two decades due to continuous nest-site destruction (Carboneras et *al*., 2014).

- **Leach's storm-petrel *Oceanodroma leucorhoa***

This species is marine and pelagic, often occurring in areas of convergence or upwelling or over continental shelves, rarely coming near land except at colonies. During the breeding season, birds from the western Atlantic are highly pelagic in their foraging habits, travelling to deep (median >1,950 m) and relatively unproductive waters (chlorophyll a concentration <0.5 mg/m3) over and beyond continental slopes lying, on average, 400 to 830 km from colonies (Hedd et *al*., 2018). Its diet comprises mainly of small fish, squid, planktonic crustaceans and offal that it catches on the wing by dipping, skimming or snatching from the surface. It sometimes follows marine mammals feeding on leftovers or faeces. Leach's storm-petrels commute between their feeding areas and breeding colonies only during the hours of darkness, thus few birds are recorded in shelf waters. Its breeding season is variable depending on locality, forming colonies on offshore islands on high ground or slopes, usually among rocks but also in soft soil between trees (del Hoyo et *al.,* 1992).

May and June: Leach's storm-petrels were first recorded in April in very small numbers, becoming more evident in May and June. Low densities of birds were recorded over and to the west of the shelf-break; highest densities were found around the near Rosemary Bank and the Anton Dohrn Seamount.

July: Most sightings were located over waters deeper than 1,000 m north-west of Scotland. Moderate to high densities were recorded to the east of Lousy Bank, and south of the Faroes and Bill Bailey's banks. Low densities were observed along the continental slope to the north-west of the Western Isles. The main breeding site in Britain and Ireland is on St. Kilda, although few birds were recorded near these islands (Lloyd et *al.,* 1991).

August: Highest densities of Leach's storm-petrels were recorded in August. The centre of distribution was similar to July, situated in deep waters north-west of Scotland, although the overall distribution was widespread over the Ymir and Wyville-Thomson ridges. More birds were recorded in the north-east of the study area, along the Faroe-Shetland Channel, than in other months. Low to moderate densities were again observed along the continental slope to the west of the Western Isles.

September to January: Leach's storm-petrels are migratory, departing the breeding grounds in autumn to winter in the tropics (Cramp & Simmons, 1977). Very few birds were recorded in September, and only five were recorded between October and January, when stragglers are known to remain in the cooler waters of the North Atlantic during the northern winter (Cramp & Simmons, 1977).

Data collected from 1977 to 2016 representing 75-80% of the global population, points to a decline of ≥30% over three generations (BirdLife International, 2015). The cause(s) of declines are unknown, but are likely multi-faceted and further research is needed to inform conservation actions. Brooke, (2004) estimated the global population to number >20,000,000 individuals. Based on the compilation of available data the current population comprises 6.7-8.3 million breeding pairs; 40-48% of these breed in the Atlantic basin and 52-60% in the Pacific. Throughout the western Atlantic (>90% of basin total), populations are declining. Brown Rats *Rattus norvegicus* and House Rats *R. rattus*, are considered to exert a considerable predation pressure on the species where they establish on breeding islands, and may be a key determinant of the present breeding distribution, possibly along with cats. Cats *Felis catus* predate large numbers of adult and fledgling Leach's Storm-petrels where present, and may have been responsible for the extirpation of the species from a number of formerly occupied sites. Foxes caused the extirpation of the species from numerous islands in Alaska following their introduction, with their eradication on a number of islands leading to subsequent recolonization by Leach's Storm-petrel. Mice *Mus musculus* are also suspected to be impacting the species through nest predation, but the effects are unclear.

Leach's Storm-petrel *Hydrobates leucorhous* experiences high levels of predation also from native predators. Foraging ranges during the breeding season for five out of seven western Atlantic colonies overlapped with offshore oil and gas operations; three of these colonies have declined in recent decades (Hedd *et al.*, 2018). Attraction to lights and flares and subsequent collisions with oil rigs poses a risk (Hedd *et al.*, 2018). Large oil spills represent a relatively unlikely but potentially very severe threat, although due to this bird's large range, it would be likely to affect only a small portion of the population.

- **Gannet *Morus bassanus***

The species nests in large colonies on cliffs and offshore islands, but also on the mainland. This strictly marine species wanders mostly over continental shelves, feeding on shoaling pelagic fish such as herring (*Clupea harengus*), mackerel (*Scomber scombrus*), sprat (*Sprattus sprattus*) and sandeels (Ammodytes). Prey is mostly caught by plunge diving from large heights. It also attends trawlers and will form large congregations where food is plentiful. Breeding is highly seasonal starting between March and April. Young birds will migrate to the extreme south of its range, whereas adults range less extensively but still regularly winter in the Mediterranean (Carboneras et *al*., 2014).

March to August: Gannets are partial migrants, with some adults and most immature birds moving as far south as west Africa during the winter months. Adults began to return in March whereas immature birds tended to start arriving in May. This has also been noted for gannets in the North Sea (Tasker *et al.*, 1985). Between March and August, gannets were widely dispersed at low densities regardless of water depth. Areas of high concentration were found near the breeding colonies at Shetland, Sula Sgeir, North Rona, Ailsa Craig and especially St. Kilda where birds were regularly observed over the shelf edge. These concentrations consisted mostly of adults and may reflect the limited foraging range of breeding birds, as they are mostly within the estimated maximum foraging range of 150 km from the colony (Tasker *et al.*, 1985). Immature birds were widely dispersed and tended not to associate with the colonies. The proportion of immature birds peaked in July at 16.5%. Gannets regularly scavenge around fishing vessels (Camphuysen *et al.*, 1995); peak concentrations were found associating with boats along the slope north and west of the Western Isles in April.

September to February: Gannets leave during September and October, resulting in lower densities during the winter months. Between August and November, just over 9% of gannets recorded were immature but by January, this proportion had dropped to just over 1%. Although overall numbers were much reduced, concentrations remained around the colonies and along the continental shelf edge. Gannets were associated with fishing vessels off the north coast of Scotland and along the shelf break.

The European population is estimated at 683,000 pairs, which equates to 1,370,000 mature individuals. The population in the EU27 is estimated at 641,000 pairs, which equates to 1,280,000 mature individuals. In Europe and the EU27 the population size is estimated to be increasing.

Overfishing and prey depletion is likely to affect this species, although populations in the U.K. and Ireland were not seriously affected by Shetland sandeel stock crash in the mid 1980s (Carboneras et *al*., 2014). Incidental captures in fishing gear, including in longlines and purse seines also poses a threat The species is hunted for food in some places, for example, a small annual harvest is carried out on Sula Sgeir, off north-west Scotland. The small population of northern Norway has suffered local declines and extinctions thought to be mainly due to harassment by White-tailed Eagles (*Haliaeetus albicilla*).

- **Cormorant *Phalacrocorax carbo***

Throughout its range the species is sedentary or locally dispersive, with northerly populations also making strong migratory movements (Orta et *al*., 2014). The species frequents both coastal and inland habitats (Orta et *al*., 2014). In marine environments it occurs in sheltered coastal areas on estuaries saltpans, coastal lagoons, deltas and coastal bays, requiring rocky shores, cliffs and islets for nesting (Orta et *al*., 2014) but generally avoiding deep water and rarely extending far offshore. It also inhabits fresh, brackish or saline inland wetlands including lakes, reservoirs, wide rivers, flood waters, deep marshes with open water, swamps and oxbow lakes, requiring trees, bushes, reedbeds or bare ground for nesting (Orta et *al*., 2014) and avoiding overgrown, small, very shallow or very deep waters. The species's diet consists predominantly of fish, including sculpins, Capelin, gadids and flatfish as well as crustaceans, amphibians (Orta et *al*., 2014), molluscs and nestling birds. At sea the species preys mostly on bottom-dwelling fish, occasionally also taking shoaling fish in deeper waters (Orta et *al*., 2014).

January to December: Cormorants are resident birds and the largest colonies are located in the Northern Isles (Lloyd et *al.*, 1991). This species was recorded in shallow inshore waters, along almost all of the coastlines surveyed. Although also found in freshwater and estuarine habitats, cormorants are rare at sea away from the coast (Stone et *al.*, 1995), as they usually feed in water less than 10 m deep. The plumage of cormorants, which is less water repellent than that of ducks, may also limit their distribution, necessitating the need for nearby roost sites either on land or hard structures such as oil production platforms (Dunnet, 1986).

The UK wintering population of cormorant has been estimated to be 23,000 birds, although many birds are found inland on freshwater (Kershaw & Cranswick, 2003). Historic estuary counts show that at least 9,000 birds winter on the coast around the UK.

The European population is estimated at 401,000-512,000 pairs, which equates to 803,000-1,020,000 mature individuals. The population in the EU27 is estimated at 224,000-258,000 pairs, which equates to 448,000-516,000 mature individuals. In Europe and the EU27 the population size is estimated to be increasing.

The species is often persecuted by the aquaculture industry and may be shot, drowned or poisoned in attempts to control numbers (Carss, 1994) or for hunting. It may also suffer from disturbance and displacement from coastal wind farms (wind turbines) (Bradbury et *al*., 2014), and is susceptible to avian influenza (Melville and Shortridge, 2006) and Newcastle disease so may be threatened by future outbreaks of these viruses (Melville and Shortridge, 2006). Recreational activities taking place at sea may also cause displacement from critical habitat. The species is susceptible to oil spills across its range. It is also highly vulnerable to bycatch in gillnets (Žydelis et *al*., 2013), and the species is also caught in longlines and purse seines (Oliveira et *al*., 2015).

- **Shag *Phalacrocorax aristotelis***

This is a coastal species that shows high nesting site fidelity. It feeds exclusively diurnally, and one bird is always present with the clutch during the breeding season. The species breeds in colonies that can hold more than a thousand well-spaced pairs (del Hoyo et *al.*, 1992;). It is largely sedentary, although immatures may undergo post-breeding dispersive movements over short distances (del Hoyo et *al.*, 1992). Some birds undergo short-distance migrations during winter. Individuals often forage alone when away from nesting colonies and in winter, but may follow dense shoals of fish in flocks of several hundred individuals (del Hoyo et *al.*, 1992;).

Habitat It occupies marine habitats, but does not usually occur far from land (del Hoyo et *al.*, 1992). It shows a strong preference for rocky coasts and islands with adjacent deep, clear water, and forages over sandy and rocky seabeds (del Hoyo et *al.* 1992). It also prefers sheltered fishing grounds such as bays and channels, although it generally avoids estuaries, shallow or muddy inlets and fresh or brackish waters.

Diet The species feeds on a wide range of benthic, demersal and schooling, pelagic fish. Sandeels (*Ammodytidae spp*.) are the dominant prey of birds in British and some Spanish populations (Velando et *al.*, 2005), and are consistently present in the species's diet in most other locations studied. Other prey species include fish of the families Gadidae, Clupeidae, Cottidae, Labridae, and *Trisopterus* spp., although birds also take small numbers of polychaetes, cephalopods, other molluscs and small benthic crustaceans. Adults provide their chicks with sandeels, but consume a broader variety of prey for themselves.

The nest is constructed of marine vegetation and flotsam, from just above the high-water level to over 100 m high on ledges, in crevices or in caves on sea cliffs, rocks and stacks, and at the base of sea cliffs amongst boulders (Nelson, 2005).

At Islas Cíes, Spain, birds foraged within 20 km of the colony all year round (Velando et *al.*, 2005). During the breeding season, the foraging range was typically within 4 km of the colony, and birds foraged in groups of 300-1000 individuals (Velando et *al*., 2005). Foraging areas tend to coincide with areas of sandy benthic sediment, and occur where depth is less than 80 m (Velando *et al.*, 2005). At the Isle of May, Scotland, over 90% of foraging occurred within 13 km of the colony, and the maximum distance recorded was 17 km. Foraging individuals visited more than one area during a trip, often feeding at sites several kilometres apart. Birds were often found feeding in areas of strong tidal flow. The available data on European Shag feeding habitat suggest that, within the inshore zone as a whole, the species is fairly plastic in its habitat requirements. In some areas, the birds' foraging range is considerably less than 20 km. The distribution of shags at sea may also be limited by the less water-repellent properties of their plumage. The feathers of the Phalacrocoracidae are less water repellent than the feathers of ducks.

January to December: Shags are an inshore species but, in contrast to cormorants, are found only in marine waters. Moderate concentrations were found in the sea lochs of north-west Scotland as well as near Foula in the Shetland Isles, which holds 2,400 pairs during the breeding season (Lloyd et *al.*, 1991).

Unlike cormorants, shags are a fully maritime species. The UK wintering population of shags is estimated to be between 100-150,000 birds. Within the north-west Europe biogeographic region, the wintering total is estimated to be 222,000 – 258,000 (Delaney & Scott, 2002).

The global population is estimated at 230,000-240,000 individuals. The European population is estimated at 76,300-78,500 pairs, which equates to 153,000-157,000 mature individuals (BirdLife International, 2015).

The overall trend is decreasing, although some populations may be stable (Wetlands International, 2015). The European population is estimated to be decreasing by less than 25% in 26.4 years (three generations).

The species is highly dependent on herring and sand eel stocks. Failure of these food supplies results in extensive non-breeding and increased mortality (between 1974 and 1976, sand eel abundance decreased by 48%, and the Illas Cíes shag population halved in response. Climate change and increased frequency of severe weather events is likely to be responsible for the major population declines recorded over the past decades (Joint Nature Conservation Committee, 2016), including wrecks (mass mortality events with no obvious cause). In 2012/13, wreck resulted in up to 53% decreases in study populations in Scotland (Gunn et *al*., 2014). All causes combined, the species shows unusually large variability in population size and more frequent cases of extreme weather (due to climate change) is likely to continue threatening the population in the future (Frederiksen et *al*., 2008).

Coastal oil pollution poses another threat to the species through direct mortality (e.g. Prestige Oil Spill in 2003) and more significantly, through indirect ecosystem effects reducing prey availability (Velando et *al*., 2005). Bycatch is major cause of mortality, with significant numbers being trapped in gillnets annually (Velando and Freire, 2002). In the past, paralytic shellfish poisoning has caused mass mortality, notably in Shag colonies on the Farne Islands in 1968 when most individuals died and 90% of nests were deserted over the course of one week (Coulson et *al*., 1968).

- **Common eider *Somateria mollissima***

The species breeds on offshore islands and islets (Kear, 2005) along low-lying rocky coasts (Carboneras et *al*., 2014), on coastal shores and spits, on islets in brackish and freshwater lagoons, lakes and rivers, close to the sea or on tundra pools, rivers and lakes up to 5 or 6 km inland. It shows a preference for boulder-strewn or grassy islands with sheltered approaches that are safe from nest predators. The species typically winters on shallow seashores, bays and estuaries (Carboneras et *al*., 2014), especially where there are high abundances of benthic molluscs (Camphuysen et *al*., 2002). The species breeds from early-April (although the most northerly populations may not breed until mid-June (Madge and Burn, 1988), and generally nests in colonies. The nest is a slight hollow in the ground that is usually positioned in the shelter of rocks or vegetation but may also be in the open. Its diet consists predominantly of benthic molluscs although crustaceans, echinoderms, other marine invertebrates and fish may also be taken. During the breeding season incubating females frequently complet their diet with algae, berries and the seeds and leaves of surrounding plants (Carboneras et *al*., 2014). The majority of this species is migratory, with some populations e.g. in Europe being largely sedentary (Scott and Rose, 1996).

The eider is the commonest species of seaduck in the UK, with a mainly sedentary breeding population of around 31,000 pairs (Gibbons et *al*., 1993). Approximately 7,000 eiders are thought to breed around the Firth of Clyde each year, including Arran, Bute and Inchmarnock, with smaller populations along the Ayrshire coast and in the Inner and Outer Hebrides. Around 230 pairs bred on Walney Island (Cumbria) in 2002 & 2003, with a further 77 nests on Foulney Island (Cumbria) in 2003.

The UK winter population of eider is estimated at around 73,000 birds, with further 12,000-13,500 birds found on Shetland and Orkney (Delaney & Scott, 2002). The biogeographic population of the nominate race (*S. m. mollisima*) of eider is currently estimated at between 1,248,400 and 1,858,400 individuals.

December and January: This species is very much an inshore feeders as it normally feeds in waters less than 4 m deep. During December and January, moderate to high densities of wintering common eiders were recorded around the Western Isles with low densities elsewhere. There were no sightings in deep waters (>200 m). The inshore waters of Orkney, Shetland and south-west Scotland are the most important areas for wintering eiders.

February to November: Lower densities of common eiders were recorded between February and November. Common eiders generally disperse only short distances between breeding grounds and wintering areas .

The European population is estimated at 791,000-955,000 pairs, which equates to 1,580,000-1,910,000 mature individuals. The population in the EU27 is estimated at 224,000-320,000 pairs, which equates to 449,000-640,000 mature individuals. In Europe the population size is estimated and projected to decrease by 30-49% over the period from 2000, when the declines were estimated to have begun, to 2027 (three generations).

The species is vulnerable to chronic coastal oil pollution (Nikolaeva et *al*., 2006), especially oil spills (Carboneras et *al*., 2014), in areas where large moulting and wintering concentrations occur. It also comes into conflict with the shellfish aquaculture industry which depletes the species's food resources and has previously led to mass starvation events due to the over-fishing of benthic molluscs (e.g. in the Dutch Wadden Sea) (Ens, 2006). On the breeding grounds, disturbance from the development of mineral resources along the coast and from local shore-based activities (e.g. angling, dog-walking) increases the likelihood of predation on young. Unregulated tourism and shipping also cause disturbance to the species on its wintering grounds (Nikolaeva et *al*., 2006). The species commonly becomes entangled and drowned in monofilament nets, and it is hunted unsustainably (Nikolaeva et *al*., 2006).

- **Long-tailed duck *Clangula hyemalis***

This species breeds on small tundra lakes, pools, bogs, rivers and coastal sites of the high Arctic. It winters mostly at sea, generally far offshore, but also inland in large, deep, freshwater lakes or brackish lagoons.

It breeds from late-May onwards in single pairs or loose groups. The nest is a natural depression, or rock crevice, lined with surrounding plant matter and down, among vegetation or in the open and frequently close to water. Clutches are normally six to nine eggs (Carboneras and Kirwan, 2014). The species shows a preference for marine foods. Its diet consists predominantly of animal sorces such as crustaceans, molluscs, other marine invertebrates, fish, and in fresh water, insects and their larvae; also a little plant material. The species is migratory, moving in large flocks at night. Many birds winter at sea in the far northern regions, generally as far south as Britain, the Danube River and the Black Sea. Birds leave their breeding grounds in the first half of October and return mid-March (Carboneras and Kirwan, 2014). An estimated 16,000 long-tailed ducks winter around the coast of the UK, with the majority of these in Scotland, (Pollit et *al*., 2003). Numbers tend to peak in late December/early January, remaining high until mid-February, then declining sharply.

Birds wintering around Britain are thought to originate from the Iceland/Greenland breeding population of 150,000 birds, although some birds from the western Siberia/north-west Europe population (some 4,600,000), which winters primarily in the Baltic, may also winter in UK waters.

October to March: The long-tailed duck is a winter visitor to Britain probably from Fennoscandia and north- western Russia, though their exact origins are unknown. The distribution was mainly inshore. Scapa Flow, Orkney held the only notable concentration. This site is the second most important wintering area for this species in Britain. Although this duck appears to be thinly dispersed it may be under-recorded, as with other inshore species. Most birds were recorded in March.

May: Long-tailed ducks were also seen during May, again in Orkney. Small numbers of long-tailed ducks are frequently recorded during the summer in Britain (Gibbons et *al.*, 1993).

- **Pomarine skua *Stercorarius pomarinus***

This species is marine outside the breeding season, remaining somewhat coastal, especially in upwelling regions of the tropics and subtropics. It breeds on Arctic tundra, favouring low-lying moss tundra with pools, and hummocky areas in moist bogs. Breeding begins in June at scattered sites across the tundra where lemming concentrations are high. Individuals are highly territorial. The nest is an unlined scrape and is inconspicuous. Clutches are normally two eggs. Whilst breeding it specialises on catching lemmings which frequently constitute over 90% of their diet, also feeding on young waders and gamebirds, bird eggs and carrion. In winter it takes fish, sometimes by kleptoparasitism, small seabirds, and scavenges on carrion. Outside the breeding season, it migrates south, including long migrations over land (Furness, 1996).

May to November: Pomarine skuas migrate between wintering grounds off west Africa and breeding grounds in the high Arctic (Furness, 1987b). At-sea sightings between May and November show that the species is widely distributed over the continental shelf, shelf-edge and deep water. Spring passage occurred mostly in May when high numbers were recorded on the shelf-edge from 57°N north-eastwards to the Faroe-Shetland Channel suggesting its utilisation as a migra tion route. During autumn most sightings were made in October. This species occurs in British waters conspicuously later than Arctic skua and often in large numbers made in October.

- **Arctic skua *Stercorarius parasiticus***

This species is marine and predominately coastal but will migrate over land. It breeds on tundra, moorland or grassland. Breeding begins in May or June, occurring later in the north than the south. It is either colonial at seabird sites or widely scattered across the tundra where it is territorial. The nest is an unlined scrape and is inconspicuous. Clutches are normally two eggs, but inexperienced birds may only lay one. Most or all of its food will be obtained by kleptoparasitism when nesting near other seabird colonies, otherwise its diet can include microtine rodents, adult and fledgling passerines, wader chicks, birds' eggs, insects and berries. The species is mainly a transequatorial migrant, with very small numbers wintering in Northern Hemisphere (Furness, 1996).

March to May: Arctic skuas return from their southern wintering grounds between March and

May, to the main breeding areas on Shetland and Orkney. Records around Shetland and Orkney, and the north and west coasts of Scotland, closely mirror the locations of breeding colonies. It is possible that the continental shelf records are of birds returning to more northerly colonies in north-west Europe.

June to August: During the breeding season, between June and August, the species was widely distributed in low densities, mostly in inshore waters close to the colonies. The largest colonies in the study area are in the Northern Isles and most birds were recorded in these waters. Only low densities were found over deep water.

September and October: Arctic skuas begin to leave their breeding areas during August and migrate southwards largely via inshore waters on the east coast of Britain (Stone *et al.*, 1995a). Consequently, few birds were recorded during this period; most records were from inshore waters, which are thought to be favoured by Arctic skuas during the autumn so they can kleptoparasitise terns gathering at near-shore feeding sites.

- **Long-tailed skua *Stercorarius longicaudus***

This species is marine and highly pelagic, rarely occurring within sight of land except when breeding. It feeds mainly on lemmings during the summer but will also take shrews, many insects, berries and small birds when microtines are scarce. Its winter diet is largely unknown, but probably includes marine insects and fish with some scavenging and kleptoparasitism. Breeding begins in June with birds widely scattered over the Arctic and subarctic or montane tundra, up to 1,300 m in Scandinavia. It is highly territorial. The nest is an unlined, inconspicuous scrape into which two eggs are typically laid. It is a transequatorial migrant but due to its pelagic nature its migration routes and winter distribution are poorly known (Furness et *al.*, 2013).

May and June: Long-tailed skuas are uncommon migrants in British waters. In common with Pomarine skuas, they are Arctic breeders that pass through the Atlantic Frontier migrating to and from their wintering areas off West Africa. Some are thought to cross the Atlantic and winter off South America along with birds from Arctic Canada (Furness, 1987b). Highest numbers in the Atlantic Frontier were recorded during May. Most sightings were from the north end of the Faroe-Shetland Channel with some also seen north-west of the Western Isles near to Rosemary Bank. Relatively few sightings were made in June presumably because most birds had by then passed through on their way to the breeding grounds in Scandinavia and northern Russia.

July to September: Large scale departures from the breeding grounds occur in August, continuing through to September, with a much slower migration southwards than in spring (Cramp & Simmons 1983). In the period from July to September, again almost all sightings were over deep waters, except in August when there were several sightings in coastal waters west of Scotland.

- **Great skua *Stercorarius skua***

This marine species avoids land during migration and aggregating in winter in areas where it can scavenge from fisheries. It breeds on islands, usually avoiding areas frequented by humans and favours flat ground with some vegetation cover, but less than 20 cm tall. Breeding begins in May and it is loosely colonial but highly territorial. The nest is a scrape typically lined with dead grass. Clutches are normally two eggs, but inexperienced birds may only lay one. It has a hugely varied diet owing to being a highly opportunistic feeder. Individuals regularly show individual specialisations in diet and feeding with some colony-specific learning. The maximum foraging range of a great skua from its colony is estimated at 60 km (Furness & Hislop, 1981). The species is migratory; wintering mostly off the coast of Iberia but younger birds will travel further (Furness, 1996).

April and May: In April and May, the great skua was widespread, but mostly in low densities. In shelf waters, the distribution centred on the main colonies in Orkney and Shetland. In offshore waters, low densities of birds were found along the shelf break. An area of higher concentration south-west of the Faroe-Shetland Channel occurred where great skuas associated with fishing vessels. Low numbers of birds were found associating with fishing vessels at other areas along the shelf-break.

June: In June, great skuas were widespread inshore around Orkney and Shetland in low to moderate densities. Densities were still mostly low, although a moderate concentration was found around Foula, the site of the largest great skua colony in the world (Lloyd et *al.*, 1991). Great skuas were generally less widespread in deep waters although present at low densities in the Faroe-Shetland Channel. As most mature birds will have started nesting at this stage, these birds are probably mainly non-breeders. There were few records of great skuas attending fishing vessels in June.

July: In July, low densities of skuas were widespread over the continental shelf around the Northern Isles. Moderate densities were recorded in waters near the colonies. Again the offshore distribution mainly consisted of low densities of birds in the waters closest to the Northern Isles. This is possibly due to influxes of immature birds, which visit club sites (a collection of non-breeders) within colonies during July before departing in August along with adults and fledged young (Tasker et *al.*, 1985b). Associations with fishing vessels were widespread north of Scotland during July, although the densities recorded were low. Discards from fishing vessels form a major part of the diet of breeding great skuas on Foula from June onwards (Furness & Hislop, 1981).

August to October: Between August and October, great skuas became more widely dispersed as birds began to leave the colonies and move into the surrounding seas. Associations with fishing vessels were recorded in all three months. Low densities were encountered around fishing vessels mostly around Lewis, apart from one area of high density to the north-east of Shetland.

November to March: Few great skuas were recorded between November and March. Birds encountered at this time of the year are likely to be adults. Although adults winter principally in the Eastern Atlantic south to Iberia, some stay in home waters and the North Sea which are deserted by younger birds during the winter months (Cramp & Simmons, 1983).

The European population is estimated at 16,300-17,200 pairs, which equates to 32,600-34,500 mature individuals. The population in the EU27 is estimated at 9,600 pairs, which equates to 19,200 mature individuals.

Declines in Shetland have been due to a recent reduction in sand eel stocks that have resulted in reduced breeding success and less birds at the largest colonies. Changes in fishing practices could also have serious impacts as more than half the summer diet at Shetland is made up of discards from fisheries (Furness, 1996) and when discard rates are reduced this species will switch to predating other birds, especially if small shoaling pelagic fish are scarce. Fishing activities also pose a threat through drowning in fishing nets or being caught on hooks. Human persecution (often illegal) has limited the size of some colonies although harvesting for food has now nearly ceased (Furness, 1996). The species is also affected by climate change.

- **Black-headed gull *Larus ridibundus***

Some populations of this species in milder areas of Europe are resident, with the remaining populations wintering to the south over a large range, encompassing much of the southern coast of Europe. It breeds mainly inland, with much breeding habitat created by rising water levels. It inhabits the temperate zone to the edge of boreal forests of the Palearctic; mainly at low altitudes, and generally near calm, shallow water of coastal or inland waters, including rivers and their estuaries. In winter it tends to occur far more in coastal habitats, but also inland at relatively low elevations. It relies heavily on aquatic and terrestrial insects, earthworms and marine invertebrates, and to lesser extent on fish for prey.

Winter populations of black-headed gulls in Britain and Ireland have been estimated at 3,000,000, with around two thirds of these of continental origin (Lack, 1986). Many winter inland, roosting at reservoirs, sometimes in very large numbers. During very cold or harsh weather, birds move to shelter coastal sites.

January to December: The black-headed gull is a common resident in Britain. Low densities were found inshore, mainly off the west coast. Black-headed gulls were recorded sporadically in the Atlantic Frontier. During the autumn, small numbers were observed in deep waters (>200 m). These may be Icelandic birds, which are partially migratory, some wintering in Scotland and Ireland (Horton et *al.*, 1984).

The European population is estimated at 1,340,000-1,990,000 pairs, which equates to 2,670,000-3,980,000 mature individuals. In Europe the population size is estimated to be fluctuating. In the EU27 the population size is estimated to be stable.

The species is susceptible to avian influenza and avian botulism so may be threatened by future outbreaks of these diseases. It may also be threatened by future coastal oil spills and has suffered local population declines in the past as a result of egg collecting. In some areas of its breeding range the species may also suffer from reduced reproductive successes due to contamination with chemical pollutants.

- **Common gull *Larus canus***

Common gulls are widely distributed throughout England and around the coasts of Scotland, during winter, often feeding far inland and returning to roost on estuaries, lakes or reservoirs at dusk (Lack, 1986). Some of these roosts may be very large, containing tens of thousands of birds, particularly during cold weather. The wintering population in Britain and Ireland is estimated to be around 702,000, with the comparatively milder climate offering an important wintering area for northern European breeding populations (Lack, 1986).

Populations in Iceland, and around the North and Baltic seas are generally year-round residents, while other populations migrate between breeding and wintering grounds (Burger and Gochfeld, 2014). During the winter the species expands its range to the North East Atlantic coasts of France and Portugal, the southern and eastern coasts of the Mediterranean, and the entire coasts of the Black Sea (Burger and Gochfeld, 2014). Within Europe it inhabits coasts, tidal estuaries, agricultural land, reservoirs and breeds on coastal cliffs and islands, in beaches, bogs, marshes and meadows. It feeds on earthworms, insects, aquatic and terrestrial invertebrates, small fish and grain. It occasionally kills birds and small mammals (Burger and Gochfeld, 2014).

This species was formerly considered a complete migrant, with only occasional birds remaining in winter, but increasing numbers now remain over winter, predominantly in the southern half of Britain.

January to December: Common gulls were recorded in small numbers in all months. Records were largely from inshore waters, especially off the west coast of Scotland, though some were encountered over the deeper water of the Faroe-Shetland Channel. Sightings over the Faroe-Shetland Channel occurring during the late summer and autumn may reflect birds migrating from more northerly colonies in Norway.

The European population is estimated at 640,000-1,080,000 pairs, which equates to 1,280,000-2,160,000 mature individuals. The population in the EU27 is estimated at 262,000-352,000 pairs, which equates to 525,000-705,000 mature individuals**.** In Europe the population size is estimated to be decreasing by less than 25% in 29.4 years (three generations).

Within its breeding grounds the species is threatened by predation from introduced ground predators such as American Mink (*Neovison vison*) (Bukacińska and Bukacińska, 2003), and by disturbance from human activities during the laying period (Bukacińska and Bukacińska, 2003). Inland populations breeding in colonies near rivers are also vulnerable to mass outbreaks of Black Flies (Simuliidae). The species is also threatened by the transformation and loss of its breeding habitats through land reclamation, drainage, afforestation (e.g., with conifers) and dam construction (Bukacińska and Bukacińska, 2003). In its wintering range the species is potentially threatened by the activities of fisheries (e.g., reductions in fishing effort, increases in net mesh sizes and exploitation of formerly non-commercial fish species) and their effects on competition for prey resources (Bukacińska and Bukacińska, 2003). Other threats to wintering sites include land reclamation and drainage (Bukacińska and Bukacińska, 2003). Eggs are collected from colonies in

Germany, Scotland, and Poland (Bukacińska and Bukacińska, 2003).

- **Lesser black-backed gull *Larus fuscus***

The species breeds around Scandinavia, Germany, Belgium, the Netherlands and northern U.K. to Iceland. It also breeds year-round on the coast of Portugal, southern Ireland, the U.K. and northern France, and one seasonally breeding population is found in north-east Spain. Seasonal breeders disperse widely, expanding its range to include the entire North Sea coast, much of the Mediterranean and Black Sea. It inhabits coastal and inland waters, estuaries, harbours, rubbish dumps, fields, but breeds mainly on sandy, rocky or grassy sea coasts, rocky islands, islands of lakes and rivers, buildings, moorland, while it tends to avoid cliffs, favoured by *L. argentatus* (Burger et *al*., 2013).

April to August: In Scotland, most lesser black-backed gulls migrate south for the winter, although some birds over-winter in the south of the country (Hickling, 1986). Between April and August this species was widespread at low densities both over shelf and slope waters. During this time, lesser black-backed gulls regularly associated with fishing vessels especially south of 60°N along the shelf-break. Birds associated with fishing vessels in April and May accounted for the areas of high density.

September to March: Fewer birds were recorded between September and March and the majority was recorded in inshore waters. There were occasional sightings in deep waters. In October, some birds were recorded associating with fishing vessels over shelf waters between Lewis and Shetland, and account for moderate densities.

The European population is estimated at 394,000-460,000 pairs, which equates to 788,000-920,000 mature individuals.

In Europe this species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence 10% in ten years or three generations, or with a specified population structure). The population trend appears to be increasing, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (30% decline over ten years or three generations). For these reasons the species is evaluated as Least Concern in Europe.

Some populations of this species have significantly declined due to decreasing food availability caused by competition and predation from Larus argentatus and Larus marinus (Burger et *al*., 2013) and by changes in fishing and refuse disposal practices (Burger et *al*., 2013). Population declines may also have been aided by poisoning from organochlorine pollution. Colonies have been culled in Britain and Ireland in order to protect other breeding seabirds, such as terns, from predation and competition). The species is hunted unsustainably in Denmark, and is threatened by egg-collecting and general human disturbance on the Iberian Peninsula. The species is susceptible to avian botulism, so may be threatened by future outbreaks of this disease.

- **Herring gull *Larus argentatus***

It winters in north and west Europe. Its habitat includes coastal and near-coastal areas and also inland localities such as large lakes and reservoirs, on fields and at rubbish dumps. It is sometimes found at sea. Its breeding habitats are varied, including coastal cliffs and stacks, rocky and grassy islands, sandy beaches, gravel bars, salt-marshes, limestone outcrops, and buildings. The species also exploits man-altered habitats such as clay pits. It is omnivorous and highly opportunistic, exploiting superabundant food when available; it spans the full range of gull dietary items and feeding behaviour, as powerful predator. Feeds extensively on fish, earthworms, crabs, and other marine invertebrates (Burger and Gochfeld, 2013).

In winter, herring gulls are widely distributed throughout Britain and Ireland, with greatest numbers along east coasts, along the south coast of England and north Wales. Total estimates for Britain and Ireland were of half a million birds (Lack, 1986).

May to September: Herring gulls were primarily recorded near the coast, with few birds further offshore over the Atlantic Frontier. Between May and September, during the breeding and post-breeding periods, the distribution was almost entirely coastal with concentrations along the west coast of Scotland south of Skye. This area is one of the main breeding centres of the herring gull in Scotland (Lloyd et *al.,* 1991). Some herring gulls were associated with fishing vessels along the west coast.

October to April: From October to April, a larger component of the distribution was situated on the continental slope, although densities remained low. This wider distribution may be due to herring gulls from more northerly colonies moving into the study area for part of the winter. Migrants arrive during September and October, with many returning northwards during March and April (Cramp & Simmons, 1983). Offshore areas favoured lay to the west and north of Shetland and to the west of Scotland south of also over slope waters west of Scotland, mainly between February and April.

The European population is estimated at 685,000-809,000 pairs, which equates to 1,370,000-1,620,000 mature individuals. In Europe the population size is estimated to be decreasing at a rate approaching 30% in 39 years (three generations).

The species is threatened by coastal oil pollution and is susceptible to avian influenza and so may be threatened by future outbreaks of the virus. It is susceptible to colliding with offshore wind farms (Bradbury et *al*., 2014). It is vulnerable to being caught as bycatch in fisheries, including longlines, trawls and gillnets (Zydelis et *al*., 2013).

- **Great black-backed gull *Larus marinus***

The species occurs along rocky or sandy coasts, estuaries and open seas, and larger inland waters, fields and moorland. It breeds on vegetated islands, dunes, flat-topped stacks, and sometimes salt-marsh islands among bushes, and locally on buildings (Burger et *al*., 2013). It is omnivorous and opportunistic, preying on fish, adult and young birds, bird eggs, mammals, marine invertebrates, insects, carrion, rubbish, offal and berries. Fish include cod (*Gadus morhua*), herring (*Clupea harengus*), and capelin (*Mallotus villosus*). It is an aggressive predator, particularly on eggs and chicks of *L. argentatus*, *Rissa tridactyla*, ducks, seabirds, and other species (Burger et *al*., 2013).

The winter population of great black-backed gulls is widely distributed inland and around the coasts of England, with a more coastal distribution in Scotland, Wales & Ireland. Ringing recoveries have shown that many birds on the east coast in winter breed in Norway, while those on west coasts are local breeding birds (Lack, 1986).

The great black-backed gull occurs only in the North Atlantic and Arctic and is the least common of the *Larus* species breeding regularly in Scotland. Great black-back gulls are opportunistic feeders known to scavenge around fishing vessels, (Camphuysen et *al.*, 1995; Furness, et *al.* 1992) as well as around land-fill sites during the winter.

May to September: During the breeding and post-breeding seasons, between May and September, great black-backed gulls were widespread at low density over waters within 50 km of the colonies. Almost no birds were observed beyond this distance to the west of the Northern Isles. Their overall distribution was more widespread than that of the herring gull, especially around Orkney, Shetland and the Western Isles. These islands hold the majority of the breeding population of great black-backed gulls in Britain and Ireland, as well as the largest colonies (Lloyd et *al.*, 1991). Few birds were recorded in waters deeper than 200 m, and it is likely that these birds were non-breeders.

October to December: Between October and December, the distribution was patchier with lower densities around the colonies. Great black-backed gulls were widely dispersed along the shelf-break and in deeper waters particularly to the north-west of the Western Isles. Patches of higher density were observed inshore due to birds associating with fishing vessels. Outside the breeding season, British birds are mostly sedentary remaining within 300 km of their colonies.

January to April: Great black-backed gulls were most widespread and abundant during this period. In March and April the highest densities of great black-backed gulls are found in north-western Europe (Stone et *al.*, 1995a). Areas of moderate to high density, found along the slope as well as over shelf waters, were mostly caused by birds associating with fishing vessels. Most associations with fishing vessels were recorded between January and April, with a peak in April, when highest densities were recorded in waters around Shetland and north of the Western Isles.

The European population is estimated at 118,000-133,000 pairs, which equates to 237,000-266,000 mature individuals. In Europe and the EU27 the population size is estimated to be decreasing by less than 25% in 36 years (three generations).

The species is hunted for sport in Denmark. It is vulnerable to collision with offshore wind farms (Bradbury et *al*., 2014). It is also vulnerable to being caught as bycatch in fishing gears, including longlines, trawls and gillnets (Zydelis et *al*., 2013). It is vulnerable to coastal oil spills and other types of surface water pollution.

- **Kittiwake *Rissa tridactyla***

In Europe this species breeds on cliffs and coastlines in both Arctic and temperate regions. This species is migratory and disperses after breeding from coastal areas to the open ocean. It returns to its breeding grounds from January where it breeds from mid-May to mid-June in huge single- or mixed-species colonies (Burger et *al*., 2013) that often exceed 100,000 pairs. Non-breeders may also remain at sea during the breeding season. It nests on high, steep coastal cliffs with narrow ledges in areas with easy access to freshwater (Burger et *al*., 2013). The species moults on sandy beaches and on passage it may concentrate at sea on continental shelves, areas of upwelling (Burger et *al*., 2013) and at rich fish banks. During the winter the species is highly pelagic, usually remaining on the wing out of sight of land (Burger et *al*., 2013). Its diet consists predominantly of marine invertebrates (e.g., squid and shrimps) and fish, although during the breeding season it may also take intertidal molluscs, crustaceans, earthworms, small mammals and plant matter (Burger et *al*., 2013). Many species of fish have been recorded in diet, but sandeels (*Ammodytes spp*.), capelin (*Mallotus villosus*) and herring (*Clupea harengus*) are particularly important (Burger et *al*., 2013).

Outside the breeding season kittiwakes are mostly found offshore. Some are recorded around British and Irish coasts in winter, but the numbers involved are just a small portion of the total population.

January to April: Between January and April, kittiwakes were widespread, with highest densities of kittiwakes over the continental slope recorded at this time. This was most prevalent along the length of the Rockall Trough slope and less obvious on the slope adjacent to the Faroe-Shetland Channel. Kittiwakes are well known scavengers (Camphuysen et *al.*, 1995) and in this area were often associated with fishing vessels, particularly in April. On the shelf, moderate to high densities were present north of Scotland with highest densities to the north-east of Shetland, where kittiwakes were associated with fishing vessels. Shelf waters west of Scotland held mainly low densities of kittiwakes with isolated patches of moderate to high density.

May to July: From May to July, while still widespread, kittiwakes were concentrated in coastal waters close to the colonies. This was particularly noticeable around Orkney and the northern coasts of Caithness and Sutherland, which hold the majority of Scotland's breeding kittiwakes (Lloyd et *al.*, 1991). During the breeding season the foraging range varies from less than 5 km to 160 km, depending on feeding conditions (Hamer et *al.*, 1993). Most birds were recorded within c. 25 km of the nearest colony. Generally low densities were recorded offshore, although there were areas with moderate concentrations in the Faroe-Shetland Channel, probably comprising Faroese birds. A small patch of high density in the Faroe-Shetland Channel, and similarly an area of moderate density along the continental slope west of Scotland, were due to kittiwakes congregating around fishing boats.

August and September: In August and September, the distribution was patchier than the previous seven months. There appeared to be movement away from the colonies on the north coast and around Orkney. Concentrations were now found in the Minch and other inshore waters off the west coast of Scotland. Kittiwakes often occur in mixed species flocks with auks and Manx shearwaters in autumn, commonly feeding on clupeid fish which are unavailable at other times of year (Tasker et *al.*, 1987) No birds were recorded associating with fishing vessels in August and

September. By August, most kittiwakes have finished breeding, and disperse from the colonies, some young birds even crossing the Atlantic.

October to December: Highest numbers of kittiwakes were still recorded in inshore waters west of Scotland, although there were high densities once again north of Scotland, around Orkney and to the east of Fair Isle. Kittiwakes associating with fishing vessels accounted for some of the high densities in the Minch and directly to the north. Kittiwakes are easily out-competed at trawlers by the larger gull species and so depend more on naturally occurring food sources compared with some other scavenging species (Camphuysen et *al.*, 1995). Lowest numbers were recorded in offshore waters at this time. Further dispersal occurs as the species moves out into the North Atlantic.

The European population is estimated at 1,730,000-2,200,000 pairs, which equates to 3,460,000-4,410,000 mature individuals. This abundant small gull began undergoing rapid declines across the majority of its European breeding range since the 1980s. Extrapolated over a three-generation period (39 years) these declines result in its classification as Vulnerable in Europe, and Endangered in the EU27 (where declines have been even more rapid).

The species is threatened by the depletion of food resources (e.g. through over-fishing), marine oil spills (Nikolaeva et *al*. 2006, Burger et *al*. 2013) and chronic oil pollution (Nikolaeva et *al*., 2006). It is also susceptible to avian influenza so may be threatened by future outbreaks of the virus. The species is potentially threatened by climate change because it has a geographically bounded distribution: its global distribution is restricted to within c. 10° latitude from the polar edge of continent and within which 20–50% of current vegetation type is projected to disappear under doubling of CO2 levels. It is caught as bycatch in longline fisheries, with significant numbers estimated to be caught off the western coast of Ireland and the U.K. The species is hunted in the Faroe Islands and in Greenland (Burger et *al*., 2013, Thorup et *al*., 2014).

The species is listed under the African-Eurasian Waterbird Agreement, but is not listed on the Bern Convention, the Convention of Migratory Species or on the EU Birds Directive Annexes. The species is categorised as Vulnerable in the Norwegian Red List and the All-Ireland Vertebrate Red Data Book (OSPAR, 2010). Population monitoring occurs across much of its breeding range, including Greenland, Norway, Iceland, France and the U.K. The species is considered within the Nordic Action Plan for Seabirds.

- **Common tern *Sterna hirundo***

This species breeds in a wide variety of habitats in coastal and inland areas from sea-level to heights of greater than 4,000 m (Gochfeld et *al*., 2013). Along the coast it shows a preference for nesting on flat rock surfaces on inshore islands (Snow and Perrins, 1998), open shingle and sandy beaches, dunes and spits (Snow and Perrins 1998; Gochfeld et *al*., 2013), vegetated inter-dune areas, sandy, rocky, shell-strewn or well-vegetated islands in estuaries and coastal lagoons saltmarshes mainland peninsulas and grassy plateauxs atop coastal cliffs. Inland it may nest in similar habitats including sand or shingle lakes shores (Richards, 1990), shingle banks in rivers (Snow and Perrins, 1998), sandy, rocky, shell-strewn or well-vegetated islands in lakes and rivers

(Snow and Perrins, 1998; Gochfeld et *al*., 2013), sand- or gravel-pits (Richards, 1990; Snow and Perrins, 1998), marshes, ponds, grassy areas and patches of dredged soil (Snow and Perrins, 1998). It breeds between April and June in solitary pairs or colonially in groups of up to several thousand pairs (inland colonies often smaller and more widely-dispersed than coastal ones).

The nest is a shallow depression on open substrates with little or no vegetation placed near a vertical object (e.g. rock, shell, plant or artefact) to provide shelter for chicks and to facilitate nest identification. Nest sites include the edges of bare sand amongst vegetation, rocks or logs, open areas on the margins of vegetation on beaches, the edges of mats of vegetation in marshes, and grassy or rocky substrates on rocky islets. The species will also readily nest on artificial rafts. Clutches at higher latitudes are normally three eggs, however this is affected by food availability. It is an opportunistic feeder, its diet consisting predominantly of small fish and occasionally planktonic crustaceans and insects. This species is a strongly migratory coastal seabird (Snow and Perrins, 1998, Gochfeld et *al*., 2013). Palearctic breeders migrate south after breeding between August and October, returning to the breeding grounds in March or April (Gochfeld et *al*., 2013).

The majority of common terns spend the winter along the coast of West Africa, between Sierra Leone and Ghana, returning to Britain and Ireland to breed between April and October.

April to October: Common terns visit the British Isles in summer. They were recorded predominantly between the months of May and August, with single sightings in April and October. Their distribution was generally coastal and concentrated near colonies. In June there were several records of common terns feeding over deeper water along the continental slope. These may have been migrating birds from more northerly colonies. By August, the number of sightings had declined considerably as most common terns migrate south to winter off the coast of West Africa.

The European population is estimated at 316,000-605,000 pairs, which equates to 631,000-1,210,000 mature individuals.

At both European and EU27 scales this species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence 10% in ten years or three generations, or with a specified population structure). The population trend appears to be increasing, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (30% decline over ten years or three generations).

During the breeding season the species is vulnerable to human disturbance at nesting colonies and to the flooding of nest sites as a result of naturally fluctuating water levels (Gochfeld et *al*., 2013). On its breeding grounds the species is also threatened by habitat loss as a result of coastal development (Gochfeld et *al*., 2013), erosion, vegetation overgrowth (rapid vegetation succession encroaching upon nesting habitats) (Gochfeld et *al*., 2013), and chemical pollution (which may also result in eggshell thinning) Gochfeld et *al*., 2013). It suffers predation at nesting colonies from rats (especially on islands) (Gochfeld et *al*., 2013) and from expanding populations of large gull species such as Herring Gulls (*Larus argentatus)*. The species is susceptible to avian influenza so may be threatened by future outbreaks of the virus. Other threats include organochlorine pollution, over-fishing by man and fatalities from wind turbine collisions.

- **Arctic tern *Sterna paradisaea***

The species breeds along northern coastlines (Gochfeld et *al*., 2014) and on inshore islands, as well as inland on tundra and forest-tundra (Flint et *al*., 1984). It shows a preference for habitats with a vegetation cover of less than 40%, nesting on sand or shingle beaches, ridges (Gochfeld et *al*., 2014) and spits, rocky ground and small islands in lakes and coastal lagoons (Gochfeld et *al*., 2014). It may also nest on islets or banks along rivers (Snow and Perrins, 1998), on swampy tundra and peatlands with bog hummocks (Gochfeld et *al*., 2014) and reed-covered flats (Flint et *al*., 1984), or on inland heaths, rough pastures, meadows (Gochfeld et *al*., 2014) and sedge grassland (Snow and Perrins, 1998) not far from water.

The species also forages offshore, in ice-filled coastal bays or over wet tundra (Gochfeld et *al*., 2014). On passage it largely flies over open ocean (Snow and Perrins, 1998) resting at sea on kelp, logs or flotsam, but may occur inland or along coastlines on beaches, reefs and spits. It breeds between May and July (although the exact timing varies with temperature and food availability) in solitary pairs or colonies of a few to several hundred pairs (usually 2–25). The nest is a shallow scrape (Gochfeld et al., 2014) in sand, shingle or turf on beaches, ridges and spits, rocky ground, small islands in lakes, coastal lagoons (Gochfeld et *al*., 2014) and rivers (Snow and Perrins, 1998), swampy tundra and peatlands with bog hummocks (Gochfeld et *al*., 2014) and reed-covered flats (Flint et *al*., 1984), or on inland heaths, rough pastures, meadows (Gochfeld et *al*., 2014) and sedge grassland (Snow and Perrins, 1998) not far from water. It will also nest on artificial structures. Clutches are two to three eggs.

Its diet consists predominantly of fish as well as crustaceans (especially planktonic species), molluscs, insects (e.g. caterpillars, Chironomidae) and earthworms. It will also take berries in the early spring on arrival on its breeding grounds but does not readily switch to other prey items when preferred prey supplies fail. The species is a very strong migrant and makes exceptional long-distance movements offshore or along western continental coastlines between its high Arctic breeding grounds and Antarctic wintering grounds (Gochfeld et *al*., 2014).

Arctic terns that breed in Britain and Ireland head south to Antarctic seas after the breeding season, moving down the west coast of Europe and Africa to South Africa, and on south to the edge of the pack ice. Return passage begins in early March and retraces the autumn migration route northwards.

May to July: Arctic terns were recorded between May and October. During the breeding season, from May to July, Arctic terns were found mainly in inshore waters around the Northern and Western Isles. The highest densities were concentrated in inshore waters around Orkney and Shetland, which hold over 80% of the British breeding population (Lloyd et *al*., 1991). The distribution was patchy in deep waters. These records presumably relate to adults returning to more northerly colonies during May, or to fail and non- breeders later.

August to October: In August, Arctic terns began to disperse from the main breeding sites. Low densities were observed in the Minch and again in deep waters partic- ularly around the shelf break south of the Faroes. By late autumn Arctic terns migrate south, down the coast of West Africa, some wintering as far south as the Antarctic, before returning north in May (Cramp & Simmons, 1983).

The European population is estimated at 564,000-906,000 pairs, which equates to 1,130,000-1,810,000 mature individuals.

Within the EU27 this species has a very large range, and hence does not approach the thresholds for Vulnerable under the range size criterion (Extent of Occurrence 10% in ten years or three generations, or with a specified population structure). The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (30% decline over ten years or three generations). For these reasons the species is evaluated as Least Concern in the EU27.

The species is potentially threatened by climate change because it has a geographically bounded distribution: its global distribution is restricted to within c.10° latitude from the polar edge of continent within 20–50% of current vegetation type is projected to disappear under a doubling of CO_2 levels. In many parts of Scandinavia, declines have been caused in the past by egg collecting, however this has decreased in recent years allowing the population to recover (Gochfeld et *al*., 2014). In some areas predation by Starlings (*Sturnus vulgaris*) and American Mink (*Mustela vison*) can be a problem and mortality has been recorded as a result of red tide. In northern Britain the collapse of sand eel stocks have caused a crash in the population and in Svalbard the population may be vulnerable to oil, particularly in the post-breeding period (Gochfeld et *al*., 2014). Pollution is likely a major factor in the species's decline and yachting and other leisure activities have led to an increase in disturbance. Declines have also been correlated with gull abundance.

- **Common guillemot *Uria aalge***

This species is exclusively marine, occurring along sea coasts on rocky cliffs and offshore islands. It breeds mainly on steep sea cliffs and low, flat islands. During the winter it is mostly found offshore, along the edge of continental shelf and shallow banks, marine coasts and bays, usually in boreal waters but some birds occur in the cool subtropical zone. The time of breeding is variable and is largely determined by water temperature and ice. Generally, egg-laying takes place mid-May to early June and fledging mostly by late July to mid-August. It lays on a broad or narrow cliff ledge and on low, flat islands; occasionally also in crevices, under boulders and in caves. It does not build a nest and lays a single egg on bare rock. It is a pursuit-diving marine bird, which forages primarily during daylight. During the breeding season, schooling pelagic fish species are the most important prey for adults, though benthic species can also be important. In the U.K., the main prey taxa are sandeel (*Ammodytes spp.*) and clupeids. Small gadoids are also important at some colonies. The species winters mostly within its breeding range with some birds remaining relatively sedentary (Nettleship et *al*., 2013).

Guillemots are primarily a shelf species preferring waters less than 100 m deep (Stone *et al.*, 1995b), but were recorded along the shelf break at low densities throughout the year. Guillemots are resident and are found mostly in waters over the continental shelf. During autumn and winter months, guillemots are widespread around the coasts of Britain and Ireland, with first year birds moving furthest from the colonies. Most breeding birds feed within 55 km of their colony (Leaper *et al.*, 1988).

May to July: From May to July very high concentrations of common guillemots were found in near-shore waters with low densities further offshore and extending to waters deeper than 200 m. The highest densities were found around Shetland, Orkney, along the northern coast of Caithness and Sutherland, and off the west coast of Scotland – an area that holds most of the breeding birds in Scotland (Lloyd *et al.*, 1991).

August and September: After the breeding season, common guillemots disperse from the colonies and gather in large flocks in inshore waters. At this time, they undergo a complete body moult rendering them flightless for several weeks. The highest concentrations were found to the east of Orkney and off the west coast of Scotland over the shallow inshore waters of the Minch and the Sea of Hebrides southwards to Islay. Although these areas are very important for moulting auks overall numbers are lower than expected given the size of the breeding population. Some common guillemots from the west coast probably move into the Irish Sea (Pollock *et al.*, 1997), while those from the Shetland colonies move both east and south into the North Sea, an estimated one third of which move into the Moray Firth (Tasker *et al.*, 1986). Beyond the shelf break common guillemots were widespread at low densities over the Faroe-Shetland Channel and an area to the south of the Faroe Bank.

October and November: By October and November the moulting flocks had dispersed further offshore. Low densities were found along the shelf-edge over the Ymir and Wyville-Thomson Ridges and the Faroe-Shetland Channel. High to moderate densities were still found inshore off the west coast particularly in the Minch. Fewer birds were present in the study area and some may winter in the North and Irish Seas (Pollock *et al.*, 1997; Stone *et al.*, 1995a).

December to April: Between December and April, common guillemots were more widely distributed than in previous months. Highest densities remained over the continental shelf but the Minch was less important. Instead, the inshore waters around Orkney and the southern half of Shetland held the highest concen- trations. Although adult birds visit the colonies during the autumn and winter months most of the high densities around the colonies were observed in April, when colony attendance increases. Low densities of common guillemots were observed over the deep waters along the continental slope.

The European population is estimated at 2,350,000-3,060,000 mature individuals. This auk began undergoing rapid declines in its European breeding range during the 2000s. Extrapolated over a three-generation period (45 years) these declines result in its classification as Near Threatened in Europe.

This species is highly vulnerable to human disturbance as it is found in high concentrations outside the breeding season. Throughout the 19th and early 20th centuries, egg collection and shooting at colonies, as well as introduced alien predators caused severe declines in the world population and unregulated hunting in Greenland is still a major threat. As human populations increased and expanded the species was extirpated in many regions, particularly in the south of its range. Other important threats are overfishing of important forage species (e.g. capelin, herring, cod and sandeels) in the North Atlantic (Barents Sea, Iceland), uncontrolled gill-net fisheries in the north-east Atlantic and oil pollution and offshore petroleum developments in areas such as the Barents and North Seas and Greenland (Nettleship et a*l*., 2013). The species is susceptible to avian cholera so is threatened by future outbreaks of this disease. Wind farm development has a negative impact on this species as well (Vanermen et *al*., 2014). The species is also likely threatened by future climate change (Frederiksen et *al*., 2013).

- **Razorbill *Alca torda***

The species lives on rocky sea coasts, breeding on cliff ledges and under boulders. Northern populations migrate outside the breeding season, while southern ones are both migratory as far as the Mediterranean (mainly immatures) and dispersive (adults). Iceland holds over two-thirds of the European total, followed in importance by the U.K. and Norway, these three countries together supporting over 90% of the European population (Tucker and Heath, 1994).

The species is a pursuit diver that propels itself through the water with its wings. They are capable of diving to 120 m depth, but mostly forage nearer the surface. They spend most of their lives at sea, only arriving ashore to reproduce. They are known to consume Krill, Sprat (*Sprattus sprattus*), Sandeels (*Ammondytes spp*.) and Capelin amongst other prey (Nettleship, 1996).

Razorbills are more widespread in winter than in the summer months, leaving the breeding colonies by mid-August with most birds not returning to land until February or March. Large scale 'wrecks' of auks, including razorbills can occur, following adverse weather periods and low availability of prey.

Razorbills breed only in the North Atlantic with Iceland holding most of the world population. About 20% of the world population breeds in Britain, mostly around Scotland (Lloyd et *al.*, 1991). The razorbill is primarily a shelf species (Stone et *al.*, 1995b), but is less widespread than the common guillemot, with few birds recorded beyond the 200 m isobath.

May to July: During the breeding season, highest densities were found inshore off the west coast of Scotland. Low densities were observed over the continental shelf especially to the west of the Western Isles. Localised areas of low density were recorded beyond the shelf-break. In common with guillemots, razorbills leave the colonies in late June and July and become flightless during the moult.

August: During August, highest densities of razorbills occurred inshore off the west coast of Scotland. The Minch is an important area for moulting auks and an estimated two-thirds of the west coast population congregates there with the remainder thought to move south into the Irish Sea. Another area of high density was observed to the south of Orkney in the Pentland Firth; this area is known to be an important gathering area for moulting razorbills from Orkney and Shetland (Tasker *et al.*, 1986). As with other months, very few records of razorbills were in deep waters (>200 m). In

August west of Scotland, most birds were found inshore with a preference for shallow water with strong tidal currents (Harrison *et al.*, 1994). Other studies show highest densities within 10 km of the coast at this time of year (Tasker *et al.*, 1985c, 1986).

September to December: During the months of September to December, razorbills were recorded in low densities over shallow shelf-waters, with some distributed along the shelf-edge and over the Wyville-Thomson and Ymir Ridges. Moderate densities occurred inshore off the west coast of Scotland and north-east of Orkney. The pattern of distribution at this time was similar to that recorded between January and April although no birds were observed near the shelf-edge south of 57°N.

January to April: During winter, razorbills disperse widely; some birds winter in the North and Irish Seas and there is also immigration into the area from the north (Stone *et al.*, 1995a; Tasker *et al.*, 1987). Prior to the breeding season, from January to April, the razorbill was evenly dispersed in low densities over much of the continental shelf. Adult birds visit the colonies during the winter with visits becoming longer by March. Slightly higher densities were recorded near Orkney, Cape Wrath and around and to the north-west of Mull. These moderately high densities do not occur near the locations of the largest known razorbill colonies, possibly indicating the greater foraging range of razorbills at this time (Webb *et al.*, 1990).

The European population is estimated at 979,000-1,020,000 mature individuals. This auk began undergoing rapid declines in parts of its European breeding range during the 2000s, primarily in Iceland, which holds at least 60% of the European population, but where the population declined by 18% over the period 2005-2008. Extrapolated over a three-generation length (GL 13.6 years) period (41 years), these declines are estimated to range between 20-29%, resulting in its classification as Near Threatened in Europe under Criterion A.

This species is threatened by the current and future impacts of climate change, including temperature extremes, sea temperature rises and shifts and reductions in prey availability (Sandvik et *al*., 2005). The species is vulnerable to extreme weather, with severe winter storms causing large-scale mortality across north-western Europe in the past. As a pursuit diver the species is at risk from being caught in gillnets and driftnets, with gillnet fisheries in the North and Baltic Seas known to catch significant numbers (Zydelis et *al*., 2013; Skov et *al*., 2011). As the species spends much of its life at sea, including at and below the sea surface, it is vulnerable to both chronic oil pollution and oil spill events.

Offshore renewable energy, such as wind farms are also likely to pose a threat to this species, including through habitat displacement (Furness et *al*., 2013) and collision, although collision risk is currently considered low (Bradbury et *al*., 2014). Disturbance from shipping lanes and marine constructions occurs in coastal and offshore areas with high human presence, and habitat degradation at sea from mining and aggregate extraction also threatens this species. On land during its breeding season this species is exposed to invasive mammalian predators (e.g. rats, cats, mink), which could increase in severity as climate change allows their northward movement. The species is also vulnerable to disturbance from recreational and tourism activities. It is hunted in the Faroe Islands (Thorup et *al*., 2014).

- **Black guillemot *Cepphus grylle***

The species breeds along cliffs and rocky shores. The species is exclusively marine and is a pursuit diver that propels itself through the water using its wings. The species is probably primarily a benthic forager, since much of the prey consists of benthic fish and invertebrates, including crustaceans. Various studies find sandeels (*Ammodytes spp*.) and blennies (particularly butterfish *Pholis gunnellus*) to be the most important prey species of fish, although the relative contributions of each of these to the overall diet differs. Flatfish and gadoids (Ewins, 1990) are also sometimes important. Adults tend to consume a higher proportion of invertebrates than the chicks do (Ewins, 1990). The few data on winter food suggest that invertebrates are of greater importance during the winter than during the summer (Ewins, 1990). Black guillemot is a resident species found in coastal waters along rocky coastlines. The winter distribution of black guillemots is mainly concentrated around Shetland, Orkney, the north and west coastal waters of Scotland, and around Irish coasts, with fewest in the south-east. In Europe the breeding distribution of the black guillemot stretches north-east from Scotland and Ireland (with a few pairs in northern England and Wales) encompassing Scandinavia, Spitsbergen and northern Russia (Cramp, 1985). Within this area it is usually found inshore, occurring offshore less often than other auks (Cramp, 1985; Stone et *al.*, 1995b).

March to August: Black guillemots were widespread in low densities in coastal waters. Black guillemots usually feed within 5 km of their nests during the breeding season (Cramp, 1985) so the distribution closely matches that of the breeding colonies (Lloyd *et al.*, 1991; Webb *et al.*, 1990).

September to February: The distribution pattern in winter was very similar to that of the previous period, reflecting the sedentary nature of the species, though fewer birds were recorded. Most Shetland birds remain within 15 km of their colonies while ringing recoveries of Orkney birds suggest most move less than 50 km (Ewins, 1988). Black guillemots from Foula and Fair Isle have been found to move further than birds from other colonies, possibly because the coastlines of these islands provide limited shelter. The sheltered, shallow inshore waters of Shetland provide an important gathering area for flocks of moulting black guillemots during autumn and winter (Ewins & Kirk, 1988).

- **Little auk *Alle alle***

September to December: The little auk is a winter visitor to Britain from the islands of Arctic Europe, and although generally uncommon, in some years large wrecks (birds driven inland and stranded in atypical habitats) can occur involving several thousand birds (Platteeuw, 1996). Little auks were generally scarce in the study area. Low densities were observed in the Faroe-Shetland Channel from September to December and over the continental shelf edge north-west of the Western Isles in November. Although recorded between September and May, little auks were most abundant in November. A major wintering ground for little auks is the relatively shallow northern North Sea which may hold up to 31% of the North-east Atlantic population (Skov et *al.* 1995b). During this period, 40% of the birds were recorded over the deep waters of the Atlantic Frontier.

January to March: From January through to March numbers of sightings were reduced with very few little auks recorded beyond the shelf edge.

April and May: By April and May most little auks had migrated north to their breeding grounds leaving only a few scattered birds.

The European population is estimated at 304,000-742,000 mature individuals.

This species is likely to be susceptible to the impacts of climate change, such as sea temperature rise and shifts in prey distribution and abundance. The species is vulnerable to oil spills and other marine pollution (Nettleship et *al*., 2014). At the breeding colonies the species is vulnerable to invasive predators, such as rats, cats, and American Mink (*Neovison vison*). The species is susceptible to being caught in gillnets (Zydelis et *al*., 2013), although other fishing gears may also catch significant numbers. Increasing numbers of offshore wind farms may result in displacement from habitat, and a low risk of collision (Bradbury et a*l*., 2014). It is hunted for consumption in parts of Scandinavia (Mendel et *al*., 2008).

- **Puffin *Fratercula arctica***

The species nests on grassy maritime slopes, sea cliffs and rocky slopes (Nettleship et *al*., 2014). During the winter the species is highly pelagic and is dispersed widely across the sea from the Azores to the western Mediterranean and Canary Islands. When feeding chicks, birds generally forage within 10 km of their colony, but may range as far as 50 to 100 km or more (Rodway and Montevecchi, 1996). Birds of this species are pursuit-divers that catch most of their prey within 30 m of the water surface (Piatt & Nettleship, 1985). They prey on 'forage' species, including juvenile pelagic fishes, such as herring (*Clupea harengus*), juvenile and adult capelin (*Mallotus villosus*), and sand eel (*Ammodytes spp*.). At times, they also prey on juvenile demersal fishes, such as gadids (Rodway and Montevecchi, 1996). Sand eels usually form the majority of the prey fed to chicks and many chicks starve during periods of low sand eel abundance (Martin, 1989).

Puffins have a more widespread distribution than common guillemots or razorbills and are common in the deep waters of the Atlantic Frontier during the summer. Puffins are often more abundant in oceanic waters than inshore waters (Harrison et *al.*, 1994), and appear to prefer deeper waters than common guillemots or razorbills (Stone et *al.*, 1995b).

April and May: During April and May with the onset of the breeding season, puffins were widespread and numerous over the shelf waters. Eggs are laid mostly in April. Moderate to high densities were observed around Shetland but remained low around other known colonies. Low to moderate concentrations of probable non-breeders or Faroese breeders were observed over the Faroe shelf break and the Faroe-Shetland Channel.

June - July: From June to late July, highest densities of puffins occurred, with concentrations around the main breeding sites of Shetland, Orkney, North Rona, the Shiants and St. Kilda (Lloyd et *al.*, 1991). Low to moderate densities were observed beyond the shelf edge and over deep water as far west as the Rockall Trough and north to the Norwegian Sea. These are most likely non-breeders as breeding birds are generally thought to feed near the colony (Harris 1984) although a maximum foraging range of 40 km has been recorded for St. Kilda puffins (Leaper et *al.*, 1988). Foraging ranges of 50 km and 137 km from the nearest breeding site have been recorded during periods of low food availability. At this time there is a considerable influx of non-breeding birds around the colonies (Harris, 1984).

August to September: Puffins were most widespread in deep waters at this time, possibly due to movement away from the colonies once chicks have fledged (Stone et *al.*, 1995b). Moderate densities were recorded in deep waters south and west of the Faroes. In shelf waters moderate densities were found between Orkney and Shetland and in the Minch.

October and November: By October and November overall numbers had decreased considerably and the distri- bution became very scattered. Many of the birds from the Shetland and Orkney colonies move south and winter in the North Sea (Stone et *al.*, 1995b; Tasker et *al.*, 1987). Low to moderate concentrations were recorded over and beyond the shelf break north-west of Shetland and over the deeper waters of the Faroe Bank Channel, the Wyville-Thomson Ridge and the Rockall Trough.

December to March: From December to March there was a further decrease in overall numbers of puffins in the study area. Most puffins were distributed east of 4°W and they were very scarce west of Scotland. Low densities were recorded in waters beyond the shelf edge, the majority of which were north and west of Shetland over the Faroe- Shetland Channel and over the shelf break. During the winter, puffins from the west coast are thought to disperse widely, moving west into the Atlantic as well as south as far as the Mediterranean Sea (Harris, 1984).

The European population is estimated at 4,770,000-5,780,000 pairs, which equates to 9,550,000-11,600,000 mature individuals. This species began undergoing rapid declines across the majority of its European breeding range during the 2000s. Extrapolated over a three generation length period (65 years), allowing for considerable uncertainty given the long trend period (and even assuming current rates of decline do not continue), the species warrants classification as Endangered in Europe, and Near Threatened in the EU27 (where declines have apparently been less rapid, although uncertainty remains over the post-2000 trend in the key range state, the UK).

This species is highly susceptible to the impacts of climate change, such as sea temperature rise and shifts in prey distribution and abundance (Sandvik et *al.*, 2005). This is a particularly important threat when prey species are exploited unsustainably, leading to prey reductions and subsequent unsuccessful breeding. The species is vulnerable to oil spills and other marine pollution. The species is also vulnerable to extreme weather events and storms, with large wrecks recorded following severe winter storms at sea. At the breeding colonies the species is vulnerable to invasive predators, such as rats, cats, and American Mink (*Neovison vison*). The species is susceptible to being caught in gillnets, although other fishing gears may also catch significant numbers. Increasing numbers of offshore wind farms may result in displacement from habitat, although the risk of collision is considered very low (Bradbury et *al*., 2014). The species is hunted for human consumption in Iceland, and in the Faroe Islands (Thorup et *al*., 2014).

3.2.3 Fish

Over 330 species of fish have been recorded on the UK continental shelf.

Pelagic

Mackerel (*Scomber scombrus*) are widely distributed around the north-east Atlantic, and usually grow to 35-45 cm long. They feed on pelagic crustaceans and other zooplankton and small fish. Mackerel are fast growing and are sexually mature by three years of age, while they may live for 20-22 years. Spawning is pelagic and the spawning season prolonged. Eggs are shed in large batches and studies of spawning patterns reveal there to be two main mackerel stocks in UK waters: a western stock and a North Sea stock (Coull et *al*., 1998).

Atlantic herring (*Clupea harengus*) are widespread throughout the north-east Atlantic, although they reach the southern limit of their range just south of the UK. A number of different spawning grounds exist around the UK, with spawning occurring in late summer. Spawning usually takes place at depths of between 15-40m, when herring deposit their sticky eggs on coarse sand and gravel. The dependency of herring on these specific substrates makes the species potentially susceptible to disturbance at these sites and largely limits herring distribution to the shelf region. Each female produces a single batch of eggs every year from the age of about 3 years, although the number, size and weight of eggs will vary between spawning populations. Young herring occur in dense shoals in inshore waters

Sprats (*Sprattus sprattus*) are widespread along Atlantic coasts and usually found in shallow water close to shore, where they can tolerate low salinities. They range in length from 8-12cm and are a short-lived species, feeding on a range of planktonic crustaceans. Spawning mainly occurs in the summer months, at depths of 10-20m (Gordon, 2006). Juvenile sprats are generally found in dense schools in shallow, coastal waters.

Horse mackerel (*Trachurus trachurus*) is a schooling fish, particularly abundant to the south and west of the UK. Adults form large shoals in coastal areas with sandy sediments, where they feed on fish, cephalopods and crustaceans.

Demersal

Two species of argentine, the greater (*Argentina silus*) and lesser (*Argentina sphyraena*) are present in the north-east Atlantic. The greater argentine is larger and tends to be found in deeper water, closer to the edge of the continental shelf than the lesser argentine. They feed on bottom living worms and molluscs and also predate on pelagic fish, crustaceans and squid at night. They spawn between March and September, producing pelagic eggs and larvae.

Blue whiting (*Micromesistius poutassou*) is a meso-pelagic species, usually found in shoals 30-400m from the surface in water between 150-3,000m deep. Shoals move towards the surface at night. They are widely distributed around the north-east Atlantic, typically reach lengths of 25-30cm and live for 5-7 years (Gordon, 2006). They feed primarily on small crustaceans such as euphausiids.

The Atlantic cod (*Gadus morhua*) can be found from the shoreline down to depths of 600m and is widely distributed around European coasts. It can reach lengths of 50-80cm and has the potential to live to 15 years or older. Cod are omnivores, feeding on a variety of invertebrates and fish. Sexual maturity is reached between 4-5 years and spawning occurs over the continental shelf between January and April. Cod show a preference to spawn in waters with temperatures between 5-7 °C and high salinities, over coarse sand with a low tidal flow (González-Irusta & Wright, 2015). Larval abundance peaks at fronts and juveniles remain pelagic until they reach a length of 5-7cm. Adult cod aggregate in loose shoals within the continental shelf area (Hislop et *al*., 2015).

The haddock (*Melanogrammus aeglefinus*) is found around north-east Atlantic coasts, over rock, sand or gravel bottoms at between 80-200m (Albert, 1994). It can reach 50-75cm long and feeds on small benthic invertebrates and fish. There is some evidence of a winter migration of adult haddock from the North Sea to north-western Scotland (Hislop et *al*., 2015). Haddock is a batch spawner, with the season typically extending from February to May, with the north-west coast of Scotland as one of the usual spawning areas.

Whiting (*Merlangius merlangus*) are widespread around European coasts at depths of 10-200m over sandy or muddy ground. They typically grow to 30-40cm in length and may reach 20 years of age. Their diet comprises mainly crustaceans and fish. Spawning can take place as late as July in more northerly areas. Whitings spend their first 2-3 months near the surface, often associating with Cyanea jellyfish blooms, after which they adopt a demersal way of life.

Saithe (*Pollachius virens*) are most abundant at depths of between 125-200m around north-east Atlantic coastlines, usually entering coastal waters in spring and migrating back to deeper sea in winter (Hislop et *al*., 2015). They grow to 60-90cm and have a diet of fish and small crustaceans. They spawn in winter and spring, later in the year for populations further north.

Pollack (*Pollachius pollachius*) live inshore over rocky ground at depths of up to 200m, around north-east Atlantic coasts. They can grow to between 60 and 80cm. The pollack feeds primarily on fish, cephalopods and crustaceans. Juvenile shoals are common inshore but the adults shoal only during the spawning period, which takes place in winter and spring at about 100m depth (Whitehead et *al*., 1986).

A number of smaller gadoid species such as poor cod (*Trisopterus minutus*), Norway pout (*Trisopterus esmarkii*) and bib (*Trisopterus luscus*) can be very abundant in places and may be ecologically important as prey for other species.

Plaice (*Pleuronectes platessa*) live to depths of 200m, mainly on soft sediments with older individuals generally found in deeper water. Spawning occurs in water temperatures of approximately 6°C to produce pelagic eggs. Larvae move to coasts, and sandy beaches and estuarine regions act as nursery grounds. Plaice have a complicated life cycle, with each life stage having a specific set of habitat requirements. Larvae and juveniles rely on transport by currents to move them from spawning grounds to nursery areas, a habit that adults retain by making use of tidal transport during seasonal migrations between spawning and feeding grounds (Goldsmith et al., 2015).

Dab (*Limanda limanda*) and long rough dab (*Hippoglossoides platessoides*) are spring and summer spawners which mature at 2-3 years. Dab are typically found in shallower water, where they feed on small benthic invertebrates. The long rough dab tends to be found in deeper waters, up to 500m, over muddy substrates. Other important flatfish include the lemon sole (*Microstomus kitt*), mainly on coarser sediments to 200m, and the sole (*Solea solea*), especially on finer sandy and muddy seabeds to around 120m, including estuarine areas.

The monkfish, white-bellied (*Lophius piscatorius*) and black-bellied (*L. budegassa*) are typically found in northern UK waters ranging from shallow, inshore waters down to depths of up to 1,100m. Spawning is thought to take place in deep water, with each female thought to produce just one batch of eggs (in a large, buoyant and gelatinous ribbon) in winter and spring (Laurenson et *al*., 2008).

Juvenile monkfish descend to the seabed after 3-4 months spent in the water column and are generally found in shallower water than adults. Monkfish are ambush predators, enticing prey (typically fish, cephalopods and crustaceans) towards their mouths with a lure that extends from the top of their head.

The grey gurnard (*Eutrigla gurnardus*) is very abundant in shallow, sandy areas and migrates inshore during summer. Spawning takes place between January and June, with juveniles moving into deeper water as they mature. Red gurnards (*Aspitrigla cuculus*) tend to be found in shallow water and spawn over the summer months. Gurnard feeds on a range of fish, crustaceans and benthic invertebrates.

The scorpionfish include bullrout (*Myoxocephalus scorpius*), sea scorpions (*Taurulus bubalis*) and pogge (*Agonus cataphractus*). These species tend to favour coarse sediments in shallow waters and may enter estuaries and river mouths (Power & Attrill, 2002). They feed on crustaceans and small fish and pogge have sensory barbels to detect prey. Most scorpionfish will spawn between October and April, producing benthic eggs, which they deposit on a secure holdfast.

Sandeels (Ammodytidae, principally *Ammodytes spp*. and *Hyperoplus spp.)* are shoaling species, which lie buried in the sand at night and feed in mid-water during daylight (Winslade, 1974). Spawning usually takes place between November and February, on sandy sediments. The eggs are demersal and are laid in sticky clumps on sandy substrates. Larvae remain pelagic for between 2-5 months after which they are thought to over-winter buried in the sand. There is little movement between spawning and feeding grounds, and so fishing activity may have a direct effect on spawning (Sparholt, 2015). As well as being a major component of the industrial fishery, sandeels are an important food item for predatory fish and seabirds.

Sea Bass (*Dicentrarchus labrax*) are attracted to warm water discharges and so are common inshore, close to the mouths of rivers, particularly around the southern coasts of the UK. Bass move inshore to spawn from March to June and form large shoals during this migration, making them a target for fisheries.

Salmonids, including Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*) undertake extensive migrations out to sea to feed, before returning to "home" rivers to spawn, which takes place in the late autumn to winter. Spawning takes place in shallow excavations (redds), in shallow gravelly areas in clean rivers and streams. After a period of 1-6 years the young salmon migrate downstream to the sea as smolts. Atlantic salmon leave their home rivers in spring and early summer as smolts, and migrate towards feeding areas in the Nordic Seas and West Greenland (Guerin et *al*., 2014). Juvenile fish, including herring, sandeel and blue whiting form an important part of the diet of smolts during oceanic feeding (Haugland et *al*., 2006). Returns of salmon to western rivers are confined largely to the summer months. In contrast, sea trout appear to remain within nearshore waters rather than undergoing extensive migrations leading to concerns about their greater risk of exposure to sea lice infections from salmon farms in these areas (Gillibrand et *al*., 2005).

The European eel (*Anguilla anguilla*) spends most of its life in freshwater or inshore coastal waters, before migrating across the Atlantic to the Sargasso Sea to spawn in late summer. The larvae drift north-east with the Gulf Stream and return to European coastal waters during the spring where they transform into transparent elvers (glass eels). Glass eels gather in river estuaries and wait for the river water to reach 10-12°C, before swimming upstream and migrating into inland waters. Peak migration takes place on the increasing tides in April and May, and Eels which successfully reach fresh water acquire green and brown pigments and become yellow eels. They spend between 2 and 20 years in rivers and other inland waters, to migrate seawards as silver eels.

Elasmobranchs

The most abundant sharks found in UK waters are the lesser and greater spotted dogfish (*Scyliorhinus canicula* and *Scyliorhinus stellaris*), the spurdog (*Squalus acanthias*) and the tope (*Galeorhinus galeus*). They feed on crustaceans, cephalopods and fish (Ellis et *al*., 1996) and are egg layers, with the peak of breeding in June and July. Tope are also widespread and juveniles are often found in large bays and estuaries. They are long-lived, reaching an age of at least 36 years. They are viviparous and young are generally born during the summer, after a year-long gestation period. Large open water species such as the porbeagle (*Lamna nasus*) may occasionally occur around the coast of the UK. Waters to the west of Scotland, beyond the continental shelf, are home to a large number of deep-water shark species.

There are 27 species of skate within the north-east Atlantic (Ellis et *al*., 2015). Among the most widespread are the thornback ray (*Raja clavata*) and the cuckoo ray (*Raja naevus*). The starry ray (*Amblyraja radiata*), the blonde ray (*Raja brachyuran*), the small-eyed ray (*Raja microocellata*), the undulate ray (*Raja undulata)* and the spotted ray (*Raja montagui*) are regionally abundant.

The basking shark (*Cetorhinus maximus*) is widespread in Atlantic waters; it feeds by filtering plankton by its gill rakers. The shark is commonly seen at the surface in the summer months. They make extensive migrations both vertically and horizontally to locate high concentrations of plankton that will often be associated with fronts, and that they principally migrate north to south during the winter months along the continental shelf of Europe (Sims et *al*., 2005a, b).

Shellfish

The Norway lobster (*Nephrops norvegicus*), lives in burrows dug into muddy and sandy sediments, at depths between 20-800m. They range in body length from 8-24cm. Nephrops feed mainly on detritus, small crustaceans and worms and are most active at night. Eggs hatch in spring or summer after being carried by females for 9 months. The relative inactivity of females during this period, when they remain hidden in burrows, means that males are more heavily exploited in the fishery through most of the year. There is considerable variation in the life-histories of Nephrops at different locations. In part, this is linked to sediment type, with higher population densities found at sandier sites, resulting in a reduction in the rate of growth and maximum size.

The most commercially valuable bivalves are scallops (*Pecten maximus)*, found predominantly sandy, muddy, shell and gravel substrates, down to depths of over 100m. They occupy depressions in the sediment and are able to escape danger by swimming using jet propulsion. Their shells are lined with eyes and sensory tentacles, allowing them to detect light levels and even to form rudimentary images. Scallops are filter feeders for phytoplankton and suspended detritus. They spawn in spring.

Cockles (*Cerastoderma edule)* live on inter-tidal beaches of sand, muddy sand and fine gravel, where they burrow into the sediment. They use a siphon tube to feed on material suspended in the water column and can be found in very high densities.

Mussels (*Mytilus edulis*) are suspension feeders generally found attached to hard substrates within the inter-tidal zone, although they also attach to reefs and man-made structures in shallow waters. The settlement of spat is influenced by a range of factors, including tidal currents, water temperature and predation and so can be variable.

Wild fish, particularly Atlantic salmon and sea trout, are an important economic resource and component of biodiversity in Argyll and Bute. Atlantic Salmon are widely distributed, usually spending two years in rivers as fry and parr before migrating to sea as smolts. Most salmon spend one winter at sea before returning, although some remain at sea for two or more years before returning to spawn; these are known as multi-sea winter salmon. Sea trout have a similar freshwater life history to salmon but differ in that after entering the sea they generally remain in local inshore waters for several months before dispersing more widely. There are many freshwater and marine factors that can affect migratory fish populations but the most significant factor is the number of returning fish that survive and spawn in their natal river. In inshore coastal waters wild and farmed salmonids can be susceptible to predation and sealice infection, with recent studies suggesting the impact of coastal sea lice exposure accounts for 1-2% of salmon mortality. In determining planning applications for finfish development, Argyll and Bute Council will consider advice in relation to potential interactions between wild migratory salmonids and farmed salmonids, from Marine

Scotland, Scottish Natural Heritage (SNH), the local District Salmon Fisheries Board (DSFB) and SEPA as statutory consultees.

The following species list belongs to Scottish Priority Marine Features

Table 11: Species included in Scottish Priority Marine Features

Eel (marine part of life cycle)	*Anguilla anguilla*
Atlantic salmon (marine part of life cycle)	*Salmo salar*
European river lamprey (marine part of life cycle)	*Lampetra fluviatilis*
Sea lamprey (marine part of life cycle)	*Petromyzon marinus*
Sea trout (marine part of life cycle)	*Salmo trutta*
Sparling (marine part of life cycle)	*Osmerus eperlanus*
Anglerfish[12]	*Lophius piscatorius*
Atlantic halibut	*Hippoglossus hippoglossus*
Atlantic herring[13]	*Clupea harengus*
Atlantic mackerel	*Scomber scombrus*
Black scabbardfish	*Aphanopus carbo*
Blue ling	*Molva dypterygia*
Blue whiting	*Micromesistius poutassou*
Cod	*Gadus morhua*
Greenland halibut	*Reinhardtius hippoglossoides*
Horse mackerel	*Trachurus trachurus*
Ling	*Molva molva*
Norway pout	*Trisopterus esmarkii*
Orange roughy	*Hoplostethus atlanticus*
Round-nose grenadier	*Coryphaenoides rupestris*
Saithe[14]	*Pollachius virens*
Sandeels	*Ammodytes marinus* & *Ammodytes tobianus*
Sand goby	*Pomatoschistus minutus*

Whiting[15]	*Merlangius merlangus*
Basking shark	*Cetorhinus maximus*
Common skate	Formerly *Dipturus batis* now split provisionally into *D.* cf. *flossada* and *D.* cf. *intermedia*
Leafscale gulper shark	*Centrophorus squamosus*
Porbeagle shark	*Lamna nasus*
Portuguese dogfish	*Centroscymnus coelolepis*
Sandy ray	*Leucoraja circularis*
Spiny dogfish	*Squalas acanthias*

Specific Legislative Requirements for Basking Sharks

Since March 1998, basking shark were afforded full protection under Schedule 5 of the Wildlife and Countryside Act 1981, protecting the shark from intentional killing, capture, or disturbance out to 12 nm. The Nature Conservation (Scotland) Act (2004) also protects the species from 'intentional and reckless' disturbance in territorial waters. Furthermore, a UK Biodiversity Action Plan for the basking shark is now being taken forward by the Scottish Government as part of the Scottish Biodiversity Strategy. Basking sharks are listed as vulnerable worldwide and endangered in north-east Atlantic (IUCN Red List) and are listed under CITES Appendix III in UK waters. European Council Regulation 2555/2001 provides protection with a zero total allowable catch in European waters.

3.2.4 Mammals

European Protected Species (EPS) are listed on Annex IV of the EC Habitats Directive as in need of strict protection: marine EPS in Scotland are otters, cetaceans and marine turtles. It is an offence to deliberately or recklessly injure, capture, kill, harass or disturb an EPS (Conservation Regulations 1994).

Otters are distributed widely throughout Argyll and Bute. Although marine aquaculture development is not considered likely to significantly affect otters, an otter survey may be required in certain circumstances. Disturbance of otters/holts could be an issue for; onshore facilities and activities (sheds/ feed lines/ vehicle movements etc), for works in intertidal areas (shellfish operations), and marine construction activity (if within 200m of high-water mark). Disturbance is less likely to be an issue for finfish marine operations as they are usually at some distance from shore.

Cetaceans should be considered in terms of possible exclusion effects from the use of Acoustic Deterrent Devices to deter seal predation, particularly where ADDs use is proposed in narrow restricted areas of sea that are well used by cetaceans.

Cetaceans that can be encountered in Argyll waters (Mull of Kintyre to Isle of Mull) include:

- Harbour porpoise (*Phocoena phocoena*)
- Risso's dolphin (*Grampus griseus*)
- Bottlenose dolphin (*Tursiops truncatus*)
- White beaked dolphin (*Lagenorhynchus albirostris*)
- Common dolphin (*Delphinus delphis*)
- Minke whale (*Balaenoptera acutorostrata*)
- Killer whale (*Orcinus orca*)

Sightings of cetaceans in the Clyde include minke whales, bottlenose dolphins and porpoises. Other species do occur but are only occasional visitors to the inshore waters.

Two species of seal live and breed in Argyll and Bute waters; the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*), which is also known as the common seal. The Inner Hebrides supported approximately 8% of the Scottish grey seal pup production in 2010, with about 3,400 pups being born in the region each year. The 2007 - 2010 population estimate for harbour seals in the Strathclyde and Clyde regions combined is 6645, which is approximately 32% of the Scottish population. Good practice in managing interactions with seals involves initial farm site selection, appropriate husbandry practices, choice of the most appropriate net designs and tensions, creation of seal-exclusion barriers, reduction of attractants to seals and use of Acoustic Deterrent Devices (ADD). The shooting of rogue seals as a last resort is managed through a separate licensing process under the Marine (Scotland) Act, including requirements for reporting and monitoring to Marine Scotland.

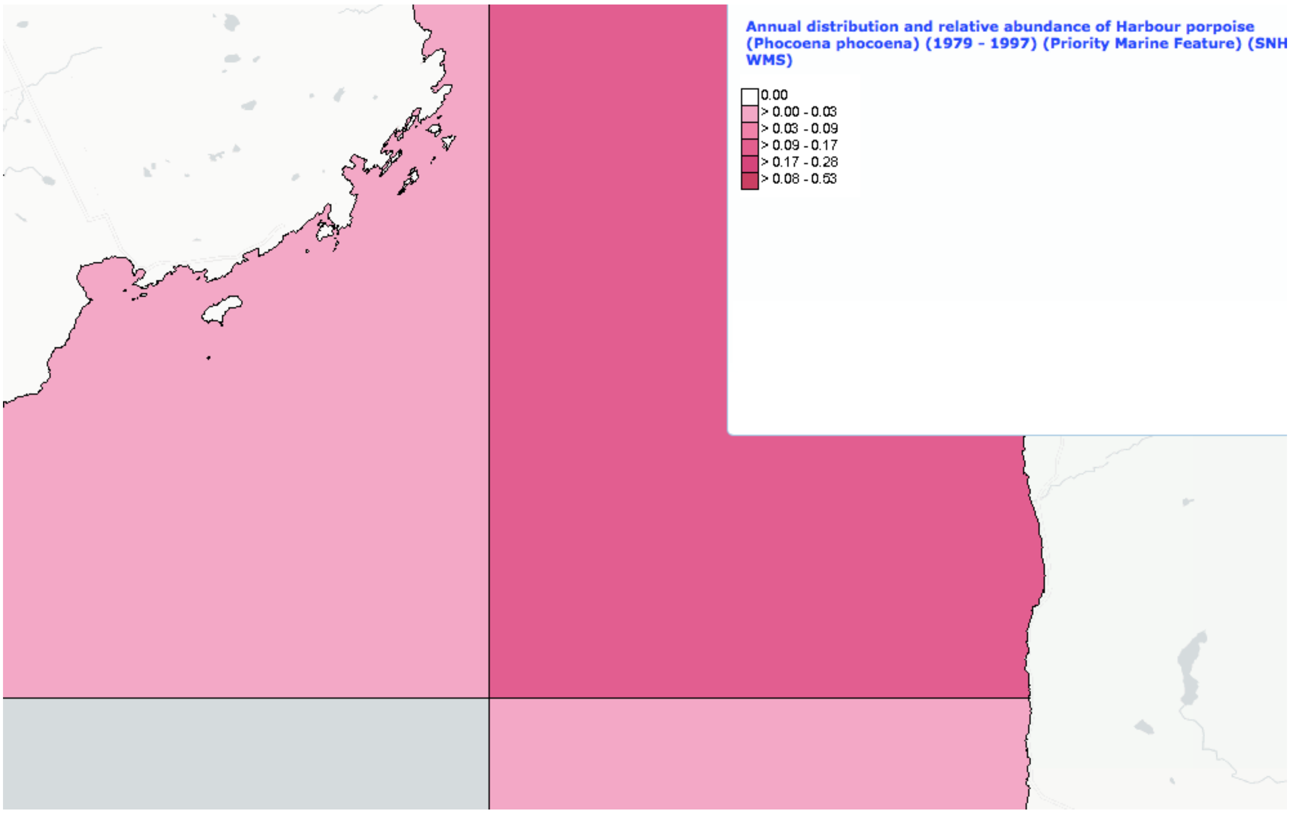


Figure 33: Annual abundance of harbour porpoise (*Source: Marine Scotland*)

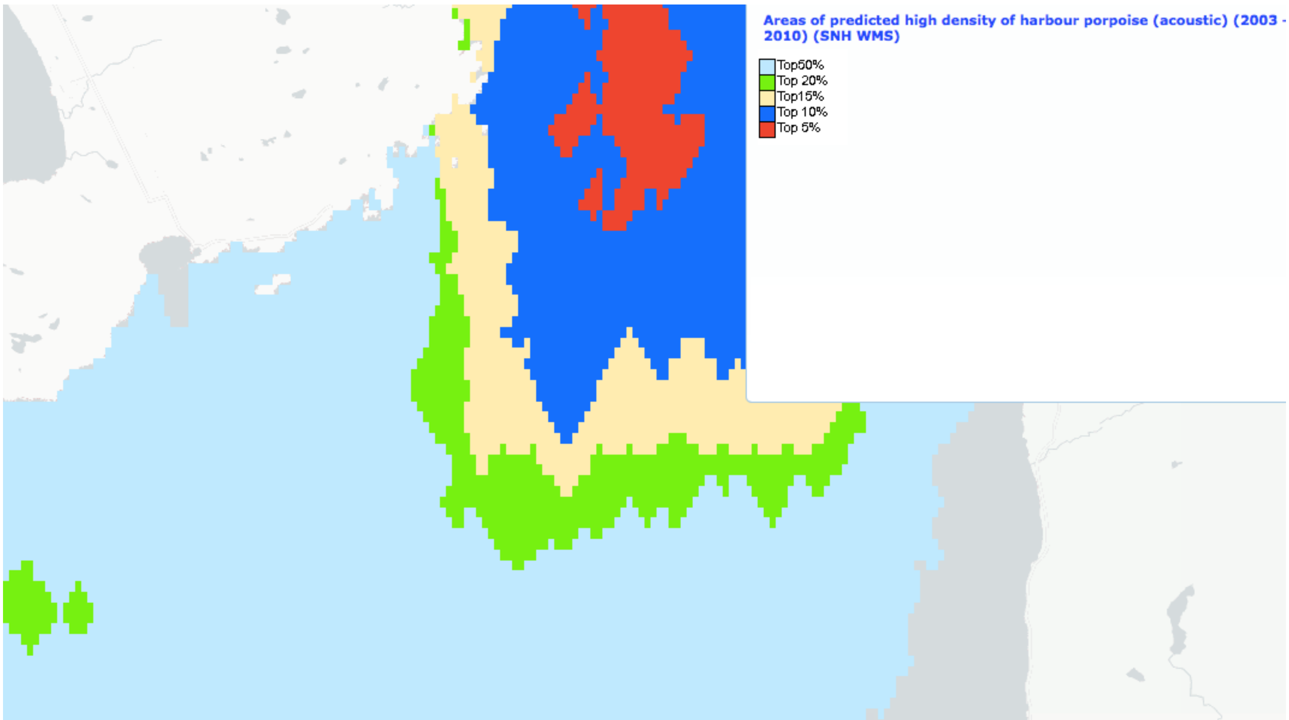


Figure 34: Areas of predicted high density of harbour porpoise, Islay (*Source: Marine Scotland*)

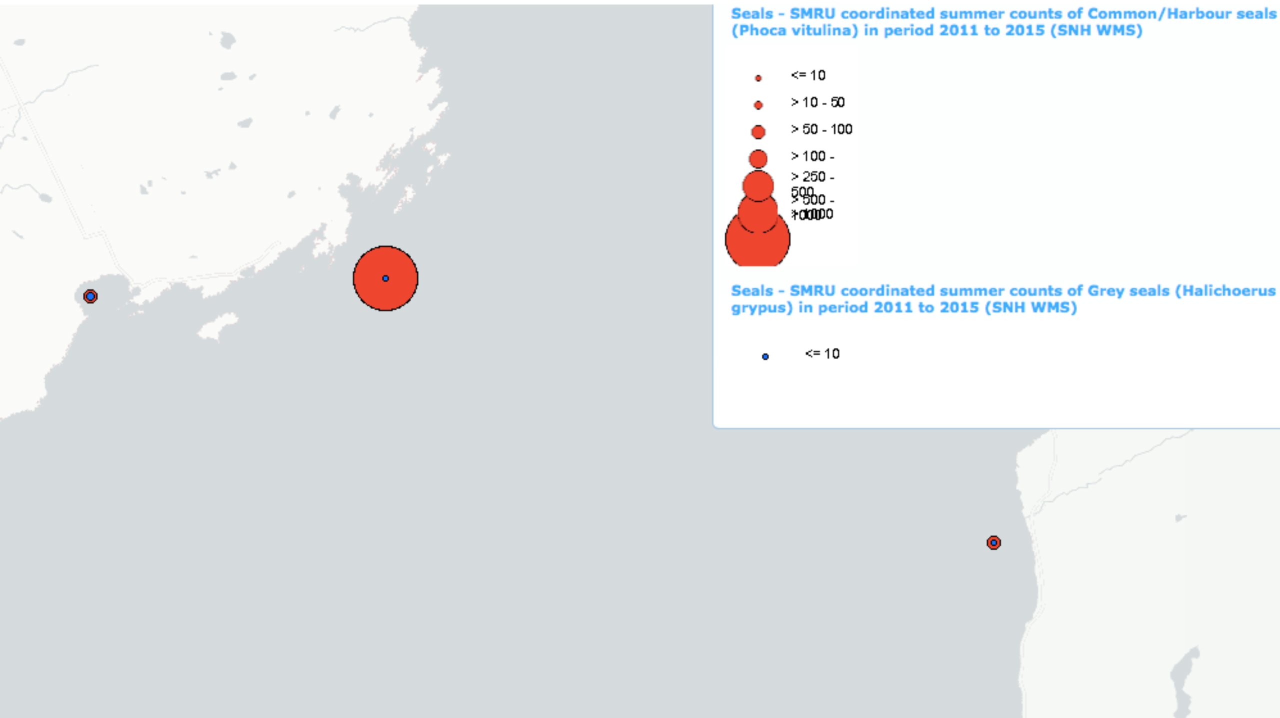


Figure 35: Summer counts of Seals, Islay (*Source: Marine Scotland*)

3.2.4.1 International Legislation

Table 12: Summary of Legal Status of Species occurring at the Islay Island

Species	Habitats Directive	WCA 1981 Schedule	HR 1994 Schedule	Bern Convention Appendices	Bonn Convention Appendices	Other
Harbour porpoise	II and IV (EPS)	5	2	II		IUCN Red List Least Concern and PMF
Bottlenose dolphin	II and IV (EPS)	5 and 6	2	II		PMF
Risso's dolphin	IV		2			PMF
Minke whale	IV (EPS)		2	III		PMF
Harbour seal	II and V		3	III	(II but not local population)	PMF
Grey seal	II and V		3	III	II	PMF
Basking sharks		5			I and II	PMF, CITES Appendix II, Nature Conservation (Scotlan) Act 2004, OSPAR List of Threatened and/or Declining

Bottlenose dolphin and harbour porpoise are listed in Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), while harbour seal (the eastern Atlantic population), grey seal and minke whale are listed in Appendix III as 'protected faunal species'.

As an endangered migratory species, common dolphin is listed in Appendix I of Bonn Conventions (Convention of Migratory Species, CMS 1979); grey seals and harbour seals (Baltic and Wadden Sea sub-populations only) are included in Appendix II, as migratory species that need or would significantly benefit from international co-operation. ASCOBANS (the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas) was established under the auspices of the Bonn Convention, and protects all toothed whales (odontocetes), except for the sperm whale.

The OSPAR convention lists species and habitats, which require further protection. Harbour porpoise is included in Annex IV, as threatened or declining.

The requirements of the Bern Convention, Bonn Convention and OSPAR in regard to marine mammals are principally addressed through the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora).

All species of cetaceans and seals cited here are listed in one or more of Annex II, IV and V of the Habitats Directive, as species of 'Community interest'. This affords particular levels of protection through spatial measures to protect habitats that are fundamental to the survival of the species, and strict protection measures applied to individuals and populations.

For Annex II species (harbour seal, grey seal, harbour porpoise and bottlenose dolphin), spatial protection measures should be developed through designation of Special Areas of Conservation (SACs) that contribute to a 'coherent European ecological network' of protected sites (through Natura 2000).

Further strict protection measures are required for European Protected Species (EPS), listed on Annex IV of the Directive (including all cetaceans). These species are afforded strict protection from all forms of deliberate capture or killing; deliberate disturbance, particularly during the period of breeding, rearing, hibernation or migration; and deterioration or destruction of breeding places or resting sites. Grey seal and harbour seal are also protected under Annex V of the Habitats Directive, which has particular implications for the exploitation of this species. These conservation requirements are now addressed in Scotland under the Marine (Scotland) Act (2010).

3.2.4.2 National Legislation

The Wildlife and Countryside Act (WCA) 1981 (as amended) ratifies the Bonn Convention in Scotland, providing protection of all cetaceans found within territorial waters (to 12nm). 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. In Scotland, the WCA (1981) Act was amended by the Nature Conservation (Scotland) Act 2004, which in reference to the species of concern here, makes it an offence to "intentionally or recklessly disturb a dolphin, whale or basking sharks." Bottlenose dolphin, common dolphin and harbour porpoise are included in Schedule 6 of the WCA (1981) Act, with basking sharks listed in Schedule 5.

Regulation 39 (1) and (2) and 43 of the Habitats Regulations provide protection by making it an offence to harm any EPS, through "deliberate" or "reckless" action resulting in death, injury, harassment or disturbance.

Pending the development of specific guidance for Scottish waters, the term "deliberate" has been interpreted in guidance for the offshore area (JNCC, 2010a) as including indirect but foreseeable actions. A deliberate injury offence may occur if a cetacean receives a sound exposure level which may cause permanent threshold shift in hearing.

A deliberate disturbance offence may occur if the level of disturbance is likely to:

- Impair the ability to survive, to breed or reproduce, or to rear or nurture their young;

- Impair the ability of hibernating or migratory species, to hibernate or migrate; or
- Affect significantly the local distribution or abundance.

A disturbance offence is more likely to occur when there is a risk of animals incurring sustained or chronic disruption of behaviour scoring 5 or more in the 'behavioural response severity scale, (Southall et *al*., 2007) or of animals being displaced from the area, with redistribution significantly different from natural variation.

Regulation 41 of the Habitats Regulations prohibits the use of certain means, which are listed in the regulation, of "capturing" or killing wild animals listed on Schedule 3 to the Regulations (Annex V (a) of the Habitats Directive; including grey and harbour seals). The prohibition also applies to EPS, listed in Schedule 2 to the Regulations where the capturing or killing is permitted by virtue of a relevant licence.

A separate list of Marine Protected Areas (MPA) search features has been produced. Three species of cetaceans are included on the MPA search feature list for Scottish territorial waters - Risso's dolphin, white-beaked dolphin and minke whale, along with basking sharks.

3.2.4.3 Specific Legislation Requirements for Seals

In addition to the protection outlined above (through the Habitats Regulations and protection of SACs), the Marine (Scotland) Act 2010 introduces increased protection for seals and a new seal licensing system, under the species pillar of the conservation strategy. Section 6 of the Act makes it an offence to kill, injure or take seals at any time of the year except to alleviate suffering, or where a licence has been issued to do so (by Marine Scotland). Licences to kill individual can be granted for the protection of fisheries and aquaculture and for scientific and welfare reasons.

The Act also made it an offence to intentionally or recklessly harass seals at haul-out sites, which have been identified for protection under Section 117 of the Marine (Scotland) Act 2010.

To support the management of seals at a national level, seven 'Seal Management Areas' (SMAs) have been proposed based on advice from SMRU (Scottish Government, 2012). The management areas are used to define the levels of acceptable take from the population (Potential Biological Removal; PBR) which is calculated annually by SMRU using the latest counts and population estimates. The PBR level is currently set at 442 for harbour seals and 297 for grey seals of the West Scotland Management Area (Scottish Government, 2012).

In response to local declines in harbour seal numbers, the Scottish Government introduced conservation orders under the Conservation of Seals Act 1970 to provide additional protection on a precautionary basis for vulnerable local populations of common seals.

Specific Legislative Requirements for Basking Sharks Since March 1998, basking shark were afforded full protection under Schedule 5 of the Wildlife and Countryside Act (WCA) 1981, protecting the shark from intentional killing, capture, or disturbance out to 12 nm. The Nature Conservation (Scotland) Act (2004) also protects the species from 'intentional and reckless' disturbance in territorial waters. Furthermore, a UK Biodiversity Action Plan for the basking shark is now being taken forward by the Scottish Government as part of the Scottish Biodiversity Strategy. Basking sharks are listed as vulnerable worldwide and endangered in north-east Atlantic (International Union for Conservation Nature 2004 Red List) and are listed under CITES Appendix III in UK waters. European Council Regulation 2555/2001 provides protection with a zero total allowable catch in European waters.

3.2.4.4 Cetaceans

- **Harbour porpoise (*Phocoena phocoena*)**

Figure 36: Harbour porpoise (*Phocoena phocoena*)

Harbour porpoises are the smallest and the most commonly encountered cetaceans found in Scottish waters. They are just 1.35–1.8 meters long, and weigh up to 90 kg. They have small, rounded bodies and short heads, without the typical beaks of dolphins. All the dolphins found in Scottish waters have tall, sickle-shaped dorsal fins, whereas the fin of the harbour porpoise is small and triangular in shape. Harbour porpoises are the most abundant cetaceans found in Scottish coastal waters. They are typically found in shallow, coastal waters within 15 km from shore with depths of 50-150 meters. Although they are found throughout all Scottish waters, a particular concentrations of porpoise abundance have been identified in several areas including the Sound of Jura, Firth of Lorne, the area between Mull and the Treshnish Isles, and the Sound of Sleat, especially in summer.

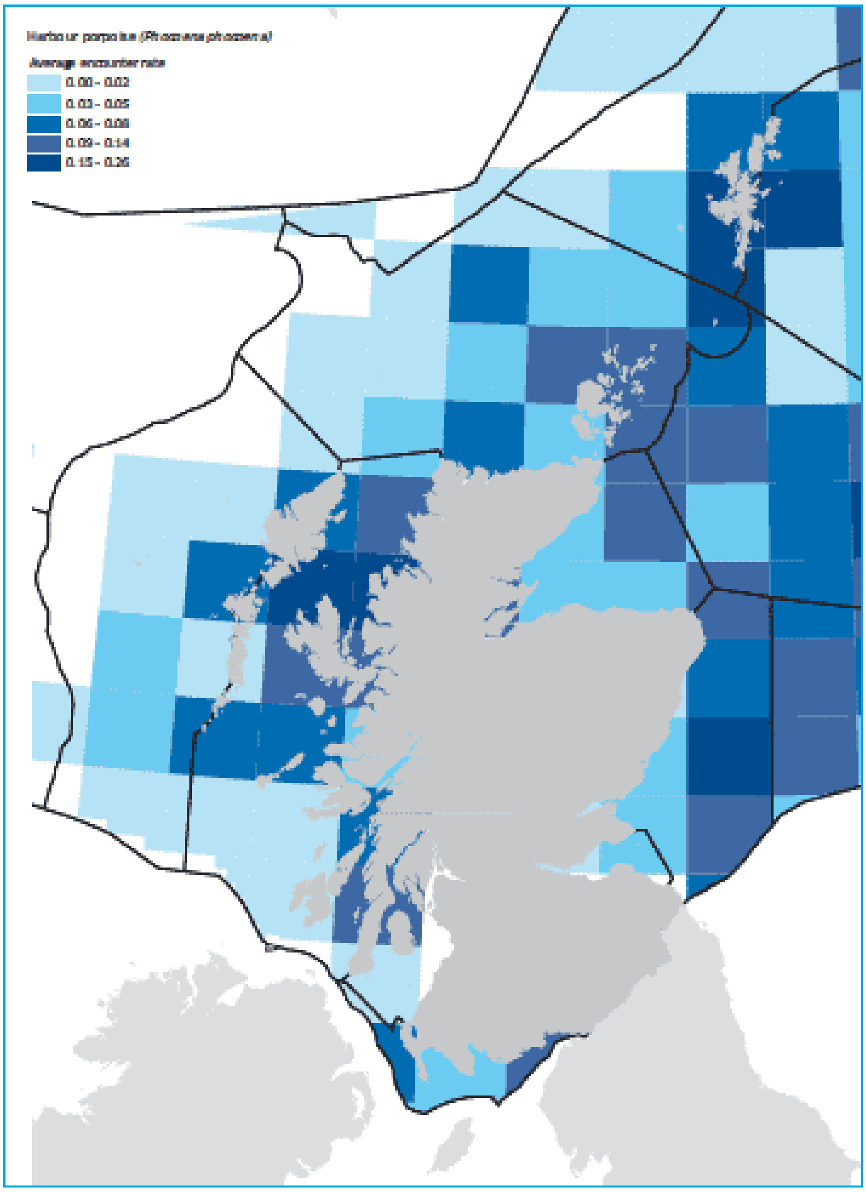


Figure 37: Harbour porpoise Scotland distribution (*Source: Marine Scotland*)

Harbour porpoises feed on a wide range of fish, including herring, whiting and sandeels. They usually travel alone or in small groups. However, if they find an abundant source of food, they will often come together to feed in groups of 100 animals or more. Reproduction of harbour porpoise occurs annually, with mating and calving reported between May and September with a peak between June and July.

- **Bottlenose dolphins (*Tursiops truncatus*)**

Figure 38: Bottlenose dolphins (*Tursiops truncatus*)

Bottlenose dolphins are perhaps the best-known cetaceans found around Scotland and can grow up to three meters in length and weigh around 200 kilograms. They can be seen close inshore on both the east and west coasts. They occur regularly close to the shore in specific areas, and are therefore easier to see from land than other cetaceans. The Moray Firth supports the North Sea's only known resident population of bottlenose dolphins. This small population of about 195 animals ranges throughout the Moray Firth and down the east coast, at least as far as the Firth of Forth.

Moray Firth Special Area of Conservation (SAC) – a marine nature site - was created to protect the bottlenose dolphins that use this important area.

Their diet is very diverse and includes flatfish, herring, mackerel, cod and salmon, squid and octopus, and different types of shellfish.

Bottlenose dolphins live in social groups and take part in cooperative hunting. In the Moray Firth, bottlenose dolphins are also known to kill harbour porpoises, although the reasons for this behaviour are not fully understood.

In coastal waters, groups can include up to as many as 25 animals. This may have led to the development of a whole range of social behaviour not known in other species. Their ability to use sound to communicate is also highly developed. There is increasing evidence that each dolphin has its own distinctive whistle, like a unique signature tune.

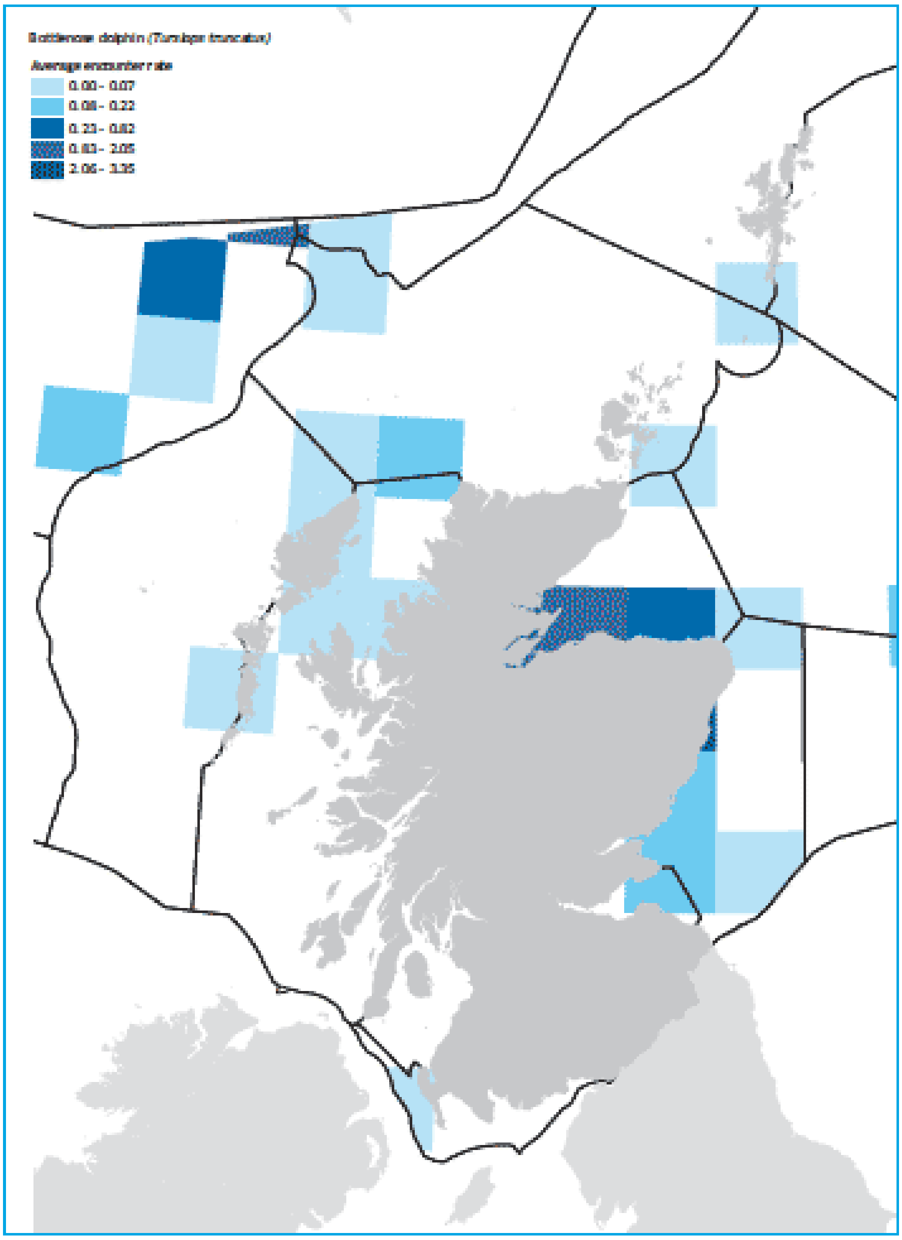


Figure 39: Bottlenose dolphins Scotland distribution (*Source: Marine Scotland*)

- **Minke whale (*Balaenoptera acutorostrata*)**

The minke whale is the most common of the baleen whales around Scotland. They are the smallest of the baleen whales, but they are still pretty big – typically around eight or nine meters long and weighing up to nine tonnes. They are closely related to fin, sei and blue whales. As well as being smaller than the others, the most obvious way to tell a minke whale is to look at the shape of its head. It is slender and streamlined with a pointed, triangular head and a single prominent ridge running forward from the blowhole to its snout.

Figure 40: Minke whale (*Balaenoptera acutorostrata*)

Minke whales feed on a wide variety of different animals, including sandeels, herring, cod, haddock, mackerel and krill. They do not live in large groups; they are usually found swimming individually or in pairs but can congregate in groups of ten or more animals when a good source of food is found – up to 100 have been seen at feeding sites in Norway. This is when they are at their most impressive: they lunge through the water on their sides, with their enormous mouths stretched wide open to engulf a shoal of fish, erupting right out of the water with a huge splash, then snapping their mouths shut to capture as much food as possible.

Minke whales undertake long migrations southwards to give birth and breed, but the locations of their breeding and calving grounds remain a mystery. Some individuals have been found to spend whole summers feeding around the Isle of Mull, stocking up for the long trip ahead. In the Moray Firth, some return from their breeding grounds as early as March or April; most sightings around the Western Isles and along the west and south-east coasts occur between May and September. Around Orkney and Shetland they are regularly seen in August and September. In Scotland, they're most often spotted between July and September, but may be present year-round.

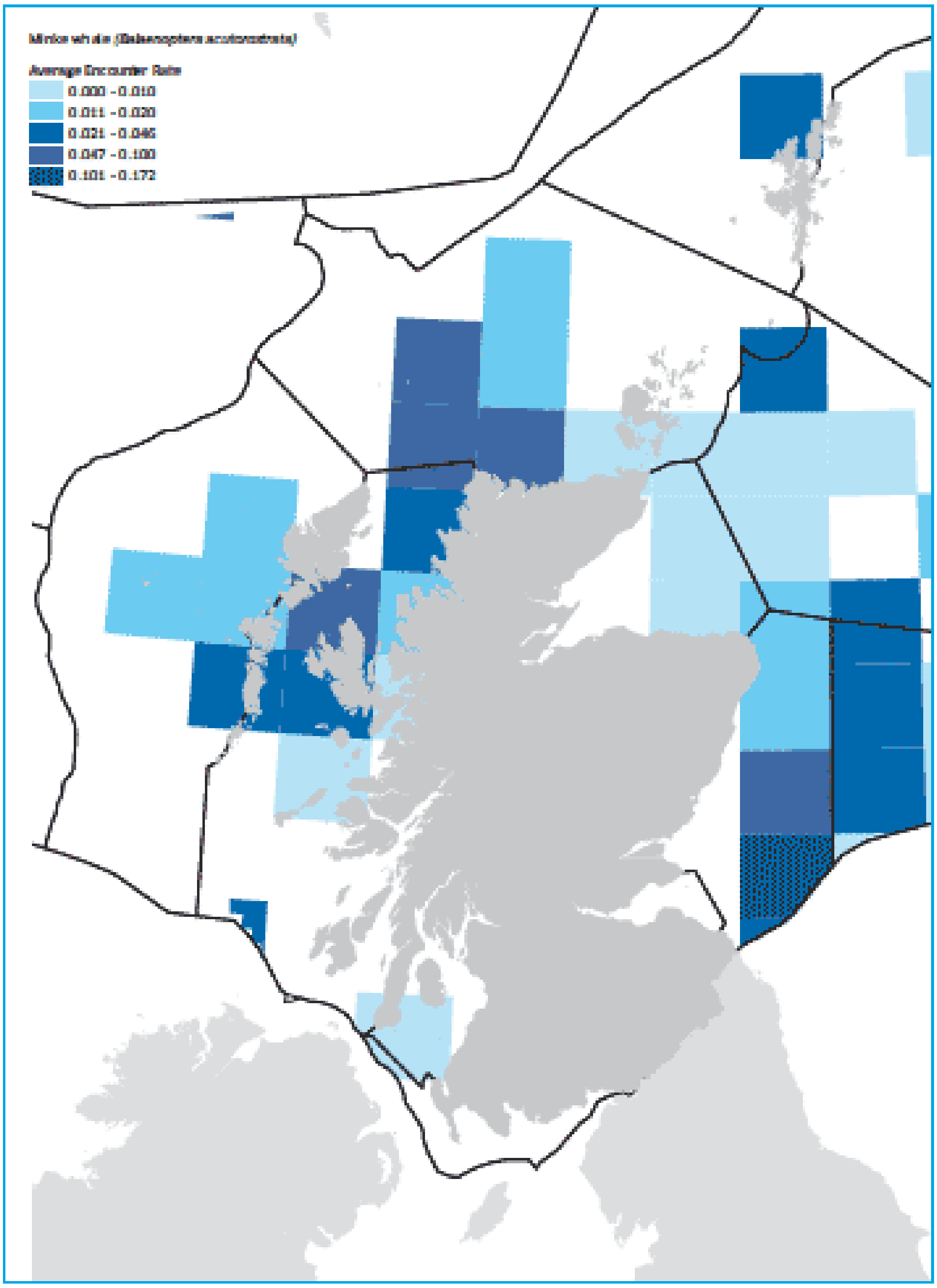


Figure 41: Minke whale distribution in Scotland (*Source: Marine Scotland*)

Killer whale (*Orcinus orca*)

Figure 42: Killer whale (*Orcinus orca*)

Orcas (killer whales) are the largest species of dolphin. Their distinctive black-and-white coloration makes them easy to recognise. Their sheer size and bulk is awe-inspiring: the largest can be up to nine meters long, with a maximum weight of 10 tonnes. Their dorsal fins can be 1.8 meters tall. Killer whales are found in both shallow coastal waters and in deeper water to the north and west of Scotland. They live in organized and highly social groups known as pods. In Scottish coastal waters these groups tend to have up to eight members, but in deeper, offshore waters they may contain up to 100 animals. The oldest female is usually the dominant animal in the pod, and strong connections are maintained between mothers and their offspring. The value of these bonds can be seen most obviously in the way a pod of killer whales hunts. Different pods have preferences for different types of food. Some specialize in catching schooling fish, such as herring and mackerel, often in large pods; others target seals or small cetaceans, usually by hunting in smaller groups. Although individual whales may catch some prey, pod members work closely together to herd and eventually capture their prey. When hunting, communication between individuals, using a variety of honks and screams, is vital to ensure that they work together effectively and leave no room for prey to escape. Some killer whales have been seen playing with their food, in particular, tossing both seals and porpoises into the air, an activity which is thought to be a way of teaching their young to hunt.

The best chance of seeing killer whales in Scottish waters is when pods come closer inshore between April and September around the Western Isles, the west mainland, and the Northern Isles.

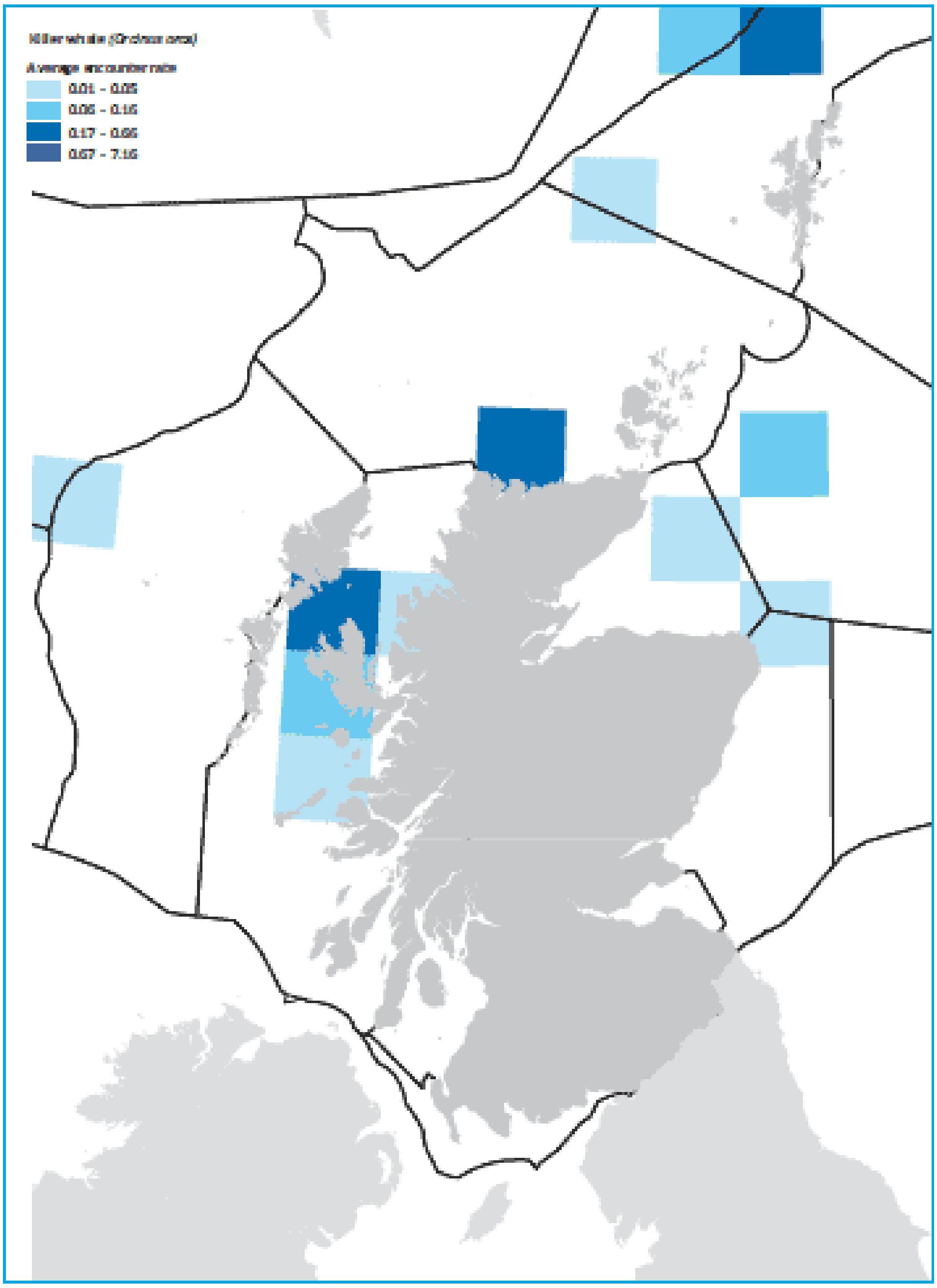


Figure 43: Killer whale Scotland distribution (*Source: Marine Scotland*)

- **Risso's dolphin (*Grampus griseus*)**

Figure 44: Risso's dolphin (*Grampus griseus*)

The Risso's dolphin *(Grampus griseus)* is a large dolphin, which grows up to 4 meters in length and can weigh as much as 500 kg. Generally, adult Risso's are medium to dark grey on the back, paler on the sides and have a white anchor-shaped patch on the belly. The species tends to become whiter with age and is most easily recognised by the scars on its skin, particularly around their blunt, rounded head and mouth.

The majority of UK sightings of Risso's dolphin occur along the west coast of Scotland (typically groups of 6-12 individuals were observed). They're most often seen in the Minch and to the north of the Outer Hebrides, in the outer Moray Firth and off the Aberdeenshire coast. This apparent preference for the Outer Hebrides is likely to do with the abundance of prey and the closeness of the continental shelf where they also tend to feed. The abundance of Risso's dolphin in Scottish seas (May and October) is known to increase when their prey species, particularly squid, are at their most abundant. Scientific research indicate that Risso's dolphins have variable social structures which range from stable long-term groups to fluid groups prone to split and reform on a regular basis.

Although highly migratory, it has been shown that many Risso's dolphins are faithful to particular areas of Scotland's coast, returning year after year. These studies also record the frequent observation of juveniles and calves, suggesting that these areas may be being used as a breeding and nursery area for the species.

Risso's dolphins are known to feed primarily on squid and octopus, although they also eat cuttlefish and various fish species.

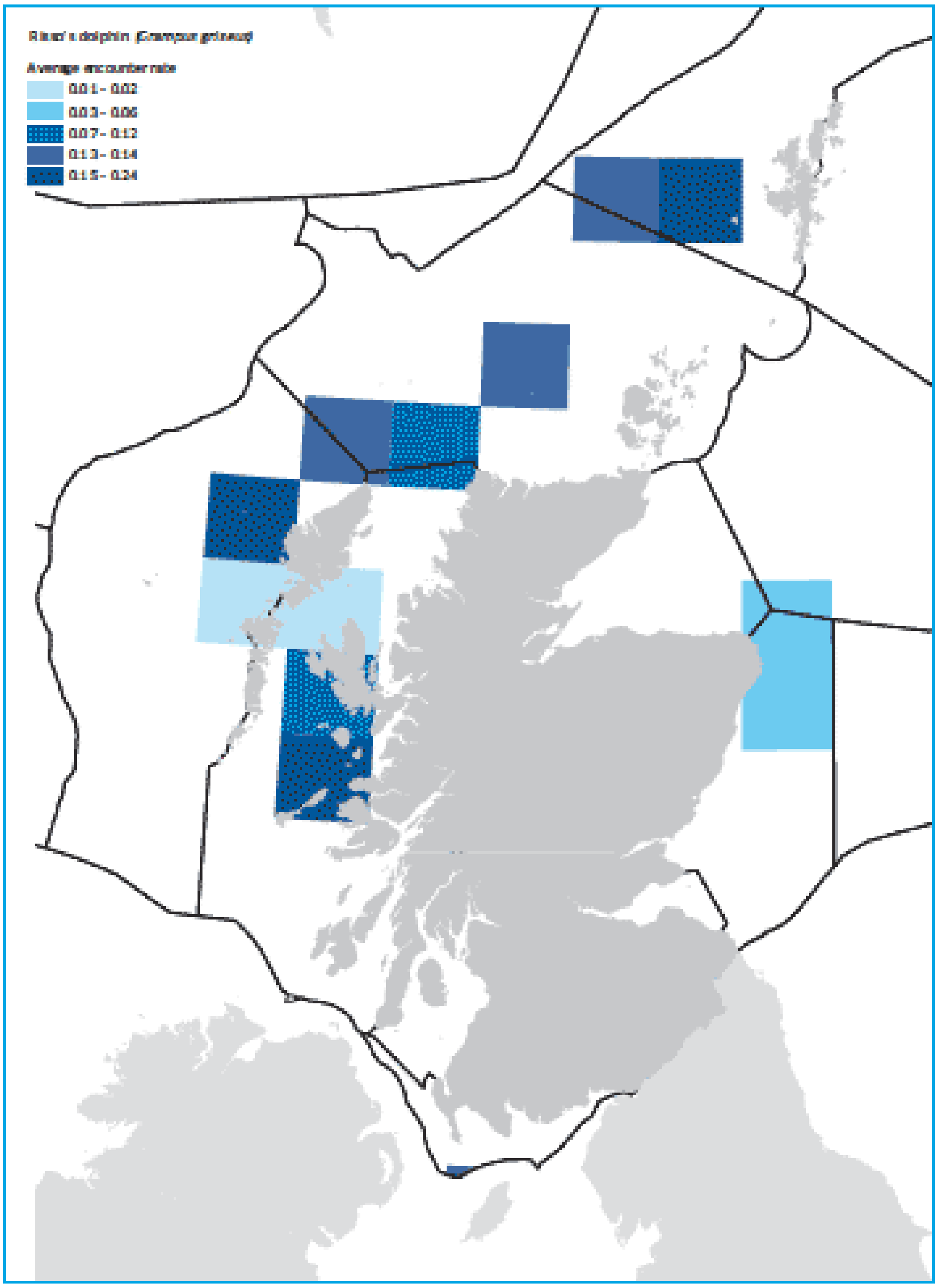


Figure 45: Risso's dolphin Scotland distribution (*Source: Marine Scotland*)

- **Common dolphin (*Delphinus delphis*)**

Figure 46: Common dolphins (*Delphinus delphis*)

The common dolphin has a distinctive creamy yellow hourglass pattern along the sides, with a dark grey back, tail and flippers and a cream coloured belly. The beak is relatively long and slender. Adult common dolphins measure between 1.7 to 2.7 meters long and weigh about 150 kg. Lifespan is about 20 to 30 years. Common dolphins are seen every year off the West Coast of Scotland. They are seen in larger groups than bottlenose dolphins and these superpods can contain over a hundred of individual dolphins.

Common dolphins are smaller that bottlenose dolphins and can be identified by their distinctive hour-glass marking on their sides.

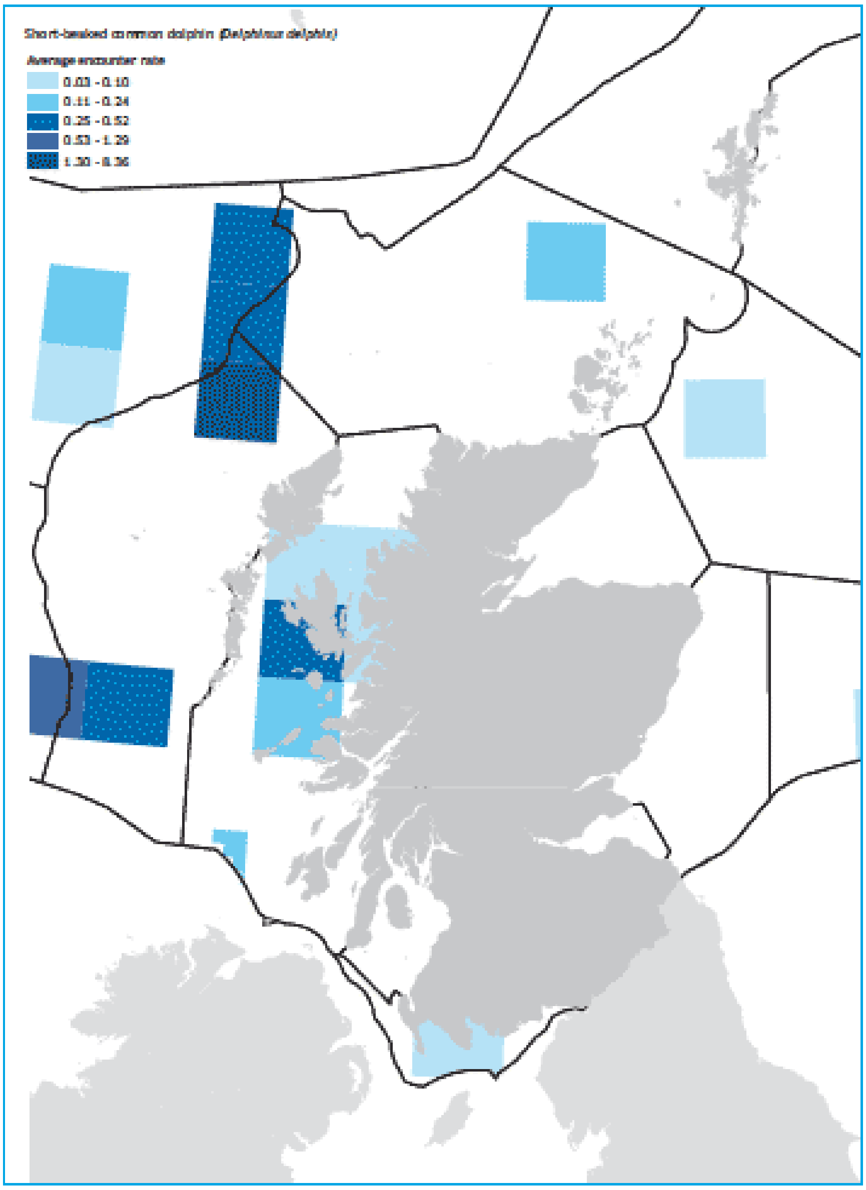


Figure 47: Common dolphins Scotland distribution (*Source: Marine Scotland*)

- **White-beaked dolphin (*Lagenorhynchus albirostris*)**

Figure 48: White-beaked dolphin (*Lagenorhynchus albirostris*)

The white-beaked dolphin is a sturdy, robust-bodied animal that can reach 3.2 meters in length and weigh up to 350 kg when fully grown. The dark grey dorsal fin is tall and falcate (curved) and the beak is short and often entirely white. Colouration is a mix of dark grey back, tail and pectoral fins, with greyish-white flashes along the flanks and a pale grey patch behind the dorsal fin (known as the saddle-patch). The tailstock is quite thick. Abundant in all Scottish waters but concentrated around the Hebrides and Northern Isles. The white-beaked dolphin is an offshore species and prefers waters less than 200 m deep.

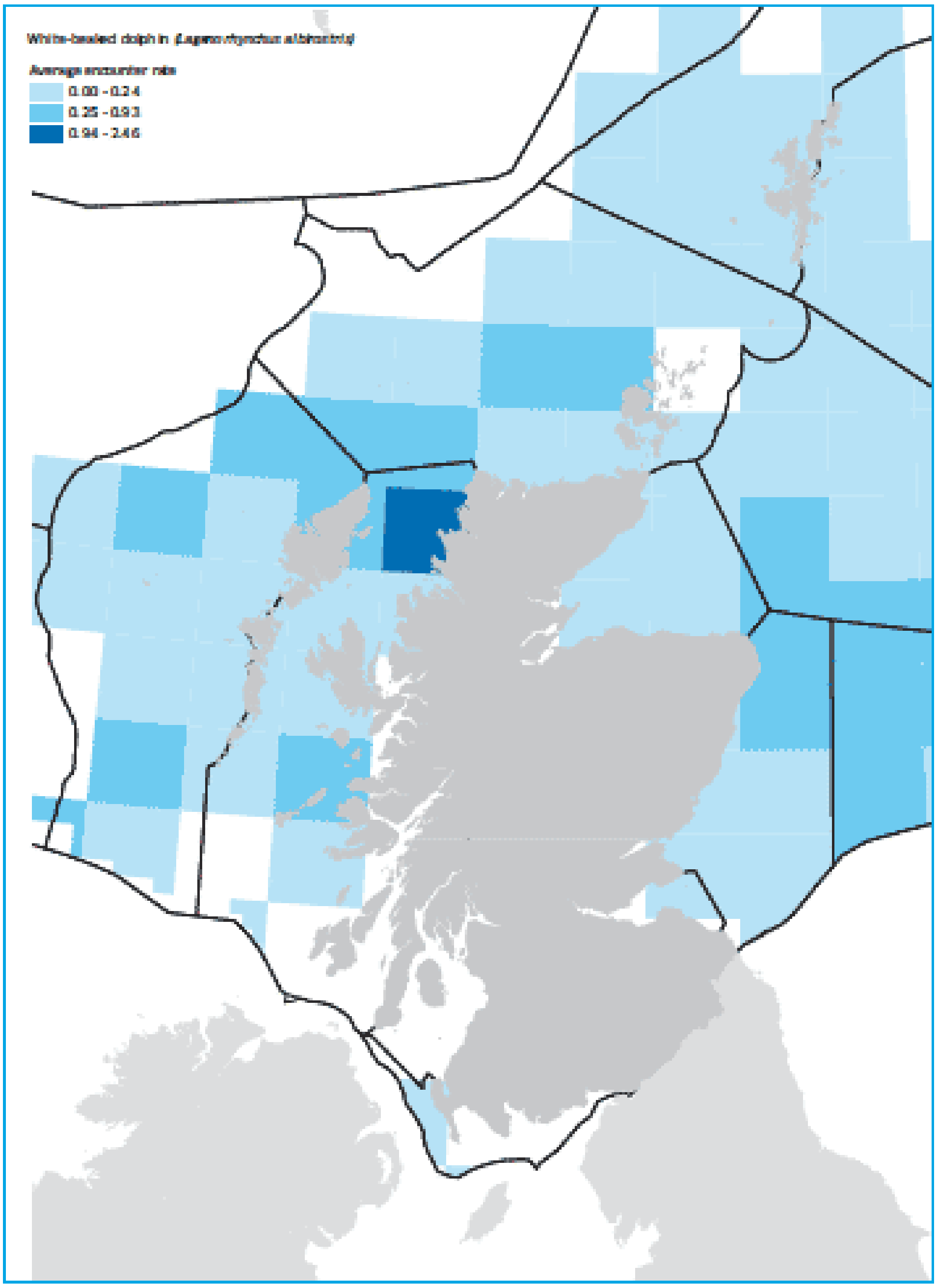


Figure 49: White-beaked dolphin Scotland distribution (*Source: Marine Scotland*)

<u>Seals species</u>

The seas around Scotland are among the richest in Europe for marine mammals. Scotland holds about 70% of Europe's population of grey seals (*Halichoerus grypus*) and about 35% of the EU population of common seals (*Phoca vitulina*), emphasising the important role that these mammals have in Scottish waters.

Grey seal (*Halichoerus grypus*)

Figure 50: Grey seal (*Halichoerus grypus*)

The grey seal (*Halichoerus grypus*) is found only in the North Atlantic Ocean, the Baltic Sea and the Barents Sea. As one of the rare seal species, its world population runs to just 350,000 to 400,000 individuals. Approximately 38% of the global grey seal population breed in the UK. Of these, 88% breed in Scotland (SCOS, 2014). The main breeding areas are located in the Outer Hebrides and Orkney, whilst Shetland and the northern and eastern UK coasts and the south west of England and Wales also hold breeding colonies. Increasing use of the northern and east coasts of Scotland has been recognised.

Grey seals travel large distances to forage and favour more exposed coasts and islands. Outside of the breeding season they can be found hauled out on islands and coasts closest to the open sea.

Such areas include the:

- outer fringes of Shetland and Orkney
- the west coast of the Outer Hebrides
- outer islands in the Inner Hebrides
- outer sandbanks in the Firth of Tay and the Moray Firth

Large groups of pregnant grey seal females return to traditional breeding sites on rocky coasts in the autumn to give birth. Grey seals in Scotland pup from September to late November and then moult from December to April. Pups are born with white hair that is moulted over the first three weeks of life.

Grey seals are much bigger than harbour seals. Adult males weigh up to 300kg and can be 2m in length, while adult females weigh up to 180kg and are about 1.8m long. Grey seals have a long, sloping nose.

Grey seal are known for being an opportunistic predator, capable of consuming a wide variety of prey. In close proximity to the development, grey seal are known to feed primarily on sandeels and gadoid fish species, feeding on salmon and marine fish in the Don and Dee estuaries (Carter 2001, Genesis 2012). Sandeel habitat includes gravel and sandy areas, where grey seal will often forage.

Conservation

Grey seals are a Priority Marine Features (PMF) and are therefore considered to be of particular importance to Scotland's seas, it is also under protection for the European Directives, since they are listed as an Annex II and Annex V species under the Habitats Directive. Due to the importance of the Isle of May for breeding grey seals, it has been designated as an SAC accordingly. Whilst no other SACs exist for grey seal within the Scottish east coast region, grey seal are a designated feature of the Berwickshire and North Northumberland SAC4 to the south in northeast England, whilst the Faray and Holm of Faray SAC5 to the north at Orkney is also designated for grey seal, due to the second largest breeding colony in the UK occurring there with approximately 9% of annual UK pup production. However, 3 breeding colonies are designated haul-outs within the Firth of Forth at Fast Castle, Inchkeith and Craigleith respectively

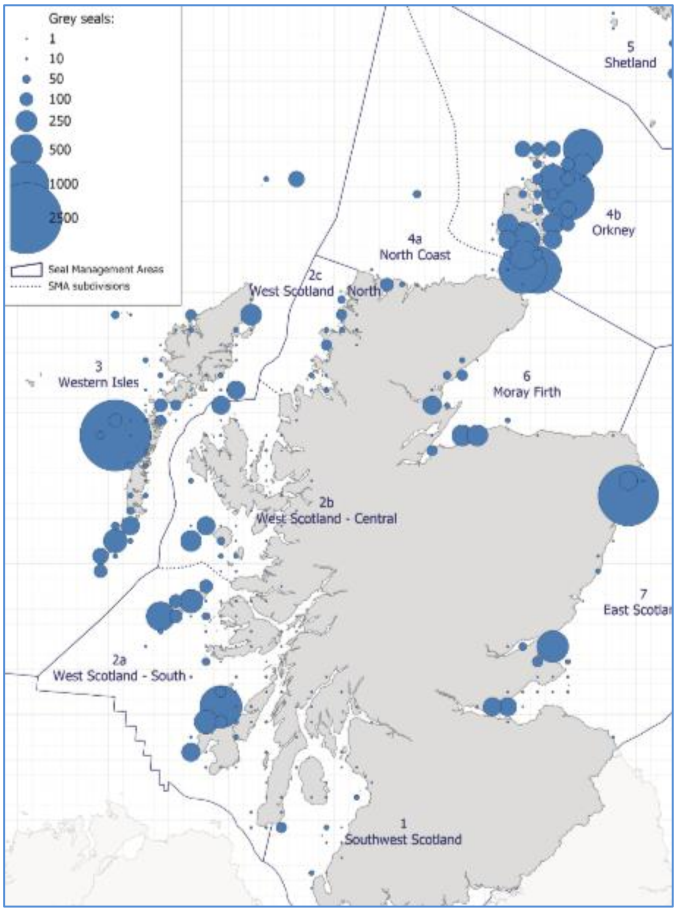


Figure 51: Distribution of grey seals (2013-2017) at haul-out sites in Scotland by 10 km squares. Seal Management Areas (SMAs) and subdivisions (dotted lines) are outlined. Data from aerial surveys by the Sea Mammal Research Unit.

Harbour seal (*Phoca vitulina*)

Figure 52: Harbour seal (*Phoca vitulina*)

The harbour or common seal (*Phoca vitulina*) occurs in the North Atlantic and North Pacific. There are about 83,000 harbour seals in Europe. About 35% of this population is found in UK waters, and 83% of these in Scottish waters.

Haul-out, breeding and moulting sites are typically situated in sheltered estuaries and on sandbanks but they also use rocky areas. Harbour seals are present along the coast of Aberdeenshire although the area is not particularly important for this species, with seals widespread around the Scottish west coast, the Hebrides and Northern Isles. On the eastern Scottish coast, the species is distributed in slightly less ranging concentrations, with the Firth of Tay and Moray Firth considered to be the important locations for harbour seals. Harbour seals spend a high proportion of time ashore during the pupping and moulting seasons from June to September. Their annual moult takes place between June and September, and the pupping season takes place from June to July. It is during these important seasons that harbour seals will spend more time in coastal waters and ashore in local haul-out sites.

Adult harbour seal males weigh about 85kg and measure about 1.45m long. Females aren't much smaller, at about 75kg and 1.35m. It's very hard to tell males and females apart. A harbour seal's face resembles that of a dog.

Harbour seals prefer more sheltered waters and have a more restricted range than grey seals. They tend to travel 40 to 50km from their haul-out site to forage for food.

Strongholds for harbour seals:

- Shetland

- Orkney
- East coast of the Outer Hebrides
- Most of the Inner Hebrides
- West coast of Scotland (from Skye to Arran)
- Moray Firth
- Firth of Tay

Female harbour seals haul out to give birth at natal breeding sites – i.e. where they themselves were born – within their more restricted range in early summer. Pups are born having already shed their white coat in the womb.

Prey typically comprises sandeels, gadoids, flatfish, scorpion fish, sandy benthic fish, pelagic fish and cephalopods, although regional differences are thought to occur.

Conservation

Harbour seals are listed as a PMF in Scotland, they are also protected under European law as they are listed as an Annex II and Annex V species under the Habitats Directive. The Firth of Tay and Eden Estuary and Dornoch Firth and Morrich More SACs are designated due to the importance of the breeding colonies at these sites, which support nationally significant populations of harbour seals.

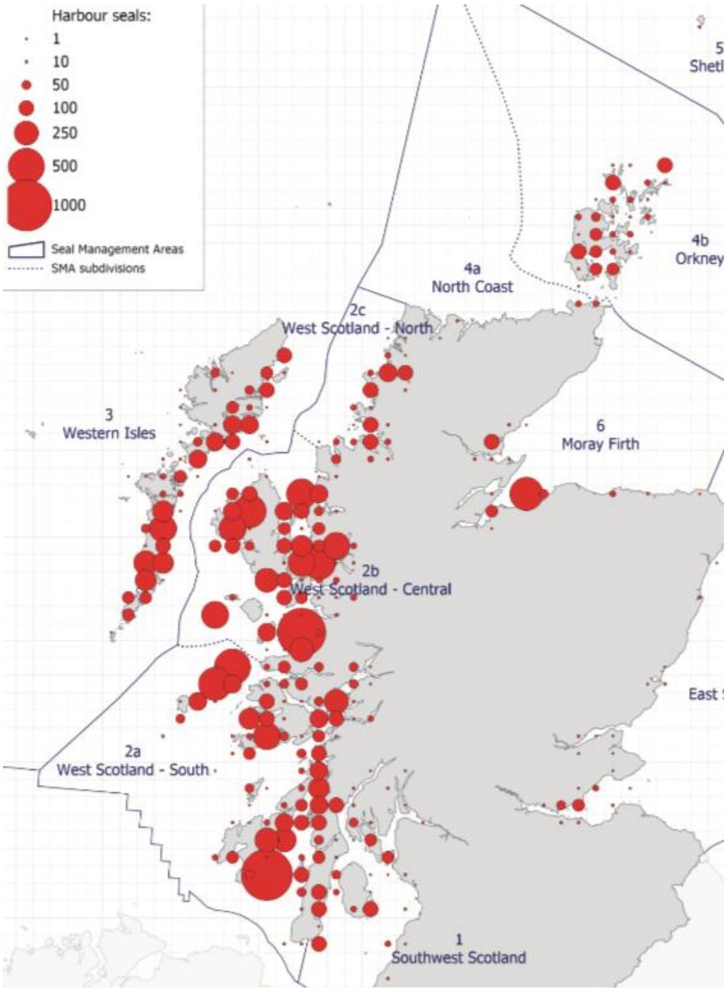


Figure 53: distribution of harbour seals (2013-2017) at haul-out sites in Scotland by 10 km squares Seal Management Areas (SMAs) and subdivisions (dotted lines) are outlined. Data from aerial surveys by the Sea Mammal Research Unit.

3.2.4.5 Bats

Law protects all bat species in the U.K. because their numbers have declined so dramatically. The decline is due to loss of feeding habitats and flight lines, loss of insects to feed on, and development affecting roosts. All UK bat species are protected by European and UK legislation: the Conservation of Habitats and Species Regulations 2010 and amendments and Schedule 5 of the Wildlife and Countryside Act 1981. This affords complete legal protection to all bats and their roosts.

All bat species found in Scotland are classed as European protected species. They receive full protection under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

General informations

Bats are found throughout Scotland, including on many of the islands. In Shetland they occur as vagrants only. Ten bat species occur in Scotland, five of which are considered to be common or widespread (common pipistrelle; soprano pipistrelle; Daubenton's bat; brown long- eared bat; and Natterer's bat) (Racey et *al*., 2004). A further five are considered rare or range-restricted (whiskered bat; Brandt's bat; Noctule; Nathusius' pipistrelle; and Leisler's bat). In Scotland, the number of bat species living in an area generally decreases the further north and west you travel. In northern Scotland, bats contend with long, cold winters, which make for longer hibernation times than in England and Wales. Shorter summers, and relatively few hours of darkness for foraging during summer months, make the conditions inhospitable for many of the species commonly found in more southerly areas of the UK.

Bats are highly specialised animals with some amazing features. They are the only mammals capable of powered flight. Whilst in flight, bats emit a series of high- pitched sounds and listen to the returning echoes to produce a sound picture of their surroundings. This is known as echolocation and it enables them to both avoid obstacles whilst flying, and catch tiny insects, even in complete darkness. These ultrasonic calls are too high-pitched for us to hear, but can be detected using electronic bat-detectors to convert them into audible sounds. As different bat species use slightly different echolocation calls, listening to the calls can help us to identify them. Some bat calls can sound similar on a bat detector (e.g. Myotis species) so it is useful to record calls and view sonograms (a picture of bat call structure) to identify the bat species.

There are very few insects around in winter, so all British bats hibernate. As the weather gets colder in the autumn, they become torpid and allow their body temperature to drop close to that of their surroundings; this helps conserve fat reserve.

Migration data relevant to British species

There is currently very limited information available on bat migration in the UK. Altringham (2003) states that: "*In Europe, migration is invariably to hibernation sites and is typically south-west in autumn and north-east in spring, although short 'migration' flights can go in all directions.*" Altringham (2003) also noted that migration distances can exceed 2,000 km; for both large species such as noctules (*Nyctalus noctula*) and small species such as Nathusius' pipistrelle.

There will invariably be some differences in migratory behaviour of UK species compared to other European countries and findings from mainland Europe cannot be extrapolated directly to the UK. Each species, apart from Soprano pipistrelle (for which the migratory status is currently unknown), has been assigned a general description to reflect their migratory behaviours, as described by Hutterer et *al*. (2005):

- Long distance migrant : Regularly flies 3,000-4,000km one-way from summer breeding area to winter habitat and back.
- Regional migrant : Seasonal migration a few hundred km but also disperse or facultatively migrate over distances up to 800km.
- Sedentary species : Travel short ranges between roosts (tens of km) barely disperse or

migrate <100km.

Table 13: UK, Scotland and Islay Island bat species and their red list classification

Common Name	Scientific name	Scotland's bats	Islay Island	RL UK	RL Scotland	RLG
Alcothoe bat	*Myotis alcathoe*			DD	DD	DD
Barbastelle	*Barbastella barbastellus*			VU	NA	NT
Bechstein's bat	*Myotis bechsteinii*			LC	NA	NT
Brandt's bat	*Myotis brandti*	Rare		DD	DD	LC
Brown long-eared bat	*Plecotus auritus*	Common	x	LC	LC	LC
Common pipistrelle	*Pipistrellus pipistrellus*	Common	x	LC	LC	LC
Daubenton's bat	*Myotis daubentonii*	Common	x	LC	LC	LC
Greater horseshoe bat	*Rhinolophus ferrumequinum*			LC	NA	LC
Grey long-eared bat	*Plecotus austriacus*			EN	NA	LC
Leisler's bat	*Nyctatus leisleri*	Rare		NT	NT	LC
Lesser horseshoe bat	*Rhinolophus hipposideros*			LC	NA	LC
Nathusius' pipistrelle	*Pipistrellus nathusii*	Rare		NT	VU	LC
Natterer's bat	*Myostis nattereri*	Common	x	LC	LC	LC
Noctule	*Nyctalus noctula*	Rare		LC	LC	LC
Serotine	*Eptesicus serotinus*			VU	NA	LC
Soprano pipistrelle	*Pipistrellus pygmaeus*	Common	x	LC	LC	LC
Whiskered bat	*Myotis mystacinus*	Rare		DD	DD	LC

Islay Island bat

- Natterer's Bat *Myotis nattereri*: Recorded for the first time in 1996, in the south-east of the island. Also seen on Jura in the same year.
- Daubenton's Bat *Myotis daubentoni*: Recorded for the first time in summer 2001 and again in 2002, when at least one was identified, through the use of a bat detector, flying over the River Sorn at Bridgend.
- Pipistrelle *Pipistrellus pipistrellus*: Found around several of the villages, but not common. The only small bat on Islay.
- Common Long-eared Bat *Plecotus auritus*: The only common large bat on Islay. Only definitely recorded from Gruinart, Port Ellen and Kildalton.
- Soprano pipistrelle : *Pipistrellus pygmaeus* is one of the five found species in the island through a study on bats habitat preferences for bats (Archer & Davidson, 2016).

3.2.5 Reptiles

The only sightings of marine reptiles are referred to *Dermochelys coriacea,* at a very rare frequency, since the North Atlantic represents its areal northern limit. Leatherback turtles feed primaly on jellyfish and their diet in temperate and boral waters is known to include cnidarians and tunicates. In UK and Irish waters they are often reported in proximity of jellyfish swarm, and there are several observations of leatherback turtles feeding on surface. Hays et *al*. (2004), indicate that periodic residence in specific areas in open sea is linked to enhance prey availability, as they target frontal features and mesoscale eddies. Sightings have been reported in every month, but the most part are restricted to July-October, with a peak of strandings in Septemeber-October (Penrose, 2003).

Leatherbacks turtles seem to move to UK and Irish cost from south and west, and pass nothward up the western coast and Irish sea.

The animal recorded are often juveniles, likely to be born in Florida and later enterd into the the Gulf Stream, taking them to North European coast, at risk of succumbing to low winter sea temperatures (Hays and Marsh, 1997). Strandings concern live animals during spring and winter, when animals are lethargic in cold waters.

This group will not be commented further, being of any interest in BGF impact assessment.

3.2.6 Primary production

The North Sea basin has a large-scale anticlockwise circulation in which water from the North Atlantic enters mainly west and north of Shetland (Rodhe, 1998), carrying nutrients regenerated in deep water and brought to the ocean's surface during winter mixing. Exchange between west coast waters and the Atlantic is less regular. The main feature of these western waters is the Scottish Coastal Current. This contains water of lower salinity, originating in the Irish Sea, and including contributions from the Firth of Clyde and Firth of Lorne. It flows northwards, narrowing to pass between Coll and Mull, and thereafter branches: one part flows up the Minch, the other travels to the west of the Long Island. Its behaviour to the north of Scotland is less well known. In general, the large-scale circulation around Scotland is clockwise.

The coastal current's freshwater content makes it buoyant, compared to full seawater, and so it aids layering in these western seas.

Firths and sea-lochs are the most striking features of the western coastline of Scotland and of many of the islands. Many of these features are glacially deepened river valleys, with a characteristic shallow entrance region, the sill. Freshwater entering at the head many lochs drives an estuarine circulation, in which near-surface water flows towards the sea. By entraining deeper waters, it causes a counterbalancing landwards flow at middle depths. Underneath this, in deep lochs and Firths, water can stagnate for weeks or months. In the case of deeper-silled fjords, wind-driven exchanges, and the intermediate circulation, which results from density differences between inside and outside, are also important.

Many lochs are long and narrow, and water movements largely take place parallel to their sides.

The Firth of Clyde is a large and deep fjord, which is sufficiently wide to support transverse circulations. The outer waters of the main Scottish east-coast firths (Moray, Tay, Forth) are semi-enclosed coastal seas, somewhat diluted with river-water but generally well mixed in the vertical in their shallow inshore regions. The estuaries proper of the large rivers Clyde, Forth and Tay are usually vertically mixed by tidal stirring, and mostly too turbid to support phytoplankton growth.

All expose banks of sand or mud at low water, and these banks can support flourishing populations of photosynthetic benthic micro-organisms, some of which may be suspended by the incoming tide and so appear in the plankton.

Phytoplankters typically show marked seasonal changes in abundance, as a result of seasonal changes in illumination, predation, the availability of nutrients, and the intensity of vertical mixing of the water column in which they grow. The strength of mixing is important, since the average light received by algal cells diminishes with the depth to which they are mixed. The start of the Spring Bloom in temperate waters is the result of both increasing sunlight and the onset of stratification due to surface warming. Much of the algal biomass made during the Spring Bloom, at the expense of a supply of nutrients made by winter stirring, ends up in deeper waters and there decays, releasing nutrient salts back into the sea. In summer, the presence of a seasonal thermocline separating upper and lower water layers typically acts a barrier to the return of nutrients to surface waters. Strong tidal stirring, however, can prevent seasonal stratification, and in such waters the Spring Bloom may occur late or never. Conversely, in the case of lochs and coastal waters receiving large discharges of freshwater, haline stratification can persist throughout the winter, aiding the growth of phytoplankton during winter and leading to an earlier Spring Bloom. The estuarine circulation in lochs can bring deeper, nutrient-rich, water into the illuminated surface layer during summer. Such waters are naturally productive.

The highest rates of annual new primary production are confined to the outer shelf regions (West Shetland, North Scotland Coast and Hebrides). Long-term average potential new primary production declined with distance into the interior of the North Sea (Fladen and Forties), and is lowest in the inshore regions. River inputs during spring and summer had the greatest effect on annual potential new primary production in the East Scotland Coast region (11% of total annual PNP), Moray Firth (9%) and Irish Sea and Clyde region (7%). In all other areas, river inputs contributed less than 2% to total annual potential new primary production, which was less than the input from atmospheric deposition.

The annual river inputs of oxidised nitrogen are small compared to the southern North Sea. Evidence from salinity data shows that the high rates of potential new primary production in the outer shelf regions (Hebrides, North Scotland Coast and West Shetland) were sustained by inflows of nutrient rich North Atlantic water from across the continental shelf edge. Without this inflow of nitrate, and inflows from rivers and atmospheric deposition, the shelf waters would become depleted in nitrogen due to the action of denitrifying bacteria, which cause the breakdown of nitrate to nitrogen gas and venting to the atmosphere.

The extent, to which a supply of nutrients allows the growth of algal populations in illuminated waters, depends on the rate of algal loss. Phytoplankters provide food for pelagic protozoa and small crustacea, and, in shallow water, for attached animals such as mussels and barnacles and for their planktonic young. Where such grazers are abundant and active, the Spring Bloom may be short-lived and apparently smaller than might have been expected from observations of nutrient concentrations in winter. The early Spring Blooms that occur in some sea-lochs may have a large amplitude because they occur before the populations of grazers have begun to increase. In such cases the algal cells that comprise the Bloom may become nutrient- depleted and sink to the seabed; where grazers are abundant, it is their faeces, containing partly-digested algae, that provide the main vehicle for downwards transport of algal production and nutrients. The interaction amongst all these physical and biological factors results in great variability in the abundance of phytoplankton.

Diatoms are most abundant under conditions of weak stratification, such as those typical of spring. Many dinoflagellates and flagellates seem to prefer conditions of stronger stratification, and some seem especially susceptible to concentration by the local circulations found in frontal regions. Grazers have preferences amongst algae, and so regional, seasonal and inter-annual changes in grazer abundance can influence the relative survival of different algal types. Waters of the northern sea lochs are dominated in spring by diatoms and to a lesser extent by phytoflagellates (Wood et *al.*, 1973). During early summer months the silicate supply to these lochs can prolonge diatoms dominance, as well as in further offshore regions. During summer months the phytoplancton assemblage is dominated by dynoflagellates; as summer progresse autotophic species become dominant (Dodge, 1995). Smaller nano-plankton can be significantly abundant throughout the year.

To the west Scottish coast, the community composition is governed by the dynamyc interplay between the Scottish coastal current and waters moving onto the shelf from the open Atlantic. During early spring diatoms dominate the oceanic assemblage, while in June coccolitophorids can be dominant, diatoms still maintaining a significant presence into the assemblage. As summer progress, all groups decline in abundance, and autotrophic flagellates show a small peak in July. A small bloom of coccolitophorids may be possible in late summer (Longhurst, 1998).

The shelf zooplankton community is dominated by Calanoids, important as major food source sor many commercial fish species. Other groups include larvea of benthic crustaceans, polycheates, echinoderms, chaetognats, fish eggs and larval stages. Large thaliacea, siphonophora and sciphozoa are also present.

3.2.7 Benthos

Benthic communities in the BGF selected areas belong all to the Circalittoral belt, being located at a depth of around 90 m. The area is characterized by a range of sediments from coarse gravels to fine mud, and benthic communities are mainly structured by the sediment features, in addition to other ochenographic and edafic factors. Below are descrided the main stationary features of the likely community of the area, and the several facies are included in absence of a puntual descritption in the area of study.

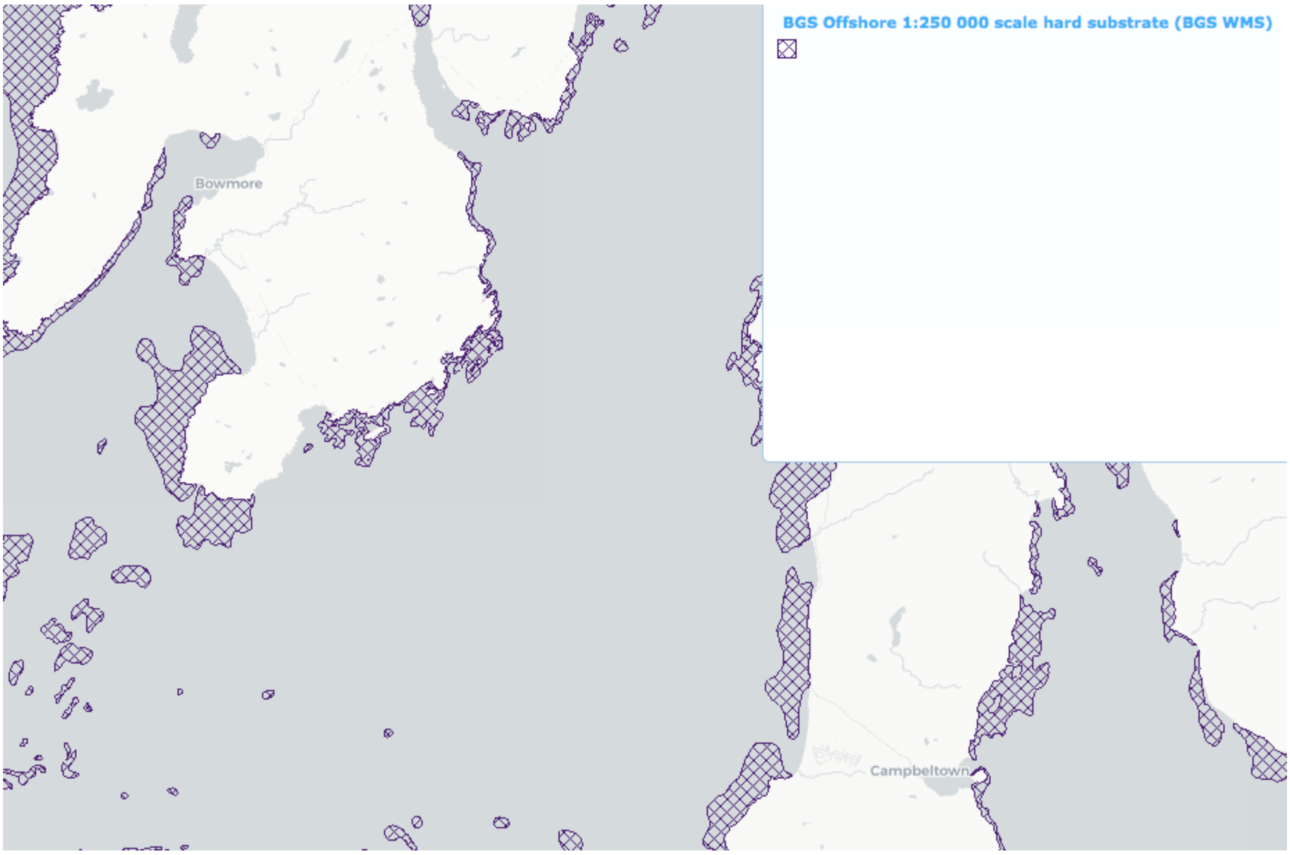


Figure 54: Rocky bottoms extension (*Source: Marine Scotland*)

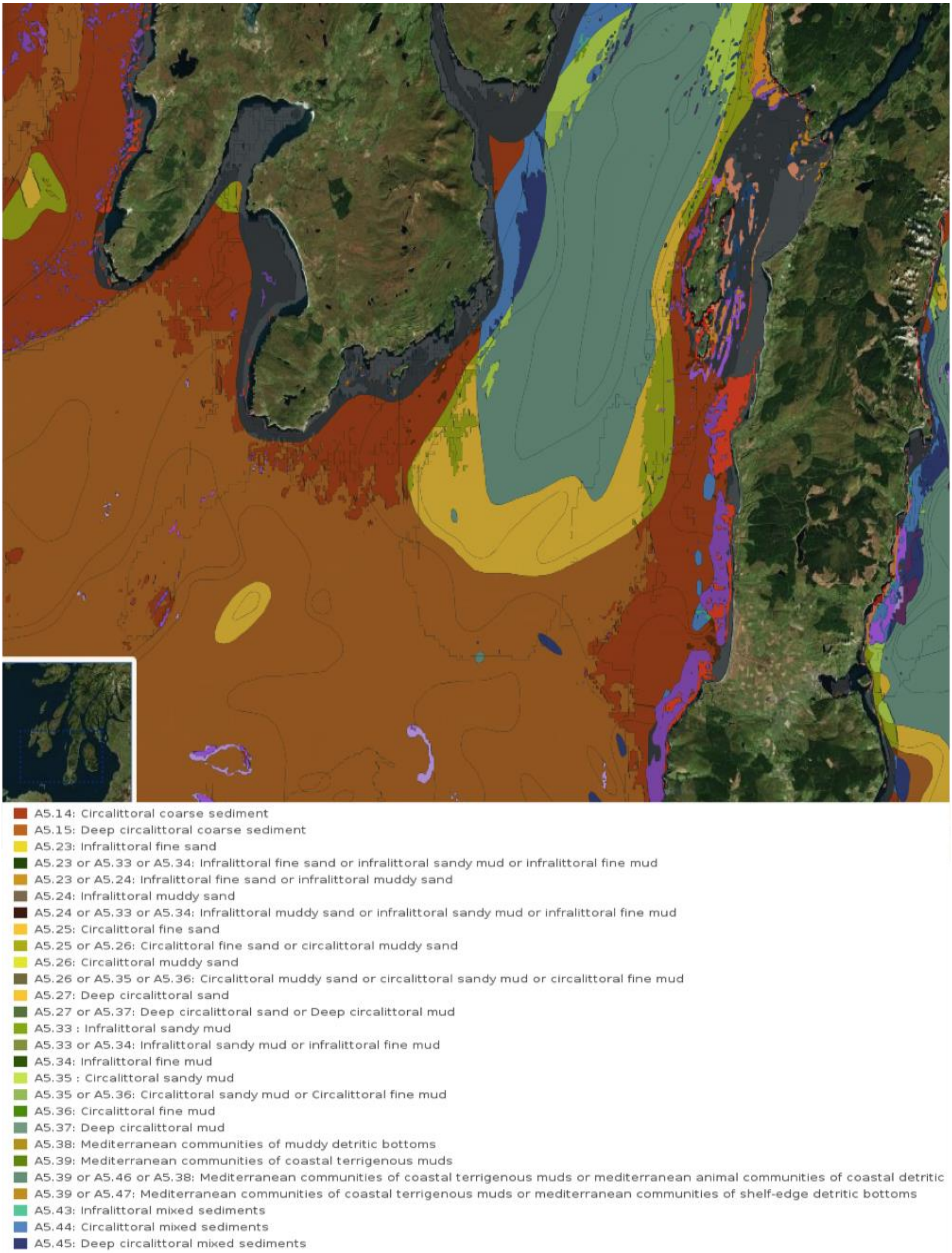


Figure 55: The map of benthic communities in the Islay area, EUNIS classification (*Source: www.EMODnet.eu*)

Circalittoral Coarse sediments

EUNIS A5.14

Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore.

This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum*.

This biotope can host different facies of the same community, as:

- A5.141 - *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
- A5.142 - *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
- A5.143 - *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand
- A5.144 - *Neopentadactyla mixta* in circalittoral shell gravel or coarse sand
- A5.145 - *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel

A5.141: This biotope is characterized by a few ubiquitous robust and/or fast-growing ephemeral species, which are able to colonise pebbles and unstable cobbles and slates which are regularly moved by wave and tidal action. The main cover organisms tend to be restricted to calcareous tube worms such as *Spirobranchus triqueter* (formerly *Spirobranchus triqueter* (or *Spirobranchus lamarcki)*, small barnacles including *Balanus crenatus* and *Balanus balanus*, and a few bryozoan and coralline algal crusts. Scour action from the mobile substratum prevents colonisation by more delicate species. Occasionally in tide-swept conditions turfs of hydroids such as *Sertularia argentea* and *Hydrallmania falcata* are present. These stones may be disturbed in the winter and therefore long-lived and fragile species are not found (Connor *et al.*, 2004; JNCC).

A5.142: Circalittoral gravels, coarse to medium sands, and shell gravels, sometimes with a small amount of silt and generally in relatively deep water (generally over 15-20 m), may be characterized by polychaetes such as *Mediomastus fragilis*, *Lumbrineris* spp., *Glycera lapidum* with the pea urchin *Echinocyamus pusillus*. Other taxa may include *Nemertea* spp., *Protodorvillea kefersteini*, *Owenia fusiformis*, *Spiophanes bombyx* and *Amphipholis squamata* along with amphipods such as *Ampelisca spinipes*. This biotope may also be characterized by the presence of conspicuous venerid bivalves, particularly *Timoclea ovata*. Other robust bivalve species such as *Moerella* spp., *Glycymeris glycymeris* and *Astarte sulcata* may also be found in this biotope.

Spatangus purpureus may be present especially where the interstices of the gravel are filled by finer particles, in which case, *Gari tellinella* may also be prevalent (Glemarec, 1973). Such communities in gravelly sediments may be relatively species-rich and they may also contain epifauna such as *Hydroides norvegicus* and *Spirobranchus lamarcki*. In sand wave areas this biotope may also contain *Magelona* species. This biotope has previously been described as the “Deep Venus Community” and the 'Boreal Off-Shore Gravel Association', and may also be part of the Venus community described in the infralittoral etage described by Glemarec (1973).

Furthermore, mosaics of cobble and lag gravel often contain ridges of coarse gravelly sand and these localised patches are also characterized by robust veneriid and similar bivalves including *Arcopagia crassa*, *Laevicardium crassum* and others including *Glycymeris glycymeris*.

A5.143: In coarse gravelly or shelly sand sometimes with slight mud content, along open coasts in depths of 10 to 30m, and in shallower offshore areas, an impoverished community characterized by *Protodorvillea kefersteini* may be found. This biotope has a number of other species associated with it including *Nemertea* spp., *Caulleriella zetlandica*, *Minuspio cirrifera*, *Glycera lapidum*, *Ampelisca spinipes* and numerous other polychaete species all-occurring at low abundances. The polychaete *Sabellaria spinulosa* is also found in low numbers in this biotope.

A5.144: Sublittoral plains of clean, shell, maerl, stone gravels or sometimes-coarse sands, with frequent *Neopentadactyla mixta*. *Pecten maximus* may occur occasionally along with *Lanice conchilega*. Other epifaunal species may include *Ophiura albida*, *Pagurus* spp. and *Callionymus* spp. These sediments may be thrown into dunes by wave action or tidal streams. Widespread species such as *Cerianthus lloydii* and *Chaetopterus variopedatus* are present in many examples of this biotope. Scarcely recorded species such as *Molgula oculata*, *Ophiopsila annulosa* and *Amphiura securigera* may also be found. *Ophiopsila annulosa* only occurs in records from the south-west of the British Isles. It should be noted that *Neopentadactyla* may exhibit periodicity in its projection out of, and retraction into, the sediment. (Connor *et al.*, 2004).

A5.145: Gravel and coarse sand with shell gravel often contains communities of robust venerid bivalves (SCS.MedLumVen). Shallower examples, such as the biotope presented here, may support a significant population of *Branchiostoma lanceolatum*. Other conspicuous infauna may include *Echinocyamus pusillus*, *Glycera lapidum*, *Polygordius*, *Pisione remota* and *Arcopagia crassa* (in the south of UK). Sessile epifauna are typically a minor component of this community. This biotope has been described from a limited number of records and as such may need revising when further data become available. This biotope is related to the 'Boreal Offshore Gravel Association' and 'Deep *Venus* Community' described by others, and may also be closely allied as the '*Venus fasciata*' community of Cabioch (Glemarec, 1973).

<u>Deep circalittoral coarse sediment</u>

EUNIS A5.15

Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little quantitative data available. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus*. In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt leading to the development of the biotope A5.622.

This biotope can host different facies, as:

- **A5.151 - *Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand**
- **5.152 - *Hesionura elongata* and *Protodorvillea kefersteini* in offshore coarse sand**

A 5.151: Offshore (deep) circalittoral habitats with coarse sands and gravel, stone or shell and occasionally a little silt (<5%) may be characterised by the polychaetes *Glycera lapidum* and *Amythasides macroglossus* with the bivalve *Thyasira* spp. (particularly *Thyasira succisa*). Other taxa include polychaetes such as *Exogone (Exogone) verugera*, *Notomastus latericeus*, *Spiophanes kroyeri*, *Aphelochaeta marioni* (*Tharyx marioni*) and *Lumbrineris gracilis* and occasional numbers of the bivalve *Timoclea ovata*.

This biotope bears some resemblance to the shallow A5.135 and also to the circalittoral and offshore venerid biotopes (units A5.142 and A5.451) but differs by the range of polychaete and bivalve fauna present. This biotope is notable for the presence of the rarely recorded ampharetid polychaete *Amythasides macroglossus* and also for the small ear file clam *Limatula subauriculata,* which is common in some examples of this biotope.

A 5.152: Offshore (deep) circalittoral habitats with coarse sand may support populations of the interstitial polychaete *Hesionura elongata* with *Protodorvillea kefersteini*. Other notable species include the phyllodocid polychaete *Pseudomystides limbata* and the bivalve *Moerella pygmaea*. This biotope was reported in the offshore northern North Sea by Eleftheriou and Basford (1989). Relatively little data exists for this biotope.

Circalittoral fine sand

EUNIS A 5.25

Clean fine sands with less than 5% silt/clay in deeper water, either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20 m. The habitat may also extend offshore and is characterised by a wide range of echinoderms (in some areas including the pea urchin *Echinocyamus pusillus*), polychaetes and bivalves. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community.

A 5.251: *Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand

Circalittoral and offshore medium to fine sand (from 40 m to 140 m) characterised by the pea urchin *Echinocyamus pusillus*, the polychaete *Ophelia borealis* and the bivalve *Abra prismatica*. Other species may include the polychaetes *Spiophanes bombyx*, *Pholoe* sp., *Exogone* spp., *Sphaerosyllis bulbosa*, *Goniada maculata*, *Chaetozone setosa*, *Owenia fusiformis*, *Glycera lapidum*, *Lumbrineris latreilli* and *Aricidea cerrutii* and the bivalves *Thracia papyracea* and *Moerella pygmaea* and to a lesser extent *Spisula elliptica* and *Timoclea ovata*. This biotope has been found in the central and northern North Sea.

A 5.252: *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand

In circalittoral and offshore medium to fine sands between 25 m and 100 m a community characterised by the bivalve *Abra prismatica*, the amphipod *Bathyporeia elegans* and polychaetes such as *Scoloplos (Scoloplos) armiger*, *Spiophanes bombyx*, *Aonides paucibranchiata*, *Chaetozone setosa*, *Ophelia borealis* and *Nephtys longosetosa* may be found. Crustacea such as the cumacean *Eudorellopsis deformis* and the opheliid polychaetes such as *Ophelia borealis*, *Travisia forbesii* or *Ophelia neglecta* are often present in this biotope and the brittlestar *Amphiura filiformis* may also be common at some sites. This biotope has been reported in the central and northern North Sea (Basford and Eleftheriou, 1989).

Circalittoral muddy sand

EUNIS A 5.26

Circalittoral non-cohesive muddy sands with the silt content of the substratum typically ranging from 5% to 20%. This habitat is generally found in water depths of over 15-20 m and supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves such as *Abra alba* and *Nucula nitidosa*, and echinoderms such as *Amphiura* spp. and *Ophiura* spp., and *Astropecten irregularis*. These circalittoral habitats tend to be more stable than their infralittoral counterparts and as such support a richer infaunal community.

A 5.261: *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment

Non-cohesive muddy sands or slightly shelly/gravelly muddy sand characterised by the bivalves *Abra alba* and *Nucula nitidosa*. Other important taxa include *Nephtys* spp., *Chaetozone setosa* and *Spiophanes bombyx* with *Tellina fabula* also common in many areas. The echinoderms *Ophiura albida* and *Asterias rubens* may also be present. The epibiotic biotope A5.241 may overlap this biotope. This biotope is part of the *Abra* community defined by Thorson (1957) and the infralittoral etage described by Glemarec (1973).

A5.262: *Acrocnida brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand

In shallow, circalittoral non-cohesive muddy sand (typically less than 20% silt/clay) abundant populations of the brittlestar *Acrocnida brachiata* may occur with other echinoderms such as *Astropecten irregularis*, *Asterias rubens*, *Ophiura ophiura* and *Echinocardium cordatum*. Other infaunal species typically include *Kurtiella bidentata*, *Lanice conchilega* and *Magelona filiformis*.

This biotope is likely to form part of the non-cohesive/cohesive muddy sand communities, which make up the 'off-shore muddy sand association' described by other workers (Jones 1951; Mackie 1990). It is possible that in some areas this biotope forms an epifaunal overlay which may cover a range of biotopes in years of good recruitment but does not develop into a settled or established community.

Deep circalittoral sand

EUNIS A 5.27

Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.

A 5.271: Maldanid polychaetes and *Eudorellopsis deformis* in deep circalittoral sand or muddy sand

In deep offshore sand or non-cohesive muddy sand dense populations of maldanid polychaetes such as *Maldane sarsi* and the cumacean *Eudorellopsis deformis* may be found. Accompanying these species are abundant ophiuroids including *Amphiura filiformis*, polychaetes such as *Terebellidae* sp., *Chaetozone setosa*, *Levinsenia gracilis*, *Scoloplos (Scoloplos) armiger*, the amphipod *Harpinia antennaria* and the bivalves *Ennucula tenuis* and *Parvicardium minimum*. This biotope is similar to the *Maldane sarsi-Ophiura sarsii* community defined by Glemarec (1973).

A 5.272: *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand

Areas of slightly muddy sand (generally <20% mud) in offshore waters may be characterised by high numbers of the tube building polychaete *Owenia fusiformis* often with the brittlestar *Amphiura filiformis*. Whilst *O.fusiformis* is also found in other circalittoral or offshore biotopes it usually occurs in lower abundances than in A5.272. Other species found in this community are the polychaetes *Goniada maculata*, *Pholoe inornata*, *Diplocirrus glaucus*, *Chaetozone setosa* and *Spiophanes kroyeri* with occasional bivalves such as *Timoclea ovata* and *Thyasira equalis*. The sea cucumber *Labidoplax buskii* and the cumacean *Eudorella truncatula* are also commonly often found in this biotope.

Circalittoral sandy mud

EUNIS A 5.35

Circalittoral, cohesive sandy mud, typically with over 20% silt/clay, generally in water depths of over 10 m, with weak or very weak tidal streams. This habitat is generally found in deeper areas of bays and marine inlets or offshore from less wave exposed coasts. Sea pens such as *Virgularia mirabilis* and brittlestars such as *Amphiura* spp. are particularly characteristic of this habitat whilst infaunal species include the tube building polychaetes *Lagis koreni* and *Owenia fusiformis*, and deposit feeding bivalves such as *Kurtiella bidentata* and *Abra* spp.

A 5.351: *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud

Cohesive sandy mud off wave exposed coasts with weak tidal streams can be characterised by super-abundant *Amphiura filiformis* with *Kurtiella bidentata* and *Abra nitida*. This community occurs in muddy sands in moderately deep water (Picton *et al.* 1994) and may be related to the 'off-shore muddy sand association' described by others and is part of the infralittoral etage described by Glemarec, 1973. This community is also characterised by the sipunculid *Thysanocardia procera* and the polychaetes *Nephtys incisa*, *Phoronis* sp. and *Pholoe* sp., with cirratulids also common in some areas. Other taxa such as *Nephtys hombergii*, *Echinocardium cordatum*, *Nucula nitidosa*, *Callianassa subterranea* and *Eudorella truncatula* may also occur in offshore examples of this biotope.

A 5.352: *Thyasira* spp. and *Ennucula tenuis* in circalittoral sandy mud

Circalittoral cohesive sandy muds with small quantities of gravel, off sheltered or moderately exposed coasts may support populations characterised by *Thyasira* spp. and in particular *Thyasira flexuosa*. Other characteristic taxa may include *Ennucula tenuis*, *Goniada maculata* and in some areas *Rhodine gracilior*. *Kurtiella bidentata*, *Abra alba*, *Harpinia antennaria* and *Amphiura filiformis* may be abundant in some examples of this biotope. Whilst moderately diverse, animal abundances are often low and it is possible that the biotope is the result of sedimentary disturbance e.g. from trawling and is possibly an impoverished version of A5.353. Collectively the biotopes A5.351, A5.352, A5.353 and A5.272, may form the *Amphiura* dominated components of the 'off-shore muddy sand association' described by by Glemarec (1973).

A 5.353: *Amphiura filiformis* and *Ennucula tenuis* in circalittoral and offshore muddy sand

In cohesive and non-cohesive sandy mud, off moderately exposed coasts in deep water dense populations of *Amphiura filiformis* with the bivalve *Ennucula tenuis* may occur. This biotope together with A5.351, A5.352 and A5.272 may be part of the *Amphiura filiformis* dominated infralittoral etage described by Glemarec (1973). Other species characteristic of this biotope may include the echinoderms *Ophiura albida* and *Echinocardium flavescens* and the bivalve *Kurtiella bidentata*. *Phaxas pellucidus*, *Owenia fusiformis* and *Virgularia mirabilis* may also be present. At the sediment surface the hydroid *Sertularia argentea* may be present although only at very low abundances. Variations of this biotope exist in the northern North Sea (see below) and it is possible that more than one entity exists for this biotope.

A 5.354: *Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus* on circalittoral sandy or shelly mud

Circalittoral fine sandy mud may contain *Virgularia mirabilis* and *Ophiura* spp. A variety of species may occur, and species composition at a particular site may relate, to some extent, to the proportions of the major sediment size fractions. Several species are common to most sites including *Virgularia mirabilis* which is present in moderate numbers, *Ophiura albida* and *Ophiura ophiura* which are often quite common, and *Pecten maximus* which is usually only present in low numbers. *Virgularia mirabilis* is usually accompanied by occasional *Cerianthus lloydii*, *Liocarcinus depurator* and *Pagurus bernhardus*. *Amphiura chiajei* and *Amphiura filiformis* may occur in some examples of this biotope. Polychaetes and bivalves are generally the main components of the infauna, although the nemerteans, *Edwardsia claparedii*, *Phoronis muelleri* and *Labidoplax buskii* may also be widespread.

Of the polychaetes *Goniada maculata*, *Nephtys incisa*, *Prionospio cirrifera*, *Chaetozone setosa*, *Notomastus latericeus* and *Owenia fusiformis* are often the most widespread species whilst *Myrtea spinifera*, *Lucinoma borealis*, *Kurtiella bidentata*, *Abra alba* and *Corbula gibba* are typical bivalves in this biotope. This biotope is primarily identified on the basis of its epifauna and may be an epibiotic overlay over other closely related biotopes such as A5.361, A5.351 and A5.353.

Situation: Such sediments are very common in sealochs, often occurring shallower than the finest mud or in somewhat more exposed parts of the lochs.

A 5.355: *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud

In stable circalittoral sandy mud dense populations of the tube building polychaete *Lagis koreni* may occur. Other species found in this habitat typically include bivalves such as *Phaxas pellucidus*, *Kurtiella bidentata* and *Abra alba* and polychaetes such as *Mediomastus fragilis*, *Spiophanes bombyx*, *Owenia fusiformis* and *Scalibregma inflatum*. At the sediment surface easily visible fauna include *Lagis koreni* and *Ophiura ophiura*. *Lagis koreni* is an important source of food for commercially important demersal fish, especially dab and plaice.

Temporal variation: In some areas e.g. Liverpool Bay, A5.261 and A5.355 have exhibited cyclical behaviour with the community periodically switching from one biotope to another - possibly in relation to dredge spoil disposal (Rees *et al.*, 1992) along with other environmental and biological factors. Both *Lagis koreni* and *Phaxas pellucidus*, are capable of tolerating sudden increases in the deposition of sediment and often dominate such areas following such an event. Indeed, it is likely that the two biotopes are merely different aspects of the same community as *Lagis koreni* is often recorded with high densities of *Abra alba* (Rees and Walker 1983). Densities of mature populations of *L. koreni* may exceed 1000 m-2.

Circalittoral fine mud

EUNIS A 5.36

Sublittoral muds, occurring below moderate depths of 15-20 m, either on the open coast or in marine inlets such as sealochs. The seapens *Virgularia mirabilis* and *Pennatula phosphorea* are characteristic of this habitat type together with the burrowing anemone *Cerianthus lloydii* and the ophiuroid *Amphiura* spp. The relatively stable conditions often lead to the establishment of communities of burrowing megafaunal species, such as *Nephrops norvegicus*.

Deep circalittoral mud

EUNIS A 5.37

In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.

Circalittoral mixed sediments

EUNIS A5.44

Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20 m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as *Cerianthus lloydii* are often present in such habitat and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as *Nemertesia* spp. and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities. Coarser mixed sediment communities may show a strong resemblance, in terms of infauna, to biotopes within the A5.1. However, infaunal data for this habitat type is limited to that described under the biotope A5.443, and so are not representative of the infaunal component of this habitat type.

A5.445: *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment

Circalittoral sediment dominated by brittlestars (hundreds or thousands m-2) forming dense beds, living epifaunally on boulder, gravel or sedimentary substrata. *Ophiothrix fragilis* and *Ophiocomina nigra* are the main bed-forming species, with rare examples formed by *Ophiopholis aculeata*. Brittlestar beds vary in size, with the largest extending over hundreds of square metres of sea floor and containing millions of individuals. They usually have a patchy internal structure, with localized concentrations of higher animal density. *Ophiothrix fragilis* or *Ophiocomina nigra* may dominate separately or there may be mixed populations of the two species. *Ophiothrix* beds may consist of large adults and tiny, newly-settled juveniles, with animals of intermediate size living in nearby rock habitats or among sessile epifauna. Unlike brittlestar beds on rock, the sediment based beds may contain a rich associated epifauna (Davoult & Gounin, 1995). Large suspension feeders such as the octocoral *Alcyonium digitatum*, the anemone *Metridium senile* and the hydroid

Nemertesia antennina are present mainly on rock outcrops or boulders protruding above the brittlestar- covered substratum.

The large anemone *Urticina felina* may be quite common. This species lives half-buried in the substratum but is not smothered by the brittlestars, usually being surrounded by a 'halo' of clear space. Large mobile animals commonly found on Ophiothrix beds include the starfish *Asterias rubens*, *Crossaster papposus* and *Luidia ciliaris*, the urchins *Echinus esculentus* and *Psammechinus miliaris*, edible crabs *Cancer pagurus*, swimming crabs *Necora puber*, *Liocarcinus* spp., and hermit crabs *Pagurus bernhardus*. The underlying sediments also contain a diverse infauna including the bivalve *Abra alba*.

Deep circalittoral mixed sediments

EUNIS A5.45

Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore gravels and coarse sands and in some areas populations of the horse mussel *Modiolus modiolus* may develop in these habitats (see A5.622).

A5.451: Polychaete-rich deep *Venus* community in offshore mixed sediments

In offshore circalittoral slightly muddy mixed sediments, a diverse community particularly rich in polychaetes with a significant venerid bivalve component may be found. Typical species include the polychaetes *Glycera lapidum*, *Aonides paucibranchiata*, *Laonice bahusiensis*, *Mediomastus fragilis*, *Lumbrineris gracilis*, *Pseudomystides limbata*, *Protomystides bidentata* and syllid species and bivalves such as *Timoclea ovata*, *Glycymeris glycymeris*, *Spisula elliptica* and *Goodallia triangularis*. This biotope has been recorded on surveys of the Lambay and Codling Deeps and other areas of the Irish Sea and collectively with A5.142 comprise the 'Deep *Venus* Community' and the 'Boreal Off-Shore Gravel Association'. Some examples of this biotope may have abundant juvenile *Modiolus modiolus.*

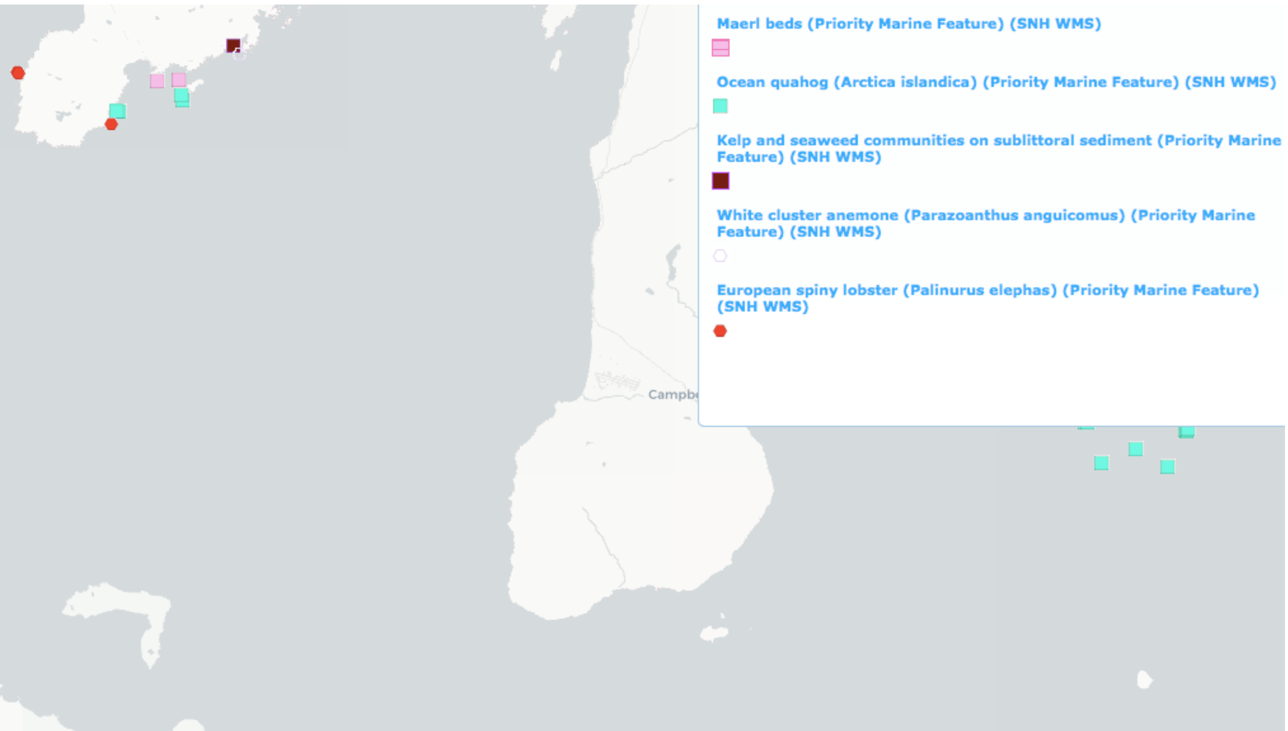


Figure 56: Priority Marine Feature in Islay area (*Source: Marine Scotland*)

3.3 HUMAN ASSETS

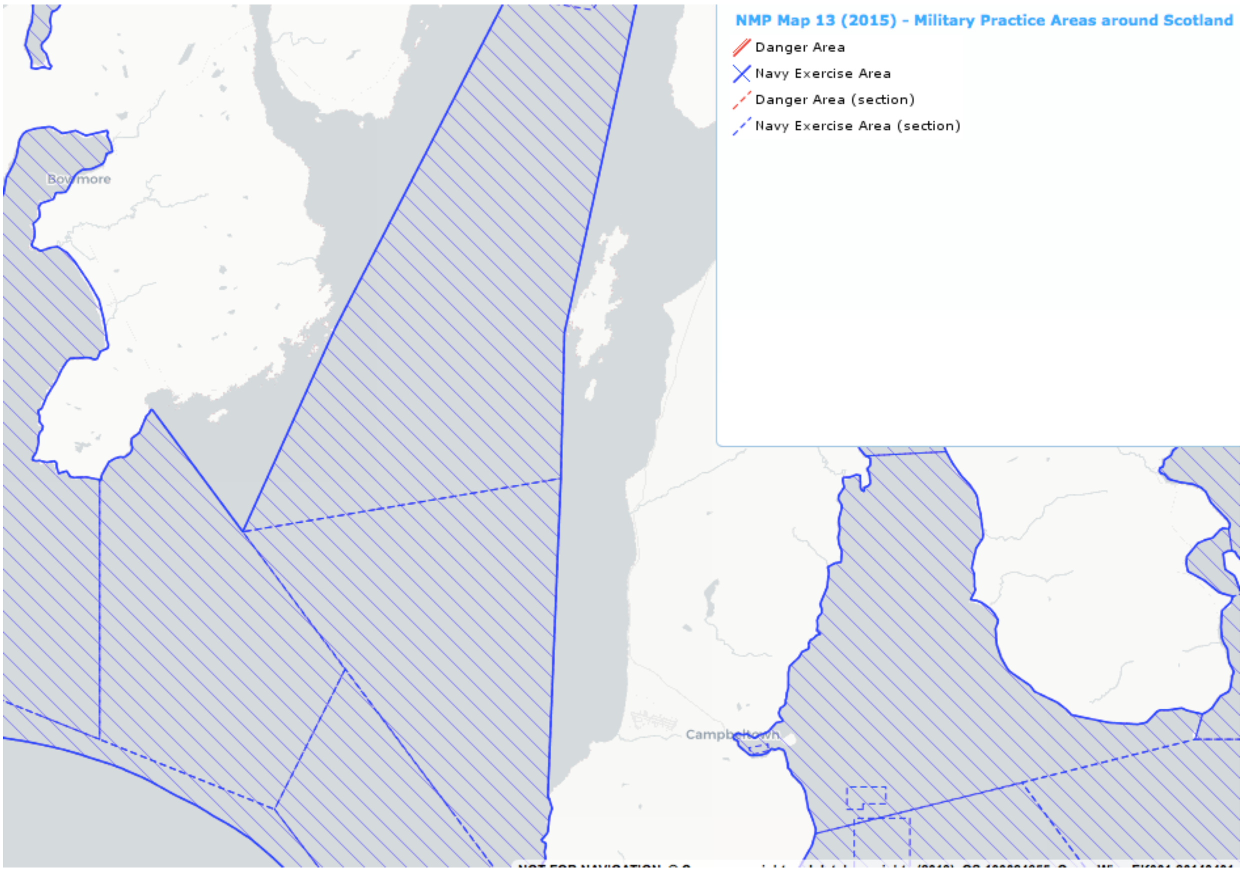


Figure 57: Military Practice Areas around Scotland (*Source: Marine Scotland*)

3.3.1 Fishery

Fleet regulation

UK fishing vessels engaged in commercial sea fishing are required by law to be registered with the Registry of Shipping and Seamen (RSS), part of the Maritime and Coastguard Agency. To fish commercially, fishing vessels must also have a licence, which specifies conditions that must be adhered to when fishing activity is being pursued. For the purpose of this statistical bulletin, active vessels are those, which are both registered and licensed as of 31st December of the year of reference. Scottish based vessels are those registered to a port in Scotland licensed at and administered by a Scottish district.

UK fishing vessel licences authorise the sea areas in which a vessel can fish and the species of fish that can be retained on-board. Restrictive licensing was introduced in 1983 following agreement of the Common Fisheries Policy (CFP) by the European Commission and has been used as the main tool to control UK fishing capacity to meet the European Union regulations for sustainable fisheries management. Initially, the licensing regime only covered vessels of over ten metres registered length and fishing for a number of designated species in specific areas. The coverage of licences has progressively extended over the years to cover all species if fished commercially and both the over ten metre fleet and ten metres and under fleet.

The capacity of fishing vessels in terms of vessel tonnage and power is also controlled through licences. With a finite number of licences in existence and no new licences made available, this places a ceiling on the total number and capacity of vessels in the UK fishing fleet. In order to license new vessels, fishermen must acquire one or more existing licences from other previously licensed vessels. To obtain a fishing licence for the first time, an entitlement has to be secured from a current licence holder. An entitlement becomes available when a licence is no longer attached to an active fishing vessel or it may be transferred alongside the purchase of a fishing vessel.

Scotland fisheries

Fishing is a long-established, and the most widespread, human activity in Scottish waters.

The sheltered, inshore Scottish waters are ideal for small day boats. Most of the vessels operating here are small, local boats, although there is a significant number of a Northern Irish activity in these inshore waters. Most fishing in the region is for shellfish, with crabs (edible and velvet), lobsters and whelk caught alongside major fisheries for scallop and Nephrops. This latter caught by trawls and creels, is the most valuable fisheries in the area, followed by scallop, caught by dredging and, at lesser amounts, by hand. Razorshell is a growing fishery. There is also a fishery targeting sandeel, alongside small-scale pelagic fisheries for herring and mackerel and demersal fisheries for small flatfish and gadoids, such as cod, haddock and saithe, which use the region as a nursery ground. Salmon and sea trout are also abundant in the rivers and lochs of the west of Scotland and licensed fisheries for these species exist.

A study on the North Sea indicated that the annual production by plankton eating fish (mainly herring, sprat, sandeel and Norway pout) was approximately 7% of annual potential new primary production. These fish species are a vital link in the food web since they constitute the major food resource for the valuable predatory fish such as cod and whiting and the bird and mammal populations, and hence are referred to as forage fish. On the basis of the North Sea study, the potential new primary production results indicate that, averaged over the period 1960-2003, the potential forage fish production in Scottish waters could be approximately 10.2 million tonnes (wet weight) per annum. The proportion of annual forage fish production that may be landed by fisheries without risking detrimental effects on high trophic levels will be variable, depending on, for example, the species and age composition of fish in a given area. In the North Sea, approximately 12% of annual forage fish production is landed each year by fisheries, but this includes the industrial fisheries for sandeels, which are of minor importance in Scottish waters.

The EU's Common Fisheries Policy regulates a large number of commercial sea fish stocks. The management of fishing is also affected by EU environmental legislation, which places obligations on Scotland in relation to fisheries management. Within the Scottish fisheries zone the Scottish Government has the ability to put in place management measures to maintain stock sustainability. Fishing effort has decreased significantly since 2000 due to continuing restrictions on fishing activity in order to promote stock recovery.

Scottish fishing fleet

The number of active Scottish based vessels has increased to 2,033 vessels in 2016, representing a 0.9 per cent increase (19 vessels) since 2015 and a seven per cent decrease (160 vessels) since 2007.

The Scottish fleet is dominated by vessels with a length of ten meters and under, with 1,464 vessels falling into this category in 2016, accounting for 72 per cent of the Scottish fleet. There are 569 vessels with a length of over ten meters. In contrast, the over ten-meter fleet holds 78 per cent of the total power of the Scottish fleet and consisted of 187 vessels. In 2016, the pelagic trawl sector decreased by one to 19 vessels and remained constant at 363 vessels in the shellfish sector. Vessels in the ten meter and under fleet, accounting for 1464 vessels (Figure 58).

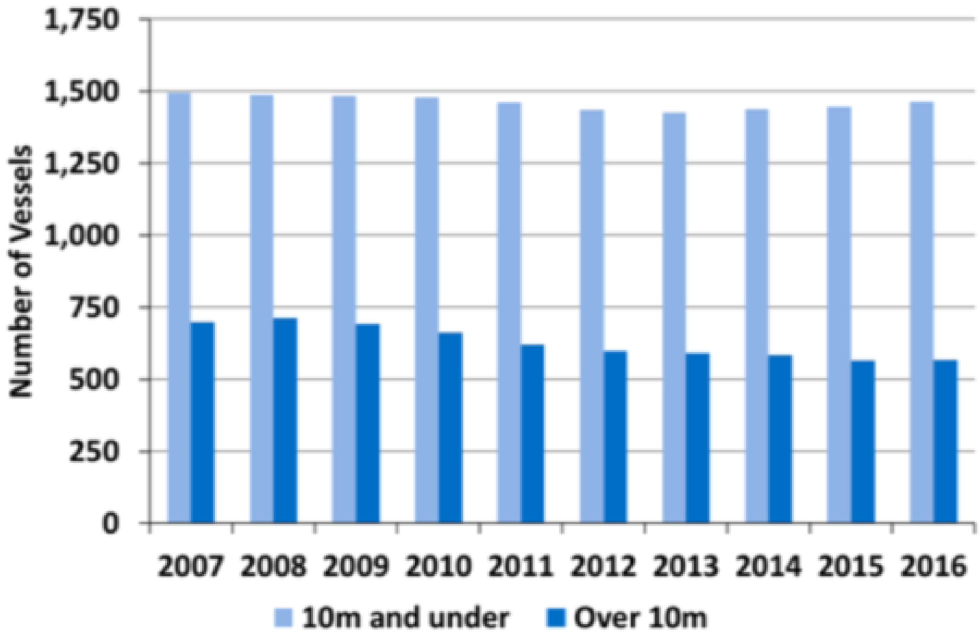


Figure 58: Number of Scottish vessels (*Source: Marine Scotland*)

The Scottish fishing fleet can be split into four broad sectors:

The pelagic fleet: which mainly targets herring and mackerel is comprised of a relatively small number of large vessels. This fleet fishes seasonally through a wide range of sea areas as they follow the highly migratory patterns of pelagic species, from the central North Sea in the summer months before moving north towards Shetland and then travelling west to follow the continental shelf edge to the south of Ireland.

Figure 59: Pelagic fleet

The demersal or whitefish fleet: (comprising a larger number of smaller vessels) which targets bottom-dwelling fish in two main types of fisheries: round fish such as cod, whiting, haddock and saithe and ground fish such as monkfish and megrim. These vessels tend to operate in the more northerly grounds of the North Sea and west coast of Scotland, fishing in deeper water and following the continental shelf edges.

Figure 60: Pelagic trawler fishing vessel

The mixed demersal and shellfish fleet: which is made up of whitefish boats, which move between whitefish and *Nephrops* (also known as langoustine) fisheries. These vessels, whilst in many cases capable of travelling further afield, tend to concentrate their main efforts in the central North Sea in an area known as the Fladen Ground with little overlap between them and the presence of larger whitefish vessels. There is also a fleet of these vessels that fish a variety of grounds on the west coast of Scotland from the North Minch south towards the Clyde and in offshore areas such as the Stanton Banks.

The shellfish fleet: which specialises in stocks such as scallops, *Nephrops* and crab and lobster and tends to fish inshore (the Scottish inshore fleet is almost completely dependent on shellfish). These smaller, more numerous vessels, which are generally under 10 metres in length, fish predominately inshore waters inside 6 nautical miles, although some larger vessels and particularly scallop vessels operate to 12 nautical miles and beyond. Activity is spread along the coastline of Scotland but tends to be concentrated more on the west coast where the local geography provides better natural conditions for the safe operation of these small vessels.

There are also seasonal inter-tidal fisheries, such as cockle fisheries, and small-scale hand-diving fisheries in some areas.

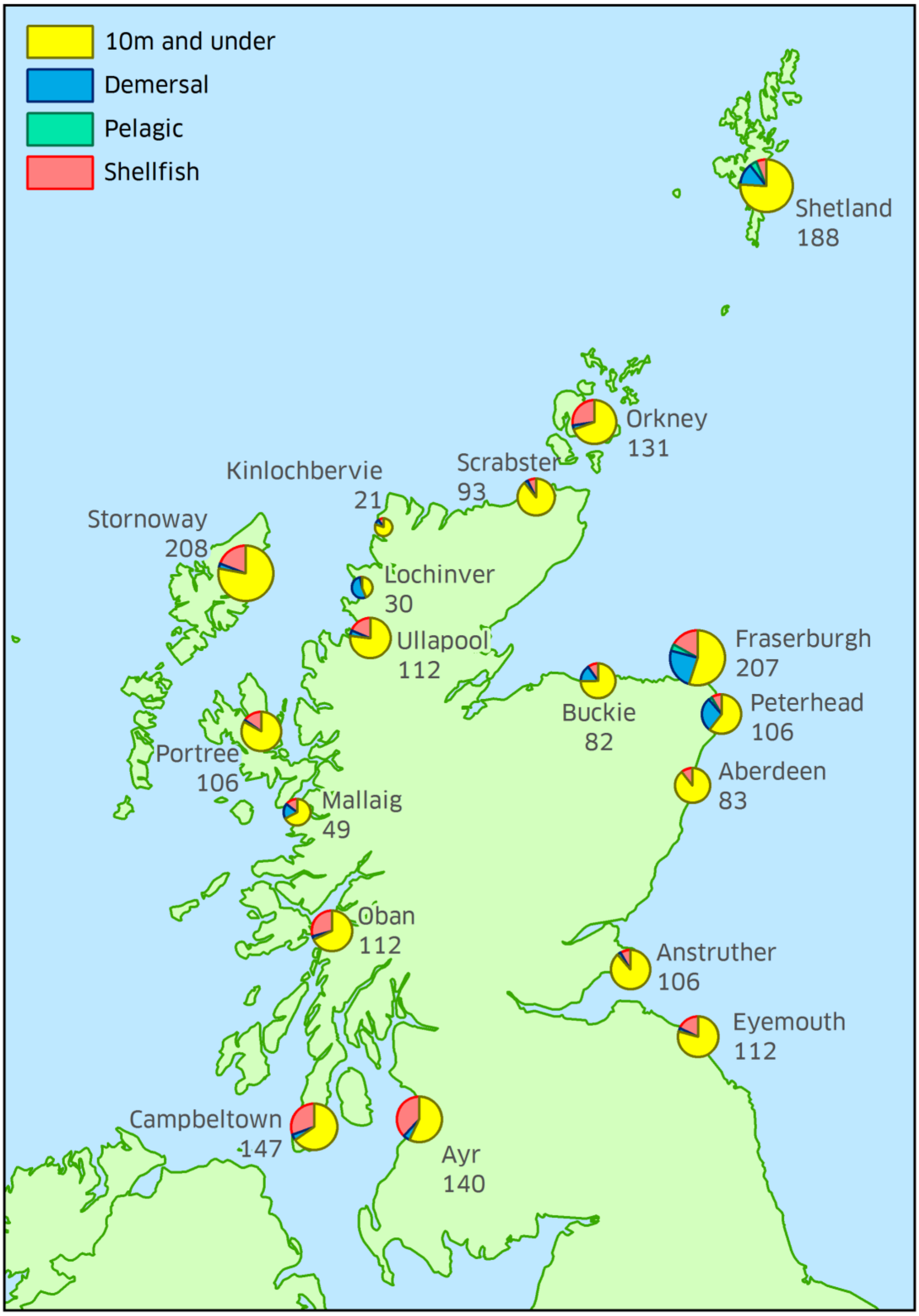


Figure 61: Scottish fishing fleet distribution (*Source: Marine Scotland*)

Fishermen

In total and in 2016, the combined fleet employed 4,823 fishermen. There can be considerable switching by vessels between fishing gear types, target stocks and fishing grounds as fishers seek to optimise the fluctuating fishing opportunities available to them from year to year. In addition to regularly and irregularly employed fishermen, Scotland has a small number of crofters that engage in commercial fishing. A crofter is a person who occupies and works a small land-holding known as a croft and operates a system of small-scale subsistence farming. There were 51 crofters engaged in commercial fishing in 2016.

Since 1970, employment on Scottish based fishing vessels has fallen 49 per cent (Figure 56). These decreases in fishermen numbers could be attributed to reductions in fleet capacity and increased vessel efficiency.

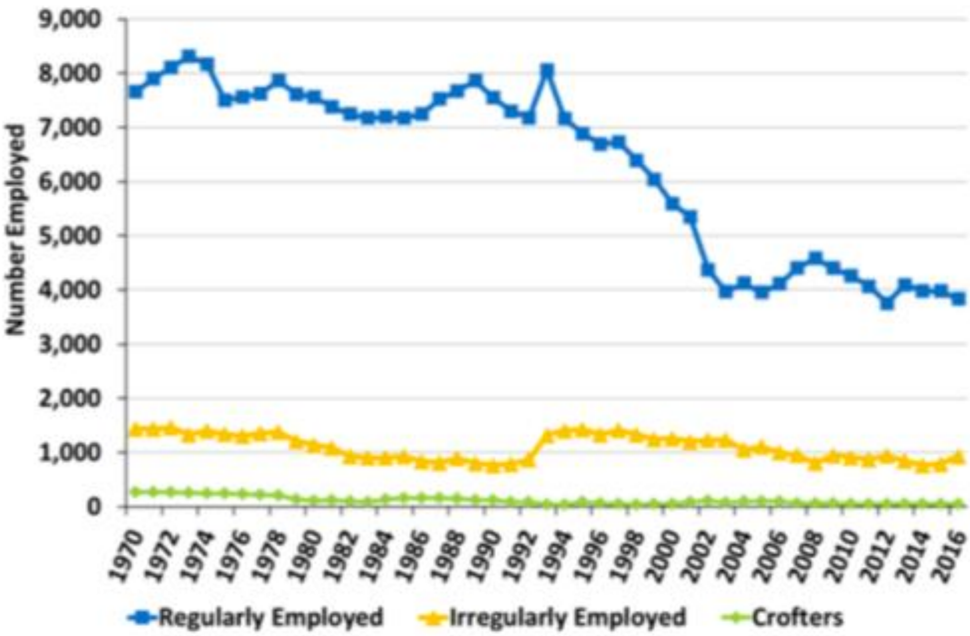


Figure 62: Number of fishermen employed on Scottish based vessels between 1970 – 2016 (*Source: Marine Scotland*)

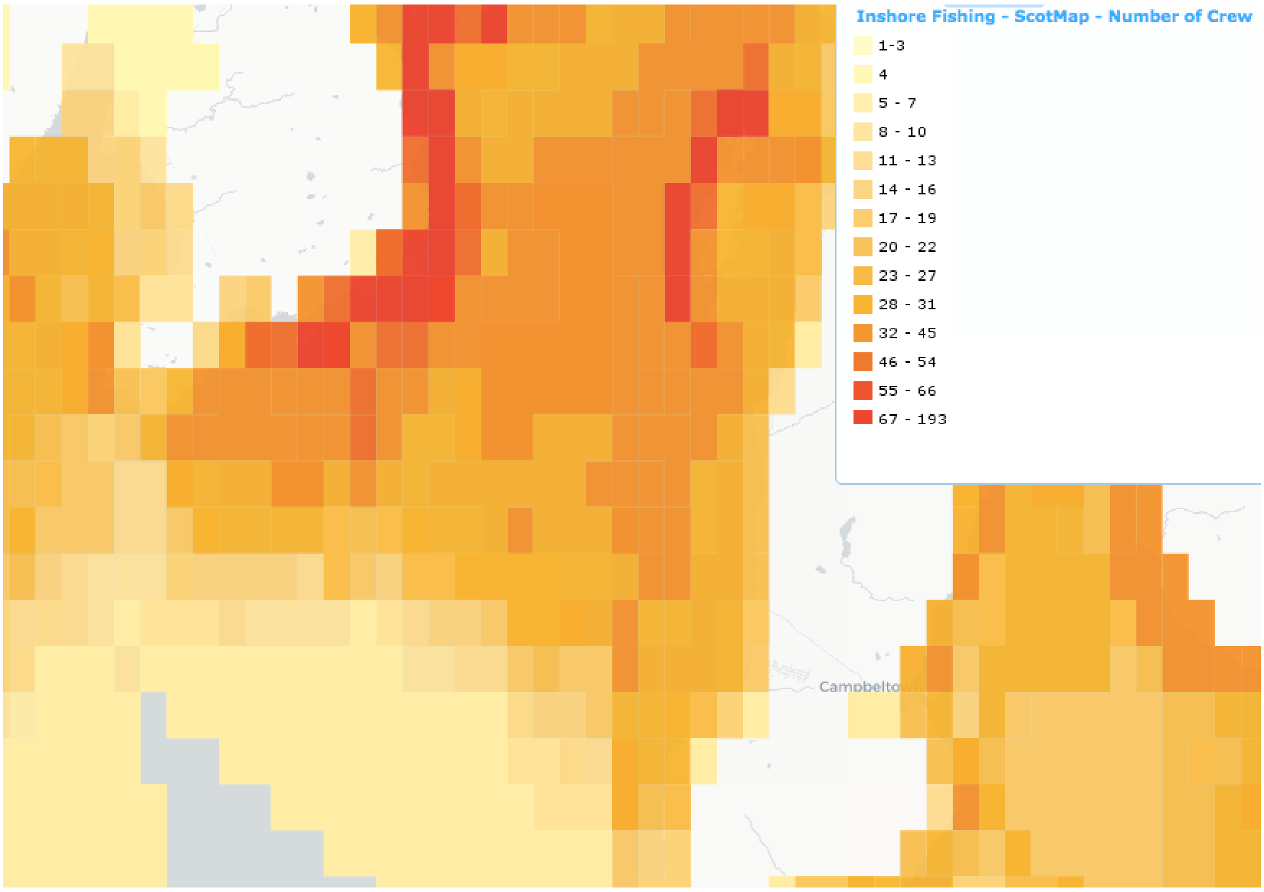


Figure 63: Number of fishermen at sea, annual basis, Islay region (*Source: Marine Scotland*)

Fishing ports

The largest part of the commercial fishing industry operates from ports located in the north-east of Scotland, especially around Peterhead and Fraserburgh. This region has both the greatest volume and value of landings, as well as a greater concentration of local fish processors and an important level of local economic dependence on fishing activity. Shetland has a fishing sector on a similar scale to that of the north-east and provides important landing facilities for some vessels of the Europe's pelagic fleets. The north coast and Orkney support a small local industry and also have some busy fishing ports, notably Scrabster and Wick.

In the north-west, Lochinver and Kinlochbervie are important ports for access to the fishing ground to the north-west of Scotland and often receive landings from fishing vessels from other EU countries that operate to the west of Scotland. The western coast still supports numerous small ports and harbours, the largest of which are Ullapool, Oban, Portree and Mallaig. Elsewhere, in the south-east and south-west, numerous small ports continue to support a small local industry based on small vessels fishing inshore grounds, mostly for shellfish. Most of the fishing industry on the west coast is now dependent upon shellfish.

Landings by Scottish based vessels

Landings in the region are dominated by shellfish, which contribute 83% of the weight and 97% of the value of landings, and by pelagic species (41% by weight and 15% by value). Shellfish landings are predominantly of high value Nephrops and scallop. Important scallop grounds are found along the east coast of the Isle of Lewis, to the west of the Isle of Skye and along the coast to the south of the region (Mason 1983). The most frequently used gear types are bottom trawls and traps (for Nephrops, crabs, lobsters and sandeels), which comprise almost 90% of days fished by UK vessels between them, while dredges are used to harvest scallop. Fishing effort (in terms of days at sea) within this region is greater than all other Regional Seas apart from Regional Sea 1, although the relatively low weight of landings is indicative of the small size of vessel fishing in the area.

Since 2000, fishing activity has been reduced significantly in order to preserve stocks. The quantity of whitefish and pelagic fish landed has decreased, while there has been a slight increase in shellfish catches. These trends are the result generally of the availability of stocks and specific measures such as the cod recovery programme and other conservation measures.

The following species make up the bulk of Scottish catches: mackerel and herring (pelagic); haddock, cod and monkfish (whitefish); Scottish langoustine (*Nephrops*); crabs and scallops (other shellfish).

The quantity of fish landed increased between 2015 and 2016. A total of 453 thousand tonnes of fish was landed in 2016, an increase of three per cent from 2015.

294 thousand tonnes of pelagic species were landed by Scottish vessels with a value of £222 million. This accounted for 65 per cent of all landings by Scottish vessels in terms of quantity and 40 per cent in terms of value. Demersal species represented 21 per cent of the quantity of all landings (95 thousand tonnes) and 30 per cent of the value (£169 million), while shellfish landings accounted for 14 per cent of landings by quantity (64 thousand tonnes) and 30 per cent by value (£166 million).

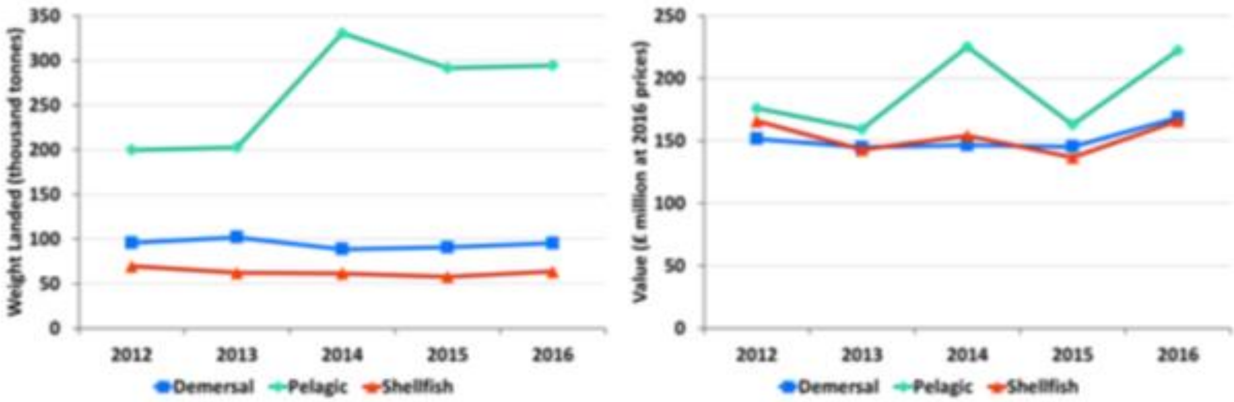


Figure 64: Weight and value of Scottish landings (*Source: Marine Scotland*)

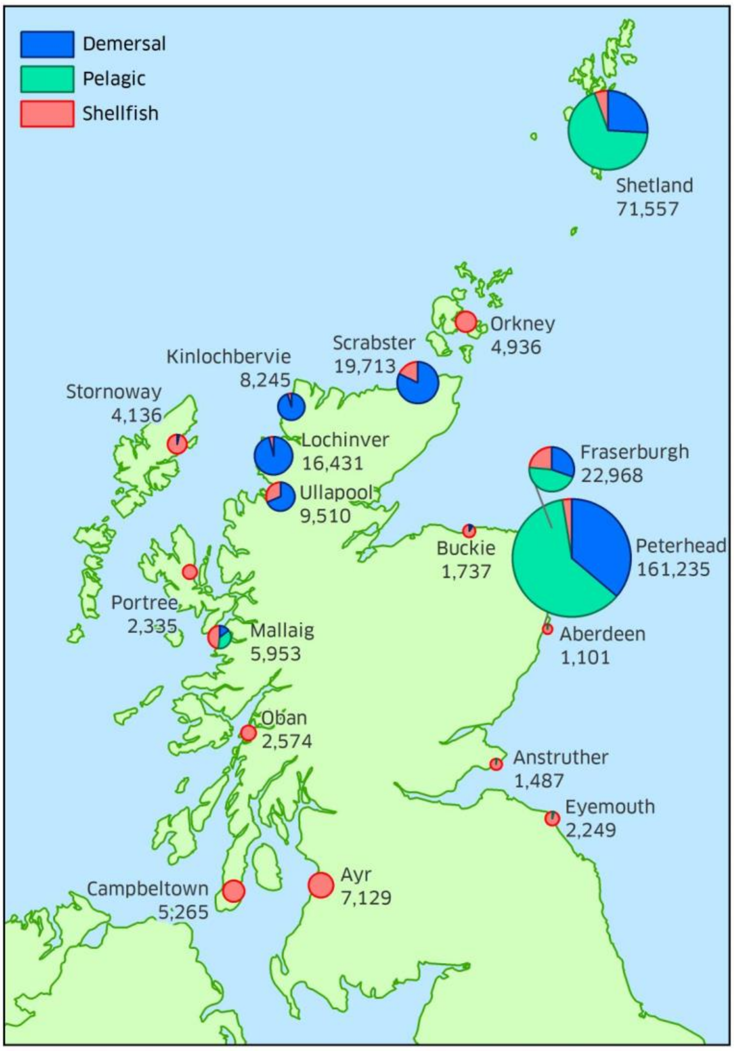


Figure 65: Landings by regions (*Source: Marine Scotland*)

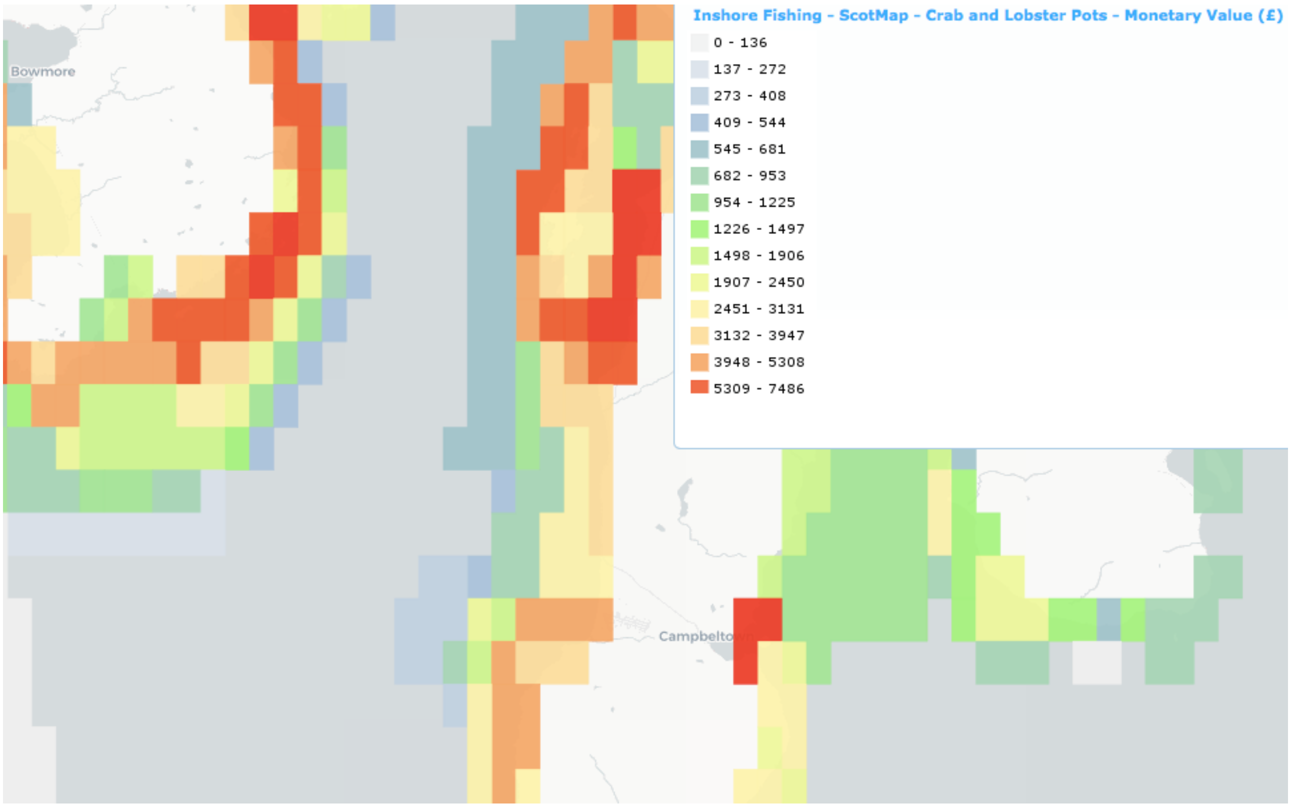


Figure 66: Value of catch on annual basis, crab and lobsters (*Source: Marine Scotland*)

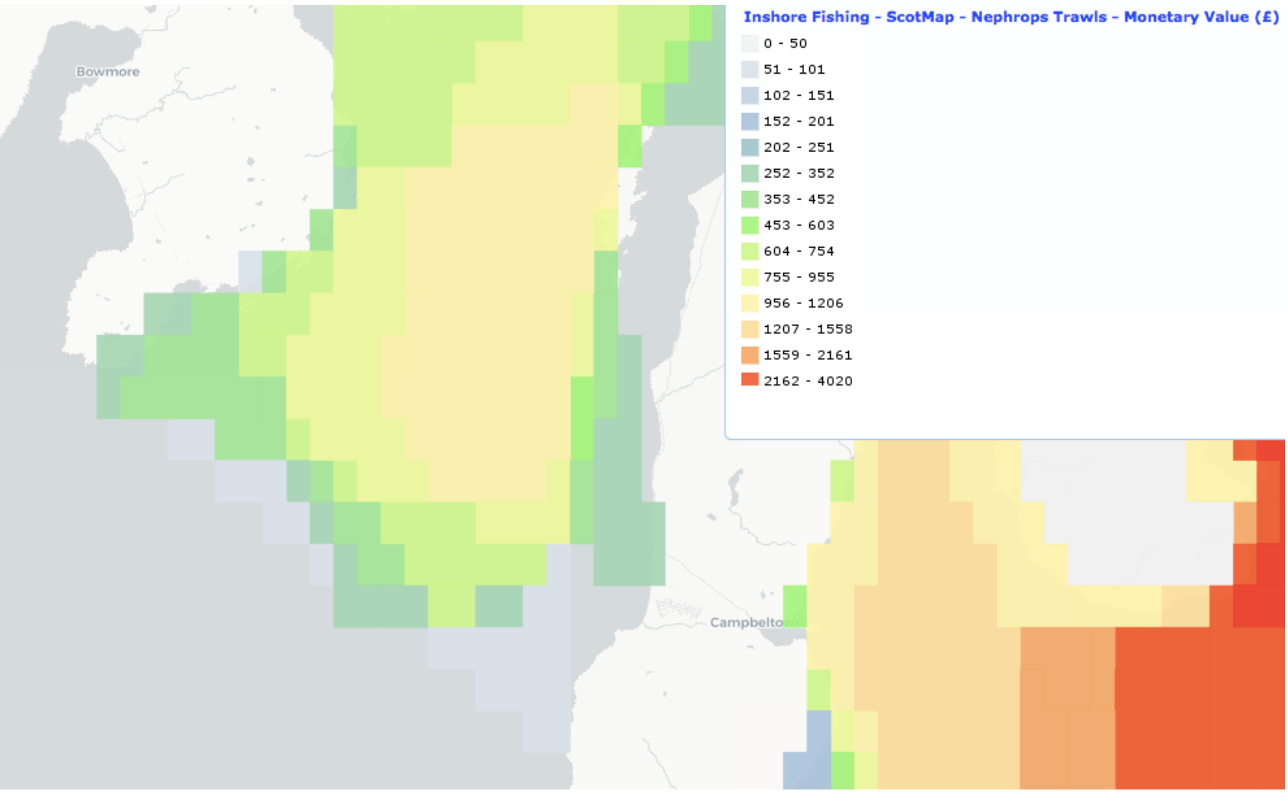


Figure 67: Value of catch on annual basis, Norway lobsters (*Source: Marine Scotland*)

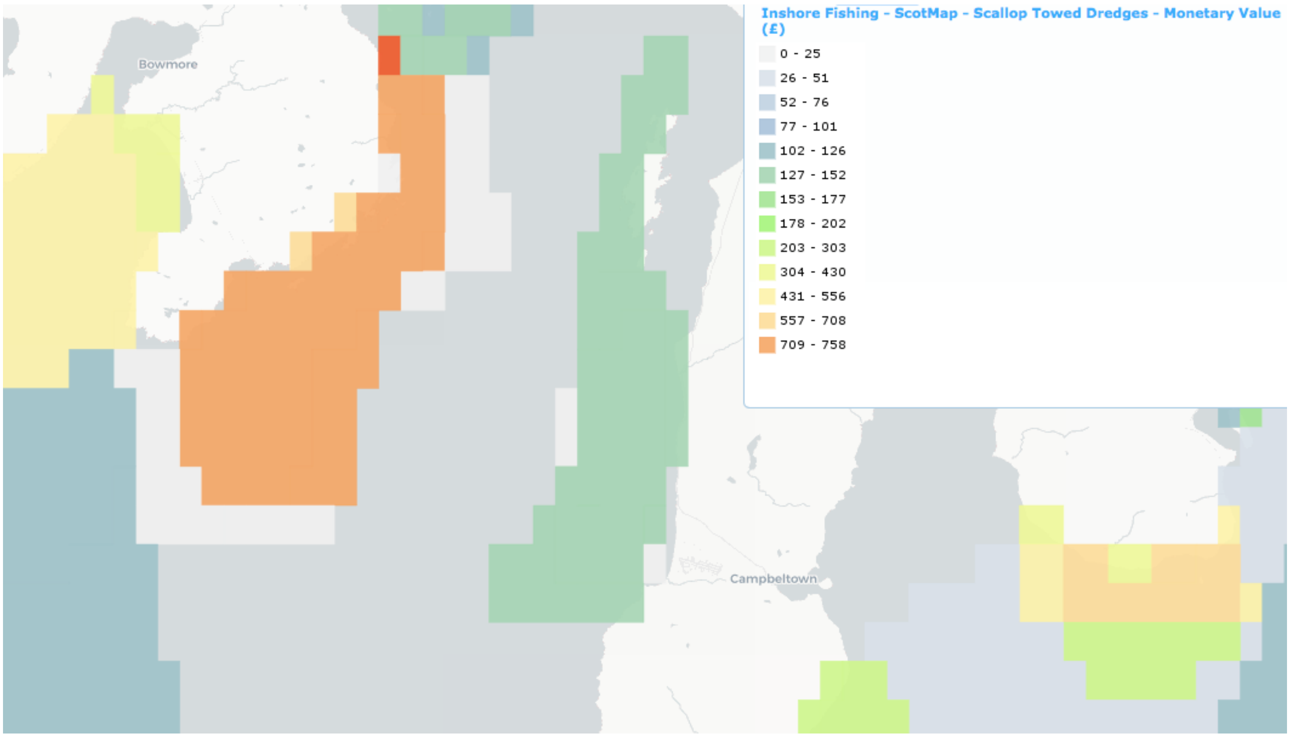


Figure 68: Value of catch on annual basis, scallops (*Source: Marine Scotland*)

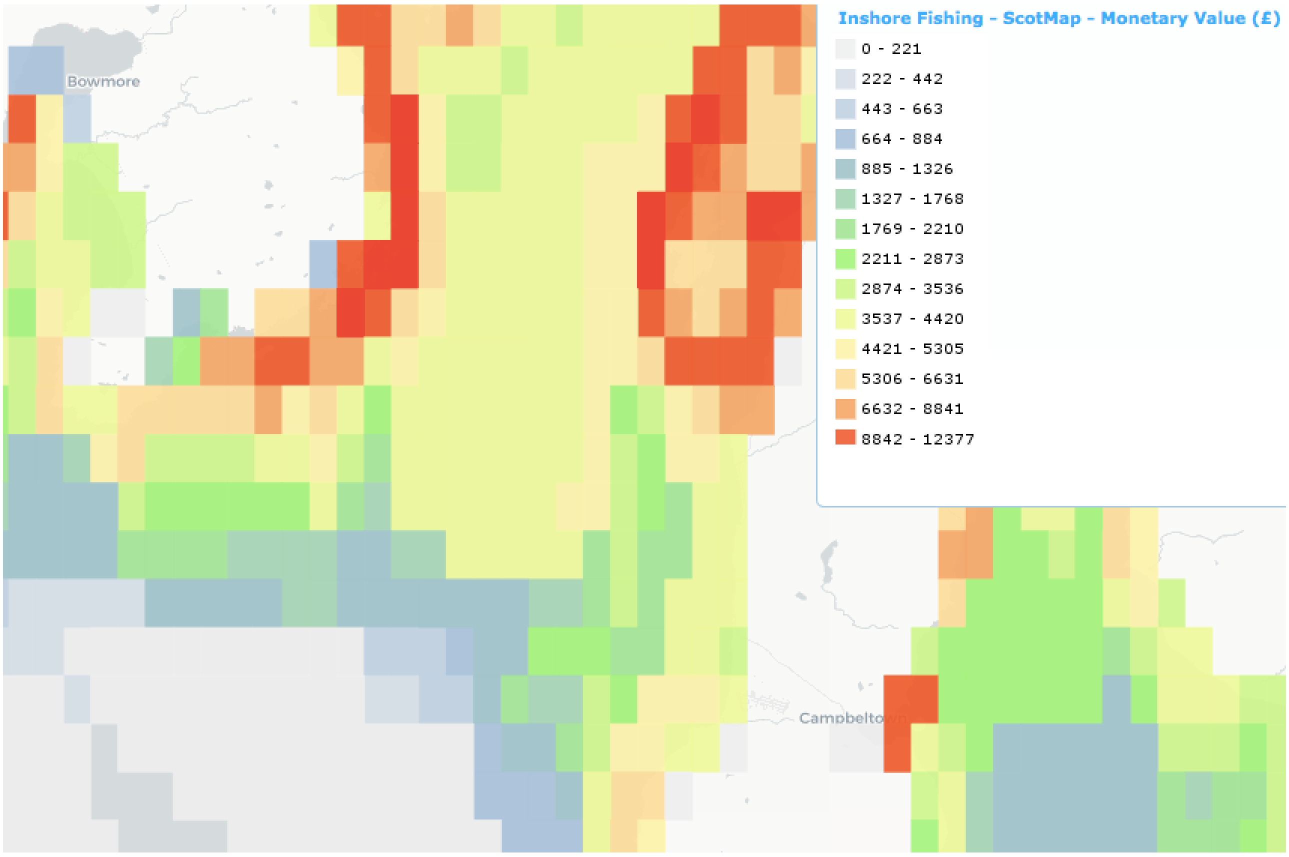


Figure 69: Value of catch on annual basis, all species (*Source: Marine Scotland*)

Pelagic fish

Mackerel is the most valuable stock to the Scottish fleet at £169 million, accounting for 30 per cent of the total value of Scottish landings in 2016. Mackerel accounted for 76 per cent of the value and 64 per cent of all pelagic landing by Scottish vessel. Its value increased by 27 per cent in real terms compared to 2015. Herring represent also one of the main pelagic fish landed by Scottish vessels in term of quantity (22%) and value (20%).

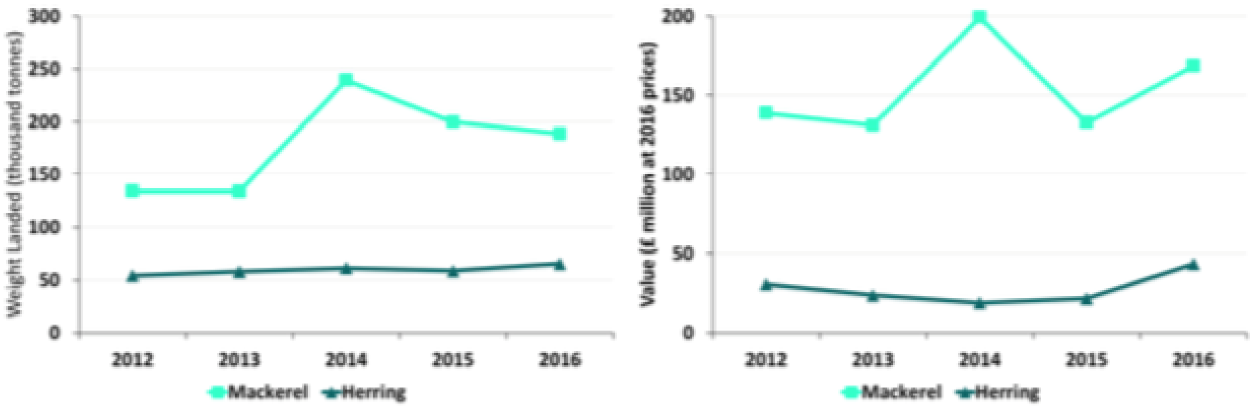


Figure 70: Quantity and value of landings of the key pelagic species by Scottish vessels 2012-2016 (*Source: Marine Scotland*)

Figure 71: Mackerel *Scomber scombrus* and Herring *Clupea harengus*

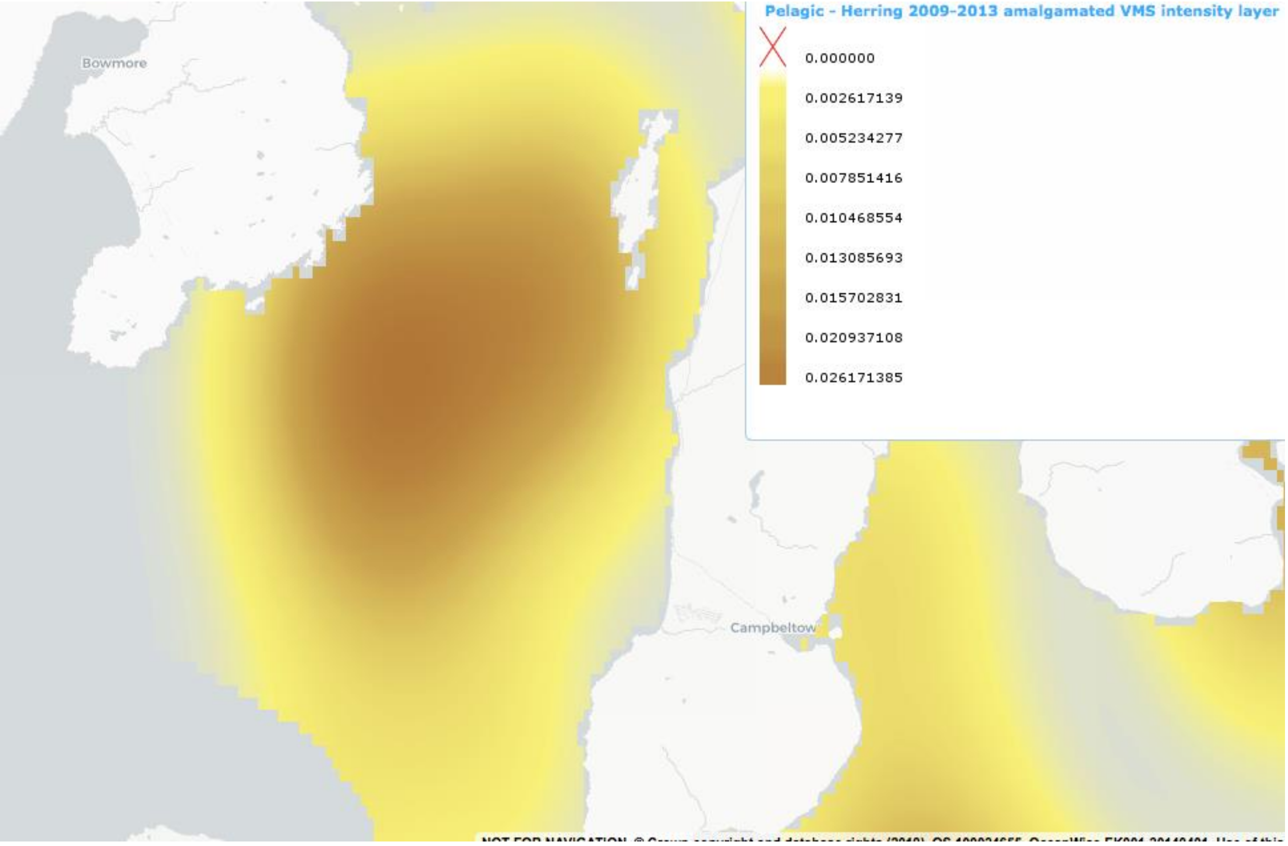


Figure 72: Fishing effort on Herrings (*Source: Marine Scotland*)

Demersal fish

The amount of demersal landings increased in real terms value since 2015. Demersal species contributed 30 per cent of the overall value of all landings by Scottish vessels in 2016 and by 21 per cent of total landed quantity. Haddock accounts for 30 per cent, cod 14 per cent, monkfish 13 per cent and hake, saithe and whiting are each eight per cent of all demersal species landed by Scottish vessels in 2016 in terms of tonnage weight. Haddock, monkfish and cod are the three main demersal fish species landed in terms of value, accounting for 22 per cent, 21 per cent and 16 per cent respectively of the total value of demersal species landed in 2016.

Demersal species increased in price per tonne in real terms, apart from haddock (down four per cent) and hake (down three per cent). The value of monkfish rose by 30 per cent, cod rose by 19 per cent, hake rose by 14 per cent, and saithe rose by 12 per cent in real terms value since 2015.

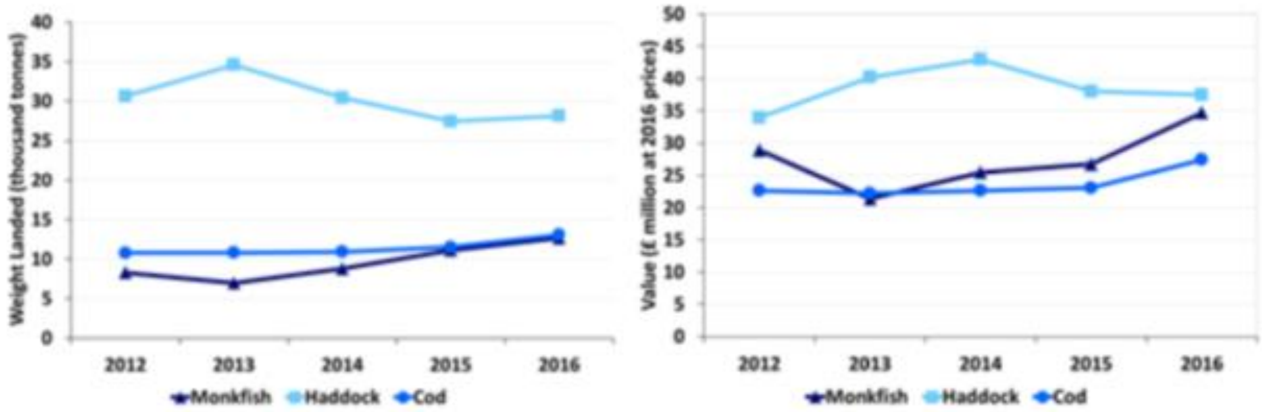
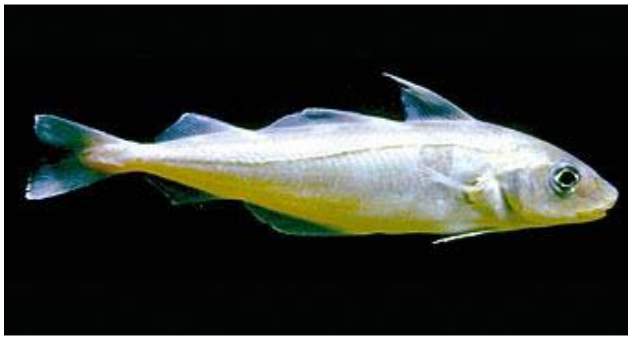


Figure 73: Quantity and value of landings of the key demersal species by Scottish vessels 2012-2016 (*Source: Marine Scotland*)

Monkfish *Lophius piscatorius*



Haddock *Melanogrammus aeglefinus*

Atlantic Cod *Gadus morhua*

Figure 74: Monkfish, haddock and Atlantic cod

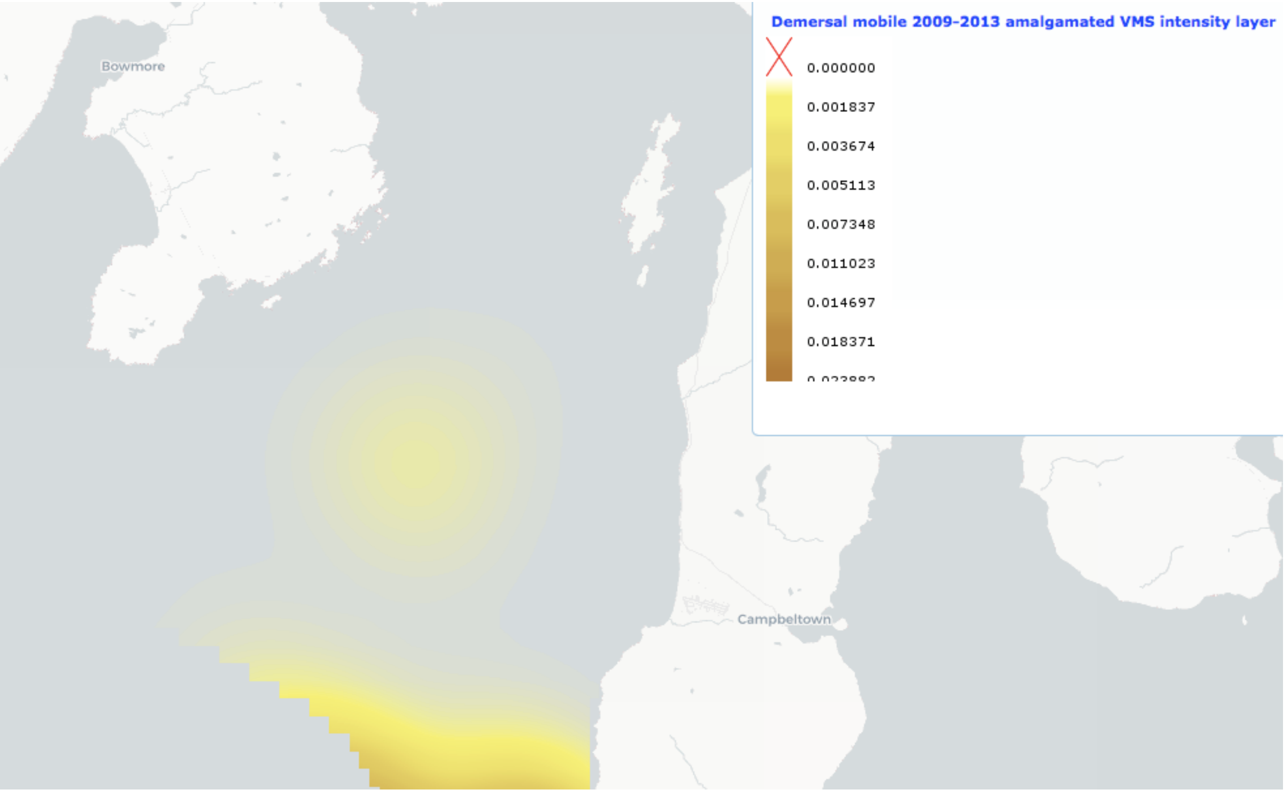


Figure 75: Fishing effort on demersal fish, Islay area, all species (*Source: Marine Scotland*)

Shellfish

There was a ten per cent increase in shellfish landings and a 21 per cent increase in value in real terms of shellfish landed in 2015. All shellfish species rose in value in real terms since 2015. Nephrops and scallops are the two main species of shellfish landed by Scottish vessels. Nephrops accounted 46% of the value and 33% of the quantity of shellfish landed by Scottish vessels in 2016 and presented the second most valuable species accounting for 14 per cent of the total value of Scottish landings. All other shellfish species rose in price per tonne since 2015.

The king scallop landings accounted for 22 per cent of the value and 24 per cent of the quantity of all shellfish landings by Scottish vessels. The value of edible crabs, lobsters, squid and velvet crabs increased in real terms between 2015 and 2016, along with the quantity landed. The quantity landed of edible crabs increased by 12 per cent from 2015 and the value in real terms increased by 21 per cent. The quantity of lobsters increased by ten per cent and the value in real terms increased by 22 per cent. The quantity of squid landed increased by 26 per cent and value in real terms increased by 50 per cent. Velvet crabs had an eight per cent increase in the quantity landed and an increase of 16 per cent in the value in real terms. Whelks had a 52 per cent increase in the quantity landed and an increase of 63 per cent in the value.

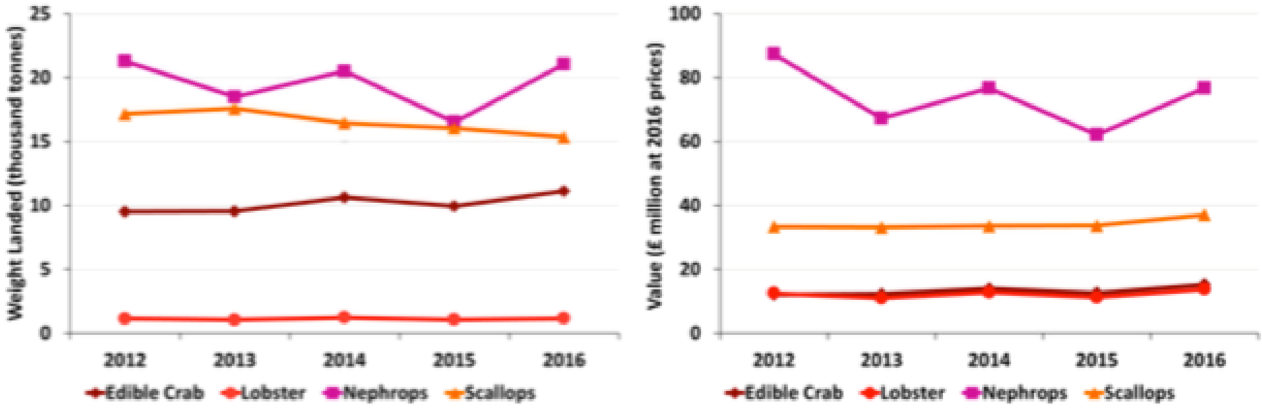


Figure 76: Quantity and value of landings of the key shellsifh species by Scottish vessels 2012-2016 (*Source: Marine Scotland*)

Nephrops *Nephrops norvegicus*

King scallop *Pecten maximus*

Figure 77: Nephrops and king scallop

Table 14: Demersal, pelagic and shelfish landings by Scottish vessels (*Source: Marine Scotland*)

	Quantity (tonnes)				
	2012	2013	2014	2015	2016
Scottish vessels					
Landings into Scotland					
Bass	0	2	1	0	0
Black scabbardfish	34	57	112	127	96
Blue Ling	48	217	305	383	287
Brill	3	4	4	5	5
Cod	10,542	10,501	10,698	11,273	12,841
Haddock	29,988	34,250	30,280	27,239	27,929
Hake	5,446	3,961	4,680	4,617	6,158
Lemon sole	501	655	597	625	734
Ling	3,634	3,283	3,309	3,434	4,010
Megrims	2,036	2,183	1,954	1,728	1,941
Monkfish	6,263	5,891	6,962	9,640	11,323
Plaice	841	1,533	1,173	1,463	1,948
Pollack	422	370	266	434	316
Red mullet	1	1	0	1	5
Saithe	9,894	10,468	8,071	7,912	7,687
Skates and rays	507	532	565	577	564
Sole	4	2	3	3	2
Turbot	40	43	44	55	46
Whiting	8,669	9,613	8,618	7,909	7,272
Wrasses	0	0	51	29	48
Other demersal	2,093	2,526	2,282	2,412	2,674
Total demersal	**80,964**	**86,090**	**79,976**	**79,866**	**85,885**
Blue whiting	6,301	8,165	9,687	12,150	11,908
Herring	31,844	28,923	31,298	32,076	33,092
Horse mackerel	1,246	588	763	694	6
Mackerel	61,972	74,211	120,539	87,362	96,093
Pilchards	-	-	-	-	-
Other pelagic	1,764	968	1,540	1,060	2,179
Total pelagic	**103,127**	**112,855**	**163,827**	**133,343**	**143,279**
Brown shrimps	1	0	0	0	0
Cockles	5	0	0	0	0
Cuttlefish	-	0	-	1	1
Edible crabs	9,471	9,516	10,596	9,656	10,806
Lobsters	1,122	1,022	1,209	1,041	1,139
Nephrops	19,634	16,816	18,803	15,148	18,757
Patagonian squid	-	-	-	-	-
Queen scallops	7,271	5,248	3,023	3,312	3,750
Razor fish	820	859	422	320	373
Scallops	9,701	11,791	10,269	10,110	11,375
Squid	1,399	1,149	2,142	1,226	1,635
Velvet crabs	2,036	1,572	1,658	1,479	1,603
Whelks	337	674	850	1,085	1,864
Other shellfish	543	695	417	278	270
Total shellfish	**52,339**	**49,342**	**49,390**	**43,657**	**51,575**

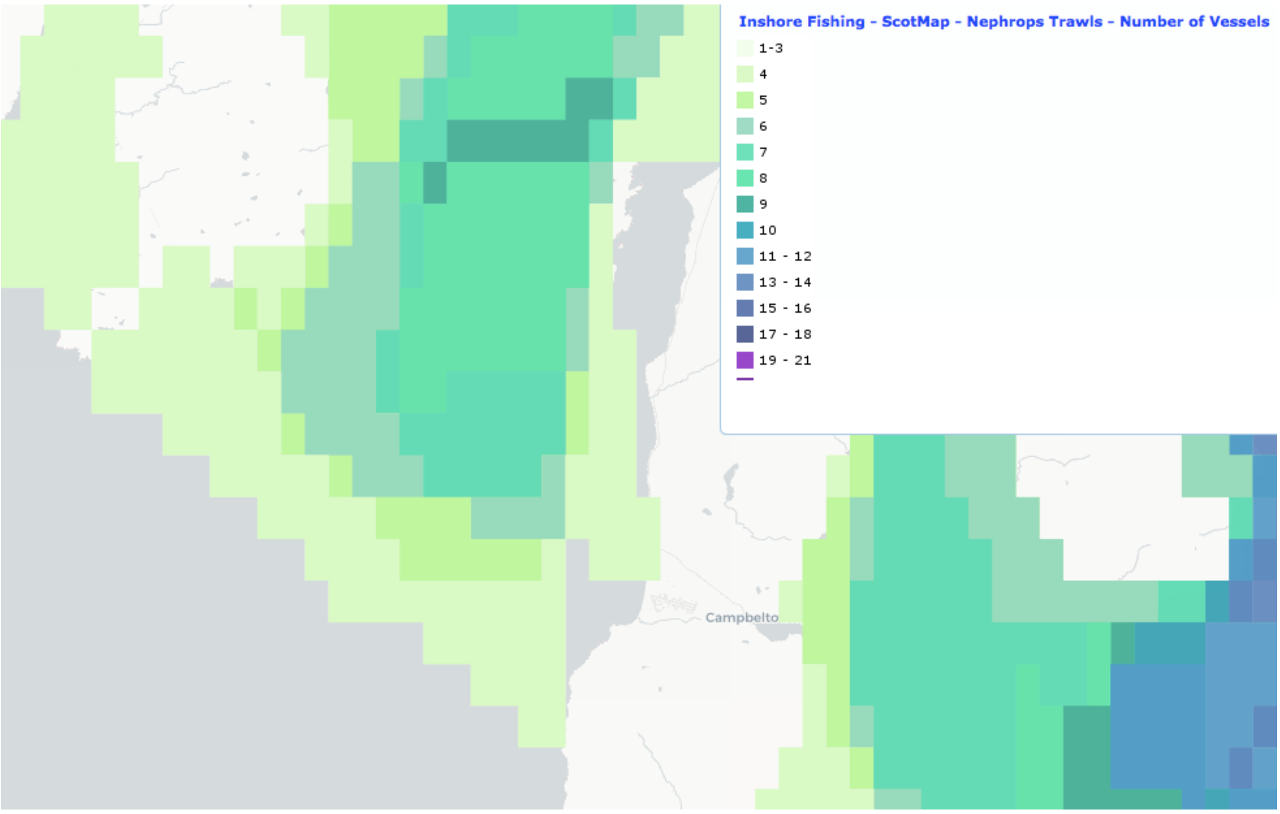


Figure 78: Number of vessels fishing Nephrops, Islay area (*Source: Marine Scotland*)

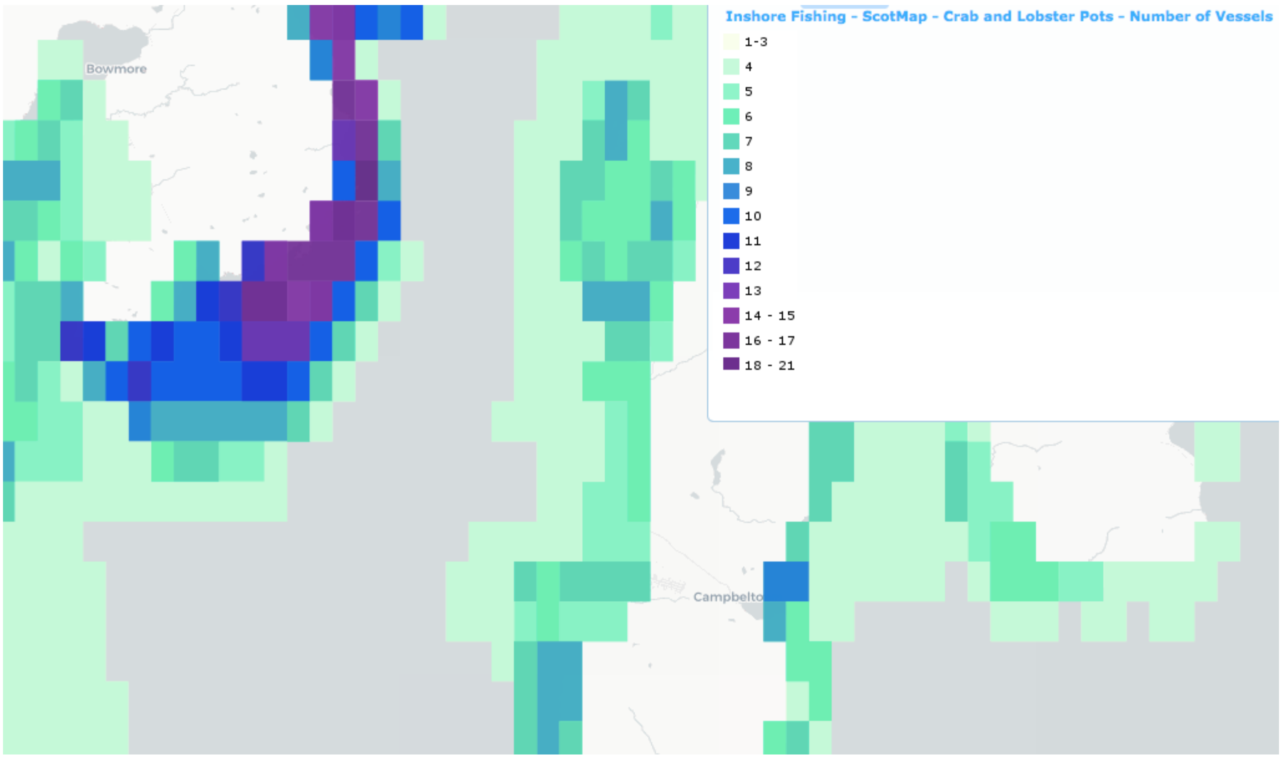


Figure 79: Number of vessels fishing crab and lobsters, Islay area (*Source: Marine Scotland*)

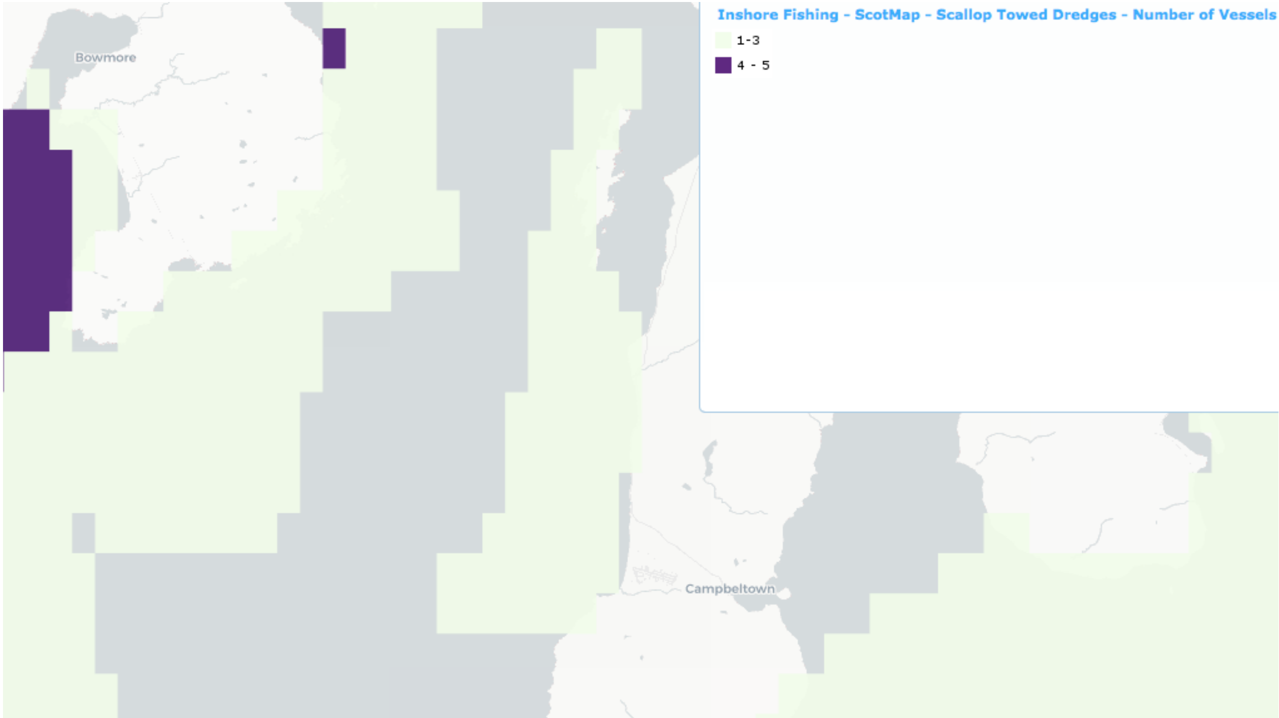


Figure 80: Number of vessels fishing scallops, Islay area (*Source: Marine Scotland*)

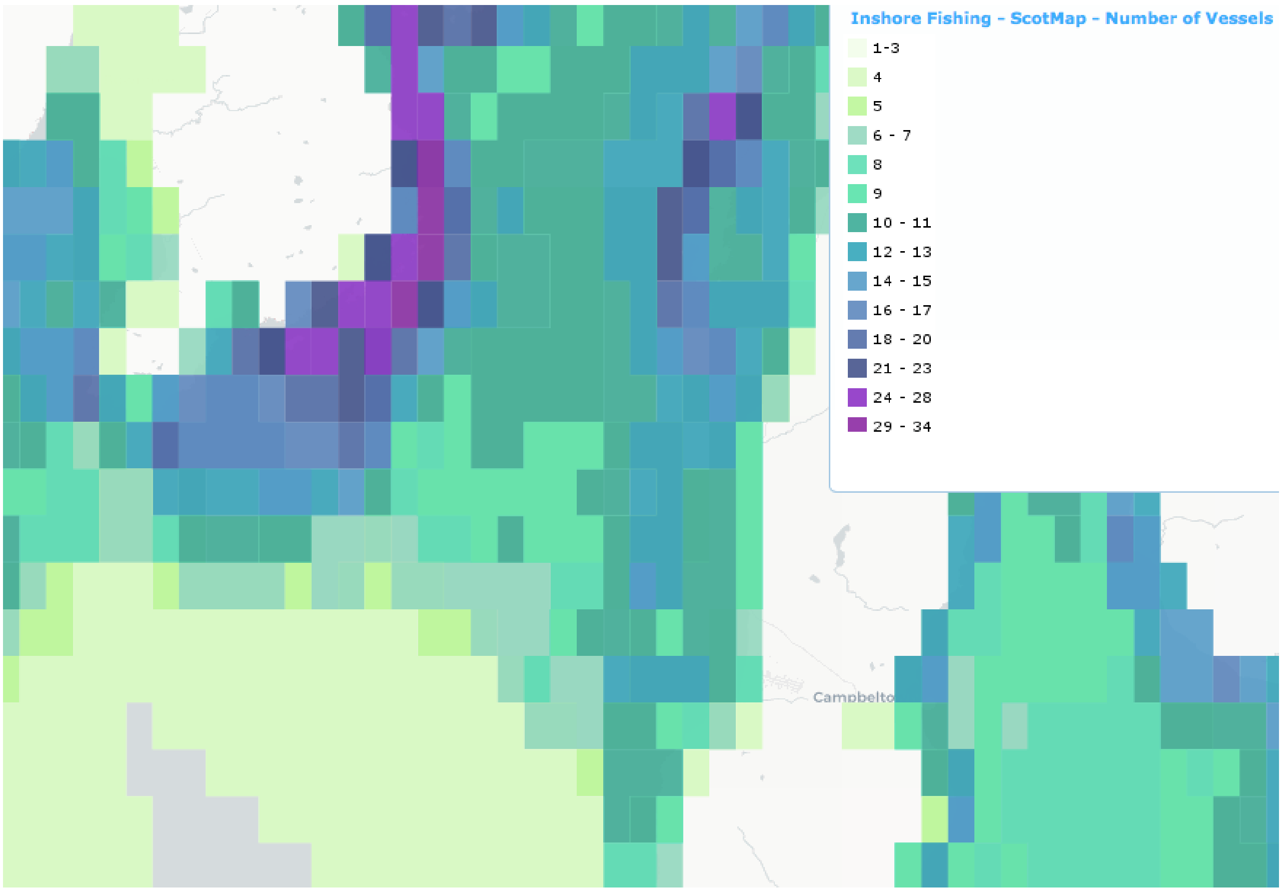


Figure 81: Number of total fishing vessels, Islay area (*Source: Marine Scotland*)

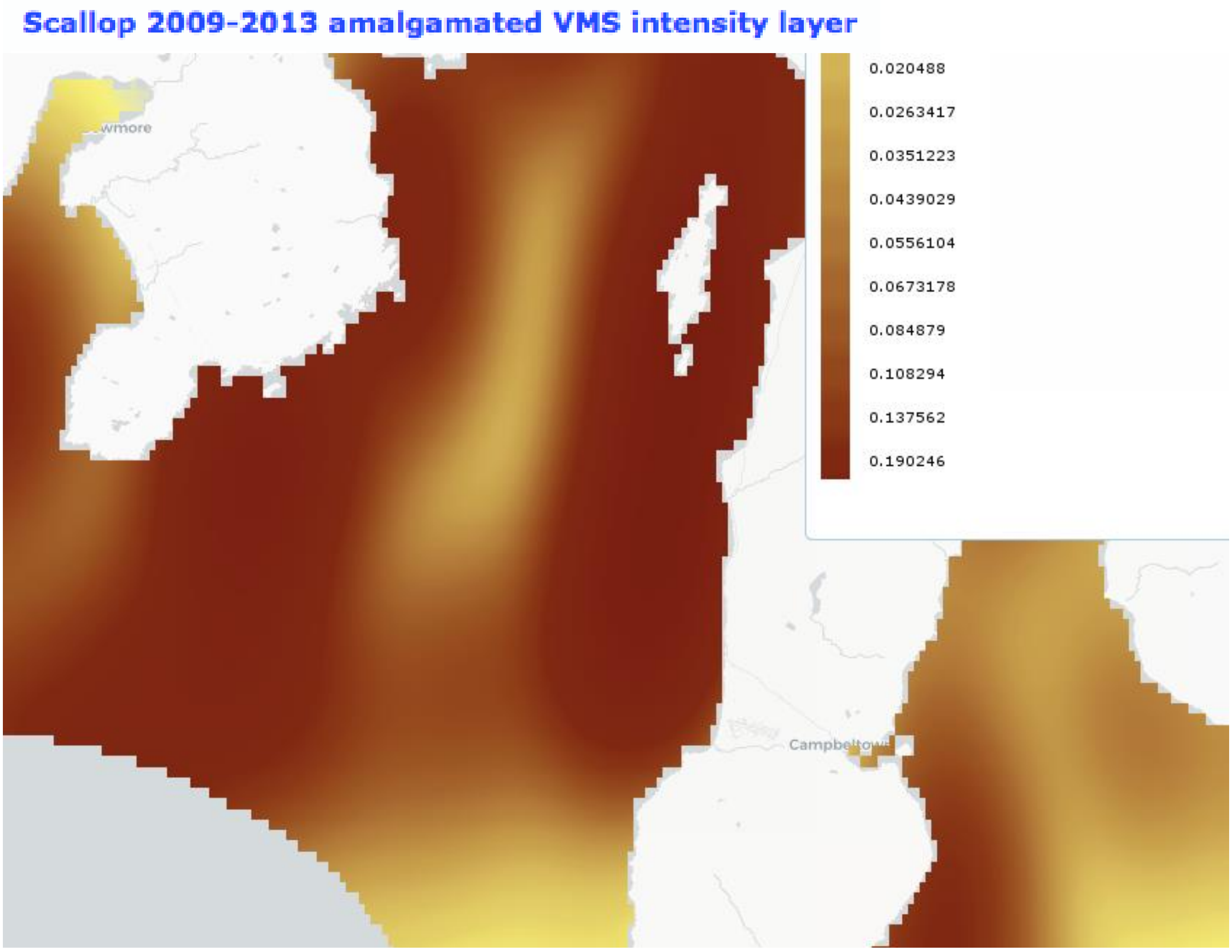


Figure 82: Fishing effort on scallops, Islay area (*Source: Marine Scotland*)

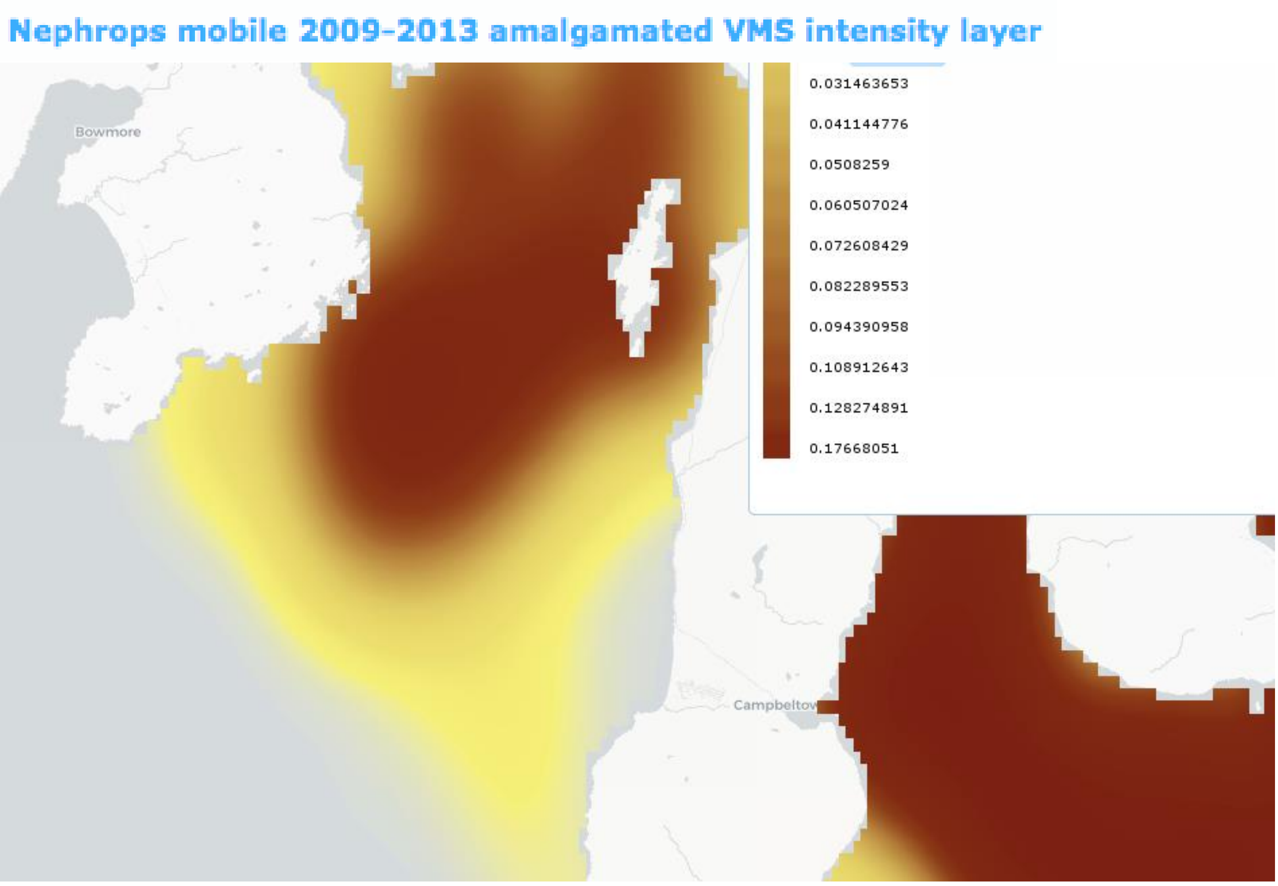


Figure 83: Fishing effort on Norway lobsters, Islay area (*Source: Marine Scotland*)

3.3.2 Marine Traffic

There are few large ports in West Scotland, with Glensanda being the largest. Glensanda only has export traffic almost entirely consisting of granite, amounting to 6.3Mt in 2014. The shipping industry is the dominant carrier of goods to and from the UK, making up approximately 95% of imports and exports to the country by tonnage. It is estimated that the maritime services sector, which would include port and shipping related activity employed approximately 239,200 people in 2013, or 0.7% of total UK employment. In terms of regional variation, this sector is particularly important in Scotland and Northern Ireland.

The major regional routes pass on either side of the Outer Hebrides. There is moderate traffic in a north- south direction through the Irish Sea between lanes, which link England and Scotland with the Isle of Man, Northern Ireland and the Irish Republic.

In relation to shipping routes and navigational safety, the Maritime and Coastguard Agency provides guidance (MGN 543) on UK navigational practice, safety and emergency response issues with regard to Offshore Renewable Energy Installations (OREI). The note makes a number of recommendations around the themes: considerations on site position, structures and safety zones;

navigation, collision avoidance and communications. A template for assessing the best distance between wind farm boundaries and shipping lanes is also provided, and attention is drawn to both the MGN 543 and DECC 2011 guidance on applying for safety zones around offshore renewable energy installations. The guidance indicates a number of scenarios with difference spacing of wind farms from shipping lanes, indicating the relative tolerability of wind farm distances from lanes. The minimum distance at which risks to shipping would be very low is recommended to be a distance greater than 5nm.

A number of recommendations are also provided in relation to search and rescue operations, counter pollution or salvage incidents which should be borne in mind during turbine design (e.g. turbines should have illuminated unique identification numbers visible in normal lighting and all tidal conditions, structures should be illuminated for aviation purposes and have high contrast markings, there should be control mechanisms so the OREI can be fixed). In addition stakeholder engagement raised several additional points to consider regarding wind farm site design:

- Search and Rescue operations are easier where turbine spacing is wider
- It can be easy to become disorientated when navigating within wind farms turbine arrangement in a regular, square grid pattern assists orientation
- Wind farms consisting of a square/rectangular block of turbines are potentially considered safer from a navigational perspective; depending on the location, odd shapes and single turbines pose a greater navigational risk
- Construction phase activities must include appropriate lighting and in some cases safety zones

Ferry routes

There is a complex network of ferry routes in West Scotland, which connects the numerous islands (e.g. Islay, Coll, Tiree, the Outer Hebrides) to the Scottish mainland.

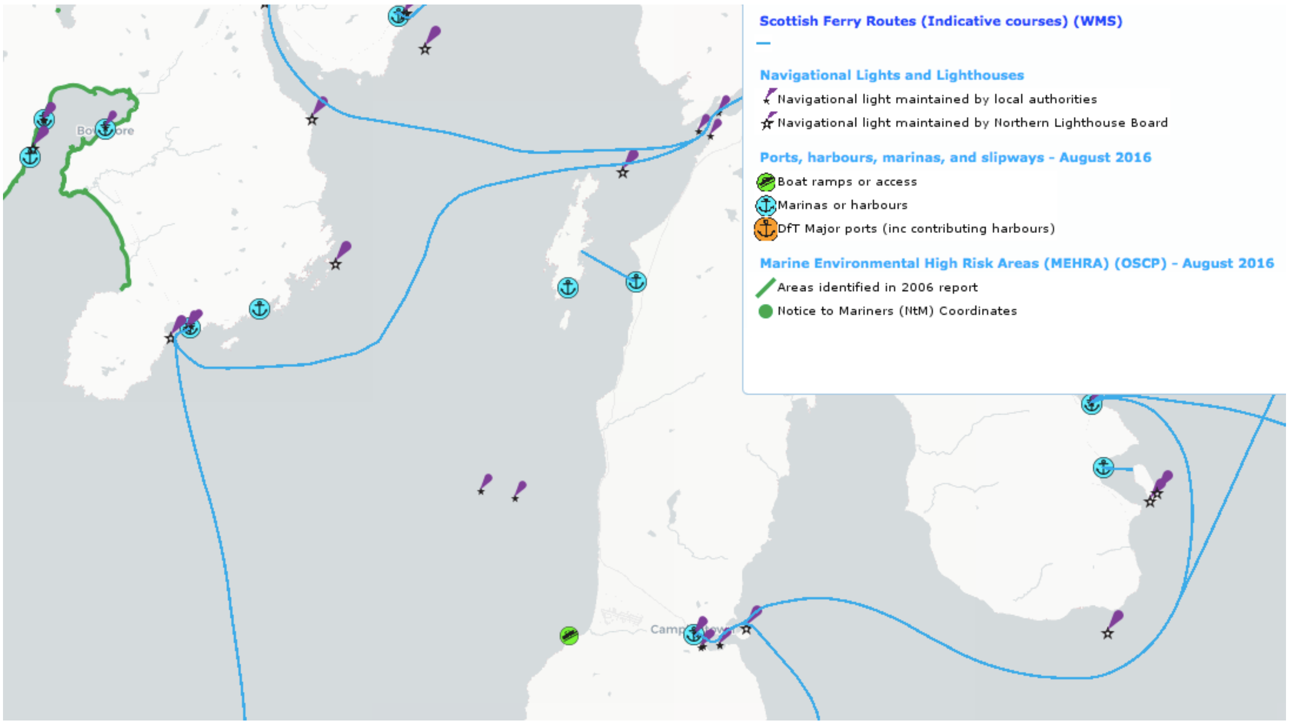


Figure 84: Main ferry lanes, Islay (*Source: Marine Scotland*)

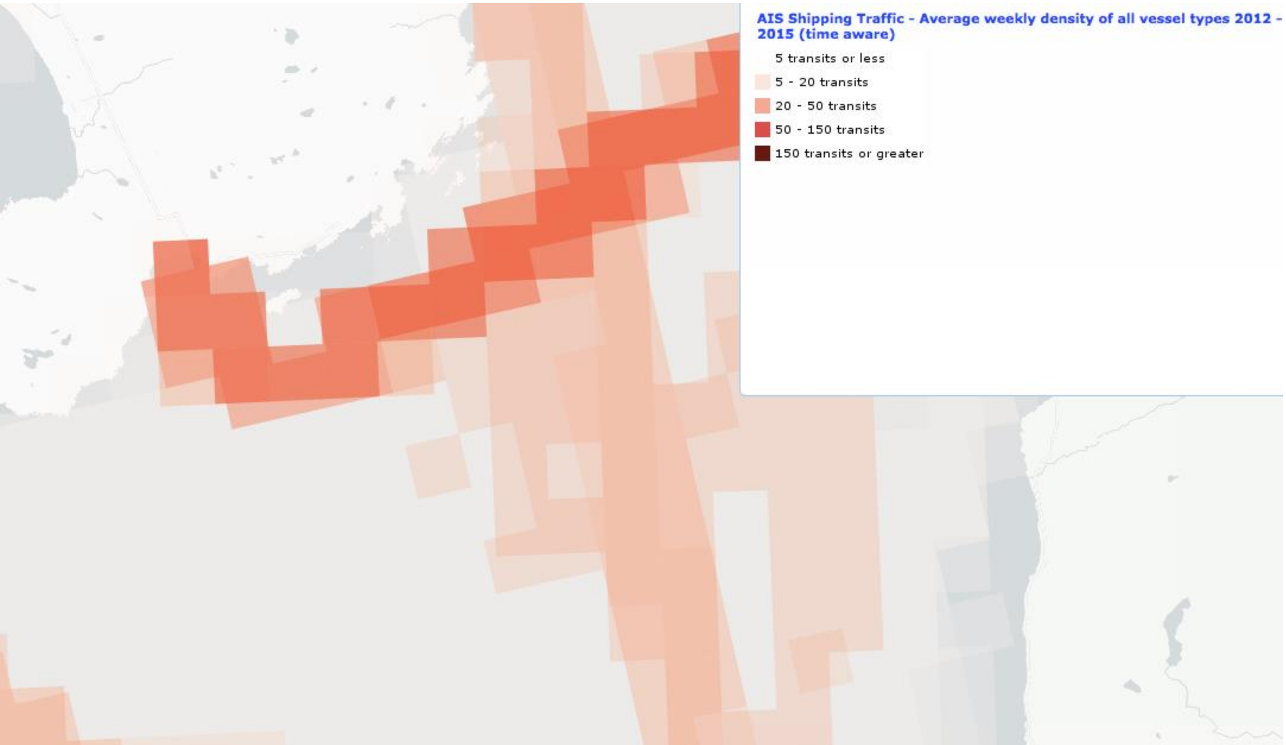


Figure 85: Average weekly density of all vessel types (2012-2015) (*Source: Marine Scotland*)

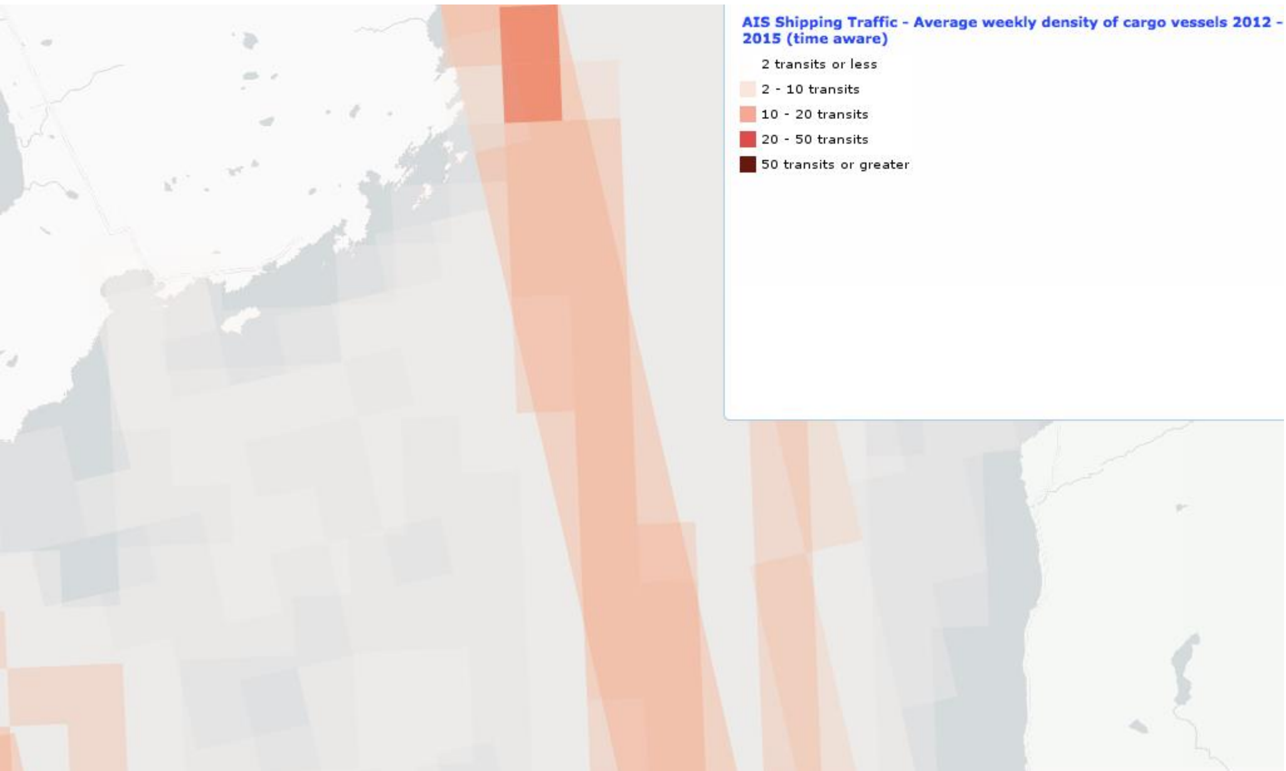


Figure 86: Average weekly density of cargo vessels (2012-2015) (*Source: Marine Scotland*)

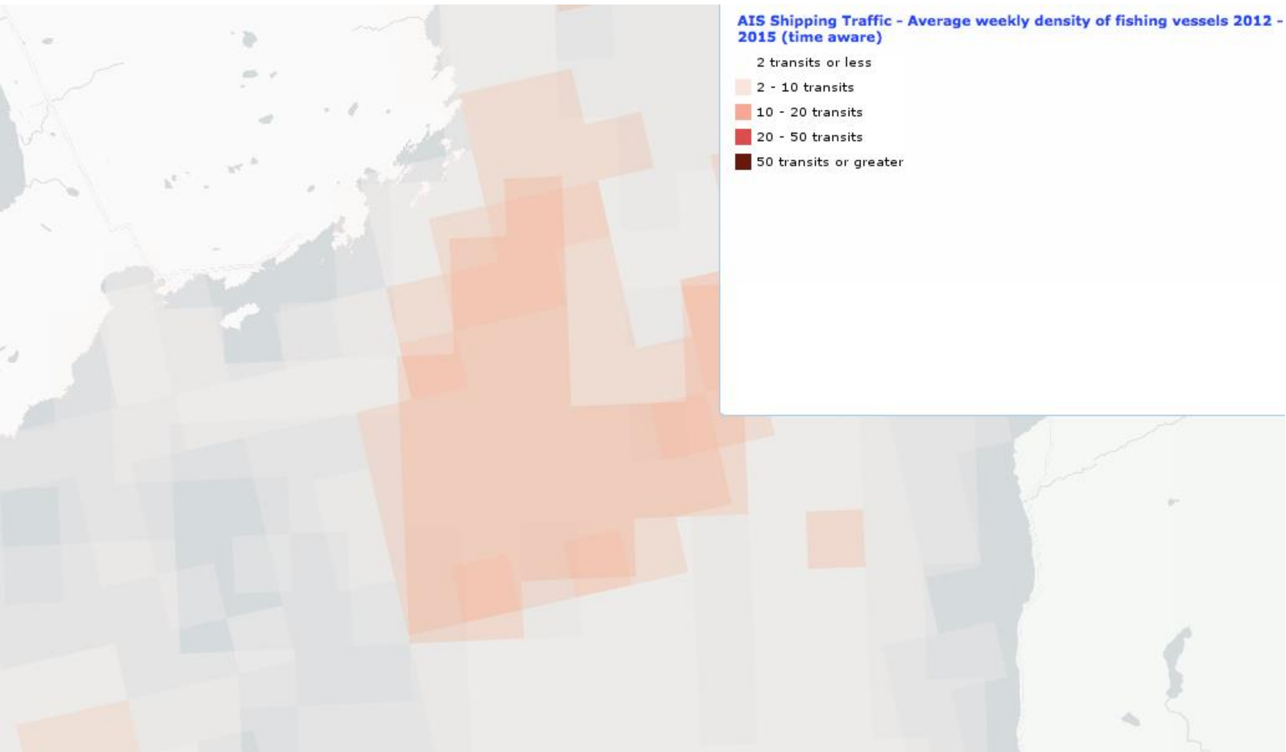


Figure 87: Average weekly density of fishing vessels (2012-2015) (*Source: Marine Scotland*)

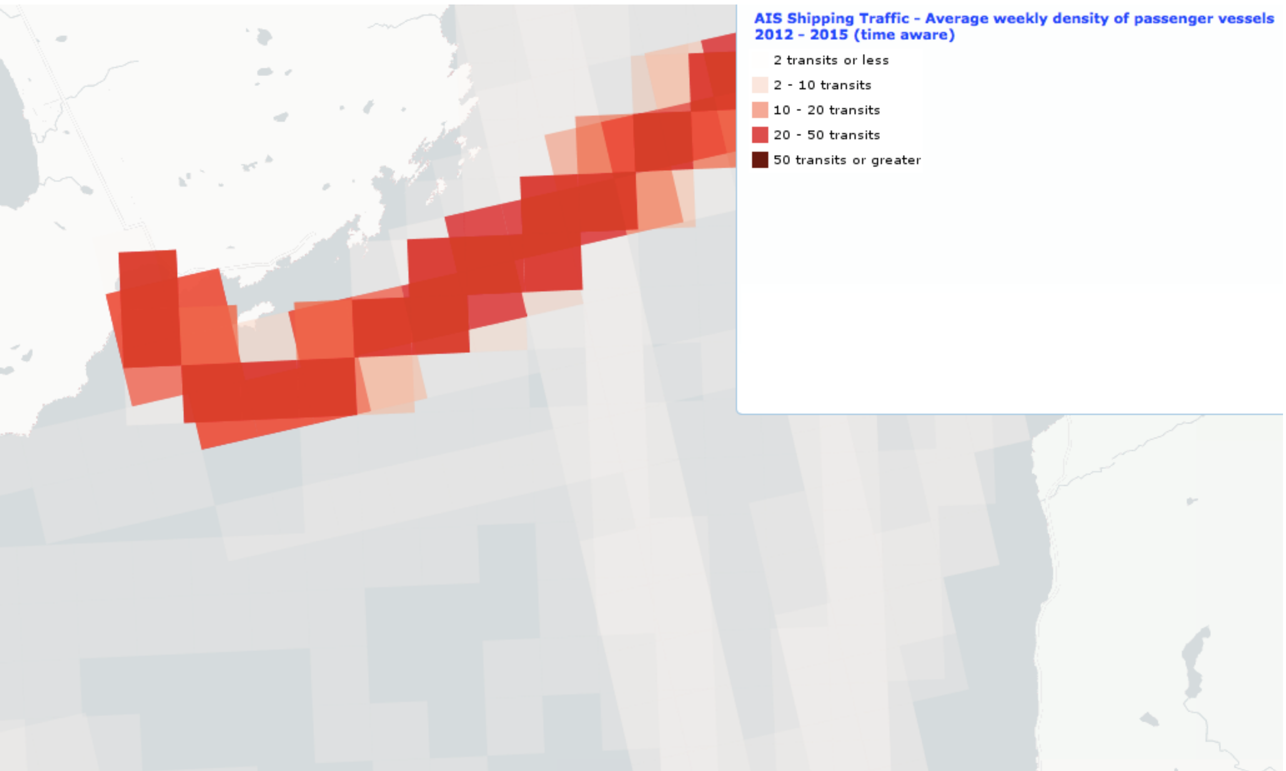


Figure 88: Average weekly density of passenger vessels (2012-2015) (*Source: Marine Scotland*)

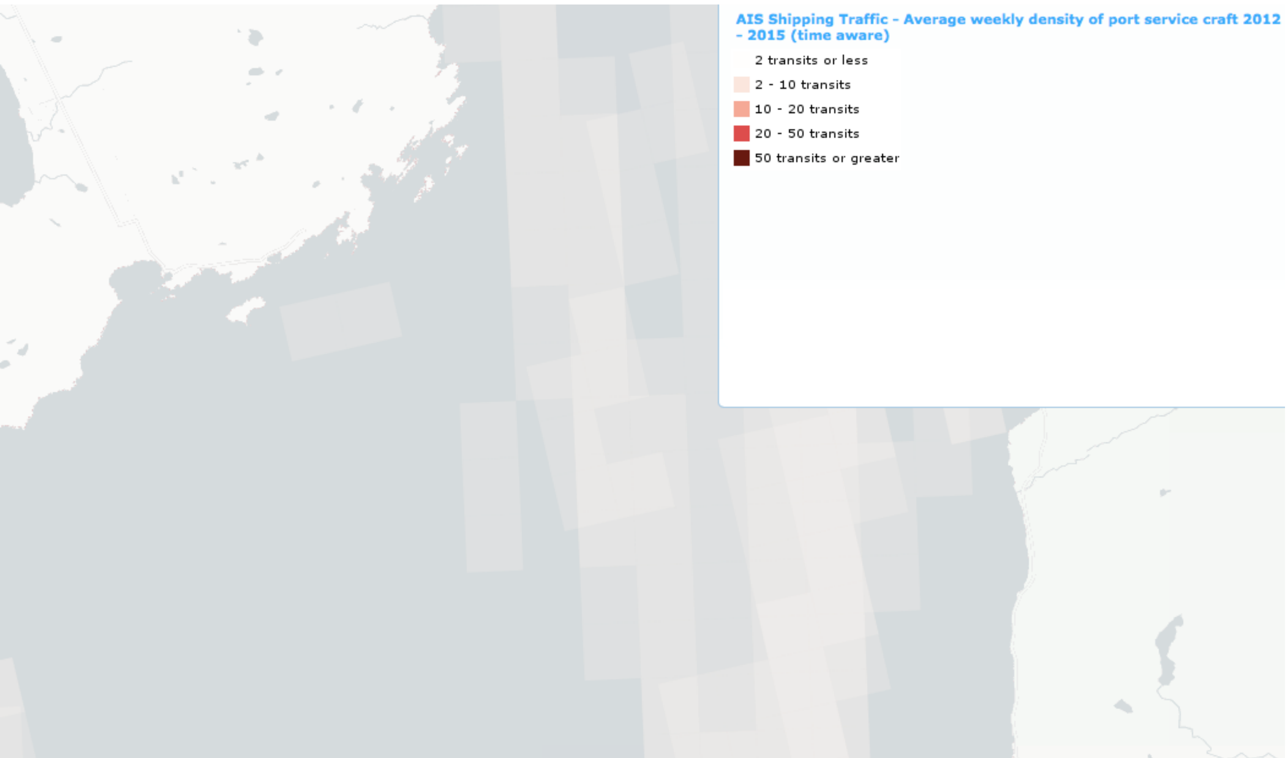


Figure 89: Average weekly density of port service craft (2012-2015) (*Source: Marine Scotland*)

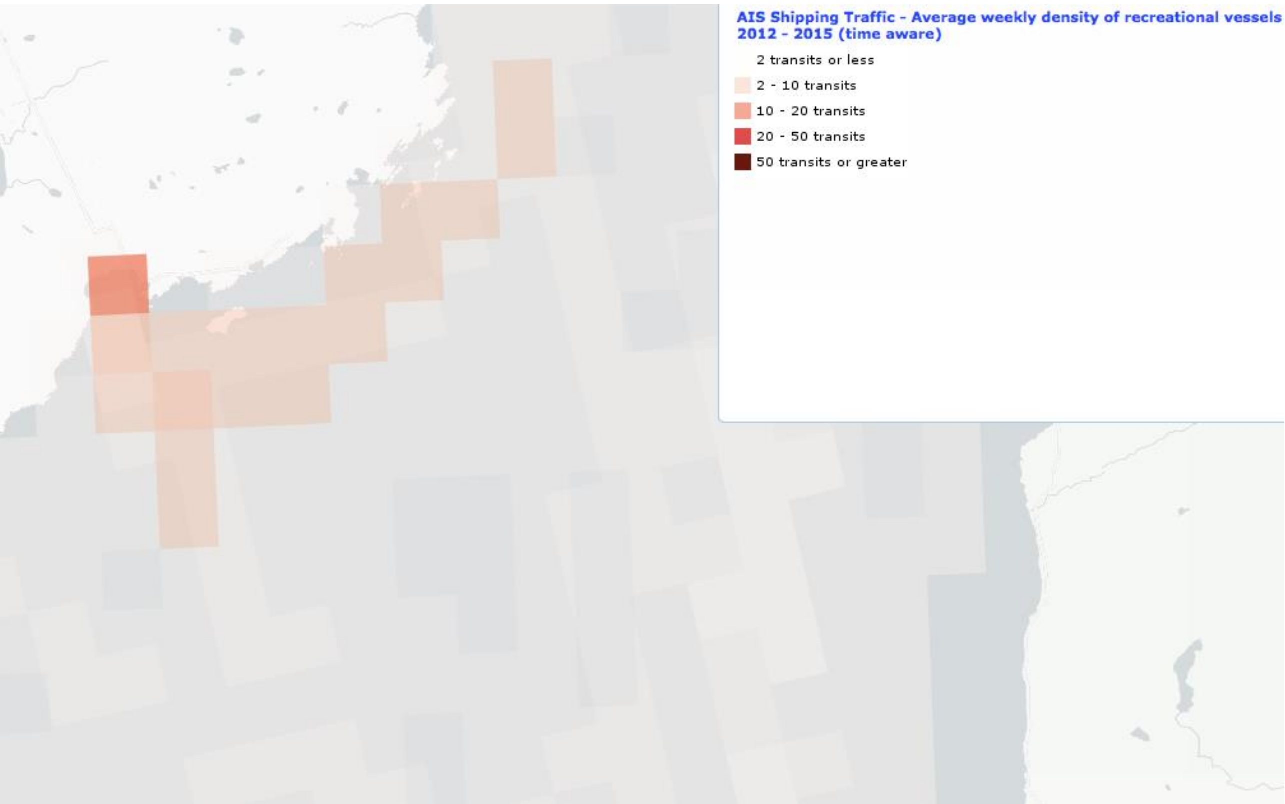


Figure 90: Average weekly density of recreational vessels (2012-2015) (*Source: Marine Scotland*)

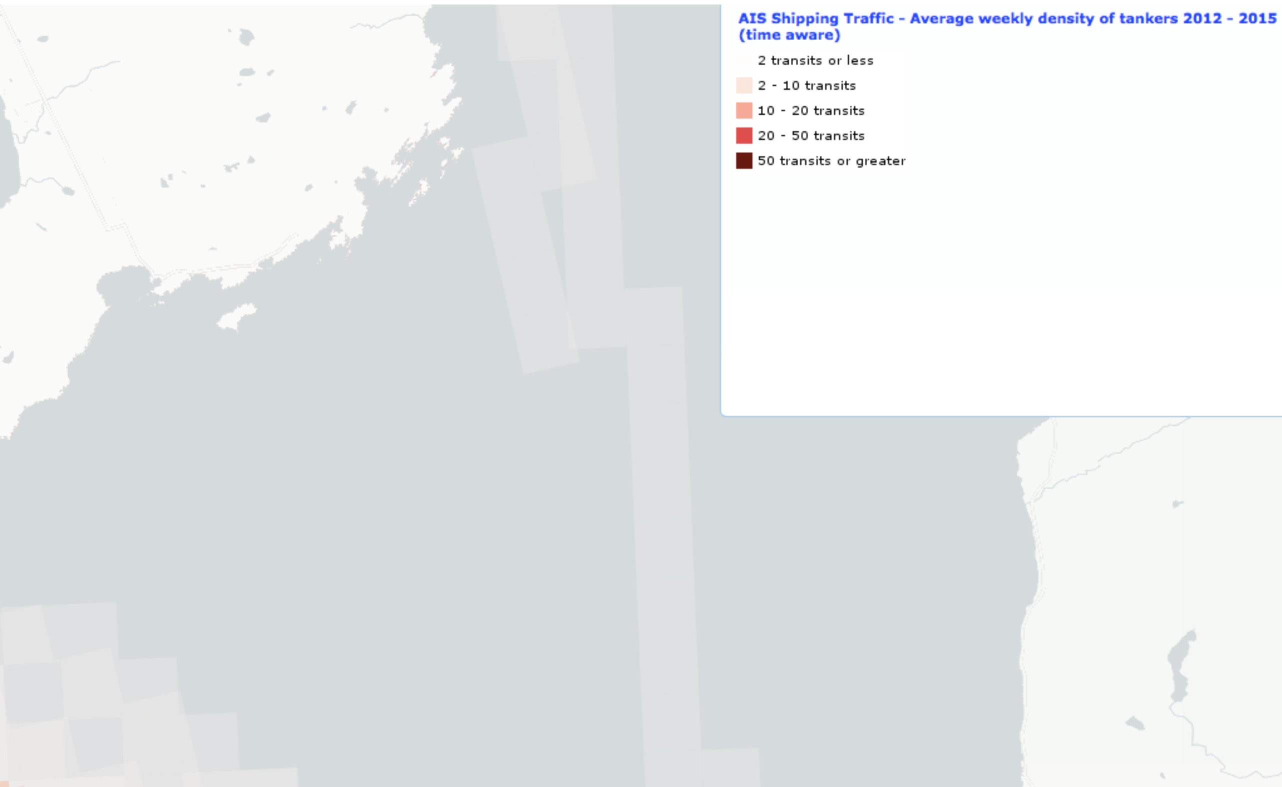


Figure 91: Average weekly density of tankers (2012-2015) (*Source: Marine Scotland*)

3.3.3 Aquaculture

In 2009 the Scottish Government in conjunction with the aquaculture industry launched ‘A Fresh Start – The Renewed Framework for Scottish Aquaculture’. The Framework set out the shared vision of the Scottish Government and the industry for the future development of the sector: “Scotland should have sustainable, growing, diverse, market-led and profitable farmed fish and shellfish industries, which promote best practice and provide significant economic and social benefits for their people, while respecting the marine and freshwater environment. The industries will contribute to the overall vision for Scotland's marine environment of "clean, healthy, safe, productive and biologically diverse seas managed to meet the long-term needs of nature and people”.

The National Marine Plan sets out objectives for Aquaculture in Scotland including; ‘An aquaculture industry that is sustainable, diverse, competitive, economically viable and which contributes to food security whilst minimising environmental impact; and support for industry targets for sustainable growth in production of finfish and shellfish to 210,000 and 13,000 tonnes respectively by 2020, from a 2011/12 baseline of 159,269 and 6525 tonnes.

Scottish Planning Policy (SPP) is a statement of Scottish Government policy on land use planning and identifies aquaculture as making a significant contribution to the Scottish economy, particularly for coastal and island communities. SPP identifies that the planning system should:

- play a supporting role in the sustainable growth of the finfish and shellfish sectors to ensure the aquaculture industry is diverse, competitive and economically viable;
- guide development to coastal locations that best suit industry needs with due regard to the marine environment; and
- maintain a presumption against further marine finfish farm developments on the north and east coasts to safeguard migratory fish species.

Local context

Aquaculture makes a significant contribution to the economy of Argyll and Bute and in particular to more remote and fragile areas. Aquaculture provides year-round jobs which are important for coastal communities and downstream jobs are also supported in transport, processing and support services. The salmon farming industry in Argyll and Bute is estimated to support 460 employees, contributing £10 million gross pay and leading to an estimated £47.2 million multiplied financial impact. Over £50 million capital investment occurred between 2006 and 2014.

In 2014, shellfish companies operating in Argyll and Bute produce roughly 80% of Scotland’s pacific oysters and 11% of Scotland’s blue mussels, together valued at approximately £2.1 million value of first sale, over 20% of the Scottish total.

In line with National aspirations, the local finfish and shellfish farming industry have expressed a desire for sustainable growth over the life of the LDP, which may lead to the consolidation of some, the enlargement of existing sites and/or new sites being established. In addition to marine sites significant investment is being made in the necessary onshore infrastructure required supporting growth and further improving sustainability of aquaculture. This includes processing plants and hatcheries to provide farmed stock but also to support innovative new environmental management such as the use of cleaner-fish in the salmon farming industry.

The current Development Plan largely takes a criteria-based approach to the assessment of individual proposals with spatial information also available in the published ICZM plans. This approach has largely been successful in guiding the industry to the most appropriate locations. National Planning policy expressed through the SPP promotes the development of a spatial approach, linked to relevant policy criteria. During the development of this, the Council has carefully explored different options for producing a spatial policy framework and has concluded that it is not currently possible to produce a robust indicative spatial strategy for Argyll and Bute, given that only a small proportion of the key criteria can be fully incorporated at this present time.

Any aquaculture proposal will also need to be consistent with other relevant Local Development Plan policies. Which policies apply depends on the location and its sensitivity, and could include, economic, environmental and access policies.

In terms of good practice in preparing development proposals, applicants are encouraged to consider the following:

- Adherence to the Code of Good Practice for Scottish Fin Fish Aquaculture or the Association of Scottish Shellfish Growers Code of Good Practice;
- Use of approved templates for development applications and EIA screening/scoping; and
- Community engagement and pre application (non statutory) activity - in particular for new, larger scale or potentially sensitive developments.

Planning permission is not the only consent required for an aquaculture development, with licensing and agreements required from Marine Scotland and Scottish Environment Protection Agency (SEPA) for finfish development.

Scottish Planning Policy states that when determining planning applications, authorities should take into account the effects of the proposed development on the environment, including effects on the seabed. Protected or important marine habitats and species both within and out with designated sites can be affected by aquaculture development through the deposition and accumulation of waste on the seabed, interactions with wildlife from the operation of the site and the control of predators.

Development Criteria:

- Landscape/seascape and visual amenity;
- Isolated coast and wild land;
- Historic or archaeological sites & their settings;
- Priority habitats/species (including wild migratory salmonids) and designated sites for nature conservation;

- Ecological status of water bodies and biological carrying capacity;
- Commercial and recreational activity;
- Amenity, arising from operational effects (waste, noise, light and odour)
- Economic Impact.

Proposals will be supported, where:

- Direct, indirect or cumulative significant adverse effects on the Development Criteria are avoided in relation to the locational characteristics of the development;
- The applicant can demonstrate that level of risk of potential impacts on any Development Criteria, relating to the operation of the site, can be effectively minimised or mitigated by appropriate operational measures.

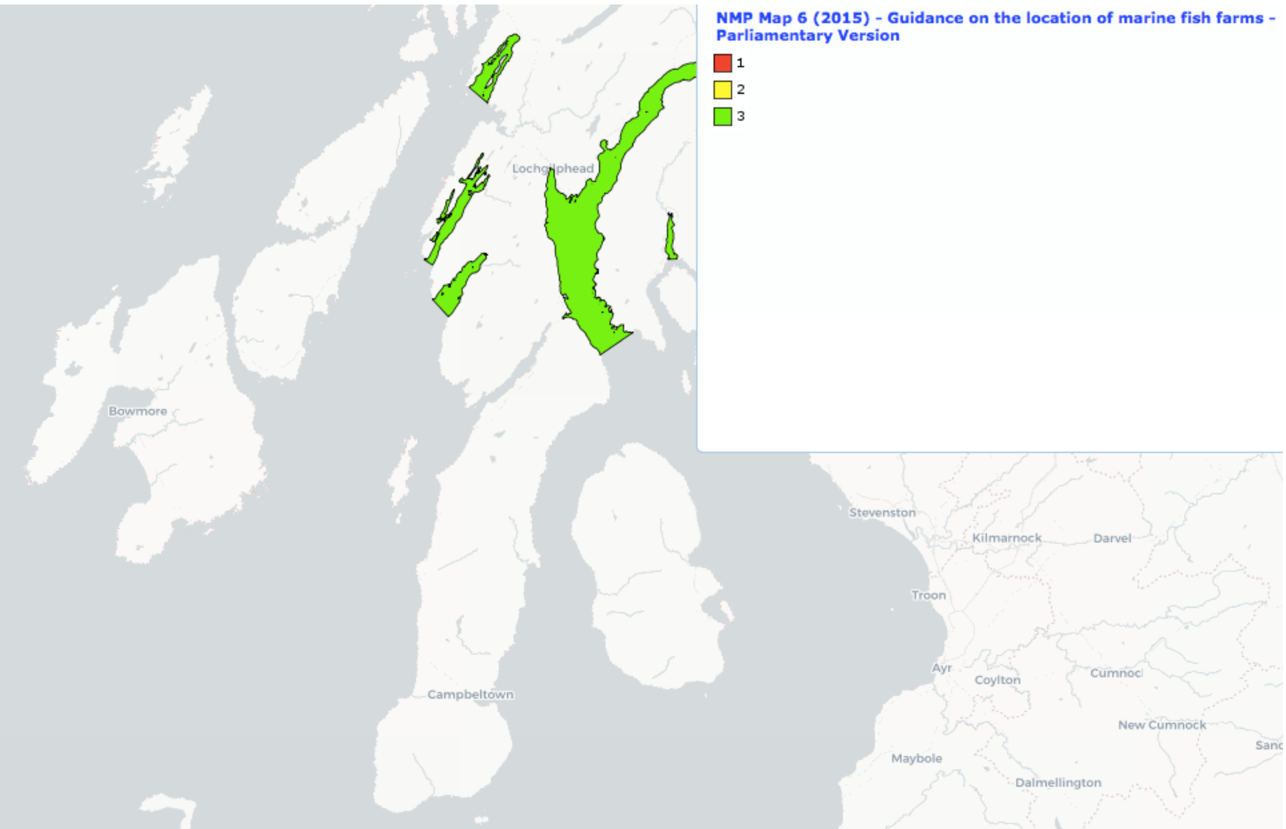


Figure 92: Marine fish farms next to Islay Island (*Source: Marine Scotland*)

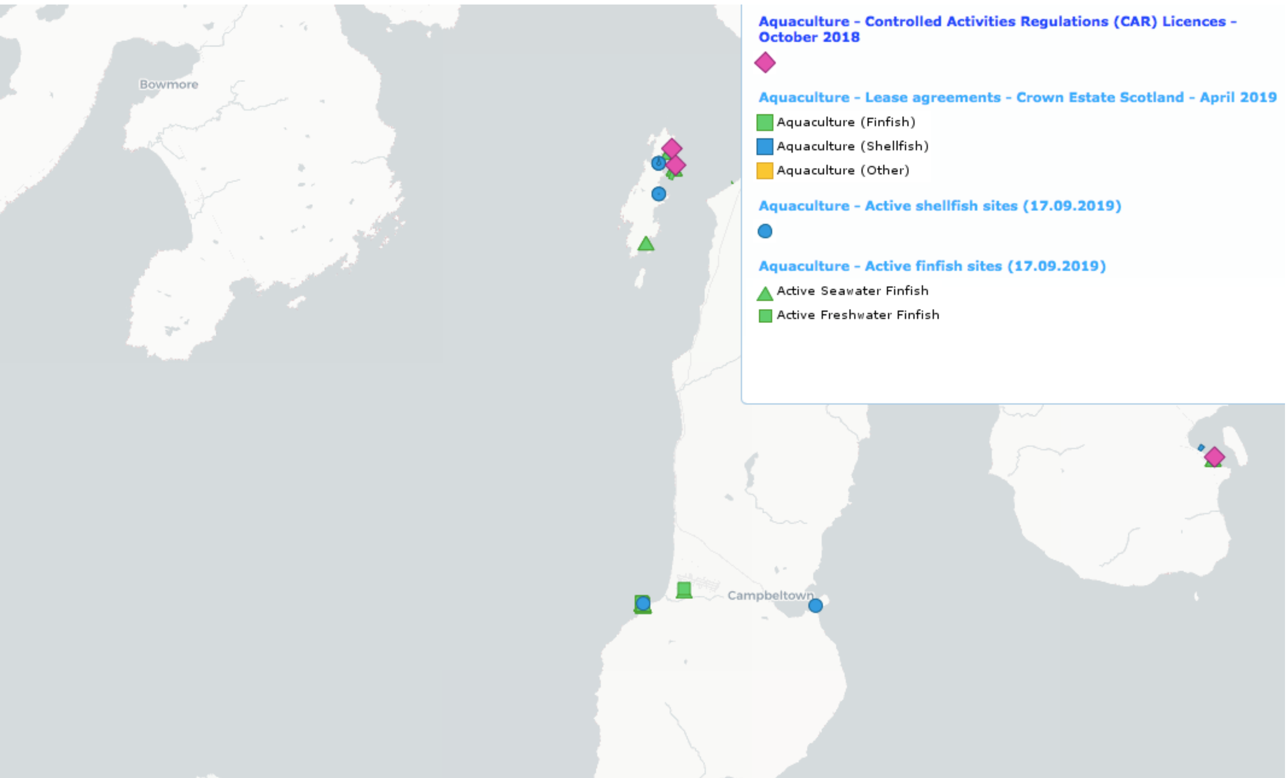


Figure 93: Aquaculture activities CAR licenses (*Source: Marine Scotland*)

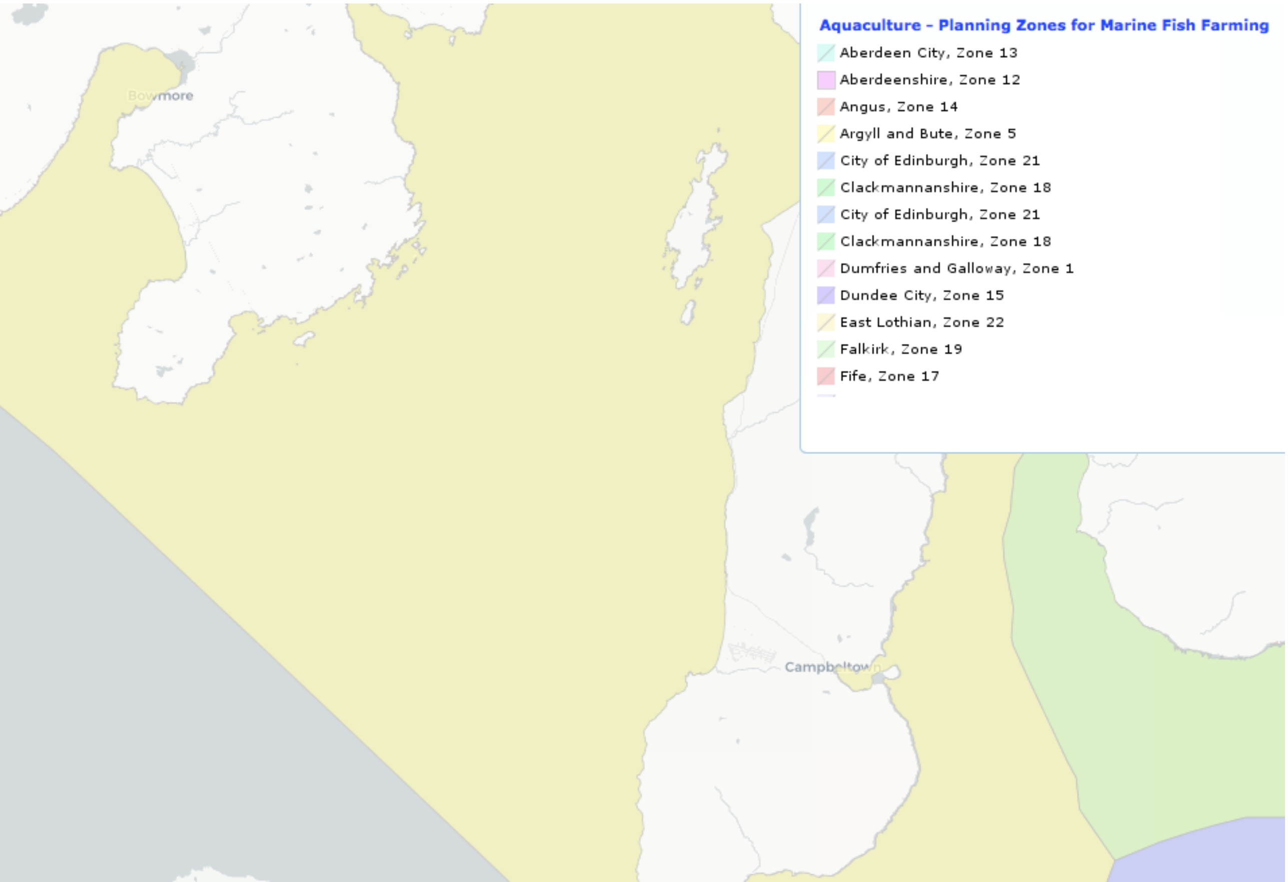


Figure 94: Planning Zones for Marine Fish Farming (*Source: Marine Scotland*)

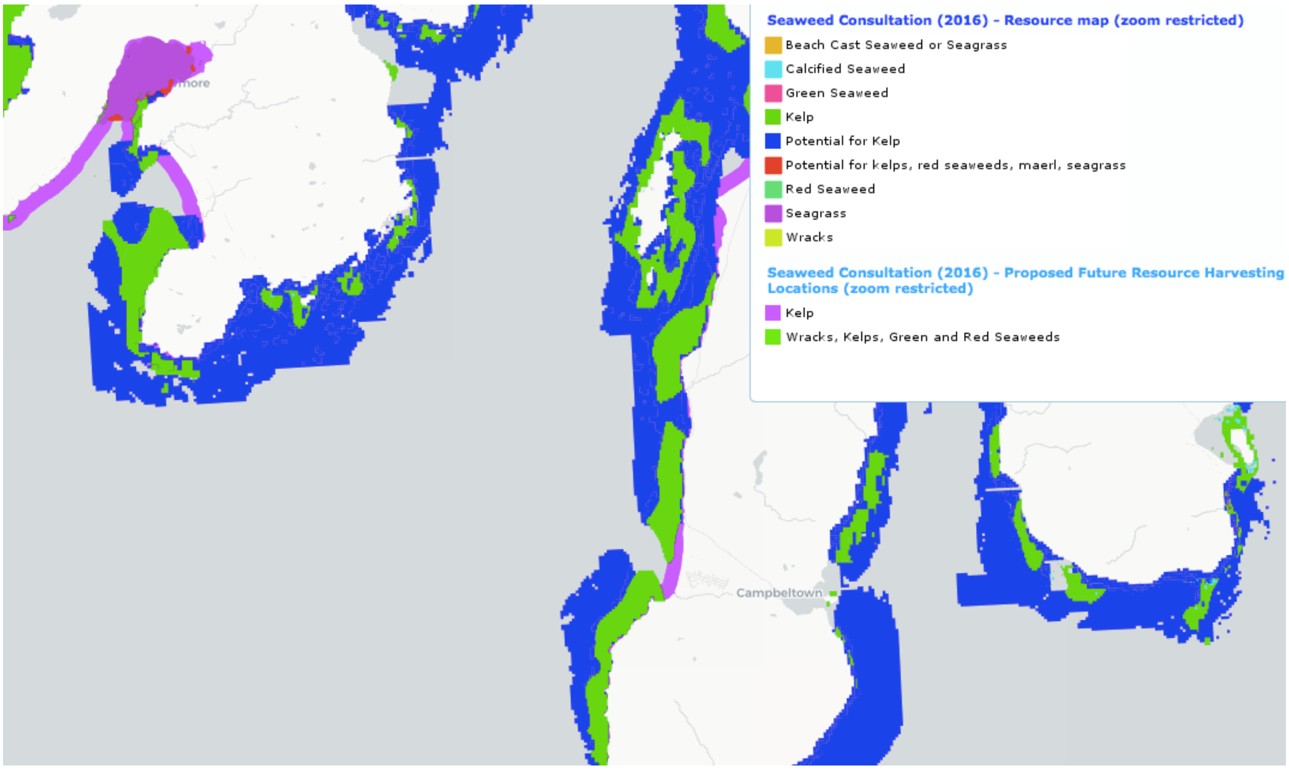


Figure 95: Seaweeds resources (*Source: Marine Scotland*)

3.3.4 Oil and Gas

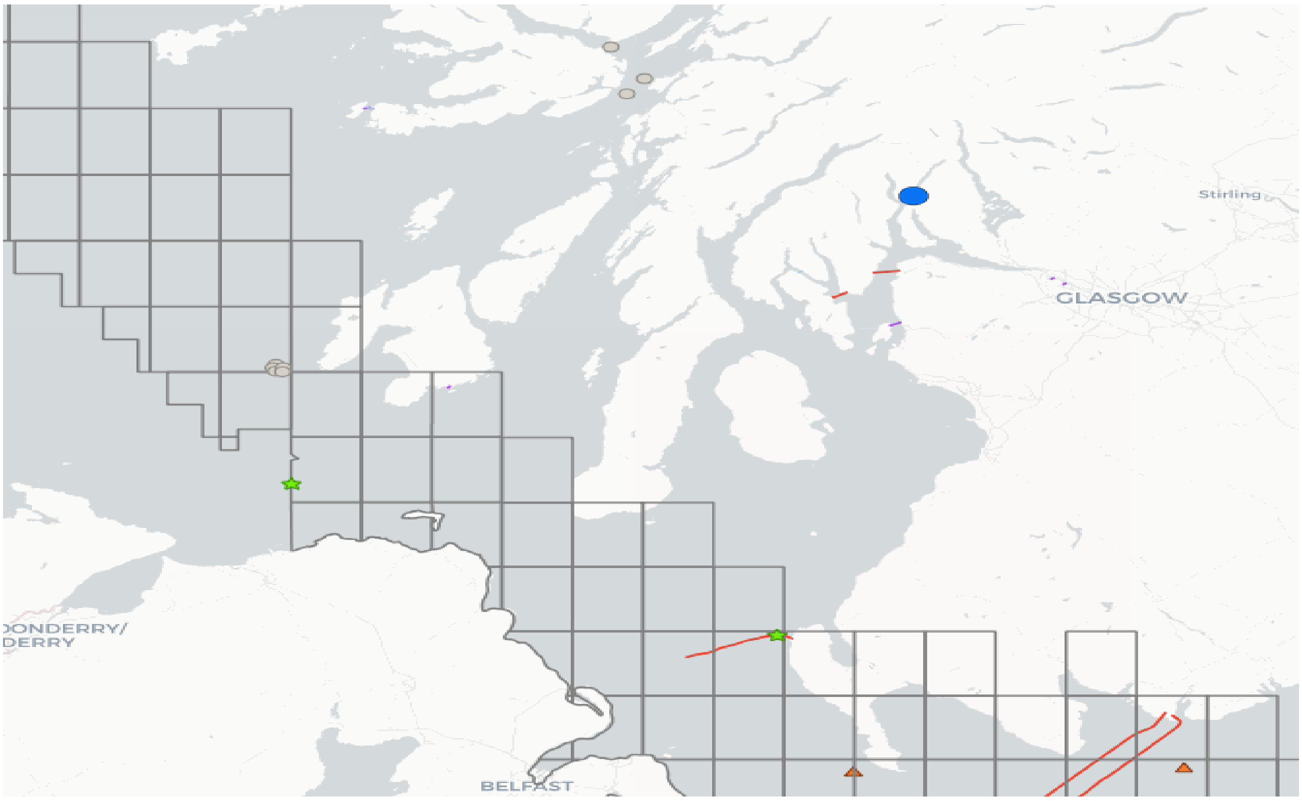


Figure 96: Oil&Gas exploratory blocks (*Source: Marine Scotland*)

Part of the Islay offshore area is included in Block 14/125 and 15/125 belonging to the 29th licencing round (2016) for O&G exploration and production. Blocks 1 and 15 are not yet assigned (source: Oil & Gas Authority, UK).

A submarine cable is connecting Islay with the Peninsula of Kintyre.

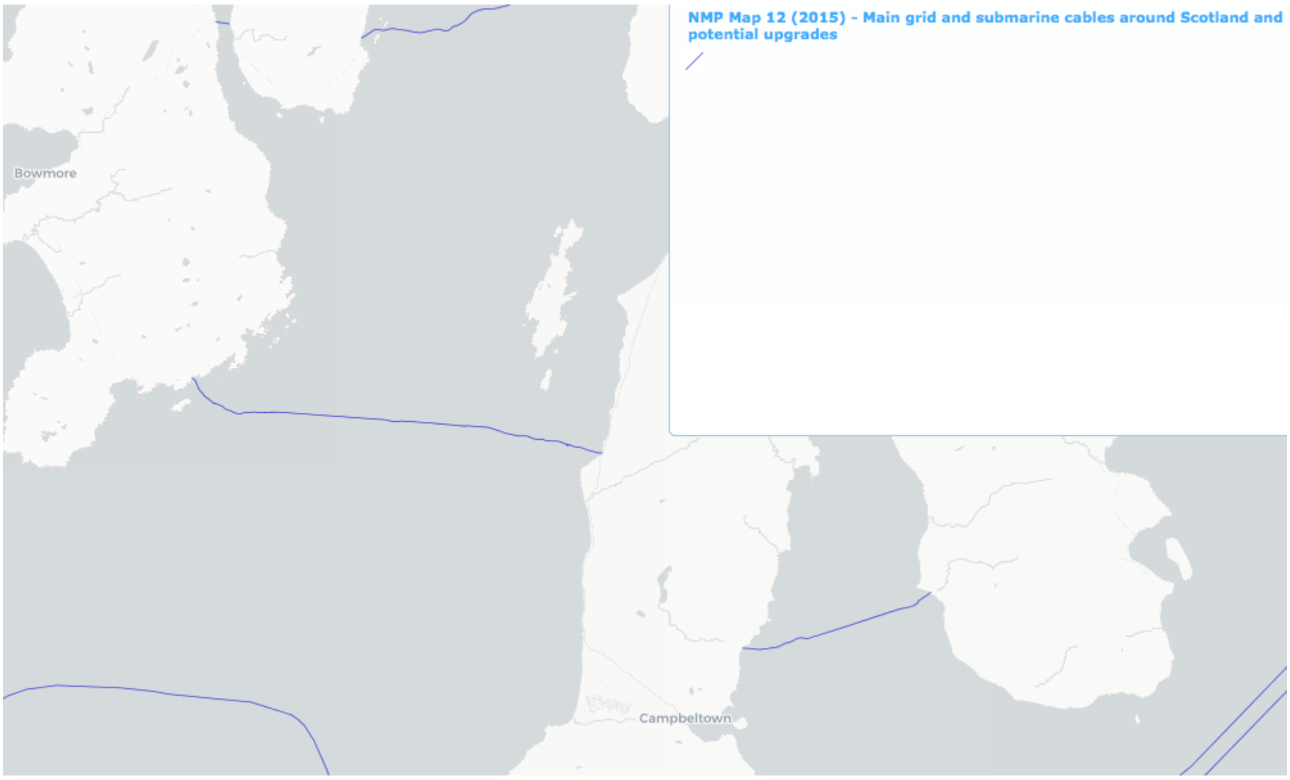


Figure 97: Submarine cables, Islay (*Source: Marine Scotland*)

3.3.5 Wind farms

There are three proposed short-term sites for development in this area: Argyll Array, Islay and Kintyre, and an additional two options to be considered in the area for development in the medium term.

- North west of Islay in an area with fewer environmental sensitivities and avoiding shipping, radar, aviation and cable and pipelines.
- South of the Mull of Kintyre in an area with fewer environmental sensitivities and avoiding shipping.

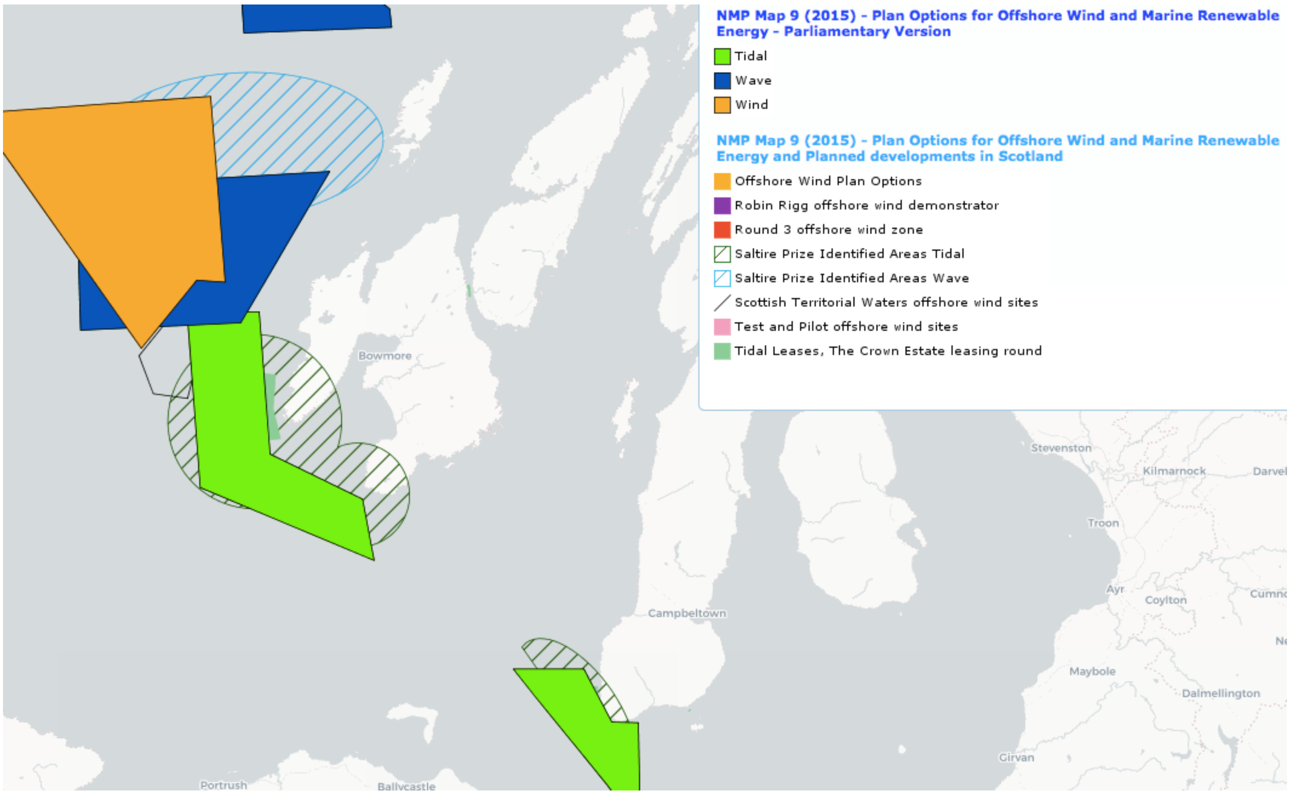


Figure 98: Offshore wind farm existing areas (*Source: Marine Scotland*)

Table 15: Status of tidal energy projects in Islay area

Project	Type of project	Installed capacity (MW)	Status
Isle of Islay (West Islay)	Commercial	30	In planning
Islay Demonstration Zone	Demonstration zone	-	In planning
Sound of Islay	Commercial demonstration	10	Pre-construction

3.3.5 Cultural heritage

Scotland's historic environment and cultural heritage is made up by historic ships, maritime museums, festivals of the sea, world heritage sites, scheduled monuments and designated wrecks. It also included are the remains of settlements from prehistory to the modern day such as harbours, lighthouses and ship-building yards; ecclesiastical buildings and defensive features from castles to war-time defences. These heritages help to create a sense of place, wellbeing and identity, enhancing the distinctiveness of the coast and attracting visitors. Scuba divers visit underwater wrecks of ships and aircraft, while in some areas archaeological sites once on land may be submerged because of changes in the coastline and sea level since the last ice age, offering the potential of fresh insights into the ancient settlements.

Cultural heritage sites make a contribution to the economy, as those which lie within the marine environment, such as shipwrecks, and those on land, where the sea forms an integral part of their identity such as lighthouses, maritime museums, coastal castles and island monasteries.

However, many heritage sites (e.g. historic harbours and lighthouses) are in commercial use and others generate economic value from tourism.

Visitor income was £1.55 million in 2008 for the 20 of 97 managed and visitable coastal heritage sites that provided economic data. Some sites, including shipwrecks offshore, can be visited for free, so do not contribute directly to the economy, but do contribute to less tangible social benefits such as education, health and well-being. However, VisitScotland statistics indicate that approximately 83% of visitors come to Scotland primarily to visit historic sites.

The coast of the Jura Sound has a number of Coastal Built Heritage sites, and a relevant number of wrecks, either coastal and offshore.

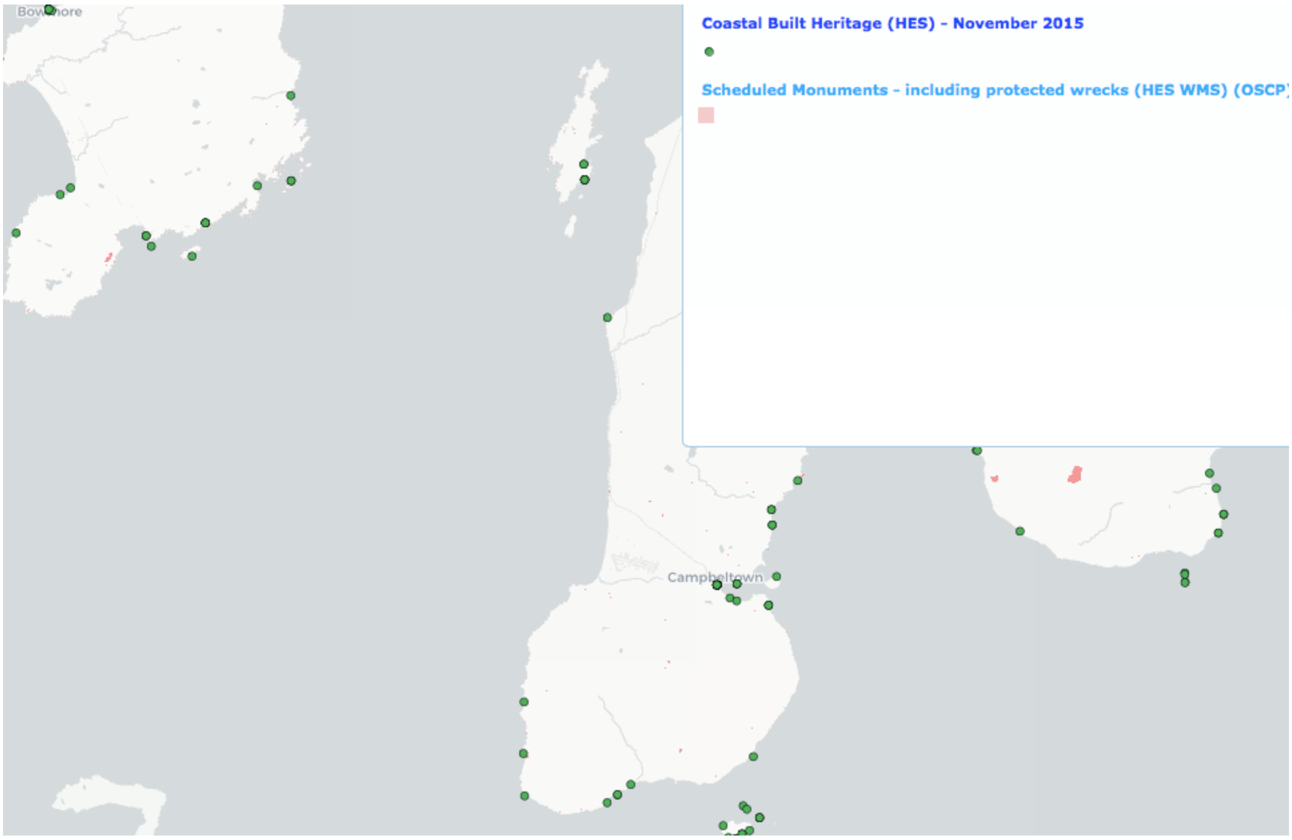


Figure 99: Heritage sites along Islay coast (*Source: Marine Scotland*)

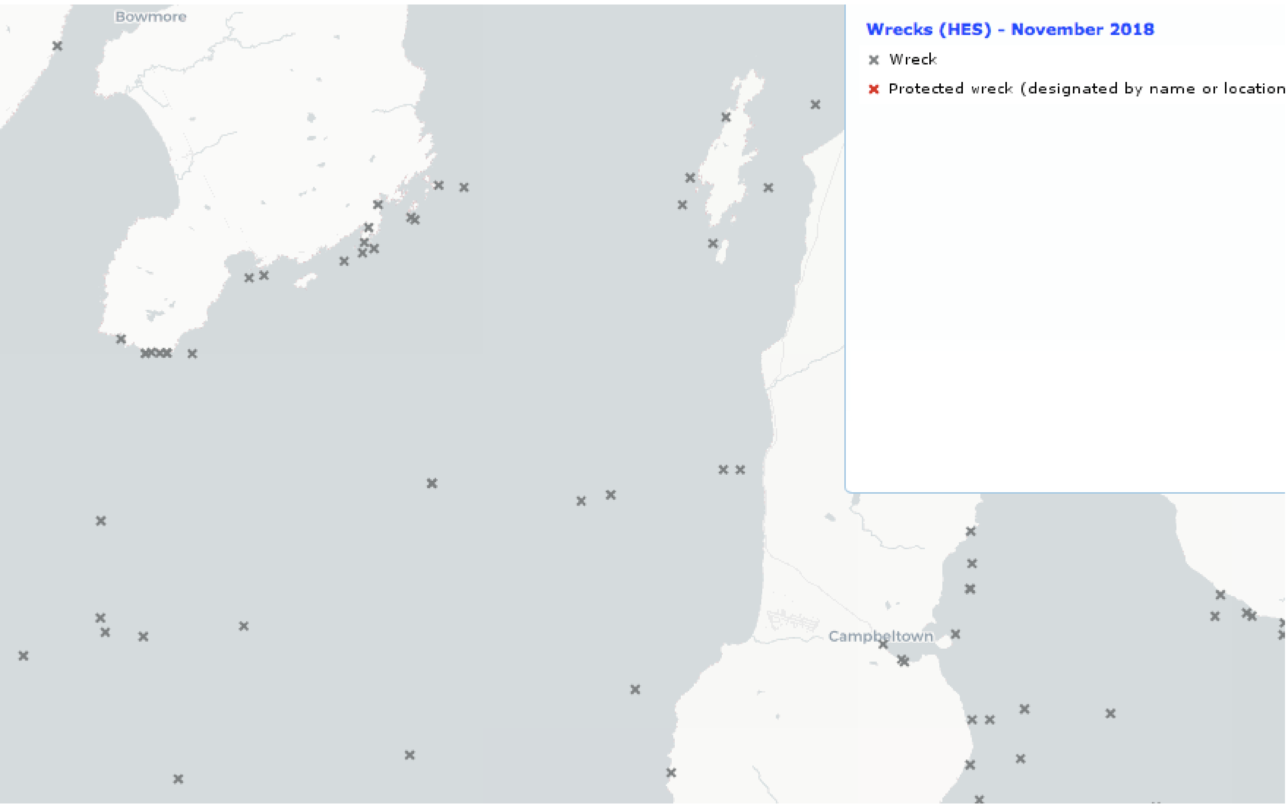


Figure 100: Marine wrecks position (*Source: Marine Scotland*)

3.3.6 Landscape

The Scottish west coast includes the area from the Kintyre Peninsula to Cape Wrath, and those islands within the Malin and Inner Hebrides (Islay, Jura, Mull, Rum and Skye). The islands are individually distinctive (e.g. the generally low-lying nature of Islay and more mountainous terrain of Skye), and the coastline highly indented and diverse. Population density is low in these areas and there is a general absence of large-scale development, with fishing and farming prominent uses of the land and sea. There are a number of National Scenic Area designations, representing the bulk of the designated for landscape in Scotland. These largely coincide with areas identified as “wild land”, and therefore represent some of the best natural and semi-natural areas in Scotland.

The more recent development of offshore wind farms, wave and tidal devices, has led to a greater consideration of landscape/seascape issues in addition to other potential environmental effects primarily due to their proximity to the coast, and therefore visibility from land compared to the position of many offshore oil and gas facilities which have been outside of visible range from the coast. Current renewables farms tend to be restricted on technical and economic grounds to water depths of between 30 and 60 m, which in most areas of the southern North Sea have led to developments being visible from the shore. The proposals for tethered turbine site 30km off the coast of Peterhead in Scotland suggests the potential for future deployment of such devices that could extend the feasible economic depth ranges of wind turbines, which could lead to a change in offshore seascapes (see SNH Guidelines on Windfarms, 2017). Renewables developments also require landfall and other onshore infrastructure for operation and maintenance, and ports presently or formerly utilised by the offshore oil and gas industry are now also servicing the renewables sector, perpetuating their connection with the offshore energy industry; however, some new port developments may be required to provide the capacity for renewables deployment.

In Scotland, aquaculture continues to develop and the changes in the coastal landscape/seascape this may generate have been the subject of guidance (SNH 2018). Marine development should implement strategies to avoid or mitigate negative visual impacts, and marine spatial planning should address the need to direct development towards areas of least sensitivity; EIA should consider visual impact, including landscape carrying capacity. Whilst sensitivity is not specifically mentioned in the National Marine Plan, seascapes are recognised, and regional marine plans have the potential to add more specificity to policies for individual areas.

The Argyll and Bute Local Development Plan provides the local planning framework for the Council area, excluding the Loch Lomond and Trossachs National Park area. The Plan is divided into the written statement and proposals maps. The written statement provides the general policy context against which planning applications for new development proposals should be assessed. This is supported by the proposals maps, which show the range of development opportunities and constraints within the area, for example:

- the key development areas, for example, the allocations for housing, industry and business, community facilities and infrastructure;
- the potential areas for future development (Potential Development Areas);
- areas requiring actions such as environmental improvement or regeneration (Areas for Action)
- environmental designations such as national Scenic Areas, Sites of Specific Scientific Interest (SSSIs), Special Protection Areas and Local Nature Conservation Sites.

3.3.8 Other sea uses

The Scotland’s National Marine Plan, in terms of recreation and tourism, has the ambition to position Scotland as a world-class sustainable coastal and marine tourism and recreation destination through the sustainable development of coastal and marine recreation activities and industries in Scotland; to reach a sufficient protection and enhancement of the unique, natural resources which attract visitors and which are relied upon for recreational activities, and continued and improved the access to marine and coastal resources for tourism activities and recreational use. The unspoilt coastal environment of coastal sea and the wild natural scenery attract tourists in pursuit of a wide range of activities and interests including walking, bird and cetacean watching, wildfowling, sailing, fishing, diving and the maritime history of the region. Visitor surveys for the relevant coastal regions of Scotland highlight the importance of the scenery and landscape in attracting tourists to the region.

The economic importance of the Scottish marine tourism industry was highlighted by a recently published strategic framework for Scotland’s marine tourism sector with the aim of developing the growth of sailing tourism in Scotland from £101 million of visitor expenditure to £145m by 2020, and to increase the overall economic value of the marine tourism sector from £360m to over £450m by 2020 (Scottish Tourism Alliance, 2014).

A watersports participation survey for 2014 estimated that *ca*. 27% of the UK population (or 13 million people) participated in watersports. The most popular activities in 2014 were the same as in previous years: spending general leisure time at the beach, coastal walking and outdoors swimming. Participation rates in any watersports activities among Northern Ireland residents were far higher (63%) than elsewhere in the UK (e.g. Wales/south west England (33.6%), south-east England (26.5%), northern England (24%) and Scotland (24.5%), particularly with respect to coastal walking and spending time at the beach (Arkenford 2015).

There were *ca*. 2.8 million (average 2012-2014) domestic overnight trips to the Scottish regions adjacent to sea, with associated spending of £0.7 billion. The Highland region (1.8 million trips) was the most popular with Argyll and Bute and Eilean Siar (the Western Isles) receiving 0.8 million and 0.1 million overnight trips respectively. 11.5 million tourism day visits were taken each year (average 2012-2014) to the relevant Scottish regions, worth £0.5 billion.

The relative remoteness of the Western Isles means that they receive fewer tourists than south-west Scotland and the coast of Northern Ireland. Most of the region’s tourism and leisure infrastructure is concentrated to the south and east of the Firth of Clyde, one of the most intensively used areas for coastal recreation in Scotland. Yachting takes place in most areas throughout the isles, but most activity is concentrated in the south.

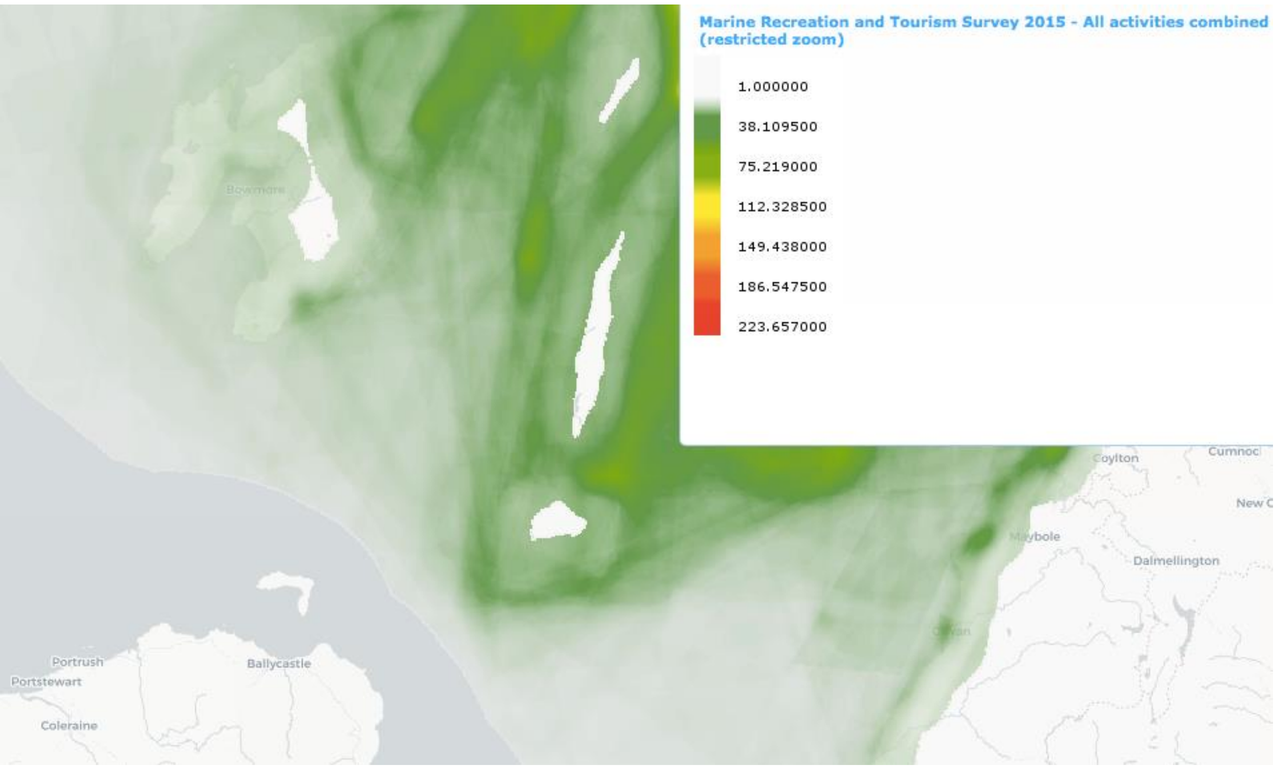


Figure 101: Index of combined touristic activities, Jura Sound (*Source: Marine Scotland*)

4. ENVIRONMENTAL IMPACT ASSESSMENT

4.1 IMPACT ASSESSMENT

4.1.1 Impact on birds

The most common seabird in the Islay area has been evaluated using the CRM model (Band et. *al.*, 2012), using the same procedure described in D 4.1 – France (see for more detailed information).

The Flight Height Distribution is that available within the model, and the median of the flight height distribution has been used in computations. Other flight distributions are in Jonston & Cook, (2016). For avoidance rates, see Cook et *al*. (2012, 2014) and Bowgen et *al*. (2018).

Bird density at sea has been derived from Pollock et *al.* (2000). Flight speeds derived from Hall & Haesy, (2010); body size and wing span from BirdLife International website. Number of pairs or presence has not been retrieved from Natura 2000 Standard Data Form, unfortunately of any help.

Since BGF is located in open sea at > 10 km offshore, on a deep bottom (90 m approx), the species with an inshore habitat have been excluded (grebes, ducks and scoters).

Wind turbine productivity has been set as similar to that of Tiree island, supplied by the BGF partner Strathclyde University.

Table 16: Selected bird and their IUCN status

Common name	Scientific name	Cat	Max range	RL UK	RL EU	RL Glo
Great northern diver	*Gavia immer*	?	poss/scarce	LC	VU*	LC
Northen Fulmar	*Fulmarus glacialis*	?	100 (460)	LC	EN	LC
Great shearwater	*Puffinus gravis*	?	300	LC	LC	LC
Manx shearwater	*Puffinus puffinus*	?	300	LC	LC	LC
European Storm-petrel	*Hydrobates pelagicus*	?	65	LC	LC*	LC
Gannet	*Morus bassanus*	?	590	LC	LC	LC
Cormorant	*Phalacrocorax carbo*	?	35	LC	LC	LC
Common Shag	*Gulosus aristotellis*	?	17	LC	LC*	LC
Common eider	*Somateria molissima*	?	80	NT	VU**	NT
Lesser Black-backed gull	*Larus fuscus*	?	181	LC	LC**	LC
Herring gull	*Larus argentatus*	?	20 (100)	LC	NT**	LC
Great Black-backed gull	*Larus marinus*	?	40	LC	LC**	LC
Black-legged Kittiwake	*Rissa tridactyla*	?	120	VU	VU	VU
Common guillemot	*Uria aalge*	?	30 (150)	LC	NT*	LC
Razorbill	*Alca torda*	?	95	NT	NT	NT
Black guillemot	*Cepphus grylle*	?	10	LC	LC	LC
Atlantic Puffin	*Fratercula arctica*	?	66	VU	EN	VU

CAT : Categories (**R** : Reproducing; **P** : Permanent; **W** : Wintering; **C** : Concentration)
MAX RANGE: Maximum range (Km)
RL UK : Red list United Kingdom *(Sources : IUCN and Bird Life)*

RL EU : Red list Europe *(Sources : IUCN and Bird Life)*
RL Glo : Red list Global *(Sources : IUCN and Bird Life)*
* Annex I Bird Directive (anyway protected)
** Annex II (protected/regulated)

Two different scenario has been tested, the first using the bird density in Pollock et *al*. (2000), on the hypotesys that the BGF do not represent an attraction to seabird, and a collision is merely a stocastic event; a second scenario, where bird density is increased due to direct or indirect attraction of the BGF structure or its operational life, basing on papers of Buschmann et *al*. (2005), Callier et *al*. (2018) and on Carss, (1993), thus mutiplying by a factor of 5 the usual bird densities.

Scenario 1 – Wind turbine only

- ***Somateria mollissima***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	
Proportion at rotor height	1,7%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		1062	1186	1617	1872	2221	2307	2314	2063	1699	1441	1114	984	
Avg collision risk for single rotor transit	3,3%													
Collisions assuming no avoidance	0,0%	3	3	4	5	5	6	6	6	5	4	3	3	***53***
Collisions assuming avoidance rate	95,0%	0	0	0	0	0	0	0	0	0	0	0	0	***3***
	98,0%	0	0	0	0	0	0	0	0	0	0	0	0	***1***
birds per month	99,0%	0	0	0	0	0	0	0	0	0	0	0	0	***1***
	99,5%	0	0	0	0	0	0	0	0	0	0	0	0	***0***

- ***Phalacrocorax carbo***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	6	6	6	6	6	6	6	6	6	6	6	6	
Proportion at rotor height	1,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		10899	12166	16592	19212	22788	23669	23741	21164	17438	14789	11431	10093	
Avg collision risk for single rotor transit	3,7%													
Collisions assuming no avoidance	0,00%	0	0	0	0	0	0	0	0	0	0	0	0	***2***
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	***0***

- ***Larus marinus***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	92,9%
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	1,99	1,99	1,99	1,99	1,99	0	0	0	
Proportion at rotor height	15,6%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		2339	2358	2940	3179	7226	7336	7428	6881	6013	0	0	0	
Avg collision risk for single rotor transit	4,9%													
Collisions assuming no avoidance	0,0%	11	11	14	15	30	32	33	32	28	0	0	0	204
Collisions assuming avoidance rate	95,0%	1	1	1	1	1	2	2	2	1	0	0	0	10
	98,0%	0	0	0	0	1	1	1	1	1	0	0	0	4
birds per month	99,0%	0	0	0	0	0	0	0	0	0	0	0	0	2
	99,5%	0	0	0	0	0	0	0	0	0	0	0	0	1

- ***Larus fuscus***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	92,9%
Stage A - flight activity														
Daytime areal bird density	birds/km2	0	0	0	0,99	0,99	0,99	0,99	0,99	0	0	0	0	
Proportion at rotor height	11,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		0	0	0	3104	3510	3564	3609	3343	0	0	0	0	
Avg collision risk for single rotor transit	4,2%													
Collisions assuming no avoidance	0,00%	0	0	0	8	8	9	9	9	0	0	0	0	43
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	2
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	1
	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	0

- ***Larus argentatus***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	92,9%
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	1,99	1,99	1,99	1,99	1,99	0,99	0,99	0,99	
Proportion at rotor height	14,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		2339	2358	2940	3179	7226	7336	7428	6881	6013	2750	2357	2254	
Avg collision risk for single rotor transit	4,3%													
Collisions assuming no avoidance	0,0%	8	8	11	12	23	25	25	25	21	10	8	8	185
Collisions assuming avoidance rate	95,0%	0	0	1	1	1	1	1	1	1	1	0	0	9
	98,0%	0	0	0	0	0	0	1	0	0	0	0	0	4
birds per month	99,0%	0	0	0	0	0	0	0	0	0	0	0	0	2
	99,5%	0	0	0	0	0	0	0	0	0	0	0	0	1

- ***Ryssa tridactyla***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	92,9%
Daytime areal bird density	birds/km2	0,99	0,99	4,99	4,99	4,99	4,99	4,99	0,99	0,99	0,99	0,99	0,99	
Proportion at rotor height	15,6%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		2394	2413	15168	16398	18543	18825	19062	3503	3061	2814	2412	2307	
Avg collision risk for single rotor transit	2,9%													
Collisions assuming no avoidance	0,00%	1	1	7	8	8	9	9	2	1	1	1	1	50
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	2
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	1
	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	0

- ***Fulmarus glacialis***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	92,9%
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	
Proportion at rotor height	5,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		1974	1990	2481	2682	3033	3079	3118	2888	2524	2320	1989	1902	
Average collision risk for single rotor transit	2,8%													
Collisions assuming no avoidance	0,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	0

- ***Morus bassanus***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		91%	96%	91%	76%	69%	66%	67%	76%	69%	91%	92%	91%	81,3%
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	
Proportion at rotor height	5,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		2723	2745	3423	3700	4184	4248	4302	3985	3482	3201	2744	2624	
Average collision risk for single rotor transit	4,2%													
Collisions assuming no avoidance	0,00%	1	1	2	1	2	1	2	2	1	2	1	1	17
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	1
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
birds per month	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	0
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	0

- ***Puffinus puffinus***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	0	0	0,99	0,99	0,99	4,99	4,99	4,99	0,99	0,99	0	0	
Proportion at rotor height	0,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		0	0	3877	3995	4354	21865	22315	21315	3858	3738	0	0	
Avg collision risk for single rotor transit	1,9%													
Collisions assuming no avoidance	0,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	***0***

- ***Gavia immer***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99	
Proportion at rotor height	5,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		1974	1990	2481	2682	3033	3079	3118	2888	2524	2320	1989	1902	
Avg collision risk for single rotor transit	3,7%													
Collisions assuming noavoidance	0,00%	0	0	0	0	0	0	0	0	0	0	0	0	***2***
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
birds per month	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	***0***

- ***Alca torda***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	1,99	1,99	1,99	5	0,99	0,99	0,99	0,99	
Proportion at rotor height	0,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		2558	2579	3216	3477	7903	8023	8124	18910	3272	3008	2578	2465	
Avg collision risk for single rotor transit	2,1%													
Collisions assuming no avoidance	0,00%	0	0	0	0	0	1	1	1	0	0	0	0	***5***
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
birds per month	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	***0***

- ***Uria aalge***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	*year avg*
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	5	5	5	5	5	0,99	0,99	0,99	
Proportion at rotor height	0,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		3655	3684	4594	4967	28367	28798	29161	27014	23606	4297	3683	3522	
Avg collision risk for single rotor transit	1,7%													
Collisions assuming no avoidance	0,00%	0	0	0	0	0	0	0	0	0	0	0	0	***2***
Collisions assuming avoidance rate	95,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	98,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
birds per month	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	***0***
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	***0***

Scenario 2 – Wind turbine + fish farm

- ***Larus marinus x 5***

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*year avg*
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	5	5	5	5	10	10	10	10	10	0	0	0	
Proportion at rotor height	15,6%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		11814	11909	14850	16054	36310	36862	37326	34578	30216	0	0	0	
Avg collision risk for single rotor transit	4,9%													
Collisions assuming no avoidance	0,00%	54	55	69	76	149	161	165	160	138	0	0	0	***1029***
Collisions assuming avoidance rate	95,00%	3	3	3	4	7	8	8	8	7	0	0	0	***51***
	98,00%	1	1	1	2	3	3	3	3	3	0	0	0	***21***
	99,00%	1	1	1	1	1	2	2	2	1	0	0	0	***10***
	99,50%	0	0	0	0	1	1	1	1	1	0	0	0	***5***

- ***Larus argentatus x 5***

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*year avg*
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	***92,9%***
Daytime areal bird density	birds/km2	0,99	0,99	0,99	0,99	1,99	1,99	1,99	1,99	1,99	0,99	0,99	0,99	
Proportion at rotor height	14,0%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		2339	2358	2940	3179	7226	7336	7428	6881	6013	2750	2357	2254	
Average collision risk for single rotor transit	4,3%													
Collisions assuming no avoidance	0,00%	8	8	11	12	23	25	25	25	21	10	8	8	***185***
Collisions assuming avoidance rate	95,00%	0	0	1	1	1	1	1	1	1	1	0	0	***9***
	98,00%	0	0	0	0	0	0	1	0	0	0	0	0	***4***
	99,00%	0	0	0	0	0	0	0	0	0	0	0	0	***2***
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	***1***

- ***Ryssa tridactyla x 5***

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year avg
Proportion of time operational wind turbine		94%	94%	95%	97%	84%	89%	90%	94%	93%	98%	93%	94%	**92,9%**
Daytime areal bird density	birds/km2	5	5	10	10	10	10	10	5	5	5	5	5	
Proportion at rotor height	15,6%													
Total daylight hours per month		240	268	366	423	502	522	523	466	384	326	252	222	
Total night hours per month		504	404	378	297	242	198	221	278	336	418	468	522	
Flux factor		12091	12188	30397	32861	37161	37726	38201	17694	15462	14214	12183	11651	
Avg collision risk for single rotor transit	2,9%													
Collisions assuming no avoidance	0,00%	25	26	65	71	70	76	78	38	32	31	26	25	**562**
Collisions assuming avoidance rate	95,00%	1	1	3	4	4	4	4	2	2	2	1	1	**28**
	98,00%	1	1	1	1	1	2	2	1	1	1	1	0	**11**
birds per month	99,00%	0	0	1	1	1	1	1	0	0	0	0	0	**6**
	99,50%	0	0	0	0	0	0	0	0	0	0	0	0	**3**

Cormorants and Shag did not show any collision risk at density 5 times the normal.

Conclusion

Seabirds showing a flight pattern ranging outside the rotating blade swept area (e.g. below 40 m), as Fulmar, Puffins, Auks, Cormorants, Shag and Shearwaters, are not exposed to a relevant risk of collision against the BGF wind turbine.

Other bird groups as large Gulls, Kittiwakes, Eiders are indeed at a low collision risk when considering only the strike event as casual; the risk became relevant under the hypotesys that the BGF platform, intended as structure, fish farm and its operational life, is able to exert a positive attraction on seabirds. In the case of the Vulnerable (VU) *Rissa Tridactyla* and the Endangered (EN) *Larus argentatus,* which population are in decline, this may give raise to a conservation concern. Large Gulls and Eiders have a moderate strike probability, due to their peculiar flight height distibution.

Migratory Birds

The Sound of Jura can be regarded as part of the migratory routes from the Artic region to the wintering territories in Europe or Africa (Pollock et *al.*, 2000).

A relevant number of species is then capable of crossing the Sound during their path, and several of them may be considereed at risk of strike against the BGF wind turbine, being capable of flight heights intercepting the blade swept area.

Amongst them, Swans, Geese, Corncrakes, Phalaropes, Scotes, Grebes are considered at various risk of collision, following literature on the subject.

As reported in D 4.1- France, the assessment of the collision risk has revealed to be unfeasible, since the ratio between the likely migration area against the blade swept area of the single BGF wind tubine is negligible, as close to zero has resulted the derived collision risk. However, a risk may not be considerd totally negligible for those species that are able to migrate in dense flocks between 40 and 200 m, and able to cross the Sound in poor visibility conditions (Cook et *al*., 2011; Langston et *al*., 2010; Petterson et *al*., 2015).

Unfortunately, at the present stage of knowledge, a quantitative assessment is still unfeasible. Nevertheless, applying a precautionary principle, at least 20 species should be considered as subjected to an unquantifyied strike risk.

Table 17: Migratory Birds, Islay Island

Common Name	Scientific Name	Family	RL UK	Risk Level
Pintail	*Anas acuta*	Anatidae	LC	
Shoveler	*Anas clypeata*	Anatidae	LC	
Common Teal	*Anas crecca*	Anatidae	LC	
Mallard	*Anas platyrhynchos*	Anatidae	LC	1
Greenland Greater White-fronted Goose	*Anser albifrons flavirostris*	Anatidae	LC	1
Icelandic Greylag Goose	*Anser anser*	Anatidae	LC	1
Pink-footed Goose	*Anser Brachyrhynchus*	Anatidae	LC	2-3
Turnstone	*Arenaria interpres*	Scolopacidae	LC	
Short-eared Owl	*Asio flammeus*	Strigidae	LC	
Common Pochard	*Aythya ferina*	Anatidae	VU	2
Tufted Duck	*Aythya fuligula*	Anatidae	LC	2
Greater Scaup	*Aythya marila*	Anatidae	LC	2
Canadian Light-bellied Brent Goose	*Branta bernicla hrota*	Anatidae	LC	1-2
Greenland Barnacle Goose	*Branta leucopsis*	Anatidae	LC	1
Common Goldeneye	*Bucephala clangula*	Anatidae	LC	
Sanderling	*Calidris alba*	Scolopacidae	LC	
Dunlin	*Calidris alpina schinzii & C. alpina arctica*	Scolopacidae	LC	
Knot	*Calidris canutus*	Scolopacidae	NT	
Purple Sandpiper	*Calidris maritima*	Scolopacidae	LC	
Ruff	*Calidris pugnax*	Scolopacidae	LC	
Nightjar	*Caprimulgus europaeus*	Caprimulgidae	LC	
Ringed plover	*Charadrius hiaticula*	Charadriidae	LC	
Long-tailed Duck	*Clangula hyemalis*	Anatidae	VU	1
Corncrake	*Crex crex*	Rallidae	LC	1
Tundra swan	*Cygnus columbianus bewickii*	Anatidae	LC	3-4
Whooper Swan	*Cygnus cygnus*	Anatidae	LC	3-4
Snipe	*Gallinago gallinago*	Scolopacidae	LC	
Oystercatcher	*Haematopus ostralegus*	Haematopodidae	NT	
Bar-tailed Godwit	*Limosa lapponica*	Scolopacidae	NT	
Black-tailed godwit	*Limosa limosa islandica*	Scolopacidae	NT	
Eurasian Wigeon	*Mareca penelope*	Anatidae	LC	
Gadwall	*Mareca strepera*	Anatidae	LC	
Velvet Scoter	*Melanitta fusca*	Anatidae	VU	2
Common Scoter	*Melanitta nigra*	Anatidae	LC	2

Goosander	*Mergus merganser*	Anatidae	LC	2
Red-breasted Merganser	*Mergus serrator*	Anatidae	LC	2
Curlew	*Numenius arquata*	Scolopacidae	NT	
Whimbrel	*Numenius phaeopus*	Scolopacidae	LC	
Red-necked Phalarope	*Phalaropus lobatus*	Scolopacidae	LC	3
Golden Plover	*Pluvialis apricaria*	Charadriidae	LC	
Grey Plover	*Pluvialis squatarola*	Charadriidae	LC	
Slavonian Grebe	*Podiceps auritus*	Podicipedidae (Grebes)	VU	1
Great Crested Grebe	*Podiceps cristatus*	Podicipedidae (Grebes)	LC	1
Red-billed Chough	*Pyrrhocorax pyrrhocorax*	Corvidae	LC	
Common Shelduck	*Tadorna tadorna*	Anatidae	LC	
Greenshank	*Tringa nebularia*	Scolopacidae	LC	
Redshank	*Tringa totanus*	Scolopacidae	LC	
Lapwing	*Vanellus vanellus*	Charadriidae	NT	

4.1.2 Impact on mammals

As reported in maps on paragraph 3.2.4.4, the cetacean most frequently seen in Jura sound is the Harbour porpoise. Other odontocetes are not recoeded sistematically there, and in a part of the Sound there are sporadic sightings of the Minke whale.

- ***Phocena phocena***

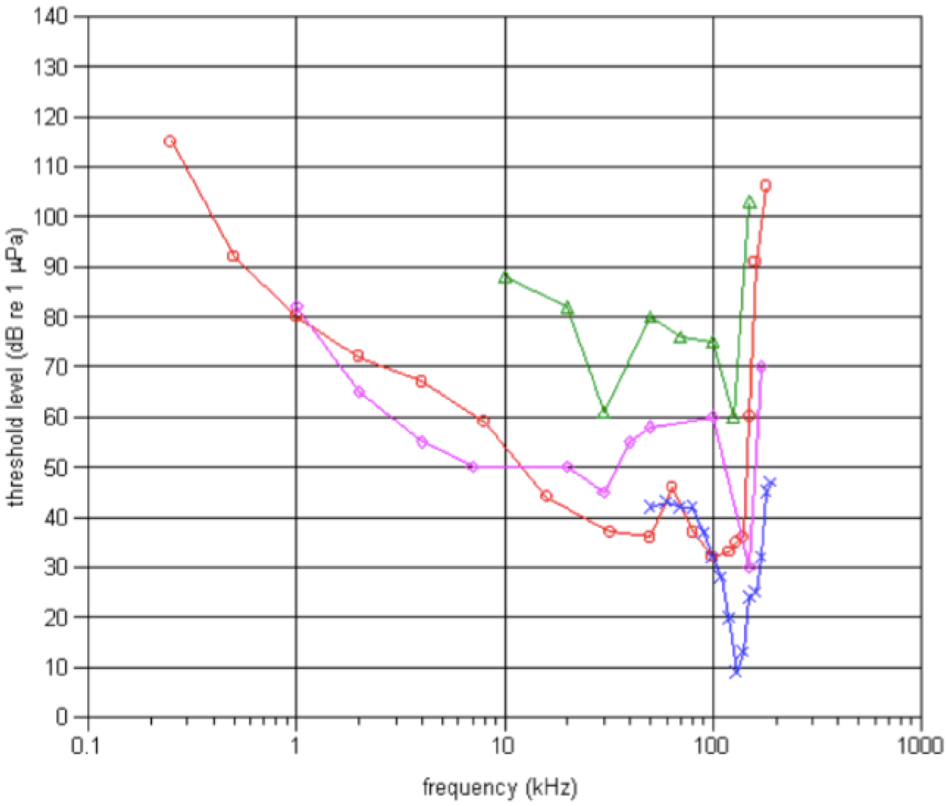


Figure 102: Harbour porpoise audiogram from various authors (*Source: Nedvell et al., 2004*)

Harbour porpoise hearing ability is spanning from 300Hz to 120 kH, with the best sensitivity in the range 10-120 kHz, where the most acute noise is situated. The BGF noise emission, at the present stage of knowledge, is hypotesized to be within the 16 Hz-20 kHz range. Those noises are fully audible by the harbour porpoises above 1 kHz to 20 kHz and an intensity of 40-80 dB. However, the most part of behavioural vocalization of Harbour porpoises seem to be located between 10 and 120 kHz, therefore mostly outside BGF noise emissions range. A noise emission of 10 kHz at 90 dB can be eared up to a distance of approx. 100, following the Thiele's law (see D 4.1- France), by the Harbour porpoise. On the other hand, emissions at very low frequencies can be eared by Harbour porpoises at relevant distances (Marmo et *al*., 2013).

A potentially masking effect is therefore very limited in space, and on frequency only partially used by this species for vocalization.

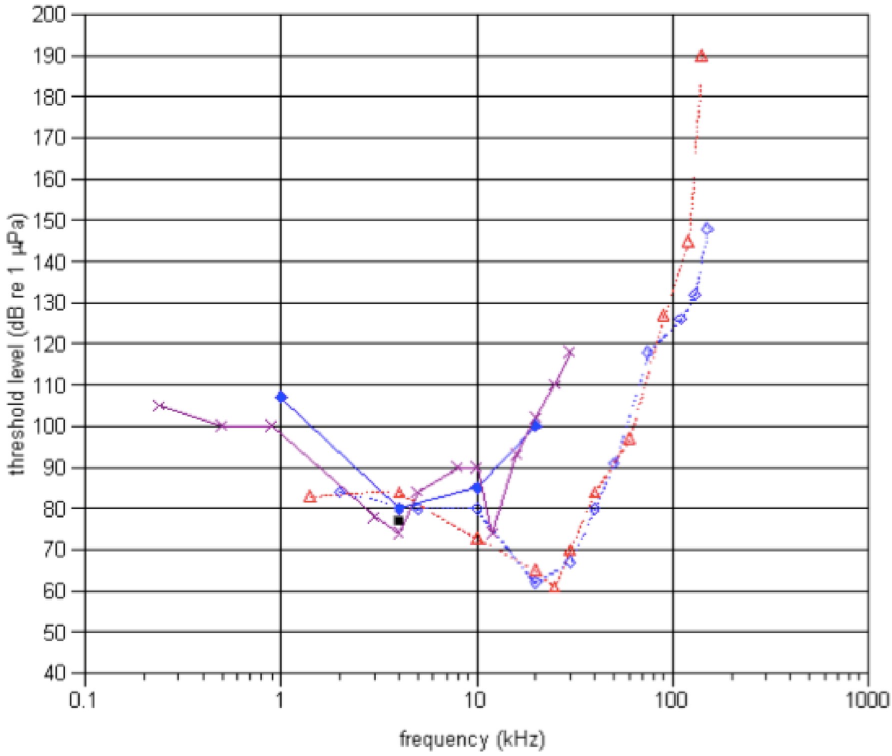


Figure 103: Grey Seal (*Halichoerus grypus*) audiogram from various authors (*Source: Nedvell et al., 2004*). Triangle symbols for audiogram in water

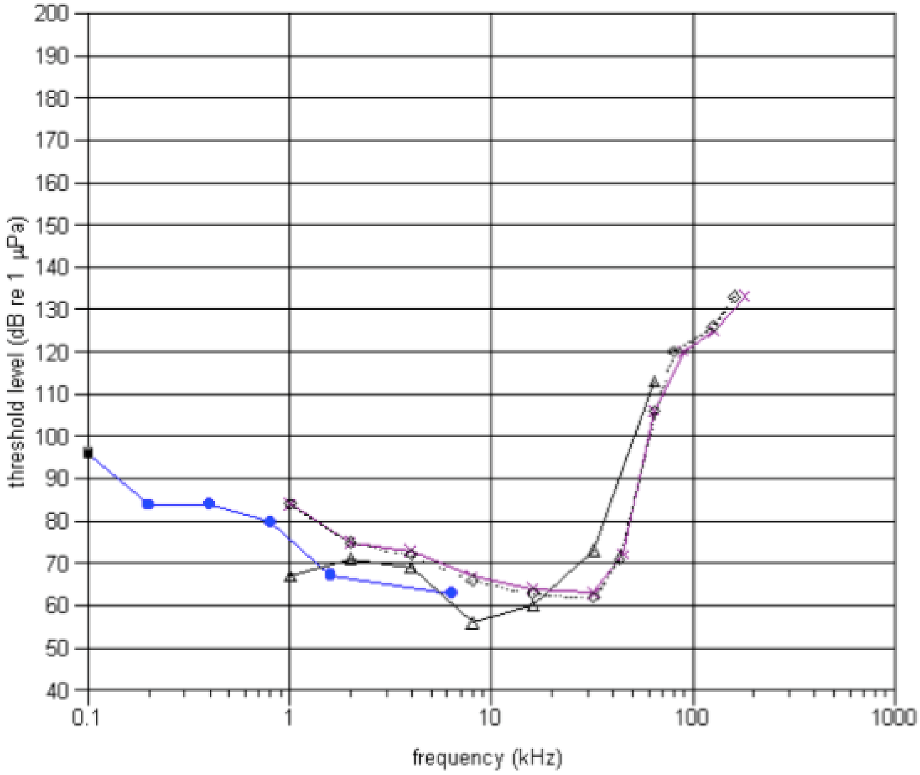


Figure 104: Common Seal (*Phoca vitulina*) audiogram from various authors (*Source: Nedvell et al., 2004*). Triangle symbols for audiogram in water

Seal sensitivity to noise is mainly restricted to the range 100 Hz - 60 kHz, with regard to the likely spectrum of emission of the BGF platform. Seals hearing capability is fine, therefore the most emitted spectrum by BGF will be perceived. However, Seals are not echolocators nor able to vocalize underwater, although the male harbour seals emit a broadband roar, making a significant contribution to ambient noise, during the breeding season.

The noise emitted by the stationary BGF platform will increase the ambient sound level, possibly masking predators (Killer whales) echolocations and vocalization, fish shoal movements or ships approach.

Marmo et *al*. (2013), argued that an operational windfarm can not cause any displacement risk on Seals and Bottlenose dolphins, while 10% of Harbour porpoise population may avoid noise area.

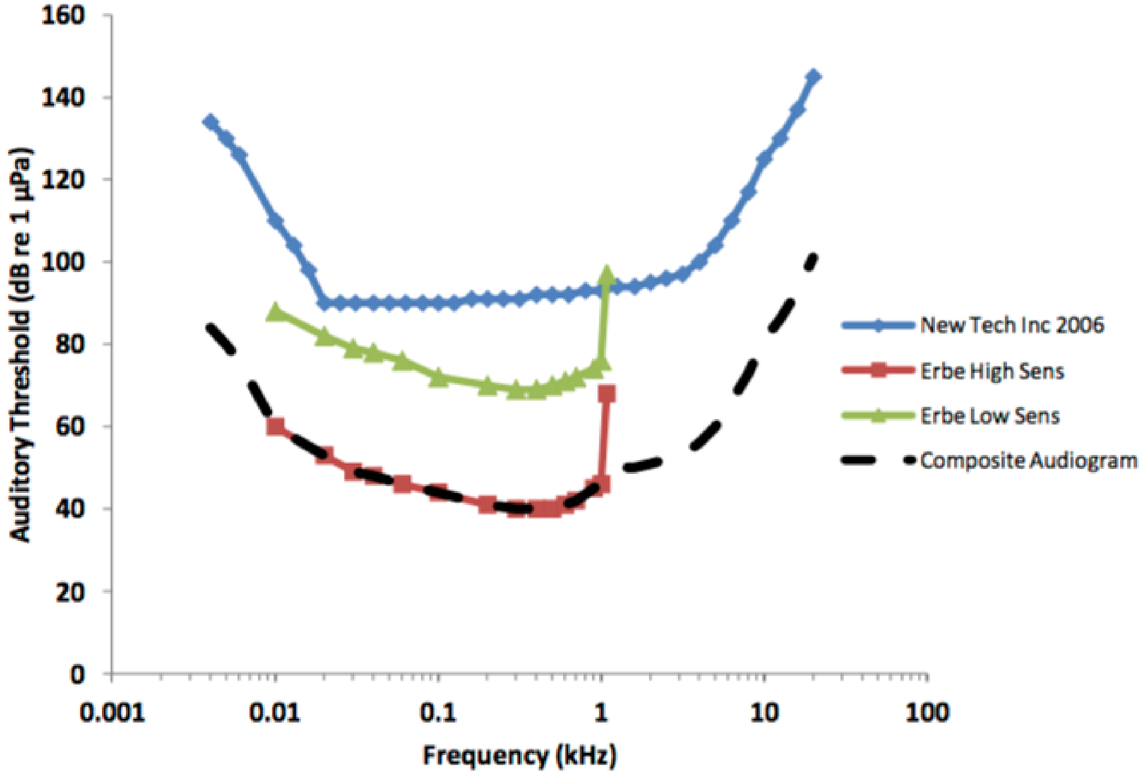


Figure 105: *Balaenoptera acutorostrata* (Minke whale) audiogram from various Authors (*Source: Marmo et al., 2013*)

For Minke whale auditory sensitivity, see D 4.1 – France.

Marmo et *al*. (2013), reported that low-frequency specialists as minke whales are most likely to be affected by renewables installations, since they are predicted to respond out to ranges of up to ~18 km.

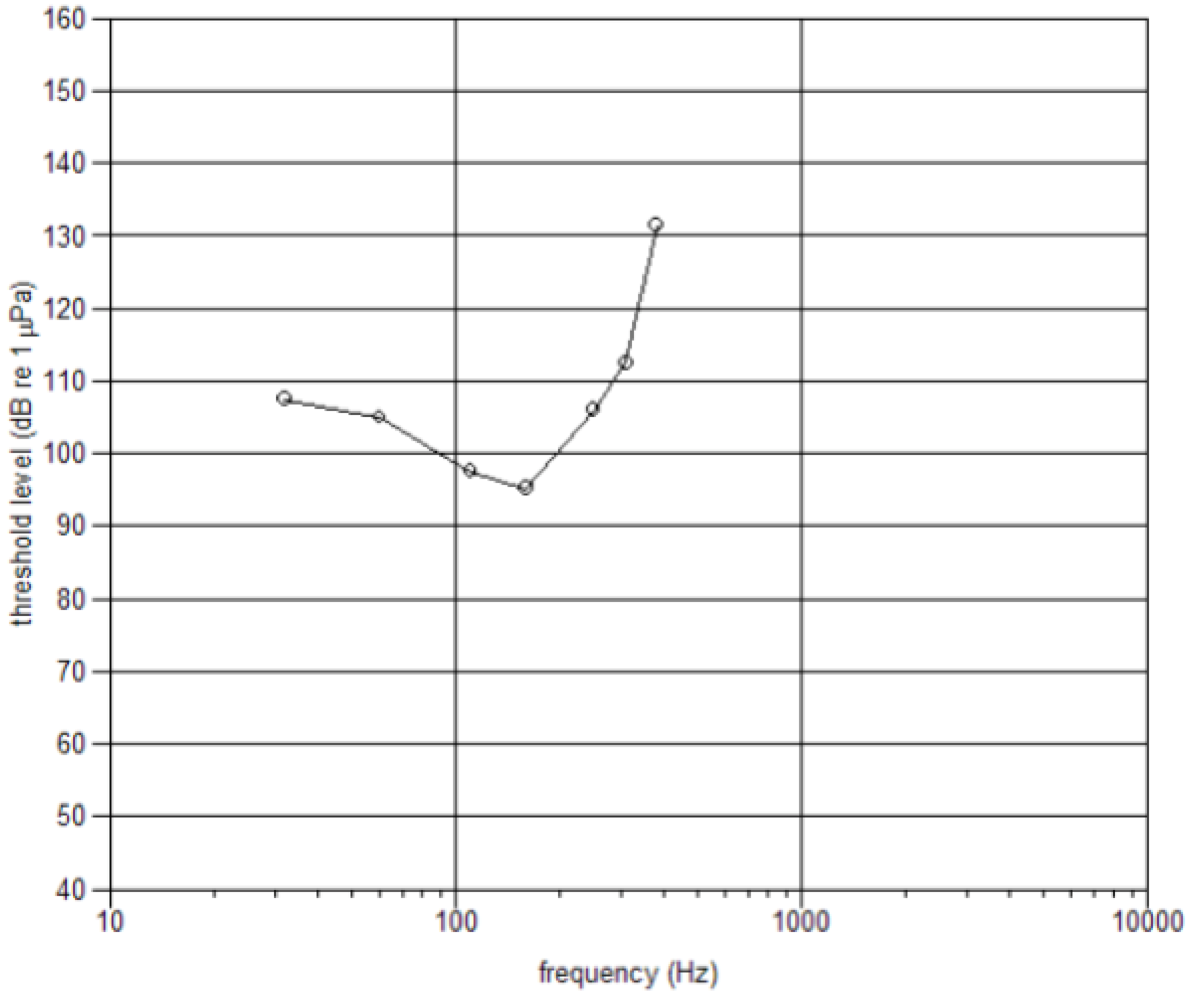


Figure 106: Atlantic salmon (*Salmo salar*) audiogram from various Authors (*Source: Marmo et al., 2013*)

Atlantic salmon has a limited earing capability, and would be able to perceive a BGF installation only in its lower frequencies (30 – 150 Hz), provided that they are emitted at intensity higher than 95 dB.

4.1.3 Impact on benthic communities

The species selected for fish farming within the Blue Growth platform facilities located near Port Ellen is the Atlantic salmon *Salmo salar (*Linnaeus, 1758). This species is one of the most farmed in temperate waters around the world, with an annual gross production of 1.488.434 tons in year 2016 (FEAP, 2017).

Atlantic Salmon has a singular life cycle, consisting of a fresh water egg to juvenile “parr” stage at the end of which the fish undergoes a metabolic adaptation to the seawater environment; is then termed a “smolt” at which point in nature migrates to sea. In farming practice, smolts can be transferred to sea cages, where they enter the growing phase experiencing fully marine conditions. Atlantic salmon are ususlly grown to sizes of 0,5 – 0,8 m, for a weight up to 5 kg. While Atlantic salmon is spread from nearly arctic waters down to Britain on the European coast (FAO, 2018; Fishbase.org, 2018), its temperature range lies between 8 and 18 °C, with suboptimal temperature from 4 °C up to 20 °C, tolerable for short periods. Market size, above 3500g, is reached after 16-20 months, depending of first month of stocking. Maximum biomass per cage is estimated in 1090 ton, while the maximum monthly feed distribution is 725 ton at year 2. The farm biomass peak, 2980 ton, is reched at beginning of year 3.

Table 18: Production cycle for Atlantic salmon at year N°1

Month	Year 1								
	(Stock 1)		(Stock 2)		(Stock 3)		(Stock 4)		
	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	
Jan	52	15							
Feb	64	19							
Mar	78	28							
Apr	100	41	52	28					
May	131	58	74	41					
Jun	176	86	105	63					
Jul	242	106	153	80	52	42			
Aug	323	117	215	91	85	51			
Sep	413	122	285	97	124	58			
Oct	507	108	359	88	168	54	79	34	
Nov	590	106	427	86	210	55	105	36	
Dec	671	88	493	72	253	48	132	32	
Jan	739	76	549	64	289	42	156	29	
Feb	798	93	598	78	322	53	178	36	
Mar	869	126	657	106	362	73	206	51	
Apr	966	168	739	142	419	100	246	71	
May	1095	82	848	187	495	134	300	98	
Jun	458	0	992	252	598	183	375	137	
Jul	0	0	1186	121	739	213	481	163	
Aug			579	0	903	222	606	173	
Sep					1073	140	739	175	
Oct					681	33	873	152	
Nov					206		990	146	
Dec							1103	119	
Jan							1194	98	
Feb							870	65	
Mar							519		
Apr									
May									
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									

Table 19: Production cycle for Atlantic salmon at year N°2

Month	Year 2									
	(Stock 1)		(Stock 2)		(Stock 3)		(Stock 4)			
	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)		
Jan										
Feb										
Mar										
Apr										
May										
Jun										
Jul										
Aug										
Sep										
Oct										
Nov										
Dec										
Jan	52	15								
Feb	64	19								
Mar	78	28								
Apr	100	41	52	28						
May	131	58	74	41						
Jun	176	86	105	63						
Jul	242	106	153	80	52	42				
Aug	323	117	215	91	85	51				
Sep	413	122	285	97	124	58	52			
Oct	507	108	359	88	168	54	79	34		
Nov	590	106	427	86	210	55	105	36		
Dec	671	88	493	72	253	48	132	32		
Jan	739	76	549	64	289	42	156	29		
Feb	798	93	598	78	322	53	178	36		
Mar	869	126	657	106	362	73	206	51		
Apr	966	168	739	142	419	100	246	71		
May	1095	82	848	187	495	134	300	98		
Jun	458	0	992	252	598	183	375	137		
Jul			1186	121	739	213	481	163		
Aug			579	0	903	222	606	173		
Sep					1073	140	739	175		
Oct					681	33	873	152		
Nov					206	0	990	146		
Dec						0	1103	119		

Table 20: Production cycle for Atlantic salmon at year N°3

Month	Year 3									
	(Stock 1)		(Stock 2)		(Stock 3)		(Stock 4)			
	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)	Hold (tonne)	Feed (tonne)		
Jan										
Feb										
Mar										
Apr										
May										
Jun										
Jul										
Aug										
Sep										
Oct										
Nov										
Dec										
Jan										
Feb										
Mar										
Apr										
May										
Jun										
Jul										
Aug										
Sep										
Oct										
Nov										
Dec										
Jan	52	15								
Feb	64	19								
Mar	78	28								
Apr	100	41	52	28						
May	131	58	74	41						
Jun	176	86	105	63						
Jul	242	106	153	80	52	42				
Aug	323	117	215	91	85	51				
Sep	413	122	285	97	124	58				
Oct	507	108	359	88	168	54	79	34		
Nov	590	106	427	86	210	55	105	36		
Dec	671	88	493	72	253	48	132	32		

Table 21: Feed distributed and total biomass

Month	Total Monthly **FEED** (tons)	Total Annual **FEED** (tonnes)	Total Monthly Holding (tons)
Jan	15		52
Feb	19		64
Mar	28		78
Apr	68		152
May	99		204
Jun	148		281
Jul	229		447
Aug	259		623
Sep	276		822
Oct	284		1.113
Nov	283		1.332
Dec	239	**1.948**	1.549
Jan	226		1.786
Feb	278		1.959
Mar	384		2.173
Apr	549		2.521
May	600		2.943
Jun	721		2.704
Jul	725		2.853
Aug	654		2.710
Sep	591		2.687
Oct	470		2.667
Nov	429		2.528
Dec	359	**5.983**	2.652
Jan	324		2.980
Feb	342		2.829
Mar	384		2.693
Apr	549		2.521
May	600		2.943
Jun	721		2.704
Jul	725		2.853
Aug	654		2.710
Sep	591		2.634
Oct	470		2.667
Nov	429		2.528
Dec	359	**6.146**	2.652

Fish Growth Parameters Selection

The following Table displays the average monthly temperatures used as a basis for metabolic computations on fish stocks farmed in the BGF platform, as derived from data available at CMEMS website.

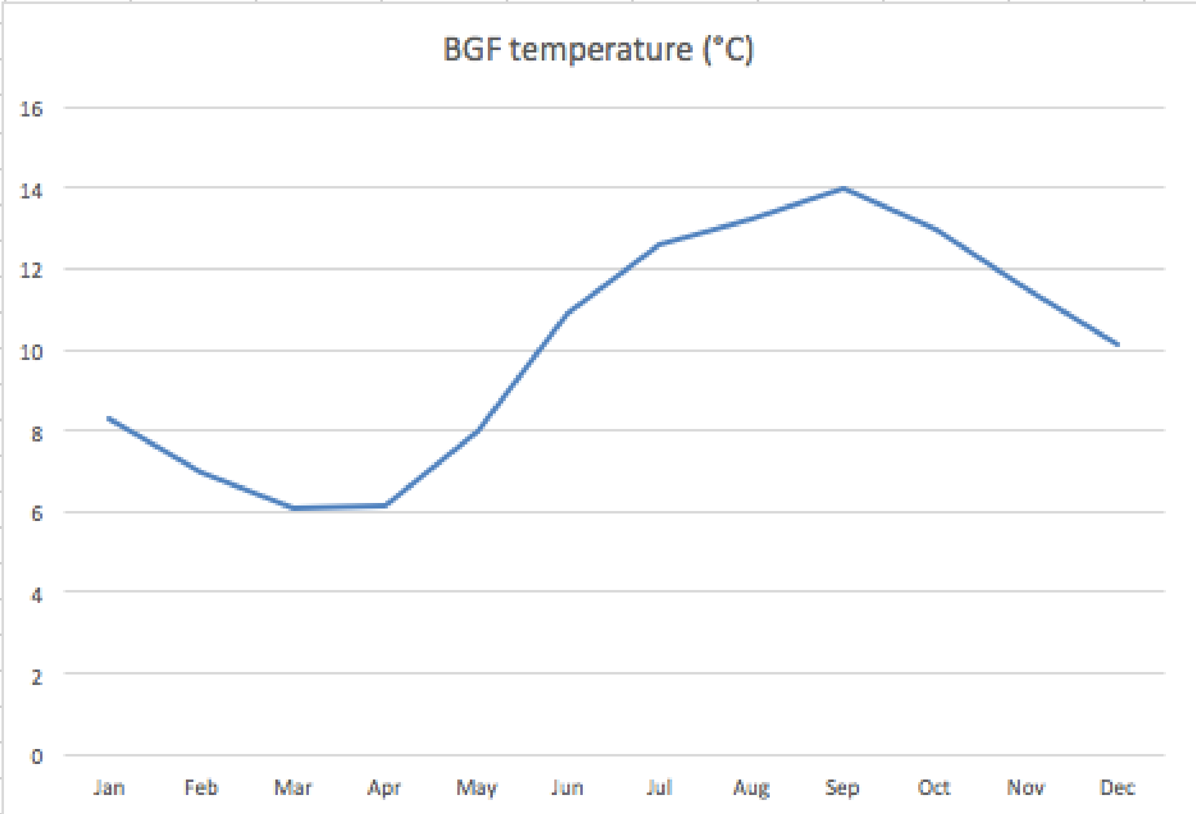


Figure 107: Temperature curves estimated for BGF site, year 2018 – data from CMEMS, IBI Analysis Forecast Phys 005-001

Fish are expected to attain the desired market size (>400 g) at around 16 months of farming cycle, with minor differences between cages due to the encountered temperature pattern through their life cycle, as a consequence of the first stocking time.

Fish growth pattern, biomass evolution, stocking plan and feed consimption has been calculated by BGF project Partner Sagro Ltd, in the frame of Deliverable 9.1. The growth curve for Salmon used in Aquamodel simulations is those supplied by the Project Partners, as the other farming values (biomass, density, harvest).

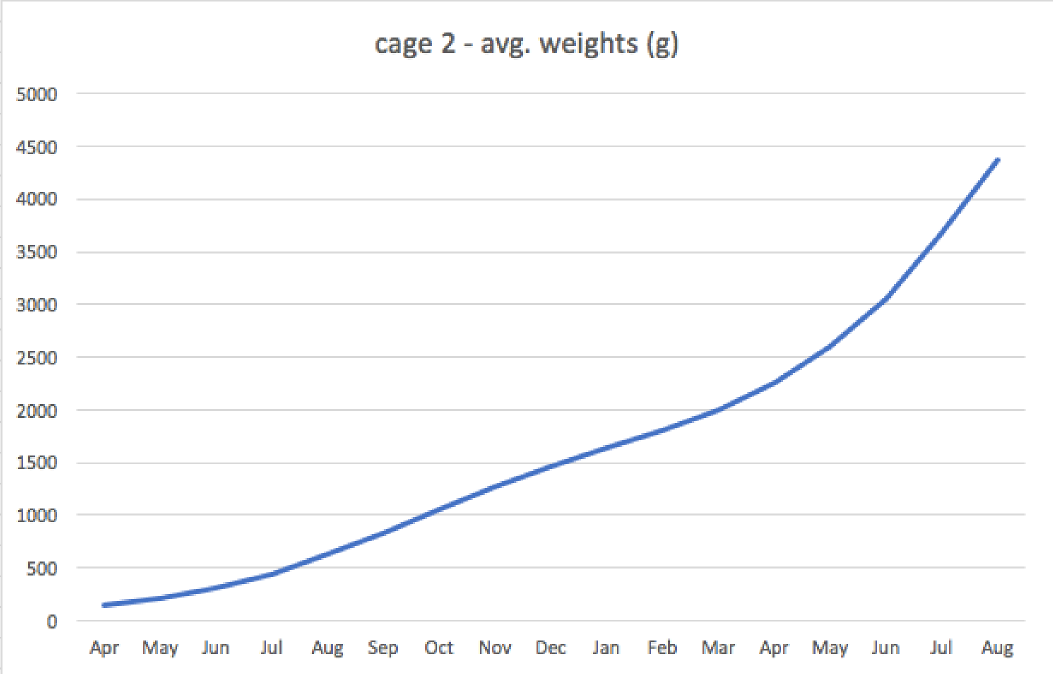


Figure 108: Salmon growth curves

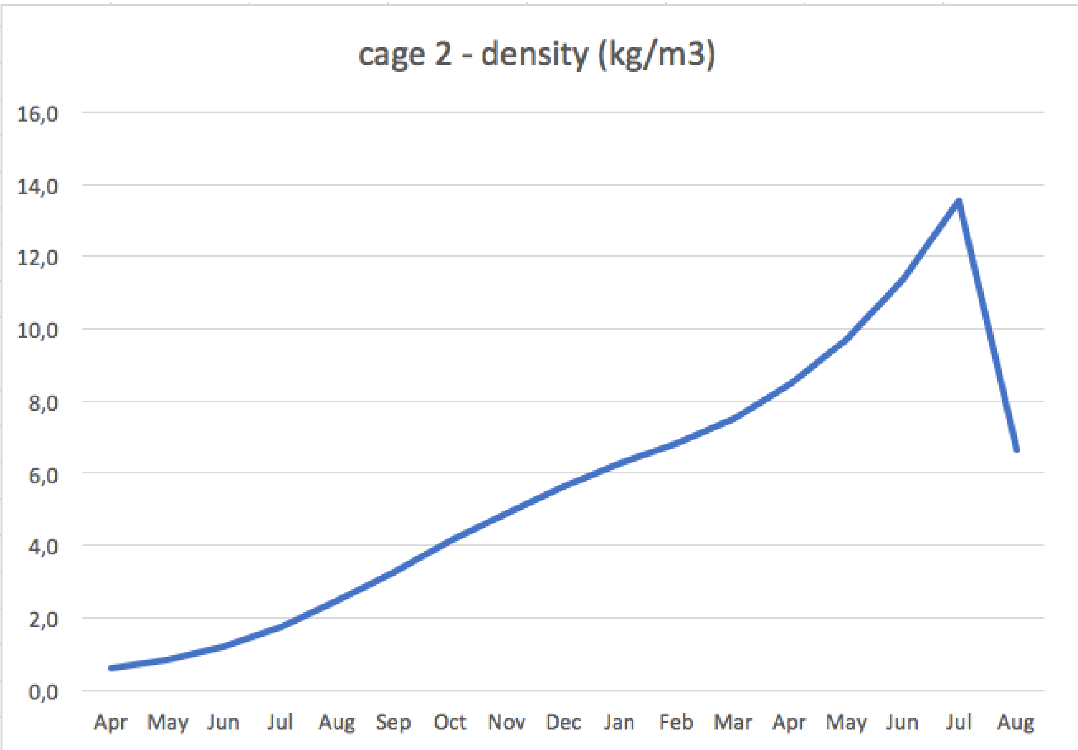


Figure 109: Salmon cage density

Faecal Settling Rates

Several authors have reported a consistent amount of faeces being released per kg of distributed food: 100-250 g/kg of food is the value from Cho et *al*. (1994), similarly to Talbot & Hole, (1994).

Faecal settling rates for salmonids are largely described in literature: Findlay and Watling, (1994), Elberizon and Kelly, (1998), Panchang et *al*. (1997), Chen et *al*. (1999).

Reid et *al*. (2009), recently reviewed the literature and found considerable variability because of differences in diet, water viscosity, fish size and study methodologies.

The mean settling rates varied from 2 to 8 cm/sec and rate was related to fish size as expected. Cromey et *al*. (2002°), found settling rates of 3.2 cm/sec on average.

Determination of faecal setting rates gives some constraint, being fecal pellet sinking rates for marine species often not-normally distributed. Fish faecal pellets also have a high water content, thus their nature in seawater is close to liquid (Vita et *al*., 2004).

The settling velocity has been found to vary with changes of shapes due to hydration, and the settling speed is also reported as not influenced by water temperature and trials showed a positive correlation between pellet weight and settling speed.

Settling rates of smaller faecal pellet, from 0.02 to 0.74 g, is reported to fall between 2.2 to 7.5 cm/sec for Sea Bream. Perez et *al*. (2014), reported similar values for *Argirosomus regius*.

Shape is variable and not correlated to fish size. They become quickly disaggregate into smaller particles with different shapes and buoyancy, mainly as an effect of water turbulence created by fish feeding activity, and settling behaviour between large and small particle can be quite different, from fast-sinking to buoyant.

This erratic behaviour has been described also in Magill et *al*. (2006).

Waste Feed Settling Rates

In comparison to fish faeces, waste feed particles are easily studied and quantified by settling columns. Settling velocity is related to pellet shape, density, porosity as well as to medium density and viscosity.

Feed manufacturers easily adjust the settling speed of extruded feeds by regulating the steam pressure and temperature in the extrusion process. This leads to a different degree of gelatinisation of starch in the pellet and to a controlled degree of "inflation" (and thus porosity) of the granule, thus affecting the receipt and entrainment of the vacuum-sprayed oils and additives. This process can be modified even on farmers' demand, and each factory can adjust sinking speed at different rates, from fully floating for raceways farming, to quick-sinking for offshore cages.

Vassallo et *al*. (2006), working on commercial extruded feed pellets for Mediterranean species, found sinking speed between 8.7 and 14.4 cm/sec.

Piedecausa et *al*. (2009), reported a sinking rate of 6.8-13,6 cm/sec for commercial pellets between 2 and 8 mm diameter, and the speed appears to be affected by immersion time, leading to hydration and subsequent changes in density, porosity and shape.

Pellets between 3 and 8 mm, as likely used for fish forecasted production in BGF offshore farm, are described with a speed between 6 and 12 cm/sec, within an immersion time of 10 min, referable to BGF site bathymetry (90 m).

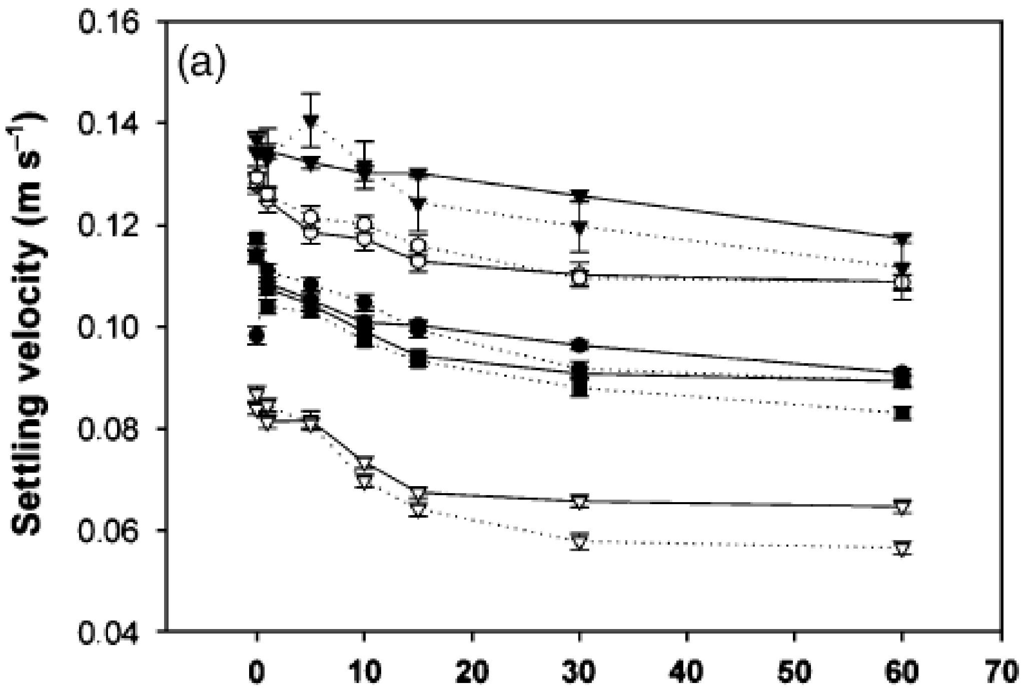


Figure 110: Settling speeds of feed pellets at different temperatures (*Source: Piedecausa et al., 2009, modified*)

Therefore, a settling speed value of 9.0 cm/sec has been considered as representative of Salmon feeds, to be used in farming in Islay condition.

Waste Feed Loss Rates

The cost of fish feed represents one of the major annual investments in raw materials of an aquaculture company. It should be noted that maximization of growth performance is attained also through the minimization of feed losses, considered as a key-factor affecting a company's profitability.

Most commonly, devices such as submerged video cameras, echo sounders or Doppler-effect devices are capable of revealing in real time the delivery of an unnecessary amount of feed pellets and supply feed-back signals to feed distributors.

Waste feed is fast-sinking, scarcely soluble, and richer in carbon and nitrogen than waste faeces and thus will have a longer environmental persistence, and therefore the adverse effects will be more pronounced compared to fish faeces (Tlusty et *al*., 2000).

Waste feed can be eaten by wild fishes and invertebrates and this has been demonstrated to act as a significant mitigating factor (Vita et *al*., 2004; Fernadez-Joven et *al*., 2007; Holmer, 2010)

In other models, as in Cromey et *al*. (2002), for Bass and Bream farming, and in Perez et *al*. (2014), for Meagre (*Argyrosomus regius*) farming, it has recently been proposed a feed loss rate of 3%.

This value has been looking as appropriate for an automatic feeding system as adopted in BGF platform, equipped by feed-back devices able to contain food releasing in case of overfeeding.

Deposition Threshold

Below a given, species-specific current flow, faecal and food wastes will settle down to the bottom and lie in the same position, thus entering in a "depositional " condition.

At higher rates of flow, in "erosional" conditions, wastes can be re-suspended and move over the bottom until current velocity decreases and leave them to settle again.

The BGF fish farm is located where hydrodynamic features can lead either to deposition or re-suspension of sediments and associated wastes, either in case of storms with associated long-length waves or by intense bottom currents.

During this process, particles can be eroded into smaller sized particles and moved in several ways and become available to the food web for assimilation, even at great distances.

Some fraction of the deposited materials will remain steady even under all the most erosive conditions, in a process known as "consolidation".

The deposition threshold is defined as the near bottom water velocity at which fish faecal and waste food particles settle out. The literature for salmonids report values which are not well defined, but Cromey et *al*. (2002a, 2002b), used 4.5 cm/sec as a combined value for faecal and feed threshold, and the same values has been fitted in Aquamodel computations.

Re-suspension Threshold

Several recent studies have indicated that re-suspension and consequent displacing of fish farm wastes are key factors in modelling of fish farms effects on marine sediments (Panchang et *al*., 1997; Cromey et *al*., 2002a, 2002b).

A prior estimate of threshold for re-suspension speed for salmon wastes (feed and faeces together) is 9.5 cm/sec, at 2 m above the bottom (Cromey et *al*., 2002a, 2002b, Cromey & Black, 2005).

Literature for faecal matter re-suspension rates in marine fish species is scant and the re-suspension speed has been set to the only value reported in literature (Cromey et *al*., 2002a, 2002b; Cromey & Black, 2005).

Consolidation Rate

For long-term modelling of the effects of fish farming on the sea bottom chemistry and fauna, an important consideration is related to the degree of consolidation of waste particles. As described by Cromey et *al*. (2002a, 2002b), this is the stickiness of materials that may remain consolidated upon the bottom, despite elevated rates of flow over the bottom. There is evidence that the rate increases with elapsed time at slow velocities, but it has not specifically been studied for fish wastes. Since this factor is poorly known or described, in the present study values have been selected from 1% to 5 %/day, these values gave the most realistic results in calibration runs.

Organic Carbon Oxidation Rates

Benthic effects are mainly influenced by the rate at which carbon is deposited and subsequently oxidised by bacteria or assimilated by the food web. The rate of organic matter degradation by microorganisms is often estimated using a first order kinetics or a Michaelis-Menton kinetics approach with similar result in cases where substrate, instead of microbial biomass, is limiting. When a new fish farm begins operating over a sedimentary bottom, the biomass of microorganisms at the water interface and in the sediments will increase in accordance to the load of organic matter released by the farm. Within reasonable bounds, after the farm operates for some period of time, the microbial biomass (and other benthic organisms, if time for communities succession is sufficient) approximate a steady state to process the wastes. When the amount of carbon deposited exceeds the capacity of aerobic processing, sediment bacterial communities shift to anaerobic sulphide reducing metabolism which tends to disadvantage the most sensitive invertebrates, either infauna or epifauna. Generally, up to 1 to 1.5 percent total organic carbon added to the top 2 cm will not result in the shift to anaerobic conditions, depending on sediment porosity and water temperature.

Sediment re-working by burrowing organisms is also known as an important factor in sediment deep layers oxygenation (Valdemarsen et *al*., 2009; Holmer, 2010).

In temperate areas, up to 5 grams of TOC can be added per square meter per day (Findlay & Waitling, 1997), although the tolerance of benthic communities may be scattered in dependence of local factors, as patchy distribution of sediment properties and of benthic communities as well (Hargrave, 1994; Karakassis et *al*., 1999). Gillibrand et *al*. (2002), reported a tolerable value for benthic communities of 7 g of carbon/m2/year.

In the present study, the background levels of TOC has been considered at a relatively low level, at 1 % of sediment WW, as reported by several authors (Thilstone et *al*., 2003) in the area. A part of this carbon is also including refractive carbon, as those from shells or "old" debris.

Tlusty et *al*. (2000), demonstrated that fish faecal matter has a very high solubility potential, loosing approximately 50% of its organic matter in a 12-day exposure to water flow. Food and faeces are therefore mostly in the "non-refractive" forms of carbon, unlike less decomposable carbon in refractive forms, such as organic matters from terrestrial origin.

Given the above, a conservative choice of 1.0% /day carbon oxidation rate in sediments and in settling in water column has been done.

The carbon oxidation value in input in the model (10 mgC/m^2/day) has been tuned at an order of magnitude bigger, at the aim of taking in account the likely microbial community adaptation to an increased organic load, as commonly experienced under heavy organic loads as in the case of a large fish farm (Mackin & Swider, 1989; Holmer & Kristensen, 1992).

Release of Nitrogen by Reared Fish

In teleost fish, the main output derived by protein metabolism is Ammonia ($NH4+$). A significant proportion (5-15%) of nitrogenous wastes are also excreted as Urea, and gills are the main excretory organs for both compounds, accounting for as 80-90% of total nitrogen excretion (Dosdat et *al*., 1996). A part of nitrogen is also lost through faeces, and from faeces can leach quickly to the ambient waters (Tlusty et *al*., 2000; Piedecausa et *al*., 2009) at a steady rate of 0.1 % of faeces DW.

In order to predict fish nitrogen excretion, several authors have underlined the importance of feeding, fish size and temperature parameters on different species (Paulson, 1980; Ramnarine et *al*., 1987; Dosdat, 1992; Jobling, 1981).

Total nitrogen excretion is related to the food conversion ratio (FCR) (Fivelstad et *al*., 1990), considered a useful indicator for assessing nutrient outputs from fish farms (Einen et *al*., 1995).

Salmon is an ammoniotelic species, with 75% to 90% of the total excreted dissolved nitrogen as ammonia. Dosdat et *al*., 1996, found that urea represented 13% of the total excretion at 16 or 20 C° for Sea bream and Sea bass, close to the value (14%) reported for rainbow trout (Kaushik, 1980) and Atlantic salmon (Fivelstad et *al*., 1990).

In the present simulation, the displayed dissolution of Nitrogen is referred to as Total Nitrogen, thus comprehensive of Ammonia + Urea.

Feed consumption in the BGF farm would attain a maximum level of 725 ton/month, just before harvesting period. The food hypotesized has the characteristics of commercial feeds, with a water content of 10% and a carbon content of 53%.

A percentage of 3% of uneaten food is also retained in the model.

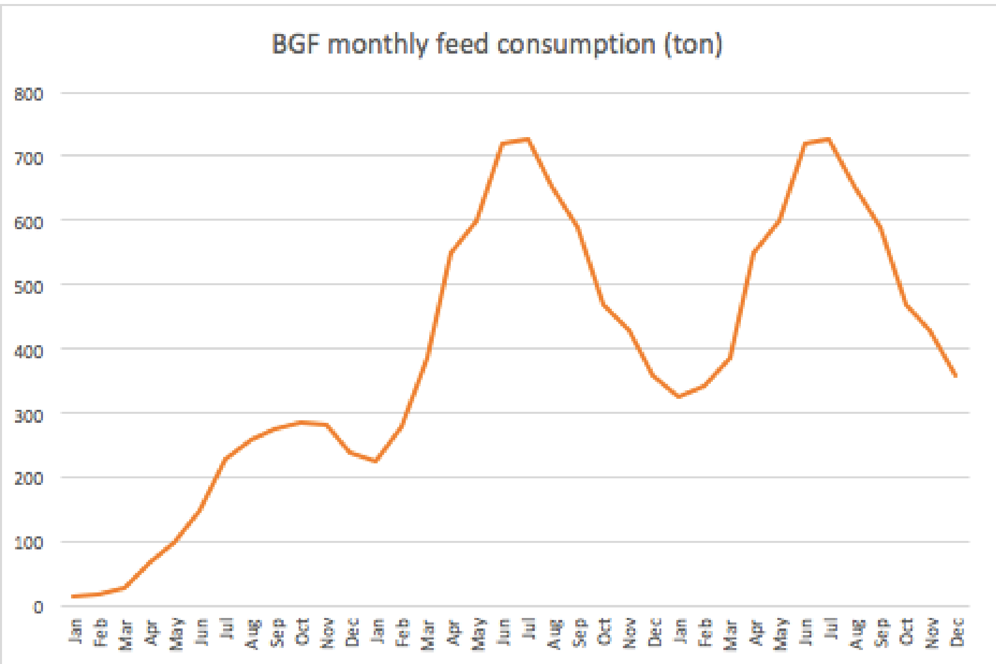


Figure 111: Temporal evolution of total feed consumption

Farm Biomass

The farming cycle of Salmon in BGF has been designed to lead to a gross fish production of approximatey 3,000 tons per year. This result is reached at the 3rd year of production by a stocking policy of 4 batches of 347,000 fingerlings per cage, starting by an average weight of 150 g (see D

9.1).

The above result is reached by maximizing the yield per cage, moving quickly to market all fish at size (>3,200 g), and re-stocking the empty cage, maintaining a correct farming density (12.5 kg/m3).

The available cages in BGF farming system are 6. Fish are grown in the same cage until they reach a maximum of biomass of 1,090 ton: over this threshold the stock is harvested within 2 months.

Therefore, the evolution of total biomass in the farm is conditioned by the above farming and harvesting policy in association, that determine a sudden decrease in standing stock in some months: the resulting biomass evolution is beyond the possibility of any modelling.

In fact, while the growth of fish can be predicted, the harvesting policy after attaining the desidered size is not connected to any biological law, but just an operators' choice.

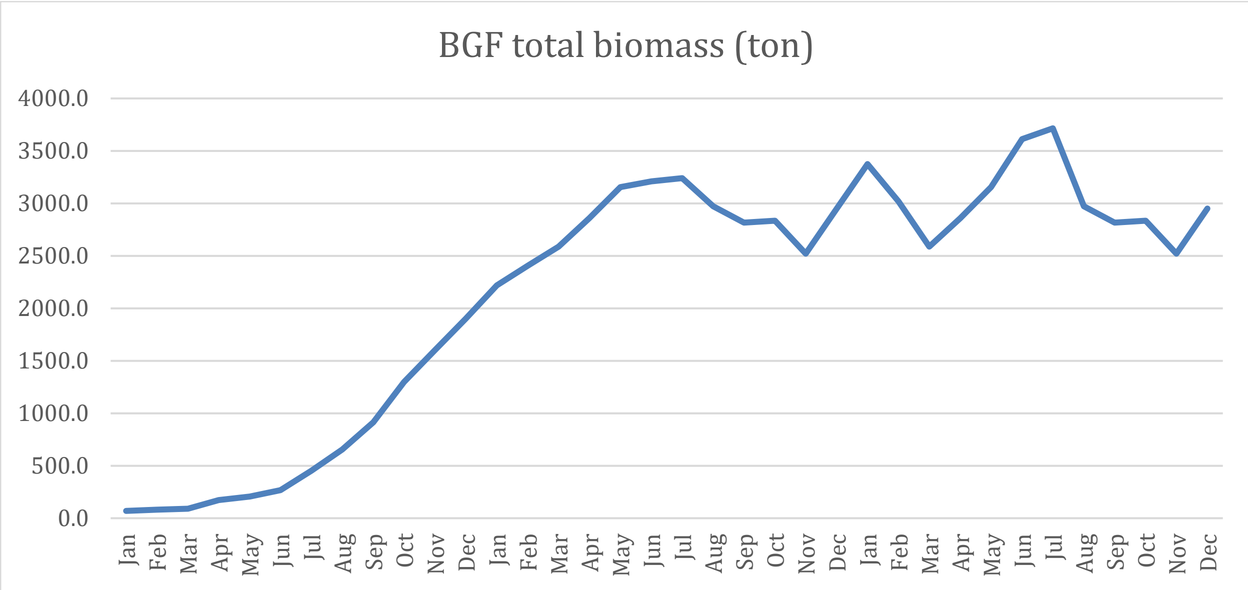


Figure 112: Temporal evolution of total biomass in Farm

Primary Coefficients for Islay Simulation – Benthic computation

The computational array was formed by a number of 41 x 41 x 6 cells, each one of 50 x 50 x 15 m, covering an area of 2,050 x 2,050 m, down to a depth of 90 m.

The simulation has been run for a period of 3 years, from 01.01.2016 to 01.01.2018, corrispondent to the the maximum production peack.

The following coefficients were used in the model setting:

Table 21: Benthic coefficents for Islay simulation

Benthic coefficient	Unit	Value
TOC sediment	%dryW	0.0015
Oxygen in sediment	ppm	4
Ambient TOC deposition	$gC/m^2/day$	0.2

Oxygen in seawater	ppm	6
Aerobic biomass	gC/m^2	0.26
Anaerobic biomass	gC/m^2	0.05
Sediment CO2	g/m^2	0
Sulfide in sediment	mM/m^3	0
Mixing depth winter-summer	M	80-40
Surface temperature	°C	4-17
Bottom temperature	°C	4-14
Inorganic Nitrogen	$\mu M/m^3$	0.3

Table 22: Depositional coefficents for Islay simulation

Depositional coefficients	Unit	Faecal	Feed
Sinking speed	cm/sec	2	9
Deposition threshold	cm/sec	4.5	4.5
Re-suspension threshold	cm/sec	9.5	9.5
TOC Consolidation rate	%/day	0.01	0.05
TOC Oxidation rate	%/day	0.01	0.01
Feed Carbon content	% dry weight		0.53
Feed Water content	% dry weight		0.1
Feed Waste %	%		3

Spatio-temporal evolution of benthic parameters

The cumulative waste deposition

The following maps report the cumulative deposition of faeces and uneaten feed on the bottom.

This map has to be intended as an integral of deposition, in other words, display the total amount of organic carbon received over one square meter of bottom, irrespective of any process of benthic digestion. Snapshots are displayed at a rate of four/year, at month 3, 6, 9, 12, 15, 18, 21, 24. Current vectors are referred at 22,5 m of depth, below BGF platform at maximum current exposition of nets. Cages are outlined at the center of map.

The velocity vectors are those retrieved from the CMEMS IBI 005-001 product, and flowfield has been forced by a semidiurnal tidal component at a maximum speed of 1.1 m/sec. The flow field adopted is similar to the one used in Marseille, since the same level of detail is not available for Islay waters: however, the flowfield has been forced by a semidiurnal tidal component, with maximum speeds of 1.1 m/sec. Therefore, the used flowfield is not referred to local conditions, but has been used as a generic flowfield encompassing moderate currents under a semidiurnal tide regime. In a subsequent step, this simulation will be re-run using a 2-dimensional flow field, derived from data originated by different sources (Copernicus, BODC).

The area affected by a deposition over 700 g/m^2/year is of 0,83 km^2 (828646 m^2). Within this area, the benthic communities have to be considered as affected by organic deposition, according to Gillibrand et *al*. (2002).

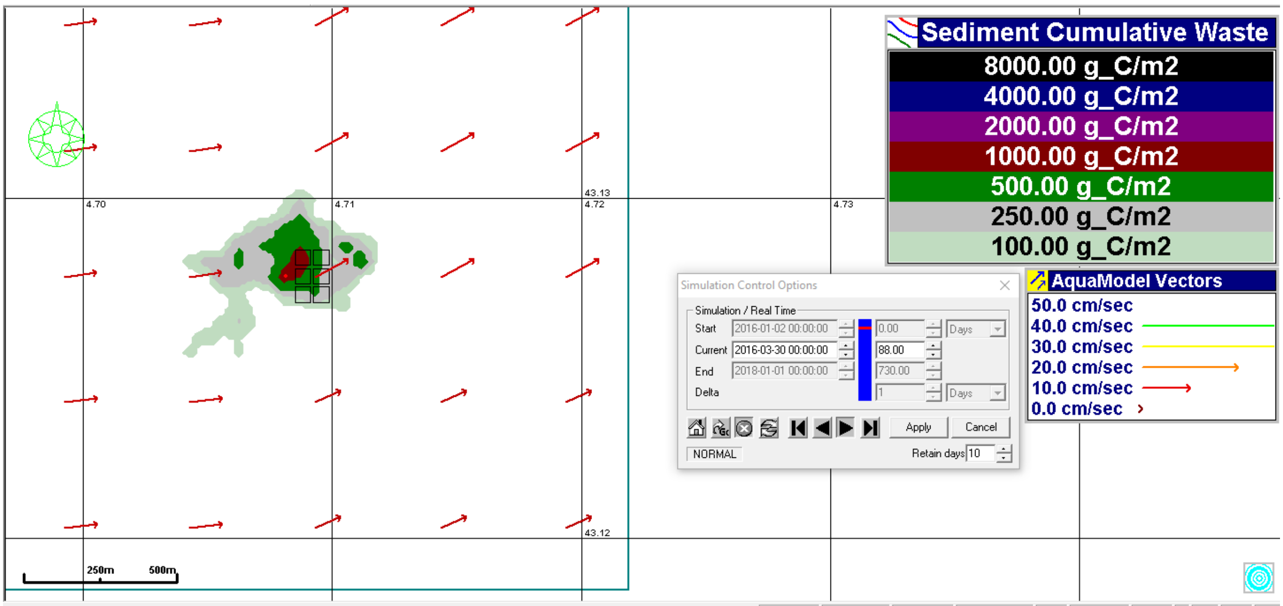


Figure 113: Cumulative deposition (faeces + uneaten feed); date March, 1st year

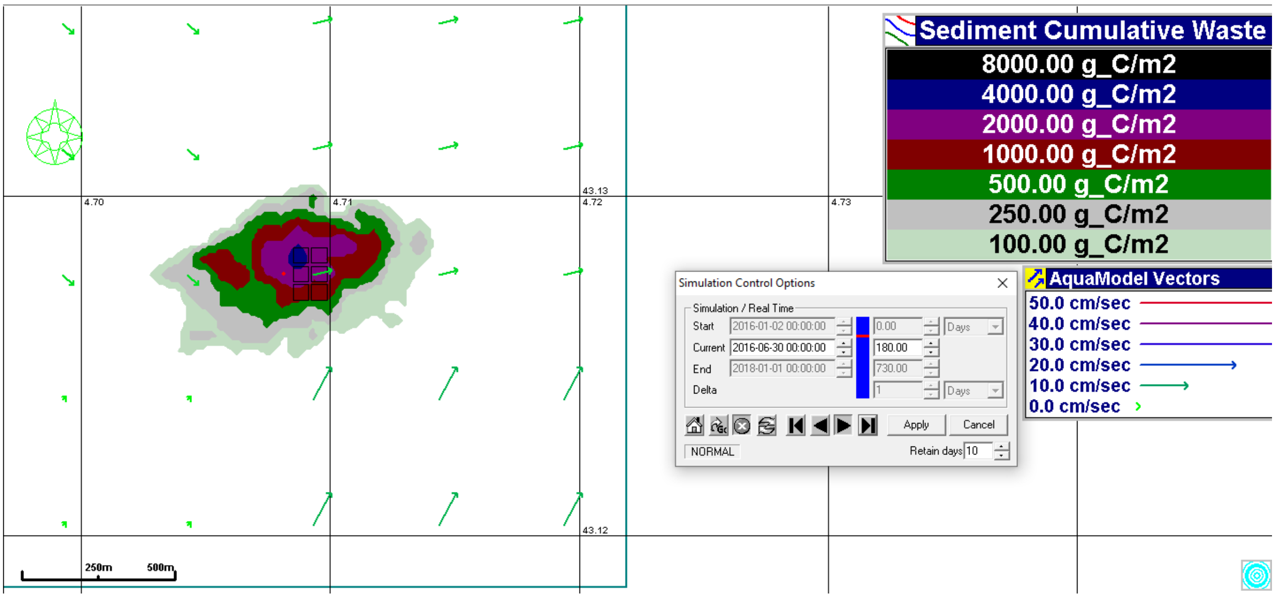


Figure 114: Cumulative deposition (faeces + uneaten feed); date June, 1st year

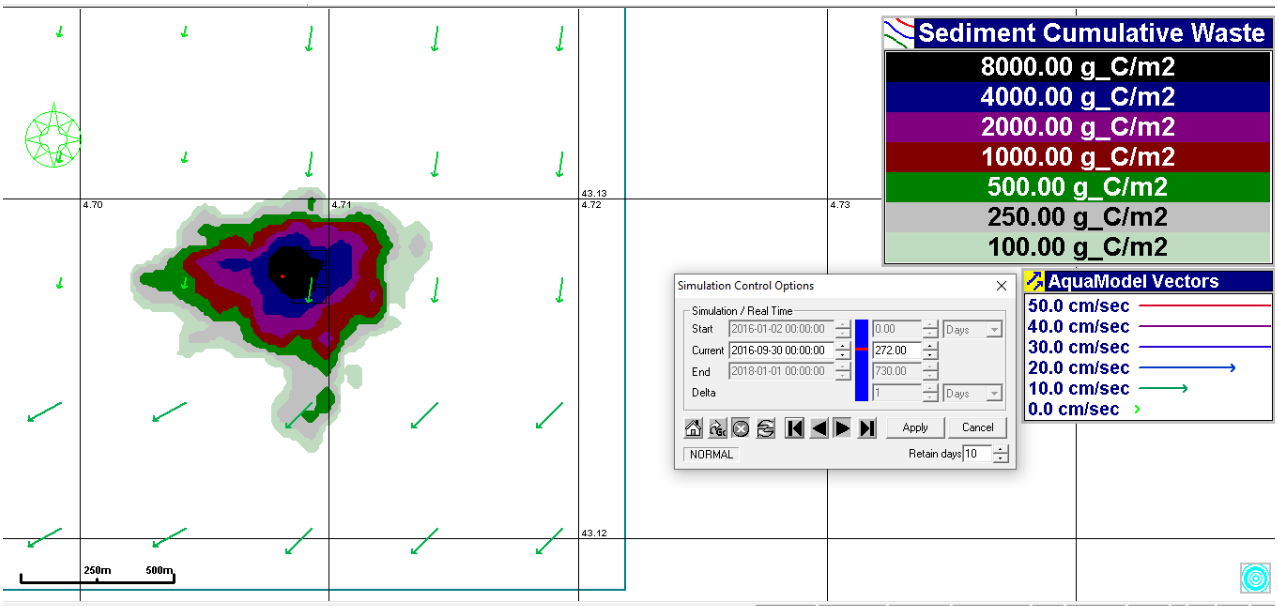


Figure 115: Cumulative deposition (faeces + uneaten feed); date September, 1st year

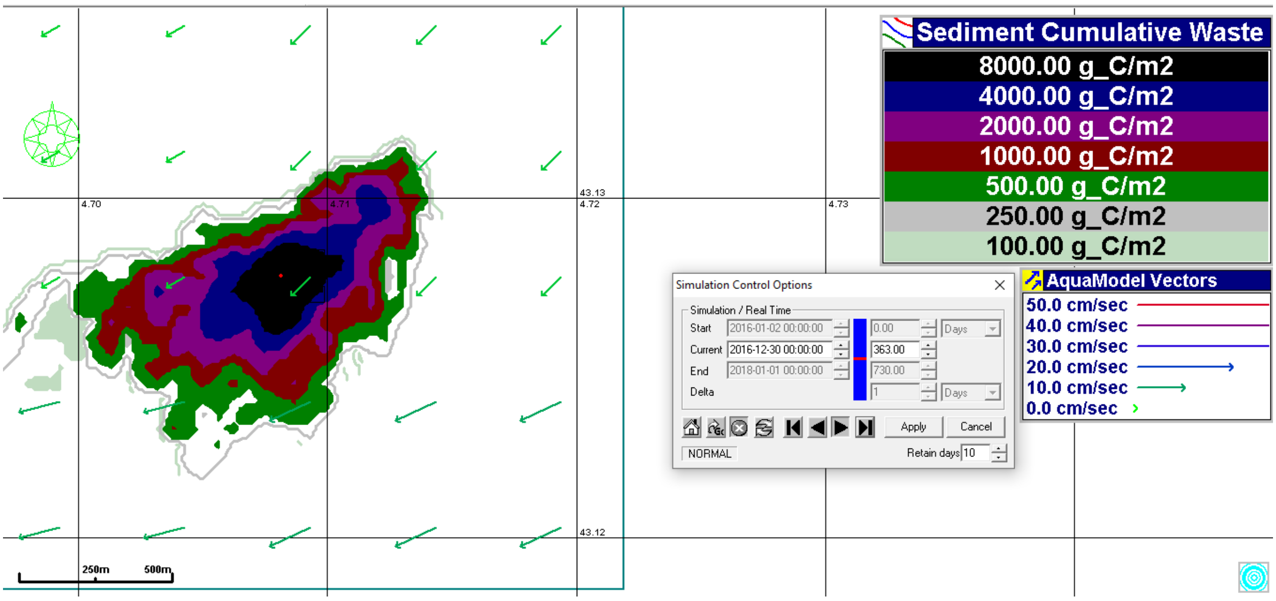


Figure 116: Cumulative deposition (faeces + uneaten feed); date December, 1st year

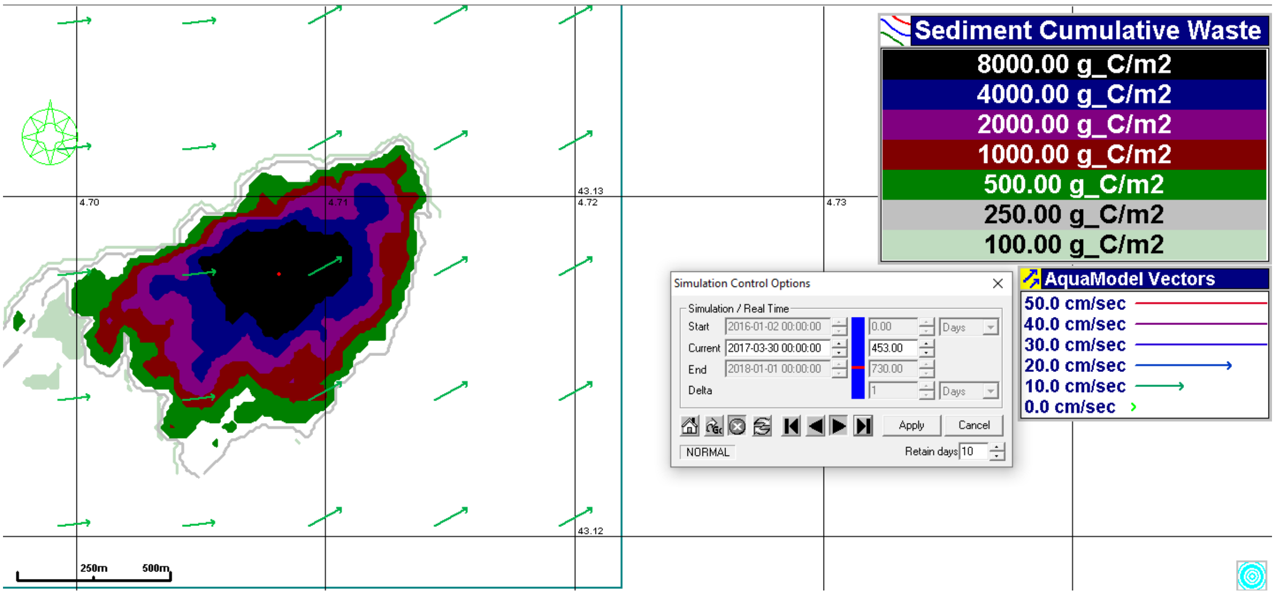


Figure 117: Cumulative deposition (faeces + uneaten feed); date March, 2nd year

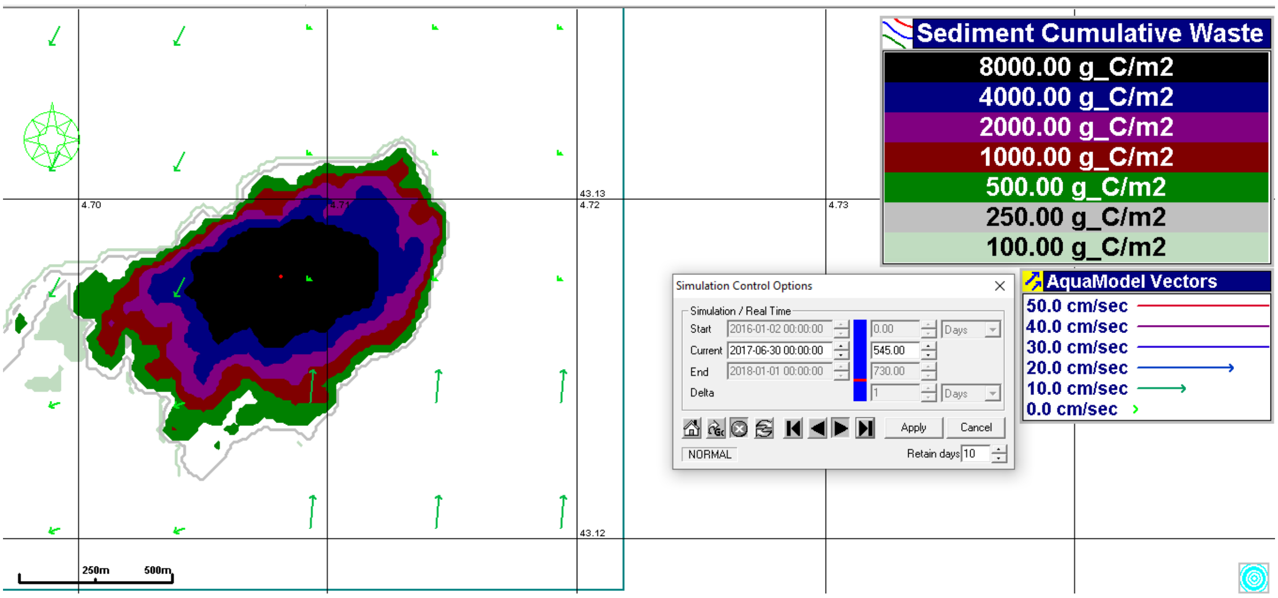


Figure 118: Cumulative deposition (faeces + uneaten feed); date June, 2nd year

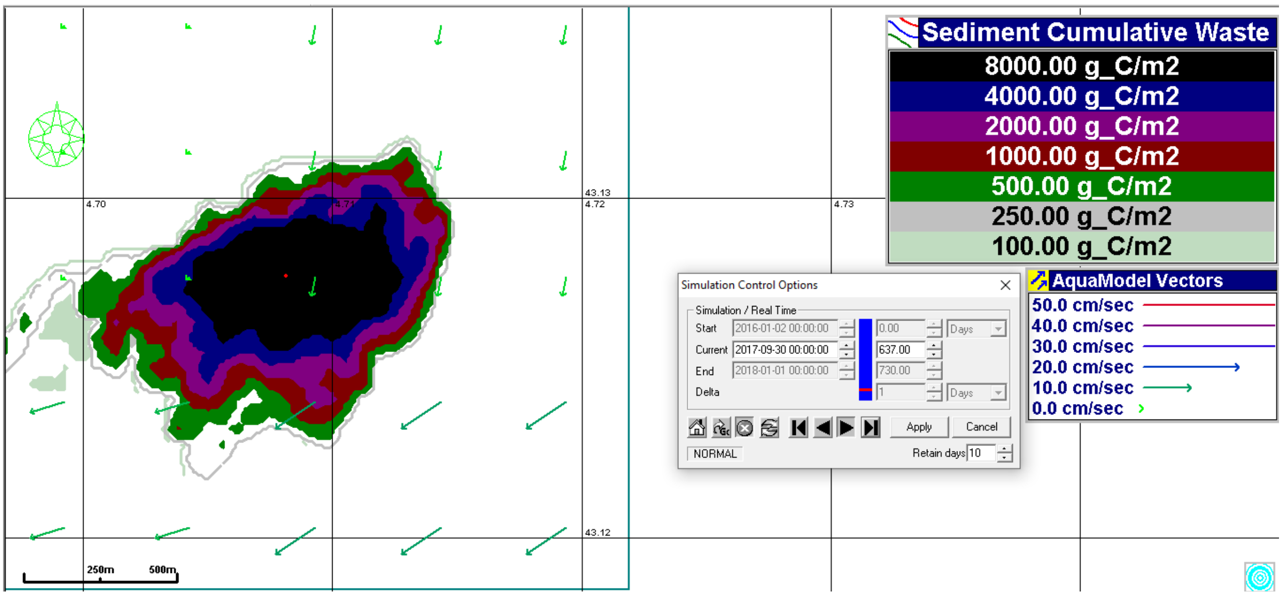


Figure 119: Cumulative deposition (faeces + uneaten feed); date September, 2nd year

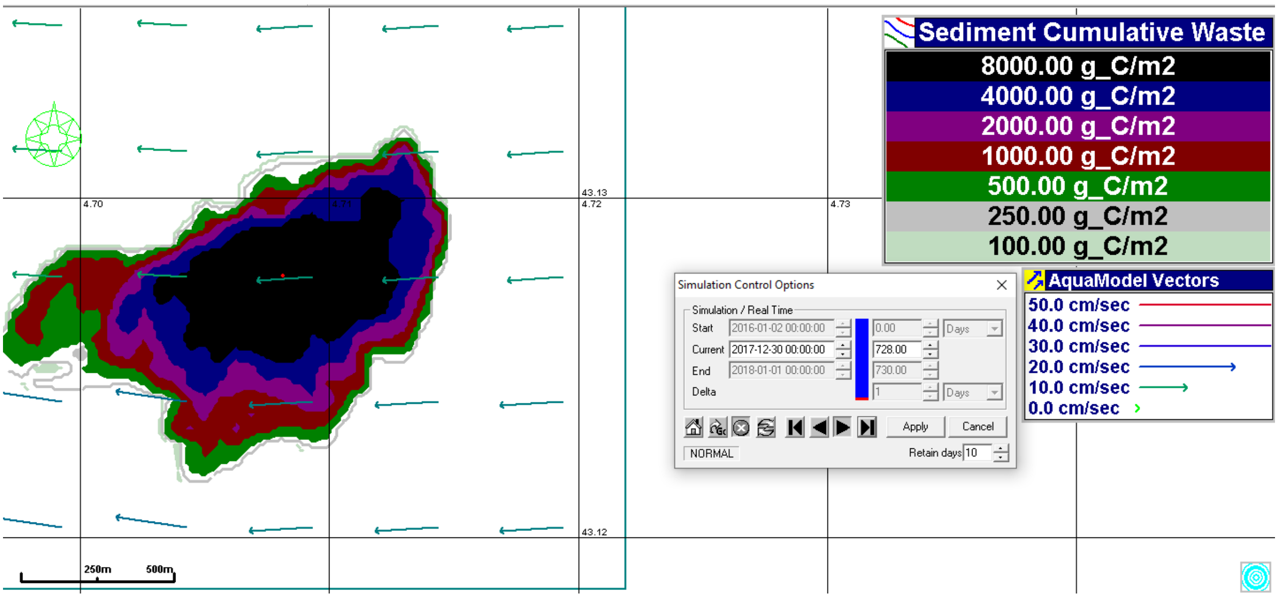


Figure 120: Cumulative deposition (faeces + uneaten feed); date December, 2nd year

The TOC Total Organic Carbon

The following maps report the fraction of total organic carbon present into the sediment. These maps have to be intended as the overall organic carbon presence, resulting from a balance between depositional and benthic respiration processes. In other words, these maps represent the final results of depositional minus respiration processes, and diplay the carbon standing stock in gC/m^2, thus summarizing the modification of benthic features due to aquaculture activities.

Snapshots are displayed at a rate of four/year, at month 6, 9, 12, 15, 18, 21, 24, starting from the first date when TOC appears. Current vectors are referred at 22,5 m of depth, below BGF platform at maximum current exposition of nets. Cages are outlined at the center of map.

The TOC area interested is of 0.64 km^2 (642,598m^2), with a maximum deposit of 0.2 gC/m^2 in the most affected area.

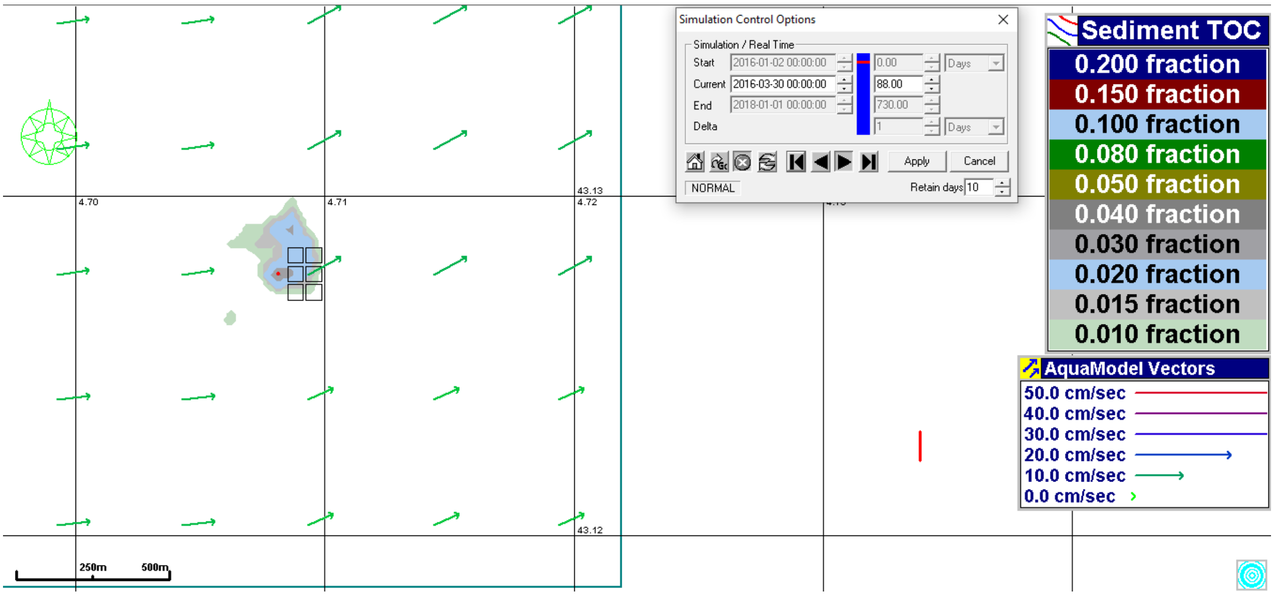


Figure 121: Total Organic Carbon load on seabed; date March, 1st year

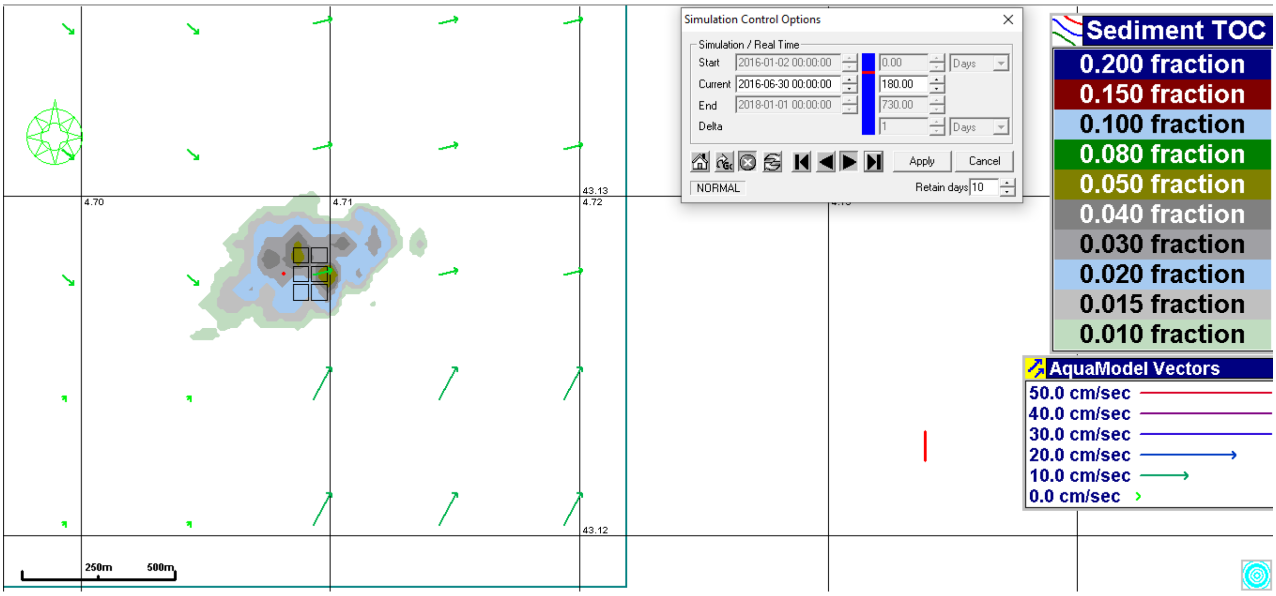


Figure 122: Total Organic Carbon load on seabed; date June, 1st year

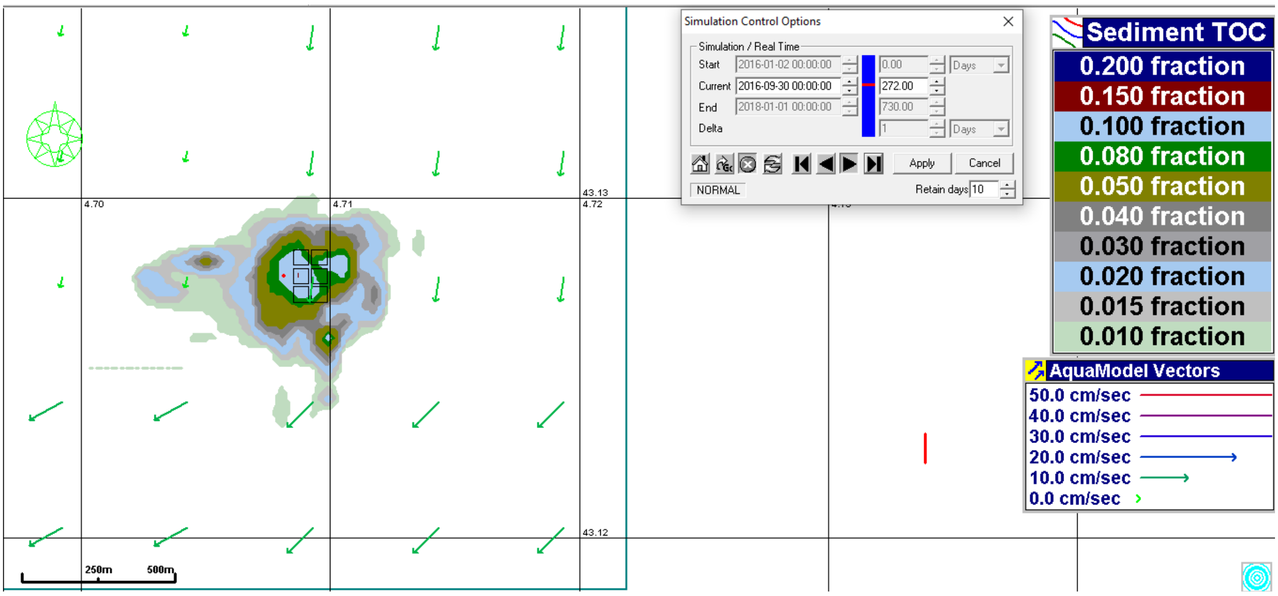


Figure 123: Total Organic Carbon load on seabed; date September, 1st year

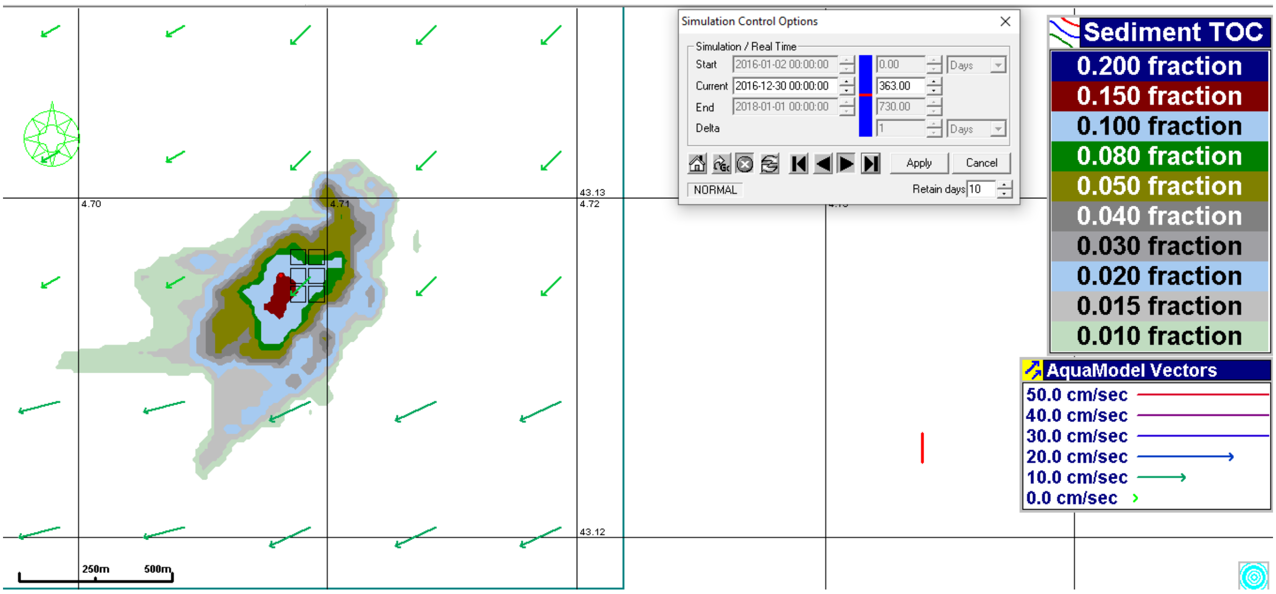


Figure 124: Total Organic Carbon load on seabed; date December, 1st year

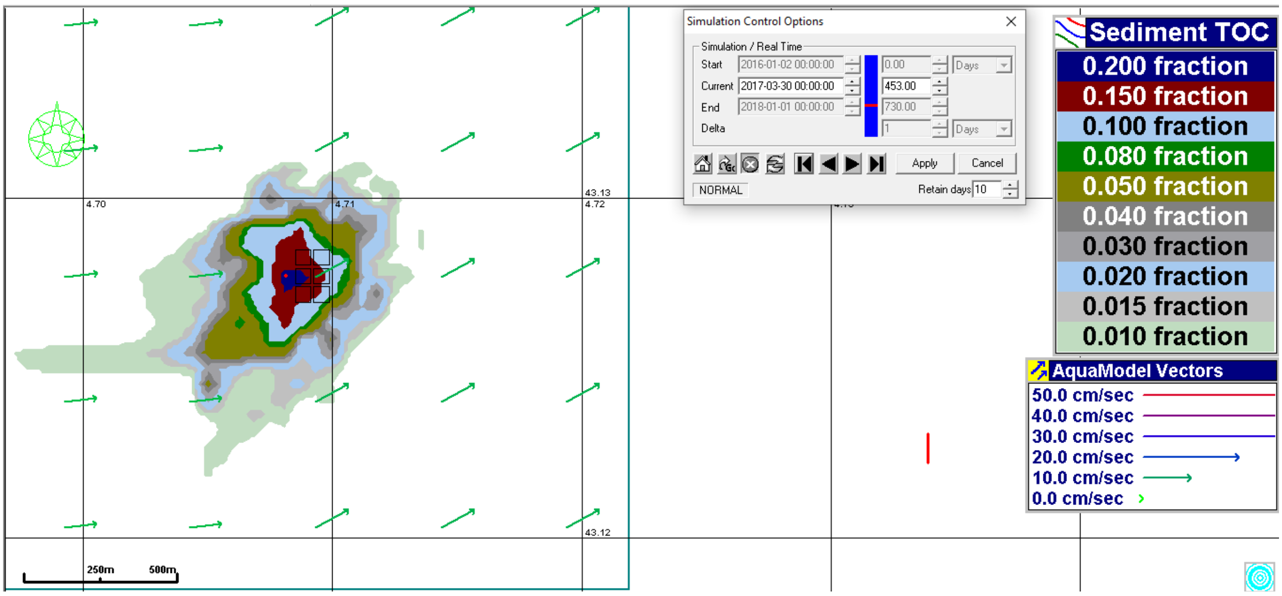


Figure 125: Total Organic Carbon load on seabed; date March, 2nd year

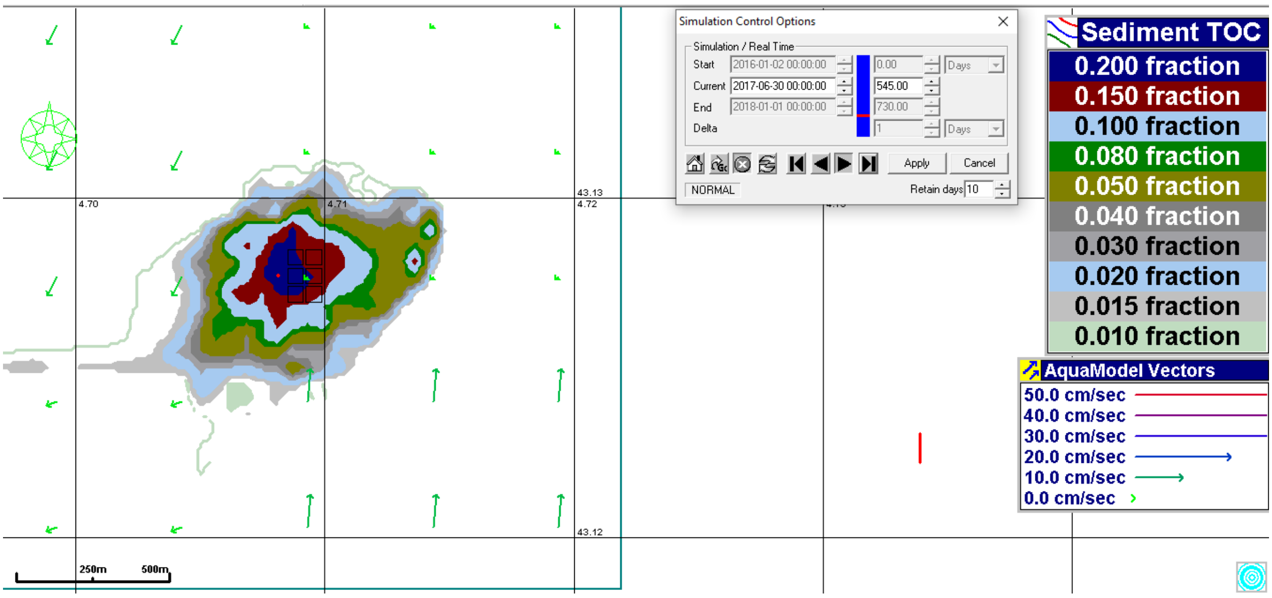


Figure 126: Total Organic Carbon load on seabed; date June, 2nd year

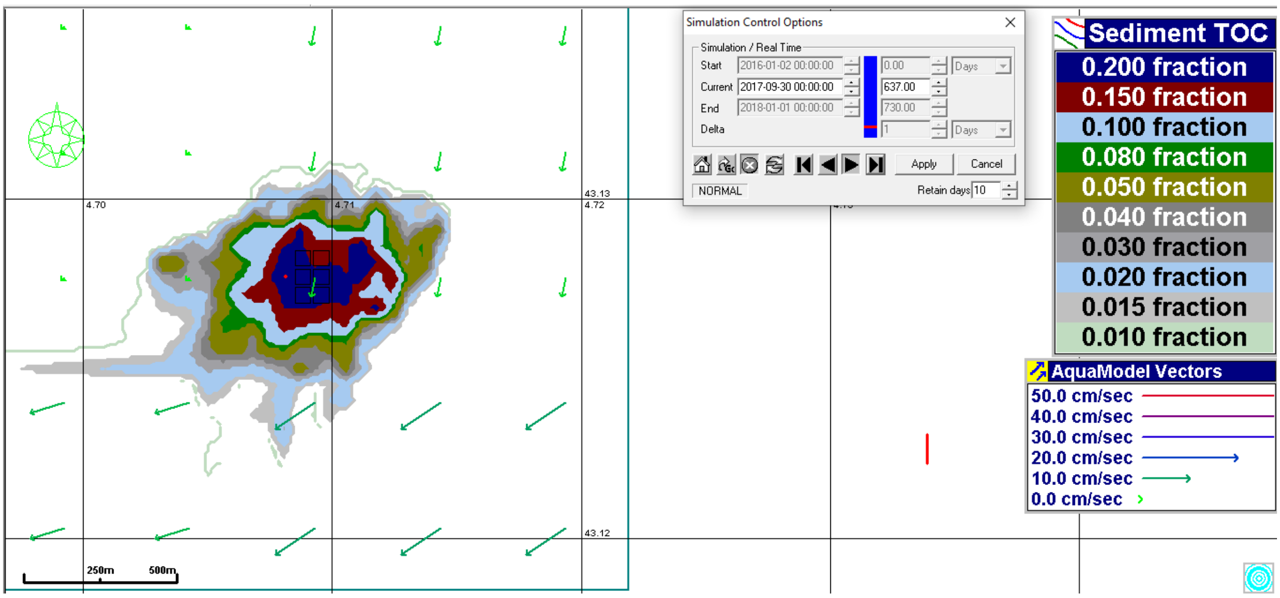


Figure 127: Total Organic Carbon load on seabed; date September, 2nd year

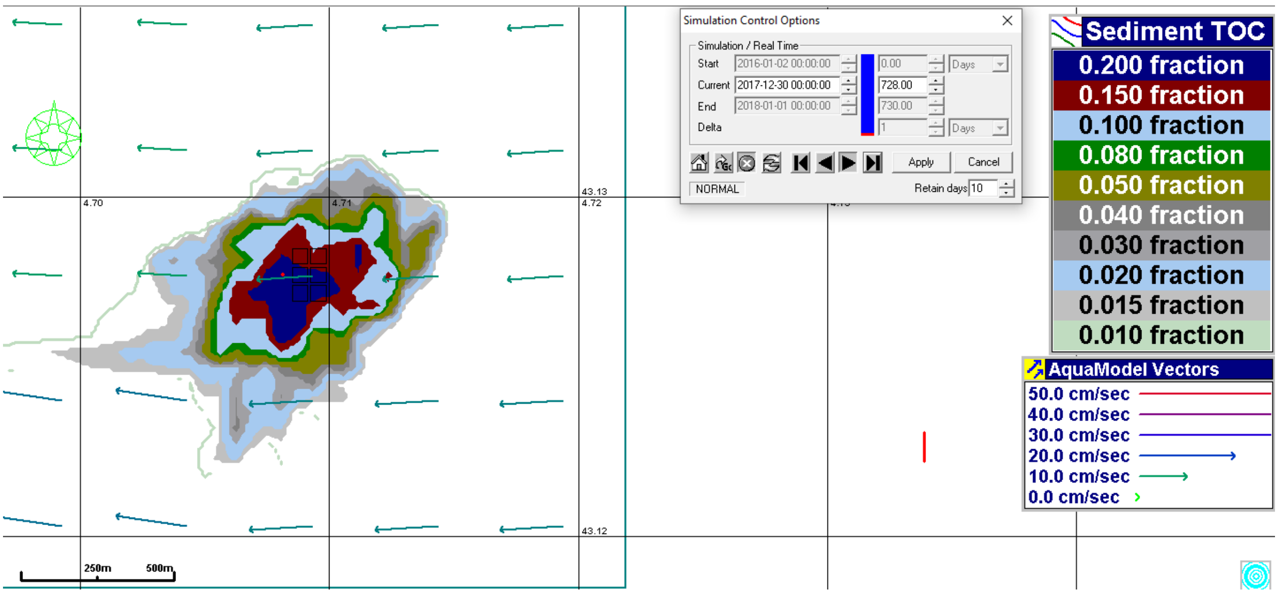


Figure 128: Total Organic Carbon load on seabed; date December, 2nd year

The site of the BGF platform is classified, from a bionomic point of view, as belonging to a **Deep Circalittoral Mud (EUNIS A 5.37)**. Due to the intense fishery effort applied on this bottom targeting *Nephrops norvegicus*, the area is likely to be better recognised as an **A 5.371 EUNIS** community, described as "***Ampharete falcata* turf with *Parvicardium ovale* on cohesive muddy sediment near margins of deep stratified seas**". Similar communities in the A 5.37 group are not hosting *Nephrops*, therefore have been excluded.

The Community is defined as "Dense stands of *Ampharete falcata* tubes which protrude from muddy sediments, appearing as a turf in localised areas. These areas seem to occur on a crucial point on a depositional gradient between areas of tide-swept mobile sands and quiescent stratifying muds. Dense populations of the small bivalve *Parvicardium ovale* occur in the superficial sediment. Other infauna in this diverse biotope includes polychetes as *Abyssoninoe scopa* (*syn. Lumbrineris scopa*), *Levinsenia* sp., *Prionospio steenstrupi*, *Diplocirrus glaucus* and *Praxillella affinis*. Both the brittlestars *Amphiura filiformis* and *Amphiura chiajei* may be present together with *Nephrops norvegicus* in high abundance. Substantial populations of mobile epifauna such as *Pandalus montagui* and *Macropodia* spp. are present" (Connor et *al.*, 2004). ***This community is listed within the Scottish Marine Priority Features***.

The presence of the specific pool, either chacteristic or associated, is most likely to be determined by the occurrence of a suitable substratum rather than by interspecific interactions. *Ampharete falcata* and *Parvicardium ovale* are functionally dissimilar and are not normally associated with each other but are both found on muddy sediment habitats. No substantial information is available regarding possible interactions between any additional species found in this biotope. In addition to *Ampharete falcata* and *Parvicardium ovale* the biotope supports several bivalve species and a group of burrowing species such as *Amphiura filiformis*, *Amphiura chiajei*, *Nephrops norvegicus* and smaller less conspicuous species such as errant polychaetes, nematodes etc.

The burrowing and feeding activities of *Amphiura filiformis* can modify the fabric and increase the mean particle size of the upper layers of the substrata by aggregation of fine particles into faecal pellets. Such actions create a more open fabric with higher water content, which affects the rigidity of the seabed (Rowden et *al.*, 1998), possibly affecting particle resuspension rate.

The hydrodynamic regime, which in turn controls sediment type, is the primary physical environmental factor structuring these benthic communities.

The biotope has very little structural complexity. The polychaete *Ampharete falcata* creates a turf of small tubes on the surface of muddy sediments in which, *Macropodia* spp. are able to live by clinging to the tubes. Within the sediment, burrowing species as *Nephrops norvegicus* create habitats that cryptic species can use. Otherwise, the fauna uses the sediment for shelter without increasing structural complexity.

An *Ampharete* biotope is likely to reach maturity very rapidly because the key species are short lived and reach maturity within a few months. *Parvicardium ovale* has a lifespan of less than a year (Lastra et *al.*, 1993). There was no information found on the life-history characteristics of *Ampharete falcata*, however a related species *Ampharete acutifrons* was found to be an annual species (Price & Warwick, 1980, MarLIN).

The biotope occurs on cohesive sandy muds, experiencing weak tidal streams, on a crucial point on a depositional gradient between areas of tide-swept mobile sand and quiescent stratified muds (Connor et *al.*, 2004). The presence of suitable substratum is considered to primarily determine the biotope establishment by supporting the development of turfs of *Ampharete falcata*, considered as the key characterizing and structural species together with *Parvicardium ovale*. In addition, this community may also support lobster *Nephrops norvegicus* and can consequently be the focus for fishing activity.

Removal of the characterizing species *Ampharete falcata* and *Parvicardium ovale* would result in loss or re-classification of the biotope. An *Ampharete* biotope is likely to reach maturity very rapidly because the key species are short lived and reach maturity within a few months. *Parvicardium ovale* is very widespread and has a short lifespan of one year so it likely that reproduction occurs yearly. Where perturbation removes a portion of the population or even causes local extinction resilience degree is likely to be determined by the recruitment possiblity from neighbouring areas. However, in case *Ampharete falcata* populations are separated by great distances, or in areas of suitable habitat that are isolated, the population recovery is likely to depend on favourable hydrodynamic conditions that will allow recruitment from farther away. Given the low energy environment where the biotope occurs and the low dispersal potential of *Ampharete falcata* benthic larvae, recruitment to recolonize impacted area may take longer. However, once an area has been recolonized, restoration of the biomass of both characterizing species is likely to occur quickly (full recovery within 2-10 years).

Concerning organic substances enrichment, both Ampharete falcata and *Parvicardium ovale* are considered as negatively correlated with high organic carbon sediments. Nevertheless, this community is reputed to live with up to 300 gC/m^2/year, therefore may be considered as tolerating a moderate organic enrichment. Similar species (*P. exiguum* and *A. grubei*) live in silty and organically rich areas. However, some mortality is expected as result of organic enrichment, and resistance is considered low, resilience high and overall sensitivity low. *Amphiura spp*. are moderately sensitive to sediment texture change, hence under high organic sedimenting loads that modify sediment texture, and may suffer a mortality (MarLIN).

The area subjected to the highest sedimentation (over 700 gC/m^2/year, see Gillibrand et *al.* (2002) is rather large (**0.83 km^2**) and expected to suffer a modification of the community characteristics.

The heavy depositional load may progressively remove the species less tolerant to organic enrichment (*Parvicardium* and *Ampharete*) gradually substituing them with a more tolerant/opportunistic infaunal community, which last term may be expected to be the "***Capitella capitata* and *Thyasira* spp. in organically-enriched offshore circalittoral mud and sandy mud"** community, **EUNIS A 5.374,** characteristic of fluid muds with associated high organic loads.

The area swept by the mooring chains (**0.167 km^2**, see D4.1- France) may be considered as likely to be defaunated by the chain movements during storm events. A partial recovery may occur during calm period, but the re-establishment of a mature community depends from events frequency.

However, recovery time for this community is considered short (2 years).

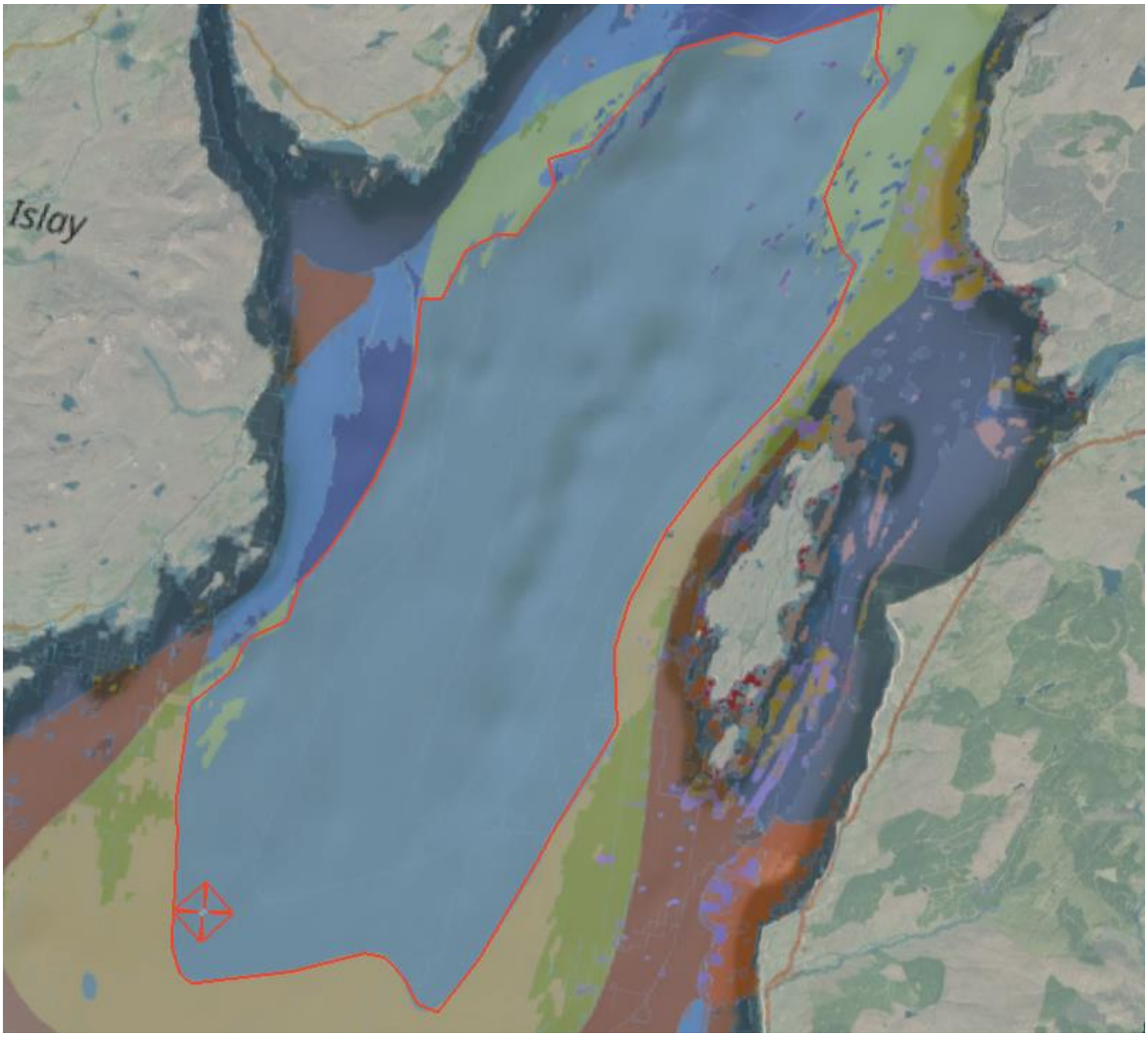


Figure 129: A5.374 community extension on seabed. Red cross: BGF platform moorings, with restricted area (red square) highlighted.

The loss of A 5.371 Eunis community are due to moorings and organic enrichment is therefore equal to **(0.167 + 0.83) = 1 km^2** approx;

The above community in the area has a surface of **383 km^2**;

In percentage, the loss will be of: **(1/383*100) = 0.26 %** of the A 5.371 available area in Sound of Jura.

4.1.4 Impact on pelagic communities

Effects on the Water Column – Near-field range

The dispersion of Total Dissolved Nitrogen has been computed on a scale of 2 km that provide an effective nitrogen dilution due to the intense flow field.

On short scale, the computational unit has been set to describe the spatial dispersion pattern around the farm, on a scale of some km, where the most part of effects are usually evident.

The computational domain has been set as follow:

- The computational cells have been set in number of 41 x 41 x 6 units;
- Each cell has a size of 50 m x 50m x 15 m;

The total size of the computational volume is therefore of:

- 50 m x 41 cells = 2,050 m;
- 50 m x 41 cells = 2,050 m;
- 5 m x 24 cells = 90 m

The above has determined a computational total volume of 2,050 m x 2,050 m x 90 m.

Within the given volume, a 3-dimensional computational mode has been used: The flow field adopted is similar to the one used in Marseille, since the same level of detail is not available for Islay waters: however, the flowfield has been forced by a strong semidiurnal tidal component, with speeds of 1.1 m/sec. Therefore, the used flowfield is not referred to local conditions, but has been used as a generic flowfield encompassing moderate currents (up to 1.1 m/sec) under a semidiurnal tide regime. In a subsequent step, this simulation will be re-run using a 2-dimensional flow field, derived from data originated by different sources (Copernicus, BODC).

the velocity vectors have been retrieved from the CMEMS IBI 005-001 product, and flowfield has been forced by a semidiurnal tidal component at a maximum speed of 1.1 m/sec.

The used flowfield dataset range from 01.01.2016 to 01.01.2018, from January to December. Computational step is at 1 hour, resulting maps are computed at steps of 1 day.

Nitrogen Dispersion

The computation has been performed at time steps of one hour, at the same interval of current data.

In this way, the information on movements due to semidiurnal tide components has been maintained. In the same time, this interval has requested a long computing time and generated as well a redundancy of images, beyond the aim of the present study.

Cages has been schematized as located between -20 and -45 m of depth, to account for dispersion due to the deepest cage part, below platform wall, here considered as a solid barrier to transversal water movement.

In order to describe the annual Nitrogen dispersion pattern, a subset of images, sampled at a rate of one image /month has been extracted and presented.

Along the images, the arrows represent the current vector, calculated at the depth of 22.5 m.

Their length is proportional to the current speed, as in the side legend. To represented Nitrogen diffusion as sourcing from the portion of cage below the platform wall, say, from 20 to 45 m, the output point has been set at 22.5 m on maps. Maps are 2,050 x 2,050 m wide.

Red line crossing image from SE to NW represent the transect line, along which the section with Dissolved Nitrogen concentration from surface to bottom is displayed.

Dissolved Nitrogen concentration is in mgN/m^3.

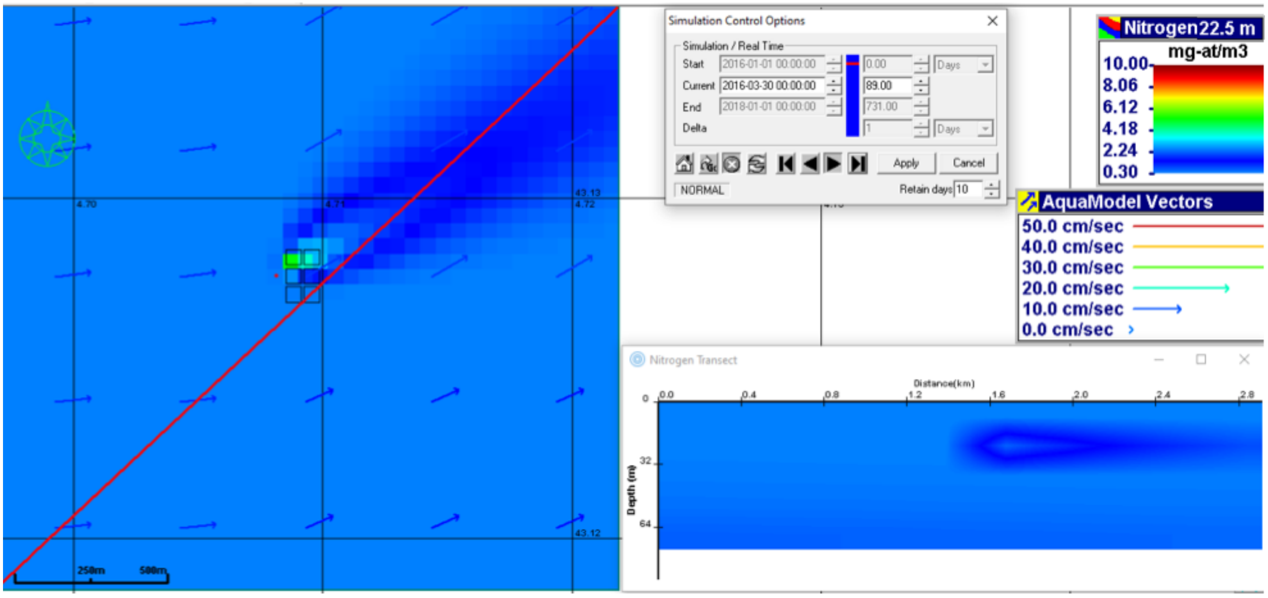


Figure 130: Nitrogen dispersion at 22.5 m (left); vertical section along red line; date March, 1st year

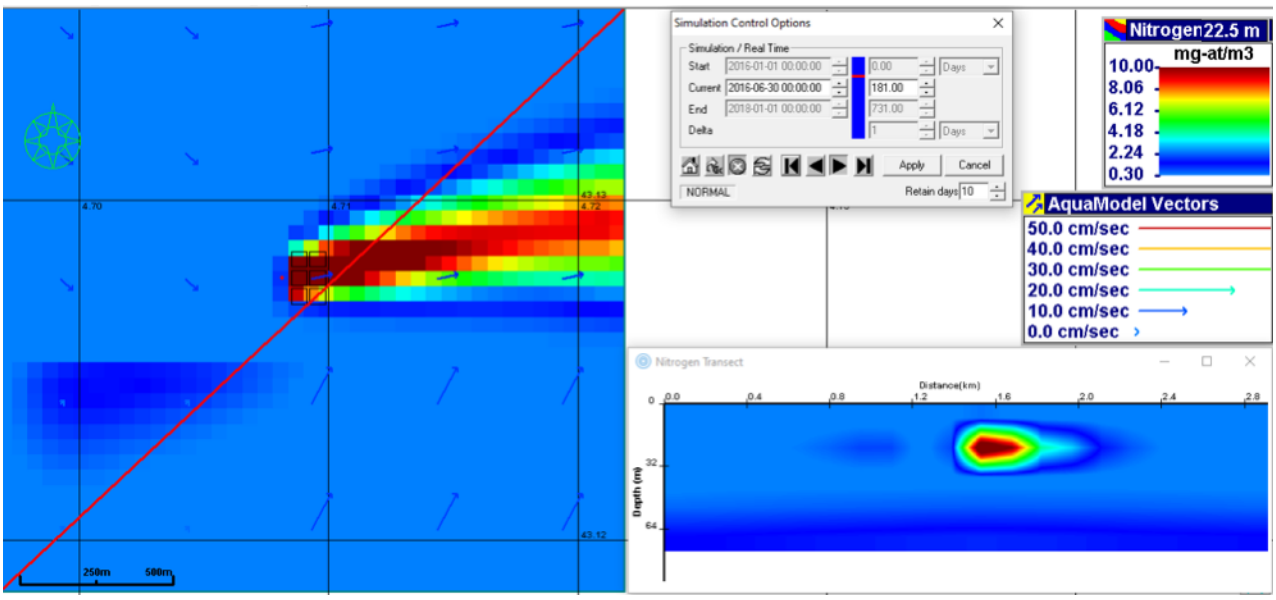


Figure 131: Nitrogen dispersion at 22.5 m (left); vertical section along red line; date June, 1st year

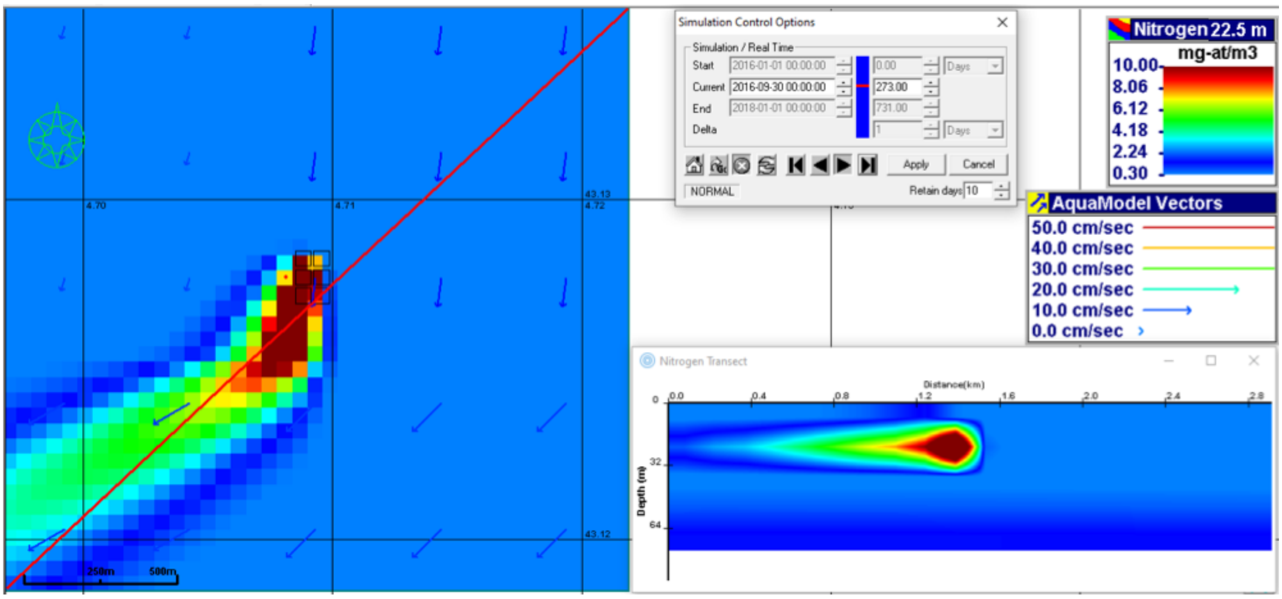


Figure 132: Nitrogen dispersion at 22.5 m (left); vertical section along red line; Date September, 1st year

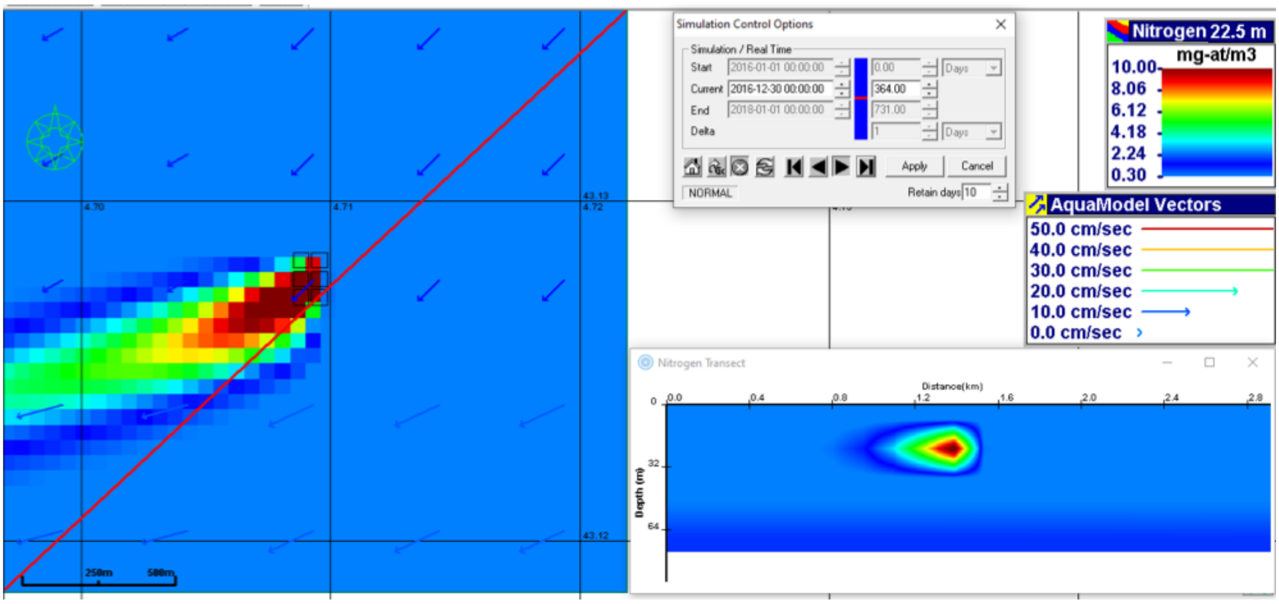


Figure 133: Nitrogen dispersion at 22.5 m (left); vertical section along red line; Date December, 1st year

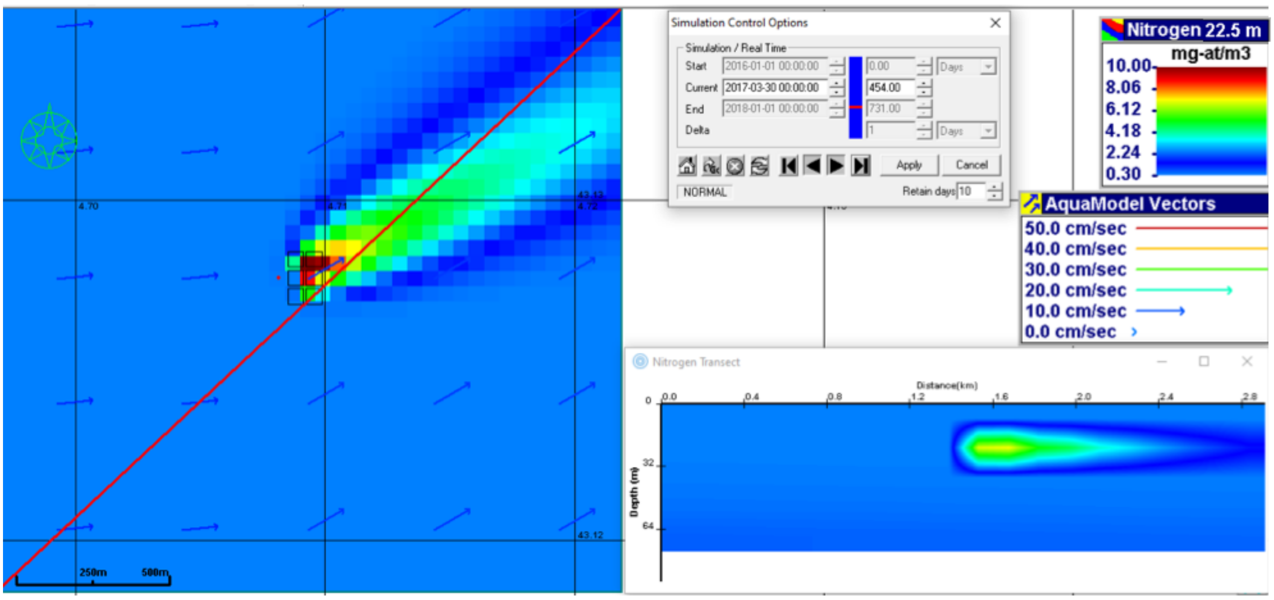


Figure 134: Nitrogen dispersion at 22.5 m (left); vertical section along red line; date March, 2nd year

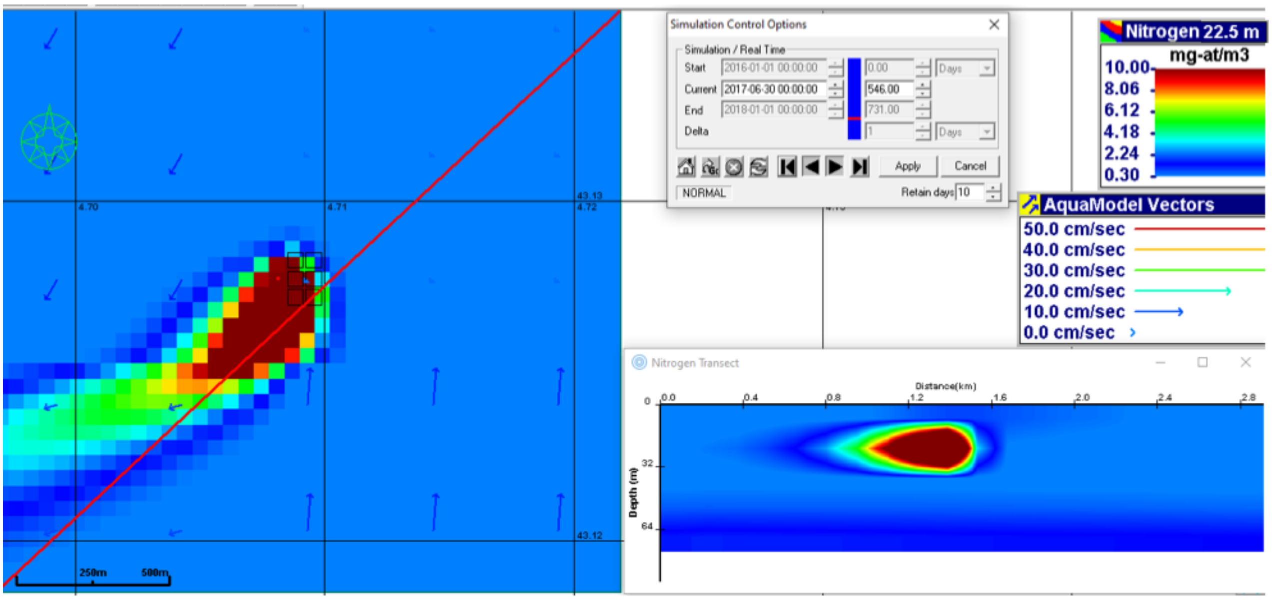


Figure 135: Nitrogen dispersion at 22.5 m (left); vertical section along red line; date June, 2nd year

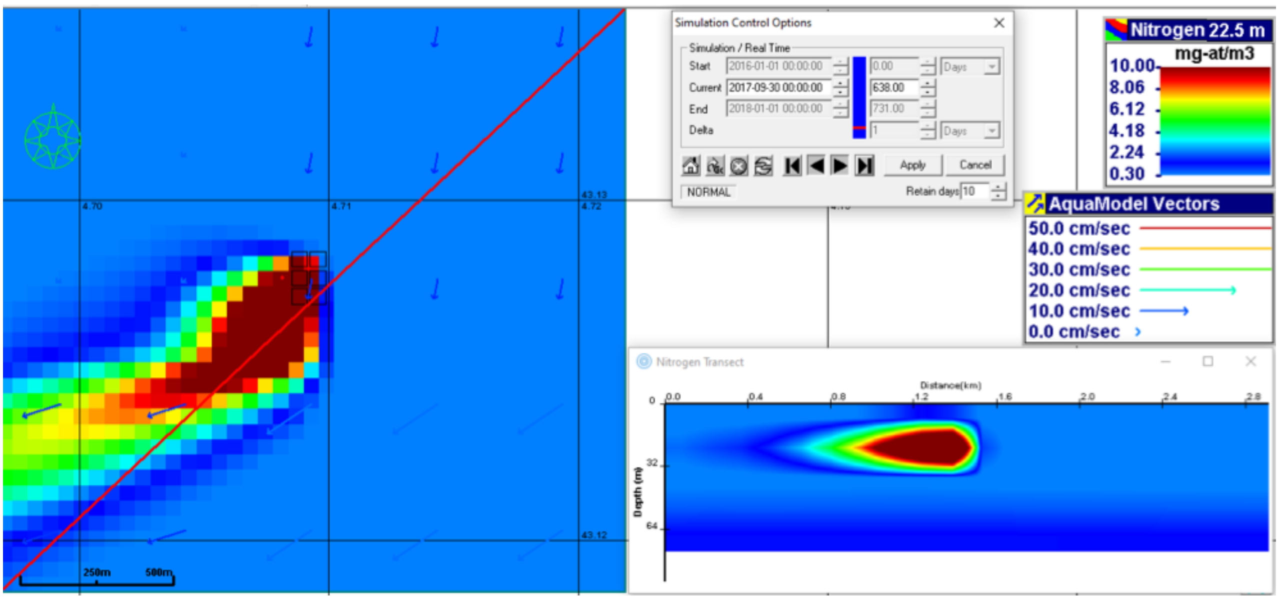


Figure 136: Nitrogen dispersion at 22.5 m (left); vertical section along red line; date September, 2nd year

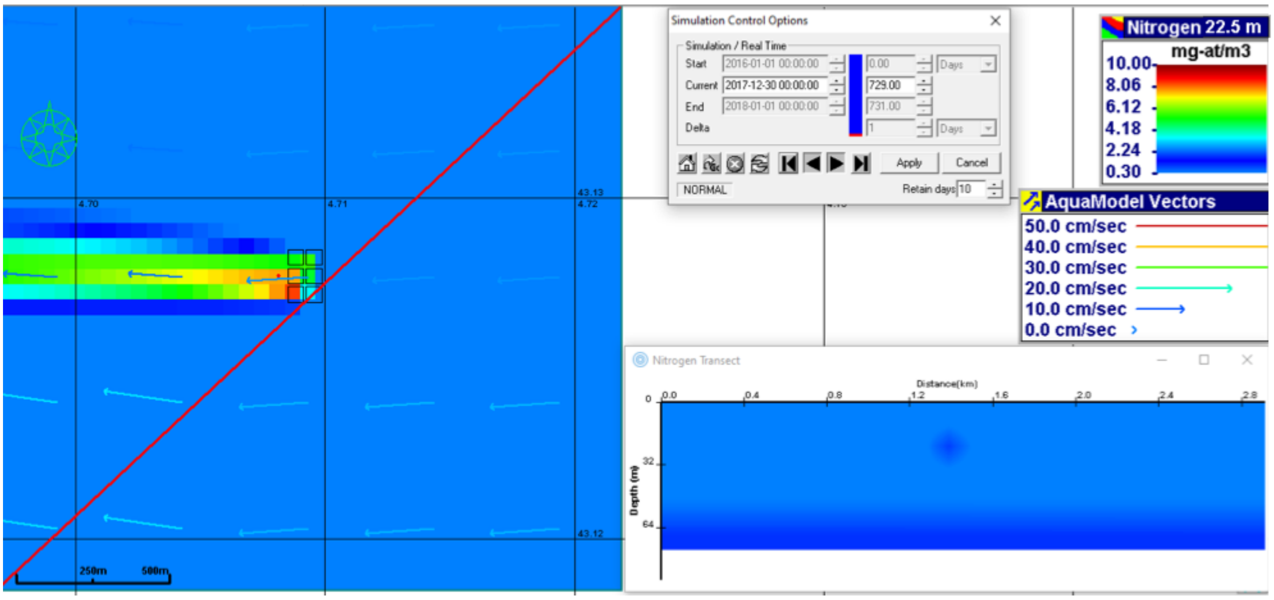


Figure 137: Nitrogen dispersion at 22.5 m (left); vertical section along red line; date December, 2nd year

Considerations

The nitrogen dispersion is fast and only in some cases moves beyond the computational limits. This is due the the intense circulation pattern that brings Nitrogen concentration quickly to the level of surrounding waters, minimizing effects on pelagic communties.

The fast dilution does not allow for a sufficient contact time between planktonic microalgal community and Nitrogen-enriched waters, thus preventing the possiblity of algal blooms. Nevertheless, the total mass of discarded Nitrogen is relevant, and its possible fate as a source of planktonic community change should be further assessed carefully.

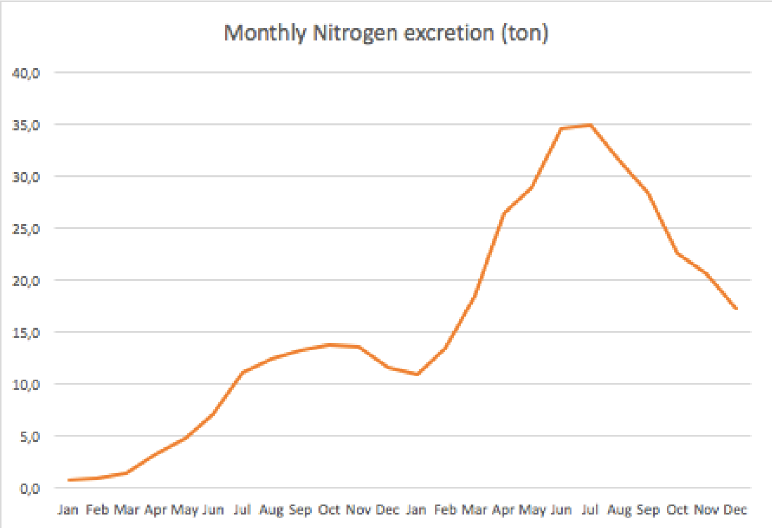


Figure 138: Nitrogen excretion by month by BGF farmed biomass, ton

Table 23: Monthly nitrogen excretion compared to consumed feed in BGF farm

Months of growth	Consumed feed (ton)	Excreted Nitrogen (ton)
Jan	15	0,7
Feb	19	0,9
Mar	28	1,3
Apr	68	3,3
May	99	4,8
Jun	148	7,1
Jul	229	11,0
Aug	259	12,4
Sep	276	13,2
Oct	284	13,6
Nov	283	13,6
Dec	239	11,5
Jan	226	10,8
Feb	278	13,3
Mar	384	18,4
Apr	549	26,3
May	600	28,8
Jun	721	34,6
Jul	725	34,8
Aug	654	31,4
Sep	591	28,3
Oct	470	22,5
Nov	429	20,6
Dec	359	17,2

The concept of Inhabitant Equivalent (IE) may be applied to clarify the picture of the discharged Nitrogen in the marine waters (Henze, 2008).

Given that the amount of total Dissolved Nitrogen released by 1 IE is equal to 15 g/day; the amount of fish feed distributed over 1 year of full production is of 5.983 ton, corresponding to an excretion of Total Nitrogen of 287 ton, then 786 kg/day.

This last amount equals to the Total Nitrogen discarded by an untreated sewage effluent serving for **52.400 IE**.

Figure of Total Nitrogen imput into the Sound of Jura are unfortunately unavailable, making comparison with excreted Nitrogen by fish metabolism unfeasible.

4.1.6 Impact on other uses of the sea

The central part of the Jura Sound is intensely exploited by the local trawlers fleet targeting the Norway lobster. Since this species is associated to muddy bottoms, the extension of the eploitable area has been calculated, based on benthic community maps (EMODnet, www.emodnet.it), resulting in a surface of 424 km^2. The area occupied by the BGF, including a likely respect area around mooring lines, is of 2.17 km^2.

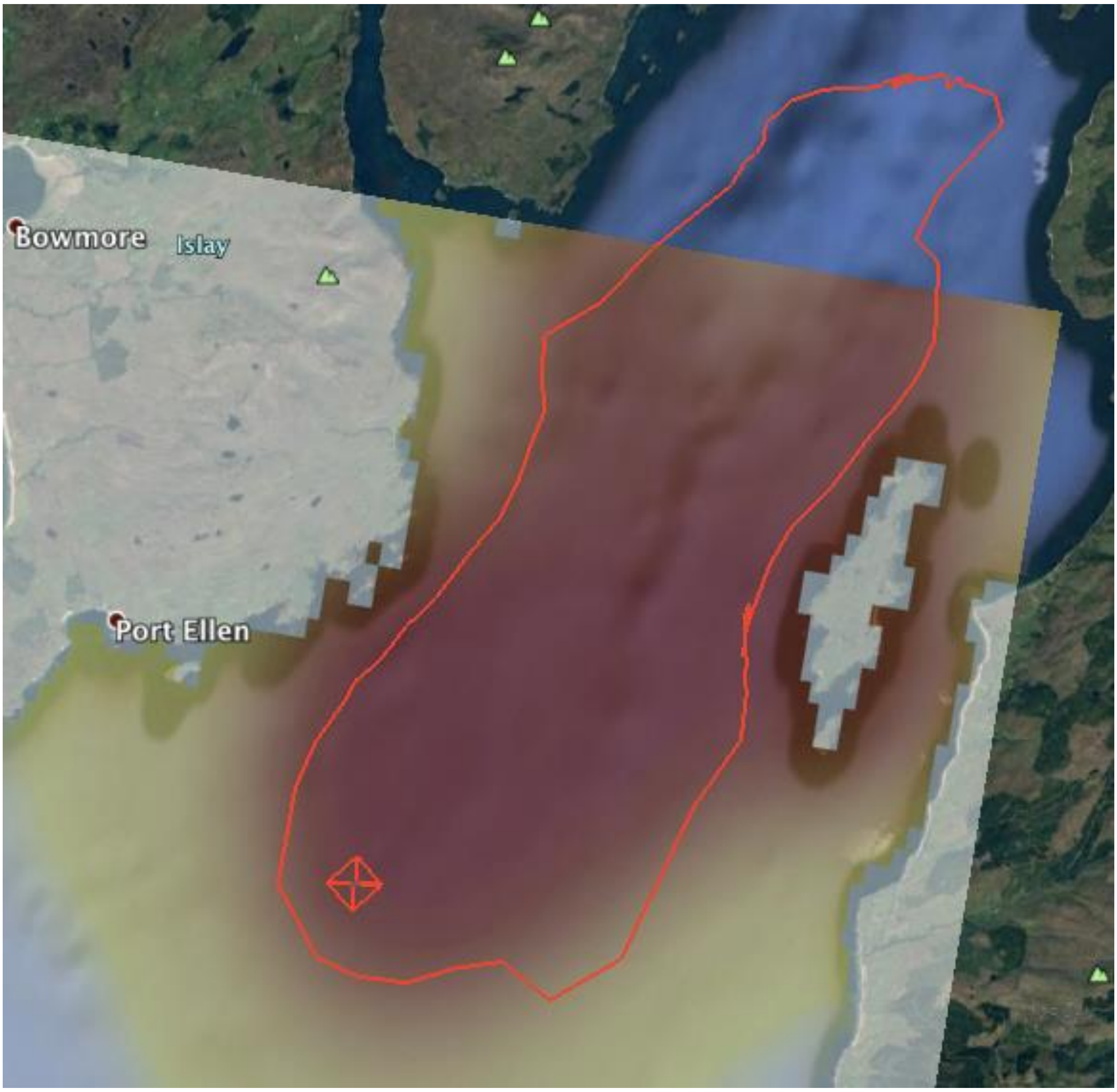


Figure 139: Area exploited Norway lobster trawling fishery (*Source: Marine Scotland*); within red line: benthic community area with N. lobster; square red area: BGF respect area

The resulting ratio (2.17/424*100) equates **0,5 %** of the exploitable surface, therefore the BGF installation will determine such a loss of exploitable area for Norway lobster fishery.

On the other hand, since the corresponding surface will be forbidden to fishing activities, the *Nephrops norvegicus* individuals living that area have the possibility to develop a population structure with several year-classes, thus contributing with elder broodstocks to the cohort renewal.

The following figures show the other uses of the sea around the BGF platform, particularly concerning sea angling, motor boating and sailig (*Source: Marine Scotland).*

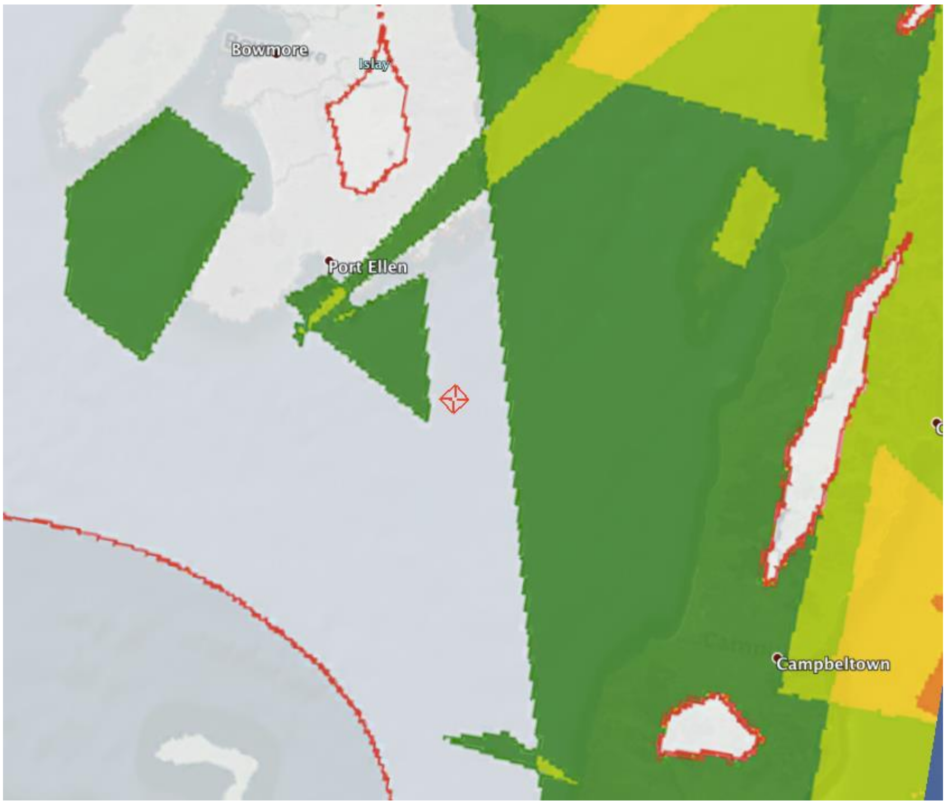


Figure 140: Areas of intense sea angling around BGF platform (*Source: Marine Scotland*)

Figure 141: Areas of intense power boating around BGF platform (*Source: Marine Scotland*)

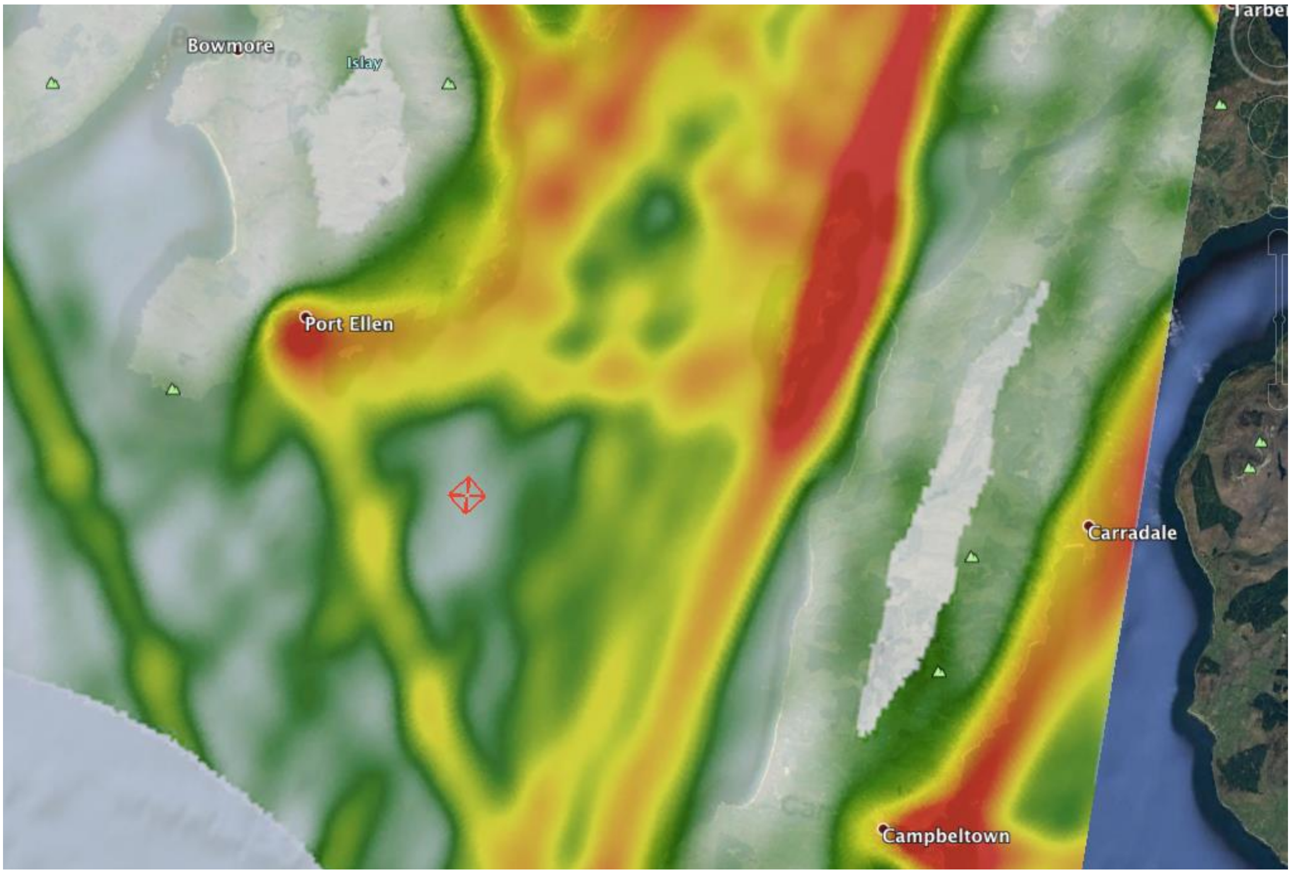


Figure 142: Areas of sailing around BGF platform (*Source: Marine Scotland*)

As visible from the above maps, the BGF site is interested by motorboats passage, an activity that can be easily displaced aroud the BGF respect area. Angling and sailing do not interest the BGF site.

4.1.7 Impact on landscape

The method adopted is described in Marseille study, see D 4.1- France.

The degree to which a particular anthropic element can be clearly perceived within an environmental context is called "visibility". The visibility of an element is strictly dependent on the intrinsic physical characteristics of the element (height, width) and on the observer's field of vision.

According to the generally adopted criterion, the visibility of an element within a given context is limited to cases in which the element occupies at least 5% of the complete visual field of the observer's eye (Felleman, 1979).

The measurement of the visual field of the human eye is based on parameters that provide the basis for evaluating and interpreting the impact of an element, evaluating the extent to which the element itself occupies the central field of eye visibility (both horizontally and vertically).

<u>**Horizontal visual field**</u>

The visual field of each eye taken individually varies between an angle of 94 and 104 degrees, depending on the person. The maximum visual field of the human eye is therefore characterized by the sum of these two fields and therefore ranges between 188 and 208 degrees.

The central field of visibility for most people instead covers an angle between 50 and 60 degrees (see Figure 143). Within this angle, both eyes observe an object simultaneously. This creates a central field of greater magnitude.

This central field of visibility is called 'binocular field'; in this field the images are sharp, the perception of depth and the discrimination between colors are verified.

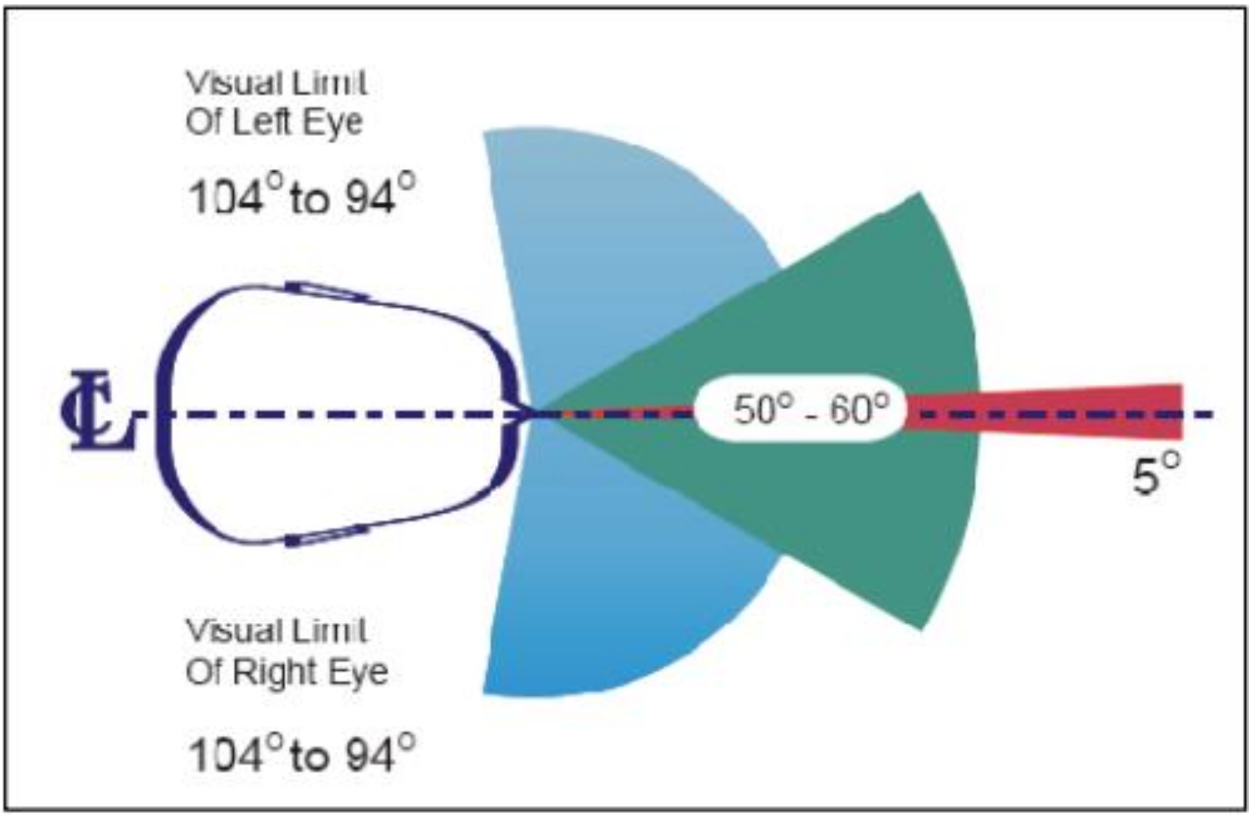


Figure 143: Visibility fields in horizontal plan

The visual impact of an element on the horizontal visual field of man therefore depends on the way in which this element impacts the central field of visibility. An element that occupies less than 5% of the central binocular field is usually insignificant for the purpose of assessing its impact in most of the contexts in which it is inserted (5% of 50 degrees = 2.5 degrees).

<u>**Vertical visual field**</u>

Evaluations similar to those described for the horizontal visual field of the human eye can be made for the vertical visual field. As shown in figure 144, the vertical visual field of the human eye corresponds to an angle of 120 degrees (50 degrees above the standard line of sight, which stands at 0 degrees, and 70 degrees below the standard line of sight).

The central field of visibility has a width of 55 degrees, while the normal visual cone varies between 10 degrees below the standard line of sight if the observer is standing and 15 degrees below the standard line of sight if the observer is seated.

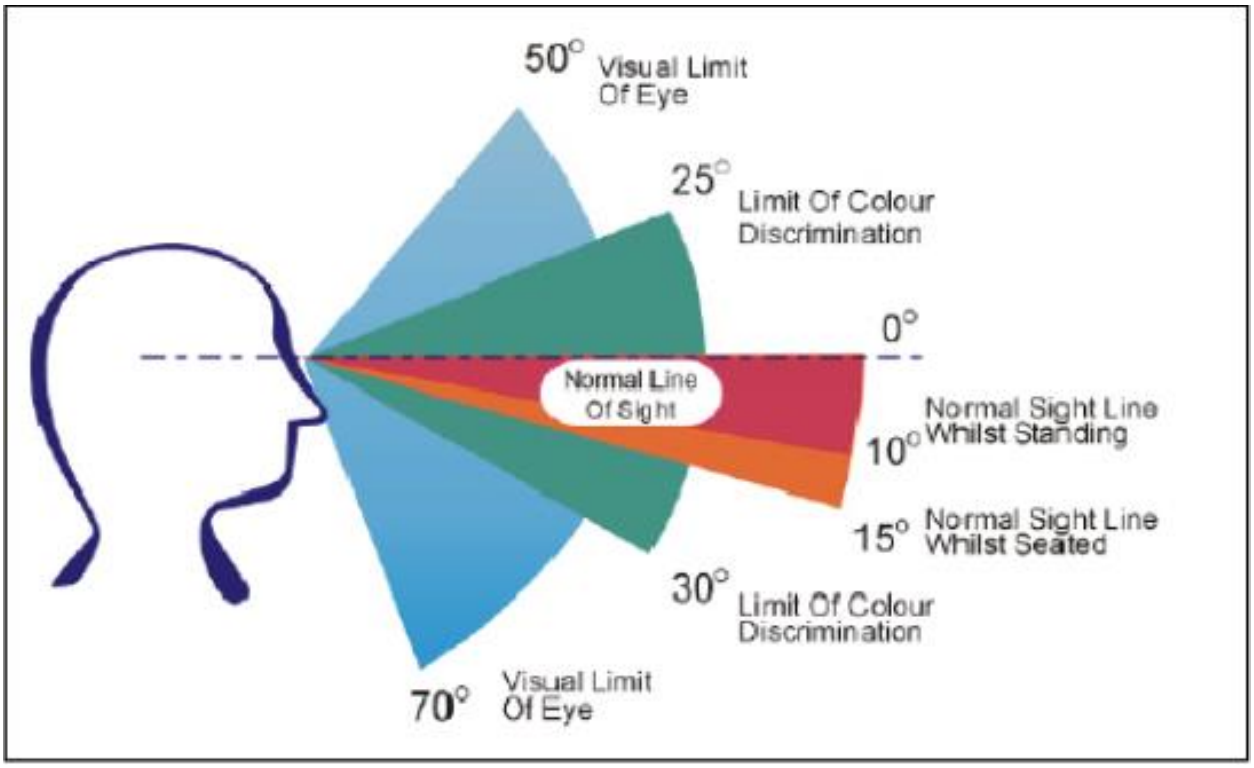


Figure 144: Visibility fields in vertical plan

The visual impact of an element on man's vertical visual field therefore depends on the way in which this element impacts the central field of visibility, as for the horizontal visual field. An element that occupies less than 5% of the normal visual cone occupies a minimum portion of the vertical visual field and is therefore visible only if concentrating directly on the element (5% of 10 degrees = 0.5 degrees).

Visibility based on the horizontal field of view

The visual impact of the offshore structure on the horizontal visual field is evaluated considering its maximum horizontal dimension that is the value of the diagonal of the plant:

- BGF Platform: 265 m;

A visual element can be cathegorized as:

- Visually dominant: the element has a dominant role within the visual field;
- Potentially distinguishable: the element is distinguishable and the level of disturbance

strongly depends from the degree of contrast with the surrounding landscape;

- Insignificant: the element, although visible, does not significantly interfere with the view of the landscape.

The results show that at the distance to which the offshore structure is placed, the landscape disturbance introduced by them can be considered not significant, as it is limited to a minimum portion of the horizontal field of view.

At the minimum distances of 13 km of the platform from the nearest village (Port Ellen), in case of good visibility, this will occupy at most about **1.2** ° of the horizontal field of view. To reach a significant visibility, say, having the BGF platform covering 5 % of his visual field, the observer have to get closer than 7 km from BGF.

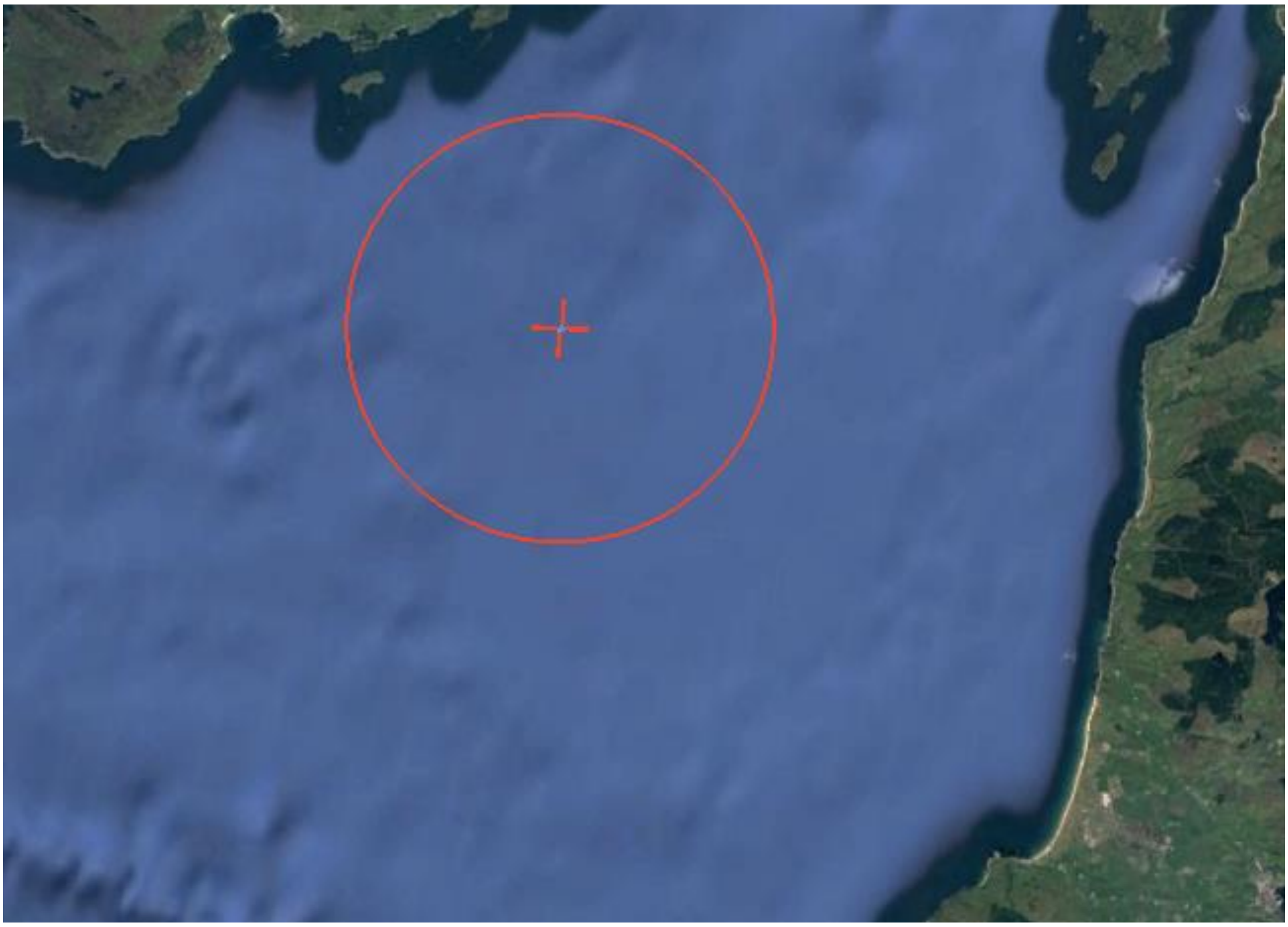


Figure 145: Range of complete visibility (> 5% of visual field) of BGF platform, Wind turbine not considered

Visibility based on the vertical visual field

An analogous reasoning can be conducted for the vertical visual field, in order to verify at what distance the considered element is reduced to an imperceptible component of the field of view. The trigonometric calculation was carried out considering the maximum heights of offshore structures.

BGF wind turbine blade tip : 208 m;

The result of the analysis of the vertical field of view shows that, at the distance from the coast to which the offshore structure is placed, its visibility is not significant, being necessary to get closer than 5.2 km to the BGF platform to get an angle wider than 2.5°. From the nearest coast (Port Ellen), the vertical visible angle for a structure of 208 m is approx **1°**. The visibility into the landscape introduced by the BGF can be considered insignificant, as it is limited at a minimum percentage of the vertical visual field. However, it should be kept in mind that, in cases where the installation is located at the end of the field of vision, only the upper portion of the structures is actually visible which, as in the case of blade tip, it consists of elements of very reduced volume compared to the base.

The following table shows the maximum theoretical visibility distances in kilometers of the BGF platform in relation to different potential altitudes of an observer, both at sea and on the coast.

Table 24: Maximum visibility range of the BGF blade tip

Blade tip height (m)	Observer height (m)	Visibility range (nm -km)
205	2	32,2 - 59.63
205	10	35,8 - 66.30
205	20	38,5 - 71.30
205	30	40,5 - 75.0
205	50	43,8 - 81.1
205	150	54-100

On the basis of the calculation of the theoretical visibility, therefore, the BGF platform would be visible in a range of 80 km within an elevation of about 50 m above sealevel, given that no obstacles (buildings, trees, hills) prevent the view. The platform and its blade tip are visible from whole coast of the Jura Sound, provided that the visual line is open. Theorethically, the BGF blade tip is visible up to the Irish coast, and fully visible from the entire hill surrounding the Jura Sound

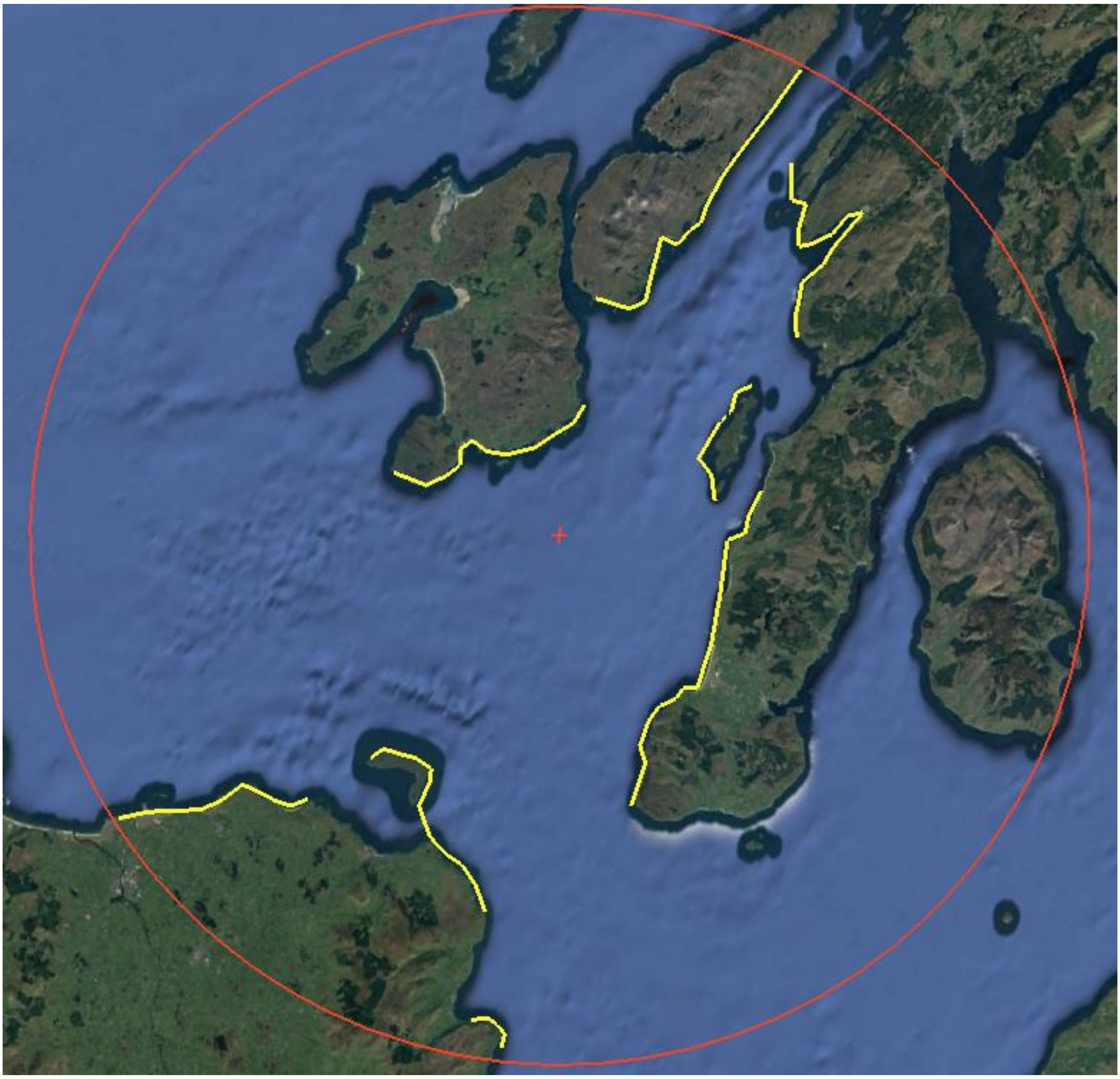


Figure 146: Visibility range of the BGF blade tip, for observers at 2 m above sea level. Yellow: zones of visibility form coastline, observer at 2 m

However, it should be noted that the BGF platform would be located in open sea, in an area where visual lines are free, and the horizon is empty of any element perceived as artificial. The BGF may be then be regarded as a standing alien element, and hardly be integrated in an area of pristine landscape.

However, the BGF platform has to enter a proper procedure of Landscape and Visibility assessment during consenting process (see SNH, 2011).

4.1.8 Risk of major accidents

This risk will be assessed in later stage of BGF design, when more deitails on anti-intrusion and alarm systems will be known. In the same way, the quantification of risk of fish escapees and consequent genetic pollution on wild salmon population will be assessd when details of nettings and ancillary system will be defined.

At this stage it's worth noting that the two major ferry and boats lanes pass at 7 and 5 km from BGF respectively, in this way decreasing the possibility of unintentional collision due to bad weather, poor visibility or crew inattenction.

However, guidelines on safety for navigation for Wind farm installation will be duly kept in account for definitive siting (see MGN 543).

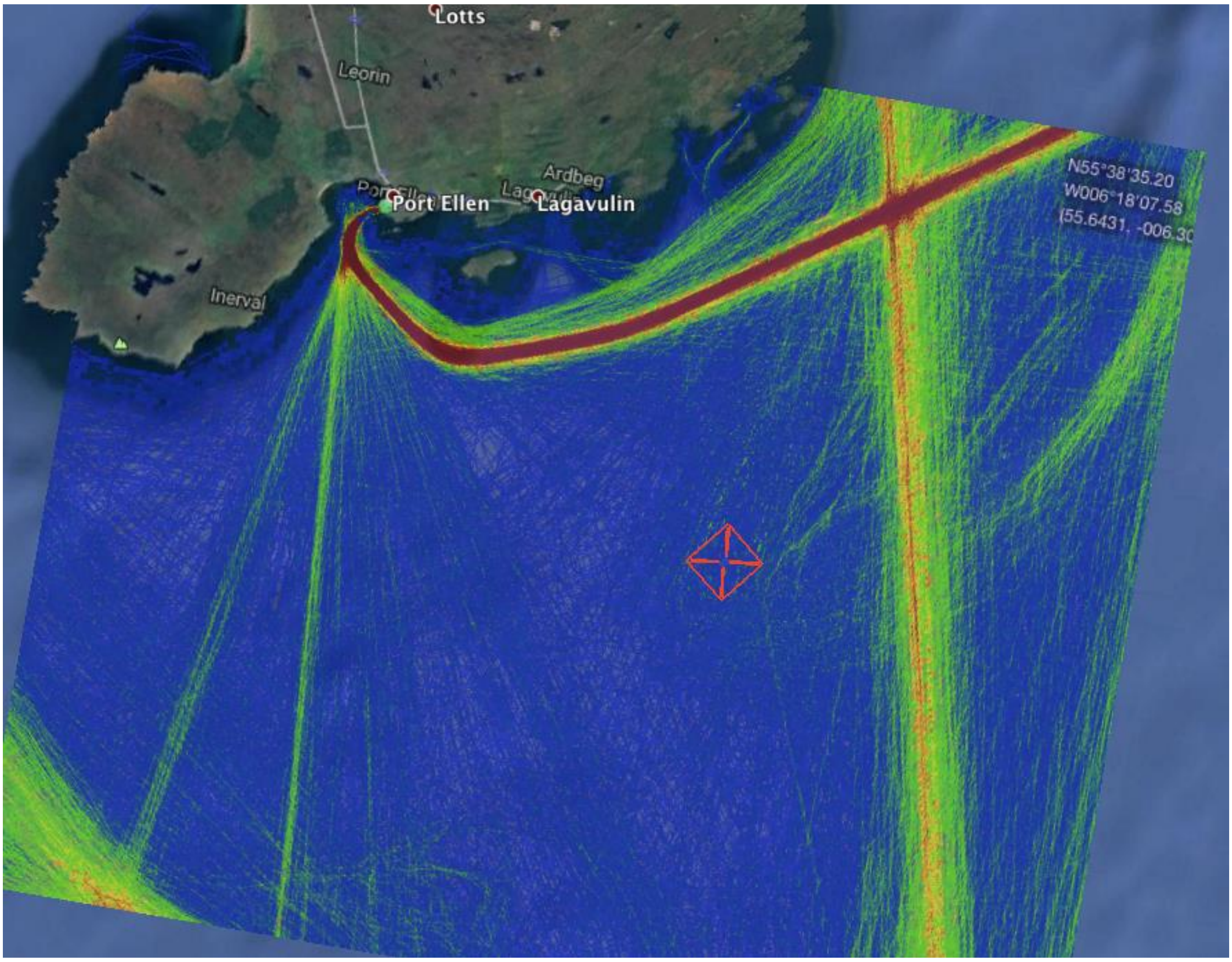


Figure 147: Cumulative marine traffic intensity, year 2017, based on AIS signals (*Source: www.marinetraffic.com*)

4.2 RANK OF COMPONENTS

The four environmental components taken into account in the present study will be affected by the BGF activity at different order of magnitude, and are:

- Seawater
- Marine communities
- Terrestrial communities
- Landscape

However, it's opportune to assign a rank of importance to any resource involved into the BGF operational life, at the aim of highlighting or decreasing their intrinsic value on the basis of two criteria, determining the Rank A and Rank B respectively.

Rank A is a criterion that aims to objectively assign a weight to the resource, basing on its availability and functionality; ranks from 1 to 5 are:

Table 25: Rank A

Rank A	Resource feature	Value assigned
1	Common	0.75
2	Common locally	1.5
3	Rare	2.25
4	Protected	3
5	Strategic/Structural	3.75

The rational of this ranking system stay in the evaluation of ecosystemic importance of the resource.

Rank B is a criterion that account for the stakeholder interest in the resource conservation, somehow aggregating a concern on the state of the resource. Ranks are 1 to 5, as:

Table 26: Rank B

Rank B	Resource feature	Value assigned
1	Scarce- no concern	0.25
2	Low - Some stakeholders' secundary concern	0.5
3	Medium – Most of stakeholders' secundary concern	0.75
4	High - Some stakeholders' primary concern	1
5	Maximum- Most of stakeholders' primary concern	1.25

The Ranks A and B are added to obtain the definitive resource rank.
Additive rank values range between 1 and 5.
Additive ranks will be used as correction factors to determine the overall impact on the resource.

Table 27: Definitive rank values

Component	Resources	Rank A	Rank B	Additive rank
Sea water	Nutrients	0,75	0.5	1.25
	Oxygen	0.75	0.25	1
Marine communities	Phytoplankton	1.5	1	2.5
	Benthos	2.25	1	3.25
	Odontocetes	3.75	1.25	5
	Mysticetes	3.75	1	4.75
	Fish	3	0.75	3.75
	Seals	3.75	1	4.75
	Sea Turtles	3.75	1	4.75
	Pelagic birds	3	1.25	4.25
	Migratory birds	3	1.25	4.25
	Bats	3.75	1	4.75
Landscape	Visibility	3	1.25	4.25

This rank assignment is based on consideration drawn from the specificity of the environmetal context and of the legal frame where the BGF is expected to be installed. The proximity with a number of protected areas, the presence of iconic animals as seabirds, turtles and cetaceans, the turistic presence in an area of pristine landscape and the public concern on conservationist themes have driven the categorization of the ranks, leading to a high weight to pressures involved in species and landscape conservation.

This procedure maintains in itself a certain degree of subjectivity, unfortunately not completely avoidable in impact assessment procedures.

Ranks assigned here differ from those used in Marseille and Arinaga: the high communities diversity and the relevant landscape values in a pristine context makes the ranks attribution more conservative.

4.3 IMPACT MATRIX

The impact matrix is calculated as result of several matrixes, showing the detailed characteristics of the impact and concurring in determining the severity of impact. The used method is a simplification of the Leopold Matrix (Leopold et *al.*, 1971), adding 2 rank coefficients to weight the impact significance. The impact feature matrices (Frequency, Extension, Duration, Reversibility) are similar to those recommended in UNI EN ISO 14001 application.

Frequency: it indicate how frequently the stressors acts, or how many times the activity generate the pressure.

FREQUENCY	
1	RARE, 2 TIMES/YRS
2	INTERMITTENT, 4 TIMES/YRS
3	REGULAR, MONTHLY
4	RIPETITIVE, 1-2 TIMES/WEEK

5	CONTINUOUS, 3 TIMES/WEEK

Spatial extention: it display the amplitude of geographical effects of the stressors, e.g. for migrating bird is approching the species areal.

SPATIAL EXTENSION	
1	ISOLATED, ON SITE
2	CONFINED, INFLUENCING LOCAL COMMUNITY
3	LOCAL
4	REGIONAL, BEYOND LOCAL COMMUNITY
5	GLOBAL

Duration: indicates the lasting in time of stressors effect, e.g for reproducing animals, until new specimens reach sexual maturity in the same population.

DURATION	
1	LOW TERM
2	3-12 MONTHS
3	1-3 YEARS
4	> 3 YEARS
5	LONG LASTING

Reversibility, indicating if the effect can be recovered and at which degree.

REVERSIBILITY	
1	TOTALLY REVERSIBLE
2	HIGHLY REVERSIBLE
3	AVERAGE REVERSIBLE
4	LOW REVERSIBLE
5	NOT REVERSIBLE

For each factor and stressor, the four above matrix are applied, and the resulting numbers are added. The sum gives a value between 0 and 20, that determine the severity if impact, basing on the following ranges:

SEVERITY		
Sum of values, range		
0-4	NO CONSEQUENCES	1
5-8	LIGHT, LOW DANGER	2
9-12	MODERATE, POSSIBLE TO RESTORE	3
13-16	HEAVY, DIFFICULT TO	4

	RESTORE	
17-20	VERY HEAVY, POTENTIALLY FATAL	5

The probability scale indicate the probability assigned to the pressure agent to cause the impact, e.g. the probability of a rotating blade to hit a bird in presence of avoidance

PROBABILITY	
1	REMOTE, <11%
2	LOW, 12-33%
3	MODERATE, 34-67%
4	HIGH, 68-90%
5	VERY HIGH, >90%

The resulting values (from 1 to 5) of severity, mutiplied by the probability of the event, gives as result a number between 1 and 25, representing the Significativity (or magnitude) of the Impact:

SIGNIFICATIVITY
1-5 LOW SIGNIFICATIVITY
6-15 SIGNIFICANT
16-25 VERY SIGNIFICANT

This last number, multiplied by the weight resulting from the Rank A and B combined (see table 27), gives the overall impact, varying between 0 and 100.

OVERALL IMPACT
NOT RELEVANT, 1-20
LOW, 21-40
MODERATE, 41-60
RELEVANT, 61-80
HEAVY, 81-100

4.3.1 Impact of aquaculture activities

NUTRIENTS RELEASE IN WATER COLUMN

Seawater	Nutrients
Frequency	5
Extension	3
Duration	1

Reversibility	1
Severity	3
Probability	5
Significativity	Significant
Total rank	1.25
Overall impact	Low

PHYTOPLANCTON GROWTH

Marine communities	Phytoplancton
Frequency	5
Extension	3
Duration	1
Reversibility	1
Severity	3
Probability	5
Significativity	Significant
Total rank	2.5
Overall impact	Low

BENTHIC COMMUNITIES

Marine communities	Benthos
Frequency	5
Extension	1
Duration	5
Reversibility	2
Severity	4
Probability	4
Significativity	Very Significant
Total rank	3.25
Overall impact	Moderate

PELAGIC BIRDS

Marine communities	Pelagic birds
Frequency	5
Extension	3
Duration	5
Reversibility	1

Severity	4
Probability	2
Significativity	Significant
Total rank	4.25
Overall impact	Low

FISH

Marine communities	Fish
Frequency	5
Extension	3
Duration	[illegible]
Reversibility	3
Severity	4
Probability	2
Significativity	Significant
Total rank	3.75
Overall impact	Low

VISIBILITY

Landscape	Visibility
Frequency	5
Extension	2
Duration	5
Reversibility	1
Severity	4
Probability	3
Significativity	Significant
Total rank	4.25
Overall impact	Moderate

4.3.2 Impact of noise on marine communities

ODONTOCETES

Marine communities	Odontocetes
Frequency	5

Extension	2
Duration	5
Reversibility	1
Severity	4
Probability	4
Significativity	Very Significant
Total rank	5
Overall impact	Relevant

MYSTICETES

Marine communities	Mysticetes
Frequency	3
Extension	3
Duration	1
Reversibility	1
Severity	2
Probability	4
Significativity	Significant
Total rank	4.75
Overall impact	Low

FISH

Marine communities	Fish
Frequency	5
Extension	1
Duration	1
Reversibility	1
Severity	2
Probability	3
Significativity	Significant
Total rank	3.75
Overall impact	Low

SEALS

Marine communities	Seals
Frequency	5
Extension	2
Duration	5
Reversibility	1
Severity	4
Probability	3
Significativity	Significant

Total rank	4.75
Overall impact	Moderate

4.3.3 Impact of wind farm

PELAGIC BIRDS

Marine communities	Pelagic birds
Frequency	5
Extension	4
Duration	5
Reversibility	2
Severity	4
Probability	2
Significativity	Significant
Total rank	4.25
Overall impact	Low

MIGRATORY BIRDS

Terrestrial communities	Migratory birds
Frequency	2
Extension	5
Duration	5
Reversibility	1
Severity	4
Probability	1
Significativity	Low Significativity
Total rank	4.25
Overall impact	Not relevant

BATS

Terrestrial communities	Bats
Frequency	2
Extension	4
Duration	5
Reversibility	4
Severity	4
Probability	1
Significativity	Low Significativity
Total rank	4.75
Overall impact	Not relevant

VISIBILITY

Landscape	Visibility
Frequency	5
Extension	3
Duration	5
Reversibility	1
Severity	4
Probability	3
Significativity	Significant
Total rank	4.25
Overall impact	Moderate

4.3.4 Impact of entangling structures on marine communities

SEALS

Marine communities	Seals
Frequency	2
Extension	3
Duration	3
Reversibility	3
Severity	3
Probability	1
Significativity	Low Significativity
Total rank	4.75
Overall impact	Not relevant

PELAGIC BIRDS

Marine communities	Pelagic birds
Frequency	4
Extension	4
Duration	5
Reversibility	2
Severity	4
Probability	1
Significativity	Significant
Total rank	4.25
Overall impact	Not relevant

ODONTOCETES

Marine communities	Odontocetes
Frequency	4
Extension	3
Duration	5
Reversibility	2
Severity	4
Probability	1
Significativity	Significant
Total rank	5
Overall impact	Not relevant

4.3.5 Impact of electromagnetic fields on marine communities

FISH

Marine communities	Fish
Frequency	3
Extension	2
Duration	1
Reversibility	1
Severity	2
Probability	2
Significativity	Low Significativity
Total rank	3.75
Overall impact	Not relevant

4.3.6 Impact of moorings on marine communities

BENTHOS

Marine communities	Benthos
Frequency	5
Extension	1
Duration	4
Reversibility	2
Severity	3
Probability	5
Significativity	Significant
Total rank	3.25
Overall impact	Moderate

Table 28: Matrix of overall impacts. O = not relevant; Green = low impact; Yellow = moderate impact; Orange = relevant impact

Component	Resources	Aquaculture	Noise	Rotor blades	Entangling structures	Electromagnetic fields	Moorings
Sea water	***Nutrients***	Green					
Marine communities	***Phytoplankton***	Green					
	Benthos	Yellow					Yellow
	Odontocetes		Orange		O		
	Mysticetes		Green				
	Fish	Green	Green			O	
	Seals		Yellow		O		
	Pelagic birds	Green		Green	O		
Terrestrial communities	***Migratory birds***			O			
	Bats			O			
Landscape	***Visibility***	Yellow		Yellow			

4.4 MITIGATION MEASURES

Whales and fish are subject to a low level of impact, and the only mitigation consists in selecting machinery at the lowest possible noise level. The sound emissions seem not so different from those emitted by a ship, but at a lower intensity. While a ship move away, making its impact transitory in space and time, the BGF remains stationary, adding its noise signature to the ambient noise already present. The presence in the area of a concentration of sensitive receptors as harbour porpoises and seals, brings the impact on them to a degree of moderate and relevant, requesting a mitigation action whenever possible.

The possibility of entangling is evaluated as not relevant at this stage, and a further assessment will be run when the definitive design of nets and fish farm submerged ancillaries will be ready. In fact, a risk of entanglement and subsequent drowning may be expected for those animals (diving bird, seals) entering from the bottom side the swimming pool: it is not yed clear whether they can easily find the way out, and if their diving time is long enough to reach the open waters and the surface to breath. This point needs a further investigation.

The impacts on landscape of the platform structure and of the wind turbine are both calculated as moderate. These impacts can hardly be mitigated, as they are common to all offshore installation: the BGF platform is a massive structure with a very high mast and blades, which tip is potentially visible from very long distances. In the present location, the BGF is visible by the all the surrounding coast of the Jura Sound, and, at least theorethically, it can be seen from Northern Ireland.

Due to the peculiar shape of the Jura Sound, The BGF is located at only 10 km from the coast, and it can be argued that the structure will be completely visible from the coastline. In this case there are no possible mitigation, being the BGF visible in any point of the Sound from great distances in clear sky days, that amont to approximately 50 % of the total. A displacement at greater distance from the coast, provided that costs for cabling, mooring and staff displacent remain acceptable, would not mitigate the impact.

Moorings and organic deposition affect a rather large area of seabed. Both the impact of organic deposition on seabed and of mooring on benthic communities can be regarded as moderate, since the area host a community listed as Priority Marine Feature. However, this community can recover in a relative short time, after impact cessation. The possible mitigation consists in a modification of the mooring arrangements, shortening the chain length laying on seabottom, or considering the feasibility of a VLA system, particularly feasible on soft seabed.

A low risk of collision has been calculated for some species of pelagic birds, and the risk is enhanced for some species by the presence of the fish farm, attracting birds by its own structure and the feeding opportunities offered. Migratory birds are at the present state of knowledge of any concern, and this is due on one hand by a lack of knowledge on birds' movements on the Sound, on the other to the very small blade-swept area, compared to the width of a possible migration flock. The light system may rise a concern on bats, that could be attracted in case of an incorrect light system setting.

Possible mitigations:

Bird/Bat collision risk:

- Keep rotating blades at the maximum possible height above sealevel;
- Keep rotation speed at lowest possible;
- Feather and arrest blades below productive wind speed;
- Prevent birds resting on platform surfaces, nets or cages;
- Avoid releasing at sea of feeds, fish or carcasses:
- Implement acoustic scaring devices, both for birds and for seals;
- Avoid lights directed to sky or seawater
- Avoid Metal-halide and LED lights
- Avoid highest part of visible spectrum (red/reddish colour)
- Adopt lights possibly close to green color at lowest possible intensity
- Adopt flashing and on demand lights for passages whenever possible
- Implement a radar system for detecting approaching flocks in poor visibility conditions
- Install shut-off lights + other devices in case of bird flocks approaching

Benthic communities

- Decrease mooring footprint on seabottom

Visibility

- Decrease contrast of blades against horizon

Constraints:

- Blade height increase improve bird collision risk, but impair landscape impact;
- Low contrast blades improve landscape impact, but decrease visibilty for birds, thus increasing collision risk.

4.5 SUMMARY OF ENCOUNTERED DIFFICULTIES/ISSUES

This study has been performed on the basis of an overall platform design that is not yet reaching the definitive level, thus describing the general platform features but still missing a number of specific details. As a consequences, several section of the study has remained at a general level too, posponing a more detailed assessement at the Project's end, and as consequence of a detailed design availability.

This study is based completely on data found in literature, and no terrain activities of any kind are forecast within this Work package. Data are mainly retrieved from official websites or available papers on the web, and may be insufficient in temporal coverage or details.

Data to fit the Band Model are those available on papers, as bird density at sea, flight heights, proportion at rotor height and night activity per species. A local influence on bird behaviour may exists, but can not be taken into account presently. In the same way, migrators behaviour may depend from local (and highly variable) conditions, as the real migration path. Bird presence offshore is inferred also from feeding ranges in literature, and is reported as highly variable depending from local opportunities. Bird density increasing following BGF operations, is here considered as totally logical, but supported by a limited number of references.

Wind turbine productivity is based on data from a site on the Scotland's West coast, at a distance of 110 km, with similar wind exposition.

Data on bat presence offshore is largely absent, and a quantitative collision risk assessment unfeasible, although a collision risk may be hypotesized.

The benthos features has been derived from exising maps, but the detailed community present on the BGF site has been desumed (as the most likely to occur) from other informations, also derived from fishery effort, in absence of a specific site knowledge.

The model used for effluent estimation has been fitted with a flowfield similar to that used for computation in Marseille, being stratified with depth data unavailable; flowfield has therefore been forced by a strong semidiurnal component. Models needs to be validated on local or similar conditions, and at the present stage obtained simulations are indicative, and possibly in need of a further tuning. A figure of the Total Nitrogen imput in Sound of Jura is unavailable and unfortunately this makes the comparison with the excretion by fish unfeasible, aiming at deriving a local nutrient enrichment estimation.

Wind turbine noise production is desumed from a scant literature, and models of attenuation are generic and not considering speed noise mofication due to local water column and bottom features, as well the shape of the emitting body. Resonance and combined machineries noise effects can not

be considered at this stage, even when their cohesistence is logical. Noise effects on Salmon needs an additional extensive literature survey.
Landscape viewshed can only be estimated from maps, while a proper assessment would need some activities and a photographic survey on place.
Last, the assessment of impacts maintains in itself a certaing degree of subjectivity, that unfortunately can not be totally eliminated.

CHAPTER 5: FINAL RECOMMENDATION

The Sound of Jura is characterized by a pristine landscape, which appearence is mainly due to the sense of wilderness that the huge viewshed and the scarce human presence transmit to observers. The siting of a massive structure as the BGF in a site where it maintains the complete visibility from the coast around gives some constraint, and a process of improvement has to be undertaken, either in refining the design and in adjusting the siting.

A particular attention should be paid during subsequent design phases in preventing that wild animals would take advantage from platform's structure and operation to approach it frequently, feed on residuals or simply be attracted by lights or emerged or submerged structures. The area is hosting a high density of Harbour porpoises and seals, and the maximum attention has to be paid in avoiding that this species are displaced elsewhere for their ecological functions. Level of the human at-sea activity is low and the best effort sould be paid to avoid that the localization of the BGF do impair this character.

The BGF platform, as multi-funcional unit, presents a degree of complexity uncommon for marine structures, and which environmental combined effects has not been extensively investigated so far. This work represents a first environmental assesssment based on the platform features known at the present stage of design. This assement will be updated in the project progress, as new platform features, potentially interacting with marine environment, will emerge.

CHAPTER 6: CONCLUSION

The impact assessment performed at the present stage of design, when mostly of the general platform features are known, demonstrate that the general concept of the structure does not results in any specific concerns on its environmental acceptability.

The height of the nacelle and the blade tip, even increasing long distance visibility, on the other hands remains outside the flight heigths of most of marine birds, decreasing collision probability.
The platform is located at 10 km offshore, and its wind turbine will unfortunately result completely visible from the coast, at least in days of clear sky.

The soft nature of the seabottom requests a mitigation action to decrease the impact of the mooring system on benthic communities, listed within Marine Priority Features.

CHAPTER 7: REFERENCE

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