ORKNEY
ISLANDS COUNCIL

State of the Environment Assessment

A baseline assessment of the Orkney Islands Marine Region

EUROPEAN UNION
EUROPEAN MARITIME AND FISHERIES FUND
Investing in Sustainable Fisheries

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Orkney Marine Environment Project

This State of the Environment Assessment has been funded by the European Maritime and Fisheries Fund (EMFF) as part of the Orkney Marine Environment Project (OMEP). OMEP aims are to improve the availability and accessibility of marine environmental, social and economic data for the purposes of marine planning, management, education and awareness-raising in Orkney.

The cover picture is Stromness Harbour looking towards the Holms and Scapa Flow.

Foreword

I am delighted to present the Orkney Islands Marine Region: State of the Environment Assessment, which marks a significant milestone in the forthcoming process of regional marine planning in Orkney.

Our seas and coasts are an integral part of day-to-day life for Orkney communities and play an important role in the local economy, transportation, recreation and our unique way of life. Orkney has a spectacular marine and coastal environment that needs to be managed responsibly to protect its special qualities for future generations. Regional marine planning offers a significant opportunity for local communities to get involved in the sustainable management of Orkney waters, and to help realise the many environmental, social and economic opportunities.

This assessment will help the forthcoming Orkney Marine Planning Partnership to prepare the Orkney Islands Regional Marine Plan. It considers the physical, ecological, economic and social features of Orkney's seas and coasts and identifies pressures on them. The assessment provides us with a baseline from which to measure progress and identifies issues that may need to be addressed through future marine planning and management in Orkney.

I would like to thank all those that have contributed to the preparation of this assessment. Whether it be attending workshops and events or providing information and expertise, your input is very much valued.

As we enter this exciting new era of local marine planning, I look forward to seeing all our communities, right across the islands, getting involved to help deliver opportunities and benefits for Orkney.

Graham L Sinclair

"Orkney has a spectacular marine and coastal environment that needs to be managed responsibly to protect its special qualities for future generations"

Councillor Graham Sinclair
Chair of the Development and Infrastructure Committee of Orkney Islands Council

Contents

Orkney Islands State of the Environment Assessment

A baseline assessment of Orkney's marine environment and an assessment of pressures, including physical, biodiversity, social and economic factors.

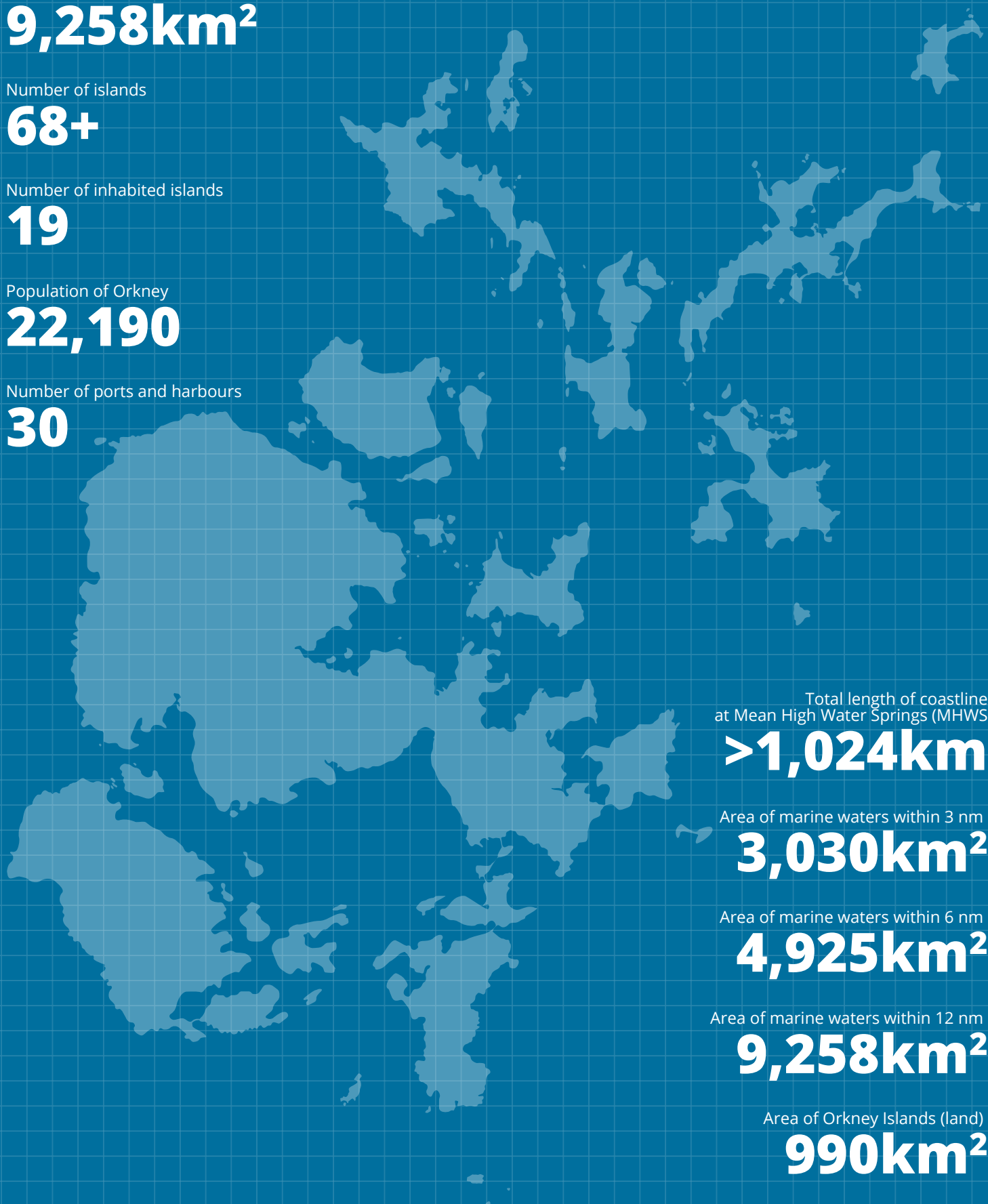
Area of Orkney Marine Region
9,258km²

Number of islands
68+

Number of inhabited islands
19

Population of Orkney
22,190

Number of ports and harbours
30



Total length of coastline at Mean High Water Springs (MHWS
>1,024km

Area of marine waters within 3 nm
3,030km²

Area of marine waters within 6 nm
4,925km²

Area of marine waters within 12 nm
9,258km²

Area of Orkney Islands (land)
990km²

Orkney Islands Council

New data will be considered as part of an iterative process as the Orkney Islands Regional Marine Plan evolves, see Figure 4 for plan making cycle. As this assessment provides the baseline it may not be re-published until the next plan making cycle for the Orkney Islands Regional Marine Plan. Contact: **marine.planning@orkney.gov.uk**

Orkney Islands Marine Region State of the Environment Assessment Summary

Table 1 presents a summary of key environmental issues considered within this assessment and identifies the key environmental pressures, assessment outcomes, trends and the level of confidence in the associated data. Refer to Section 1.8 for details of the assessment approach.

Table 1: State of the Environment Assessment Summary

Category	Topic	Pressure	Assessment	Trend	Data confidence
Physical	Geological and coastal	Erosion; Disturbance.	Some concerns	Deteriorating	High
	Landscape and Seascape	Erosion of special qualities of landscape and seascape; Coastal erosion, sea-level rise, flooding and change to vegetation types due to climate change.	Some concerns	Deteriorating	Medium
	Coastal Water Quality	Pollution	Some concerns	Static	High
	Air Quality	Pollution	Few concerns	Unknown	Low
	Marine litter	Entanglement; Ingestion; Amenity	Some concerns	Unknown	Medium
	Underwater noise	Disturbance; Injury;	Some concerns	Deteriorating	Low
Historic Coastal and Marine Environment	Historic Coastal and Marine Environment	Climate change; Erosion; Corrosion; Removal of artifacts.	Many concerns	Deteriorating	High
Climate Change	Climate Change	Multiple pressures: see Table 13	Many concerns	Deteriorating	Medium

Category	Topic	Pressure	Assessment	Trend	Data confidence
Biodiversity	Designated Nature Conservation Sites	Climate change; Barrier to species movement; Collision; Disturbance; Overfishing; Pollution.	As there are many designated sites with varying site condition status, an overview assessment of the sites would be of limited value. Refer to Appendix 2 for individual site condition assessments.		
	Birds	Climate change; Collision; Disturbance; Marine litter	Many concerns	Deteriorating	Medium
	Grey Seals	Climate change; Disturbance; Pollution	Few concerns	Static	Medium
	Harbour Seals	Climate change; Competition; Disturbance; Pollution	Many concerns	Deteriorating	Medium
	Cetaceans	Climate change; Barrier to species movement; Collision; Disturbance: visual and displacement; Entanglement; Marine litter; Noise; Pollution	Some concerns	Unknown	Low
	Commercial Fish and Shellfish	Climate change; Disturbance; Removal of target species.	Unknown	Unknown	Not applicable
	Wider Fish Community	Climate change; Disturbance; Removal of non-target species.	Unknown	Unknown	Not applicable
	Invasive Non-native Species	Alter food webs; Outcompete native species.	Some concerns	Static	High

Summary of Productive Coasts and Seas Sectors

Table 2 presents a summary of the current economic contribution, employment and production in 2020 of the key coastal and marine economic sectors in Orkney, including consideration of associated data confidence. Refer to Section 1.8 for details of the assessment approach.

Table 2: Productive sector assessment summary

Category	Topic	Economic contribution	Employment	Production	Data confidence
Productive coasts and seas	Commercial Fisheries	Increasing	Stable	Decreasing	High
	Aquaculture	Increasing	Increasing	Increasing	High
	Harbours, Port, Shipping and Marine Transport	Increasing	Stable	Stable	High
	Offshore Wind Energy	Unknown	Unknown	Not applicable	Not applicable
	Wave and Tidal Energy	Stable	Stable	Stable	Medium
	Oil and Gas	Stable	Stable	Decreasing	High
	Marine Supply Chain, Research and Services	Unknown	Unknown	Unknown	Not applicable
	Tourism, Recreation, Sport and Leisure	Increasing	Increasing	Increasing	High

Abbreviations and Acronyms

A

ADDs	Acoustic Deterrent Devices

B

BDMLR	British Divers' Marine Life Rescue
BIG-HIT	Building Innovative Green Hydrogen in Isolated Territories

C

CAR	Controlled Activities (Scotland) Regulations 2011
CES	Crown Estate Scotland
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon Dioxide
CSIP	Cetacean Strandings Investigation Programme
CVI	Climate Change Vulnerability Index

D

DIN	Dissolved Inorganic Nitrogen

E

EC	European Commission
EMEC	European Marine Energy Centre
EPS	European Protected Species

F

FCA	Flotta Catchment Area
FEAST	Feature Activity Sensitivity Tool
FTE	Full-time Equivalent

G

GB	Great Britain
GCR	Geological Conservation Review
GES	Good Environmental Status
GVA	Gross Added Value

H

H_2O	Water
HMPA	Historic Marine Protected Area
HMS	Her Majesty's Ship
HRA	Habitats Regulations Appraisal

I

ICIT	International Centre for Island Technology
INNS	Invasive Non-Native Species
IUCN	International Union for Conservation of Nature

J

JNCC	Joint Nature Conservancy Council

K

KG	Kilogram
KM	Kilometre
KM^2	Kilometre Squared
KW	Kilowatts

L

LBAP	Local Biodiversity Action Plan
LCA	Landscape Character Assessment
LLSCA	Local Landscape and Seascape Character Assessment
LNCS	Local Nature Conservation Sites
LNG	Liquid Nitrogen Gas
LNR	Local Nature Reserves
LPG	Liquid Petroleum Gas

M

M	Metre
M/S	Metre per second
MARPOL	The International Convention for the Prevention of Pollution from Ships
MCCIP	Marine Climate Change Impacts Partnership
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MOD	Ministry of Defence
MPA	Marine Protected Area
MPPs	Marine Planning Partnerships
MSFD	Marine Strategy Framework Directive
MS-LOT	Marine Scotland Licensing and Operations Team
MSP	Marine Spatial Planning

N

N/A	Not Applicable
NBN	National Biodiversity Network
NERC	Natural Environment Research Council
NILPS	North Isles Landscape Partnership
NM	Nautical Miles
NMPi	National Marine Plan Interactive
NNS	Non-Native Species
NO_2	Nitrogen Dioxide

O

OHA	Orkney Harbour Authority
OIC	Orkney Islands Council
OMPP	Orkney Marine Planning Partnership
OSF	Orkney Sustainable Fisheries
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic

P

PAD	Pressures and Activities Database
PFOW	Pentland Firth and Orkney Waters
PMF	Priority Marine Feature
PPT	Parts Per Thousand
pSPA	Proposed Special Protected Area

R

RAMSAR	The Ramsar Convention on Wetlands of International Importance
ReFLEX	Responsive Flexibility
RIFG	Regional Inshore Fisheries Group
RSPB	Royal Society for the Protection of Birds

S

SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SHA	Statutory Harbour Authority
SMASS	Scottish Marine Animal Stranding Scheme
SNH	Scottish Natural Heritage
SO_2	Sulphur Dioxide
SPA	Special Protected Area
SSSI	Site of Specific Scientific Interest
SST	Sea Surface Temperatures
STS	Ship-to-Ship Transfer

U

UK	United Kingdom
UKRI	UK Research & Innovation
U/W	Under water

W

WEWS	Water Environment and Water Services (Scotland) Act 2003
WFD	Water Framework Directive

Section 1: Introduction

PHOTO CREDIT: PAINTED GOBY ON MAERL, ORKNEY © NATURESCOT

1.1 Purpose of the State of the Environment Assessment

Orkney has an outstanding coastal and marine environment of international significance and of great value to local communities. This environment needs to be sustainably managed to safeguard its value for future generations and to help deliver environmental, social, economic and quality of life benefits. Whilst Orkney's diverse marine economy presents significant potential for sustainable development and use of marine resources, such development and activities can result in pressures on marine ecosystems.

This assessment presents a summary of the environmental pressures and impacts of human activities affecting the Orkney Islands marine region. It includes ecological, social and economic factors and presents associated pressures and trends. It provides a snapshot in time of the current issues facing Orkney's marine environment, as of November 2020, and the current status of the key economic sectors.

The assessment area is the Orkney Islands Scottish Marine Region (Figure 1). The assessment will inform the preparation of the Orkney Islands Regional Marine Plan in accordance with the requirements of the Marine (Scotland) Act 2010.

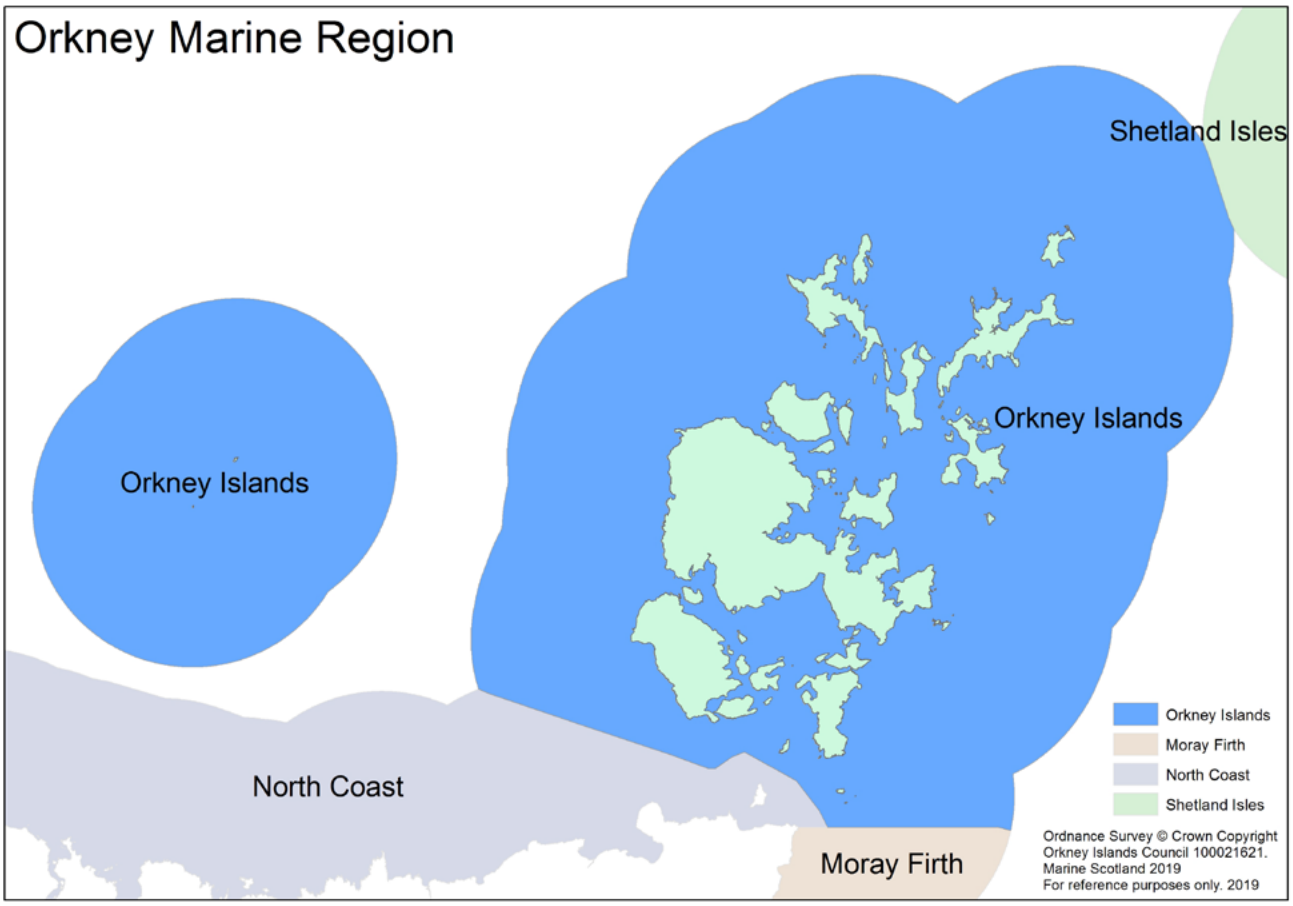


Figure 1: The Orkney Islands Scottish Marine Region, showing the 12 nm boundaries

Geographic context

The Orkney Islands are located approximately 6.2 miles (9.9 kilometres) north of mainland Scotland, from Ness of Duncansby, Caithness, to Brough Ness, South Ronaldsay, across the Pentland Firth. The archipelago is made up of 68 islands and smaller skerries. Figure 2 shows the location of the Orkney Islands.

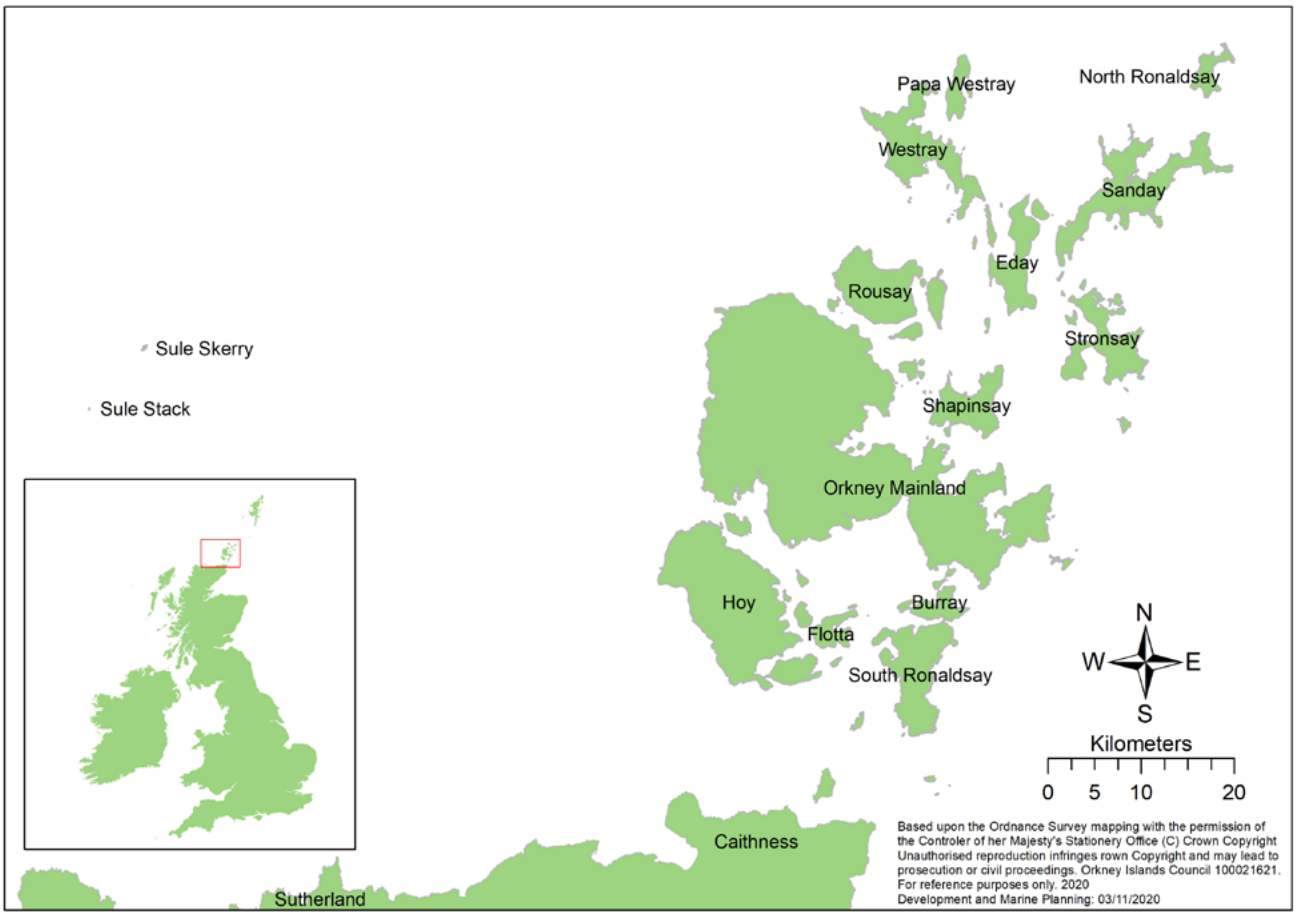


Figure 2: Orkney Islands location map

1.2 Marine planning legal and policy context

The Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009 provide the statutory framework for marine management and planning. The Marine (Scotland) Act 2010 legislates for marine planning, licensing and conservation activities in Scottish inshore waters (0-12 nautical miles). The UK Act provides executive devolution to Scottish Ministers for marine planning, licensing and conservation powers in the offshore region (12-200 nautical miles).

The Marine (Scotland) Act 2010 established responsibility for Scottish Ministers to prepare Scotland's National Marine Plan for Scotland and regional marine plans for the eleven adopted Scottish Marine Regions[1] (Figure 3). The Marine (Scotland) Act 2010 makes provision for Scottish Ministers to delegate functions in relation to regional marine plans to a nominated person(s) and public authorities with an interest in the region. The Act also sets out the statutory requirements for the preparation and adoption of regional marine plans including the need to prepare an assessment of the condition of the relevant Scottish marine region, including a summary of significant pressures and the impact of human activity on the region.

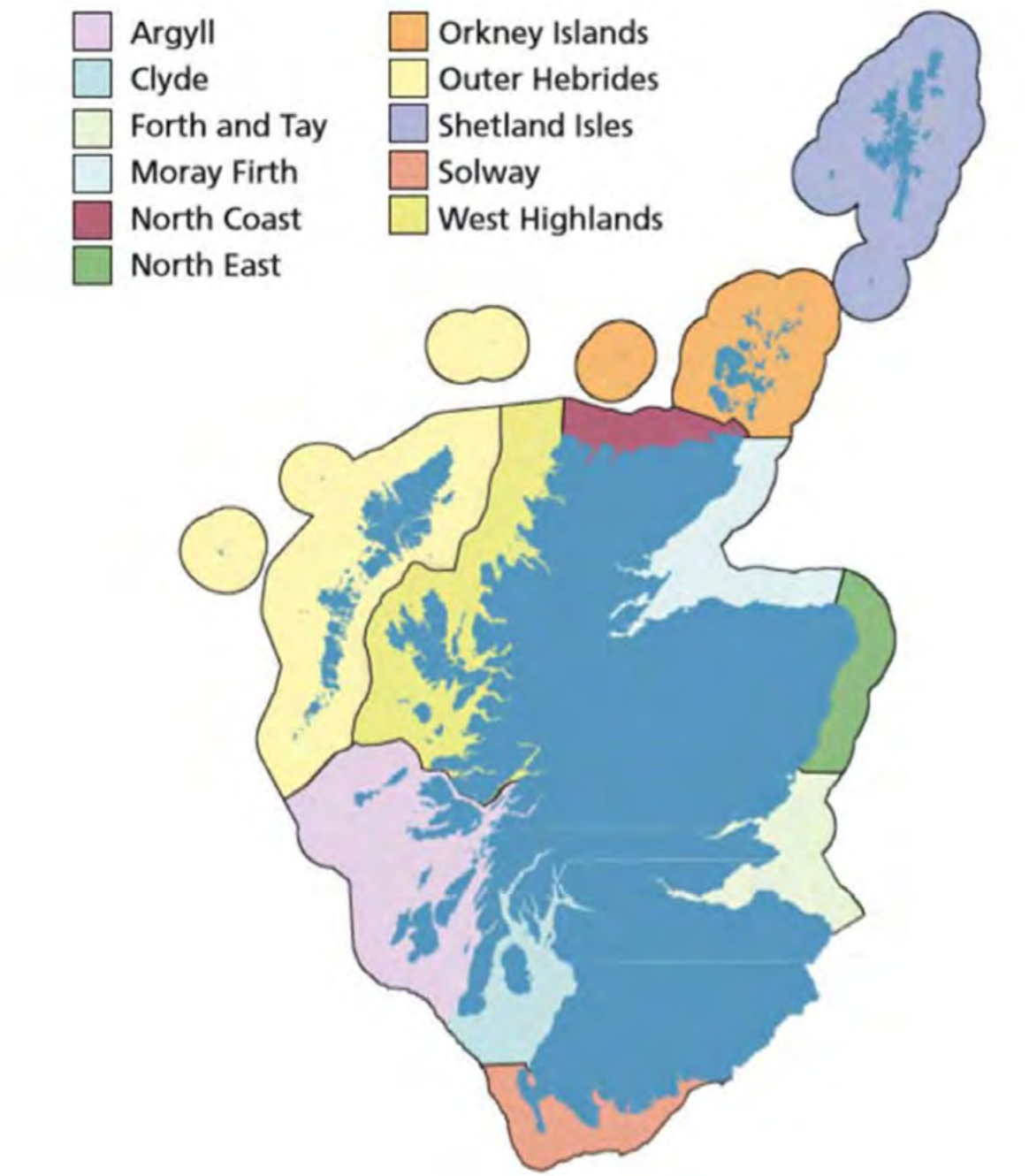


Figure 3: The Eleven Scottish Marine Regions

1.3 Regional marine plans

A regional marine plan contains statutory policies and spatial information to guide decision making on marine consenting and management. Public authorities must take authorisation or enforcement decisions in accordance with adopted regional marine plans and must have regard to these plans in making any decision capable of affecting the marine region to which they apply.

The benefits of regional marine planning include:

- Safeguarding the functioning of marine ecosystems whilst supporting economic activities;
- Policies, spatial allocations and data to improve certainty at the development consenting stage and support investment;
- Regional marine planning can help to reduce the conflicts between marine users;
- Partnership working and building a collective understanding between the many marine interests, including the issues and constraints within which each other are working;
- The development of a locally relevant marine planning strategy; often national legislation contains a 'one size fits all' approach, which may not be appropriate in an island context;
- Regional marine planning will allow the national interest to be interpreted at the local level in a way that is appropriate to local circumstances.

This state of the environmental assessment will inform the development of the Orkney Islands Regional Marine Plan to help deliver these benefits.

1.4 Orkney Marine Planning Partnership

The Orkney Marine Planning Partnership (OMPP) will be established in late 2020 to deliver statutory regional marine functions in the Orkney Islands marine region on behalf of Scottish Ministers. The key function of the OMPP is to prepare an Orkney Islands Regional Marine Plan. Marine Planning Partnerships enable local stakeholders to shape regional marine planning policy, taking account of local circumstances and enhancing local accountability.

Marine Planning Partnerships consist of delegate organisations, or persons, and advisory organisations or persons. The delegate is legally responsible for delivering regional marine planning functions and advisors have a formal role within an Advisory Group to help steer the regional marine plan making process.

In the OMPP, Orkney Islands Council undertakes the delegate role. An Advisory Group will be established enabling the economic, community, environmental and recreational interests within Orkney to provide support and guidance. The Orkney MPP presents an opportunity to develop a locally appropriate marine policy framework empowering the local community to deliver sustainable development, protect the local marine environment and realise economic opportunities.

Figure 4 illustrates how the OMPP will coordinate the development of the regional marine pan and the relationship between the various plan making stages, assessments and processes.

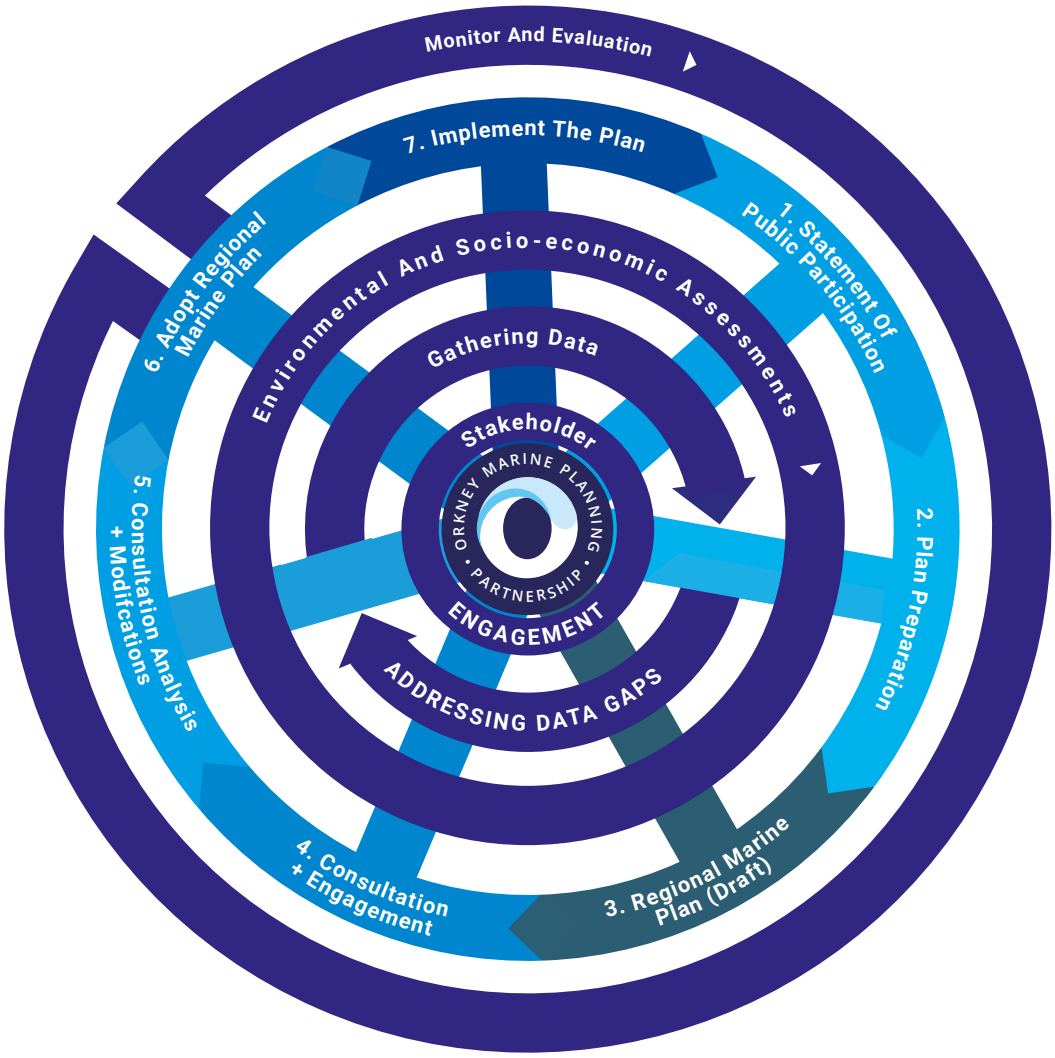


Figure 4: The Orkney Islands Regional Marine Planning Process Diagram

1.5 Pilot Pentland Firth and Orkney Waters Marine Spatial Plan

From 2012 to 2016, the Pilot Pentland Firth and Orkney Waters Marine Spatial Plan[2] was developed by Marine Scotland, Orkney Islands Council and Highland Council. The Plan was adopted by the Orkney Islands Council in 2016 as non-statutory planning guidance and a material consideration in the determination of works licence applications. The Plan has been adopted by Scottish Ministers for the purpose of determining marine licence and Section 36 consent applications for electricity generation applications.

This marine spatial planning pilot put in place a planning policy framework to guide marine development and management decisions in advance of statutory regional marine planning. The pilot process tested governance mechanisms to consider how an Orkney Marine Planning Partnership might operate in the future. A 'Lessons Learned[3]' report was published setting out the experience gained from the pilot including governance, stakeholder engagement, resourcing and plan-making practice.

1.6 Scope of State of the Environment Assessment

This State of the Environment Assessment provides a high-level appraisal of the condition of the Orkney Islands marine region and a summary of significant pressures and impacts of human activities. The assessment is informed by relevant published data sources. The scope of the report does not include carrying out new research but does discuss ongoing work and research being carried out by relevant bodies. Where appropriate, gaps in knowledge and data have been identified and subsequent stages of the marine planning process may help ascertain how these can be addressed. Where known, trends in data have been identified.

There are many environmental features that are best understood as integrated marine and terrestrial systems, for example, coastal bird breeding sites and the associated marine foraging areas. There are also socio-economic activities that have integral marine and land-based components including, but not limited to, aquaculture, marine renewable energy, ports and harbours, tourism, and recreation. This assessment therefore addresses both coastal and marine environmental factors.

It would be beneficial to establish an integrated baseline for Orkney's marine and land area for the purposes of monitoring and evaluating the regional marine plan and the local development plan for Orkney in the future.

Topics of current minor significance in Orkney

There are marine activities addressed in the Scotland's National Marine Plan that are currently of limited or no relevance in Orkney's marine region. Therefore, these activities have been summarised in this introductory Section, but have not been further assessed within this report. Should the situation change for any of these activities, they will be considered accordingly in relevant phases of the regional plan-making or updating assessment process (see Section 8).

Marine Aggregates

There are no current licences for marine aggregate extraction in the region and are unlikely to be in the foreseeable future.

Defence

Defence is a reserved matter and cannot be assessed beyond the high level already outlined in Scotland's National Marine Plan and the Pilot Pentland Firth and Orkney Waters Marine Spatial Plan. Military exercises tend to be located on the periphery of the Orkney marine region and limited value could be added by assessing this activity in further detail.

Seaweed Harvesting and Cultivation

Seaweed wild harvesting and cultivation are subject to various regulatory requirements and legislation as outlined in the Seaweed Review Steering Group paper[4]. Hand harvesting of wild seaweed can be a licensable activity, though not under a marine licence. A licence may be required for this if it takes place on Crown owned foreshore or seabed. A marine licence may be required from Marine Scotland for wild seaweed harvesting using a vessel. For SSSI's, consent may be required from NatureScot to harvest seaweed from the foreshore, depending on the Operations Requiring Consent for a given SSSI.
Crown Estate Scotland (CES) issues licenses for hand harvesting, as well as Foreshore Harvesting Options for larger scale near shore harvesting[5]. Permission from the owner is always required whether wild seaweed is harvested from Crown or private foreshore.

In the past kelp stipes were collected on a semi-commercial basis. This practice had largely died out by the late 1980s. For a short period in the 1990s seaweed was harvested commercially on the island of Westray to produce a liquid plant feed.

At present large-scale commercial seaweed harvesting or cultivation are not activities that take place in Orkney. However, there is a growing interest in seaweed harvesting and cultivation in Scotland, including for relatively small-scale wild harvesting in Orkney. The Scottish Crown Estate Act 2019 places restrictions on the removal of wild kelp from the seabed. At the time of drafting this report, the Seaweed Review was ongoing and will make recommendations for suitable management of the sector.

1.7 Pressures

An environmental pressure is the mechanism through which an activity has an effect on an ecosystem. The nature of a pressure is affected by the activity type, intensity and distribution. These pressures can result in the appearance of environmental problems or issues in a given location and at various spatial scales.

Understanding the links between activities and the pressures they may cause is the first step in helping identify potential impacts on the marine environment. This assessment therefore identifies key pressures on the marine and coastal environment in Orkney under each of the identified topics, using the methodology set out at Section 1.8.

Identified pressures in this assessment also include interactions between the different human activities and how these activities affect each other.

1.8 Assessment Approach

There are no definitive tools to identify pressures on every aspect of the marine environment. There are however tools developed for more specific habitats, species, and activities. The method that has been applied to inform the identification pressures in this assessment is JNCC's Marine Activities and Pressures Evidence tool, which contains a Pressures-Activities Database (PAD)[6]. This is a compilation of evidence base for relationships between 112 marine-based human activities and their associated pressures (based on the OSPAR pressure list).

The PAD incorporates information on activities in Scotland based on Marine Scotland's Feature Activity Sensitivity Tool (FEAST[7]) and a range of new activities that may occur in UK waters. In addition, information provided by expert organisations and stakeholders, such as Scottish Environment Protection Agency (SEPA), NatureScot (formerly Scottish Natural Heritage), the International Centre for Island Technology (ICIT), the Royal Society for the Protection of Birds (RSPB) and Orkney Sustainable Fisheries (OSF), has informed this assessment for the Orkney marine region and has informed the identification of any additional pressures.

These identified pressures, and the supporting baseline information, will subsequently help inform the Strategic Environmental Assessment (SEA) process during the preparation of the Orkney Islands Regional Marine Plan.

For each topic an assessment has been made under four assessment categories (see Table 3):

- **Many concerns:** the topic item shows significant signs of deterioration against baseline through both a decline in abundance/quality against baseline or where population or condition levels are considered unacceptably low.
- **Some concerns:** the topic item shows signs of deterioration against baseline or quality is low.
- **Few concerns:** the topic item shows few signs of deterioration against baseline and is not declining in quality, quantity or abundance.
- **Unknown:** There are insufficient data available to make an accurate assessment.

Data Trend: The data trend has been assessed under four categories:

- **Improving:** There is evidence that the topic item is positively increasing in abundance, condition or frequency against the long-term trend.
- **Static:** There is evidence that the topic item is not changing in abundance, condition or frequency when assessed against the long-term trend.
- **Deteriorating:** There is evidence that topic item is declining in terms of abundance, condition or frequency.
- **Unknown:** No data are available to assess the trend.

Data Confidence: The data confidence has been assessed and divided into four categories:

- **High:** Long term data available, collected by experts at regular intervals.
- **Medium:** Data available does not allow a full assessment either due to infrequent data collection or inconsistent data collection approach.
- **Low:** No or limited data assessment is possible either due to low quality data or low data collection frequency.
- **Not applicable:** No assessment has been made.

Data gaps are discussed in Section 8.

Table 3 Physical, Historic Environment, Climate Change and Biodiversity Assessment Summary Terms

Topic	Pressure	Assessment	Trend	Data confidence
Physical, Historic Environment, Biodiversity and Climate Change Sections	Brief summary of key pressures	Few concerns	Improving	High
		Some concerns	Static	Medium
		Many concerns	Deteriorating	Low
		Unknown	Unknown	Not applicable

The economic sectors in the Productive coasts and seas Sections have been assessed in relation to available data on economic contribution, employment and production. An appraisal has been carried out on the level of confidence that can be attributed to these data.

The economic sectors have been assessed considering the recent/current available data and stakeholder input. For each economic factor assessed the assessment determines whether it is increasing, stable or declining. For some economic sectors these data are regularly collected and are publicly available e.g. aquaculture. There are sectors with limited regularly collected and/or publicly available specific data, therefore the position is unknown, and no assessment has been completed.

The pressures associated with the Productive sectors (see Section 6) have been identified using the JNCC PAD and stakeholder input. These pressures have in turn informed the Physical, Historic Environment, Climate Change and Biodiversity assessments.

Table 4 Productive coasts and seas assessment summary terms

Topic	Economic contribution	Employment	Production	Data confidence
Productive coasts and seas Section	Increasing	Increasing	Increasing	High
	Stable	Stable	Stable	Medium
	Declining	Declining	Declining	Low
	Unknown	Unknown	Unknown or Not applicable	Not applicable

1.9 Independent Review

To enable appropriate scrutiny of the process undertaken to prepare this state of the environment assessment report, it has been subject to an independent review. This was undertaken by the International Centre for Island Technology (ICIT), Heriot -Watt University. This review aimed to ensure that the assessment and data are accurate and robust. Key university experts have been involved from the inception of the assessment to guide the initial structure, share expertise and data input, and review the draft stages of the assessment report.

1.10 Spatial Jurisdictions and Data

The geographical extent of the Orkney Islands marine region comprises the territorial waters around Orkney from Mean High Water Springs (MHWS) out to 12 nautical miles. Due to the interactions with coastal environmental features, where appropriate, such features above MHWS have been included within this assessment. For example, coastal historic assets and coastal landscape character areas can be impacted by development activities in the marine area.

The Orkney Islands marine region area is nearly ten times the size of Orkney's land area (see page viii). Sule Skerry and Sule Stack forms part of the Orkney marine region, and with a separate 12 nautical mile boundary, this area significantly increases the scale of the region.

The extent of land use planning jurisdiction extends to Mean Low Water Springs (MLWS). This is a deliberate spatial overlap between the land use planning and marine planning systems in the intertidal zone which is intended to assist integration[8].

Some aspects of regulation, policy and activity in the marine waters are only applicable out to the three or six nautical mile (nm) boundary (see Figure 5). These include the Water Framework Directive (3nm) (see Section 2.9) and the current jurisdiction of the Orkney Sustainable Fisheries Ltd (OSF) (6nm), which acts as the Regional Inshore Fisheries Group (RIFG) equivalent for Orkney (see Section 6.2). Planning control (i.e. the requirement for planning permission) for marine fish farming extends from Mean High Water Springs to 12 nautical miles. Currently, the jurisdiction of local development plans in relation to development planning for fish farming extends out to the 3 nautical mile limit.

National Marine Plan Interactive

The spatial data and other data in this assessment comes from publicly available sources. A key data source is Scotland's National Marine Plan interactive (NMPi)[9]. NMPi is a web based spatial data tool that hosts information at a national level, to support the Scotland's National Marine Plan, but also hosts data for each of the eleven Scottish Marine Regions. These data are continuously updated so whilst this report provides a snapshot of each topic, the most up-to-date relevant information will be available on NMPi.

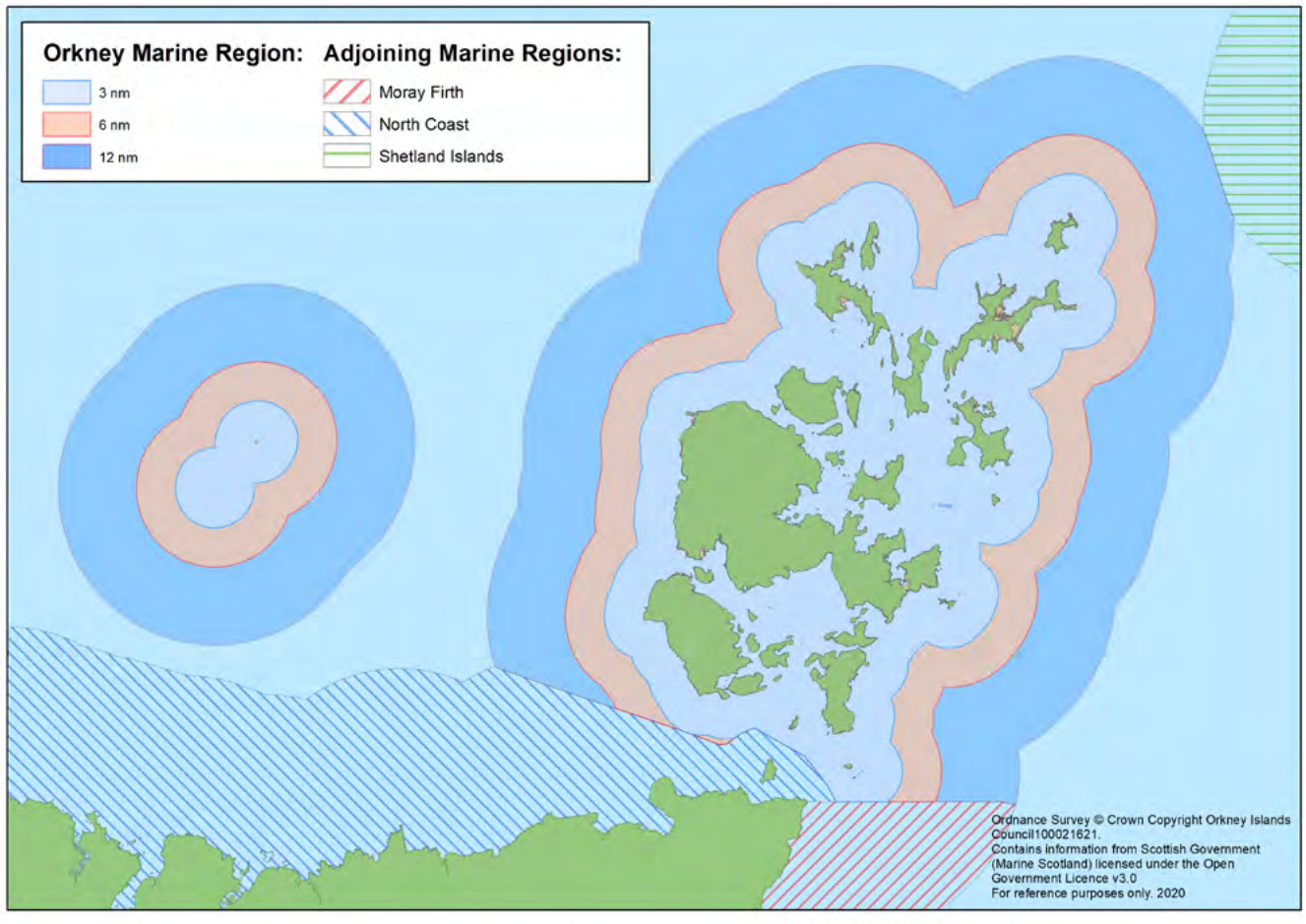


Figure 5 Map of Orkney showing 3, 6 and 12 nautical mile (nm) boundaries

1.11 Ecosystem Services

As well as having its own significant intrinsic value, Orkney's coastal and marine environment provides a wide range of services and natural resources that support communities and underpins the economy. These are often referred to as ecosystems services. Ecosystem services are processes by which the environment produces resources utilised by humans, such as clean air, water, food and materials[10].

The 'Ecosystems Services Approach' to marine planning recognises the value of these services so that they can be fully considered within policy and decision making as well as 'on the ground' actions. Although limited data are available on the mapping and valuation of ecosystem services in Orkney's marine waters, along with the cumulative impacts on ecosystem functioning, the range of ecosystem services that benefit Orkney include:

- Water purification through soil processes and natural filtration and the marine nutrient cycle.
- Food production in the form of wild fish and shellfish and an environment which supports both wild stocks and aquaculture activity.
- Energy from renewable and non-renewable sources including electricity and fuels.

- Flood mitigation by peatlands, wetlands, saltmarsh and kelp beds.
- Coastal protection by dune systems, shingle/cobble beaches, saltmarsh, mudflats and kelp forests.
- Carbon sequestration and storage in for example, marine sediments, kelp forests and biogenic reefs.
- Landscape and seascape features and natural beauty provided by the diversity of landforms and vegetation cover.
- The health and well-being benefits people obtain from ecosystems through recreation, reflection, and spiritual enrichment.

Ecosystems services can be categorised under the service types of provisioning, supporting, regulating or cultural. Detailed information on Orkney's ecosystems services is not currently available, therefore this has been identified as a data gap in Table 33. Further information on applying the ecosystems approach is provided by NatureScot[11] and the actions and tools provided will be used in developing the Orkney Islands Regional Marine Plan. Refer to Section 7.2 for information about the Oceans of Value project and the consideration of ecosystems services in the Orkney marine region.

1.12 Structure of the report

The following sections two to six of the report are divided under five headings: Physical, Historic Coastal and Marine Environment, Climate Change, Biodiversity, Productive coasts and seas and Social and Community Value. It is acknowledged that there is some overlap between topics e.g. climate change and physical aspects, therefore cross-references have been provided to avoid significant duplication of information. Sule Stack and Sule Skerry are included within the assessment where relevant and more information is in Appendix 5.

Each Section commences with a brief summary of key factors to allow rapid assessment of the Section, followed by an introduction, details on the current status, a summary of pressures, and where available, trends, followed by an assessment summary.

This assessment structure is based on a draft structure of the topics provided by Marine Scotland that will be addressed in the forthcoming updated Marine Atlas for Scotland. This regional assessment has been adapted in accordance with the characteristics of the Orkney marine region i.e. not all topics at the national level are relevant to the Orkney marine region. In the main, the format of the report follows the structure of Scotland's Marine Atlas[12], which, at the time of writing, was being updated. Topics throughout this report are not listed in order of importance or priority.

Section 8 identifies the main data gaps and the next steps for regional marine planning in Orkney. Reference numbers throughout the report relate to the referenced information in Appendix 8. Appendices provide supporting information to the assessment.

Section 2: Physical

PHOTO CREDIT: ST JOHN'S HEAD, HOY © REBECCA KAVANAGH

Summary (Sections 2.1 – 2.6)

- The length of the Orkney coastline at Mean High Water Springs (MHWS) is 1,024 km, which makes up 5% of the Scottish coastline.
- Orkney's climate is cool, windy and temperate due to the influence of the Gulf Stream.
- The west coast of Orkney is exposed to a fetch of over 3,000km across the Atlantic Ocean, resulting in wave heights of over 18 metres during storm events.
- The water masses of the North Sea and the Atlantic Ocean meet in Orkney waters, producing diverse hydrodynamic conditions.
- There are strong tidal flows between islands, headlands and through relatively shallow constrained channels e.g. Pentland Firth, Hoy Sound, Lashy Sound, Westray Firth and Stronsay Firth.
- Salinity around most the islands' surface waters is just under 35 grams per kilogram (known as ppt); seawater generally ranges from 33 ppt to 38 ppt.
- The average sea surface temperatures (STT) in Orkney ranges from 6.2°C in February to 14.6°C in August.
- Orkney's marine region water depths to seafloor, or bathymetry, are characterised by relatively shallow depths within the internal waters of the archipelago with increasing depths in the peripheral offshore areas of greater than 100 metres.

2.1 Introduction

Orkney's marine waters and associated islands have a complex and ancient geology with an indented and varied coastline. It includes high cliffs and sheltered bays as well as pocket beaches and vegetated dunes and a range of coastal habitats including cliffs, dunes, machair, shingle, saltmarsh and saline lagoons. Orkney is one of the most important areas in Scotland for saline lagoons. Below the water, the seabed is dominated by coarse sediment (see Section 2.7) and water movement is influenced by the North Atlantic Current (see Section 2.4).

The Orkney Islands lie at the transition between the North Atlantic and the North Sea, which provide sea-passage between Orkney and Shetland and via the Pentland Firth. These waters experience powerful seas and strong tides. Exceptionally strong tidal flows are associated with most of the channels and headlands within Orkney e.g. between Mainland and Hoy, Mainland and Rousay or Sanday and North Ronaldsay. Tidal flows that sweep around the top of Scotland create oscillating falls in water level across Orkney[13]. The impact of the two seas meeting at this point adds to the geographical and physical diversity of Orkney's physical environment and associated habitats, species and marine resources.

The interface between the landscape and seascape is a key feature of the Orkney landscape character (North Caithness and Orkney Coastal Character Assessment, SNH[14]). The western seaboard is characterised by dramatic sea cliffs and associated arches, stacks, geos and gloups. The lower lying coastal areas are dominated by tilted flags, dune systems and sandy bays. The numerous shallow inland sea lochs and indented bays of the mainland expose the lower lying areas to coastal flooding.

The physical environment factors are assessed in accordance with the methodology outlined at Section 1.8. The assessments in relation to climate, wave climate, salinity, acidity and temperature factors are presented in the climate change assessment in Section 4.

2.2 Orkney's Climate

Orkney's cool but temperate climate is one of the windiest places in the UK, with gale force winds recorded in low-lying areas at least 30 days per year. The Gulf Stream, a warm, surface ocean current from the Gulf of Mexico[15], flows north-east across the Atlantic Ocean and brings with it the humid air that makes Orkney's climate much milder than other areas on the same latitude; thus the prevailing winds are westerlies. Due to the Gulf Stream, there is less than 10 degree C difference between the average winter and summer temperatures i.e. relatively mild winters (average temp 5/6 degrees C) but lower summer temperatures (average 15 degree C with a maximum of around 19 degree C).

2.3 Wave climate

The west coast of Orkney is exposed to a fetch of over 3,000km across the Atlantic Ocean resulting in wave heights of over 18 metres during storm events14. This is contrasted by the relatively sheltered waters of Scapa Flow and areas of more limited fetch between the North Isles. Scotland's National Marine Plan Interactive provides access to spatial data for annual significant wave heights in Orkney waters[16].

The projected change in significant wave height over the next 110 years is between 0.18m lower to the west of the Orkney Mainland to 0.35 lower to the north and east of the Orkney.

The North Atlantic Oscillation index is a measure of mean atmospheric pressure difference between the Azores to Iceland. It is a measure of wide-reaching changes in the atmosphere over the North Atlantic and especially in the strength of the storm track guiding atmospheric depressions towards Scotland. It influences storms and wave heights around Orkney, particularly between December to March.

Although there was a trend for increased storminess between 1960s to 1990s, recent trends are not clear, therefore data on storminess are not currently measured in NMPi[17]. However, wave and tidal factors could have increasing impacts on coastal erosion and damage to assets and infrastructure (see Section 4).

2.4 Tidal conditions

The water masses of the North Sea and the Atlantic Ocean meet in Orkney waters producing diverse hydrodynamic conditions. The East Shetland Atlantic Inflow (ESAI) and the Fair Isle Current are major influencing factors[18,19] (see Figure 6). Tidal heights and times on the west coast of Orkney are dominated by the Atlantic Ocean, while on the east side, tides are dominated by the North Sea.

The flood tide in Orkney runs from west to east and ebb tide east to west[20]. Orkney has a relatively small tidal range; the mean range of neap tides is 1.22m and 2.6m at spring tides. Tidal ranges are 30% greater to the west of Orkney compared to the east and amongst the islands.

The sounds between the islands create extraordinarily strong tidal flows providing a significant renewable energy resource (see Section 5.6). The tidal energy resource in Scottish waters is at its strongest in the Pentland Firth. The mean spring annual power density at this location is 6.65 kWatt m-2 and can reach a maximum of 211 kWatt m-2 in a small number of locations. Mean neap power density is 0.9 kWatt m-2 with a maximum of 32.95 kWatt m-2.[21] Scotland's National Marine Plan Interactive provides access to spatial data for tidal peak flow for mean spring tides in Orkney waters[22]. The Pentland Firth, Hoy Sound, Lashy Sound, Westray Firth and Stronsay Firth record significant peak tidal flows.

Since their construction between 1940-1944, the Churchill Barriers have significantly altered hydrodynamic conditions around the East Mainland, Burray, South Ronaldsay and Scapa Flow. This has resulted in changing tidal flows, altered patterns of accretion and erosion, and coastal ecology.

Pentland Firth © Liz Anderson

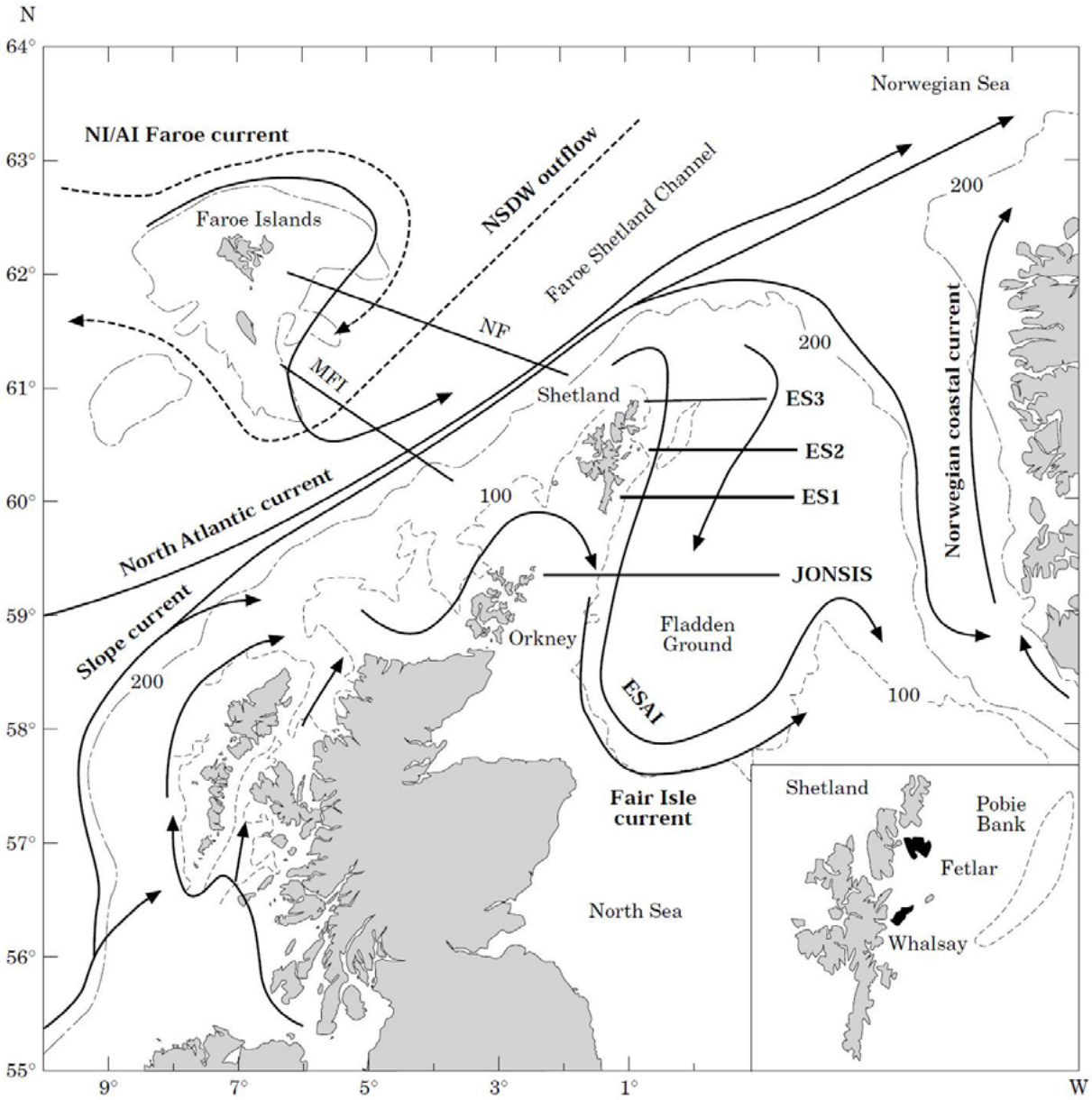


Figure 6 Key features of the topography of the northern North Sea and adjacent oceanic areas in relation to the proposed circulation and the location of the standard hydrographic Sections. Solid arrows represent surface circulation and broken arrows sub-surface; NF – Nolso–Flugga standard hydrographic Section; MFI – Munken–Fair Isle Section; NI/AI – North of Iceland/Arctic intermediate water; NSDW – Norwegian Sea Deep Water (source: Turrell *et al,* 1996[19])

2.5 Salinity, acidity and temperature

As there are no large rivers or estuaries in Orkney, there is relatively little variation in salinity compared to some other parts of Scotland. The salinity around most of the islands' surface waters is just under 35 grams per kilogram (known as ppt); seawater generally ranges from 33 ppt to 38 ppt. One clear variation to this, however, is the Loch of Stenness, the UK's largest saline lagoon, with an area of 786 hectares. Data from 2002 noted the salinity varied from 7 to 23 ppt[23]. Saline lagoons are defined as 'Areas of shallow coastal water, wholly or partially separated from the sea by sand banks, shingle or, less frequently, rocks'.

Since the Industrial Revolution, the CO_2 absorbed by the oceans has resulted in a decrease in pH of 0.1 units, but there are currently no baseline measurements of ocean acidity against which changes in UK waters can be judged[24].

In 2020, average sea surface temperatures (SST) in Orkney ranges from 6.2°C in February to 14.6°C in August[25].

Anemones, sponges and hydroids on gravelly sand covered bedrock, Orkney © NatureScot

2.6 Bathymetry

Orkney's marine region water depths to seafloor, or bathymetry, are characterised by relatively shallow depths within the internal waters of the archipelago with increasing depths in the peripheral offshore areas. Figure 7 shows an indication of the varied water depths (in metres) around Orkney.

The Pentland Firth is a deep water channel that separates Orkney from Scottish Mainland. Depths vary from 20 metres to 96 metres, with an average depth around 60 metres; the western part of the area is deeper and the central area south of Stroma is the shallowest part.

The Westray and Stronsay Firths are a deep water channel that transects the North Isles splitting the archipelago from the much shallower internal water to the north and south.

Scapa Flow is a large sheltered marine water body bounded by the islands of Mainland, Graemsay, Burray, South Ronaldsay and Hoy. Water depths vary but are predominantly 20-40m, with much deeper water in Bring Deeps.

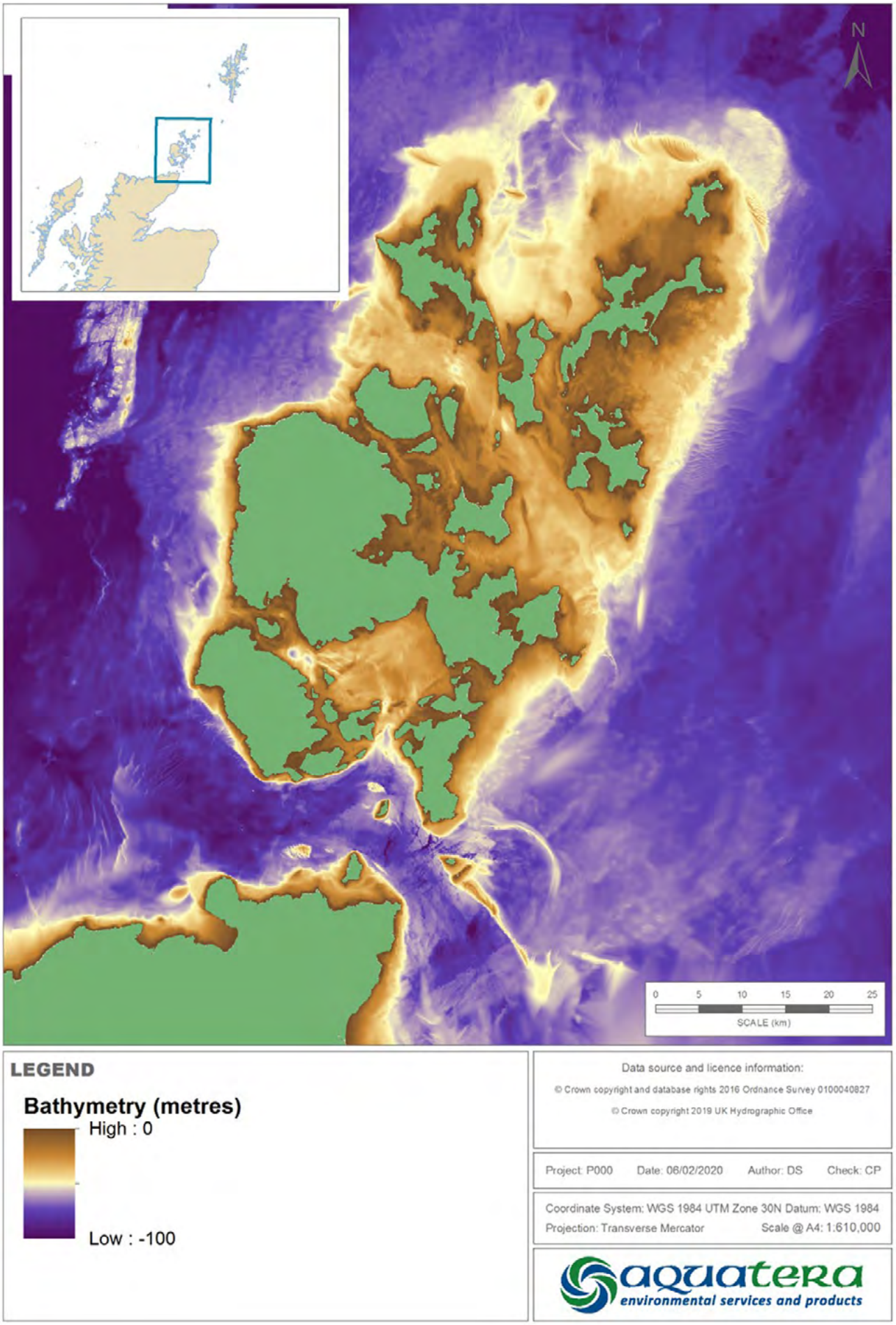
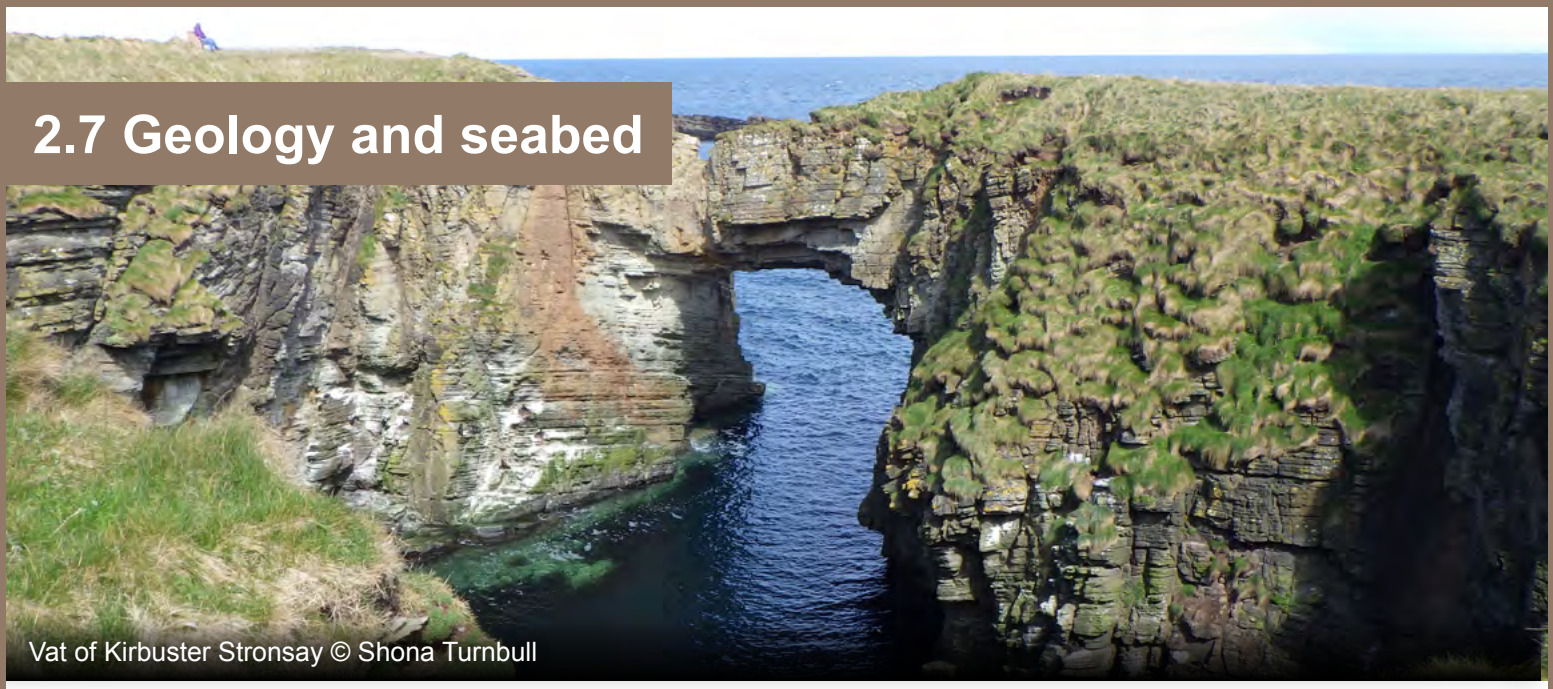


Figure 7 Map of Orkney's bathymetry

2.7 Geology and seabed



Vat of Kirbuster Stronsay © Shona Turnbull

Summary

- The seabed is dominated by coastal sediment and high energy infralittoral rock around most of the islands, with large areas of sand and muddy sand to the east and west of the islands.

2.7.1 Introduction

The geology within the Orkney marine region is predominantly Devonian Red Sandstone often as flagstone whilst the seabed is dominated by course sediment and high energy infralittoral rock around most of the islands, with large areas of sand and muddy sand to the east and west of the islands.

2.7.2 Current Status

The length of the Orkney Islands coastline at Mean High Water Springs (MHWS) is 1,024 km, which makes up 5% of the Scottish coastline[26]. Of this length, 61% (623 km) has been categorised as hard, 36% (373 km) as soft and 3% (28 km) as artificial. The geology is predominately flagstone and sandstone deposited in Lake Orcadie, a large freshwater lake belonging to the Devonian (Old Red Sandstone) period (416 – 359 million years ago)[27]. Metamorphic rocks are exposed near Stromness, Yesnaby and on Graemsay, mostly consisting of granitic gneisses.

The surrounding seabed is composed of a rich variety of marine and coastal habitats including submerged reefs, maerl beds, sandbanks, burrowed mud, salt marshes and dune systems. The seabed is dominated by course sediment and high energy infralittoral rock around most of the islands, with large areas of sand and muddy sand to the east and west of the islands, out towards and beyond the 12 nm limit (see Figure 8).

Of the 36 Sites of Special Scientific Interest (SSSIs) around Orkney, approximately 12 of them include geological qualifying features such as maritime cliff, fossil plants and animals,

sedimentary landforms, and quaternary tills (see Appendix 2). The greatest pressures to these sites come from coastal change, partly due to increased levels of erosion and changes to freeze-thaw activity, which means the features formed by these processes will be impacted by an ongoing process as the climate warms. However, coastal change is a fundamental attribute of the Coastal Geomorphology interest on Sanday. Overall, the site condition of all the geological SSSIs are classed as 'Favourable'.

Geological Conservation Review (GCR)

Geological Conservation Review (GCR) sites are the best and most representative geological and geomorphological features of Britain. Although most have statutory protection through designation as features in SSSIs, some remain unprotected and are termed unnotified GCR sites. A small number of unnotified GCR sites, including South Fersness Bay in Eday and Taracliff to Point of Ayre in Deerness, are coastal exposures which are listed as Local Nature Conservation Sites (LNCS)[28].

Tidal race off Copinsay © Shona Turnbull

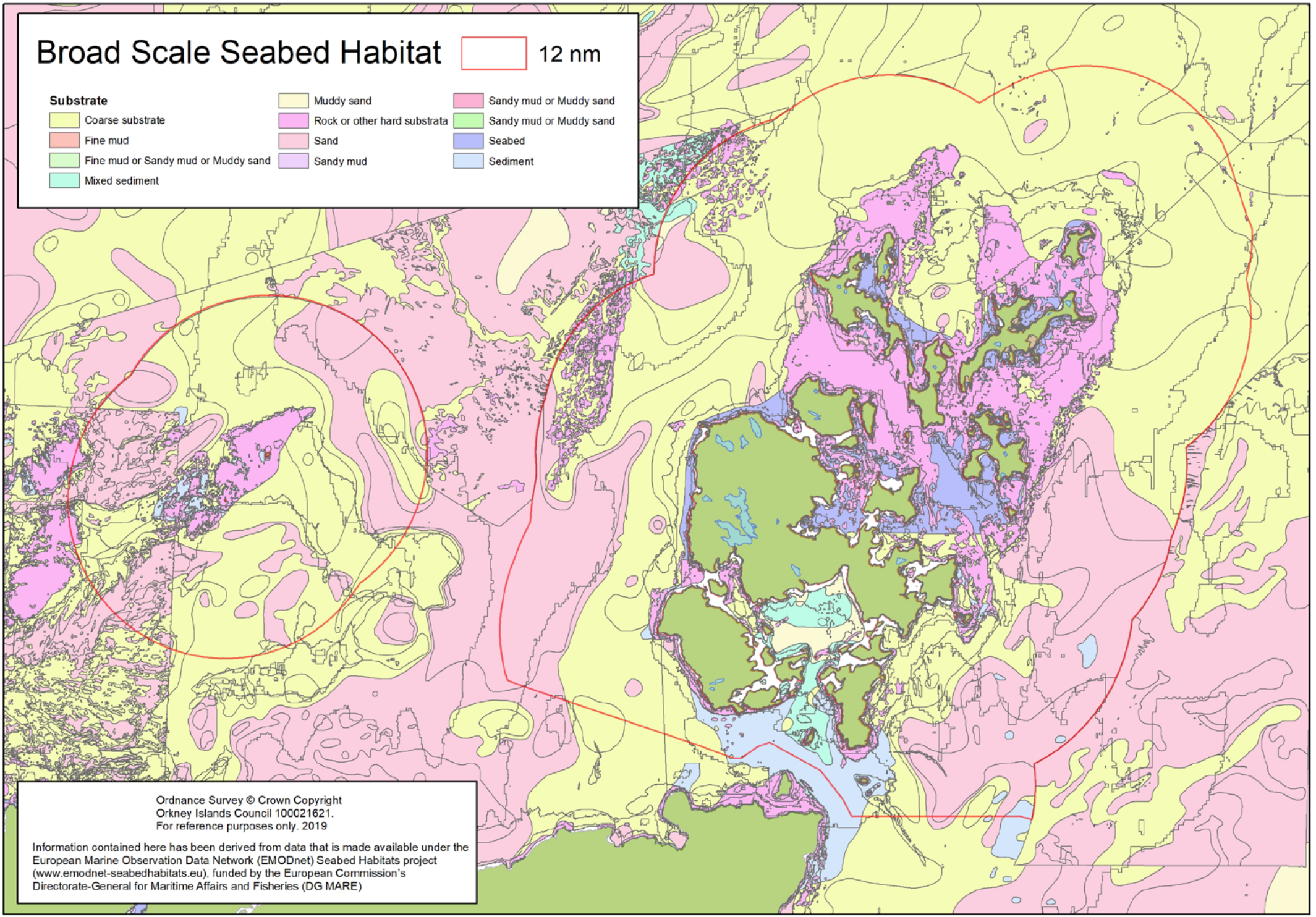


Figure 8 Seabed habitat for the Orkney Island's Marine Region

2.7.3 Pressures and trends

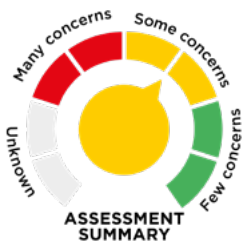
All of the economic sectors assessed within this report are likely to cause some physical disturbance to the seabed. These pressures are due to abrasion; physical disturbance of seabed; disturbance in relation to physical change to another seabed type (e.g. concrete); habitat structure changes and substratum extraction. Developments including ports and harbours, aquaculture, cable laying and marine renewable energy are likely to exert the most significant pressures.

Erosion in areas of soft coast can require the installation of built defences, altering the profile and changing the substrate type. In addition, pressures from the potential effects of climate change including sea-level rise and soft coast erosion, are discussed in more detail in Section 4.

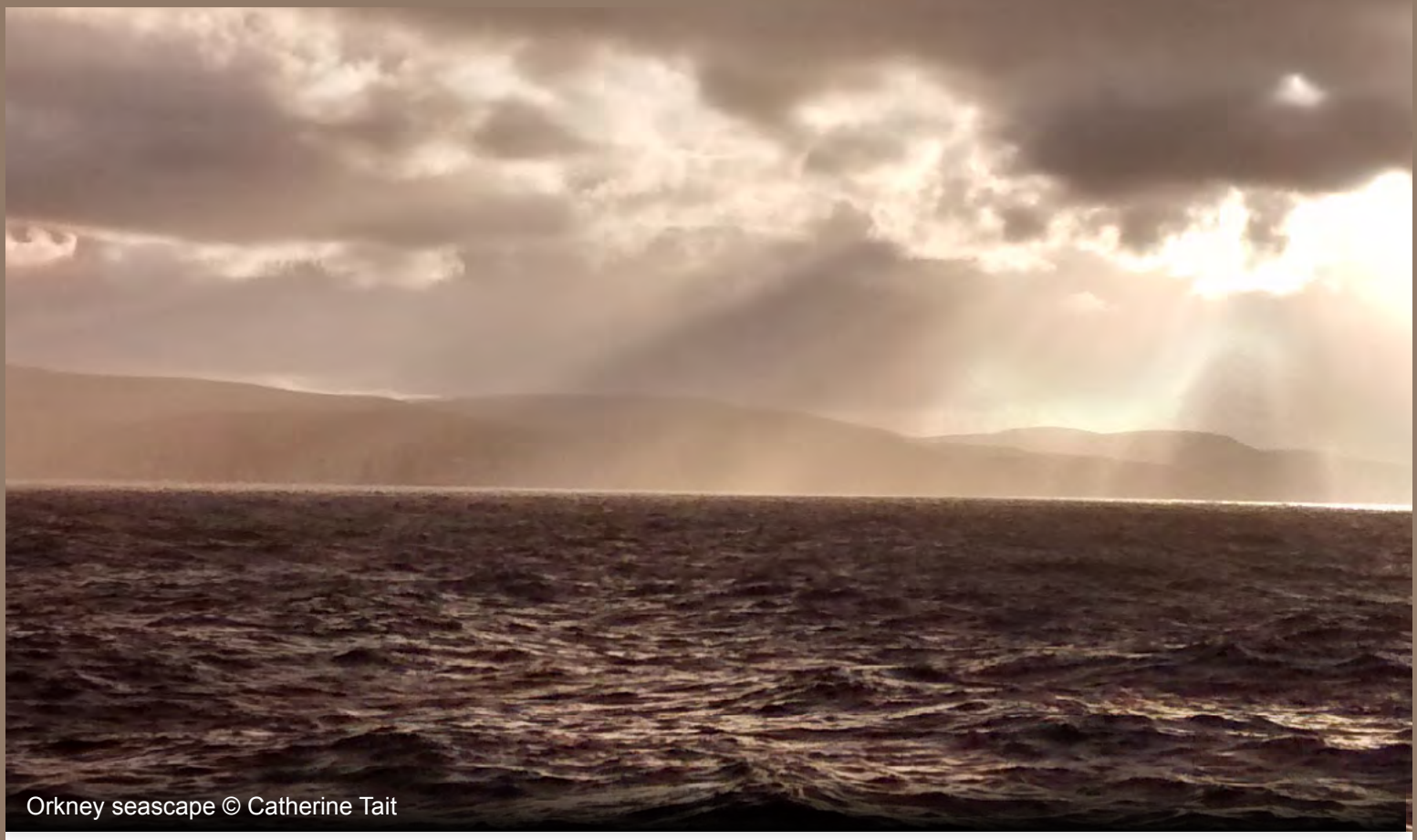
2.7.4 Assessment Summary

The PAD tool (see Section 1.8) identifies that all the productive sectors considered in this assessment have a medium to high risk of causing disturbance on the seabed; climate change will potentially increase associated rates of erosion. The anticipated trend towards growth of aquaculture, offshore wind, marine renewables and the developments outlined in the Orkney Harbours Masterplan Phase 1 (see Section 6.4), are likely to increase seabed impacts, leading to some concerns.

Table 5 Geological and Coastal Processes Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Geology and Seabed	Erosion. Disturbance			

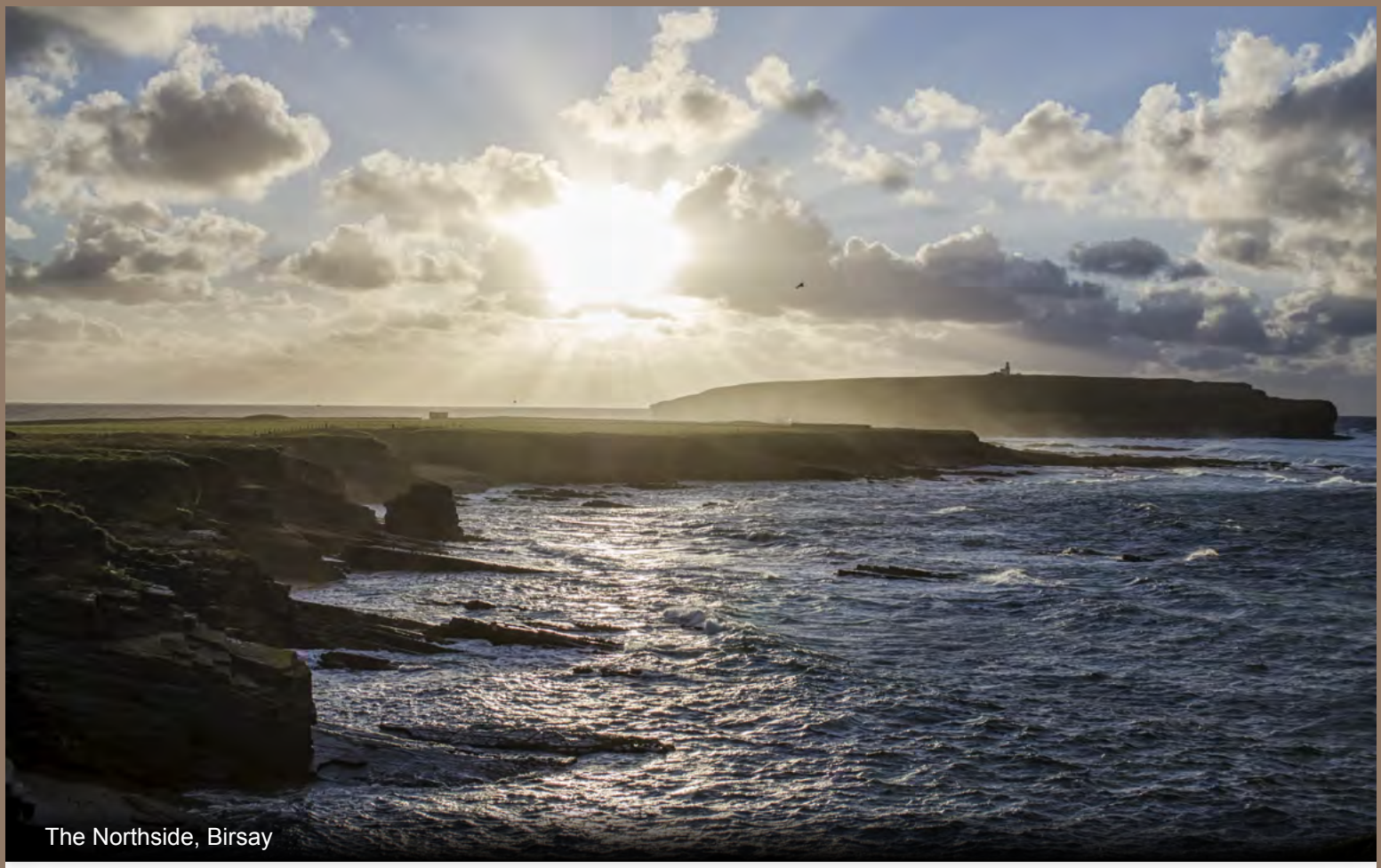
2.8 Landscape and Seascape



Orkney seascape © Catherine Tait

Summary

- The Orkney landscape is a complex mosaic of undulating island pasture, cliff landscapes, inclined coastal pasture, moorland, mixed agriculture and beaches, dunes and links.
- Landscape and seascape are dominated by cliffs, sheltered bays and energetic sounds.
- The Hoy and West Mainland National Scenic Area (NSA) has been designated as a nationally significant landscape due to its identified special qualities for outstanding scenery.
- A large area of Hoy (4,990 ha) is classified as a Wild Land area due to wildness qualities and the associated minimal signs of human influence.
- Coastal and marine developments have significant potential to affect the special qualities of the Orkney landscape and seascape.
- Coastal landscape character will continue to experience significant change due to climate related pressures including coastal erosion, sea-level rise, flooding and change to vegetation types.



The Northside, Birsay

2.8.1 Introduction

The dramatic, intimate clash of landscape and seascape contributes to Orkney's unique sense of place. The area in-between, the coastal zone, is where many people most frequently engage with the marine environment. Collectively, the three elements of landscape, seascape, and coastal zone, provide panoramic views and a coastal landscape experience made up of open seas, dramatic cliffs, sheltered bays and quiet beaches.

2.8.2 Current status

The Orkney landscape is a complex mosaic of undulating island pasture, cliff landscapes, inclined coastal pasture, moorland, mixed agriculture, beaches, dunes and links (see Figure 9). The Coastal Character Assessment: Orkney and North Caithness (2017) provides an outline classification and description of both regional and local coastal character areas[29]. This Coastal Character Assessment provides an appraisal of Orkney and North Caithness using thirteen national seascape character types based on coastal, marine and hinterland characteristics. Three of these coastal character types predominate in Orkney:

- Remote High Cliffs (mainly west coast of Hoy, West Mainland, the west coast of Westray and north coast of Papa Westray.
- Deposition Coasts of Islands; and
- Coastal Islands.

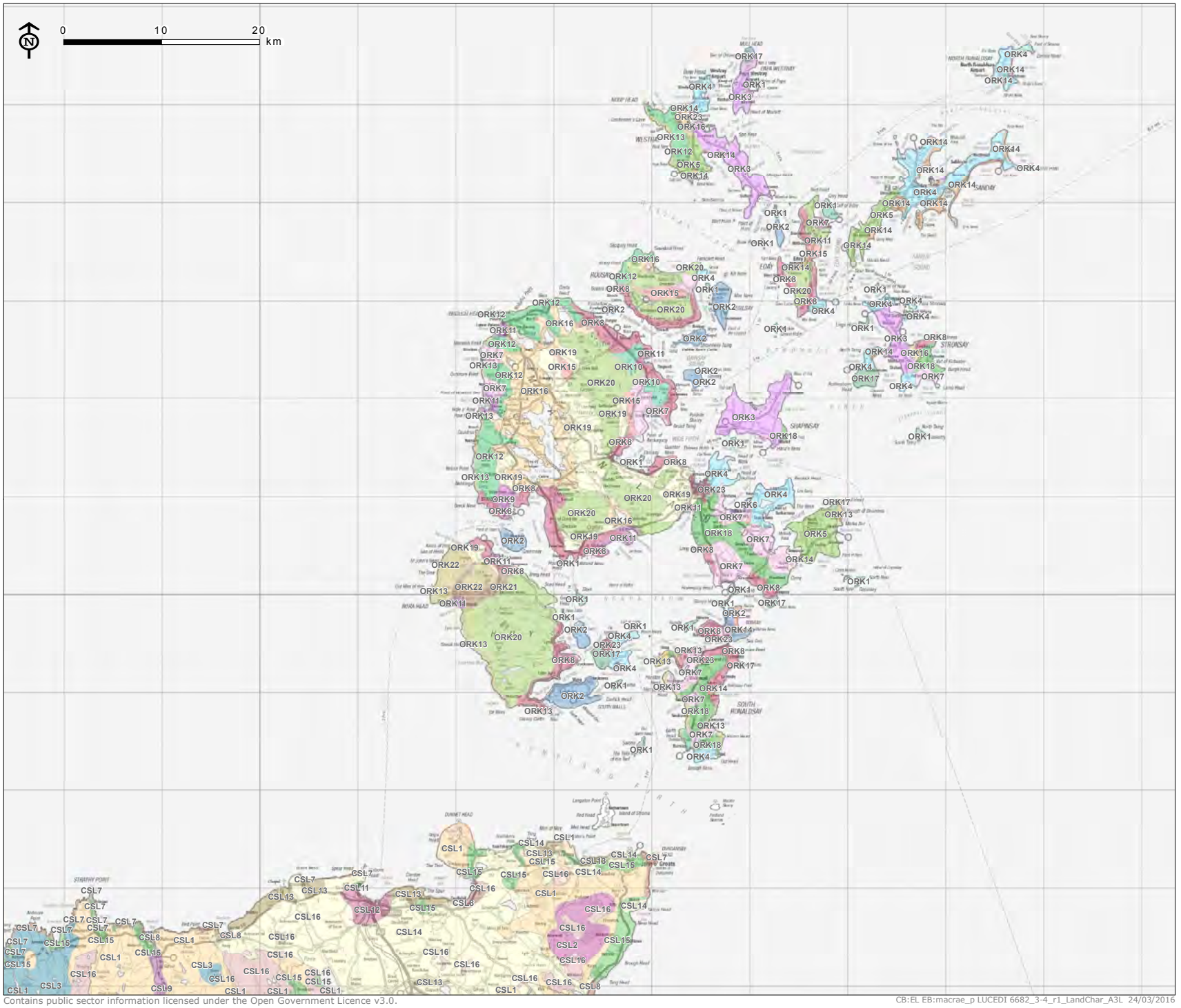
The Orkney Local Character Assessment (1998), although a little dated, provides a robust outline of the area in relation to the terrestrial features[30]. The Orkney Landscape Capacity for Aquaculture: Scapa Flow and Wide Firth (2011)[31] provides more up to date landscape characterisation for these areas.

The Local Landscape and Seascape Character Assessment 2017 (LLSCA) prepared for the North Isles Landscape Partnership Scheme provides a more detailed appraisal of the North Isles that includes an assessment of coastal landscape and seascape character[32]. The North Isles are characterized by open ocean seascapes and sheltered sounds running between the islands. These seaways are turbulent with rapidly changing weather conditions adding to the strength and speed of change in coastal morphology.

The Hoy and West Mainland National Scenic Area (NSA) has been designated as a nationally significant landscape due to its identified special qualities for outstanding scenery[33]. These special qualities include spectacular coastal scenery and the constantly changing combinations of land and sea under open skies. The NSA encompasses a significant area of marine waters around north Hoy, Graemsay, West Mainland and the Loch of Stenness (see Figure 10). North Hoy has a strong visual interrelationship with the south-west mainland, the rural character of which, around the shores of the Loch of Stenness, makes a foil for the Hoy hills.

A large area of Hoy (4,990 ha) is classified as a Wild Land Area due to wildness qualities and the associated minimal signs of human influence. Wild Land Areas are non-statutory designations but are considered nationally important. The Hoy Wild Land Area has significant coastal features on the west coast of Hoy, where it borders dramatic cliffs (see Figure 10).

View from Orphir to Hoy and Graemsay, National Scenic Area



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Source: SNH

Figure 9 Broad Landscape Character Types for Orkney

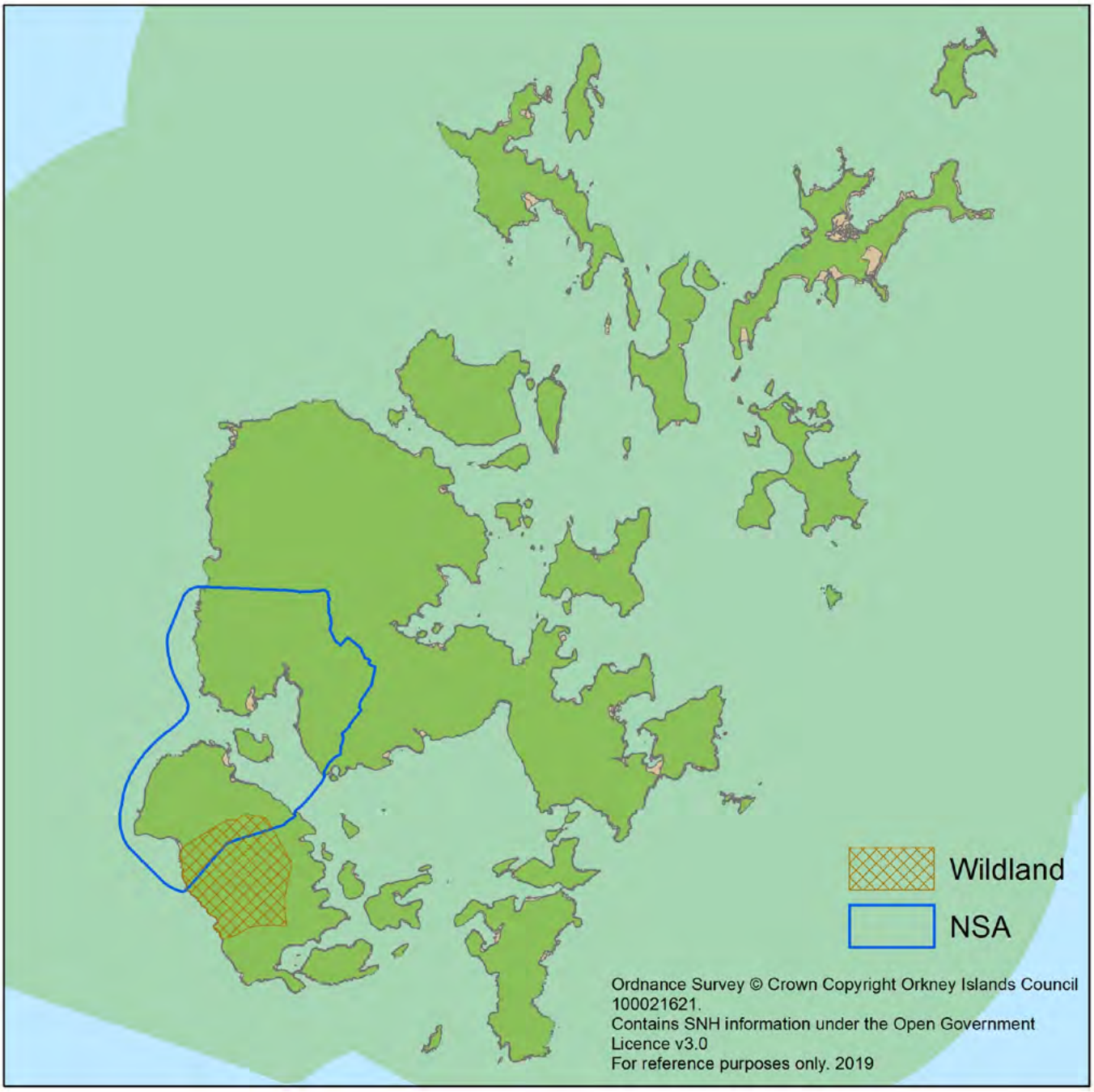


Figure 10 National Scenic Area and Wild Land

2.8.3 Pressures and Trends

Coastal and marine developments have significant potential to affect the special qualities of the Orkney landscape and seascape. Landscape and seascape impacts relate to the physical effect a proposed development can have on the character, special qualities and identity of a location. Visual impacts relate to what people can experience and see from places they frequent, in particular their local communities and residences or important viewpoints.

The magnitude of these impacts can be more significant in areas of isolated and undeveloped coast and locations where the scale of local landscapes can be significantly impacted by larger scale developments. The key pressures that could contribute to landscape and seascape character change are:

- Coastal erosion which can be accelerated due to extreme weather and can have indirect impacts inland of the immediate footprint of erosion.
- Sea-level rise affects both the shape of the coast and land use patterns, in turn impacting landscape and seascape characteristics.
- Increased risk of flooding could potentially damage vegetation, have an adverse impact on landscape and hinder utilisation of land e.g. impact coastal roads and footpaths.
- Loss and change of vegetation types due to increases in temperature and changes in weather patterns.
- Growth of fish farm development in new and existing locations, particularly within the NSA.
- Development of new and extended port and harbour developments.
- Growth of offshore wind, marine energy, coastal onshore wind developments and associated electricity infrastructure.
- Changes in agricultural practices as farmers adapt to changing weather patterns will have an impact on coastal landscape character and may also impact on water quality e.g. if there is an increase in run-off from the land due to increased storm weather events with predicted climate change impacts.

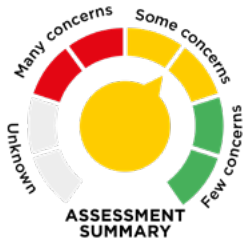
2.8.4 Assessment Summary

The cumulative impact of coastal and marine development has had a significant effect on the character of landscapes and seascapes and this trend is anticipated to continue due to the anticipated trend towards growth of marine economic sectors.

Aquaculture, port and harbour and marine renewable energy development has increased in Orkney over the past decade and it is anticipated that this trend will continue, resulting in impacts on landscape and seascape character. Marine planning and development management can help to guide development to less sensitive locations and implement appropriate mitigation to help minimise adverse landscape and seascape impacts.

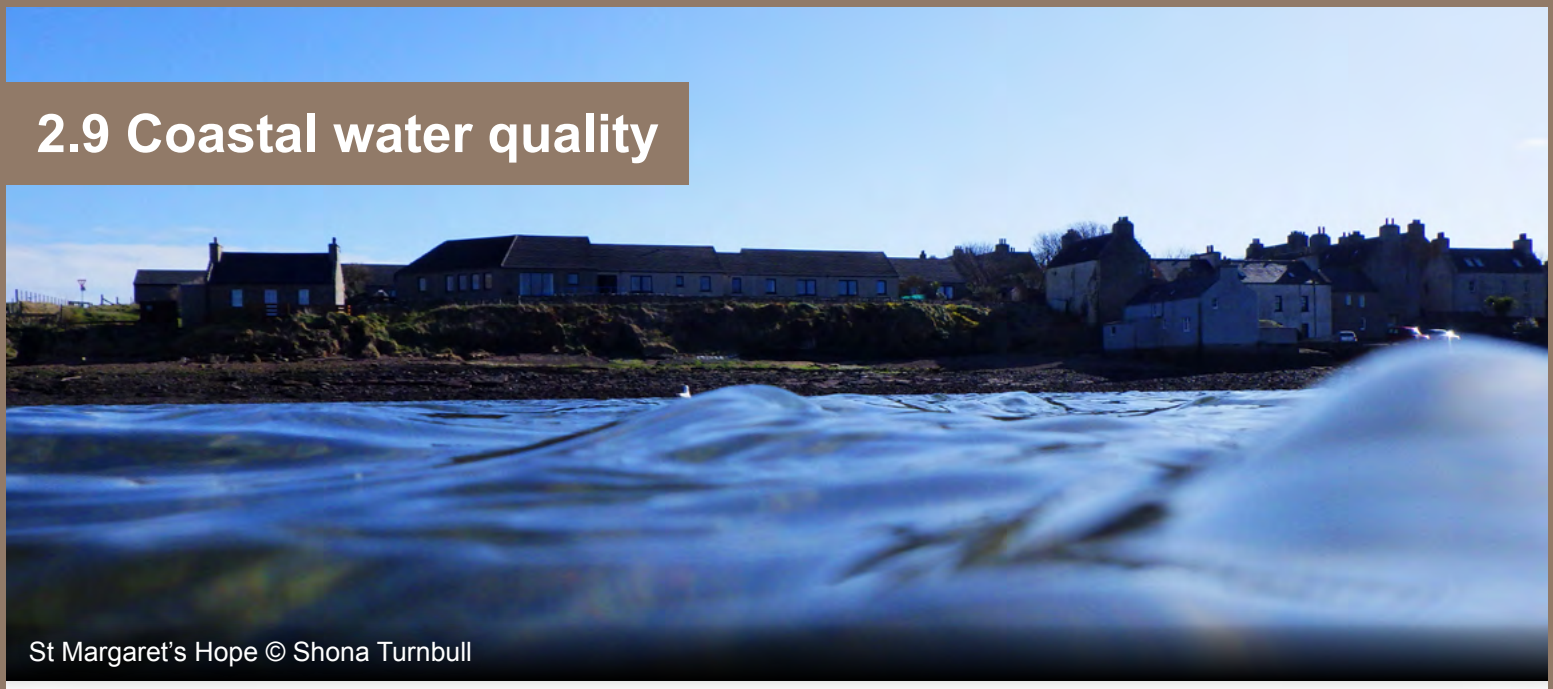
It is anticipated that coastal landscape character in Orkney will continue to experience significant change due to climate related pressures and impacts. The Climate Change Vulnerability Impact Assessment and the Dynamic Coasts Project, considered in Section 4, provide detail on the anticipated trend of deterioration for landscape and seascape features. These impacts are predominately associated with eroding forces and sea-level rise.

Table 6 Landscape and Seascape Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Seascape/ landscape	Erosion of special qualities of landscape/ sveascape due to development. Coastal erosion, sea-level rise, flooding and change to vegetation types due to climate change.			

View of Papa Westray © Shona Turnbull

2.9 Coastal water quality



St Margaret's Hope © Shona Turnbull

Summary

- Coastal water quality status for the North Isles, Scapa Flow and West Mainland coast is classified as good under Water Framework Directive (WFD) standards.
- Coastal water quality status to the west of Hoy, the Pentland Firth and East Mainland coast is classified as high under Water Framework Directive (WFD) standards.
- Pressures on water quality include inputs from aquaculture, agriculture, urban run-off and sewage treatment plants.

2.9.1 Introduction

The European Union Water Framework Directive 2000 (WFD) aims to ensure the protection, improvement and sustainable use of rivers, lochs, ground, transitional and coastal waters out to three nautical miles. The WFD was transposed into Scottish Law in the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act) and the Water Environment (Controlled Activities (Scotland) Regulations 2011(CAR), and all subsequent amendments. These Acts ensure that activities which may affect Scotland's water environment have regulatory controls to minimise impacts. The Scottish Environmental Protection Agency (SEPA) is the lead authority responsible for implementing the WEWS Act and for the enforcement of CAR.

2.9.2 Current status

Orkney and the surrounding waters are categorised into 56 water bodies for the purposes of monitoring water quality in accordance with the WFD[34]. Figure 11 shows that most of the coastal waters are classified as good; these waters are mainly located around the northern isles and the waters classified as high are generally found around the southern isles and south east Mainland.

There are no classified bathing waters or classified Shellfish Harvesting Areas in Orkney. At present, there is one Shellfish Water Protected Area, located in the Bay of Firth (Figure 12). These areas are regulated and protected in order to support shellfish life and growth, contributing to the high quality of edible shellfish products and to protect shellfish growing waters against pollution and, where necessary, establish programmes to reduce pollution. There is a Ballast Water Management Policy for Scapa Flow; this is discussed in Section 6.4.

Data from National Marine Plan Interactive shows the nutrient enrichment concentrations, represented by Dissolved Inorganic Nitrogen (DIN: = ammonia + nitrate + nitrite concentrations). DIN usually limits algal growth in seawater; in large quantities DIN can lead to eutrophication, resulting in various species' impacts. The levels around Orkney are between 0–10 µM. The amount of phytoplankton in the water is estimated by measurements of the plant pigment, chlorophyll. The chlorophyll in transitional and coastal waters is 0–5 µg/l in Orkney.

In 2018, the Scapa Flow Aquaculture Water Quality Impact Modelling Assessment[35] determined that dissolved nutrient released from eight operational fish farms, three proposed fish farms, watercourses and sewage treatment plants is sufficiently low to maintain current compliance with High WFD Coastal Water DIN standards. For clarity, this work only considered nutrients and not chemical pollution.

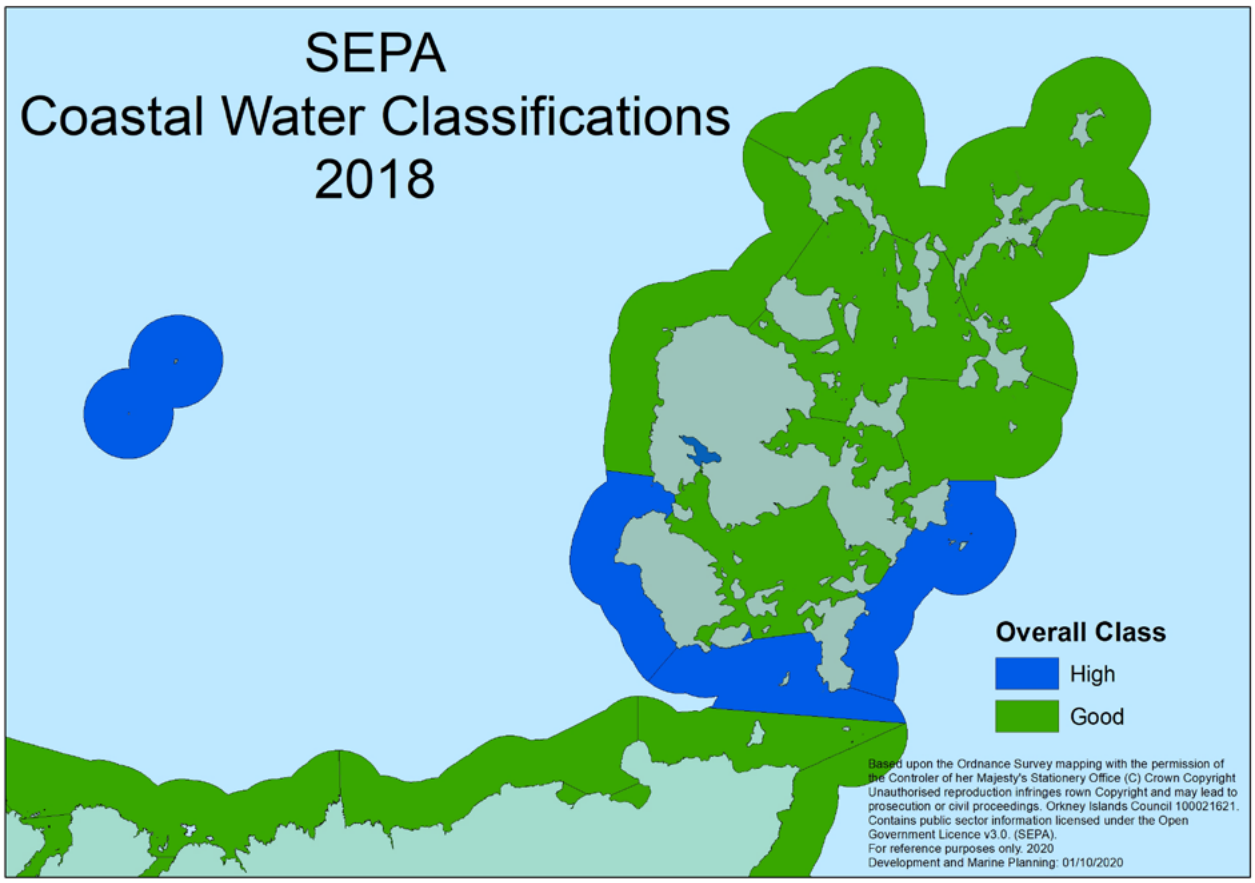


Figure 11 SEPA coastal water classifications 2018 out to three nm

Figure 12 Shellfish Water Protected Area in the Bay of Firth, Orkney

2.9.3 Pressures and trends

Pressures on water quality include inputs from aquaculture, agriculture, urban run-off and sewage treatment plants. Changes in suspended solids affects water clarity, along with siltation, nutrient enrichment and pollution.

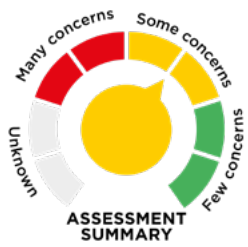
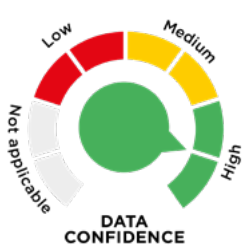
Aquaculture is an activity that can significantly affect water quality. It is likely that there are legacy pollutant impacts due to aquaculture. Data on cumulative effects of pollutants from this sector are poor at present, but it is being recognised across Scotland as an issue to be addressed and better understood going forward. There are currently limited identified pressures on water quality from aquaculture due to the strict regulatory controls for discharges associated with development and activities. The water quality modelling assessment in Scapa Flow (2018) concluded regulatory compliance with High WFD Coastal Water DIN standards (see Section 2.9.2).

If there were significant growth or changes in practices by impacting economic sector e.g. agriculture or aquaculture, this could potentially cause pollution discharge to coastal waters, resulting in changes to water quality and localised impacts in the marine region. Oil pollution risks in relation to shipping are discussed in Section 6.4.

2.9.4 Assessment Summary

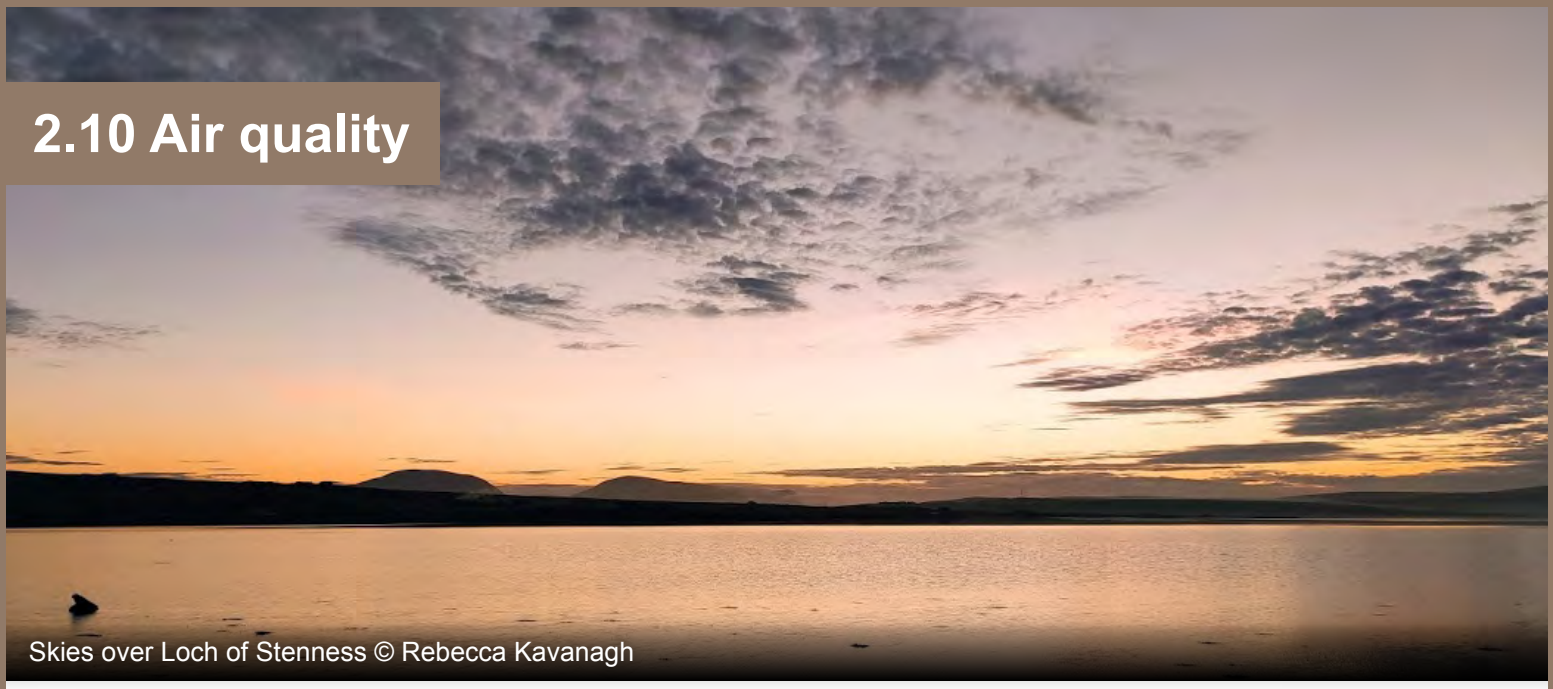
The coastal water quality status in Orkney, out to 3 nautical miles, is classified under WFD standards as high or good. The continued growth of the aquaculture industry in Orkney's coastal waters could add to these pressures on the water environment. Potential water quality impacts will need to be effectively managed through the SEPA Water Environment Controlled Activities regulatory regime. It is anticipated that updated SEPA monitoring and licensing requirements for fish farms will help to ensure that water quality standards are maintained.

Table 7 Coastal Water Quality Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Water quality	Pollution			

Water column, Fourth Churchill Barrier © Shona Turnbull

2.10 Air quality



Skies over Loch of Stenness © Rebecca Kavanagh

Summary

- Orkney has relatively good air quality with measured pollutant concentrations substantially below the national limits.
- There are limited data on air pollution from marine activities.

2.10.1 Introduction

Air pollution is transient by its very nature and can be attributed to sources including transportation, heating and industrial process. There is significant evidence to suggest that industrial marine sources and developments contribute to poor air quality. In Orkney, marine developments and activities can impact air quality through direct and indirect means. For example, marine transport and shipping activity can impact air quality, with potential localised impacts in proximity to ports and harbours. Emissions are also associated with other marine economic activities that require vessel operations or fossil fuel powered electricity generators.

2.10.2 Current status

At present limited air quality monitoring is undertaken in Orkney by Orkney Islands Council (OIC). Monitoring data is presented in Appendix 4. Nitrogen Dioxide (NO_2) is monitored through a network of diffusion tubes[36]. It is important to note that although the largest contributor of NO_2 in Orkney is transport, the data are deficient for purposes of marine planning in that it is not known what the contribution as a percentage is from marine sources. Further studies are required to understand the full effects of existing (baseline) and future marine developments and activities.

OIC does not currently monitor for particulate matter (pm) and relies on data and maps produced on behalf of the Scottish Government, which provides the spatial distribution of background and roadside annual mean concentrations of pm10 and pm2.5. These data support the review and assessment of local air quality[37].

Additional data for ambient air quality in Orkney of both particulate matter and sulphur dioxide (SO_2) can be gained from SEPA's Volcanic Emissions Network[38].

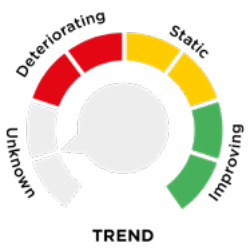
2.10.3 Pressures and Trends

The Orkney Islands has relatively good air quality with pollutant concentrations substantially below the national limits. However, it is important that these levels are maintained, and where possible improved, and that any related policies should address air quality matters and be supported by appropriate monitoring to improve the available local data.

2.10.4 Assessment Summary

The PAD tool did not identify impacts from development and activities on air quality as a pressure on the marine environment. The current nature and scale of marine development indicates there are relatively minor concerns regarding likely impacts on air quality in the Orkney marine region. Table 33 identifies a need for more robust data on maritime air pollution and how it can be monitored and recorded to inform future policy and assessment.

Table 8 Air Quality Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Air quality	Pollution			

2.11 Marine Litter and Waste

Bag the Bruck © Stronsay High School

Summary

- The SCRAPbook project undertook an aerial photographic survey of Orkney in 2019 identifying the distribution and accumulation of marine litter on the Orkney coastline.
- The SCRAPbook data for Orkney indicated that the most common item of litter was miscellaneous plastic, with almost 60% of recorded sites containing plastic items.
- It takes 600 years for fishing line to biodegrade, plastic bottles 450 years and a plastic shopping bag 20 years.
- Despite relative remoteness and comparatively small human population, a study in Orkney found that the intertidal sediment loads of microplastic were comparable to locations on the UK mainland.
- The distribution and accumulation of marine litter is affected by factors including wave exposure, tidal currents, physical coastal enclosure and proximity to source e.g. settlements and fishing grounds.
- Orkney has a varied coastline with complex patterns of tidal flow, wind and wave exposure resulting in a tendency for marine litter and debris to accumulate in specific areas or pockets on the coast.
- 'Bag the Bruck' is a community beach and coastal area clean-up initiative that has been running in Orkney since 1992.
- More data are required on the presence and source of plastics in the coastal and marine environment in Orkney.

2.11.1 Introduction

Marine litter has been an environmental problem in the oceans and seas for decades. Litter is widespread in the marine environment and is harmful to wildlife and ecosystems. Plastic debris was first observed in the oceans in the 1960s[39], following the invention of mass-produced single-use plastics in the 1950s[40]. It is estimated that about 60-80% of marine debris is plastic and plastic comprises a large percentage of beach litter[41].

It takes 600 years for fishing line to biodegrade, plastic bottles 450 years and a plastic shopping bag 20 years (see Figure 13)[42]. Plastic degrades in the environment becoming microplastic that can be ingested by marine life. The extensive media coverage of marine litter over the last few years has brought the issue to much wider public attention, highlighting the significant impacts on the environment and potential impacts on human health.

The Scottish Government's Marine Litter Strategy[43] (2014) outlines a range of legislation and regulatory methods to help support the reduction of effects from marine litter[44]. Key elements of the strategy include proposals to incorporate marine litter reduction policy measures within regional marine plans, encourage partners to treat waste as a resource to generate value and the development of a regional approach to reduce marine litter.

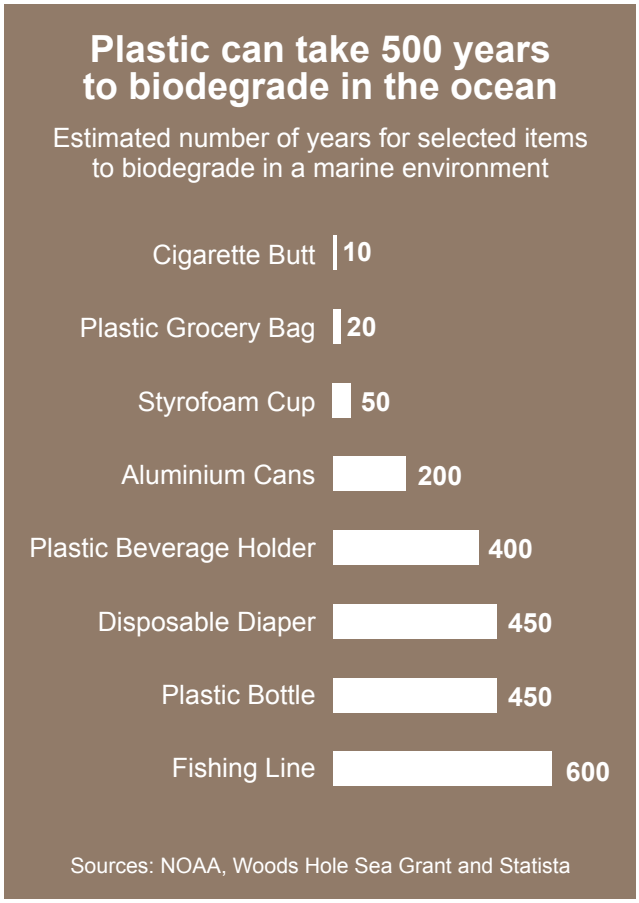


Figure 13 Biodegradation of Ocean Plastic Graphic

2.11.2 Current status

Orkney has a varied coastline with complex patterns of tidal flow, wind and wave exposure. This results in a tendency for marine litter and debris to accumulate in specific areas or pockets on the coast. The distribution and accumulation of marine litter is affected by factors including wave exposure, tidal currents, physical coastal enclosure and proximity to source e.g. settlements and fishing grounds.

More data are required on the presence and source of plastics in the coastal and marine environment in Orkney. Greater knowledge is required on the biological responses to plastic and impacts on food webs and the human food chain. Seabed and water column analysis is required, along with data on microplastics within the coastal and marine environment in Orkney.

More data are required on the source of plastics in the coastal and marine environment in Orkney, biological responses to plastic and impacts on food webs and the human food chain.

SCRAPbook (Scottish Coastal Rubbish Aerial Photography) is a project founded by UK Civil Air Patrol (Sky Watch), Moray Firth Partnership and Marine Conservation Society. The project utilised aerial photography taken from light aircraft to map coastal litter hotspots around the Scottish coastline[45]. The primary output from the project was the SCRAPbook interactive map, which shows the spatial distribution and intensity of macro-scale coastal litter through colour-coded points, with photographs attached to points with the greatest litter accumulation. This project undertook an aerial photographic survey of Orkney in 2019 identifying the distribution and accumulation of marine litter on the Orkney coastline (Figure 14).

The SCRAPbook data for Orkney indicated that the most common item of litter was miscellaneous plastic, with almost 60% of recorded sites containing plastic items. Common litter types included pieces of wood, buoys, pipes and cables, metal, net, rope, creels and tyres. The litter recorded originates from both land and marine sources. The project identified litter hotspots containing large items such as abandoned cars, scrap metal, old boat parts and pipes. There are several sites of historic waste tipping on the Orkney coastline, including farmstead fly tips used as informal coastal erosion defences.

Marine litter on Scapa Beach © James Green

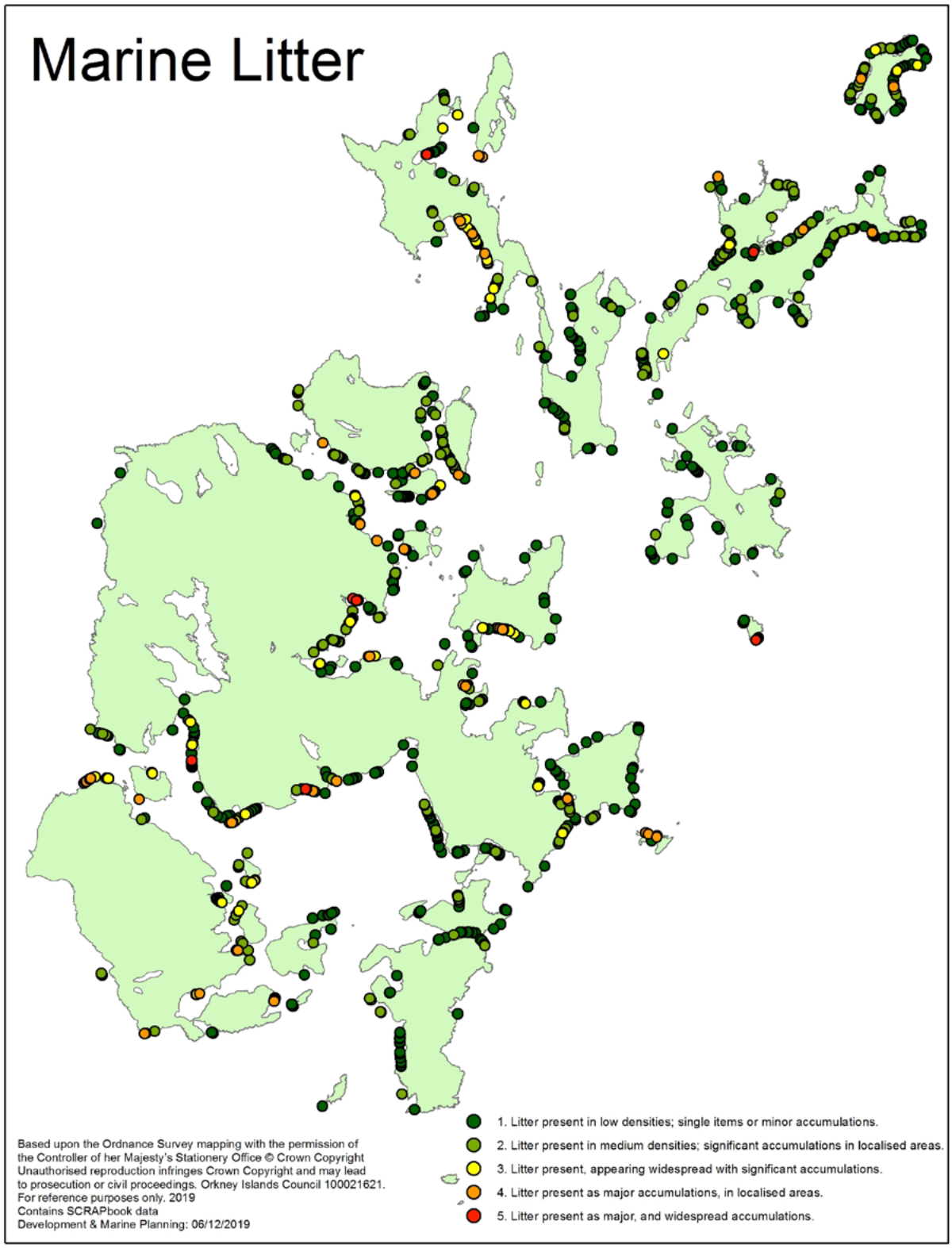


Figure 14 SCRAPBook Project Map: Orkney

'Bag the Bruck' is a community beach and coastal area clean-up initiative that has been running in Orkney since 1992; 'bruck' is a local word for rubbish. The success of this initiative is down to the many Orkney-wide community groups and individuals that volunteer their time and effort, whatever the weather, to clearing up local areas from hillsides to beaches and other coastal sites. Figure 15 shows the active Bag the Bruck clean-up sites for 2018 and 2019.

Figure 15 Map of Active 'Bag the Bruck' Sites in Orkney 2018 and 2019

Throughout the year, members of the public are encouraged to 'pick up three pieces' of litter on their visits to the beach and coast. The 'Pick up three pieces' initiative has a number of waste bin sites around Orkney, managed by Orkney Islands Council, where the public can discard these items. This innovative project was started in 2012 and continues to be promoted by Orkney school children. This simple and effective idea has subsequently been adopted by KIMO Scotland as part of their coastal element to their Fishing for Litter project.

Ghost gear, i.e. abandoned, lost, or discarded fishing equipment, can be a hazard to human life, marine life and the environment. It can remain in the marine environment for up to an estimated 600 years, snagging on the seabed, wrecks and marine life. Ghost Fishing UK coordinated the Big Scapa Clean-up with a group of divers and scientists in order to conduct a clean-up of abandoned, lost, or otherwise discarded fishing gear (ALDFG) in Scapa Flow. Numbers of ALDFG have decreased from 51 in 2015 to 16 in 2018. At present, the German wrecks of Scapa Flow are clear of actively fishing lost gear[46]. The extent of the ghost fishing gear throughout Orkney is not fully known, and whilst a clean-up of Scapa Flow is 2018 is a positive step, the amount of ghost gear is likely to be slowly increasing in other areas of Orkney waters.

A recent study assessed the amounts and sources of marine debris, which was quantified for 35 Orkney beaches[a]. Plastic string and cords were most abundant macro debris; half of these items were attributed to fishing, a fifth to terrestrial agriculture and construction, with less than 10% to leisure and tourism. Distribution was related to public accessibility, directional aspect of the beach and proximity to ports. Of the microplastics quantified, it consisted mainly of plastic fibers.

Data indicates that microplastics accumulate in Orkney's seagrass beds at much higher rates than in surrounding areas. Marine scientists from Heriot-Watt University surveyed 100m transect of seagrass bed in Orkney. There were microplastics found on all seagrass blades and in over 94% of all samples collected[b].

A snapshot of the type of microplastics found was conducted at 13 intertidal sites around Scapa Flow; it found particles and fibers in every replicate[47]. Thus, despite its relative remoteness and comparatively small human population, the study found that the intertidal sediment loads of microplastic were comparable to locations on the UK mainland with much higher anthropogenic activity[48]. Further seabed and water column analysis is required, along with more data on microplastics.

The Beach Litter Performance Indicators report produced by Marine Scotland included a case study based in Orkney. This project used the data produced by the Marine Conservation Society's beach cleans on four sites around Orkney. It noted that Orkney had the lowest average beach litter loadings in Scotland, with an improving trend. It is unclear how representative the samples were given the bulk of beach cleans tend to be undertaken by other local initiatives.[49]

OSPAR monitors and assesses plastics in the stomachs of northern fulmars as one of its indicators of environmental quality for the North Sea, including the marine waters around Orkney and Shetland. The quantity of plastics ingested by marine wildlife mainly reflects the abundance of floating litter in their environment. Fulmars are abundant and widespread seabirds known to regularly ingest litter. This monitoring programme found that currently 58% of beached North Sea fulmars have more than 0.1 g of plastic in their stomachs, exceeding OSPAR's long-term goal of 10%[50]. There has been no significant change in the amount of plastic in fulmar stomachs over the past ten years.

2.11.3 Pressures and trends

Environmental pressures and concerns associated with marine litter relate to the longevity of litter, particularly plastics, in the marine environment and effects on marine ecosystems. Despite the high-profile publicity given to the problems associated with marine and single use plastics, evidence suggests that global levels of plastics entering the marine environment are predicted to increase. At the local level, despite significant efforts to collect and remove coastal and marine litter, there are still significant quantities of litter present in the local coastal and marine environment.

Entanglement associated with marine litter can cause injury and death to marine species including cetaceans and birds. Entanglement is known to be a pressure in Orkney though the extent and magnitude of the impacts associated with this pressure are not currently well understood.

Ingestion of plastic litter is recognised as a potential threat contributing to the status of fulmar populations. It is probable that sub-lethal effects of ingested plastics can reduce body condition and health for birds and other marine species. The effects of ingesting marine litter on bird populations and other marine species in Orkney is not currently well understood.

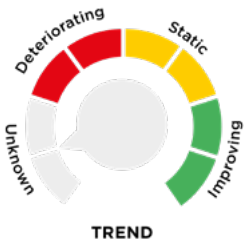
Marine litter can impact water quality and the amenity of coastal areas. It is recognised that economic activities including aquaculture, fishing and coastal and marine tourism rely on a clean marine environment for product quality and associated socio-economic benefits. There is potential for impact from marine litter on the human food chain and human health. More data are required on the source of plastics, biological responses to plastic and impacts on food webs and the human food chain.

2.11.4 Assessment Summary

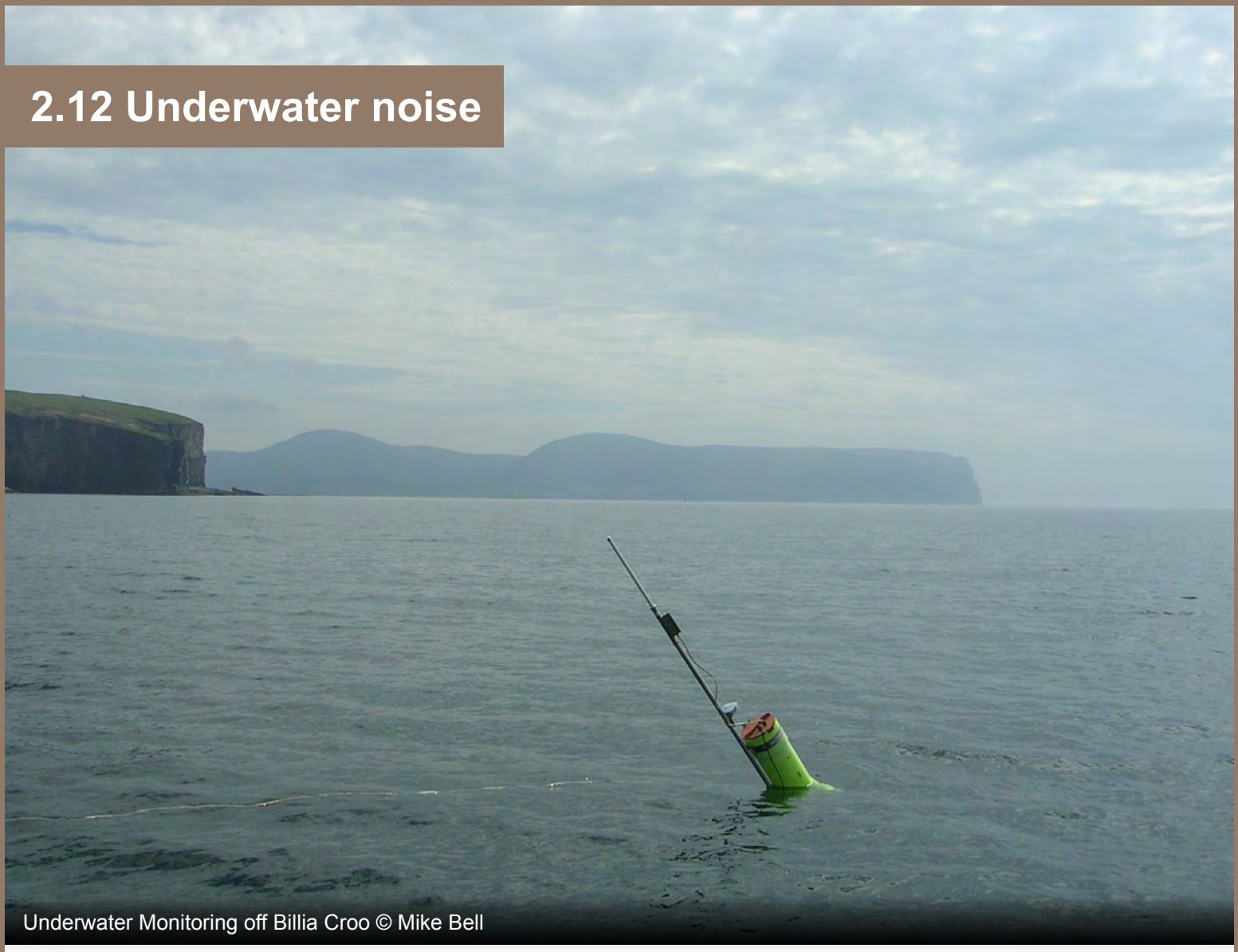
The JNCC assessment tool identified that the risk of litter from the productive sectors in this report was ranked as low. However, locally, marine litter is known to cause a number of concerns. Entanglement in lost or discarded fishing gear causes injury and death to birds and cetaceans within Orkney Waters, as discussed in Sections 5.4 and 5.6. Birds in particular are likely to contain ingested plastics as discussed in Section 5.4, though other species are also affected due in part to ingested microplastics, as outlined in the information. As there are some local data available, data confidence is medium.

The importance of water quality and cleanliness of Orkney's beaches are key economic priorities for sectors such as aquaculture and tourism therefore unsightly litter can cause socio-economic pressures, as well as environmental pressures.

Table 9 Marine Litter and Waste Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Marine litter and waste	Entanglement; Ingestion; Amenity. Entanglement; Ingestion; Amenity.			

2.12 Underwater noise



Underwater Monitoring off Billia Croo © Mike Bell

Summary

- Noise in the marine environment emanates from natural physical, biological and anthropogenic i.e. human, sources and can significantly impact marine wildlife, particularly marine mammals and fish, causing injury and disturbance.
- There is a lack of data on the sources and levels of underwater noise in the Orkney marine region.
- Aquaculture, Ports and harbours, shipping and renewable energy development can cause significant impacts due to underwater noise.

2.12.1 Introduction

Noise in the marine environment emanates from natural physical, biological and anthropogenic i.e. human, sources. Both impulsive noise and ambient noise are considered under Descriptor 11 of the Marine Strategy Framework Directive (MSFD). Anthropogenic noise can significantly impact marine wildlife, particularly marine mammals and fish. Seismic surveys, sonar, oil drilling, piling and dredging can cause physical damage to marine species whilst persistent background noise can alter feeding and communication ability in some species. Given the nature of sound underwater, noise can be audible for hundreds of kilometres from source in the marine environment.

Boats in Stromness Harbour

2.12.2 Current Status

There is a lack of local data on the sources and levels of underwater noise in the region and uncertainty regarding the impact of noise on marine species in Orkney. No comprehensive monitoring of underwater noise has been undertaken in Orkney. It is therefore not known whether underwater noise is currently at levels that can significantly impact marine life. The Department for Environment, Food and Rural Affairs (Defra) and the Joint Nature Conservation Committee (JNCC) have developed the Marine Noise Registry (MNR) to record human activities in UK seas that produce loud, low to medium frequency (10Hz – 10kHz) impulsive noise[51].

The key areas of vessel movements are well known in Orkney e.g. ferry, shipping and regular vessel transit routes. There are regular sightings of cetaceans and seals in close proximity to these routes with potential for associated noise related effects, though these effects are not well understood. Given that these species are regularly recorded in close proximity to shipping routes, this provides an indication that the magnitude of disturbance is relatively low. The International Maritime Organisation (IMO) issued guidelines for reducing noise from vessels in 2014[52].

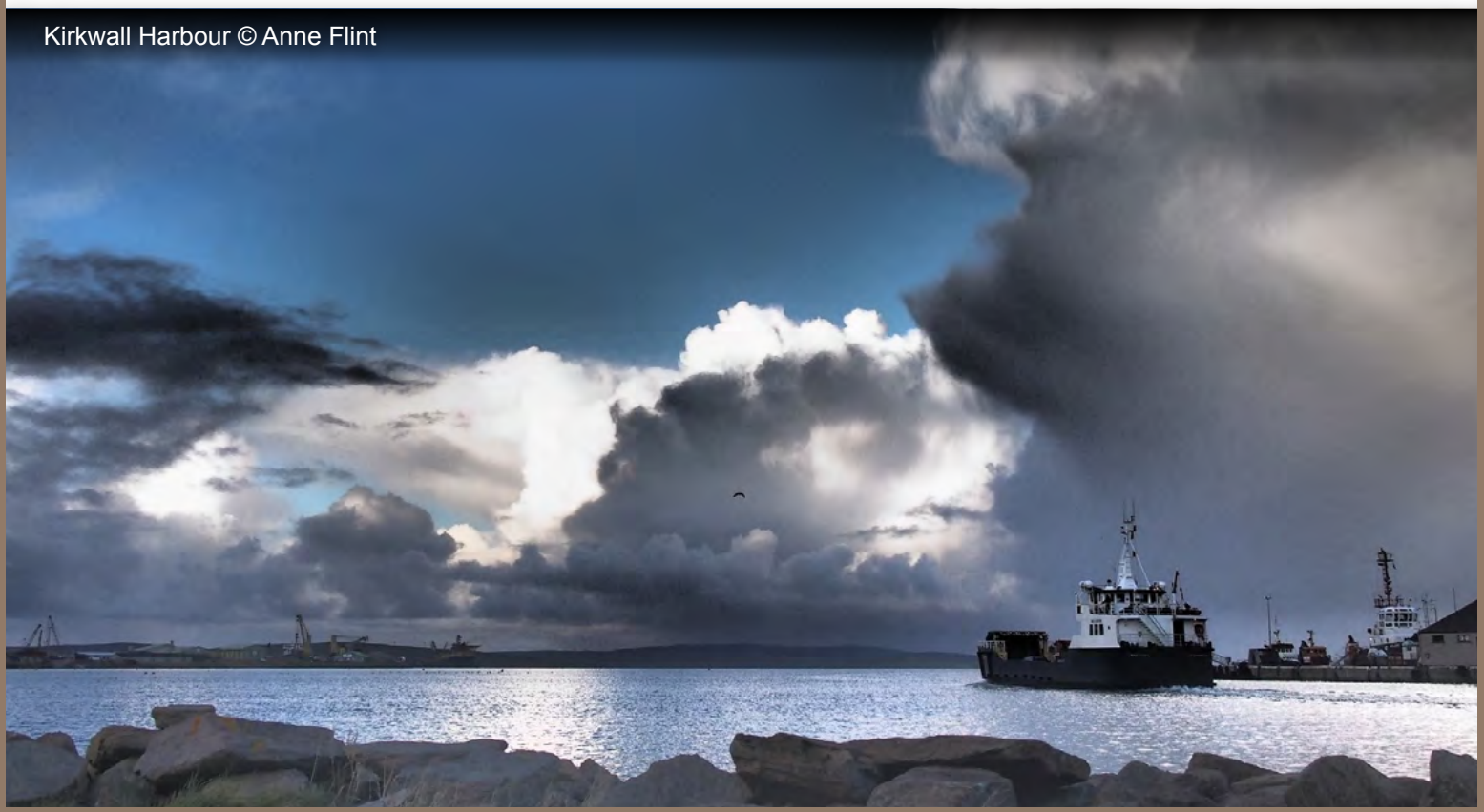
2.12.3 Pressures and Trends

Seismic surveys, military sonar, oil drilling, piling, dredging and ship engines can, depending on the circumstances, cause physical and/or auditory damage and disturbance. The JNCC PAD tool identifies that noise generated by most of the productive sectors in this report (see Section 6) can cause disturbance or injury to a variety of protected species and wider biodiversity[c]. Aquaculture (ADDs), Ports and harbours, shipping and renewable energy and have been identified as having potential impact pathways in Orkney.

Development and increases in the intensity of shipping in Orkney has the potential to increase levels of underwater noise with potential for adverse effects on Orkney's marine environment. At present there is insufficient information available on noise levels to undertake an assessment of underwater noise and its impacts in Orkney.

Port and harbour developments, including those proposed in the Orkney Harbours Masterplan Phase 1[53], can result in significant noise impacts on marine mammals and other species. Increased vessel movements, the use of dynamic positioning equipment, drilling, piling, dredging and blasting associated with harbour development can result in underwater noise changes, injury and behaviour change including displacement. Construction noise associated with harbour development is considered temporary and is often managed by avoiding noise emitting activities whilst marine mammals are in the vicinity.

Renewable development can cause underwater noise pressures and impacts. These include drilling and piling to attach foundations to the seabed and mechanical noise emitting from energy devices. The identified potential for significant growth of renewable energy development, particularly the offshore wind, wave and tidal sectors, is likely to result in an increase in noise related pressures.



Kirkwall Harbour © Anne Flint

The use of Acoustic Deterrent Devices (ADDs) to deter predation by seals at finfish farms can have an impact on cetaceans and other marine mammals. ADDs are potentially an important component of the underwater acoustic environment in Orkney as they are a source of intense regular underwater noise. Particularly within or near to the following sensitive areas, the deployment of ADDs has potential to adversely affect marine mammals:

- Special Areas of Conservation, where seal is one of the qualifying interests;
- Designated seal haul-out sites and pupping areas;
- Straits, sounds and embayments, where cetaceans (which are European Protected Species) are frequently observed and where the presence of ADDs may cause a barrier to passage;
- Headlands and tidal upwelling areas that may be important feeding areas for cetaceans.

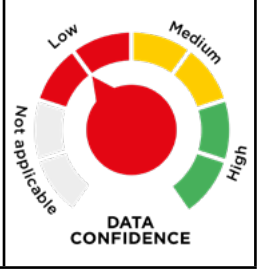
If the use of ADDs on finfish farms in Orkney were to increase, this could pose an additional pressure in the future. Guidance on ADD use is being developed by Scottish Government and improvement in fish farm net technology is reducing the need to use ADDs[54].

In 2011 a mass stranding of long-finned pilot whales at the Kyle of Durness coincided with the detonation of three 1,000lb bombs in the area for military practice activities to the west of Orkney. This example demonstrates that activities outwith the 12nm marine planning boundary can have an impact on mobile species that may use the Orkney marine region.

2.12.4 Assessment Summary

This assessment indicates that there is likely to be an increase in port and harbour, shipping, aquaculture and renewable energy development in Orkney waters. These developments and activities are likely to increase the pressures associated with underwater noise. Key species likely to be most affected are seals and cetaceans. Potential impacts on other species, including fish, are not well understood for the Orkney marine region.

Table 10 Underwater Noise Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Underwater noise	Disturbance Injury			

2.13 Summary of Physical Assessment

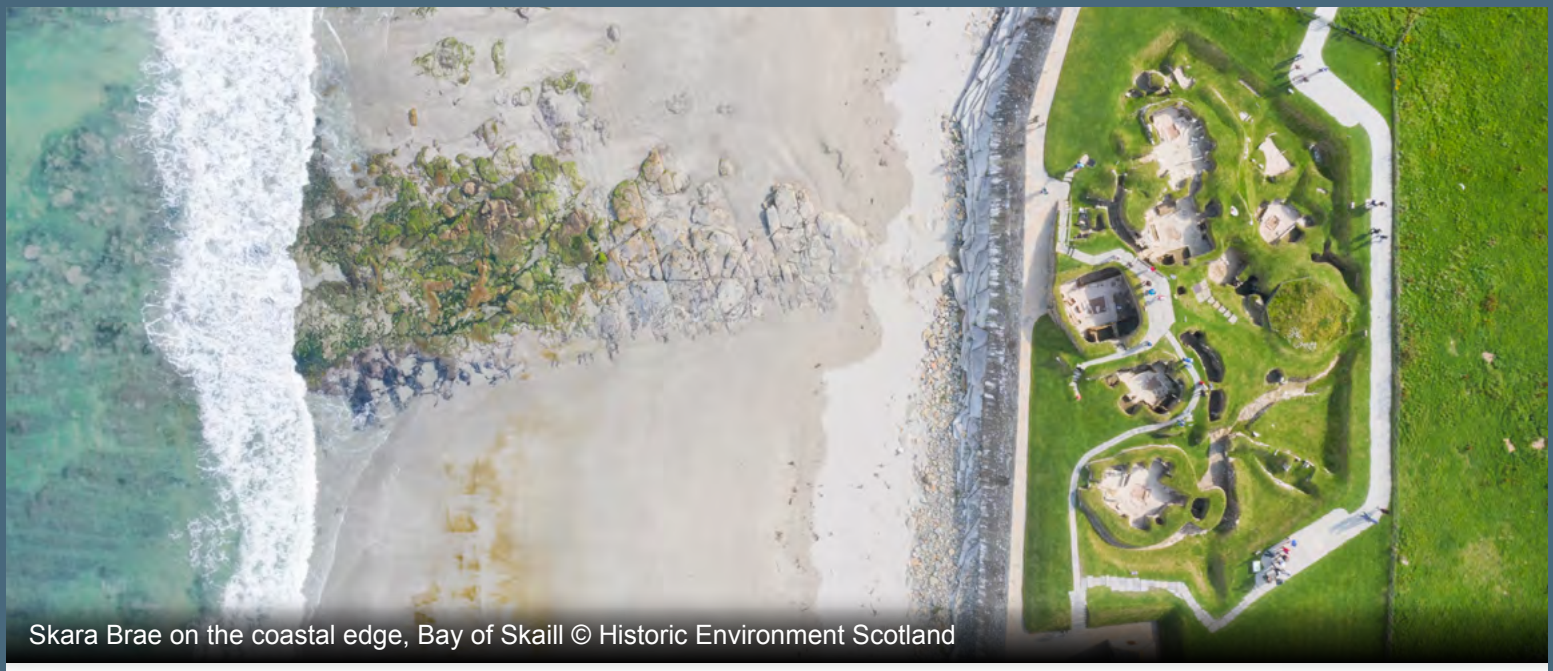
For the physical aspects of Orkney's marine environment, many of the pressures relate to issues that are best understood at a wider geographical scale than Orkney's waters (see Table 11 below). Climate change (see Section 4), marine litter (see Section 2.11) and underwater noise (see Section 2.12), for example, are global, regional, and local issues. Regardless of the scale of the pressures, there are actions that can be taken at an Orkney level to help improve their management and contribute to global action.

Table 11 Physical Section: Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Geology and seabed	Erosion; Disturbance	Some concerns	Deteriorating	High
Landscape and Seascape	Erosion of landscape and/or seascape qualities; Coastal erosion; Sea-level rise; Flooding.	Some concerns	Deteriorating	Medium
Coastal Water Quality	Pollution	Some concerns	Static	High
Air Quality	Pollution	Few concerns	Unknown	Low
Marine Litter and Waste	Entanglement; Ingestion; Amenity	Some concerns	Unknown	Medium
Underwater noise	Disturbance; Injury	Some concerns	Deteriorating	Low

Section 3: Historic Coastal and Marine

PHOTO CREDIT: KNAP OF HOWAR, PAPA WESTRAY © SHONA TURNBULL



Skara Brae on the coastal edge, Bay of Skaill © Historic Environment Scotland

Summary

- Orkney has internationally significant coastal and marine historic environment assets.
- Since the Neolithic period some 5,000 to 6,000 years ago, when the land was first farmed, sea-levels have risen approximately 5 metres.
- Sea-level change, precipitation change and storm intensity and frequency are the three key climate drivers impacting Orkney's coastal archaeology.
- Climate-change causing rising sea-levels is the single greatest threat to Orkney's coastal historic environment assets.
- Orkney contains 3,000 documented archaeological sites of which 800 are coastal and threatened or presently eroding[55].
- Coastal and marine historic environment assets can be significantly impacted by renewable energy, aquaculture and harbour developments.
- Uncontrolled recovery of artefacts and associated damage to historic assets has a significant detrimental effect on historic significance.

3.1 Introduction

Orkney is internationally renowned for the preservation and richness of 6,000 years of its archaeology upon which its successful tourism economy is based. This includes a Neolithic World Heritage site; spectacular Iron Age tower houses of the broch villages; rich Viking heritage of international significance and the unique 1st World War submerged archaeology of the German High Seas Fleet, that is at the heart of Stromness' diving industry. Orkney also has a rich maritime industrial past from the kelp industry to the herring boom and the Hudson's Bay Trading Company. Through history, the islands have played a significant role in trade, industry, politics and war.

The archaeology of Orkney's maritime cultural landscape is represented by not only the eroding remains of ancient harbours, nousts, piers, landing places, but also by most of the settlements, churches, and remains of industrial booms and bust. Changing land and

seascape is reflected in e.g. 5,000 year old oyster shells in middens demonstrating a long-lost lagoon, and inundated peat on beaches, that captures significant coastal change, and where preserved pollen offers the opportunity to understand the wider environment over thousands of years[56]. Many of Orkneys famous visitor sites are temporarily protected by sea-walls, including Skara Brae.

In more recent times, Orkney played a pivotal role in both World Wars and poignant reminders of these turbulent periods is etched on our landscape and seascape in the shape of the Churchill Barriers, wrecks and coastal defences.

3.2 Current status

Submerged landscapes of the past

Sea-levels in Orkney have been rising in relationship to the land since the end of the last glaciation. Caves in the west coast cliffs indicate that an approximate 40m rise has occurred during this period. Since the Neolithic period some 5,000 to 6,000 years ago, when the land was first farmed, sea-levels have risen approximately 5 metres. The Rising Tide Project has undertaken investigations into the submerged archaeology of Orkney and has mapped sea-level change[57]. In Orkney's predominately low rolling landscape this means extensive inundation, and the creation of islands by separation. Sea-level rise was not consistent, and it was faster in the earlier period. Work by the Orkney County Archaeologist on eroding chapel sites indicates that since the Middle Ages, sea-level has risen by 20 to 30 cms.

Skara Brae, and the earlier Neolithic house more recently excavated at Cata Sand, Sanday, were originally set back from the shore behind an area of low-lying land. Contemporary peat deposits in the Bay of Skaill enabled the understanding of the landscape at the time of Skara Brae, and new deposits have been discovered in the beach containing the remains of deer of the period. However, the very different results of sea-level rise, whether it be break through into marshy bays, as at Skaill, or a more gentle set of inundations and erosion, e.g. at the Bay of Firth, the differing levels of subsequent wave damage will lead to very different levels of preservation.

On average Orkney contains three archaeological sites per square mile[58] . The understanding and management of this historic environment relies on the accurate recording of heritage assets in publicly accessible databases. Historic Environment Scotland maintains a national database known as 'Canmore', which holds records on archaeological sites, buildings, industry and maritime heritage across Scotland. It contains approximately 5,565 records of archaeological sites in Orkney, 1,657 of which are classified as maritime[59].

A significant number of Orkney's historic environment assets are protected under various legal and policy instruments due to their international, national and local significance. For the purposes of this assessment, the key protected coastal and marine historic assets have been identified (Figure 16). PastMap is a web based Geographical information System (GIS) maintained by Historic Environment Scotland containing data on the sites identified in Figure 16[60].

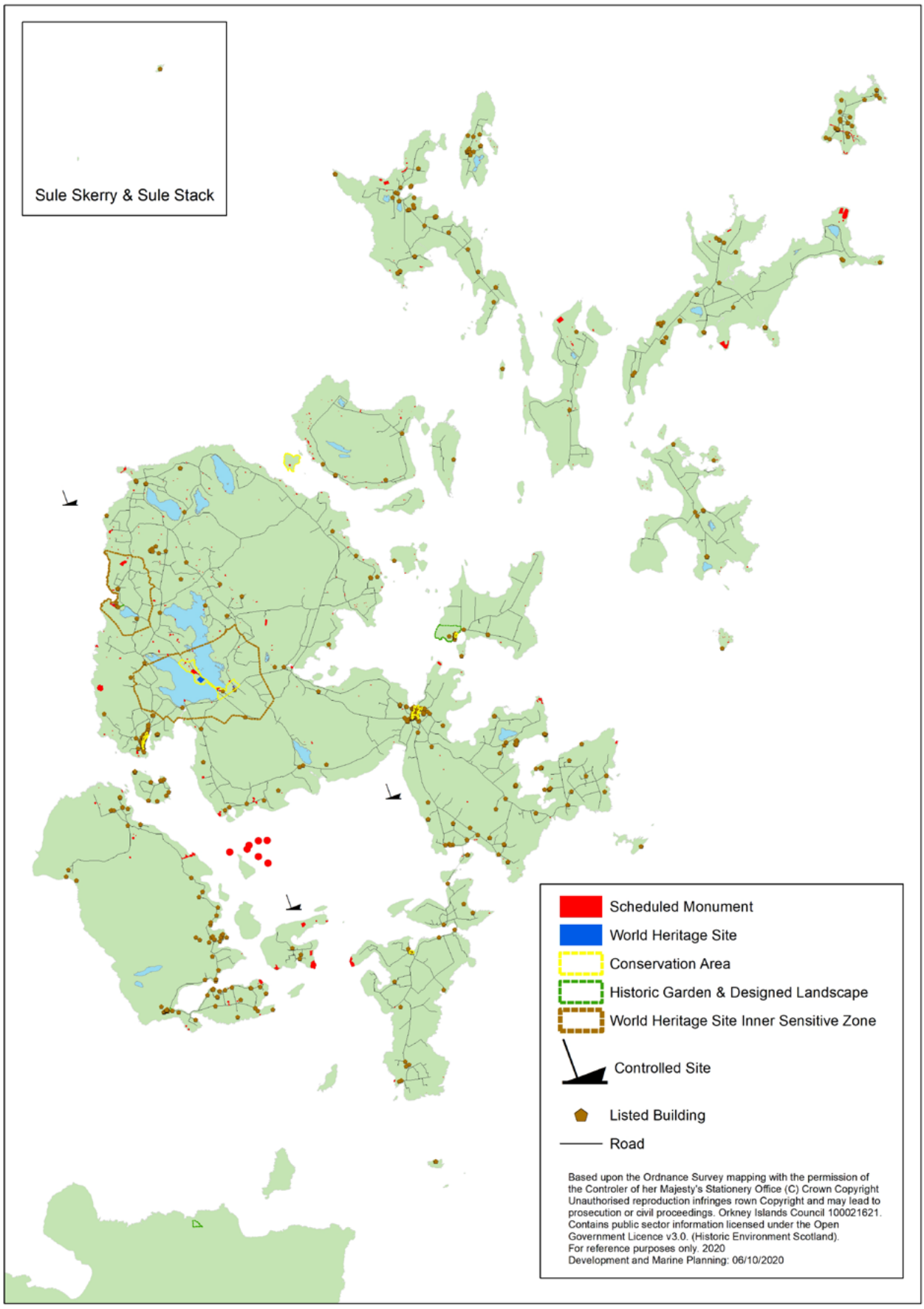


Figure 16: Protected Coastal and Marine Historic Environment Assets

The Heart of Neolithic Orkney World Heritage Site

The Heart of Neolithic Orkney World Heritage Site comprises six individual component sites, each of which are Scheduled Monuments: the settlement of Skara Brae, Maeshowe, the Stones of Stenness, the Watch Stone, the Barnhouse Stone and the Ring of Brodgar and its associated ritual and funerary monuments.

The World Heritage Site was formally inscribed onto the World Heritage List on 2 December 1999 as a group of sites deemed to be an outstanding testimony to the cultural achievements of the Neolithic peoples of Northern Europe, fulfilling four of the six criteria of Outstanding Universal Value for cultural sites. These sites are major tourist destinations, as discussed in Section 6.9.

Scheduled monuments

Orkney's coasts and waters are littered with scheduled monuments which are archaeological sites, buildings or structures of national historic importance. These monuments include the wrecks of the German High Sea Fleet in Scapa Flow, numerous broches, burnt mounds, WW1 and WW2 coastal defences, castles and Neolithic, Iron Age to medieval settlements.

Skara Brae on the coastal edge, Bay of Skaill © Historic Environment Scotland

St Margaret's Hope Conservation Area © Anne Flint

Listed buildings

There are many coastal and marine related listed buildings including lighthouses, harbour infrastructure such as the Lyness Golden Wharf and Kirkwall Harbour, North Ronaldsay Sheep Dyke and clusters of numerous listed buildings within coastal settlements. Listed buildings are buildings of special architectural or historic interest and are listed by Historic Environment Scotland. The term building has a broad definition and includes structures such as piers, walls and bridges.

Conservation Areas

The coastal settlements of Kirkwall, Stromness, St Margaret's Hope and Balfour Village are designated Conservation Areas. Conservation Areas are areas of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance. Eynhallow and Brodgar are also Conservation Areas.

Gardens and Designed Landscapes

Balfour Castle, Skaill House and Melsetter House are designated Gardens and Designed Landscapes, which are located in areas of coastal landscape character.

Controlled Sites

HMS Hampshire, HMS Royal Oak and HMS Vanguard are designated controlled sites under the Protection of Military Remains Act 1986 i.e. they are war graves. Permission is required from the Ministry of Defence (MOD) to access these sites. The MOD has indicated that they are considering extension of designation boundaries for the HMS Royal Oak and HMS Vanguard to reflect discoveries through recent surveys.

Scapa Flow Proposed Historic Marine Protected Area

In 2019, Historic Environment Scotland undertook consultation on a proposal to designate a Scapa Flow Historic Marine Protected Area (HMPA) in order to protect marine historic assets of national importance. The area comprises places within the sheltered natural harbour of Scapa Flow, where marine historic assets are located that originate from Scapa Flow's role as a Royal Navy base during the First (1914-18) and Second (1939 -1945) World Wars, as the anchorage where the German Imperial Navy's High Seas Fleet was interned in 1918, scuttled on 21 June 1919, and where a major programme of marine salvage took place during the years 1919 -1939, and 1956 to the 1970s.

The wrecked vessels lying on the seabed within the proposed HMPA are the auxiliary vessels SS Prudentia and HMD Chance close to the north coast of the island of Flotta, the HMS Strathgarry in Hoxa Sound, the German submarine UB-116 close to the east coast of Flotta, merchant vessels purposefully sunk as blockships in Burra Sound, Kirk Sound, Skerry Sound, East Weddel Sound and Water Sound to prevent enemy access through these channels, and wrecked vessels of the German High Seas Fleet, scuttled close to the islands of Cava and Rysa Little. The remains of the German High Seas Fleet comprise the wrecks of three battleships, four light-cruisers, and three torpedo boats, as well as widespread debris remains of other vessels and objects left on the seabed in the course of the salvage activities. The total area of seabed proposed for designation is just over 11 km^2 (see Figure 17). Studies in recent years have also indicated the presence of Priority Marine Features in close association with some of the historic wreck sites[d].

Multibeam sonar image of SMS Brummer © Historic Environment Scotland

Traditional Boat Building

Traditional boating, including boat building and maintenance, is important to Orkney's maritime heritage. The Orkney Historical Boat Society was formed in 2013 to support efforts to salvage both old craft and pass on the skills required to repair or rebuild them. The Orkney Yole Association Supports community involvement in preserving and handing on these skills.

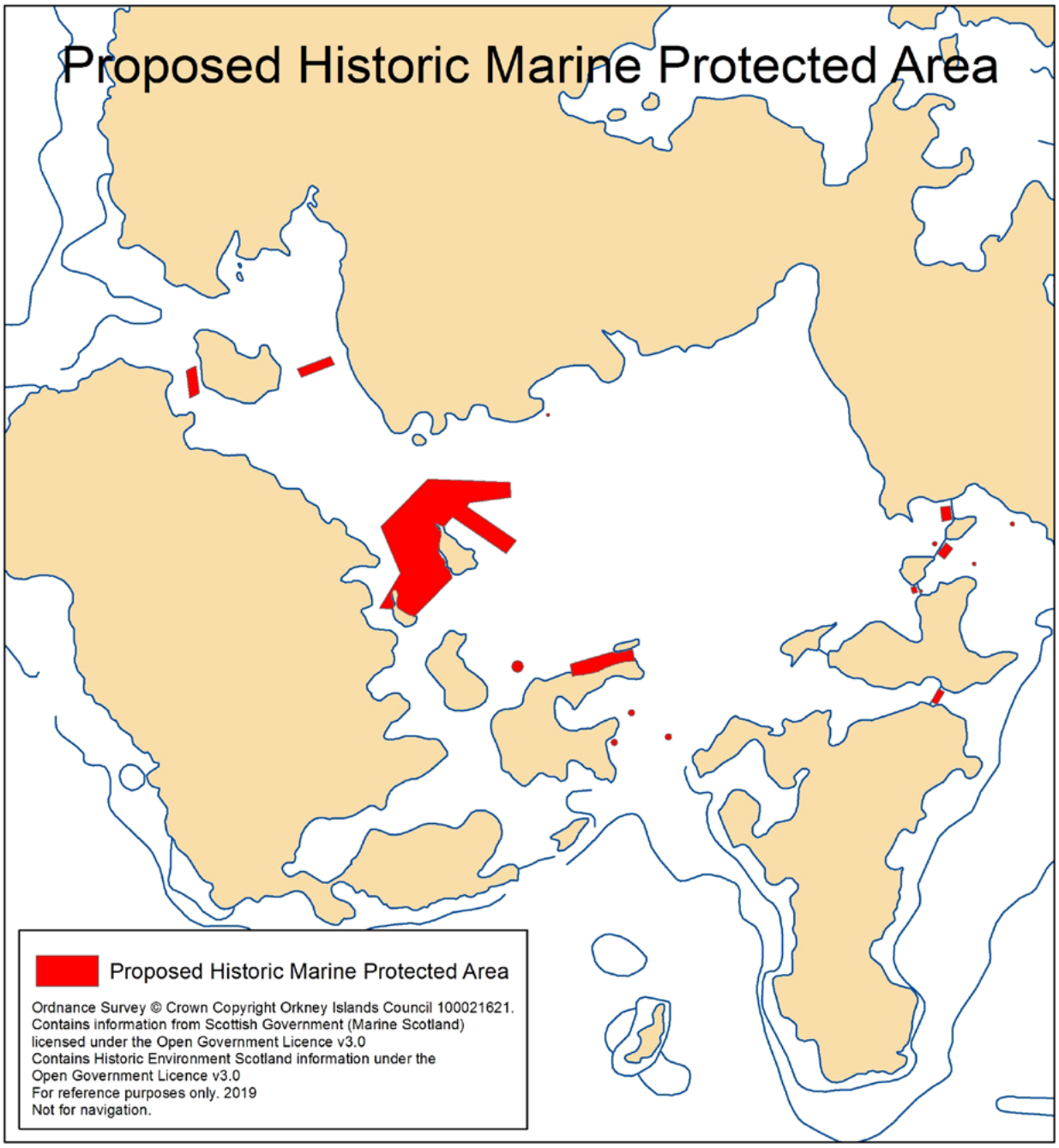


Figure 17 Proposed Historic Marine Protected Area

Danes Pier, Stronsay: remains of a medieval harbour adapting a natural reef © Frank Bradford

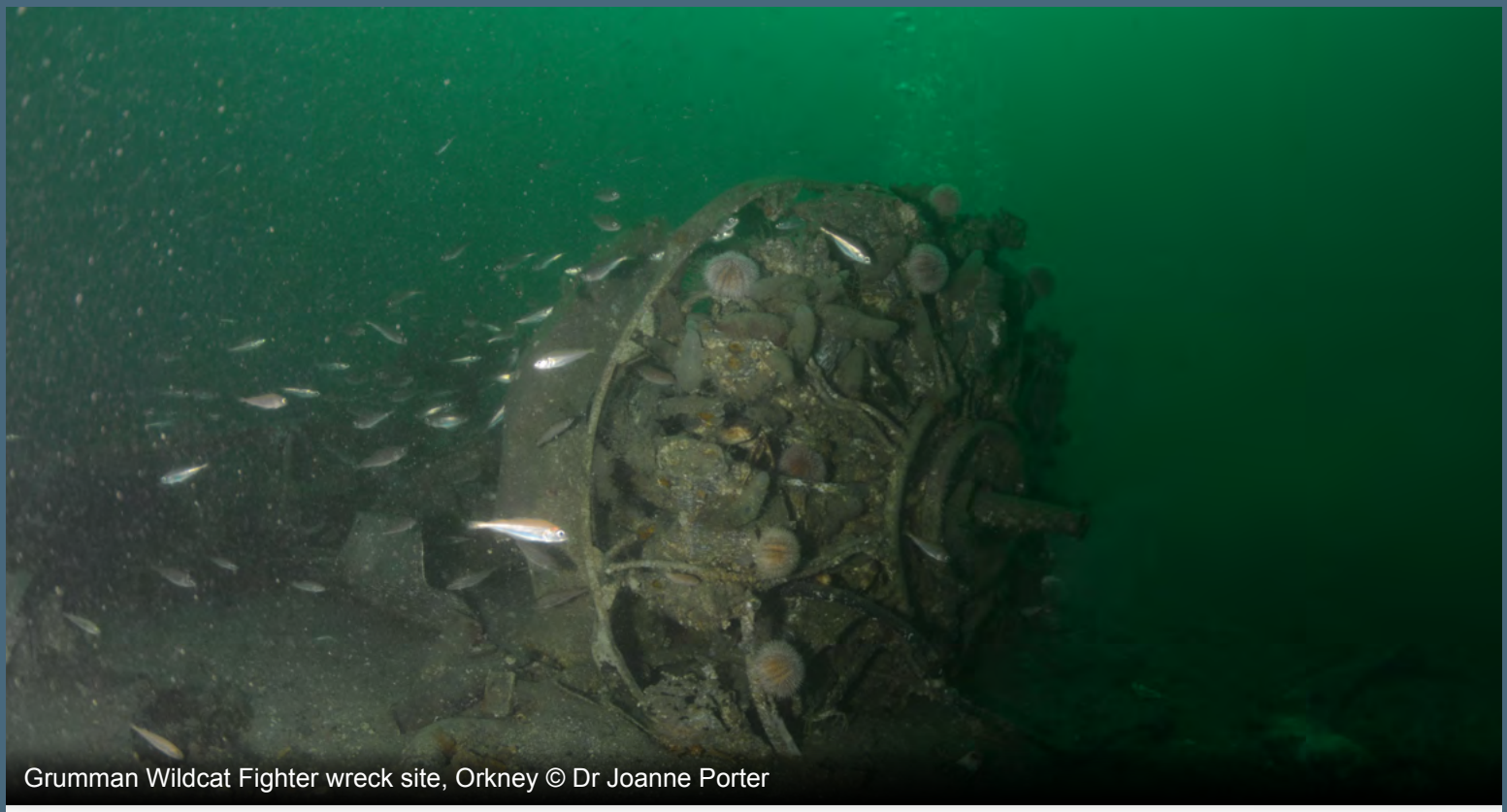
3.3 Pressures and Trends

Sea-level rise, along with the potential for changing weather patterns and coastal processes due to climate change, pose a significant risk to coastal and marine historic assets in Orkney. Storms, and the combined erosive effects of wave and tidal action, particularly in recent years, have caused substantial damage to historic coastal sites and monuments.

Orkney contains 3,000 documented archaeological sites of which 800 are coastal and threatened or presently eroding[61]. In a recent interdisciplinary analysis,[62] sea-level change, precipitation change and storm intensity and frequency were identified as three key climate drivers that would impact on archaeology in Orkney. Climate-change causing rising sea-levels is thus the single greatest threat to Orkney's coastal built heritage. Changes to storminess are more difficult to project[63] and experts differ on the subject, but rising sea-levels will exacerbate any changes to prevailing conditions.

Erosion due to changes in precipitation (i.e. increases in numbers of damaging downpours, with increases in winter rainfall of around 69%[64]) is damaging both to buried archaeology (changing sub-surface conditions, washing out soils) and to exposed built heritage where upstanding drystone and clay-bonded walls are affected by rain washing through. This effect is made worse by exposure in coastal locations, where increased precipitation can undermine structures and deposits, e.g. at the medieval cemetery at Newark, where skeletons wash out, both through rainfall as well as by storm-related wave action. Sub-sea installations, associated with aquaculture, harbour and renewable energy development have potential to damage the underwater historic environment resource, although multi-agency collaboration has been an aid to planning for conservation, e.g. Pollard *et al*[65].

The Climate Risk Assessment for Heart of Neolithic Orkney World Heritage considers climate related pressures and risks applying the Climate Vulnerability Index[66]. This study highlights pressures on the World Heritage Site, particularly Skara Brae, due to climate change, which has potential to result in significant cultural, social and economic impacts.



Grumman Wildcat Fighter wreck site, Orkney © Dr Joanne Porter

In common with wrecks worldwide, the wrecks of the German High Seas Fleet and other marine wrecks and artefacts of historic significance in Orkney are deteriorating in condition as a result of natural processes. Corrosion, abrasion and structural deterioration are taking effect as the wrecks age. In addition to naturally occurring factors, marine archaeology can be impacted by development and other activities. These include commercial fishing activities using mobile gear which can impact on the seabed and snag on historic structures or debris fields. Anchoring or mooring of vessels onto or into wrecks can also cause physical damage. Developments such as aquaculture, renewables energy, new harbours and redevelopment of existing harbours and piers can all have impacts on the historic environment, both in terms of marine assets and associated coastal assets.

Safe, sustainable and responsible access to Orkney's underwater heritage is encouraged, as are positive efforts to record and monitor these sites. However, uncontrolled recovery of artefacts and associated damage to historic assets has a significant detrimental effect on historic significance. A recent instance of this has been the stripping of non-ferrous artefacts from the wreck of a German First World War pinnace (i.e. small support vessel), located within the High Seas Fleet anchorage area. Such activities remain unregulated for sites without statutory protection, with the sole requirement being to report recoveries to the UK Receiver of Wreck. Unfortunately, these recoveries seldom involve recording or reporting artefacts and therefore result in a loss of important information. Artefacts recovered in this way also generally do not undergo conservation, resulting in damage to the objects and potentially also to the sites from which they have been recovered.
Marine wrecks and artifacts, and other man-made subsea structures, can create artificial reefs creating new habitats by providing substrate on which marine life can attach and grow. For example, the historic wrecks in Scapa Flow have developed into rich artificial reefs supporting an abundance of marine life[67]; whilst not necessary a pressure, this has resulted in a change to the ecological communities of Scapa Flow.

3.4 Assessment Summary

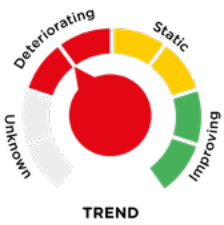
Rising sea-level due to climate change has been identified as the greatest threat to Orkney's coastal built heritage. Sea-level change, precipitation change and storm intensity and frequency vare the three key climate drivers that impact Orkney's coastal archaeology. These factors contribute to erosion pressures at coastal sites resulting in impacts including the undermining of structures and deposits, and damage to buried archaeology and upstanding built heritage.

Corrosion, abrasion and structural deterioration is taking place at wrecks sites, including the German High Seas Fleet, and other marine wrecks and artefacts of national significance. Sub-sea installations, associated with renewable energy, harbour and aquaculture development have potential to damage the underwater historic environment resource; these pressures are predicted to increase as these sectors increase their development activities in the Orkney marine region.

The uncontrolled recovery of artefacts has taken place at wreck sites in Orkney resulting in significant detrimental effects on historic significance.

The cumulative effects of these pressures indicate that there are currently many concerns and a predicted deteriorating trend for the protection and conservation of Orkney's coastal and marine historic environment assets.

Table 12 Coastal and Marine Historic Environment Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Coastal and Marine Historic Environment	Climate change Erosion Corrosion Removal of artefacts			

Balfour Battery, Hoxa Head © Julian Branscombe

Section 4: Climate Change

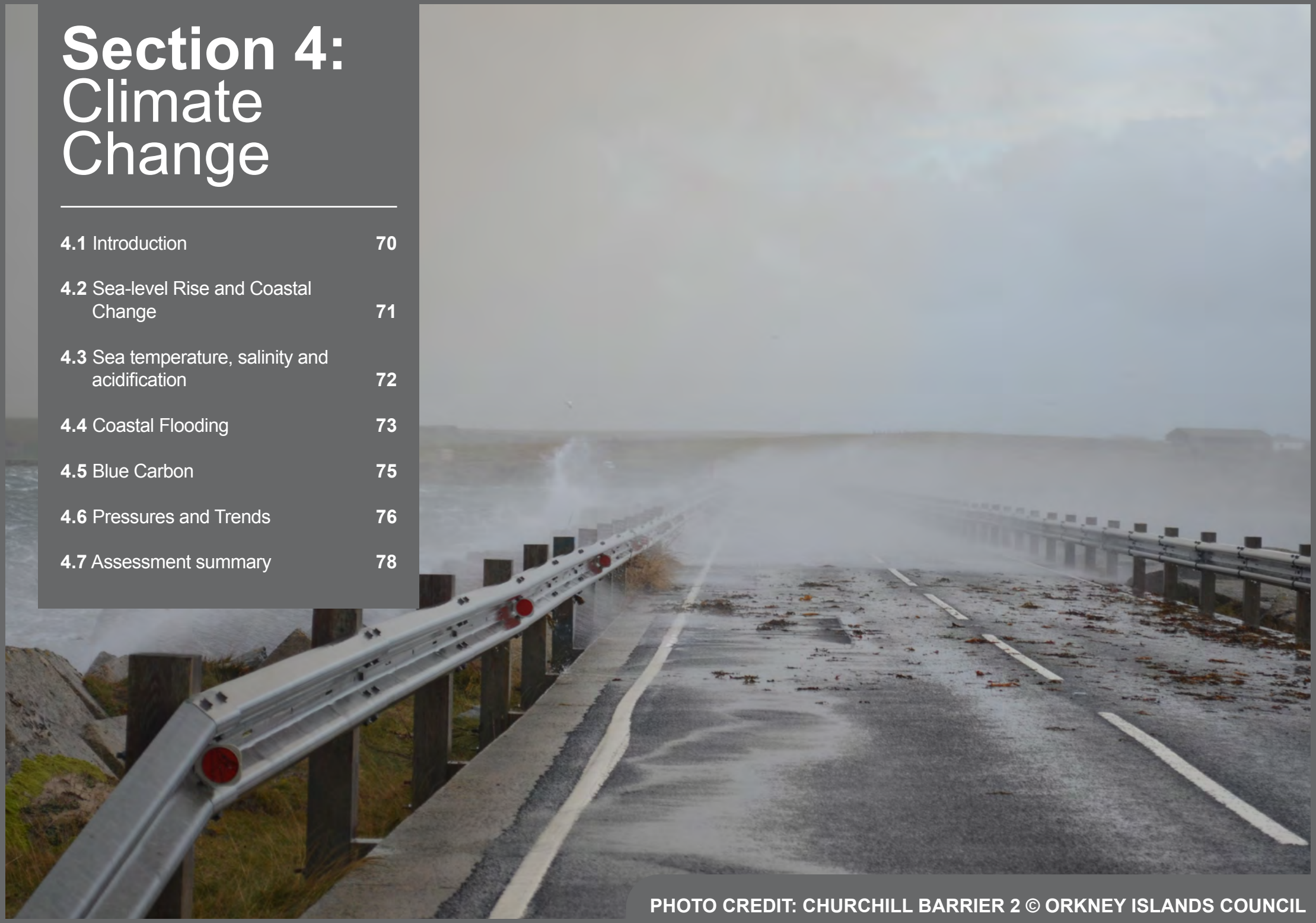
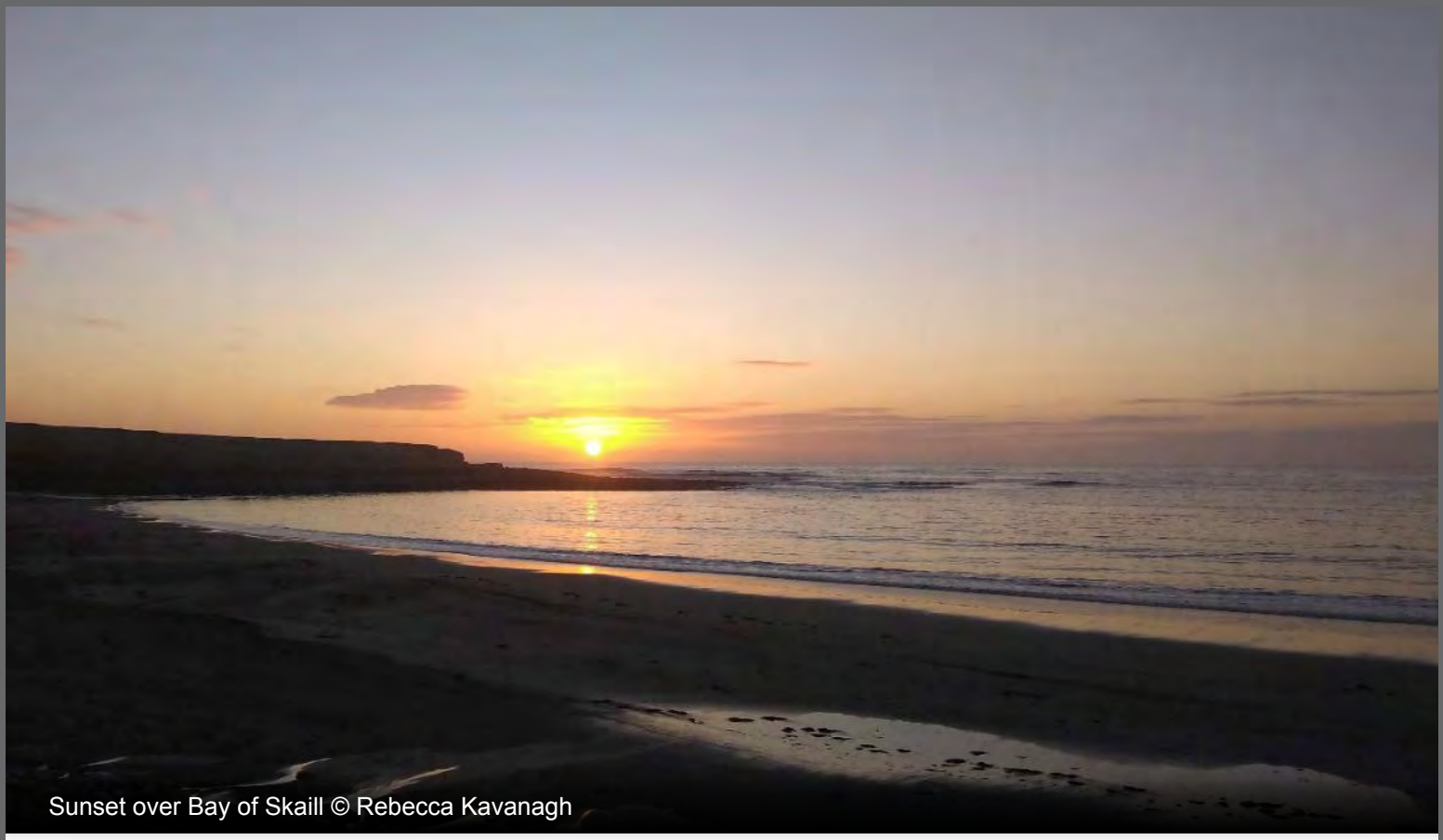


PHOTO CREDIT: CHURCHILL BARRIER 2 © ORKNEY ISLANDS COUNCIL



Sunset over Bay of Skaill © Rebecca Kavanagh

Summary

- Climate change is caused largely by human activities releasing greenhouse gases into the atmosphere, resulting in global temperature increases over the last century.
- There is clear evidence that warming seas, reduced oxygen, ocean acidification and sea-level rise are affecting seas and coasts in the UK.
- These changes are having an impact on food webs, with effects seen in ocean-dwelling species, as well as plankton, fish, birds and mammals.
- Climate change has the potential to significantly affect multiple components of Orkney's marine ecosystems resulting in significant environmental, social and economic impacts.
- UK Climate Projections predict a 50% likelihood of 67cm sea-level rise for Orkney by 2100 in a high-emissions scenario.
- Sea-level rise and changes to natural sediment supply is causing both erosion and accretion around coasts.
- The Orkney Flood Risk Management Plan identifies that the main source of flooding in Orkney is from the coast, which accounts for approximately 92% of the annual average damage.
- The Marine Climate Change Impacts Partnership (MCCIP) has reported that the last three decades have seen sea surface temperature (SST) warming trends of 0 .2 - 0.6 ºC per decade around the UK.
- The marine environment forms the world's largest natural carbon sink absorbing and storing atmospheric carbon through physical and biological mechanisms.
- The Blue carbon audit of Orkney estimated that the region contains 67 million tonnes (Mt) of blue carbon; 61.4 Mt in sedimentary stores and 5.9 Mt in living biological habitats.

4.1 Introduction

Climate change is one of the most significant global issues of this age. The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 providing a universal convention that acknowledged the existence of anthropogenic (human-induced) climate change and responsibilities for industrialised countries to tackle this global issue. The Intergovernmental Panel on Climate Change (IPCC) has concluded that without urgent action, climate change will bring severe, pervasive and irreversible impacts on all the world's people and ecosystems. The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 sets targets to reduce Scotland's emissions of all greenhouse gases to net-zero by 2045 at the latest.

In 2015, the Paris Agreement proposed to keep the increase in global average temperature to less than 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. It was the first international treaty to give legal effect to the 2 °C global temperature target. Limiting dangerous rises in global average temperature to below 2°C compared with pre-industrial levels (the below 2°C objective) will require substantial and sustained reductions in greenhouse gas emissions by all countries and action delivered at the local level.

Climate change is caused largely by human activities releasing greenhouse gases into the atmosphere, resulting in global temperature increases over the last century. There is clear evidence that warming seas, reduced oxygen, ocean acidification and sea-level rise are affecting seas and coasts in the UK. Increasingly, these changes are having an impact on food webs, with effects seen in seabed-dwelling species, as well as plankton, fish, birds and mammals[68]. These factors affect the marine environment by altering native plant and animal communities, causing increased risks from non-native species, increasing erosion and flooding and causing significant social and economic impacts. Whilst it is acknowledged that there is also an element of natural variability to these aspects, it is the accelerated speed of anthropogenic change that is of major concern. Climate change therefore has the potential to significantly affect multiple components with Orkney's marine ecosystem and all of the environmental, social and economic topics assessed within this assessment.

Innovation, research and development in renewable energy, zero-carbon fuels and local energy networks have established Orkney as a global centre of excellence. It is a key strategic priority for Orkney to make a significant contribution towards achieving the national target for net zero carbon by 2045. The marine environment, the public and economic sectors can contribute to achieving zero-carbon economy through:

- Renewable energy and zero-carbon fuel technologies;
- Management and protection of marine habitats that store and sequestrate carbon; and
- Safeguarding and enhancing the integrity of coastal and marine ecosystems, and geomorphological features, that mitigate and reduce adverse impacts from climate change.

4.2 Sea-level Rise and Coastal Change

Following the end of the last ice-age some 11,000 years ago, the archipelago was formed by inundation as sea-levels have risen, leading to the division of Orkney from a single island. Since the first farmers settled here, current estimates of sea-level rise model a 5m of sea-level rise between c.5,000 Before Present (BP) until c.2,000 years BP, when the curve levelled out[69]. However, a recent study has shown that sea-levels have risen by at least 20cm since the 14th century and map comparisons show the rate of coastal erosion doubling in the last 50 years[70], over the previous century.

Over the last thousand years or so, the average relative sea-level rise in Orkney has been around 0.2 mm per annum, due to the ongoing isostatic emergence of the Scottish land mass after the effects of glaciation due to the thawing of the Scottish Ice Sheet[71]. The net effect of local isostatic land uplift, when considered with global sea-level rise, provides relative sea-level rise for a locality. Orkney has virtually no uplift, and therefore has among the highest rates of relative sea-level rise in Scotland[72]. Sea-level rise predictions have increased over recent years as detailed in the UK Climate Projections, which predict a 50% likelihood of 67cm sea-level rise for Orkney by 2100 in a high-emissions scenario[73]. Even if global zero net emissions can be achieved, sea-level rise will continue[74].

The Dynamic Coast – Scotland's National Coastal Change Assessment project established historic coastal change by extracting the previous coastline position from OS maps (1892 -1905) and comparing both the 1970s and current coastal position in order to estimate past erosion and accretion rates[75]. By using the erosion rates combined with a number of socio-economic datasets, key assets at risk from future coastal erosion can be identified. This work was updated by a coastal change andvulnerability assessment in 2017[76]. This assessment noted since the 1970s, the extent of erosion has increased from 3% to 4%, whilst accretion has reduced from 9% to 4% and stability has increased from 89% to 93%. These Figures indicate the level of vulnerability Orkney faces due to rising sea-levels. Phase 1 of the Dynamic Coast project concluded in 2017 and is now in its second phase. In addition, Dynamic Coast has prepared a Coastal Change & Vulnerability Assessment for Orkney[77] which included projection of the known past erosion rates forward into the future to the year 2050. Within Orkney (Cell 10) a total land area of 12.2 hectares, which supports various assets, is anticipated to be lost by 2050.

Sign indicating coastal erosion Sanday © Rebecca Kavanagh

Thermocline mixing in shallow water, Copinsay © Shona Turnbull

4.3 Sea temperature, salinity and acidification

Any short-term trends in sea surface temperatures (SST), as a result of year to year fluctuations, must be understood in the context of the underlying long-term warming trend. Thus, overall, the Marine Climate Change Impacts Partnership (MCCIP) have reported that the last three decades have seen SST warming trends of 0.2 - 0.6ºC per decade around the UK[78]. These changes could affect the range of some species and their prey availability.

The projected change in near bed temperature for Orkney over the next 110 years, based on 1975 Figures, would be around 2°C increase in the area to the western most extent of the Orkney marine region. For the waters around much of Mainland Orkney, temperature increase is predicted at just under 2°C and 1.7°C to the eastern area of the islands. These temperature data from the UK Climate Projections, available from NMPi, only show projections based on a medium emission scenario, yet currently, emissions are at a high level, so the impacts are likely to be greater[79].

Salinity is most often calculated from measurements of temperature and conductivity. Those measurements are available from fixed and profiling instrumentation. A sampling site in Scapa Flow is used as part of the Long Term Coastal Monitoring project, run by Marine Scotland[80]. Changes due to climate change may impact a variety of ecological processes e.g. specialist species are at risk from increased salinity[81].

Changing acidity of sea water can have an effect on biogeochemical and ecosystem processes including planktonic calcification, carbon and nutrient assimilation, primary production and physiology.

Overall, the impacts on marine ecosystems, particularly changes in acidity and on ecosystem services provision are poorly understood for Orkney's waters. Sea-level rise and associated modelling of impacts on coastal resources, assets and infrastructure is required and the climate related impacts on species distribution including commercial fisheries require further research.

4.4 Coastal Flooding

Coastal flooding can arise from a combination of factors including high tides, wind and wave exposure and storm surge. Such events are predicted to be further exacerbated by increases in sea-level and storm conditions attributed to climate change. The upper range for the latest UK sea-level rise projections is higher than previous estimates, implying increased coastal-flood risk. The likelihood of compound effects from tidal flooding and extreme rainfall is increasing, which can greatly exacerbate flood impacts[82].

The Orkney Flood Risk Management Plan identifies that the main source of flooding in Orkney is from the coast, which accounts for approximately 92% of the annual average damage[83]. The Flood Risk Management Plan considers the County's priorities and actions to avoid and reduce the risk of flooding. There are eight Potentially Vulnerable Areas across Orkney as identified in Figure 18; the flood risk management plan provides detail on how flood risk is managed and minimized in these areas. The eight vulnerable areas shown include all localities at risk from flooding, some from river flooding rather than coastal flooding.

Where assets are at risk, there are two main types of coastal defence: 'Coast Protection' where engineering works are used to protect an eroding coastline from further erosion, and 'Sea Defence' where works are provided to prevent flooding of the coastal hinterland due to extreme wave and/or tidal conditions. Considerable investment has been made in new coastal flood defences in Kirkwall that has protected the heart of Kirkwall from coastal flooding.

Following guidance from SEPA and the OIC Flood Risk Management, as part of the Environmental Engineering team, coastal flood risk is assessed for individual projects, which identifies and prioritises coastal defence infrastructure works. Flood risk mapping is based on a variety of scenarios that take the potential effects of climate change into consideration. Areas most at risk, which are priorities for action, include St. Margaret's Hope (South Ronaldsay), Dingieshowe (south-east Mainland), Whitehall village on Stronsay and Stromness. Surveys carried out by SEPA show that the Annual Average Damages are estimated to be £220,000 for Stromness alone with the majority caused by coastal flooding. Over the longer term, impacts on the Churchill Barriers may also need to be considered, as they form a vital link for many local communities[84].

Coastal flooding, Front Road St Margarets Hope © Orkney Islands Council

Figure 18 Map of the eight Potential Vulnerable Areas in Orkney

Inshore kelp bed Orkney © NatureScot

4.5 Blue Carbon

The marine environment forms the world's largest natural carbon sink absorbing and storing atmospheric carbon through physical and biological mechanisms. Blue carbon refers to carbon captured by biological metabolic processes, i.e. in the soft tissues, shells, and skeletons of plants and animals, and buried in the marine environment in sediment[85]. Marine and coastal habitats provide a natural way to reduce greenhouse gases in the atmosphere through the sequestration and storage of atmospheric carbon. The protection and appropriate management of blue carbon resources within the marine environment thus provides an opportunity to mitigate the effects of climate change.

Blue carbon audit of Orkney waters

The Blue carbon audit of Orkney waters[86] provides an audit of the potential blue carbon resources present in the coastal waters around Orkney within the 12 nautical mile limit, including the Loch of Stenness brackish water lagoon. The territorial waters around Sule Stack and Sule Skerry where not assessed as part of this audit. The audit builds on previous work[87] in 2017 in which blue carbon stocks in Marine Protected Areas in Scottish waters were estimated from contributions of biological material to the fixation of carbon, also referred to as production, and contributions of sediments to blue carbon storage[88].

The main findings from the Blue carbon audit of Orkney waters are:

- The overall estimated blue carbon in Orkney regional waters is 67 million tonnes (Mt), and this is divided into 61.4 Mt in sedimentary stores and 5.9 Mt in living biological habitats.
- The largest blue carbon source in Orkney waters came from the inorganic carbon in sediments; 59.1 Mt carbon in inorganic carbon stores and 2.3 Mt carbon in organic stores.
- The coastal waters around Sanday and North Ronaldsay contained large accumulations of organic carbon due to the kelp forest habitats in the shallow coastal zone and carbon deposits in sediments.
- The maerl beds at Wyre and Rousay constitute a hotspot of both organic and inorganic carbon.
- In Scapa Flow, the area to the north-west of Cava Island and also through Gutter Sound, represent key areas for blue carbon due to accumulations of horse mussel beds and flameshell nests.
- Orkney waters account for 8.1% of Scottish inshore waters holding 67 Mt of blue carbon, defined by a 12 nm boundary not including the territorial waters around Sule Stack and Sule Skerry.
- Orkney's estimated 67 Mt of blue carbon lies within a sea area of 7,290 km; this equates to a density of 9,190 tonnes C per km^2 in Orkney waters. This Figure is likely to increase when further data on the thickness of deposits underlying the biological habitats becomes available.

4.6 Pressures and trends

The combination of sea-level rise, changes in coastal processes and flooding, salinity, acidity, temperature and weather patterns, driven by climate change, have the potential, individually or in-combination, to have significant effects on Orkney's physical and biological environment, including designated sites and species, along with economic and cultural assets.

The trend has been, and is likely to be, an increase in climate change impacts. A report card[89] published in 2020 by the UK Marine Climate Change Impacts Partnership (MCCIP) demonstrates the important effects climate change is having on UK seas and coastlines. Key findings from the 2020 MCCIP report card are:

- There is clear evidence that warming seas, reduced oxygen, ocean acidification and sea-level rise are already affecting UK coasts and seas. Increasingly, these changes are having an impact on food webs, with effects seen in seabed-dwelling species, as well as plankton, fish, birds and mammals.
- The upper range for the latest UK sea-level rise projections is higher than previous estimates, implying increased coastal-flood risk. The likelihood of compound effects from tidal flooding and extreme rainfall is increasing, which can greatly exacerbate flood impacts.
- Oxygen concentrations in UK seas are projected to decline more than the global average, especially in the North Sea.

- Impacts of climate change have already been observed at a range of heritage sites. Coastal assets will be subjected to enhanced rates of erosion, inundation and weathering or decay.
- Fisheries productivity in some UK waters has been negatively impacted by ocean warming and historical overexploitation.

Table 13 summarises the key climate change related pressures and interactions for the Physical, Historic Coastal and Marine Environment, Biodiversity, Productive coasts and seas and Social topics within this assessment. Further detail on the climate related pressures and trends for the historic environment and designated nature conservation sites are presented in Sections 3 and 5.2 respectively.

At the local level, numerous actions to help reduce carbon are being undertaken to mitigate the impacts of climate change and thus deliver a declining trend in carbon emissions. The Scottish Parliament and Orkney Islands Council declared a Climate Change Emergency in May 2019, following updated reports from the IPCC. As part of this national climate change action, a Scottish target for net zero emissions by 2045 has been adopted by the Scottish Government. In Orkney, there are numerous projects aimed at reducing the carbon emissions, such as pioneering renewable energy and low or zero carbon fuel initiatives. The Islands Growth Deal aims for the Scottish Islands to lead the way to a low carbon future. The Zero Carbon Energy Systems Innovation Programme (Proposal IP 3) in the Islands Deal will be led by Orkney.

The MARPOL convention defines some of the sea area around Orkney's marine region as a 'special area' which means vessels must switch to marine gas oil, which is a mandatory method for the prevention of sea pollution[64]. Orkney is ideally placed to support the forecasted rapid growth in shipping around the North West and North East Passages as Arctic ice cover recedes due to climate change. There is the opportunity to support marine low carbon fuel transition through Liquid Natural Gas (LNG) refueling in Scapa Flow, and future hydrogen and other zero-carbon fuel technology (see Sections 6.4 and 6.5)


Yesnaby cliffs


Marwick Head

4.7 Assessment Summary

The pressures arising from climate change affect each of the physical, historic environment, biodiversity and productive coasts and seas topics within this assessment. Changing weather patterns, ocean chemistry, sea-level rise and temperature will alter the physical, ecological, historic/cultural heritage, economic and social structure of Orkney's coastal and marine environment. Given the cross-cutting nature of this issue, and its wide-ranging potential for impacts across all of the topics, the assessment summary is insufficient to capture the many pressures, therefore, further detail is provided in Table 13.

Despite various initiatives to help mitigate climate change impacts at the local level, the global trend is one of increasing global warming above pre-industrial levels. Data confidence is medium as there are limited available data, and related assessment, on many aspects of the climate related pressures in the Orkney marine region specifically.

Table 14 Climate Change Assessment Summary

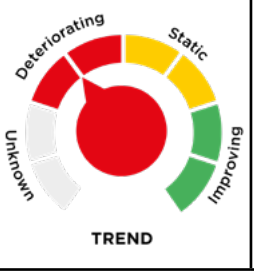
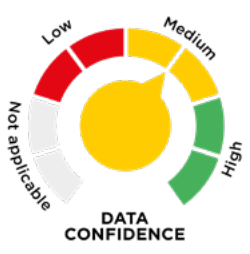
Topic	Pressure	Assessment	Trend	Data confidence
Climate change	Multiple pressures: see Table 13			

Table 13 Summary of the key pressures and interactions of climate change on the physical, biodiversity, economic and social environment of Orkney.

Topic	Climate Change pressures and interactions
Physical	Sea-level rise and erosion, along with changes in temperature, salinity and weather patterns, will alter the physical characteristics and dynamics of marine and coastal areas and have landscape impacts. Coastal flooding can arise from a combination of factors including high tides, wind and wave exposure and storm surge. Such events are predicted to be further exasperated by increases in sea-level and storm conditions attributed to climate change. Physical features containing marine inorganic carbon can be disturbed by processes of erosion and impacts from development and activities. See Section 2.
Historic coastal and marine environment	Sea-level rise, along with the potential for changing weather patterns and coastal processes due to climate change, pose a significant risk to coastal and marine historic assets in Orkney. Storms, and the combine erosive effects of wave and tidal action, particularly in recent years, have caused substantial damage to historic coastal sites and monuments. Climate-change causing rising sea-levels has been identified as the single greatest threat to Orkney's coastal built heritage. See Section 3.3.

Topic	Climate Change pressures and interactions
Biodiversity	Multiple species may be affected by changes in temperature, salinity and changing weather patterns as food webs are disrupted or altered. The pressures on seabirds, around Orkney and beyond, include the effects of climate change on their food supply, due in part to risks from increased storminess, which can impact bird colonies by both physical disturbance and ability to catch prey. Increasing sea temperatures have been seen to affect the timing of reproduction in different ways from species to species, leading to trophic mismatch between predators and the availability of their prey species (e.g. key prey species may bloom before predators have produced young that would normally feed on the prey). Changing acidity of sea water can have an effect on biogeochemical and ecosystem processes including planktonic calcification, carbon and nutrient assimilation, primary production and physiology. Changes due to climate change may impact a variety of ecological processes e.g. specialist species are at risk from increased salinity. Climate related pressures can affect species distribution and invasive non-native species could become established. Coastal lagoons, such as the internationally significant habitats within the Loch of Stenness Special Area of Conservation (SAC), are particularly sensitive to relative sea-level rise changes related to climate change. Overall, the impacts on marine ecosystems, particularly changes in acidity and on ecosystem services provision are poorly understood for Orkney waters. See Section 5.
Productive coasts and seas	Climate change impacts can affect the distribution of commercial fish species. Increased potential for harmful effects from invasive non-native species (INNS). Increased potential of algal blooms affecting fisheries and aquaculture. Increased risk of storm damage to fishing gear and finfish aquaculture sites. Increased adverse operational impacts on ports, harbours ferries and shipping, along with marine renewable energy activity due to sea-level rise and potential increases in storminess. See Section 6.
Social	The climate change related pressures on Orkney's physical environment, historic assets and biodiversity will significantly affect Orkney communities. Climate change pressures including sea-level rise, coastal erosion and potential increases in storminess are likely to increase impacts on coastal infrastructure, property and services. See Section 7.

Section 5: Biodiversity

PHOTO CREDIT: MALE LUMPSUCKER IN BREEDING COLOURS © NATURESCOT

Hermit crab on maerl, Orkney © NatureScot

Summary

- Orkney's varied physical conditions, coastlines, islands, and their surrounding seas support a wide variety of marine and coastal habitats and species.
- Many marine habitats and species in Orkney are identified as Priority Marine Features (PMFs) of conservation importance.

5.1 Introduction

Orkney's varied physical environment creates the conditions for wide variety of ecological communities. Located at approximately 59 degrees north, between the North Atlantic Ocean and the North Sea, Orkney is exposed to frequent gales and high energy wave conditions. The channels separating the islands give rise to strong tidal streams with some, such as Hoy Sound and the Pentland Firth, having tidal races with velocities of up to 4.5 m/s65. In other areas, the complexity of the shoreline affords more protection; this is especially apparent in Scapa Flow, where shelter and limited tidal movement provide calmer conditions and a marine environment that is very different to other parts of Orkney.

The 2020 Challenge for Scotland's Biodiversity includes provisions for marine and coastal enhancement. NatureScot undertook a review of habitats and species in order to identify those it considers to be of greatest marine nature conservation importance in Scottish territorial waters; these are termed Priority Marine Features (PMFs). A total of 81 PMFs have been identified in the seas around Scotland, out to the limit of the UK continental shelf. The full list comprises 26 broad habitats, seven low- or limited-mobility species and 48 mobile species[90].

The Marine (Scotland) Act 2010 established new provisions to designate for Marine Protected Areas (MPAs) in the seas around Scotland, to recognise features of national importance and to meet international commitments for developing a network of MPAs.

Marine, Coastal and Freshwater Habitats

A variety of marine habitats in Orkney are identified as Priority Marine Features (PMFs) of conservation importance (see Appendix 3). Kelp beds are widespread and colonise hard substrate in a wide range of wave and tidal conditions, where they provide a canopy, allowing many other animals and seaweeds to thrive. Maerl, a coralline red seaweed, requires tidal flow, clear water, and shelter from waves. The tidal flow percolates through the interlocking structure providing oxygen to the interstitial fauna. This provides ideal conditions for the development of diverse communities of plants and animals on, under and within the maerl beds.

Biogenic reefs are another feature of the benthic environment with horse mussel beds found in Scapa Flow concentrated around Cava Island. Less common are flameshell beds (see Figure 19) and blue mussel beds which, so far, have only been recorded in Scapa Flow. In the shallow water of more sheltered areas, dense seagrass meadows (see Figure 20) grow on sandy, muddy sediments, their leaves creating surfaces for the attachment of algae, diatoms, hydroids and sea anemones and shelter for crabs and fish species. Orkney's highly indented coastlines also give rise to many sheltered bays with intertidal mudflats. Rich in organic material, these support a wide diversity of burrowing species including worms, crustaceans, and bivalve molluscs which, in turn, provide food for wading bird species[91].

Orkney's coastlines include high cliffs of the western seaboard whose ledges provide nesting sites for diverse seabird colonies. In many places these are backed by upland heathland, supporting a further assemblage of ground-nesting species. Low lying coasts such as those found on the island of Sanday are fringed by coastal sand dunes, machair or coastal vegetated shingle and Waulkmill Bay in the West Mainland is backed by an extensive area of coastal saltmarsh. The Loch of Stenness, also in the West Mainland, is the largest saline lagoon in the UK. There is also connectivity with freshwater habitats where there are diadromous fish species present including important spawning grounds within burns. Sea trout and brown trout are the two forms of the same species, *Salmo trutta* (see Section 5.7.4). Some brown trout migrate to sea in springtime (as smolts) and become Sea trout, which are silvery and more like salmon in appearance. They grow quickly on a rich marine diet and, also like salmon, return to the freshwater system of their birth to spawn[92]. In addition, the European eel (*Anguilla anguilla*) is widespread in Orkney, it can be found in all running, still and brackish water. Atlantic salmon (*Salmo salar*) are not Orkney residents, although they pass through Orkney waters each year.

Twelve broad habitats are found in Orkney waters, including kelp beds, horse mussel beds, seagrass beds (see Figure 20) and maerl beds. Only three low or limited mobility species are found here; these are northern feather star, fan mussel and ocean quahog. Forty mobile species have been recorded in Orkney waters; these include harbour and grey seal, otter, sea trout, several cetacean species, and a wide range of fish species (see Appendix 3).

Priority Habitats and Species

Each local authority in Scotland has developed its own Local Biodiversity Action Plan (LBAP) that lists the priority habitats and species for its area. The Orkney Environment Partnership, through its Biodiversity Steering Group, produced the original Orkney Local

Biodiversity Action Plan (LBAP) in 2002, a document which identified a total of 83 species and 21 distinct habitats as being of importance in the Orkney Islands. This plan has been supplemented by three further targeted versions. The current revision covers the period 2018 - 2023 and focuses on four themes: Greenspace, Farmland, Peatland, and the Marine Environment. Several marine species and habitats are classed as Priority Marine Features (PMF) and as such are afforded a degree of policy protection within the Scotland's National Marine Plan. Actions to support better management of certain PMFs is being taken forward under the marine environment theme of the current LBAP.

The LBAP also includes lists of habitats and species which occur in Orkney and are identified as Priorities for Conservation on the UK Biodiversity Action Plan and the Scottish Biodiversity List. All four versions of the Plan may be accessed from the Orkney Islands Council website[93]. Further information on the distribution of species and habitats throughout the county is available from The Orkney Wildlife Information and Records Centre which is in the Orkney Library and Archive.

Wider Measures

There are a number of bird species, either listed on Annex I of the Birds Directive or regularly occurring migratory species, for which Special Protection Areas are not appropriate in Scotland and are considered under wider measures. For some other species, a large proportion of the population is not protected within SPAs. In both these cases, special measures outwith designated areas are of particular significance[94].

Article 10 of the Habitats Directive encourages national governments, through their land-use planning and development policies, to manage landscape features which are of major importance for wild fauna and flora, particularly with a view to improving the ecological coherence of the Natura 2000 site network. Features which are essential for the passage and dispersal of wild species in the countryside, such as river corridors, and features which act as 'stepping-stones' between sites such as small woods and ponds, are highlighted as particularly valuable. In Orkney, the identification of Local Nature Conservation Sites in the Local Development Plan is an effective means of highlighting areas of sensitive habitat outwith the nationally and internationally designated sites.

Wider Measures Habitats and Species Pressures Overview

The following seven Biodiversity Sections assess the main pressures on key habitats and species, in accordance with guidance from Marine Scotland. As the majority of marine and coastal economic activities can require anchoring or securing infrastructure to the seabed, cabling or pipework to land or the use of bottom contacting gear, these activities can cause some degree of abrasion, scouring or siltation, as well as physical disturbance of the benthic habitat. Thus, species such as Maerl, Flame shell and Seagrass beds, which are important habitats within Orkney, can be disturbed or damaged by such activities.

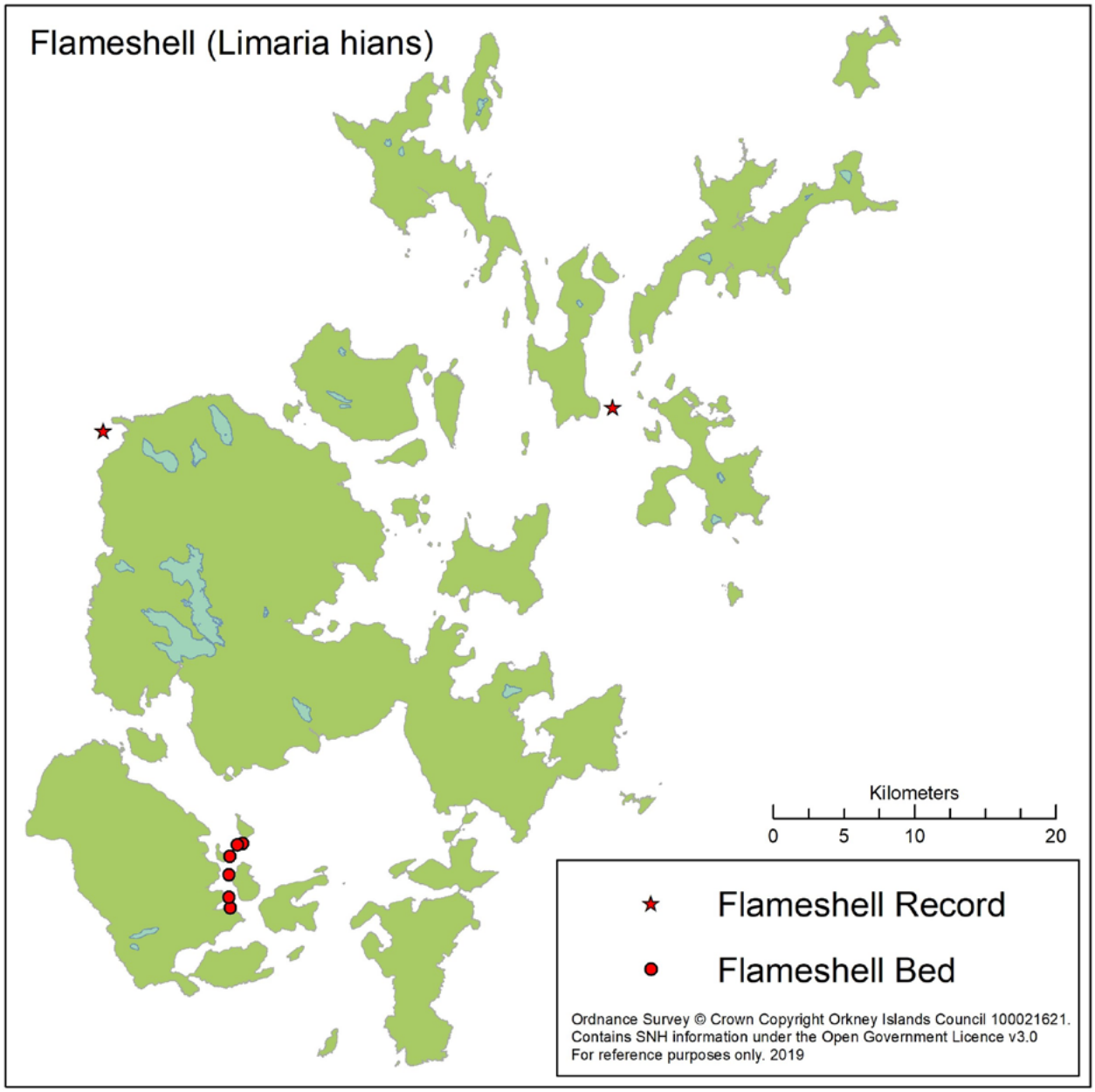


Figure 19 Flameshells (*Limaria hians*) present in Orkney


Three flame shells © NatureScot

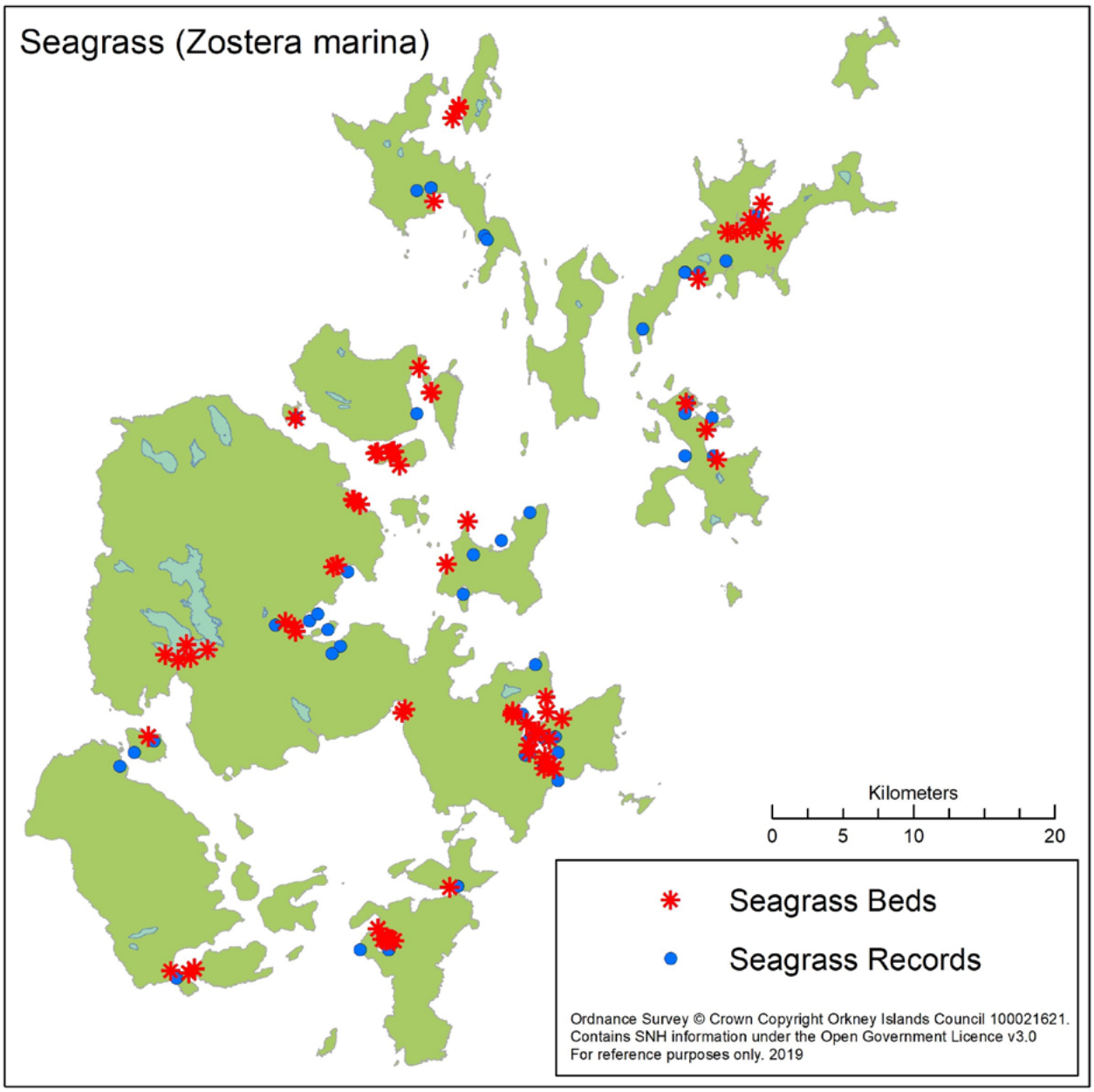


Figure 20 Seagrass (*Zostera marina*) locations in Orkney


Seagrass bed © NatureScot

5.2 Designated Nature Conservation Sites

Great skua, Bonxie © Martin Lever

Summary

- Approximately 30% of Orkney's marine region is designated as Special Protection Areas (SPAs), Special Areas for Conservation (SACs), a Ramsar site, Nature Conservation Marine Protected Areas (NC MPAs) and Sites of Special Scientific Interest (SSSIs).
- Orkney has Local Nature Reserves and Local Nature Conservation Sites designated for habitats, species and geological features of local importance, many of which have a coastal element.

5.2.1 Introduction

Both terrestrial and marine areas within Orkney are covered by a range of nature conservation designations, many of which spatially overlap. In the marine environment five types of designation have created a network of marine protected areas. These are: Special Protection Areas, Special Areas for Conservation, a Ramsar site, Nature Conservation Marine Protected Areas and SSSIs; these equate to approximately 30% of the marine area designated for their biodiversity features[95] (see Figure 21).

5.2.2 Current status

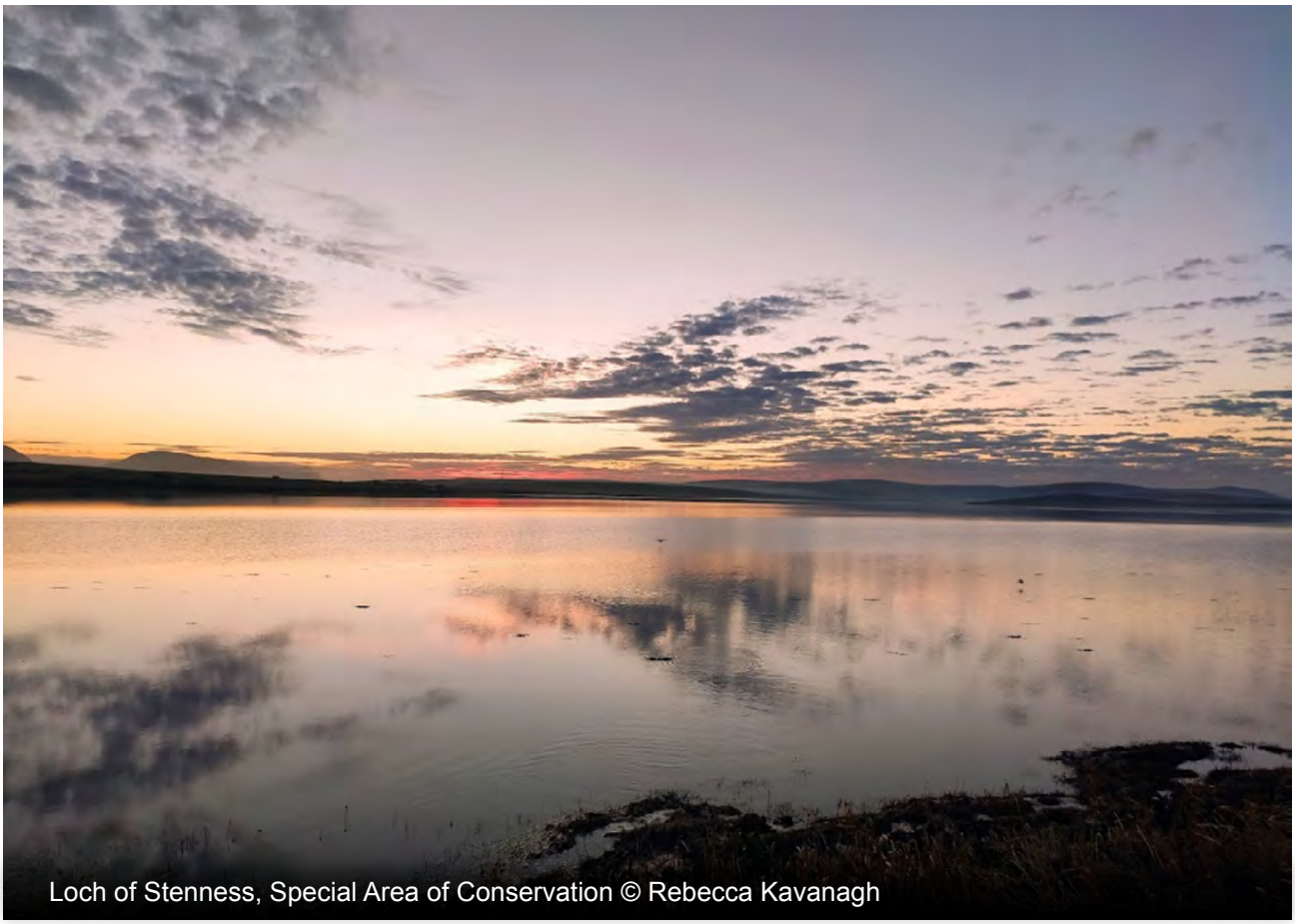
Natura 2000 is a European network of protected sites which represent areas of the highest value for natural habitats and species of plants and animals which are rare, endangered, or vulnerable in the European Community. The term Natura 2000 comes from the 1992 EC Habitats Directive; it represents the conservation of precious natural resources for the year 2000 and beyond into the 21st century. The Natura 2000 network includes two types of protected area: Special Protection Areas and Special Areas for Conservation.

Special Protection Areas (SPA) are classified under the Birds Directive and are areas which support rare, vulnerable, and regularly occurring migratory bird species which are listed in Annex I of the Birds Directive. SPAs are intended to safeguard the habitats of these species and to protect the birds from significant disturbance. Of Orkney's 33 SSSIs (see below), 13 are further designated as SPAs (see Section 5.4 for further details). These include Hoy SPA, which is designated for its assemblages of breeding seabirds and moorland species, as well as Auskerry, home to a breeding population of storm petrel. Some SPAs are entirely terrestrial, whilst others include marine extensions. Two additional wholly marine proposed SPAs have been identified; these sites are currently known as North Orkney pSPA and Scapa Flow pSPA; however, it is possible that these will merge to become a single Orkney Inshore Waters pSPA.

Special Areas of Conservation (SAC) are classified under the Habitats Directive for the protection of rare, endangered, or vulnerable natural habitats and species of plants or animals (other than birds). These are the 189 habitats listed in Annex I and the 788 species listed in Annex II of the Habitats Directive. Species occurring in Orkney for which the UK has special responsibility include otter, grey seal and common seal. There are six SACs in Orkney, three of which are designated for marine features. Faray and Holm of Faray SAC is designated for grey seal, and harbour seal is one of the qualifying features of the Sanday SAC; seals are considered in Section 5.5. The Loch of Stenness SAC is the largest brackish lagoon in the UK.

Ramsar Sites are internationally important wetland sites protecting wildfowl habitat. Orkney's only Ramsar site is East Sanday Coast which overlaps with the East Sanday Coast SSSI and SPA. Scottish Government policy applies the same protection status to Ramsar sites, SPAs and SACs.

Nature Conservation Marine Protected Areas (NC MPA) have been designated to conserve some of Scotland's most important marine wildlife, habitats and geodiversity. A subset of the Priority Marine Features was used to underpin their selection.



Loch of Stenness, Special Area of Conservation © Rebecca Kavanagh

There are three NC MPAs in Orkney:

- The North-west Orkney site is designated for sandeel and marine geomorphology i.e. sand banks, sand wave fields and sediment wave fields.
- Papa Westray NC MPA is designated for black guillemot and marine geomorphology i.e. sand wave fields.
- The Wyre and Rousay Sounds NC MPA is designated for its maerl beds and kelp and seaweed communities on sublittoral sediment.

Sites of Special Scientific Interest (SSSI) represent the best of Scotland's natural heritage and are designated for their plants, animals or habitats, their rocks or landforms, or a combination of such natural features. They form a network of the examples of terrestrial natural features throughout Scotland and support a wider network across Great Britain and the European Union. There are 33 SSSIs in Orkney, many of which include coastal features. Some, e.g. West Westray, Rousay and Marwick Head, provide important breeding, feeding and loafing habitat for cliff-nesting seabirds and others, such as the Central Sanday SSSI, include areas of sand dune, machair and saltmarsh, as well as coastal landforms such as tombolos and shingle ayres.

The qualifying features and site condition for each of the international and national designated nature conservation sites in the Orkney marine region is included in Appendix 2.

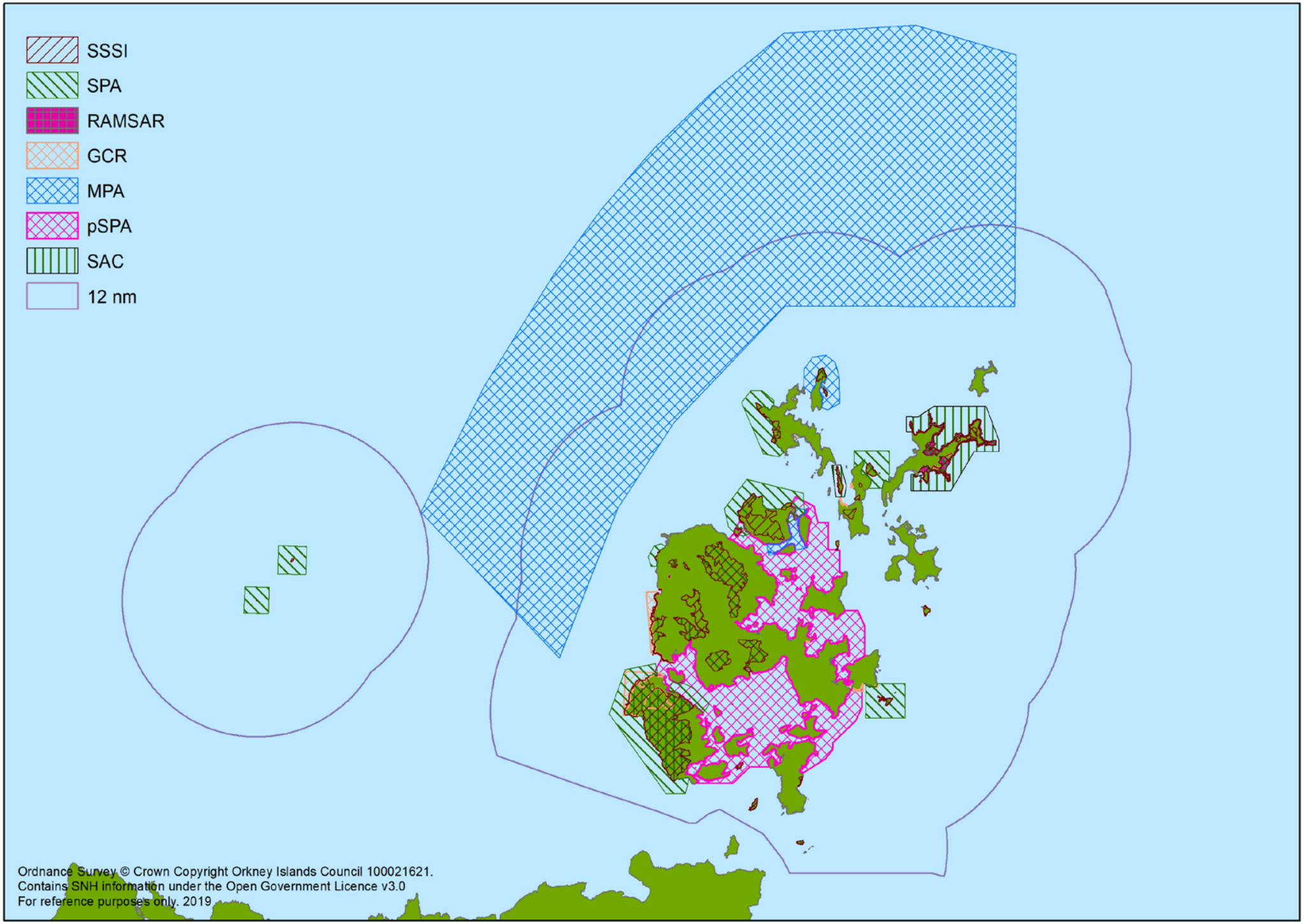


Figure 21 International and National Nature Conservation Sites[96]

Local Nature Reserves (LNR) are places with special local natural interest, set up to protect nature and for people to enjoy and appreciate; Orkney has two LNRs, one at Mull Head in the parish of Deerness and another at Happy Valley in Stenness.

The Mull Head LNR was designated in 1993 for its wildlife, geology, and archaeology. It comprises 160 ha of heathland, maritime grassland, and high cliffs, which are battered by storms in winter and teeming with nesting seabirds in the summer. The cliffs are constantly pounded by the sea, gradually eroding them, and exploiting weaknesses to form caves, stacks, narrow inlets called geos and spectacular blow holes like the Gloup. The Gloup is a long sea cave which collapsed on the landward side, leaving a large chasm still joined to the sea through a broad arch.

Local Nature Conservation Sites (LNCS) are non-statutory and are designated for their ornithological, botanical, geological or geomorphological interest, and often for a combination of these interests. Whereas statutory designations are afforded legal protection, non-statutory designations are protected through the implementation of specific local planning policies. 248 local sites are identified in the Orkney Local Development Plan 2017. Many of Orkney's LNCSs are coastal and include priority habitats for conservation such as saltmarsh, sand dune, saline lagoon and intertidal mud flats.

5.2.3 Pressures and trends

Climate change

Climate change related pressures could lead to changes in species composition within designated sites. There is therefore a risk that the qualifying features of designated sites, and wider biodiversity, could change over time, requiring a more flexible and adaptive approach to management and site designation. This could also have an impact on commercial fisheries and aquaculture.

Increasing sea temperatures are also seen to affect the timing of reproduction in different ways from species to species, leading to trophic mismatch between predators and the availability of their prey species (e.g. key prey species may bloom before predators have produced young that would normally feed on the prey)[97].

As they are connected to the sea, coastal lagoons, such as the internationally significant habitats within the Loch of Stenness SAC, are particularly sensitive to relative sea-level rise changes related to climate change[98]. When the water is stratified, the denser sea water that flows in at high tide contributes to the bottom layer, whilst the top layer of less saline water flows out. The lagoon can get progressively saltier until it is recharged by rainfall or river inflow of freshwater, but overall, the salinity will increase as sea-level rises, as progressively more sea water will enter. The danger to lagoon organisms is not so much from the saltwater itself, which they can tolerate to a certain extent, but from closely related marine species that can outcompete them.[99]

Additional pressures

As sites are designated for a wide variety of habitats and species, there are multiple pressures on their features from many sources; these include:

- abrasion, scouring, smothering and physical disturbance or removal of seabed habitats;
- barrier to species movement
- collision;
- entanglement; and
- pollution.

Fishing gear and aquaculture equipment, e.g. discarded or lost nets, creels, and ropes, continue 'fishing' for as long as it remains in the marine environment. This can cause birds and marine mammals to become entangled, causing injury and mortality.

Ropes, netting and other plastic wastes are persistent in the marine environment, breaking down into ever smaller fragments that can be ingested by birds. These accumulate in the birds' stomachs, reducing the space available for food and increasing the risk of starvation. This issue is addressed in more detail in the Birds and Marine Litter and Waste Sections, 5.4 and 2.11 respectively. Waste from aquaculture, including waste feed and faeces, can also impact the seabed communities (see Section 6.3.3).

Gannet © NatureScot

5.2.4 Assessment Summary

The quality features of the Orkney SPAs and pSPAs, along with the SACs which have seals as qualifying features, are assessed in Sections 5.4 and 5.5 respectively.

As the majority of economic sector activities includes anchoring or securing infrastructure to the seabed or other seabed disturbance, this can cause some degree of abrasion, scouring or siltation, as well as physical disturbance of benthic habitat. For example, the intertidal mudflats and sandflats form part of the Sanday SAC. Therefore some development and activities within such areas could be a cause for concern. Similarly, the Papa Westray NC MPA is designated for its 'Marine Geomorphology of the Scottish Shelf Seabed' (as well as Black guillemot) and the Wyre and Rousay Sounds NC MPA is designated for its Kelp and seaweed communities on sublittoral sediment and Maerl beds. Development and activities in such designated sites need to be appropriately managed to avoid significant adverse effects on benthic features of conservation importance.

Two SACs are designated for their seal populations which can be affected by barriers to species movement, collision and pollution. Harbour seal populations are in significant decline; these are discussed in the Seals Section (see Section 5.5). The SPAs and pSPAs features can be affected by the degradation of foraging habitats and impacts from visual disturbance (see Section 5.4).

As identified economic sectors including aquaculture, ports and harbours and renewable energy seek to expand their activities, associated impacts could correspondingly increase, leading to some concerns.

Table 15 Designated Nature Conservation Sites Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Designated sites	Climate Change; Disturbance; Barrier to species movement; Collision; Entanglement; Overfishing; Pollution.	As there are many designated sites with varying site condition status, an overall assessment of these sites would be of limited value. Refer to Appendix 2 for individual site condition summaries.		

5.3 Protected species

European Otter © NatureScot

Summary

- European Protected Species that are frequently found in coastal and marine areas of Orkney include cetaceans and otters, and occasionally turtles.
- The qualifying species of Natura sites include birds, seals and cetaceans.

5.3.1 Introduction

Many animal and plant species are listed on Annex IV of the Habitats Directive as species of European Community interest and in need of strict protection. These are commonly known as European Protected Species (EPS) and they are protected under the Conservation of Habitats and Species Regulations[100].

EPS present in Orkney include European Otter, which is known to be widespread, particularly in the vicinity of aquatic environments, as the animals routinely move between marine and freshwater environments. All species of cetaceans are EPS. Harbour porpoises are frequently seen, particularly in south Scapa Flow and regular sightings are reported of several whale and dolphin species passing through Orkney's waters. Marine turtles are also designated as EPS and rare sightings have been made in Orkney waters, although usually they are dead or injured animals found washed up on the shoreline. Further information on cetaceans is provided in Section 5.6.

Inappropriately sited or designed development can cause damage to, or loss of, habitat that is vital to birds and marine mammals e.g. for breeding, feeding, resting, and over-wintering. Marine planning provides a framework to ensure species and habitats are protected from harmful activities by informing the authorisation and enforcement decisions taken by public authorities. The assessments in Section 5.4 to 5.7 have been undertaken for key groups of protected species. The following five Sections of this report consider key groups of marine animals but it is acknowledged there are many interactions between them and their habitats, therefore they depend on each other to thrive in a healthy marine ecosystem.

A Common sunstar, Orkney © NatureScot

5.4 Birds

Flying Atlantic puffin returning to Castle o'Burrian © Martin Lever

Summary

- Orkney's varied coastlines and productive seas support internationally and nationally important populations of breeding and wintering seabirds, divers, seaduck, other waterfowl and waders.
- The Seabird 2000 census of breeding seabirds in Britain and Ireland recorded over three quarters of a million individual breeding seabirds of 21 species in Orkney.
- There are 13 designated Special Protection Areas (SPAs), two proposed SPAs (pSPAs) and one Ramsar site in Orkney designated for bird populations of international significance.

5.4.1 Introduction

Orkney's geology and landforms, along with the confluence of the Atlantic Ocean and the North Sea, where warm saline oceanic water mixes with colder, less saline, nutrient -laden coastal water, means that the sea is rich in plankton, benthic resources and fish, providing favourable conditions for a diverse range of seabirds and water birds[101]. Kelp beds and predator-free islands for species such as tysties (Black guillemot) are also important. Rocky ledges on cliff coastlines provide nesting sites for many seabird species, while sheltered inshore waters also provide important wintering grounds used for feeding, moulting and roosting by species such as shag and waterfowl, many of which migrate to Scotland every year to overwinter or to stop off at as one of their staging posts while on migration. Nesting birds such as terns, gulls and skuas use habitats such as heaths and intertidal habitats are important for wintering waders.

5.4.2 Current status

The Seabird 2000 census of breeding seabirds in Britain and Ireland recorded over three quarters of a million individual breeding seabirds of 21 species in Orkney, including over a quarter of the GB populations of Great black-backed gull, Arctic Skua and Arctic tern and 14% of the global population of Great skua, or bonxie. Cliff-nesting birds included major populations of Common guillemots, fulmar and black-legged kittiwake, while the colony of Puffins on Sule Skerry was the third largest concentration in Britain. Orkney is also an important stronghold for the Black guillemot, or tysie, which nests in crevices and boulders on rocky shores and for the Red-throated diver, which breeds on inland lochans but feeds at sea.

In Orkney there are 13 designated Special Protection Areas (SPAs) as well as two proposed SPAs and one Ramsar site; these are international designations for the protection of certain bird species and the habitats they depend on, as discussed in Section 5.2. These designations demonstrate that Orkney is an internationally significant region for breeding seabirds and wintering waterfowl.

Scapa Flow has been identified as a proposed Special protection Area (pSPA) for inshore wintering waterfowl and shag and foraging areas for breeding Red-throated diver. Over 20% of the British (GB) population of Great northern diver, 10% of black-throated diver and the largest concentration of Slavonian grebe in Britain winter in Scapa Flow[102]. North Orkney, encompassing the seas around the inner North Isles, has been identified as a pSPA for non-breeding waterfowl and foraging areas for breeding Red-throated diver[103]. Shore-based vantage point bird surveys were undertaken from November 2017 to March 2018 in North Orkney and Scapa Flow[104].

The Joint Nature Conservancy Council (JNCC) hold information on seabird trends as part of their monitoring programme[105]. Regular monitoring and reporting of seabird numbers and breeding success has been carried out since the mid-1980s and survey findings indicate a declining trend for several species. For example, data provided by the RSPB show that Kittiwake numbers in Orkney have displayed an overall trend of decline since 2003, when compared to Figures from the 1980s to the 1990s. The regular monitoring of wintering waterfowl is also significantly important; data can be found within the proposed SPA site selection documents[106] and Network Assessment accounts[107].

To help understand how seabird populations are changing, a national census of all the breeding seabirds in the UK is carried out approximately every 15 years. The current national survey is called 'Seabirds Count'. As part of this census, the local RSPB team have been surveying seabirds at various locations in Orkney over the last few years. In 2018, the focus was on counting terns, gulls and skuas and a full census was undertaken of the colony at Marwick Head, the largest seabird colony on Mainland Orkney. Table 16 summarises the count data recorded for six species at Marwick Head, comparing it with data from a similar census in 1999. It shows a clear decline in species between 1999 and 2018.

Table 16 Example of seabird declines: RSPB data from Marwick Head, Orkney

Species	1999	2018
Fulmar	823	515
Guillemot	34,679	11985
Razorbill	5,573	1100
Kittiwake	5,573	906
Herring Gull	14	1149
Shag	12	2

5.4.3 Pressures and trends

The key pressures on bird species are discussed below; they are summarised as:

- Climate change;
- barrier to species movement;
- collision;
- disturbance and displacement[108];
- entanglement;
- litter;
- noise;
- pollution;
- removal of target and non-target species or foraging habitats.

The pressures on seabirds, around Orkney and beyond, include the effects of climate change on their food supply, due in part to risks from increased storminess, which can impact bird colonies by both physical disturbance and ability to catch prey. A recent study undertaken off the east coast of Scotland has quantified how thermal relationships affect the match between hatching in Sandeel and egg production in its copepod prey[109]. While

Sandeel hatch time was found to be influenced by the rate of seasonal temperature decline during autumn and winter through effects on gonad (reproductive gland) and egg development, variation in copepod timing mostly responded to February temperature. These differing temperature relationships defined the degree of trophic mismatch, which in turn, explained variation in local Sandeel recruitment.

Developments such as renewable energy infrastructure can act as a barrier to movement. Barrier effects can be linked to the risk of collision in relation to offshore turbines, as well as underwater impacts with sub-sea devices and related infrastructure, which is described in more detail in Section 6.5.

Renewable energy development and activities can cause pressures through visual disturbance and displacement. There are knowledge gaps regarding how wave and tidal renewable energy technologies interact with species in relation to collision risk, disturbance and displacement.

Other pressures include entanglement in marine litter such as ropes and netting, and with seabirds being accidentally caught in fishing gear, particularly in some sensitive seabird areas. Entanglement in fish farm cage netting is another potential pressure; however, there are ongoing mitigation efforts to combat this issue by improvements in the design and tensioning of top nets and cage nets.

As outlined in Section 2.11.2 with regard to marine litter, the OSPAR Commission monitors and assesses plastics in the stomachs of beached northern fulmars, as one of its indicators of environmental quality[110]. Fulmars are abundant and widespread seabirds known to regularly ingest litter. Although the birds forage near the water surface their stomachs may also contain items from deeper water, or items that may be indirectly ingested through their prey. Over 90% of Fulmars found dead around the North Sea have been found to have plastic in their stomachs and, currently, 58% have more than 0.1g of plastic in their stomachs, exceeding OSPAR's long-term goal of 10%. This reflects the abundance of floating litter in their environment. There has been no significant change in the amount of plastic in fulmar stomachs over the past ten years.

Orkney participates in the North Sea Fulmar Project with local volunteers collecting beached fulmar corpses[111]. The project is enabled locally by RSPB, with dead fulmars stored at the Orkney Harbour Authority Headquarters at Scapa prior to sending the birds to Wageningen University, the Netherlands for analysis.

Visual disturbance to bird species can include displacement and barrier effects due to human activities e.g. vessels movements. Significant disturbance can affect the distribution and use of important sites for birds compromising their long-term ability to survive and/or breed. A research project was undertaken in Orkney and the Western Isles in 2018 to compare the relative sensitivities to marine activity of eleven target waterbird species during the non-breeding season[112].

Noise disturbance and marine pollution incidents linked to development can also affect bird populations, particularly in sensitive seabird areas.

Improved data are required on the population distribution of birds of conservation importance in Orkney waters, along with data on the location and extent of their foraging habitats (see Table 33).

Tracking studies undertaken by the JNCC indicate that one element in the observed decline in seabird populations is the lack of food availability for some, if not multiple, species. For example, the kittiwake relies on small forage fish species such as the Lesser sandeel and Sprat; this has been found to be a limiting factor for the species' breeding success across the Greater North Sea and beyond[113].

Given the multiple pressures on sea and coastal birds and the declining status of multiple species as outlined in this assessment, the overall trend is one of deteriorating populations.

5.4.4 Assessment Summary

Climate change is causing multiple pressures on sea and coastal birds in Orkney leading to many concerns. The pressures on bird species identified by the PAD tool and local assessments are mainly associated with commercial fishing, aquaculture, energy and infrastructure developments, and tourism and recreation. Many marine activities rely on regular vessel movements therefore key areas of disturbance may cause habituation or avoidance. The regular monitoring of populations demonstrates the overall trend is one of deteriorating populations.

Table 17 Birds Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Birds	Climate change, Collision, Development Disturbance, Marine Litter			

Black guillemot © NatureScot

5.5 Seals

Grey seal © Stuart West

Summary

- Orkney is a hotspot for Grey seal and there are concerns over the declining Harbour seal population.
- Two Special Areas of Conservation (SACs) are designated specifically for seals in Orkney; one for Grey seal at Faray and Holm of Faray and the other for Harbour seal at Sanday.

5.5.1 Introduction

Two species of seal are native to Scotland: the Harbour (common) seal (*Phoca vitulina*) and the Grey seal (*Halichoerus grypus*). Both species are widespread in Orkney's inshore waters. Harbour seals pup during June and July, whereas grey seals come ashore between late September and December to give birth. Whereas Harbour seal pups can swim shortly after birth, the young Grey seal generally remains on land for the first three weeks of its life, feeding from its mother and gaining around 2kg in weight each day before it can enter the water[114]. However, Grey seals can take to the water much earlier than this[e]; it has been noted locally around Sanday that some young grey seals take to the water from earlier than this.

Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) has a duty to provide scientific advice to government on matters related to the management of seal populations. NERC has appointed the Special Committee on Seals (SCOS) to formulate this advice provided to SCOS by the Sea Mammal Research Unit, based in St. Andrews[115].

5.5.2 Current status

Both Grey and Harbour seal are listed in Annex II of the EU Habitats Directive, requiring specific areas to be designated for their protection. Two Special Areas of Conservation (SACs) are designated specifically for seals in Orkney; one for grey seals at Faray and Holm of Faray and the other for harbour seals at Sanday. Figure 22 identifies seal sightings in Orkney with data provided by the Orkney Wildlife Information and Record Centre, though it is recognised that seals are ubiquitous around the coasts of Orkney.

Under the terms of the Marine (Scotland) Act 2010, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering. The Act also provides additional protection for seals at designated Haul-out Sites, where it is an offence to harass seals intentionally or recklessly. There are 35 designated seal haul-out sites and 19 additional designated Grey seal breeding colonies (see Figure 23), including one on Sule Skerry. These are locations where seals come ashore to rest, breed and moult.

Grey seal: Approximately 38% of the world's Grey seals breed in the UK; the UK population is estimated to be around 150,000. 88% of Grey seals breed in colonies in Scotland, with the main concentrations in the Outer Hebrides and in Orkney[116]. The approximate number, based on Grey seal pup production estimates for Scotland, is currently around 24,000, which likely makes Orkney the most important breeding area in the UK.

Although the number of pups throughout Britain has grown steadily since the 1960s when records began, there is clear evidence that the population growth is levelling off in all areas, including Orkney, since the late 1990s. To illustrate, the rate of increase in Orkney has been low since 2000, with pup production increasing at around 1.4% per annum between 2000 and 2010 and by <1% p.a. between 2012 and 2016.

Harbour seals: Approximately 30% of European harbour seals are found in the UK and the UK population is estimated to be around 45,100. Of these, some 79% are found around Scotland. Current estimates note that the population is around 1,200 for Orkney[117]. However, major declines have been documented in several harbour seal populations around Scotland, with declines since 2001 of 76% in Orkney[118]. The results of aerial counts of Harbour seals and Grey seals during August 2016 along Sections of the Scottish coastline suggest a continuing decline in Harbour seal numbers in Orkney, whilst numbers in the Moray Firth show a modest increase from the previous count, and numbers in east Scotland remain at historically low levels[119].

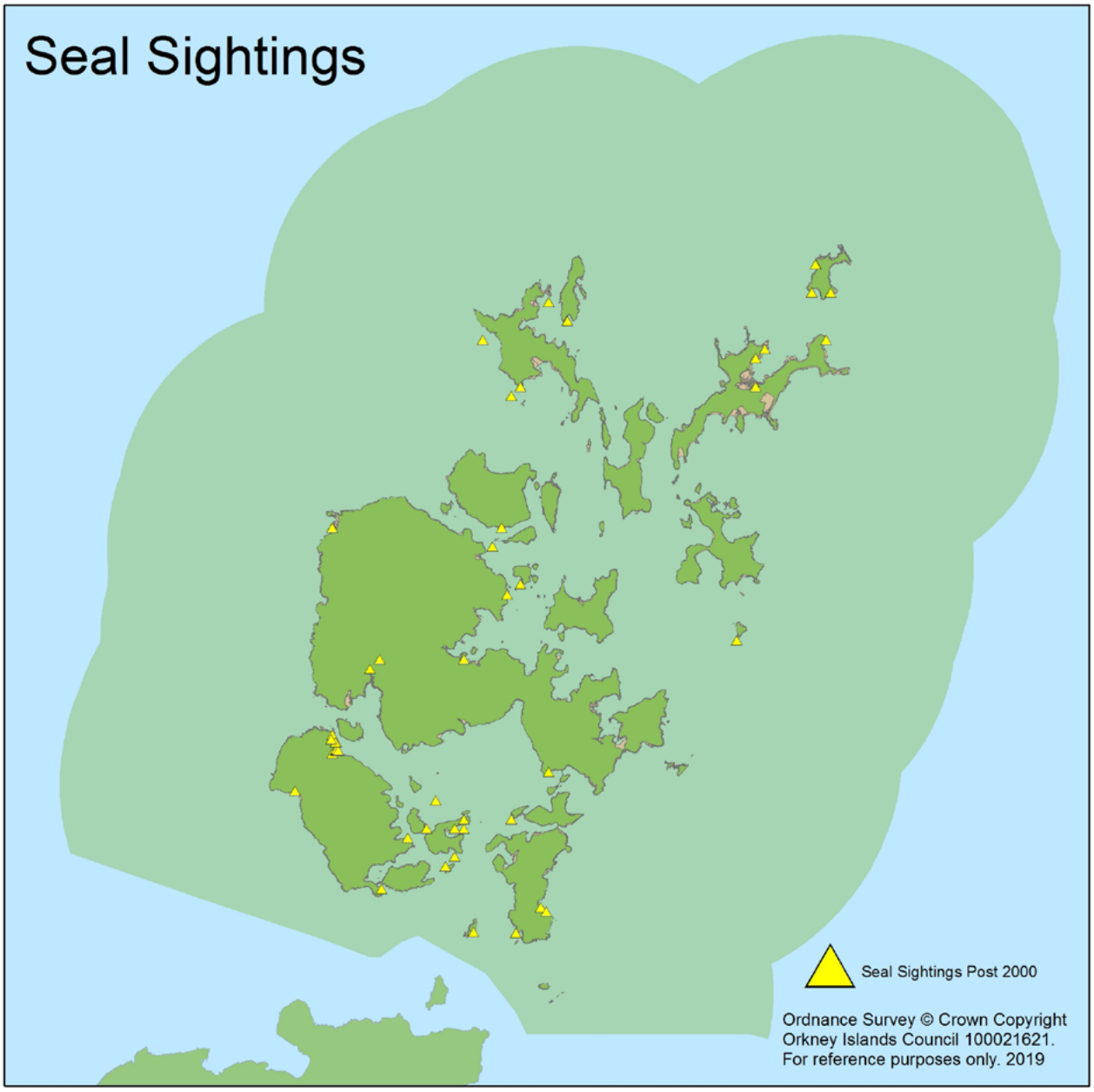


Figure 22 : Map of Seal Sightings January 2000 – July 2019 within 12nm boundary (data provided by the Orkney Wildlife Information and Record Centre).

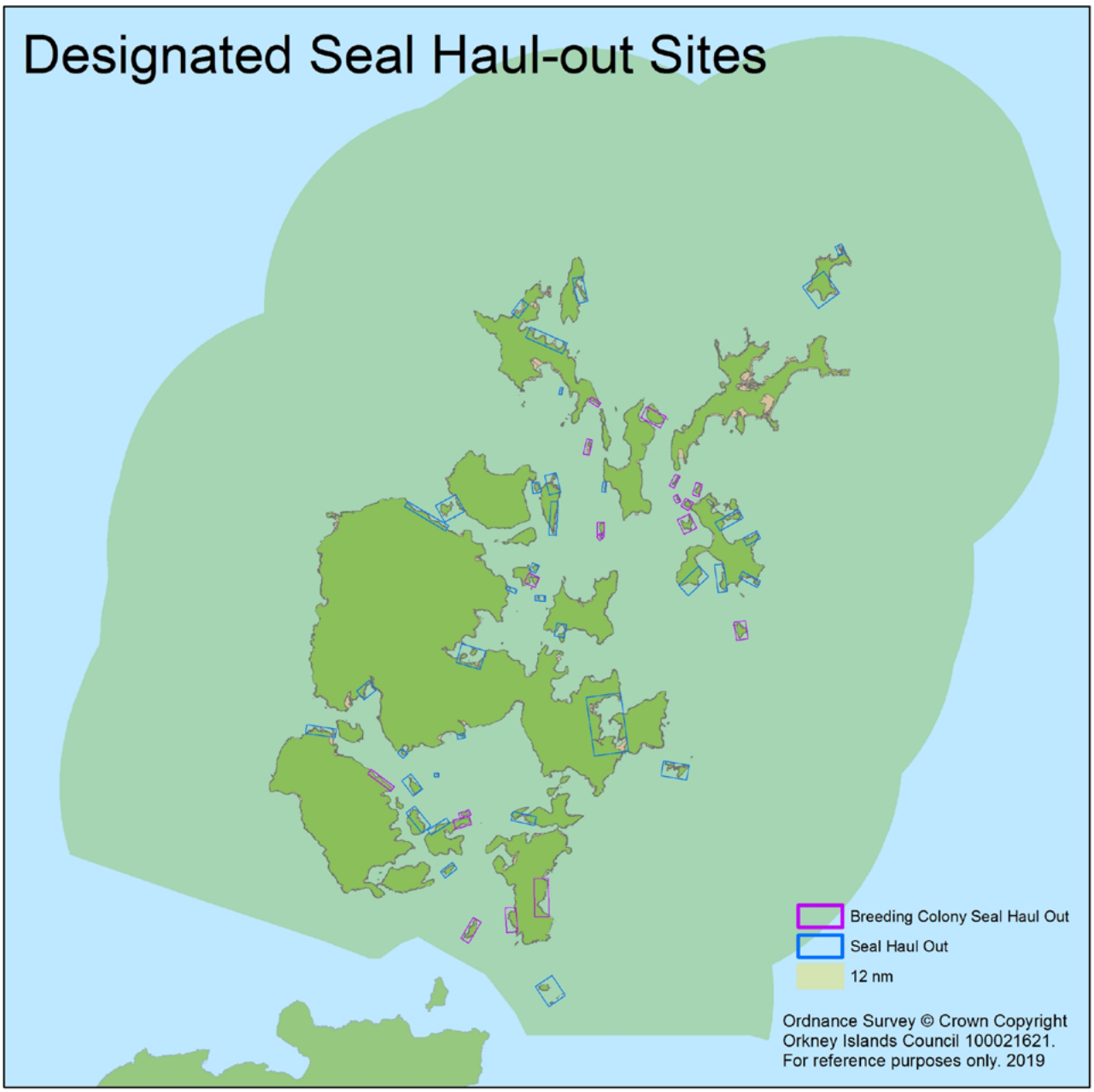


Figure 23 Map of Designated Seal Haul-out Sites within 12 nm boundary

5.5.3 Pressures and trends

The JNCC PAD tool (see Section 1.8) shows that the energy sectors have the potential for barrier effects to species movement and collision risk, as well as disturbance and displacement and pollution effects from aquaculture and energy development.

Additional pressures identified are:

- Climate change: the most noticeable effects are likely to be changes in the distribution of seals and the availability of prey[120].
- Entanglement in fishing gear.
- Predation by Killer whale (*Orincus orca*): these have been seen more regularly in Orkney and Shetland.
- Predation of Harbour seals by Grey seals: there is evidence that Grey seals can attack Harbour seals, but the level of this predation has yet to be quantified.

Studies are ongoing to obtain more detailed data on why Harbour seal populations may be declining in Orkney and it is possible that multiple factors are responsible[121]. These studies include long-term monitoring of selected Harbour seal breeding sites to assess survivorship and fecundity rates. Candidate reasons for the decline include the quality and availability of prey, competition from Grey seals, predation by Grey seals and Killer whale and exposure to toxins from harmful algae[122]. In addition, studies from Germany have shown both Grey seals and Harbour seals are predated by Grey seals[f].

Increasing sea temperature and geographical changes in species assemblages may be influencing the quality and availability of prey species and adding to the effects of competition from the larger populations of Grey seal. If future climate change were to lead to increased storminess it is possible that this could cause higher losses of pups.

Harbour seal © David Munn

In 2019, 112 applications were made to shoot Grey seal in Orkney and along the North Coast of Scotland to protect the interests of aquaculture. Of the 47 licenses that were granted in the whole of Scotland, 12 Grey seal were shot in total, all of which were in Orkney. No harbour seals were shot in 2019[123]. However, licenses to shoot seals to protect aquaculture are no longer permitted[124].

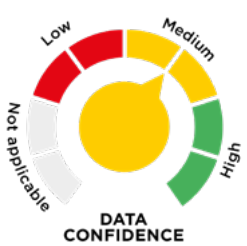
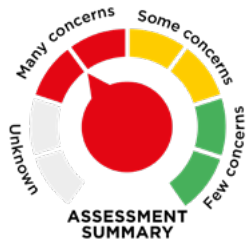
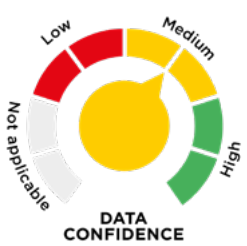
Fishing and disturbance from other vessels including recreational craft (e.g. jet skis) may add to pressures on seals, particularly at pupping time.

If commercial scale seaweed harvesting were to become established in Orkney, there may be potential for adverse impacts on seals, particularly near haul-outs or in kelp forest foraging habitats[125]. These habitats may be used by the seals as refuges from predators such as Killer whale, but there are currently limited data on this aspect.

5.4.4 Assessment Summary

As both Gray and Harbours seals are relatively well studied and monitored, the impacts upon them are understood. Whilst Grey seal populations appear to be stable, the decline in Harbour seal populations is a concern.

Table 18 Seals Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Grey seal populations	Disturbance			
Harbour seal populations	Climate change; Competition; Disturbance; Pollution			

5.6 Cetaceans

Pilot whale, Kirkwall Harbour © Martin Lever

Summary

- Species such as Harbour porpoise (*Phocoena phocoena*) and Minke whales (*Balaenoptera acutorostrata*) are frequent visitors to Orkney's waters, whilst others including Sperm whales (*Physeter macrocephalus*) are only seen occasionally.
- Seven species are most commonly recorded close to Orkney's coast: Atlantic white-sided dolphin (*Lagenorhynchus obliquidens*); Harbour porpoise; Minke whale; White-beaked dolphin (*L.albirostris*); Risso's dolphin (*Grampus griseus*); Common bottlenose dolphin (*Tursiops truncatus*) and Killer whale.
- There is a lack of information in relation to population abundance, seasonality of presence, distribution and habitat use in the Orkney marine region for all cetacean species.

5.6.1 Introduction

Orkney is a hotspot for cetaceans i.e. whales, dolphins and porpoises. This is based on Sea Watch Foundation and NatureScot Reports which have recorded numerous sightings[126]. Species such as Harbour porpoise (*Phocoena phocoena*) and Minke whales (*Balaenoptera acutorostrata*) are frequent visitors to Orkney's waters, whilst others including Sperm whales (*Physeter macrocephalus*) are only seen occasionally. Favoured localities for cetacean sightings are around headlands and through the sounds separating islands in inshore areas, as well as around fishing banks in the offshore regions[127].

5.6.2 Current status

Cetaceans are highly mobile species, therefore measures for their protection extend internationally. Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters has been produced[128]. All cetacean species within Orkney waters are currently listed in Annex IV of the EC Habitats Directive as 'Animal species of community interest in need of strict protection' and are classed as European Protected Species[129]. In addition, Bottlenose dolphin and Harbour porpoise are also listed in Annex II as 'Animal species of community interest whose conservation requires the designation of Special Areas of Conservation (SAC)'; however, no SACs are currently planned or designated in Orkney waters for the conservation of dolphins or porpoises.

Cetaceans are also given protection by policies in the Orkney Local Development Plan, Scotland's National Marine Plan and the Pilot Pentland Firth and Orkney Waters Marine Spatial Plan. At the regional marine planning level, much of the data comes from sightings, thus limited systematic data currently exist on the species in Orkney waters, including key areas for feeding or migratory routes. Of the twenty cetacean species most often seen in Scottish waters, eighteen have been recorded around Orkney[130]. Of these, seven species are most commonly recorded close to our coasts: Atlantic white-sided dolphin; Harbour porpoise; Minke whale; White-beaked dolphin; Risso's dolphin; Common dolphin and Killer whale. It is important to identify that all but one of these species are odontocetes (toothed whales), as this has implications for management and likely severity of impacts from some activities and in particular when it comes to noise.

Cetaceans are highly mobile and there is a lack of information in relation to population abundance, seasonality of presence, distribution and habitat use in the Orkney marine region for all cetacean species. There are distribution maps of relative abundance available for the north-west European waters[131]. The map below shows the recorded local cetacean sightings from January 2000-July 2019; the data are provided by the Orkney Wildlife Information and Record Centre.

Orca © Bruce Flett

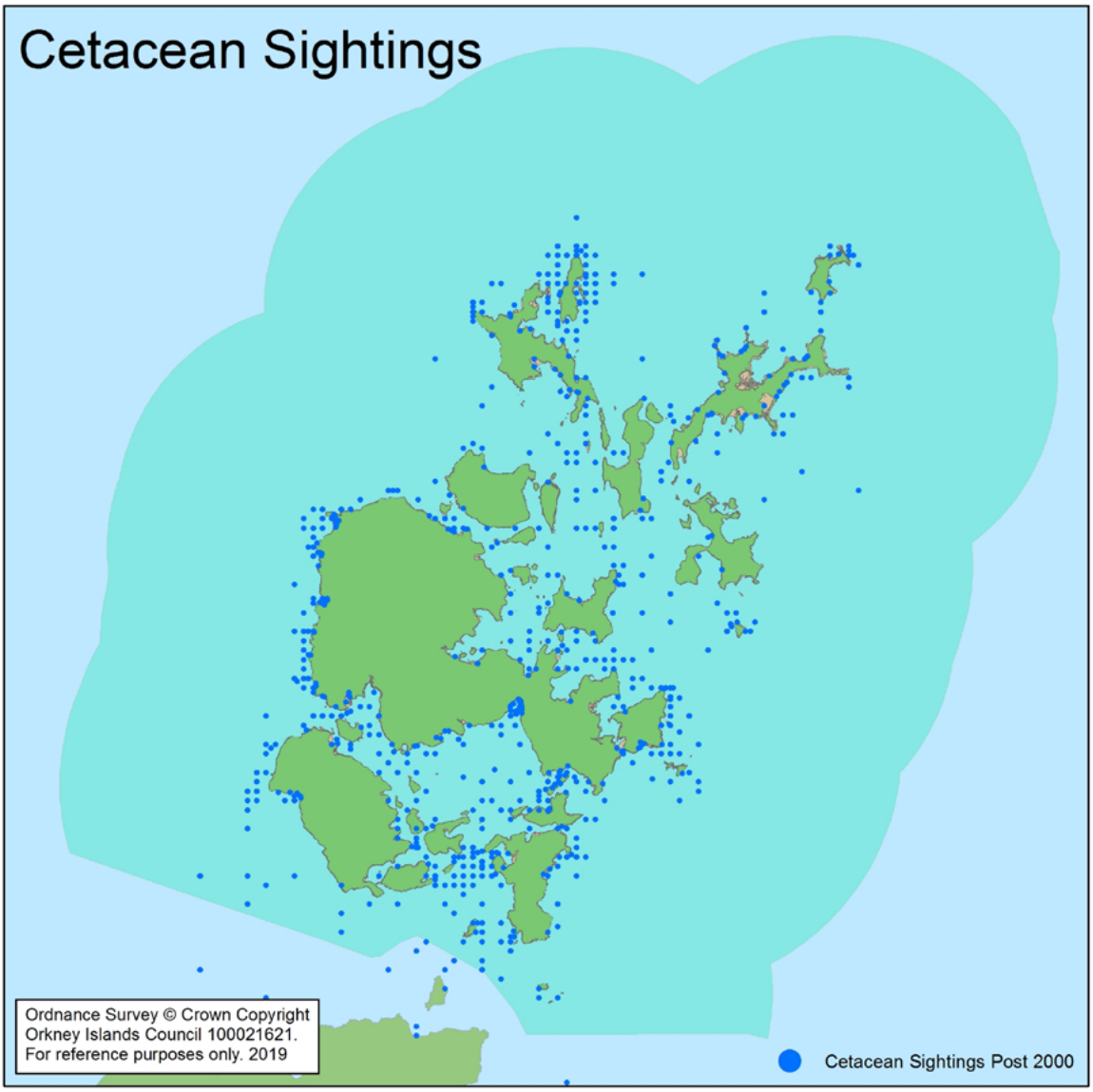


Figure 24 Map of Cetacean Sightings January 2000 – July 2019 (data provided by the Orkney Wildlife Information and Record Centre).

5.6.3 Pressures and trends

Pressures on cetaceans in Orkney are:

- Climate change;
- Barrier to species movement;
- Collision;
- Disturbance: Visual and Displacement;
- Entanglement;
- Litter;
- Noise;
- Pollution.

There are many implications from changes in climate that will affect cetaceans, particularly in relation to prey distribution, abundance and displacement or loss of foraging areas. Changes to weather patterns will also affect prey availability and for baleen whales, harmful algal blooms are a known source of mass mortalities.

The aquaculture (see Section 6.3) and renewable energy sectors (see Section 6.5) have the potential for barrier effects to species movement and collision risk, as well as disturbance and displacement and pollution effects.

Coastal developments and vessel disturbance, strike noise and contaminants are also key considerations e.g. from harbour and renewable energy development. Tidal turbines in Orkney waters and many of the threats and impacts, e.g. from seismic survey and sonar, associated with such devices, are still unclear, but could have acute impacts. Although data on this topic are limited, there is a growing knowledge base; EMEC have collected data on the interactions between tidal turbines and birds and marine mammals in Orkney waters.

Fishing activities are known to cause entanglement problems within Orkney's waters (see Section 6.2) and this is recognised as an animal welfare issue. Entanglement can lead to drowning, impaired movement, deep tissue laceration, infection and starvation. Entanglement also present serious safety issues for those involved in disentangling animals and a financial cost to fisherman due to loss of gear.

Scottish Entanglement Alliance is a partnership between six organisations dedicated to promoting and protecting Scotland's wildlife, heritage and sustainable marine industries. It researches the incidence and impacts of marine animal entanglements in Scottish waters. Over the last 20 years, Minke whale are the species most frequently recorded as dying from entanglement. In September 2019, a pregnant Minke whale was found dead on a Sanday shore, with fishing net jammed in the animal's baleen, the filter-feeding system inside its mouth.

The events highlighted above demonstrate the need to have suitably trained volunteers and equipment available at short notice to help ensure cetaceans at risk have the best chance of survival in such situations. Orkney has a team of British Divers Marine Life Rescue qualified and trained volunteer medics, albeit with limited equipment locally.

Ingestion of marine plastics and microplastics is another recognised pressure, (see Section 2.11).

Acoustic Deterrent Devices (ADDs) are designed to deter predation by seals at marine fish farms or from industrial activity such as pre-piling work for offshore wind construction. ADDs impact odontocetes due to the nature of the noise they produce (i.e. high frequency sounds) whilst low frequencies may impact Minke. They are unlikely to have such an impact on baleen whales, which utilise lower frequency bands. Renewable energy developments also have noise associated with construction (e.g. pile driving) and running of turbines. There are also more chronic noise sources from shipping and vessel traffic, as well as noise from seismic surveys and sonar, all of which can have impacts. Whilst there have been many studies on the impacts of ship noise on marine mammals[132] [133], limited data are available for Orkney Waters. See Section 2.12 regarding noise impacts.

Disorientation and stranding can also occur as a result of damage to the ears and hearing loss from various sources. Therefore, it is important to identify the source of noise and likely recipient, as well as likely exposure, as all these factors will have a bearing on the potential impact of severity of pressure in the region.

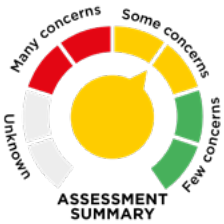
It has been noted locally that some species which are more familiar with the topography of the area are less likely to become stranded, but strandings may also occur in species unrelated to topographical familiarity. In other instances, it is due to one of the animals in a pod being sick or injured. Other species, such as sperm and pilot whales, tend to arrive in inshore waters due to navigational error; species are more likely to become stranded in shallow bays and inlets. Stranded cetaceans are recorded in the Scottish Marine Animal Stranding Scheme (SMASS), which has been in operation since 1992. It is part of the Cetacean Strandings Investigation Programme (CSIP) and is funded by the Scottish and UK Governments. The records include dead animals washed up and those that have successfully re-floated.

Pollution and contaminants can lead to bioaccumulation of fat-soluble toxins in blubber[134]. These may cause longer term impacts on, for example, breeding and feeding success. In addition to the above anthropogenic pressures, a natural pressure for Harbour porpoise or Minke whale is predation by Killer whales.

5.6.4 Assessment Summary

Multiple pressures have been identified for cetaceans within the Orkney marine region. Some pressures have been clearly demonstrated e.g. entanglement, whilst others, e.g. effects of noise in Orkney, are less well known. As highly mobile species, the trends for the local populations are unknown as there is little comprehensive data collection and monitoring of the populations, therefore the data confidence is low.

Table 19 Cetacean Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Cetaceans	Climate change; Barrier to species movement; Collision; Disturbance: Visual and Displacement; Entanglement; Litter; Noise; Pollution.			

5.7 Commercial Fish and Shellfish and Wider Fish Community

Sea trout, Orkney © Puck Kirkpatrick

Summary

- The lifecycles of commercial fish and shellfish generally take place across variable scales that do not coincide with regional or national administrative boundaries therefore there is limited Orkney specific data.

5.7.1 Introduction

The species of fish and shellfish exploited commercially comprise deep-water (>400m), demersal (close to the seabed), pelagic (open water) and shellfish species. Within the Orkney marine region, there are no deep-water areas; the depth ranges between around 0 to 110m therefore contain a variety of demersal, pelagic and shellfish species.

5.7.2 Current Status

Most of the local commercial fishing in Orkney is centered around shellfish rather than finfish due to the current limited access for the local inshore fleet to fish EU quota species. The key species landed in Orkney are brown crab (*Cancer pagurus*), velvet crab (*Necora puber*), and king scallops (*Pecten maximus*) but other important commercial species include queen scallops (*Aequipecten opercularis*), European lobsters (*Homarus gammarus*), 'prawns' (*Nephrops norvegicus*) and whelks (*Buccinum undatum*). Note the term 'prawns' is generally used by the industry to refer to Nephrops (also known as *Norway lobster; scampi or langoustine*) rather than to actual prawn and shrimp species. Although not landed in Orkney, there are many species of finfish that are resident and are fished in Orkney waters, including Mackerel, Cod, Haddock, Herring, Saithe, and Hake (see Section 6.2).

The lifecycles of commercial fish and shellfish generally take place across variable scales that do not coincide with regional or national administrative boundaries. However, this varies according to species; for example, whelk populations function at a relatively small scale, i.e. much smaller than a marine region. It is therefore important that sustainable fisheries management is coordinated at an appropriate spatial scale for each species. Section 6.2 provides more information on the data for commercial fisheries in Orkney; the associated assessments were due to be updated in 2020.

Wider Fish Community

Summary

- Basking shark, Flapper skate and Sea trout are Priority Marine Feature fish species found in the Orkney marine region.

5.7.3 Introduction

Scotland's sea fish range from tiny gobies that dart across rock pools to the world's second largest fish, the basking shark. Sea fish species that are considered significant from a conservation perspective are identified on Scotland's list of Priority Marine Features (PMFs). PMFs in the Orkney marine region are identified in Appendix 3.

All fish form a key part of food webs, providing food for other fish, seabirds, marine mammals and, as they decompose, food for many other marine species. An estimated 250 species of fish occur in Scottish territorial waters (i.e. within 12 nautical miles of the coast)[135]. The bulk of fish species are bony fish but there are also a small group of cartilaginous fish known as elasmobranchs i.e. sharks, skates and rays.

Basking shark © NatureScot

5.7.4 Current status

For non-commercial stocks, there are limited, if any, data available for many species. For example, Atlantic salmon may pass through Orkney's waters during their migration, but there are no salmon rivers in Orkney and their actual routes are not precisely known. Shoals of Sandeels can be found around Orkney and form a key part of the diet for many seabirds, including the iconic Puffin. Regional data on their status is not known, but they are thought to be declining.

The Sea trout is listed as a Priority Species in the UK Biodiversity Action Plan and the Scottish Biodiversity List. In its marine phase it is also included on the list of Priority Marine Features (PMF). The Orkney Trout Fishing Association (OTFA) has monitored several key Sea trout populations in Orkney from 2004-2008. Around 80 burns have now been surveyed by electrofishing, with Sea trout being found in the following:

- the Burn of Eyrland in Stenness;
- the Bu Burn and the Mill (Kirbister) Burn in Orphir;
- the Graemeshall Burn in Holm;
- the Burns of Voy (Ocklester) and Quoykea (Sebay) in Toab;
- the Burns of Wideford and Gill in St Ola;
- the Burns of Rennibister, Rossmyre, Binscarth and Holland (Burness) in Firth;
- the Burn of Cruan (Isbister) in Rendall;the Burns of Woodwick and Desso (Aikerness) in Evie;
- the Mill Burn in Stromness;
- the Sourin and Hullion Burns in Rousay; and
- the Whaness, Lyrawa, Mill, Ore, Heldale and Rackwick Burns in Hoy.

Data from these studies indicate that juvenile density in Sea trout burns varies between sites and between years but tends to occur within the range of zero to just over three trout per square metre of burn. 36 separate Brown trout populations have been identified in Orkney comprising fish aged up to 5+ years, with evidence of anadromy detected in 23 populations plus Loch of Harray, Stenness, Boardhouse and Hundland[136]. A data gap has been identified to undertake a local study to increase understanding of the abundance and distribution of Sea trout in Orkney coastal waters (see Section 8.1).

Loch of Harray and Stenness also produce sea trout each year; smolts have not been sampled here due to the practical difficulties of sampling the system. Sea trout migrate into the loch each year. Smolts have also been caught in the Boardhouse and Hundland system by anglers.

Flapper skate (*Dipturus intermedius*) is the largest skate species, reaching lengths of about 2.5m and is listed as Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List. It is a Priority Species under the UK Post-2010 Biodiversity Framework. The species has been recorded at sites all around Orkney waters from the shallow coastal areas around the North Isles and in Scapa Flow to the deeper waters off the West Mainland coast[137]. They are strong swimming fish, so adapted to the local fast-flowing tidal waters. They can be found over various types of seabed but prefer sandy and muddy areas.

The Orkney Skate Trust (OST) is a non-profit charity that is working towards building a robust dataset regarding the Flapper Skate. They have undertaken tag and release and baited underwater camera data recording in Orkney waters. A Skate project is being taken forward by OST under the North Isles Landscape Partnership Scheme which will enable the trust to continue to gather data and raise local awareness about species conservation. OST also uses citizen science for recording sightings of egg cases commonly known as 'Mermaid's Purses'.

Basking sharks, which are a PMF species, are regularly seen in waters around Orkney. This species is listed as a Priority Marine Feature and is protected under the Wildlife and Countryside Act 1981 (as amended 1985) and on the OSPAR list of threatened and declining species. Basking sharks are also listed on the IUCN red list as endangered in the north-east Atlantic, and vulnerable worldwide and on Appendix II under CITES.

5.7.5 Pressures and trends

The effects of climate change on commercial fish and shellfish and the wider fish community are generally unknown, but potentially significant. Warming waters may force some species further north and lead to competition from new species colonising the area.

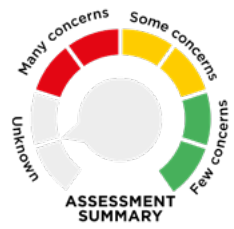
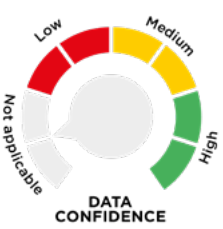
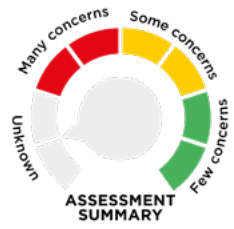
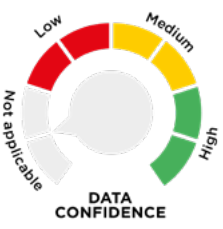
Abrasion and physical disturbance of seabed can occur due to seabed infrastructure or bottom contacting gear from activities such as fishing, harbour developments and renewable energy, which in turn can impact on all fish and shellfish species due to competition for space with expanding and new developments that may encroach key nursery sites. In addition, fishing causes the removal of target and non-target species.

Sea trout, in particular juvenile fish entering the sea from spawning burns, are vulnerable to infection by the sea lice species Lepeophtheirus salmonis. Heavy lice burdens can kill individual infected fish and have potential to impact on Sea trout at the population level. Sea lice are naturally occurring parasites which are routinely present in low numbers within fish populations; however, the intensive nature of Atlantic salmon aquaculture creates the potential for large numbers of lice larvae to become concentrated within certain areas, increasing the risk of infection in wild fish (see Section 6.3).

5.7.6 Assessment Summary

Whilst pressures such as climate change, disturbance, parasite infection or the removal of species have been identified, data for the current status of wider fish communities and shellfish populations are not available at the Orkney marine region level, therefore the current trends are not known. As such an assessment category has not been assigned and associated data gaps have been identified in Table 33.

Table 20 Commercial Fish and Shellfish, and Wider Fish Community Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Commercial fish and shellfish	Climate Change; Disturbance; Removal of target species;			
Wider fish community	Climate change, Disturbance; Removal of non-target species,			

Common starfish © Rebecca Kavanagh

5.8 Invasive Non-Native Species

OICHA Rapid Assessment Survey Gutter Sound Navigation Buoy onboard Pole Star © Jenni Kakkonen

Summary

- A monitoring programme for marine and brackish non-native species (NNS) initiated by Orkney Islands Council (OIC) has recorded 15 NNS in Orkney, though none of these are invasive, therefore do not currently pose a threat to the Orkney marine environment.

5.8.1 Introduction

Invasive non-native species (INNS) in our seas have potential to have significant impacts on both biodiversity and the economy. Away from their native habitats, and given the right environmental conditions, non-native species have the potential to grow quickly and displace native species. They could then become the most dominant species in the area, changing the balance of existing biodiversity, becoming INNS.

5.8.2 Current status

A monitoring programme for marine and brackish non-native species (NNS), ongoing since 2012, was initiated by OIC recorded 15 NNS. The details of the case study monitoring can be found in the journal paper referenced[138]. In summary, the most wide spread non-native species found were red algae *Melanothamnus harveyi* and *Bonnemaisonia hamifera*, the bryozoan *Schizoporella japonica* and the Japanese skeleton shrimp *Caprella mutica*[139].

Orkney Islands Council Harbour Authority has developed a policy for Ballast Water Management (BWM) in Scapa Flow[140]. This policy is in line with the responsibility to enable the safe, economic, and environmentally sustainable operation of the piers and harbours. Figure 25 represents the monitoring sites located around Orkney. With the greater awareness of the threat of invasive non-native species, pathogen inductions and poor water quality that indiscriminate ballast water release could pose, the existing policy precludes ballast water discharge within Scapa Flow. An exception is made in the case of certain vessels that are subject to a pre-agreement considered to afford a high level of protection from oil pollution[141].

In particular, the policy applies to all vessels over 400 gt within or using the Scapa Flow Oil Port or Anchorage Facility as defined by the harbour authority limits, and to vessels carrying out ship-to-ship oil or liquid gas and operations within 500m radius of designated ship-to-ship locations within Scapa Flow, further information is provided in Section 6.4.

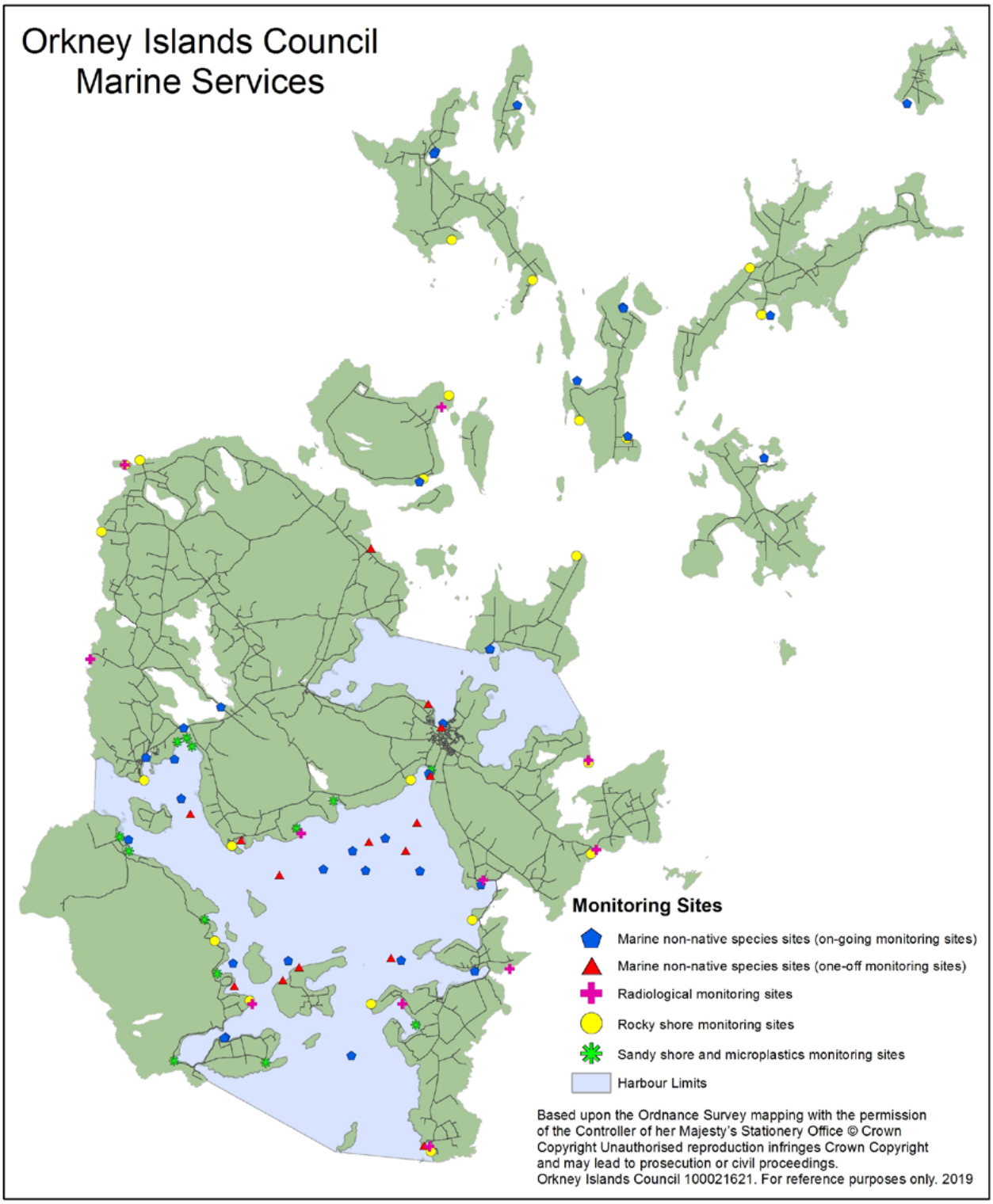


Figure 25 Orkney Islands Council Marine Services Non-Native Species Monitoring Sites

5.8.3 Pressures and trends

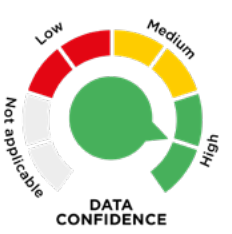
For clarity, the pressures come from the potential introduction of INNS, rather than any pressures on the INNS. The JNCC PAD tool identified the potential for INNS in many low risk scenarios, but not in the medium-high risk category (see Section 1.8), except for aquaculture. In the Orkney context, climate change has the potential to affect non-native species which are present in the marine environment by triggering them to become established and invasive. For example, the predicted sea water temperature rise in Orkney could increase the chance of some non-native species becoming established. This in turn can alter food webs and biodiversity species richness and abundance.

The potential vectors for the transport of marine non-native species into Orkney waters include rafting on floating marine litter, aquaculture, shipping and ballast water and recreational craft. The development of the renewable energy installations may also contribute to the spread of non-native species. At present, Orkney has a small number of non-native species, but none are invasive, therefore do not currently pose any significant threats to the Orkney marine environment. Though, it is acknowledged that the potential routes of infection are open which could cause greater concern in the future.

5.8.4 Assessment Summary

Climate change and aquaculture are identified as the greatest risk to the potential for invasive non-native species becoming established in Orkney's waters. Lower level risk also comes from the growth of other economic sectors including recreation and tourism, and the management of ballast water (see Section 6.4). With more activity planned in and around Orkney with different vessel types, there are some concerns regarding the potential for increased pathways for the introduction of invasive species. As key sites are monitored on a regular basis, and the data shows no increase in INNS the identified trend is static, and data confidence is high.

Table 21 Invasive Non-Native Species Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Invasive non-native species	Alter food webs; Outcompete native species			

5.9 Summary of Biodiversity Assessment

Climate change pressures are, and will have, significant effects on coastal and marine biodiversity in Orkney. They are affecting key environmental conditions including sea temperature, sea-level, weather patterns, feeding, breeding and species distribution patterns. In addition, the growth in marine development and activities has potential to adversely affect a variety of biodiversity in the Orkney marine region. Cumulatively, these pressures can lead to decline in population status and density, and many other associated issues.

Regardless of the scale at which these pressures are being exerted, there are actions that are and can be taken at an Orkney level to help improve the status of marine habitats and species. Regional marine planning has significant potential to improve our knowledge and understating of Orkney's marine environment. Through effective planning and decision making, many impacts can be minimised or mitigated.

Table 22 Biodiversity Assessment Summary

Topic	Pressure	Assessment	Trend	Data confidence
Designated Nature Conservation Sites	Climate change; Barrier to species movement; Collision; Disturbance; Overfishing; Pollution. Disturbance	As there are many designated sites with varying site condition status, an overview assessment of the sites would be of limited value. Refer to Appendix 2 for individual site condition assessments.		
Birds	Climate change; Collision; Disturbance; Marine litter	Many concerns	Deteriorating	Medium
Grey Seals	Pollution	Few concerns	Static	Medium
Harbour Seals	Pollution	Many concerns	Deteriorating	Medium
Cetaceans	Climate change; Barrier to species movement; Collision; Disturbance: visual and displacement; Entanglement; Marine litter; Noise; Pollution	Some concerns	Unknown	Low
Commercial Fish and Shellfish	Climate change; Disturbance; Removal of target species	Unknown	Unknown	Not applicable
Wider Fish Community	Climate change; Disturbance; Removal of non-target species	Unknown	Unknown	Not applicable
Invasive Non-native Species	Alter food webs; Outcompete native species	Some concerns	Static	High

Section 6: Productive coasts and seas

PHOTO CREDIT: EUROPEAN LOBSTER (*HOMARUS GAMMARUS*) AND COLEY/SAITH (*POLLACHIUS VIRENS*) IN THE BACKGROUND © MATT COLEMAN, ORKNEY SUSTAINABLE FISHERIES

6.1 Introduction

The marine and coastal environment and its associated resources are rich and diverse assets that provide significant socio-economic benefits and future opportunities. Orkney communities have a strong reliance on marine resources for economic value, jobs, food, transportation and recreation. The marine, or Blue, Economy has contributed towards the creation of jobs and relatively high levels of prosperity in Orkney over many years from sectors including fishing, aquaculture, ports and harbours, oil and gas, renewable energy and tourism.

Environmental pressures connected with marine development and activities can alter the functioning and structure of Orkney's marine and coastal ecosystem. Sustainable management and planning are therefore essential to support economic productivity alongside a healthy coastal and marine environment.

This Section of the state of the marine environment assessment identifies the marine economic sectors that are currently active within the Orkney marine region, and where data are available, the economic value and trends associated with these sectors. Economic contribution, employment and production and data confidence levels have been assessed in accordance methodology outlined in Section 1.8.

The pressures connected with these economic activities have been identified by applying the JNCC PAD tool and have been informed by local stakeholder input. The pressures have in turn been assessed in relation to the physical, historic environment, climate change and biodiversity features presented in Sections two to five.

Firstly, an economic and demographic profile provides an overview of key characteristics and trends.

Economic and demographic profile

Summary

- Orkney is Scotland's smallest local authority with an estimated population of 22,190 in 2018, which is 0.4% of the total population of Scotland.
- In 2018, Orkney had a Gross Value Added (GVA) per head of £28,600; this puts Orkney, broadly in line with the UK average and around 10% higher than the Scottish average.
- A higher proportion of the population in Orkney is older, when compared with Scotland as a whole; in 2017, the median age in Orkney was 47.4, this compares to a Scottish-wide figure of 42.

Orkney is a relevantly prosperous area of Scotland, with low levels of unemployment and relatively high levels of household income as compared to the Scottish average. Orkney performs strongly on wider socio-economic measures, including life expectancy, levels of social deprivation and quality of life. Key socio-economic challenges include remoteness from traditional economic and government centres, fuel poverty, transport connectivity and a trend towards an aging population.

Innovation, research and development in renewable energy, zero-carbon fuels and local energy networks have established Orkney as a globally recognised centre of excellence. These emerging sectors thrive alongside a buoyant agricultural, tourism and marine economy. One key issue affecting our understanding and measurement of the Orkney economy, and particularly the marine economy, is a lack of robust, reliable and locally specific economic data (see Section 8.1).

Gross Value Added (GVA) per head is a useful indicator of the amount of economic activity that takes place within an area. In 2018, Orkney had a GVA per head of £28,600. This puts Orkney, broadly in line with the UK average and around 10% higher than the Scottish equivalent figure. The 2018 Office of National Statistics data shows that Orkney has the fifth highest GVA per head in Scotland after Scotland's major cities and the Shetland Islands. Unemployment in Orkney has, and remains, much lower than the Scottish and UK levels. Employment rates in Orkney are consistently close to 90%[142].

Orkney is Scotland's smallest local authority with an estimated population of 22,190 in 2018, which is 0.4% of the total population of Scotland. A key challenge for remote island communities is maintaining a stable population. Orkney has a higher average population growth when compared to the Scottish average, with Orkney's population increasing 3.6% between 2011 and 2018, as compared to 2.6% population growth for Scotland.

A higher proportion of the population in Orkney is older, when compared with Scotland as a whole. In 2017, the median age in Orkney was 47.4. This compares to a Scottish wide figure of 42. This trend is projected to continue, and if unaddressed, will create increasing economic and public service delivery challenges. The National Records of Scotland population data predicts that the 75+ age group in Orkney is projected to increase by 40.4% between 2016 and 2026[143]. A more balanced age demographic may be required in order to support a buoyant economy and the sustainable delivery of public services.

Given the magnitude of recent events, it is important to consider socio-economic factors within the context of the coronavirus pandemic. The pandemic has had a major impact upon the immediate outlook for the economy. It is anticipated that the Scottish and Orkney economy will enter a sharp economic downturn, though the long-term economic impacts, and effect across many aspects of life, are currently unclear. It is anticipated that the economic impact of the pandemic will be temporary, though it is likely to affect many ways in which we work and do business for the long-term. There is also growing recognition that traditional models of economic growth may need to be replaced with a greater focus on wellbeing, inclusive growth and sustainability. It is envisaged that global drivers including the pandemic, and transition to zero carbon, will make Orkney a more attractive place to live and do business in the future.

Furthermore, the uncertainties of Brexit present a number of challenges to the economy, to trade and to the legal context within which we plan for the future. Agriculture and the fishing industry face significant change whether that be to markets, subsidy or regulation. There are opportunities for the local inshore fishing sector to diversify and benefit from access to quota species post Brexit (see Section 6.2.3).

6.2 Commercial Fisheries

Creel boat, Stronsay © Shona Turnbull

Summary

- Orkney's fishing industry is worth around £14 million to the Scottish economy, with an average vessel Gross Value Added (GVA) of £67,600, supporting nearly 300 jobs.
- Commercial fishing in the Orkney marine region is predominately undertaken by inshore creel boats under 10 metres.
- The Marine Scotland Scottish Sea Fisheries Statistics show that there were 128 active Scottish registered vessels in Orkney in 2018.
- There has been a declining trend in the total landings in Orkney in recent years from 4,009 tonnes in 2014 to around 3,373 tonnes in 2018, though within the same period, the value of landings in Orkney has increased from £7.7 million to £8.9 million.
- Key pressures include removal of target species, removal of non-target species, wildlife entanglement, abrasion and physical disturbance of the seabed.

6.2.1 Introduction

Fishing is a traditional industry in Orkney with a long and varied history dating back to at least Neolithic times. Most of Orkney's fishing activity take place in inshore waters between 0-6 nautical miles. The inshore fleet is composed of predominately smaller vessels under 10m in length. The majority of these vessels target a static gear mixed crustacean fishery of crab and lobster.

Fishing grounds are widespread around Orkney's coastline and different areas are used seasonally by fishers depending on the target species. Scapa Flow and the North Isles provide key sheltered fishing grounds for the inshore fleet in winter months. A significant component of overall landings in Orkney is from crabbers fishing offshore, in waters to the west of Orkney.

In 2013, Regional Inshore Fisheries Groups (RIFGs) were established as part of the Scottish Government Strategic Plan to provide local management of the inshore waters out to 6 nautical miles. RIFGs play an important role in inshore fisheries management and represent inshore fishing interests within Marine Planning Partnerships. Orkney Sustainable Fisheries (OSF) undertakes the role of RIFG in Orkney, supporting fisheries management, development and sustainable practice.

6.2.2 Current status

Orkney's fishing industry is worth around £14 million to the Scottish economy, with an average vessel Gross Value Added of £67,600, supporting nearly 300 direct fishing jobs[g]. Commercial fishing in the Orkney marine region is predominately undertaken by inshore creel boats under 10 metres fishing mainly Brown crab (*Cancer pagurus*), see Figure 26. King Scallop (*Pecten maximus*), Queen scallop (*Aequipecten opercularis*), European lobster (*Homarus gammarus*), Norway Lobster (*Nephrops norvegicus*), Pink shrimp (*Pandalus borealis*), Velvet crab (*Necora puber*), Shore crab or Green crab (*Carcinus maenas*), Whelk (*Buccinum undatum*) and Periwinkle (*Littorina littorea*) are also important commercial shellfish species.

The seas around Orkney support significant populations of commercially important species of finfish. Fishing targets both demersal and pelagic stocks in the waters adjacent to the Orkney. These include Haddock (*Melanogrammus aeglefinus*), Cod (*Gadus morhua*), Monk or Anglers (*Lophius piscatorius*), Mackerel (*Scomber scombrus*), Herring (*Clupea harengus*), Hake (*Merluccius merluccius*), Lemon sole (*Microstomus kitt*), Megrim (*Lepidorhombus whiffiagonis*), Ling (*Molva molva*), Saithe (*Pollachius virens*) and Whiting (*Merlangius merlangus*). The distributions of these stocks and their species are mainly governed by two partially inter-related factors, depth and the physical nature of the seabed.

Seafish publishes annual statistics on recorded landings for all commercial species based on vessel records of catches within International Council for the Exploration of the Sea (ICES) Rectangles[144]. The ICES Rectangles do not correlate with the 12 nautical mile boundaries of the Orkney marine region. ICES Blocks 46E5, 46E6, 46E7, 47E5, 47E6, 47E7 and 47E8, 48E6, 48E7 and 48E8 include areas of the Orkney marine region.

The Scottish White Fish Producers Association has advised that there are three white fish demersal vessels that fish within 12 nautical miles of the Orkney coast. One of these vessels also targets squid and prawns. There are no landings of white fish in Orkney. Vessel monitoring system (VMS) fishing intensity spatial data on National Marine Plan Interactive shows that demersal mobile fishing takes place in the waters that straddle the 12 nautical mile limit to west of Orkney Mainland and the waters around Sule Skerry and Sule Stack. There are four pelagic vessels that fish mainly for mackerel in Orkney waters. Mackerel fishing occurs within 12 nautical miles immediately to west of Orkney and herring fishing take place across the Orkney marine region.

In 2018, 4,860 fishers were working on Scottish based vessels, representing 0.2 per cent of the total Scottish labour force. Although employment in the fishing fleet is a small percentage of total employment in Scotland, employment in fishing accounts for a higher percentage of employment in island communities (Shetland 3%, Orkney and Na h-Eileanan Siar local authorities 2% each and in Argyll and Bute 1%)[145]. The total number of fishers employed in Orkney has fluctuated from 335 in 2005, peaking in recent years in 2013 at 442 and remaining relatively stable in the region of 300 between 2014 to 2018.

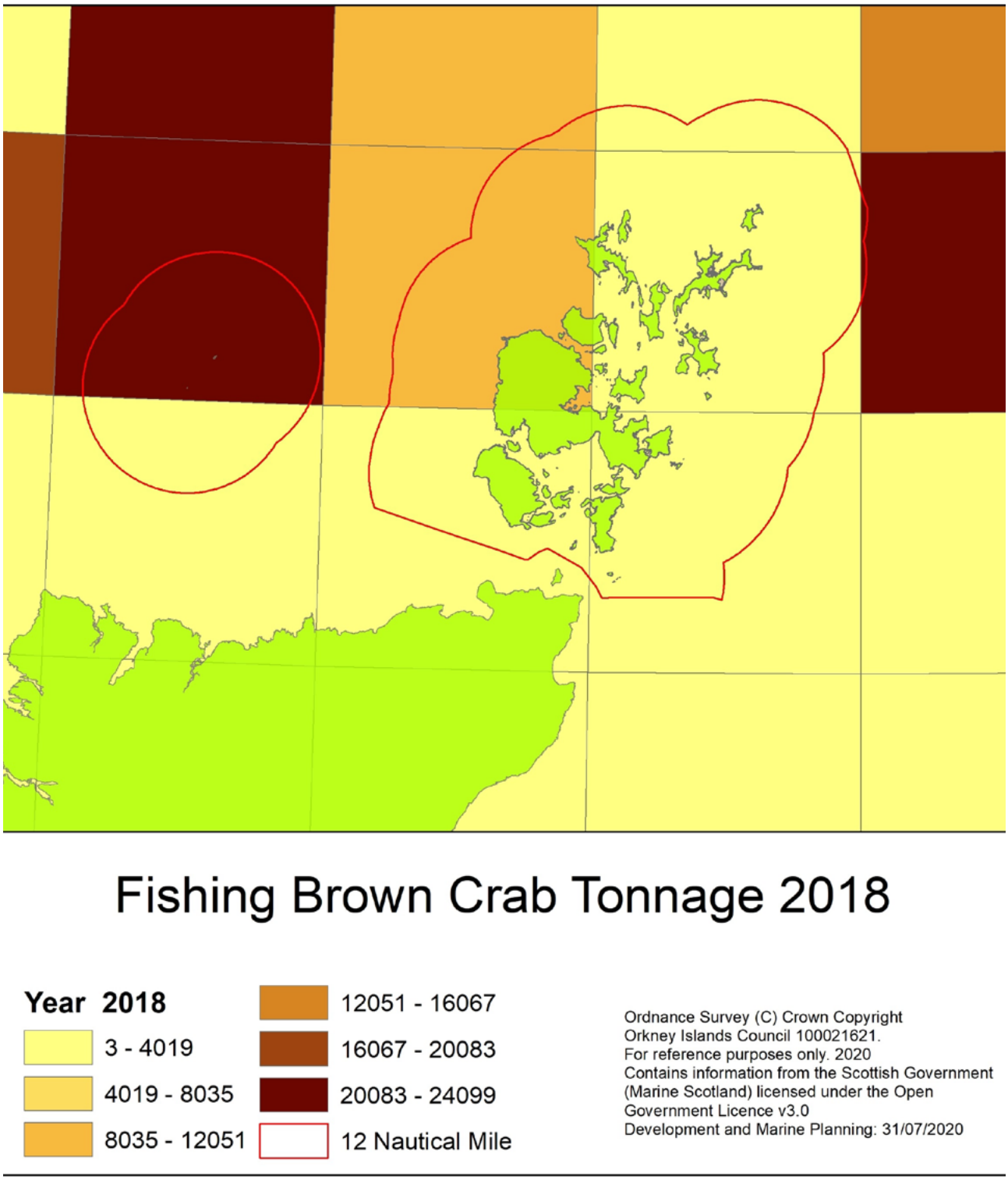


Figure 26 Landings in Orkney (tonnes) of brown crab (*Cancer pagurus*)

The Marine Scotland Scottish Sea Fisheries Statistics show that there were 128 active Scottish registered vessels in Orkney in 2018145. There has been a gradual year on year decline in the number of registered vessels in the Orkney fishing fleet over the past decade with 155 vessels registered in 2007.


Orkney fisheries © Mike Bell

There has been a declining trend in the total landings in Orkney in recent years from 4,099 tonnes in 2014 to around 3,373 tonnes in 2018. Though, within the same period the value of landings in Orkney has increased from £7.7 million to £8.9 million. The key characteristics of the Orkney fishing industry are shown in Table 23.

Table 23 Summary of statistics for Orkney fisheries 2018

Item	Number	Commentary
Number of voyages	3,685	Vessels within 6nm; increasing trend from 2,570 voyages in 2012
Quantity of Shellfish landings (tonnes)	3,336	Majority of landings are brown crab (2,285 tonnes)
Quantity of Fish landings (tonnes)	49	13 tonnes Pelagic; 36 tonnes Demersal
Total Value (£'000)	8,896	There has been a fluctuating trend in the value of landings in Orkney since 2014.
No. of vessels ≤10m	92	Under 10 metre vessels make up the vast majority of the Orkney fishing fleet.
No. of vessels >10m	36	The over 10m vessels include demersal trawl, nephrops trawl and creel fishing vessels.
Total number of vessels	128	There has been a gradual year on year decline in the number of registered vessels in the Orkney fishing fleet over the past decade.
Number of fishers employed	291	230 regularly employed; 61 irregularly employed

The principal method of fishing for king scallops, *Pecten maximus*, in Orkney waters is hand collection by divers in relatively localized patches of seabed.

Recent research by the Isle of Man fishing industry has shown benefits of having managed areas for scallop dredge fishing grounds[146]. An Orkney scallop tagging project undertaken by the International Centre for Island Technology, Heriot-Watt University and Orkney Fisheries Association described patterns of spatial turnover in a scallop population at a small spatial scale.[147] The main finding was that turnover (value) on a strip of ground 178m by 4m averaged more than 25% per month over the year and could be up to 50% per month during the summer months.

Dredging for scallops also takes place in Orkney waters. Vessel monitoring system (VMS) data on NMPi shows that the highest intensity areas for scallop dredging activity are to the east of South Ronaldsay and the Orkney Mainland, in the North Sound between Sanday, Papa Westray and North Ronaldsay[148], and in the offshore areas to west of Orkney. The Orkney Fisheries Association has reported that larger nomadic scallop vessels have been fishing scallops in North Sound, Scapa Flow and Hoxa Head during 2020.

There are two main processing businesses in Orkney: Orkney Fishermen's Society (OFS) Stromness and Westray Processors, Pierowall. OFS is a co-operative, largely owned by inshore fishermen. It handles the largest share of Orkney's lobster, velvet and brown crab catches. The OFS factory in Stromness can process up to 60 tonnes of live crab per week. The company sells into both UK retail and export markets. Westray Processors produce premium quality fresh and frozen crabmeat for a wide range of wholesale and retail customers in Orkney and elsewhere in the UK. The business provides a sales outlet for Westray's fishing fleet.

6.2.3 Pressures and Trends

The JNCC PAD tool (see Section 1.8) identifies that fishing activities currently taking place in Orkney waters have the potential to have adverse impacts on the marine environment through:

- Removal of target species;
- Removal of non-target species;
- Abrasion: physical disturbance of seabed.

This assessment considers these environmental impacts in the Orkney context and also presents an assessment of impacts on the fishing sector from other economic sectors in Orkney.

The removal of target species in Orkney is an issue that requires further data and sustainable management measures. Shellfish species are non-quota, therefore do not currently exist within a framework for regulating effort or landings. This is the main obstacle for defining sustainable fishing levels at national and regional levels and demonstrating sustainability for the removal of these species. OSF is working to provide an evidence base for assessment and sustainable management of Orkney fisheries. Improved knowledge of inshore species, fish and shellfish lifecycles, larval dispersal, nursery and spawning grounds has been enhanced over recent years with the aim to protect these stocks for the long-term benefit and sustainability of the fishery and fishing communities. Currently, these data are not publicly available. There are technical measures, such as

minimum legal sizes (most species, but most relevant for shellfish) and gear specifications (notably for scallops) that provide protection of spawning potential.

The ICES Maximum Sustainable Yield (MSY) approach to fishery management is based on a long-term strategy aimed at maintaining the stock at a productive level. Target exploitation rates (fishing mortality, denoted by F) are set at levels consistent with delivering MSY (FMSY). Precautionary management action is taken if spawning stock biomass falls below a pre-determined level (MSY Btrigger)[149] that represents the lower bound of fluctuation around the level associated with MSY. These criteria apply at a North Sea scale to quota species such as haddock and Norway lobster that are fished in Orkney waters. Equivalent criteria are not currently defined for non-quota inshore species such as brown crab and European lobster, which are managed principally by technical measures such as minimum legal size.

Wildlife entanglement, for example in creels and creel lines, occurs in Orkney leading to the potential removal of non-target species. Species of conservation importance that are particularly susceptible to entanglement are Basking sharks, Humpback whales, Minke whales and turtles[150].

Abandoned, lost, or otherwise discarded fishing gear cause several environmental pressures and impacts, some examples include the continued catch of non-target species, interactions with vulnerable or endangered species, physical impacts on the benthos, potential vector for INNS and introduction of synthetics into the food chain. Other impacts include litter, navigational hazards, loss of amenity, disruption to the enjoyment of clean beaches, concerns over maritime safety and additional costs due to the fouling of vessels[151]. Efforts have been made to remove discarded fishing gear from Scapa Flow, information on ghost fishing can be found in Section 2.11.2.

Habitats of conservation importance, for example biogenic reefs, are particularly sensitive to fishing methods such as bottom trawling and the associated impacts of seabed abrasion and disturbance. In Orkney, static gear fishing is the predominant method which is, by its nature, less damaging to the benthic environment. That said, benthic disturbance is associated with fishing practices in Orkney including scallop dredging and other bottom contact fishing gear.

Climate change, as discussed in Section 4, continues to have a significant impact on the marine environment. Specific evidence is lacking on impacts of climate change on commercially targeted species in Orkney waters, but a general tendency for species' ranges to shift northwards may be expected to cause both positive and negative impacts on both productivity and species composition over time scales of decades.

The growth of marine sectors in Orkney including aquaculture and renewable energy has created competition for space with the local fishing industry.

The potential impacts of developments and activities associated with other sectors on commercial fishing include:

- Loss of access to fishing grounds;
- Impacts on nursery and spawning areas for commercially-fished species, and associated habitats and species;

- Impacts from the displacement of fishing activities on fish stocks, the wider environment, the increased use of fuel by fishing vessels and the socio-economic costs to fishers and their communities;
- Impacts on safe access to marine space including the seabed, water column and sea surface, and navigational access to and from landfall areas that support fishing vessels;
- Impacts on the cultural and economic value of fishing, in particular to fragile coastal and island communities.

Marine development proposals need to be informed by data on the fishing, nursery and spawning grounds that deliver value for the fishing industry. This is an identified data gap in Section 8.1.

Marine Scotland has stated their policy intent to mandate Remote Electronic Monitoring on scallop and pelagic vessels by the summer of 2021, on the same timescale they will consider options for larger whitefish and Nephrops vessels as part of developing policy on future catching activity. Marine Scotland has also identified the need to increase vessel tracking to improve data on the inshore fleet activities, particularly for marine planning, as part of the Inshore Modernisation Programme.

Lobster catch © Rebecca Kavanagh

6.2.4 Assessment Summary

There has been a fluctuating trend in the value of landings in Orkney since 2014. Landing tonnage has decreased during this period though the value of landings increased from £7.7 million in 2014 to £8.9 million in 2018. Employment in fisheries in Orkney as a percentage of the population is second highest in Scotland, only lower than Shetland and fractionally higher than the Western Isles. The total number of fishers employed in Orkney has fluctuated from 335 in 2005, peaking in recent times in 2013 at 442 and remaining relatively stable in the region of 300 between 2014 to 2018.

Recent increased demand for Orkney shellfish from China and the Far East has increased catch value. This demand is, however, particularly volatile, subject to the geopolitics of international trade. The distance to many end markets, and the challenges associated with transporting live catch, impacts on the price received by local fishermen. The Orkney inshore fishing sector recognises that the local industry is overly dependent on shellfish, due to the regulatory history, and that diversification for the fleet would be both environmentally and economically desirable.

The coronavirus pandemic has significantly impacted export markets for Orkney shellfish and has adversely affected prices. The long-term effects of the pandemic on the sector are not currently clear though short to medium term impacts on employment in the local industry, markets and prices could be significant.

Brexit presents an opportunity for any additional quota opportunities to be distributed to benefit coastal communities. Marine Scotland intends to work with stakeholders to develop options for allocating additional quota opportunities differently, including community quota, new entrants and incentivising best practice. Much of this work depends on the level of additional quota that may be secured through future international negotiations, which is linked to the wider Brexit negotiations. The level of quota will influence the scope of what can be done to make additional quota available to fishers in coastal communities like Orkney.

Table 24 Commercial Fisheries Assessment Summary

Topic	Economic contribution	Employment	Production	Data confidence
Commercial Fisheries				

6.3 Aquaculture

Salmon farming, Orkney © Scottish Sea Farms

Summary

- Atlantic salmon (*Salmo salar*) is the only current aquaculture production in Orkney and forms the vast majority of finfish aquaculture in Scotland.
- Orkney currently has 22 active Atlantic salmon marine fish farm sites and no active shellfish farm sites.
- In 2018, the annual production of farmed salmon in the Orkney marine region was 20,956 tonnes a significant increase from 16,756 tonnes in 2017 and 14,752 in 2016.
- The value of farmed salmon produced in Orkney in 2018 was £118 million.
- Key pressures include physical disturbance of seabed, benthic impacts, visual disturbance, impacts on wild fish stocks, noise, landscape and visual impacts and impacts on other marine users and pollution.

6.3.1 Introduction

Aquaculture generally refers to marine fish farming which is legally defined in Scotland as finfish and shellfish farming including any kind of crustacean, mollusc or sea urchin. To date, seaweed is not included in this definition (see Section 1.6) therefore this Section focuses solely on marine fish farming.

Atlantic salmon (*Salmo salar*) is the only current aquaculture production in Orkney and forms the vast majority of finfish aquaculture in Scotland. The key shellfish species cultured in Scotland are blue mussels (*Mytilus edulis*) and Pacific oysters (*Crassostrea gigas*). However, neither of these two shellfish species are currently farmed in Orkney.

Marine fish farming requires planning permission under the land use planning system, as well as various other licences, permissions and a Crown Estate Scotland seabed lease.

6.3.2 Current status

Orkney currently has 22 active Atlantic salmon marine fish farm sites and no active shellfish farm sites. Further to this, new Atlantic salmon farm sites have been granted planning permission in Stronsay, near Hunda and at Lober near St Margaret's Hope. A number of potential new sites in the North Isles are currently undergoing Environmental Impact Assessment. There are two established finfish farm operators in Orkney; Cooke Aquaculture Scotland and Scottish Sea Farms.

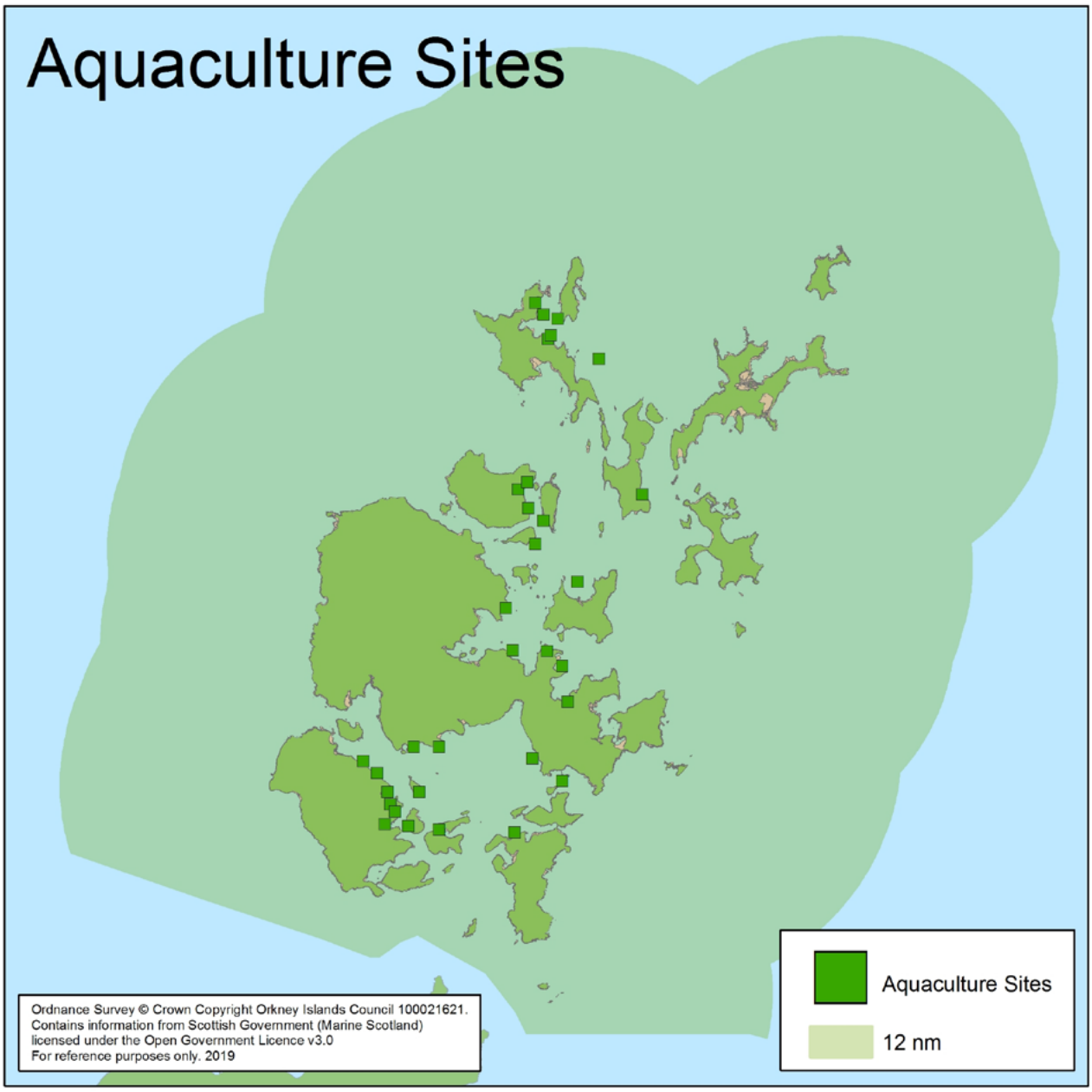


Figure 27 Aquaculture sites in Orkney

The Scottish Salmon Farm Production Survey 2018[152] contains data on the number of direct jobs and production tonnage for the salmon farming sector in Orkney. In 2018, the annual production of farmed salmon in the Orkney marine region was 20,956 tonnes; a significant increase from 16,756 tonnes in 2017 and 14,752 in 2016.

The value of farmed salmon produced in Orkney in 2018 was £118 million. Production levels since 2009 have fluctuated year by year although the broad trend has been one of increasing farmed salmon production.

In 2017, there were 108 full time and 9 part time direct jobs in the salmon farming sector in Orkney. In 2018, the number of jobs decreased to 96 fulltime. Over the period 2008-2018 Orkney salmon production increased by 266% resulting in a 55% (60-93) increase in employment[h].

The production survey for shellfish 2018 states there are no companies currently producing farmed shellfish in Orkney, but this is likely to change as pending permissions are progressed[153].

6.3.3 Pressures and Trends

The JNCC PAD tool identifies that aquaculture has the potential to cause pressures on marine environment through:

- Abrasion: physical disturbance of seabed;
- Benthic impacts; smothering and siltation; nutrient enrichment;
- Deoxygenation;
- Disturbance: Visual and Displacement;
- Impacts on wild fish stocks;
- Invasive Non-Native Species;
- Introgression with wild fish population;
- Noise;
- Nutrient enrichment;
- Parasites and disease passed on to wild populations;
- Pollution

The JNCC PAD tool identifies pressures from aquaculture associated with marine ecosystems and biological receptors. This assessment also considers wider pressures including those on landscape and seascape, the historic environment and other marine users.

Finfish cage sites impact upon the seabed. Inputs to the environment include fish feed, chemicals and medicines authorised for the treatment of sea lice and other fish health issues. Outputs from a farm include: uneaten food and therapeutants; faecal waste, dissolved nutrients; escapees and fish mortalities. Potential impacts on the benthic environment include enrichment with nutrient and carbon rich wastes, causing anoxic conditions to develop on the seabed. In addition, dissolved wastes may cause elevated levels of nutrients in the water column with potential impacts on water quality. Impacts on the benthic environment and water quality are regulated by SEPA under Controlled Activity Regulations (CAR) licensing regime. Mooring anchors can also cause disturbance to the seabed substrate and abrasion.

The Scapa Flow Aquaculture Water Quality Impact Modelling - Development Management Guidance provides an assessment of nutrient dispersion arising from existing and planned fish farms in Scapa Flow and the potential for cumulative water quality impacts[154]. Undertaken in 2018, the assessment considered impacts at a waterbody scale, beyond the immediate vicinity of the existing and planned fish farms.

The model predicts a low impact of dissolved nutrient release from fish farms, sewage treatment works and watercourse discharges, sufficient to maintain compliance with High Water Framework Directive Coastal Water Dissolved Inorganic Nitrogen (DIN) standards, with the exception of Water Sound where concentrations exceed this limit. Modelled watercourses discharging into Water Sound and St Margaret's Bay are the primary contributors to DIN (see Section 2.9) in this area. The results for Water Sound suggest an overall tendency for accumulation to occur, though the predicted DIN is deemed to be conservatively high i.e. an overestimate of actual impact. The contribution from planned and existing fish farms in this area was predicted to be minor.

The movement of vessels and gear associated with aquaculture, and other activities, creates a disturbance response in mobile species such as fish, marine mammals, seabirds and coastal birds. Disturbance to species and their displacement from a site can arise from the construction and the operation of fish farms. However, the magnitude of the pressure will depend on the nature, scale, intensity and duration of the activity, plus other factors such as species present and age, weather conditions and degree of habituation to disturbance source.

Coastal waters in Orkney support populations of Sea trout (*Salmo trutta*), a Priority Marine Feature (PMF), and species which forms part of a vibrant sport fishery, enabling angling tourism to make a significant contribution to the Orkney economy. Scottish Government's position on sea lice and sea trout reflects that there is evidence of an effect on wild sea trout at the individual level and lice can reduce the stock of wild sea trout returning to a river. These impacts need to be carefully managed through the planning system and other regulatory regimes managed by SEPA, Marine Scotland and NatureScot.

The key potential impacts of aquaculture development on wild salmonid fish populations are:

- impacts of parasites (*sea lice*) and disease on wild fish resulting from the presence of fish farms;
- disruption of genetic integrity and local adaptations of wild stocks arising from interbreeding with escapees from salmon farms; and
- introduction of non-native species.

Further information on Sea trout is provided in Section 5.7.4.

Acoustic Deterrent Devices (ADDs) are used at salmon farms as a method for deterring predation by seals. The use of ADDs can cause disturbance to cetaceans and other marine mammals (see Section 2.12).

Aquaculture development can have significant effects on the special qualities and characteristics of coastal landscapes and seascapes (see Section 2.8).

Orkney's coastal and marine historic assets have significant value as part of the county's cultural heritage (see Section 3). Aquaculture development can impact marine archaeology directly, through physical disturbance, or indirectly through changes in sediment regimes. Aquaculture developments can also affect the setting of coastal historic buildings and monuments.

Like other developments that occupy marine space and discharge to the environment, aquaculture can result in interactions and potential conflict with other marine users. These include interactions with commercial fisheries, shipping and navigation, Harbour Area operations (including ship-to-ship operations), pipelines, electricity and telecommunications infrastructure, recreation, sport, and leisure.

The growth of fish farming can put pressure on existing pier and harbour infrastructure where limited capacity exists for additional vessels to service new fish farm sites. The Orkney Harbours Masterplan – Phase 1 has sought to address these capacity issues, particularly at Kirkwall Harbour. Long term strategic planning can help to ensure that sufficient harbour infrastructure is provided to support the growth of the aquaculture sector.

Aquaculture development can have direct and displacement impacts on commercial fishing grounds (see Section 6.2) and potentially cause barrier effects on species movement.

Chemotherapeutants, such as Emamectin benzoate, have potential impacts on water quality and benthic ecology, relevant data has been collected through the survey of fish farms sites in Shetland[i]. Chemotherapeutants can potentially affect the developmental stages of crustaceans and associated fisheries, though these interactions are not currently well understood. There is currently a relatively low level of reported chemotherapeutant use in Orkney. However, the proposed expansion of salmon farm development in Orkney could lead to increased chemical pollution pressures.

The predicted trend is that finfish aquaculture production in Orkney will continue to increase in accordance with Scottish Government policy and industry targets. Recently, consented new salmon farm sites, and projects currently in the development pipeline, will increase production significantly in the coming years. Furthermore, the local salmon farming industry are currently progressing applications to increase biomass at existing sites. It is also anticipated that shellfish aquaculture will develop in Orkney as consented and emerging sites become operational.

The salmon farming industry is moving towards larger cages, higher biomass sites and locating farms in more high energy locations that benefit from higher tidal flows and improved waste dispersal. It is anticipated that current technical innovation in the sector will enable aquaculture development in offshore locations in the long-term future reducing pressures in more sensitive near shore locations. The industry is now also producing Environmental Management Plans, as required by Marine Scotland, to report on lice levels, model sea lice dispersal and collect data on wild fish interaction.

6.3.4 Assessment Summary

The growth of finfish and shellfish aquaculture production in Orkney has potential to create jobs, upskill the local workforce and benefit the local supply chain. The industry is however increasingly capital intensive. This means that growth in output is not matched by equivalent growth in employment. Significant productivity gains have been made through economies of scale and increasing automation.

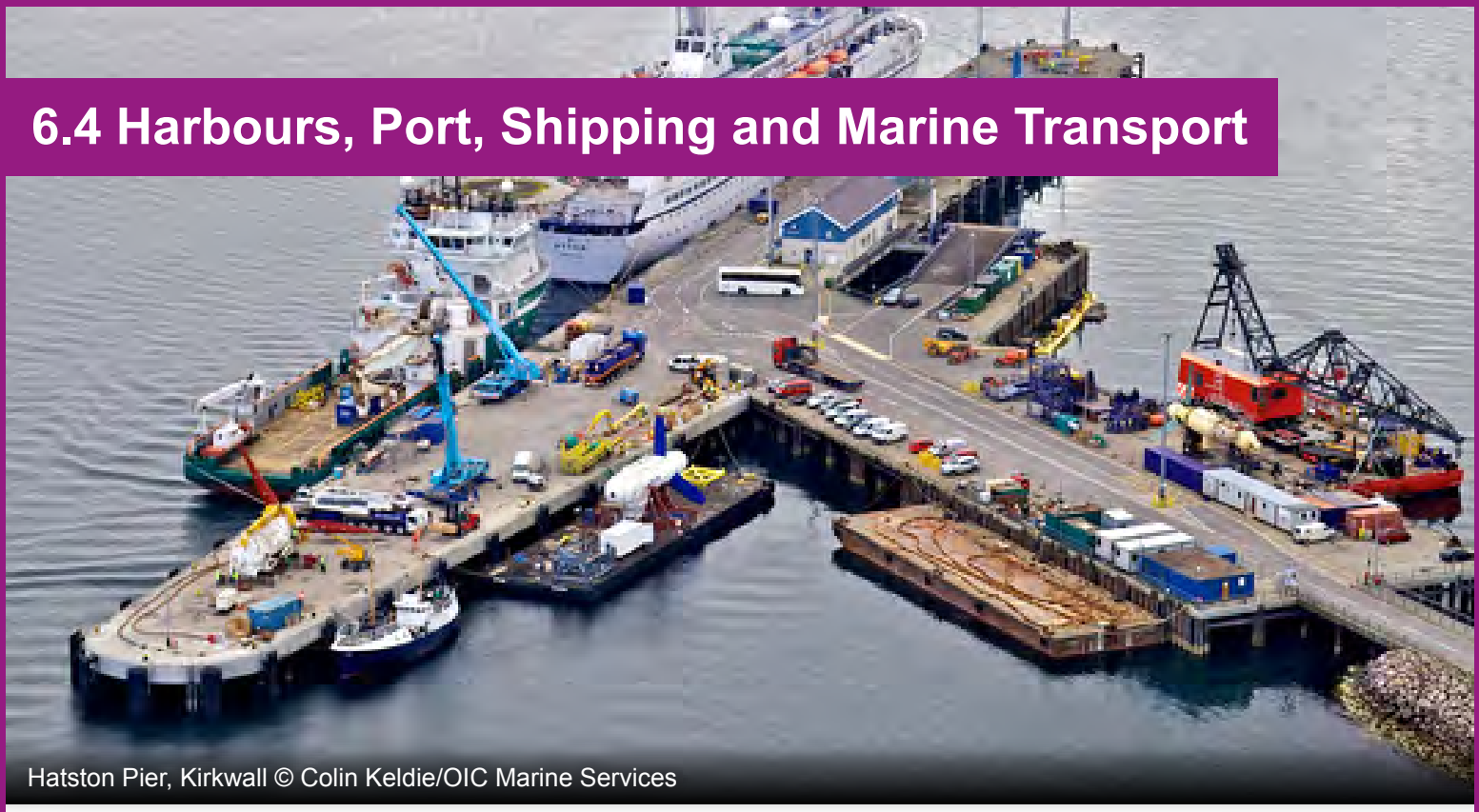
Production levels are predicted to increase for the salmon farming sector, creating more local employment and economic benefits. Aquaculture development can create significant economic benefits for peripheral island communities in Orkney.

Recruiting suitably qualified staff has been an issue for some fish farm sites in Orkney. The University of Highlands and Islands (Orkney Campus) has started to provide Modern Apprenticeships in Aquaculture and related training. This is still in an early stage of development but has allowed the staff of fish farming companies to be trained in Orkney. Training and upskilling the workforce will help to meet the local industries development ambitions and maximise employment opportunities for Orkney communities.

Table 25 Aquaculture Assessment Summary

Topic	Economic contribution	Employment	Production	Data confidence
Aquaculture				

6.4 Harbours, Port, Shipping and Marine Transport



Hatston Pier, Kirkwall © Colin Keldie/OIC Marine Services

Summary

- There are 29 piers and harbours operated by the Orkney Harbour Authority.
- Scapa Flow is Europe's largest natural harbour and a strategic asset of national significance.
- Orkney's Harbour Areas and infrastructure supports economic sectors and activities including oil and gas, ship-to-ship transfers, cruise tourism, marine renewable energy, ferry services, marine transportation, commercial fishing, aquaculture and marine recreation.
- In 2018, 34,973 passengers and 5,060 cars travelled on the Aberdeen–Kirkwall Northlink ferry service, and 153,312 passengers and 43,222 cars on the Stromness–Scrabster route.
- Orkney Ferries operate a fleet of inter-isle ferries connecting the Outer-North Isles, Inner-North and South Isles to the Orkney Mainland carrying over 82,000 vehicles and undertaking around 320,000 passenger journeys annually.
- Key pressures include penetration, abrasion and disturbance to the seabed, changes to coastal processes, noise and vibration, habitats and species disturbance, landscape and visual impacts.

6.4.1 Introduction

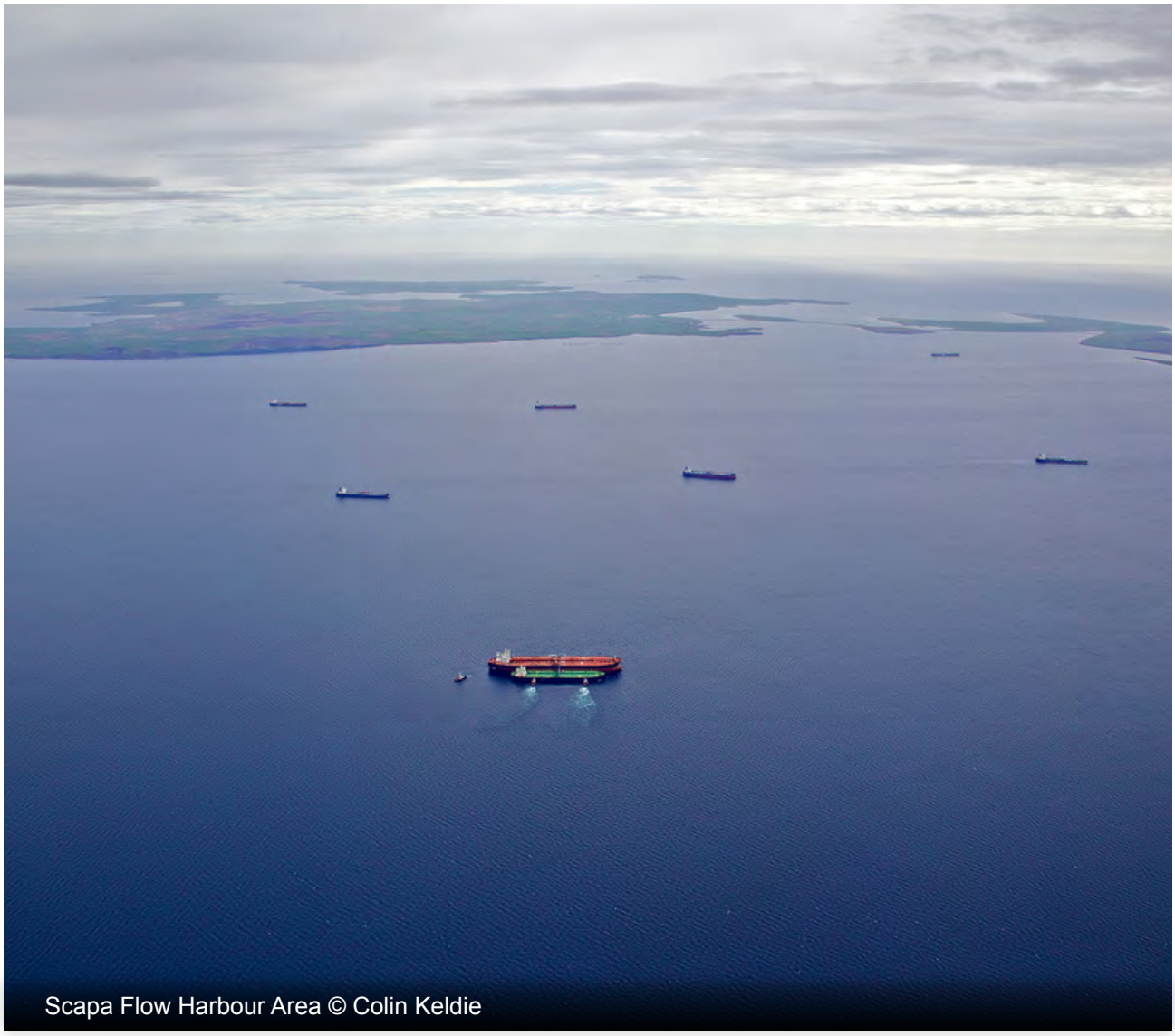
Orkney's piers and harbours provide vital infrastructure supporting every marine economic activity and the wider economy within the region. Islands communities rely on lifeline passenger and freight ferry services between the Scottish mainland and the inter-island ferry services connecting to North and South Isles. Harbour infrastructure needs to be developed, upgraded and maintained to ensure the future prosperity of Orkney and the ability to respond to changing markets and economic opportunities.

6.4.2 Current Status

There are 29 piers and harbours operated by the Orkney Harbour Authority, including Europe's largest natural harbour, Scapa Flow, which is a key strategic harbour asset identified in National Planning Framework 3, encompassing 125 square miles of sheltered water and anchorage (Figure 28). This diverse range of harbour infrastructure and facilities provides multiple berthing and anchorage options.

Orkney's Harbour Areas and infrastructure supports economic sectors and activities including oil and gas, ship-to-ship transfers, cruise tourism, marine renewable energy, ferry services, marine transportation, commercial fishing, aquaculture and marine recreation.

The Orkney County Council Act 1974 authorised Orkney Islands Council to exercise jurisdiction as a Statutory Harbour Authority (SHA) and defined the areas in which the new authority was empowered. These were Scapa Flow and its approaches, Wide Firth and Shapinsay Sound. These areas include Stromness, Flotta Oil Terminal, and Kirkwall. The Orkney Islands Council Order Confirmation Act 1978 and the Orkney Islands Council Harbour Revision Order 1989 extended jurisdiction to include 12 additional piers and harbours in the North Isles (Figure 28).



Scapa Flow Harbour Area © Colin Keldie

Figure 28 Piers and harbours

As a SHA, the Council's aim, through Marine Services, is to ensure that Orkney's piers and harbours are operated in a safe and cost-effective manner. Marine Services follow a Port Marine Safety Code, which is an advisory document, reflecting the minimum national standard. The Council is also keen to plan positively for the continued development and improvement of Orkney Harbour Areas, the associated infrastructure and landside facilities. The Orkney Harbours Master Plan Phase 1 provides a strategy for the long-term viability of the business, supporting investment in future growth and the development of infrastructure in response to predicted patterns of supply and demand[155].

The Orkney Harbour Authority operates as a business and is financially separate from the Orkney Islands Council General Fund. Any surpluses from relevant harbour business may be deposited in the Council Reserve Fund, which provides significant benefit to Orkney communities, supporting essential public services and facilities.

There are many smaller piers and harbours throughout the North and South Isles as well as across the Orkney Mainland: many of these accommodate island ferry services, aquaculture, fishing and marine leisure activities. These piers provide critical community infrastructure, particularly for Orkney's more peripheral island communities. Long-term planning and investment will be taken forward for these pier facilities in Phase 2 of the Orkney Harbours Masterplan in 2021.

Recent enhancements to harbour infrastructure in Orkney include an extension to Hatston Pier, making it Scotland's longest deep-water commercial berth with 385m, minus 10m Chart Datum of quayside; enhancements to Lyness on Hoy and the construction of a new pier in Stromness, Copland's Dock.

There is a Trust Port at St Margaret's Hope, which provides the terminal for the ferry service between St Margaret's Hope and Gills Bay, Caithness. This pier is privately-operated and supports significant freight transport. Another privately owned slip is at Deerness, which is operated by the Deerness Small Boats Owners Association.

Ferries, freight and shipping

Orkney relies on lifeline passenger and freight ferry services between Orkney and the Scottish mainland. In 2018, 34,973 passengers and 5,060 cars travelled on the Aberdeen–Kirkwall Northlink ferry service, and 153,312 passengers and 43,222 cars on the Stromness–Scrabster route. 18,770 passengers and 3,136 vehicles travelled between Kirkwall and Lerwick. Total ferry carryings to/from Orkney are greater than this as they include the Pentland Ferries vehicle service and the John O' Groats passenger service. The 2017 Orkney Visitor Survey shows an equal number of visitors use the Northlink and Pentland Ferries service across the Pentland Firth. Aberdeen is currently the dominant route for freight due largely to its connectivity south, access to the oil and gas supply chain and livestock markets.

Orkney Ferries operate a fleet of inter-isle ferries connecting the Outer-North Isles, Inner-North and South Isles to the Orkney Mainland. Nine vessels service 13 island destinations, carrying over 82,000 vehicles and undertaking around 320,000 passenger journeys annually.

Shipping fuel transition to decarbonization

A Sulphur Emissions Control Area (SECA) for the North Sea and English Channel came into effect under International Maritime Organisation (IMO) regulations from January 2015. Orkney Islands Council Marine Services view this as a catalyst for innovation and new business in relation to alternative Low Sulphur Fuel Oil (LSFO) provisions including Liquid Natural Gas (LNG).

Orkney Harbours aim to play a key role in the decarbonisation of shipping and ports as well as the transition from hydrocarbons to zero carbon fuels. The expected shift to carbon free fuels will require a stepped transition from LSFO and Marine Gasoil to LNG leading to future hydrogen and/or ammonia carbon free fuelling for shipping.

6.4.3 Pressures and trends

Port and harbour construction and operations and shipping has the potential to cause pressures on marine environment through:

- Penetration, abrasion and disturbance to the seabed;
- Changes to seabed type;
- Changes to coastal processes;
- Noise and vibration;
- Habitats and species disturbance;
- Pollution:
- Introduction of Invasive Non-Native Species (INNS).

The construction of port and harbour infrastructure can result in penetration, disturbance and abrasion of the seabed including structures driven (e.g. piled) into the seabed or placed on the seabed (e.g. geotextile bags or rock armour used in land reclamation). Shipping anchors can cause damage to the seabed upon deploying the anchor and the subsequent dragging and locking into the seabed. Anchor and mooring chains can cause abrasion and scour. The placement of structure(s), including harbour infrastructure and moorings, can lead to changes in seabed type and the permanent loss or change of habitat.

Coastal processes, including erosion and sediment transport, can be affected by the introduction of pier and harbour structures with associated effects on benthic habitats and coastal geomorphology. Detailed surveys and hydrodynamic modelling can inform harbour infrastructure design to minimise potential adverse impacts on coastal processes. Construction activities including drilling, piling, dredging and blasting can result in injury, disturbance and/or behaviour change due to noise including displacement impacts on species of conservation significance (e.g. cetaceans, seals, otters and birds). Vessel movements and survey equipment are further sources of underwater noise that can adversely affect these species (see Section 2.12).

Vessel movements and increases in the intensity of shipping associated with harbour development, can cause visual disturbance and displacement of birds particularly during the breeding and moulting season. Increased energy expenditure due to disturbance can have detrimental effects on bird populations (see Section 5.4).

Harbour development and activities can result in the release of pollutants and contaminants that, if not appropriately managed, can be detrimental to coastal water quality. These issues are regulated and controlled by SEPA including the management of discharges of surface water from ports.

Dredging activities can result in potential impacts from sediment re-suspension and distribution of contaminated sediments. These activities can cause deposition, smothering and physio-chemical related impacts on benthic habitats of conservation significance. Disposal of dredge spoil is carried out in licensed areas where it should not impact negatively upon vulnerable marine habitats or the activities of other marine users.

Port and harbour development can have significant effects on the special qualities and characteristics of coastal landscapes and seascapes (see Section 2.8).

Orkney's coastal and marine historic assets have significant value as part of the county's cultural heritage (see Section 3). Port and harbour development can impact marine archaeology directly, through physical disturbance, or indirectly through changes in sediment regimes. Port and harbour developments can also affect the setting of coastal historic buildings and monuments.

Port, harbour and shipping activities can introduce invasive non-native species (INNS) into Orkney waters e.g. via vectors such as vessels, equipment and plant or ballast water discharge. INNS can cause ecological disturbance and significant adverse socio-economic impacts. To minimise the potential for non-native species (NNS), the Orkney Harbour Authority has a Ballast Water Management Policy for Scapa Flow[156]. This policy applies to all vessels over 400 gross tonnes within or using the Scapa Flow Harbour Area. It aims to reduce the likelihood of pollution resulting from oil, chemical, heavy metals and transfer of non-native aquatic organisms and pathogens which may be contained within ships ballast water and associated sediments. The policy provides protection for the marine environment and the rich natural marine biodiversity within Orkney. In order to monitor the effectiveness of the policy, several sites are sampled on a regular basis (see Figure 29). This monitoring has found no INNS present in Orkney waters, more information on NNS can be found in Section 5.8.

Potential oil spill incidents are an identified pollution risk associated with Oil Port operations. In accordance with the Marine Management Organisation (MMO) Convention, Orkney has an Oil spill Contingency Plan which is designed to guide response personnel at OIC through the process required to manage an oil spill originating from operations within the sea area and is updated every 5 years.

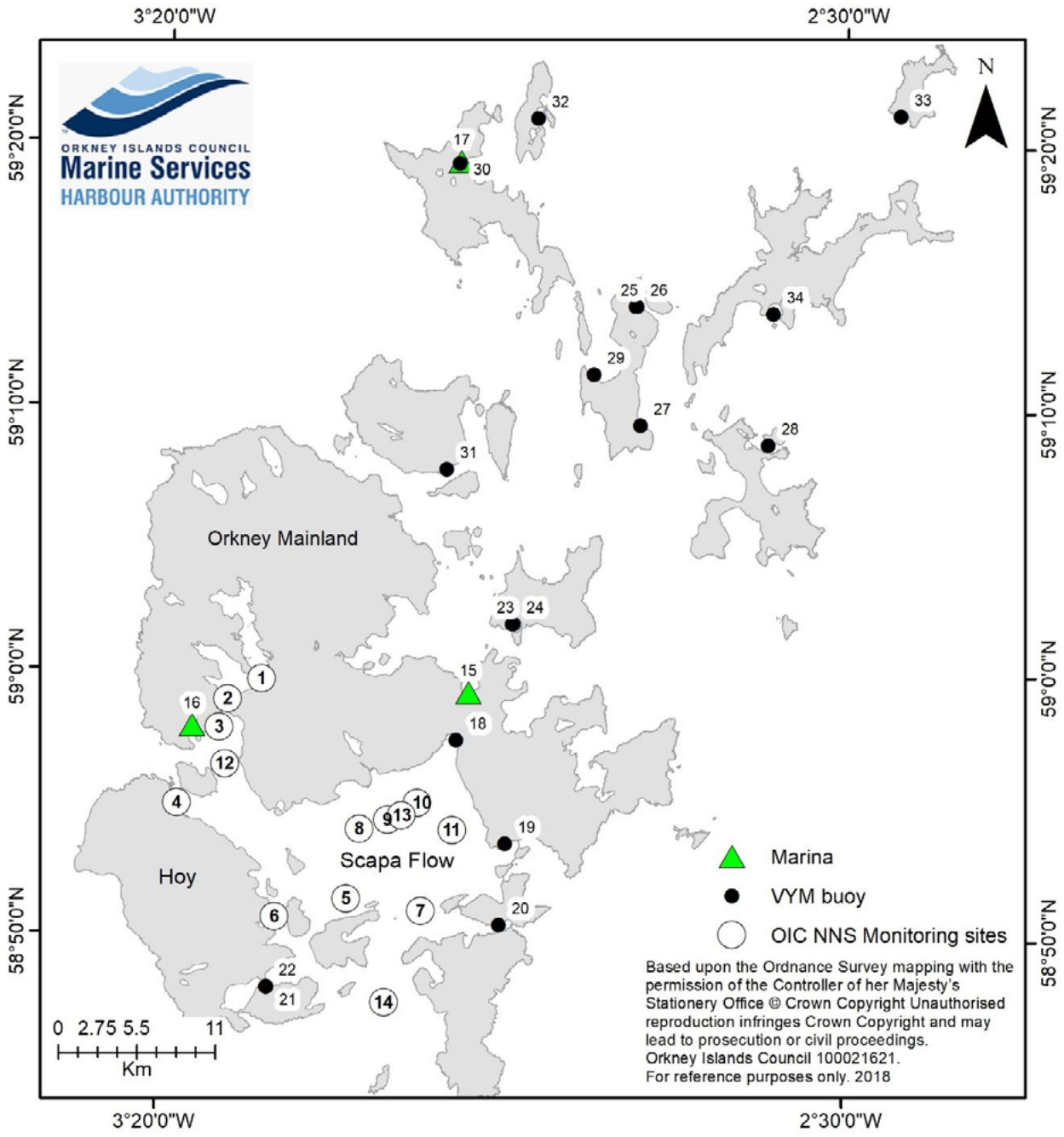


Figure 29 Location of monitoring sites in Scapa Flow (Further details can be found in the Ballast Water Management Policy for Scapa Flow)

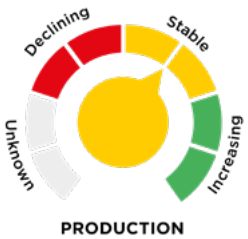
6.4.4 Assessment Summary

It is anticipated that there will be a significant increase in the development of new and extended harbour infrastructure over the next five to ten years in response to new opportunities in the aquaculture, shipping, oil and gas, renewable energy and marine tourism sectors. Adopted in April 2020, the Orkney Harbours Masterplan Phase 1 proposes new and/or extended harbour developments at:

- Hatston Pier
- Kirkwall Pier
- Scapa Pier
- Scapa Deep Water Quay
- Stromness and Copland's Dock and
- Lyness.

The diversification of harbour activities and development of harbour infrastructure aims to safeguard existing jobs and create new jobs in the coastal and marine economy. In doing so, these infrastructure investments aim to strengthen resilience and sustainability of the local community for the longer term. Overall the Gross Value Added (GVA), as a direct result of the proposed masterplan, rises to £9.7 million per annum after ten years, with an indirect and induced GVA of £5.0 million per annum in the same period and remains around that level for the remainder of the masterplan period[157].

Table 26 Harbours, Port, Shipping and Marine Transport Assessment Summary

Topic	Economic contribution	Employment	Production	Data confidence
Harbours, Port, Shipping and Marine Transport				

6.5 Offshore Wind and Marine Renewable Energy

Sr2000 © Orbital Marine Power Ltd

Summary

- European Marine Energy Centre (EMEC) was established in 2003 and provides a globally unique facility for testing wave and tidal renewable energy devices in Orkney.
- Sectoral Marine Plan for Offshore Wind Energy Draft Plan Option areas North 1 (N1) and North East 2 (NE2) have been identified for commercial-scale offshore wind development within the Orkney marine region.
- Key pressures include barriers to species movement, benthic impacts, changes in suspended solids, collision risk, disturbance to habitats and species, physical disturbance of seabed and noise.

6.5.1 Introduction

Europe's cumulative offshore wind capacity reached 22,072 MW at the end of 2019. Including sites with partial grid connection, there are now 110 offshore wind farms in 12 European countries and 5,047 grid-connected wind turbines[158]. The largest proportion of net offshore wind power capacity in 2019 was in the UK, with 1.76 MW capacity to the grid.

A 2016 estimate from the European Commission indicates wave and tidal power could account for 10% of the EU's energy needs by 2050[159]. Wave energy devices harness the movement of water carrying kinetic energy generated by waves. The size of the waves generated depends on wind speed, duration, distance of water over which it blows i.e. the fetch, currents and the bathymetry of the seafloor, which can focus or disperse the energy of the waves. Tidal stream technologies capture the kinetic energy of currents flowing in and out of tidal areas. Since relative positions of the sun and moon can be predicted with complete accuracy, so can the resultant tides. It is this predictable nature of tides that make tidal energy such a valuable energy resource.

Orkney is geographically well placed to contribute to achieving national renewable energy targets by utilising significant wind, wave and tidal energy resource. Scotland's National Marine Plan Interactive provides data on these resources in the Orkney marine region[160]. As noted in Section 2.7, the geology between the isles results in strong tidal flows and contributes to the value of Orkney waters and the Pentland Firth for tidal energy sites.

There is significant opportunity to utilise renewable energy resources in Orkney to produce hydrogen and other zero carbon fuels such as ammonia. It is anticipated that such fuels will play an important part in the transition to net zero carbon supplying terrestrial gas for homes and businesses, transport fuels and industrial processes.

6.5.2 Current Status

Figure 30 identifies the location of wave and tidal lease sites in the Orkney marine region. These include EMEC facilities and the tidal energy site at Lashy Sound between Eday and Stronsay. The Sectoral Marine Plan for Wind Energy Draft Plan Options areas are also identified.

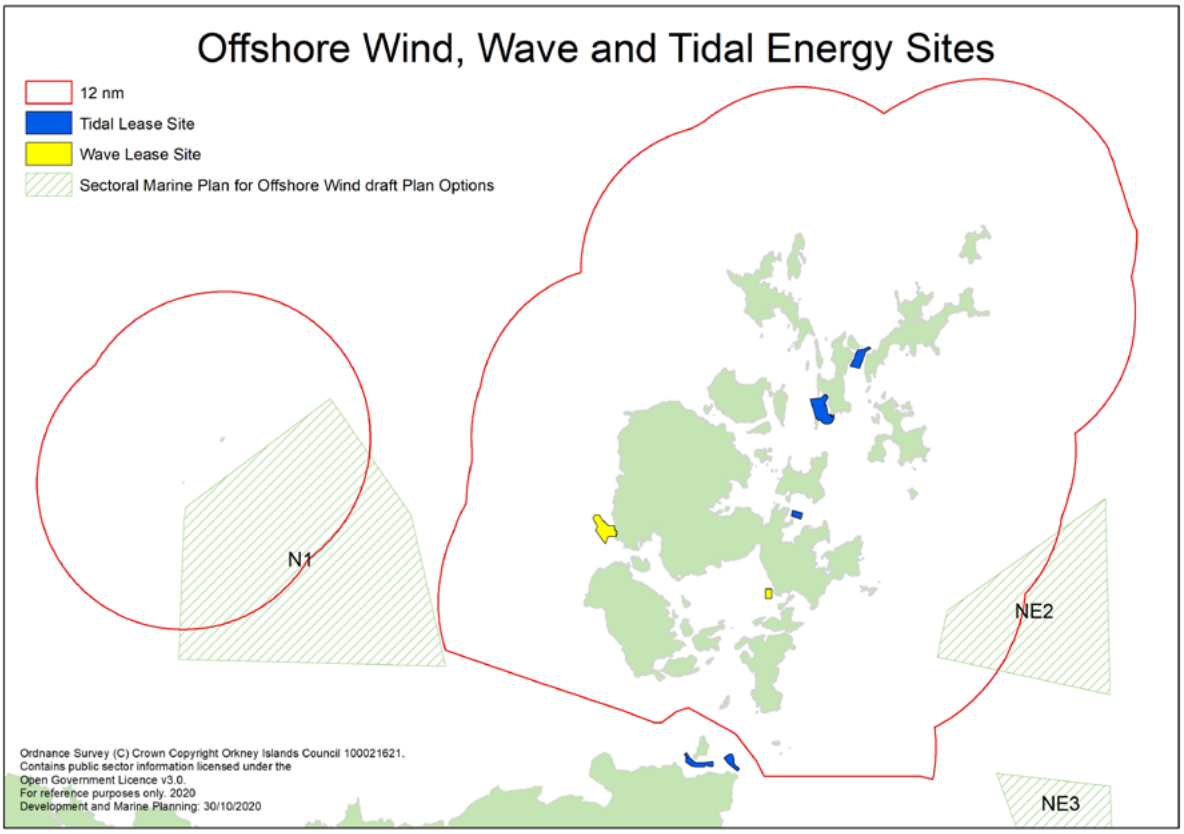


Figure 30 Offshore wind, wave and tidal energy sites

Offshore Wind Energy

In May 2018, Crown Estate Scotland announced proposals to lease seabed to encourage a new generation of offshore wind projects in Scotland's waters. Significant progress in the offshore wind industry paired with a focus on transitioning to a net zero economy created momentum for 'ScotWind Leasing'. The Scotwind leasing round is taking place throughout 2020–21, promoting the development of commercial scale offshore wind energy development areas in and adjacent to Orkney waters. Milestones such as the Offshore Wind Sector Deal 1 and Scotland's Climate Change Bill, targeting a date of 2045 for reaching net-zero emissions, have further confirmed the ambition to see Scotland as a major focus for offshore wind activity in the coming years.

In 2019, Marine Scotland prepared a Draft Sectoral Marine Plan for Offshore Wind Energy. The Draft Sectoral Marine Plan aims to identify the most sustainable areas for the future development of commercial-scale offshore wind energy in Scotland, including deep water wind technologies and covers both Scottish inshore and offshore waters. Commercial-scale offshore wind projects are defined as projects capable of generating more than 100MW of electricity. A public consultation for the Draft Sectoral Marine Plan was completed in March 2020.

The Sectoral Marine Plan for Offshore Wind Energy Draft Plan Option areas North 1 (N1) and North East 2 (NE2) have been identified for commercial-scale offshore wind development within the Orkney marine region (see Figure 30). 50% of Draft Plan Option area N1 and 34% of NE2 is located within the Orkney marine region. Draft Plan Option areas N1 and NE2 represent 8% of the Orkney marine region. Once adopted in late 2020, the Sectoral Marine Plan will set the future spatial framework for the development of offshore wind energy in Scottish waters[161].

Wave, Tidal and Hydrogen Energy

European Marine Energy Centre (EMEC) Ltd was established in 2003. It is an Orkney-based company that provides a globally unique facility for testing wave and tidal renewable energy devices. It uses purpose-built accredited open-sea testing facilities (see Figure 31)[162].

The company has five grid-connected test berths at the wave energy test facilities at Billia Croo, on the west coast of Mainland Orkney. EMEC's Fall of Warness site, located off the coast of Eday, offers developers of tidal energy technologies seven grid-connected test berths ranging from 12 to 50 metres in depth. Developers are attracted from around the globe to test their devices in some of the most challenging wave and tidal conditions. EMEC also operates two scale test sites where smaller scale devices, or earlier stage devices, can gain sea experience in less challenging conditions. The tidal site is located in Shapinsay Sound and wave site located at the east side of Scapa Flow.

In addition to wave and tidal sites, EMEC has an onshore hydrogen production plant at the Caldale site on Eday, which produces green hydrogen using renewable electricity from tidal energy converters testing at the Fall of Warness and from the Eday community wind turbine. This demonstration site for new hydrogen technologies is a key element of various hydrogen research projects in Orkney, including the 'Surf 'n' Turf' and 'Building Innovative Green Hydrogen in Isolated Territories (BIGHIT)'.

On board the Wello Penguin Wave Energy Converter 2 © Rebecca Kavanagh

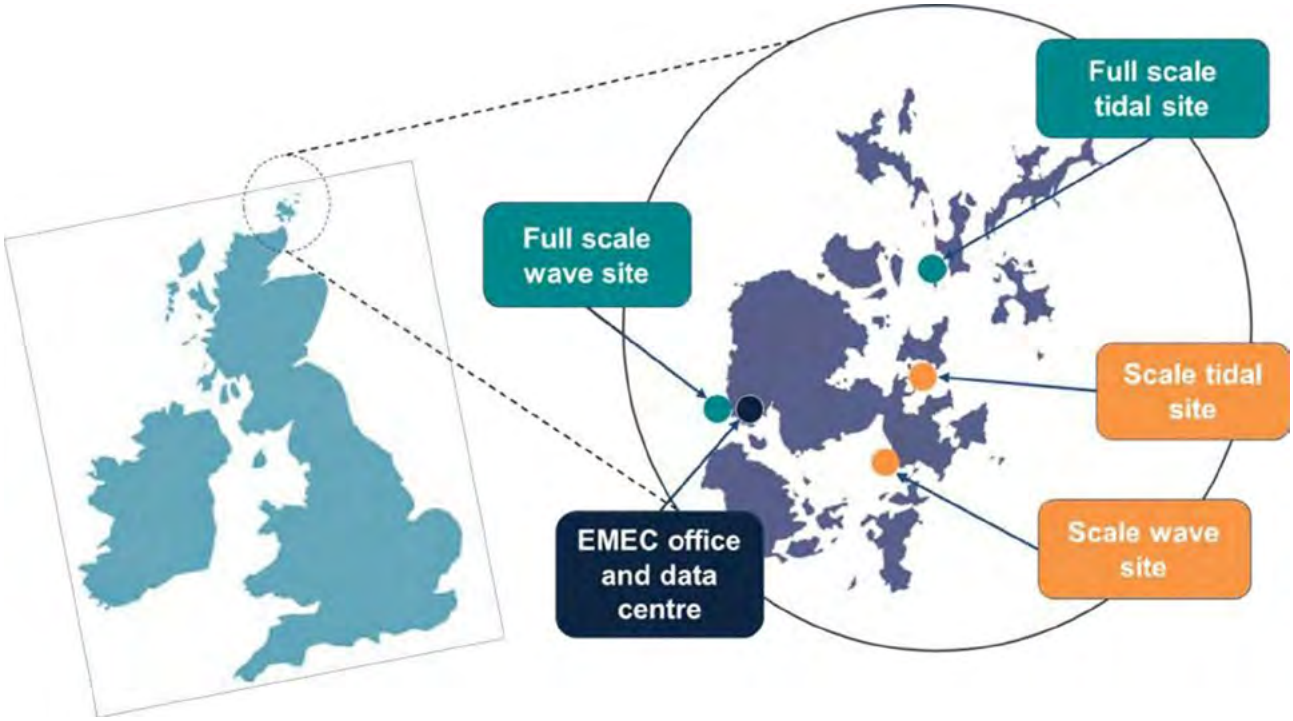


Figure 31 Location of EMEC facilities[163]

ReFLEX (Responsive Flexibility)

The ReFLEX project aims to decarbonise Orkney's current energy system, increase local use of renewable energy generation, and ultimately provide a competitive local renewable electricity tariff. ReFLEX's project partners include EMEC, Aquaterra, SOLO Energy, Heriot-Watt University and Orkney Islands Council, funded via UK Research & Innovation (UKRI) through the Industrial Strategy Challenge Fund. By creating an integrated energy system and software platform that will digitally link distributed and intermittent renewable generation to flexible demand, the project aims to reduce and eventually eliminate the need for fossil fuels. ReFLEX passed its first stage of the project following a review by UKRI in January 2020 and has moved onto phase two. 2020 will see the launch of a local electricity tariff tailored to the needs of ReFLEX's innovative integrated energy system[164].

6.5.3 Pressures and trends

The JNCC PAD tool identifies that renewable energy development and activities (wind, wave and tidal) have the potential to cause pressures on the marine environment through:

- Abrasion: physical disturbance of seabed;
- Barrier to species movement;
- Benthic impacts; smothering and siltation; changes in suspended solids (water clarity); nutrient enrichment;
- Changes in suspended solids (water clarity);
- Collision;
- Disturbance: Physical change to another seabed type;

- Disturbance: Visual and Displacement;
- Habitat loss: wave devices and related infrastructure;
- Habitat structure changes: substratum extraction;
- Noise;
- Physical loss (to land or freshwater habitat);
- Vibration;
- Water flow (tidal current);
- Wave exposure changes.

Knowledge and data regarding the interactions associated with offshore wind, wave and tidal energy developments differ as these industries are at varying stages of maturity. The associated pressures and impacts vary in relation to the technology type, size, structure and siting of the device(s). However, certain impacts are common to all three technology types but will vary on the exact cause or scale of impact. Different impacts also occur during the deployment/construction, operation, maintenance and decommissioning phases of a development.

The installation of offshore wind, wave and tidal energy device foundations or anchors and associated infrastructure can lead to abrasion and disturbance of the seabed through the placement of the infrastructure, associated scour protection and the use of jack up barges and other installation vessels.

The use of dredging in the preparation of the seabed for foundations to ensure a smooth, horizontal seabed for foundation installation and subsequent deposition of the cleared material, and the deposition of any drill arisings following drilling of the seabed for installation of foundations have the potential to lead to localised and temporary increases in siltation rate. This can also cause benthic impacts including smothering and changes in suspended solids. The level and area of impact depend on a number of factors including localised hydrodynamics, type of foundation and seabed substrate.

Offshore wind, wave and tidal energy devices, particularly in arrays, can cause obstructions to species movement by creating a physical barrier. Barrier effects can also be created by prolonged exposure to noise, light, visual disturbance or changes in water quality. The presence of vessels and associated structures as devices are installed can cause temporary barrier to species movement. Structures may also alter wave and tidal flow patterns, along with coastal processes.

Collision risk associated with wave and particularly tidal stream renewable energy structures is well recognised[j] for marine mammals, birds and fish, though often these collision risks are difficult to assess and quantify. Bird and mammal collisions with vessels can also occur, particularly at night on lighted ships near coastal areas and in poor visibility.

The installation of offshore wind, wave and tidal energy device foundations and associated infrastructure causes the seabed substrate to change from e.g. muddy sand to e.g. concrete or metal, which can alter the ecological communities in the vicinity as species colonise the infrastructure. Similarly, any dredging required will have similar effects. The noise and vibration during installation, operation and decommissioning of infrastructure may cause disturbance to a variety of species (see Section 2.12).

Offshore wind, wave and tidal energy development can have significant effects on the special qualities and characteristics of coastal landscapes and seascapes (see Section 2.8).

Orkney's coastal and marine historic assets have significant value as part of the county's cultural heritage (see Section 3). Offshore wind, wave and tidal energy development can impact marine archaeology directly, through physical disturbance, or indirectly through changes in sediment regimes. These developments can also affect the setting of coastal historic buildings and monuments.

Like other developments that occupy marine space, renewable energy development can result in interactions and potential conflict with other marine users. These include interactions with commercial fisheries, shipping and navigation, pipelines, electricity and telecommunications infrastructure, recreation, sport, and leisure.

The growth of renewable energy development can put pressure on existing pier and harbour infrastructure where limited capacity exists for additional vessels to service new development sites. These developments can result in impacts on shipping and navigation and commercial shipping routes. The Orkney Harbours Masterplan – Phase 1 has enabled close engagement with the renewable energy sector to ensure that Orkney Harbours can play a central role in the deployment, operations and maintenance of renewable developments across the north of Scotland.

Additional pressures identified locally highlight that renewable energy development can have direct and displacement impacts on commercial fishing grounds, (see Section 6.2) and potential impacts on shipping, navigation and the commercial shipping routes, along with the potential to introduce invasive non-native species (see Section 5.8).

As wave and tidal stream technologies are at a relatively early stage of development, it is acknowledged that there remain knowledge gaps regarding how these technologies interact with the environment and the resulting potential pressures. There is ongoing research to provide the evidence required to better understand the impact that these technologies may have on the marine environment and existing marine users e.g. identifying important fishing and nursery grounds, fishing displacement, shipping, tourism and recreation interactions.[129]

As the wave and tidal energy sector develops, there is a need to continue to undertake monitoring to obtain the evidence needed to inform decision-making; Orkney is at the forefront of wave and tidal monitoring through the testing of technologies at EMEC.

6.5.4 Assessment Summary

Wave and tidal energy technologies are still at very early stages of development and still some way from commercial viability. Orkney has a significant resource which may come into play if the sector develops. However, Orkney continues to benefit significantly from pre-commercial activities around research, testing and innovation. This includes technology developers, testing (European Marine Energy Centre), supply chain and academia (see Section 6.8).

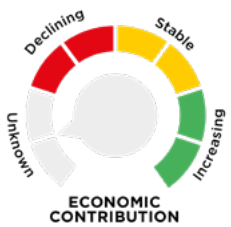
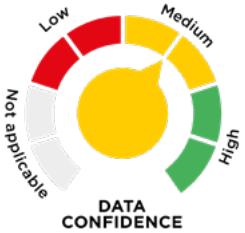
An assessment of the economic impact of EMEC's activities, commissioned by Highlands and Islands Enterprise, calculated a total GVA contribution to the UK economy of £285 million, with over 4,000 full-time equivalent (FTE) job years (1,653 of which were in Orkney) in the period 2003 to 2017. This assessment estimated an overall employment impact in Orkney, as of 2017, of 1,650 FTE job years equating to an average of 110 FTEs annually over the 15-year period (2003-2017). EMEC's total local spend in Orkney has been over £16 million, which equates to 50% of all EMEC spend 2005-2017. The cumulative supply chain impacts from EMEC's operational expenditure between 2003-2017 are 28 cumulative FTE years, cumulative earnings of £0.9 million and cumulative GVA of £1.7 million[165].

As of May 2019, approximately 200 jobs, are part or wholly, supported by the marine renewables sector in Orkney. To date, £23 million has been invested by Orkney Islands Council and Highlands and Islands Enterprise (HIE) in supporting infrastructure for the sector in Orkney. This has been supported by significant private sector investment[166].

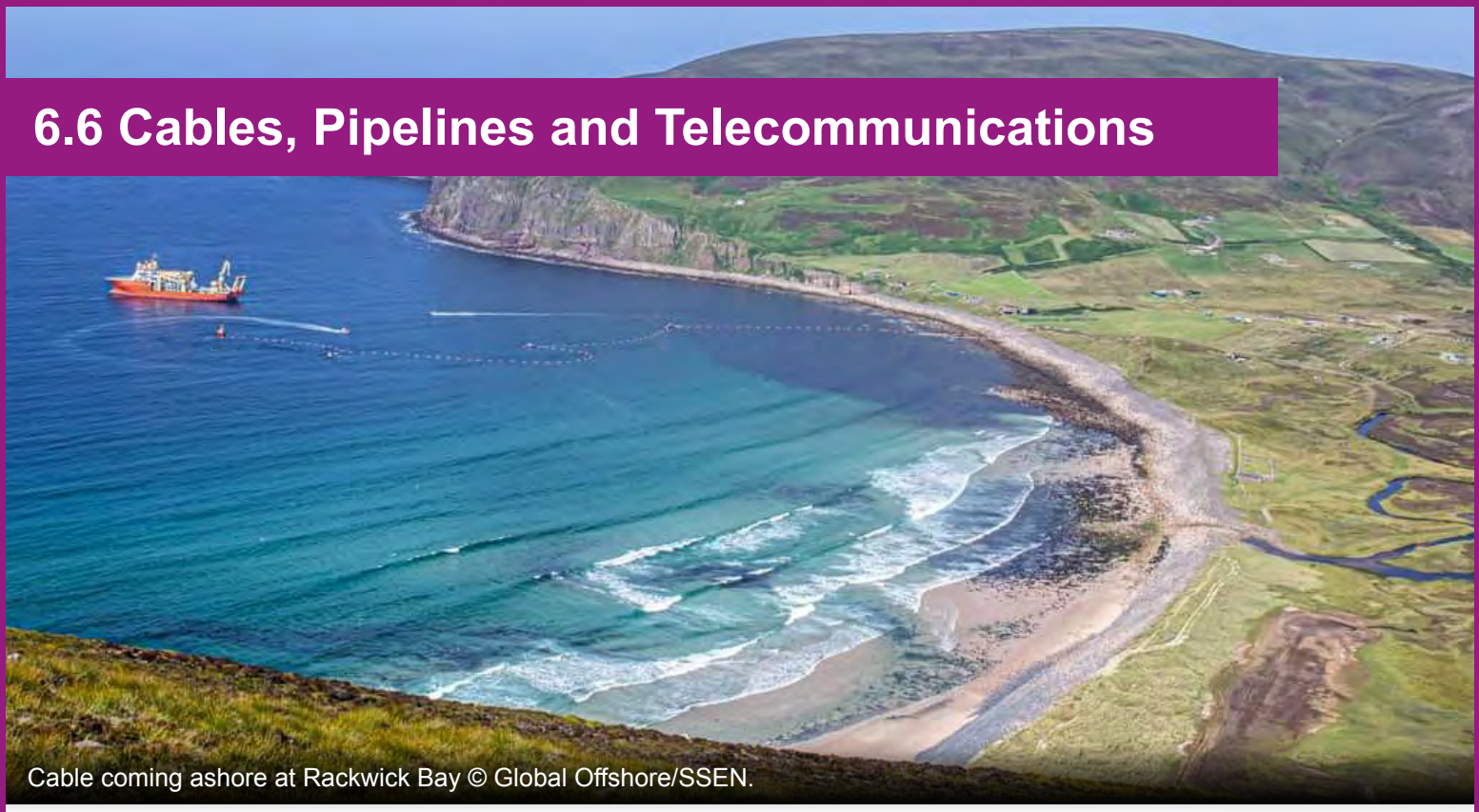
There is currently no offshore wind, wave or tidal energy being commercially generated within the Orkney marine region. However there is very significant current economic value generated by testing, research and innovation at EMEC and by other local organisations involved in the sector.

There are significant wind, wave and tidal energy resources in the marine region, and international, national and local policy drivers supporting the growth of the renewable energy sector. Offshore wind technology is well established and a commercial reality. Tidal technology is still pre-commercial but advancing rapidly. Large scale commercial wave energy remains a more distant prospect. It is anticipated that future commercial development could be established accruing significant socio-economic and climate mitigation benefits. The pace at which different technologies come on-stream will depend on technological development, government policy and investor appetite.

Table 27 Marine Renewable Energy Assessment Summary

Topic	Economic contribution	Employment	Production	Data confidence
Offshore Wind Energy				
Wave and Tidal Energy				

6.6 Cables, Pipelines and Telecommunications



Cable coming ashore at Rackwick Bay © Global Offshore/SSEN.

Summary

- Orkney is presently connected between Rackwick Bay on Hoy to the Scottish mainland at Murkle Bay near Thurso by two 33kV distribution cables.
- There are 21 cable routes that distribute electricity in the North Coast and Orkney marine region.
- A 220kV transmission cable between Dounrey and Warbeth was consented in 2019.
- The most common causes of damage to submarine cables is from fishing activity and vessel anchor drag.
- Crude oil is imported to the Flotta Oil Terminal via a 30-inch subsea pipeline from several offshore installations in the Flotta Catchment Area (FCA).
- Key pressures include physical disturbance of seabed, benthic impacts, changes in suspended solids, habitat structure changes due to substratum extraction and impacts on other marine users.

6.6.1 Introduction

Distribution and Transmission electricity cables can have different design, installation and protection requirements. Distribution cables typically relate to voltages below 33kV and may be surface laid, whereas Transmission cables are typically 132kV and above and are either buried or protected by rock berms.

Electricity Transmission is the transportation of electricity from generating plants to where it is required at centers of demand. The Electricity Transmission network, or grid, transports electricity at extremely high voltages through overhead lines, underground cables and subsea cables. The transmission network connects large scale generation, primarily renewables, to central and southern Scotland and the rest of Great Britain[167].

The Electricity Distribution network is connected into the Transmission network, but the voltage is lowered by transformers at electricity substations, and the power is then distributed to homes and businesses through overhead lines, underground cables, and subsea cables.

The cables and pipeline infrastructure within the Orkney marine region provide vital links for electricity, telecommunications, potable and wastewater and the transportation of hydrocarbons (Figure 32). Crude oil is imported to the Flotta Oil Terminal via a 30 -inch subsea pipeline from several offshore installations in the Flotta Catchment Area (FCA) (see Section 6.7).

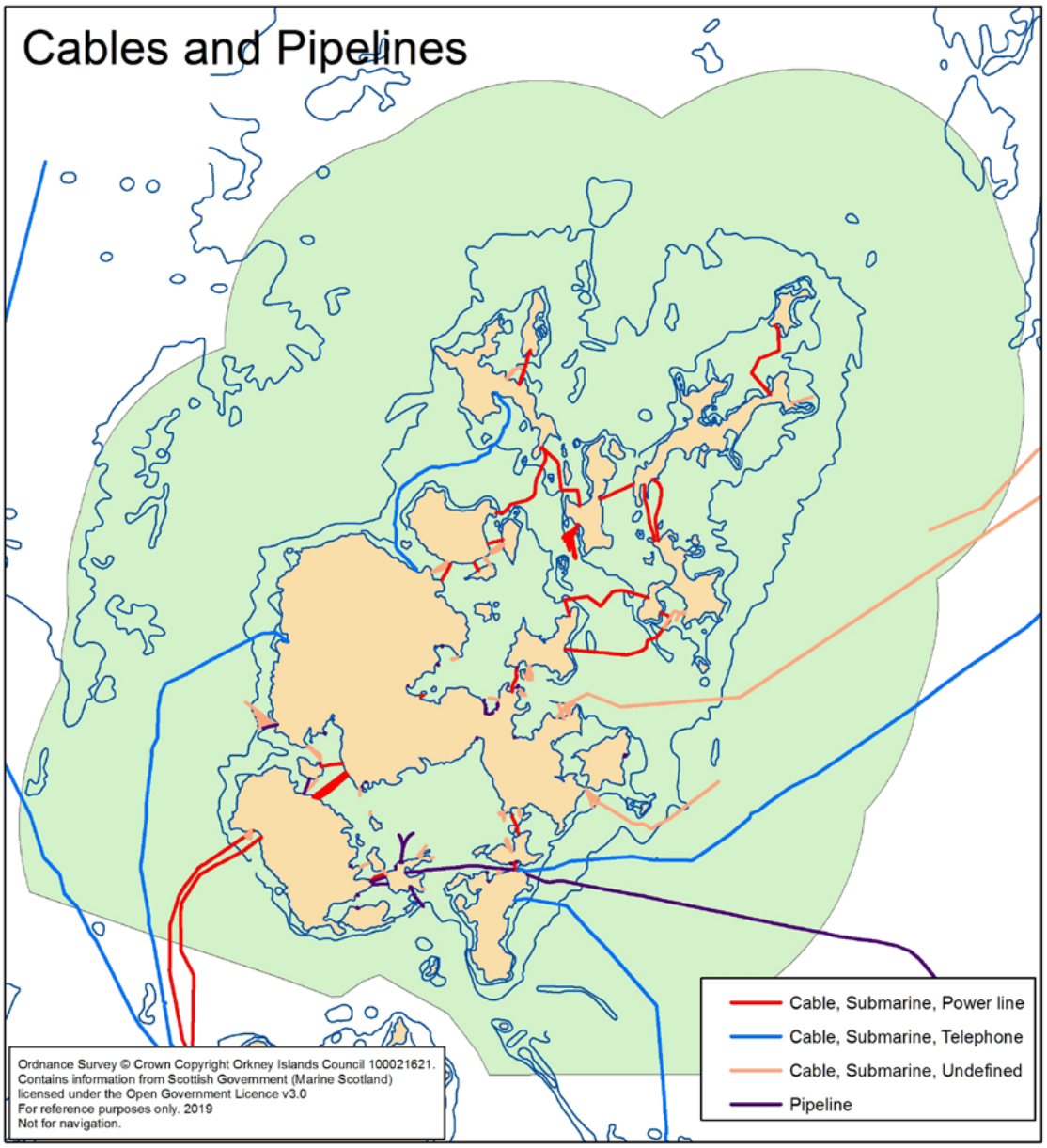


Figure 32 Cables and pipelines (not including Sula Skerry and Sula Stack marine area)

The renewable energy hub for the wave and tidal sector around Orkney includes inshore test sites (see Section 6.5), which have cable connections from energy devices to substations on shore[168].

6.6.2 Current status and trends

Orkney is presently connected between Rackwick Bay on Hoy to the Scottish mainland at Murkle Bay near Thurso by two 33kV distribution cables. They have a total capacity of 40MW and the currently connected generation in Orkney uses the available export capacity in the existing 33kV cables[169]. Scottish Hydro Electric Power Distribution plc (SHEPD) has a current project to install a new 33kV subsea electricity cable across the Pentland Firth to replace an existing cable between Rackwick Bay and Murkle Bay. The existing electricity distribution network also includes subsea cables connecting the North and South Isles, which are currently undergoing a scheduled programme of replacement.

SHEPD has 21 electricity submarine cables within the region:

- Sanday-North Ronaldsay
- Stronsay-Sanday
- Sanday-Eday
- Eday-Westray
- Westray-Papa Westray
- Rousay-Egilsay
- Rousay-Wyre
- Mainland Orkney-Rousay
- Mainland Orkney-Holm of Grimbister
- North Ness-South Ness
- Mainland Orkney-Graemsay
- Hoy-Flotta
- Mainland Orkney-Hoy North
- Mainland Orkney-Hoy Centre
- Mainland Orkney-Hoy South
- Mainland Orkney-Shapinsay
- Pentland Firth East
- Pentland Firth West
- Rousay-Westray
- Shapinsay-Stronsay North
- Shapinsay-Stronsay South

SHEPD holds a licence under the Electricity Act 1989 for the distribution of electricity in the north of Scotland including Orkney. It has a statutory duty to provide an economic and efficient system for the distribution of electricity and to ensure that its assets are maintained to deliver a safe, secure and reliable supply to customers.

The 21 cable routes listed above distribute electricity to domestic and business customers in the North Coast and Orkney regions. Regular survey and monitoring of submarine electricity distribution cables are required to ensure activities are undertaken to:

- Identify cable location and condition: SHEPD undertake programmed inspections and surveys to understand the condition of cables and to identify which cables should be taken forward for planned replacement;
- Identify fault locations and carry out repairs; and
- Inform cable routing, protection and decommissioning decisions, as well as ensure accurate installation of new cables and their protection during installation.

Scottish and Southern Electricity Networks, operating under licence as Scottish Hydro Electric Transmission Plc (SHE Transmission), are currently taking forward the Orkney Transmission Connection and Infrastructure Project which includes a HVAC 220 kV subsea cable link from Warebeth, near Stromness, to a new substation at Dounreay, Mainland Scotland. This proposed electricity transmission project also includes subsea cables from Hoy to Orkney Mainland, Hoy to Flotta, Flotta to South Ronaldsay and Burray to Orkney Mainland[170]. A 220kV transmission cable between Dounrey and Warbeth was consented in 2019. The progression of this project is subject to at least 135MW of generation either being awarded Contracts for Difference (CfD) or being judged likely to be developed by December 2021.

There are significant offshore wind, wave and tidal energy resources within the Orkney marine region and potential for future commercial scale renewable energy projects. Marine Scotland's Sectoral Marine Plan for Offshore Wind Energy (see Section 6.5) identifies areas within Orkney waters for commercial scale offshore wind development. These projects will require grid connections, electricity and communications cables linking devices to shore. Grid connections may however be directly to mainland Scotland.

Green hydrogen, and the production of other zero or low carbon fuels, will be considered as part of the potential solution to current grid constraints for offshore wind and other renewable technologies. Such projects could enhance the commercial viability of offshore wind developments and assist the future decarbonisation of other sectors including marine transportation, agriculture, and aquaculture. There is potential for commercial scale renewable energy projects to connect to shore via privately owned subsea cables for the purposes of producing zero carbon fuels in Orkney.

6.6.3 Pressures and Trends

The JNCC PAD tool identifies that the installation and operation of cables and pipelines has the potential to cause pressures on the marine environment through:

- Abrasion: physical disturbance of seabed;
- Benthic impacts i.e. smothering, siltation and nutrient enrichment;
- Changes in suspended solids i.e. water clarity;
- Habitat structure changes due to substratum extraction;
- Pollution.

The most common causes of damage to submarine cables is from fishing activity and vessel anchor drag[171]. Where sediment conditions permit, cables can be buried

throughout their length. Burial protects the cable and minimises risk of interactions which can be a danger to maritime activity through snagging of the cable with fishing gear or anchors, for example. However not all cables can be or should be buried for a variety of reasons. Engineering decisions for the lating and protection of cables need to consider the safety of mariners, energy costs for communities, impacts on economic activity and on the natural environment. SHEPD has created a Cost Benefit Analysis model that enables more informed judgements to be made about the details of submarine cable replacement and decommissioning programmes[172].

Dredging, mooring and installing infrastructure on the seabed also has the potential to affect existing cables. Potential impacts on cables can be mitigated through effective management and the correct use of cable awareness information and navigational charts. Reactive measures following damage to cables is potentially expensive and can cause disruption to power generation and distribution and telecommunications.

As well as undertaking appropriate protection measures for their cables and other marine users, cable owners provide information via cable awareness projects such as KIS-ORCA following survey and installation. Cable information is given freely to fishermen and other seabed users via KIS-ORCA so they can avoid potential snagging of cables. After laying, cable routes are notified by installers to UK Hydrographic Office (UKHO); they update charts in accordance with UKHO policy[173].

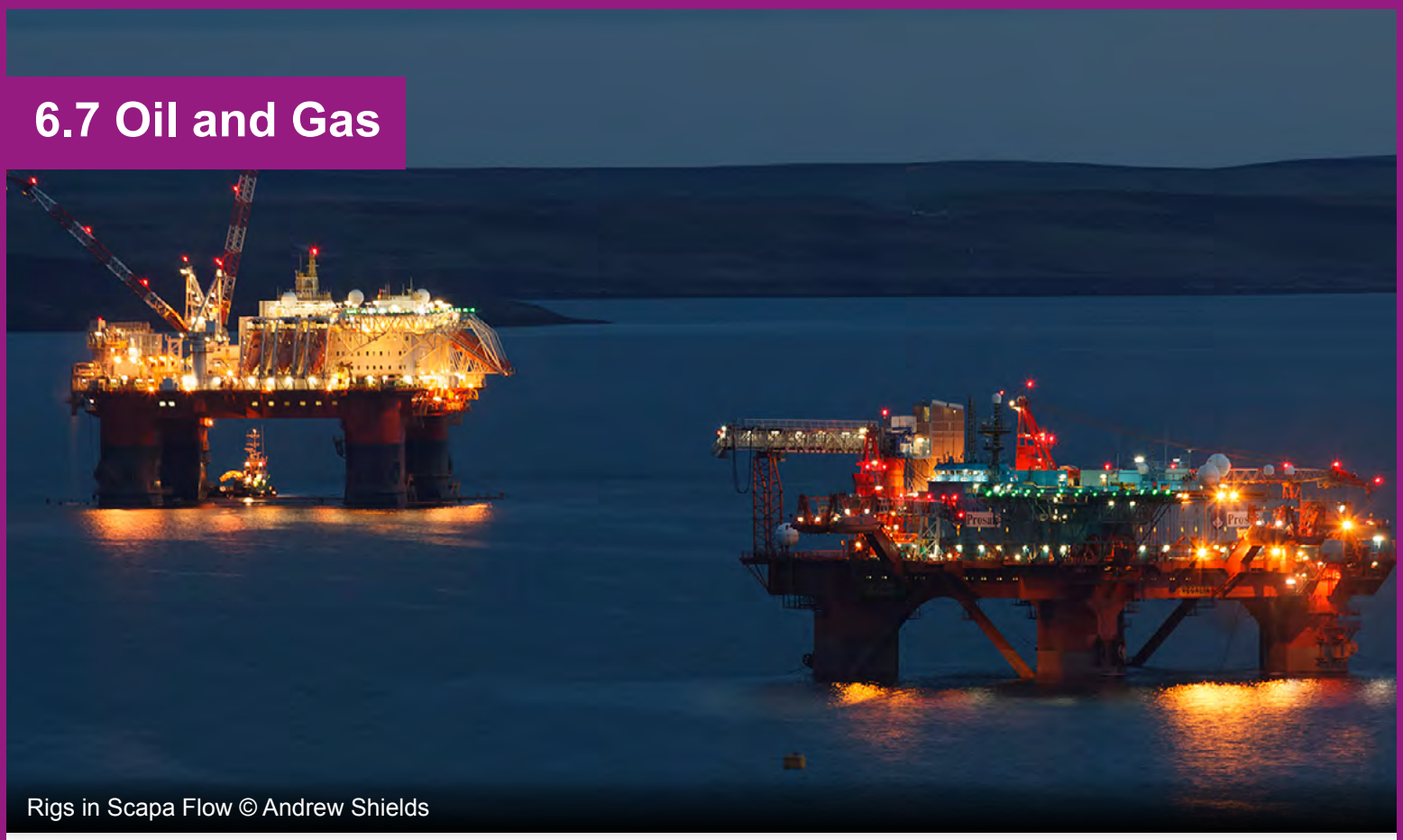
Electromagnetic fields (EMFs) may have an effect on some marine species. Carefully planned routes and laying methods can mitigate many of the issues during installation and further research is being carried out on the potential effects of EMF. Initial results suggest there are minimal effects and that burial of the cable mitigates this risk[174]. SHEPD are able to provide EMF studies on the impact of electromagnetic fields from the cables they install and manage.

6.6.4 Assessment Summary

Electricity cables, pipelines and telecommunications cables provide critical infrastructure to enable economic activity and to provide essential benefits to communities. This infrastructure enables the activities of all sectors of the coastal and marine economy in Orkney. Therefore, an individual assessment has not been carried out detailing economic contribution, employment and production.

Pentland Firth East cable laying, Murkel Bay © Global Offshore/SSEN

6.7 Oil and Gas



Rigs in Scapa Flow © Andrew Shields

Summary

- The oil and gas industry have played an important role in the Orkney economy since the 1970s providing significant employment and supporting wider economic activities.
- There has been a long-standing decline in the volume of crude oil exported from the Flotta Oil Terminal up until 2013, from then onwards there has been a marked increase in volumes, with a significant rise in 2015 followed by constant growth up until 2017 which has been stable up to 2019.
- Despite the recent positive trend, growth is not expected over the next 10-15 years, as operations at the Flotta Oil Terminal are envisaged to wind down and cease at some point during the next 20 years.
- The Flotta Oil Terminal is the primary revenue source for the Orkney Harbour Authority Scapa Flow Oil Port.
- The longer term predicted outlook is a declining trend in oil and gas economic activities as the economy in the UK continues to decarbonize, moving towards to renewable energy generation and associated alternative fuel production.
- Key pressures include physical disturbance of seabed, benthic impacts, disturbance, noise and vibration.

6.7.1 Introduction

The oil and gas industry has played an important role in Orkney since the 1970s in providing significant employment and supporting the wider local economy. The Flotta Oil Terminal (the Terminal) is the primary revenue earner for the Scapa Flow oil port, and in 2016, the Terminal represented a significant proportion of receipts for the UK. The Terminal generates revenues in the region of £7.9 million annually for the Harbour Authority[175].

6.7.2 Current status

Crude oil is imported to the Terminal via a 30-inch subsea pipeline from several offshore installations in the Flotta Catchment Area (FCA). The Terminal operators, Repsol Sinopec Resources UK Ltd, also provide transportation and processing services to the Golden Eagle Development, which is located 70km north east of Aberdeen and the second largest oil discovery in the UK North Sea. Approximately 250 people are directly and indirectly employed by the Terminal. It is expected that these services will ensure the operation of the Terminal for the medium term supporting the ongoing associated activities in the oil and gas industry in Orkney. Flotta Terminal tanker movements reduced from 51 in the 2017-18 to 34 in 2018-19[176]. There were 49 tanker movements at the Flotta Terminal in 2015-16 and 50 in 2016-17[177].

Looking at historical trends, there has been a long-standing decline in the volume of crude oil exported from the Terminal up until 2013. From then onwards there has been a marked increase in volumes, with a significant rise in 2015 followed by growth up until 2017-18, when 4.7 million tonnes of crude oil were exported[178]. Figures for 2019 show a minor decrease to 4.4 million tonnes.

Despite the recent positive trend, growth is not expected over the next 10-15 years, as operations at the Terminal are envisaged to wind down and cease at some point during the next 20 years. Diversification, and extending the longevity of the Terminal, is therefore of significant strategic importance for the Orkney economy. Orkney has the potential to act as a Liquified Natural Gas (LNG) bunkering hub or storage facility, which could be recognised as a National Strategic Asset. Proposals are underway to build a blueprint for such infrastructure; Flotta may be a potential future site. It is envisaged that the terminal could play an important part in a transition to zero carbon fuel bunkering and distribution.

Scapa Flow is one of the preferred locations in Europe for Ship-to-Ship (STS) operations for the transfer of crude and fuel oils, Liquid Natural Gas (LNG) and Liquid Petroleum Gas (LPG) (see Figure 33). Scapa Flow offers a large, sheltered, deep-water designated anchorage for these operations. There were 59 STS transfer operations of crude oil in 2018-19[179]. This was a significant increase from 33 transfers in 2017-18[180]. The current predicted trend by the Orkney Harbour Authority is for 5 STS transfers a month.

Ship to ship transfer operation, Scapa Flow © Andrew Shields

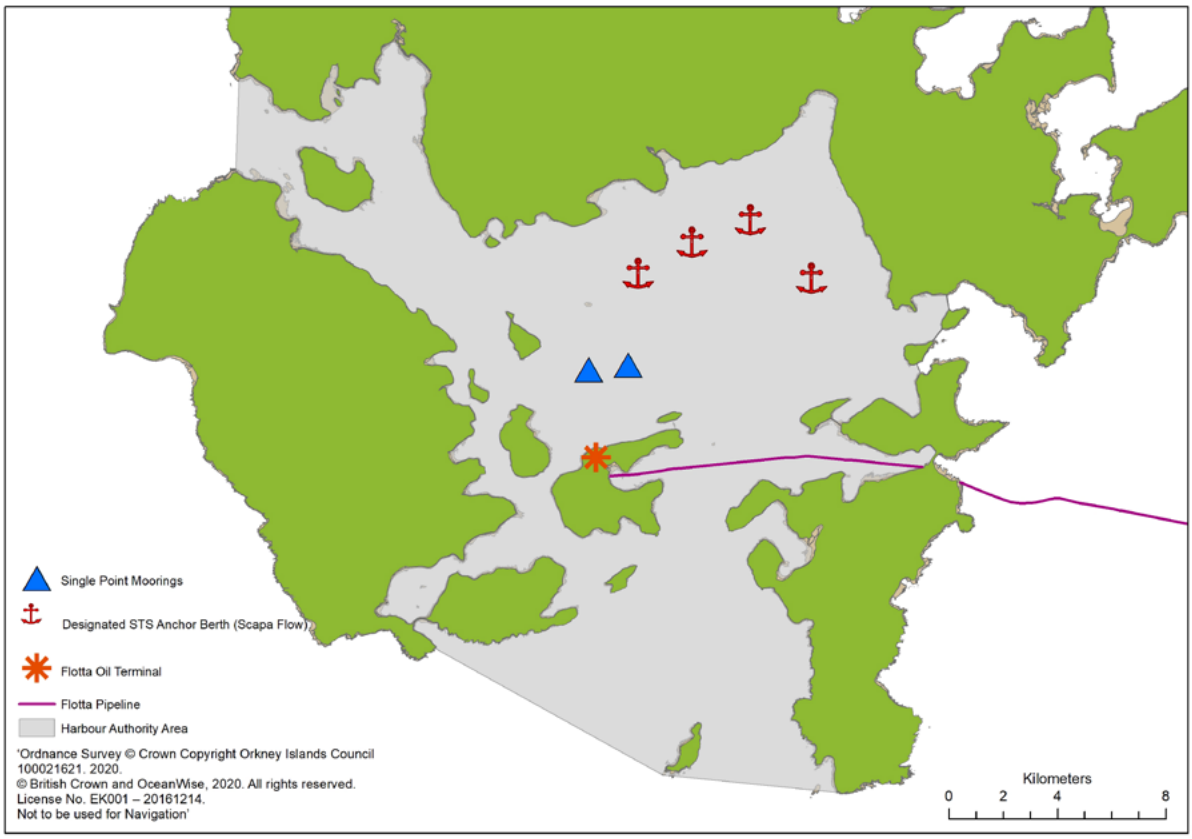


Figure 33 shows the location of the STS anchorages, Flotta Oil Terminal, Flotta oil pipeline and Single Point Moorings.

Semi-submersible vessels

In the last three years Scapa Flow has become a long-term anchorage for dynamic position semi-submersible accommodation vessels and rigs. Owning and operating companies have found the sheltered waters of Scapa Flow, the flexibility of the local supply chain, (both marine and terrestrial) and competitive charging to be an attractive proposition for storage and maintenance of such vessel types. Crew changes have been undertaken by local supply chain craft and the close proximity of Kirkwall airport has proved time efficient, in particular for crew changes.

Rig operators are looking for alternative sites to carry out large scale maintenance and modification programmes in conjunction with harbour facilities. The Orkney Harbours Master Plan - Phase 1 includes harbour infrastructure proposals to target this market through creating a new deep-water facility in Scapa Flow.

Oil Spill Contingency Plan

There are many potential environmental risks that occur as a result of oil and gas activities and thus, must be managed accordingly. The Orkney Harbour Authority has an Oil Spill Contingency Plan; this is a mandatory strategy which must be updated every five years from the date of approval from the Maritime and Coastguard Agency (MCA). It is a controlled document and all document holders are assigned a specific copy number. It is the responsibility of Orkney Islands Council's Head of Marine Services, Engineering and Transportation for the maintenance of the document.

6.7.3 Pressures and Trends

The JNCC PAD tool identifies that the oil and gas sectors have the potential to cause pressures on the marine environment through:

- Abrasion: physical disturbance of seabed;
- Benthic impacts; smothering and siltation; nutrient enrichment;
- Disturbance: Physical change to another seabed type;
- Habitat structure changes: substratum extraction;
- Noise;
- Pollution;
- Vibration.

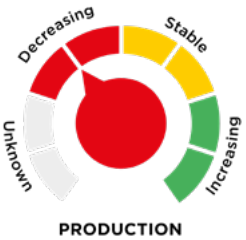
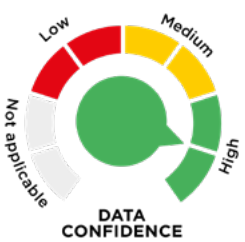
Vessel movements and anchoring, along with the anchorage for dynamic position semi-submersible accommodation vessels and rigs can cause disturbance to the seabed and noise, along with potential pollution risks. There is no active oil and gas extraction within the marine region, therefore, it is unlikely there would be any significant impacts from nutrient enrichment, removal of substratum or vibration.

This industry has significant economic benefits for Orkney since exploitation of North Sea oil began. The future predicted trend is that there will be a long-term decline of oil and gas supply from the North Sea, with an opportunity to diversify oil and gas installations and infrastructure to support the transition to alternative low and zero carbon fuels.

6.7.4 Assessment Summary

In the short to medium-term, the current activities at the Flotta Oil Terminal and the number of STS transfers operations in Scapa Flow are predicted to remain stable. The longer term predicted outlook is a declining trend in oil and gas production and economic activities as the economy in the UK continues to decarbonise, moving towards renewable energy generation and associated alternative fuel production. This declining trend is likely to be offset to some extent by diversification into long-term anchorage and potential maintenance operations for accommodation vessels and rigs, and associated supply chain benefits.

Table 28 Oil and Gas Assessment Summary

Topic	Economic contribution	Employment	Production	Data confidence
Oil and Gas				

6.8 Marine Supply Chain, Research and Services

Drilling Rig © Leask Marine Ltd.

Summary

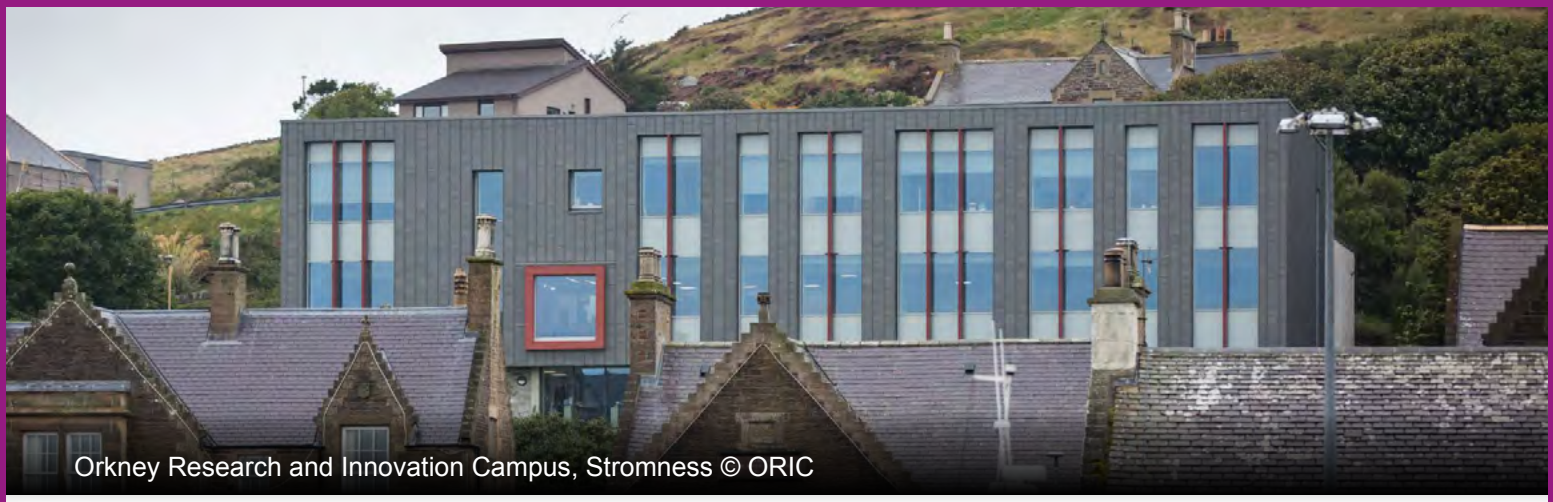
- Marine supply chain, research and services provide a wide variety of expertise to support multiple marine industries.
- An internationally renowned cluster of innovation, research and development facilities have emerged in Stromness around EMEC, Heriot Watt's International Centre for Island Technology (ICIT) and complementary businesses, services and research organisations.

6.8.1 Introduction

Orkney has a diverse range of marine related businesses, research and development services forming an effective local supply chain supporting the ports and harbours, oil and gas, renewables, aquaculture and fishing sectors. It consists of engineering, fabrication and assembly, lifting, vessels and craft, experienced mariners, consultancy, surveying, data analysis, contractors and biological analysis.

6.8.2 Current status

An internationally renowned cluster of innovation, research and development facilities have emerged in Stromness around EMEC, Heriot Watt's International Centre for Island Technology (ICIT) and complementary businesses, services and research organisations. This cluster has been consolidated in the newly completed Orkney Research and Innovation Campus (ORIC). ORIC is home to Heriot Watt University Centre for Island Technology, Robert Gordon University and the European Marine Energy Centre, as well as a number of renewable and energy related commercial enterprises. Students from all over the world are attracted to study in Orkney and often gain rewarding employment within Orkney after graduation.


Orkney Research and Innovation Campus, Stromness © ORIC

Orkney College forms part of the Highlands and Islands University, which is part of a network of 13 campus and research facilities throughout Northern Scotland. A range of topics and qualification types can be studied ranging from construction, business studies, catering, agriculture, archaeology and maritime studies. Orkney College is an internationally recognised centre for archaeology, agronomy and northern studies. The Maritime Studies department in Stromness delivers a number of sea-going courses providing training opportunities for marine industries in Orkney.

The various services provided to the marine sectors by the local supply chain include:

- Marine engineering;
- Fabrication and assembly;
- Maritime services and logistics;
- Vessels and craft;
- Experienced mariners;
- Agents and brokers;
- Environmental consultancy;
- Surveys and consents;
- Maritime training;
- Construction management;
- Cranage and lifting services;
- Underwater services;
- Towage;
- Salvage and recovery.

6.8.3 Pressures and Trends

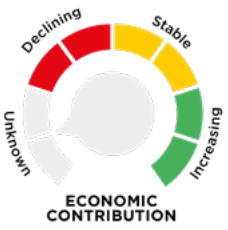
These diverse supply chain, research and service activities support other sectors assessed separately with this assessment, therefore a summary of pressures has not been presented. With regards to trends, it is anticipated that the supply chain will benefit from the anticipated growth of key sectors including ports and harbours, renewable energy, aquaculture and diversification in the oil and gas sector.

6.8.4 Assessment Summary

The diverse marine supply chain, research and service sectors in Orkney support wider sector specific activities at the international, national and local level. There are limited specific data on the economic, employment and production contributions from these activities in Orkney.

Brexit, particularly the provision of European research funding to academic and research institutions, is changing the research landscape. However, it is hoped that the UK and Scottish government's continued commitment to renewable energy will provide alternative funding routes.

Table 29 Marine Supply Chain, Research and Services Summary Assessment

Topic	Economic contribution	Employment	Production	Data confidence
Marine Supply Chain, Research Services				

Surveying concrete mooring at EMEC nursery site, Scapa Flow © Dr Joanne Porter

6.9 Tourism, Recreation, Sport, and Leisure

Free divers, Orkney © Ian Rendall

Summary

- Tourism is a vital part of the local economy, with over 288,000 visitors in 2017 drawn to the high-quality historic environment, along with spectacular coastal environment and wildlife-watching opportunities.
- Coastal and marine recreation and sport activities include walking, sailing, diving, recreational fishing, kayaking, climbing, sea swimming, snorkeling, coastal rowing and surfing.
- Significant growth in visitor numbers can in large part be attributed to the increase in cruise passenger numbers over recent years, from 50,765 passengers in 2013 to 132,000 passengers in 2019.
- For 2020, due to the coronavirus pandemic, there has been a significant decline in visitor numbers to Orkney.
- Orkney is an attractive destination for visiting recreational vessels, with 653 visiting in 2018; Kirkwall has 95 marina berths; Stromness has 72 berths and Westray has 17 berths.
- Recreational diving is predominantly charter based to the Scapa Flow wrecks from Stromness, with approximately 12 dive boats and an estimated 3,000 visiting divers annually.
- Key pressures include physical disturbance of seabed, visual disturbance and displacement, noise and removal of target species.
- Climate change poses a threat to historic assets, natural heritage assets and infrastructure in Orkney which in turn could significantly impact the tourism sector.
- The volume of tourists visiting key coastal sites can cause additional wear and tear, including erosion due to footfall, and place extra demand on historic sites, infrastructure and maintenance services.

6.9.1 Introduction

Orkney has many remarkable coastal and marine places to visit and locations to undertake a wide variety of sport, recreation and leisure activities. Many of these opportunities rely on the high quality of the marine and coastal environment. World-class coastal archaeology and wreck diving, stunning scenery and landscapes, along with the potential for spectacular wildlife watching for species such as cetaceans and coastal birds are just a few of the reasons why Orkney is a top tourism destination in Scotland and a valued place to live and work[181].

6.9.2 Current status

Local coastal and marine recreation and sport activities include walking, sailing, diving, recreational fishing, kayaking, climbing, sea swimming, snorkeling and coastal rowing (see Table 30). The tourism and recreation study undertaken to inform the Pilot Pentland Firth and Orkney Waters Marine Spatial Plan in 2015 provides a useful baseline on the various types of marine recreational activities that take place in Orkney and provides links to sources of information related to those activities[182] . It notes that there were 142,000 visitors to Orkney between Oct 2012 – Sept 2013; Figures show a significant increase for 2017, up to 288,078[183]. The significant growth in visitor numbers can in large part be attributed to the increase in cruise passenger numbers over recent years, from 50,765 passengers in 2013 to 113,805 passengers in 2017[184]. Overall, approximately 50% are day visitors and 50 % are overnight visitors, which largely relates to cruise and non-cruise visitors respectively[185]. Of the non-cruise visitors, many arrive by ferry from either Scrabster or Gill's Bay, therefore, along with the cruise visitors, a large proportion of tourists first experience Orkney via its marine waters[186].

The Green Blue environmental initiative[187] helps to minimise any adverse impact of recreational sailing on the environment. Provided that recreational boaters follow its guidance, which is consistent with The Scottish Marine Wildlife Watching Code, there should only be a low impact.

The Orkney Islands Council and Visit Scotland visitor survey in 2018, based on over 5,000 participants, noted over 70% of visitors came to Orkney for leisure purposes and around 70% were from the UK. The rest were either on business or visiting family and friends. This survey did not include cruise passengers. The key tourist sites visited, with a marine or coastal connection, were the Italian Chapel and Skara Brae; the latter is one of the principal monuments of the Heart of Neolithic Orkney World Heritage Site (see Section 3).

Wild swimmers in St Margaret's Hope © Shona Turnbull

Coastal walking, South Ronaldsay © Rebecca Kavanagh

Orkney's cruise market has grown considerably since 2010. There were 138 cruise vessel calls in 2018, compared to 70 calls in 2010, and just under 127,000 passengers; this is more than four times the number of passengers in 2010. Most of the growth has been since 2014, with vessel calls rising from 76 to 138. There were 158 vessels in 2019 which brought 132,000 passengers. For 2020, due to the coronavirus pandemic, there has been a significant decline visitor number to Orkney. This is due to the cancelling of port calls for the cruise industry, cancellations of coach day trips and the lockdown restrictions affecting travel within the United Kingdom.

Orkney is an attractive destination for visiting recreational vessels, with 653 visiting in 2018. These visits are based around the three marinas in Orkney (Stromness, Kirkwall and Westray) which are operated by Orkney Marinas Ltd (a public interest charitable company). Kirkwall has 95 berths; Stromness has 72 berths and Westray has 17 berths. These marinas cater for larger cruising, sailing and powered recreational craft, along with local piers and visitor moorings throughout the islands. Clyde Cruising Club Sailing Directions and Anchorages: Orkney and Shetland Islands including North and Northeast Scotland identifies the location of anchorages used by recreational craft in Orkney[188]. Other recreational and leisure craft in Orkney include motorboats, jet skis, kayaks and rowing boats.

Coastal walking is a key attraction for visitors and is enjoyed by local communities providing day to day opportunities to enjoy the marine and costal environment. Much of Orkney's coast is low lying, with rolling landscapes of heather moorland and inclined coastal pasture[189]. With exceptions including Hoy, where the landscape is rugged and steep, with areas of wilderness. Orkney's coasts provide stunning views, archaeological remains, bountiful wildlife and trails for all abilities. The Orkney Core Paths Plan provides maps and information on the Orkney core paths network[190].

MSC Splendida © Craig Taylor

Divers at wreck site of HMD Chance, Scapa Flow © Dr Joanne Porter

The most popular area for scuba diving in Orkney is Scapa Flow, which is considered one of the finest wreck diving sites in Europe and has ranked among the top five wreck diving areas in the world. Recreational diving is predominantly charter based from Stromness with approximately 12 dive boats and an estimated 3,000 visiting divers annually, see Table 30. Thus, the diving industry forms an integral part in Orkney's visitor economy.

The German High Seas Fleet scuttled in Scapa Flow is the main attraction for visiting divers. Orkney's seabed also has many other wrecks to explore and a wealth of different marine habitats and associated biodiversity. The dive season is traditionally from Easter though to early November; the sea temperature averages around 13 degrees celsius. Visibility is approximately around 10 metres but can increase later in the season when plankton is not so abundant.

Table 30 Summary of main types of coastal and marine tourism, recreation, sport and leisure in Orkney and key facts

Type	Key facts and Figures
Wildlife watching	Birds, seals, cetaceans, otters, rockpools and marine invertebrates are key attractions for wildlife-watchers.
Walking	Many of the walking routes relate to either the archaeological sites, landscapes/seascapes or wildlife, most of which are coastal in nature.
Landscape/seascape	Dramatic cliffs, sounds, beaches, wild and remote areas.
Archaeology and historic assets	Variety, quantity and quality of historic assets, many of which are coastal. Skara Brae, the Ring of Brodgar, the Stones of Stenness, and the Maeshowe chambered tomb form the keystones of the UNESCO Heart of Neolithic Orkney World Heritage Site (see Section 3).
Diving	Contributes an estimated £3 million to Orkney's economy with approximately 12 commercial dive boats and an estimated 3,000 visiting divers annually[191]. Scapa Flow is recognised as within the top five dive sites around the world, largely due to the World War wrecks, but in recent years also due to the chance to see Priority Marine Features in close association with the Historic Wreck locations.
Cruise	For 2019, there were 158 cruise ship calls to Orkney, carrying 132,388 passengers.
Sailing, rowing	3 marinas: Kirkwall (95 berths), Stromness (72 berths) and Westray (17 berths). There are six sailing clubs and around 10 regattas throughout the summer across the islands. Orkney Rowing Club is well established both recreationally and competitively. Stromness Rowing Club was re-established in 2018.
Kayaking	The Orkney Kayaking Club and the Kirkwall Kayak Club focusses mainly on sea kayaking. Visitors come for 'Paddle Orkney', a biennial symposium that showcases Orkneys' marine waters.
Sea Angling	Boat charters consists mostly of rough ground fishing for Cod and Ling, with Pollack caught closer in or over the shelves. The boats often also do wildlife watching trips.
Shore Angling	Fly fishing for sea trout is a popular recreational pursuit in Orkney. Other shore angling take place around the Orkney coastline.
Surfing	Orkney is renowned globally for its surfing season late summer through to autumn and is one of the top surf spots in Europe, with many local riders.

Although tourism provides many benefits for the Orkney economy, it also presents several challenges in terms of managing visitor numbers and associated infrastructure. In 2017, Orkney Islands Council entered a strategic partnership with public sector partners, VisitScotland, Highlands & Islands Enterprise, Scottish Natural Heritage (now NatureScot) and Historic Environment Scotland. The local tourism industry membership organisation, Destination Orkney Ltd, is also closely engaged. Together, they developed a framework for the sustainable management of tourism, enabling local communities to maximise the opportunities of tourism while mitigating adverse impacts.

6.9.3 Pressures and trends

The JNCC PAD tool identifies that tourism, sport, recreation and leisure has the potential to cause pressures on the marine environment through:

- Abrasion: physical disturbance of seabed;
- Disturbance: Physical change to another seabed type;
- Disturbance: Visual and Displacement;
- Noise;
- Removal of target species.

The expansion and development of tourism and recreational infrastructure and activities, particularly in proximity to fragile marine ecosystems, has the potential to have adverse environmental effects. Recreation and leisure activities such as sailing and diving can cause abrasion and physical disturbance of seabed from, for example, anchors, divers or lost equipment. In coastal areas, the volume of tourists visiting key coastal sites can cause additional wear and tear, including erosion due to footfall, and place extra demand on historic sites, infrastructure, and maintenance services. Examples of this can be found along the paths at Skara Brae, which are also under threat from coastal erosion refer to Sections 2.7, 3.3, 4.2 and 4.6.

Visiting recreational vessels are a potential vector for the introduction of NNS in Orkney waters (see Section 5.8). With regard to potential pressures on Priority Marine Features (PMFs), recreational boat anchorages within designated areas in Orkney described in the Clyde Cruising Club Sailing Directions and Anchorages volume for Orkney and Shetland have been reviewed by NatureScot (formerly Scottish Natural Heritage). This was to identify whether there would likely be any significant adverse effects on vulnerable PMFs such as maerl beds. The study concluded no significant effect therefore no controls on recreation boat anchoring were included in management measures.

Port and harbour, renewable energy, aquaculture and other development types have the potential to change landscape and seascape character, and the setting of historic environment assets. There is therefore potential for these developments to individually and cumulatively affect the quality of these features and the experience of Orkney by visitors.

Wildlife tourism, and other recreational/leisure craft (e.g. jet skis, motorboats), can exert pressures on marine wildlife, such as disturbance and noise near breeding and feeding sites; groups of species most likely affected are coastal birds, seals and cetaceans.

Recreational fishing, whilst removing species, is likely to have limited impact due to the nature and scale of the activity, though the effects are not well understood. The Orkney Trout Fishing Association promotes catch return data to help support the sustainable management of the sea trout recreation fishery.

Visiting recreational vessels are a potential vector for the introduction of NNS in Orkney waters (see Section 5.8)

Climate change poses a threat to historic assets, natural heritage assets and infrastructure in Orkney (see Sections 3 and 4) and the associated tourism activities which requires a multi-agency response. As outlined in Sections 3 and 4, a recent Climate Change Vulnerability Index study was carried out for Skara Brae and The Ring of Brodgar; monuments of the World Heritage Site.

Whilst tourism is a major economic sector in Orkney, the economic benefits are mainly concentrated on the Mainland. The travel time and costs associated with getting to the North and non-linked South Isles can be a significant barrier to dispersing the benefits of tourism to Orkney's peripheral communities. In addition, the seasonality of the industry, based largely from May–September and peaking in July and August, means key coastal sites can be under particular pressure at those times[192]. Tourism generates seasonal work; while this does benefit some members of the community, it can cause issues of economic instability within communities[193].

6.9.4 Assessment Summary

The tourism sector, prior to the coronavirus pandemic, was thriving in Orkney. Demand for accommodation, local produce and access to key visitor attractions was very high. Visitor surveys, along with cruise ship visitor and economic data outlined in this assessment, demonstrate growing trends in economic contribution, employment and production within the sector.

The coronavirus pandemic has significantly impacted the tourism sector and restricted many recreation, sport and leisure activities. The long term effects of the pandemic on the sector are not currently clear though short to medium term impacts on employment in local services, industries, markets and prices are likely to be significant.

Table 31 Tourism Assessment Summary

Topic	Economic contribution	Employment	Production	Data confidence
Tourism				

The assessments for the marine and coastal economic sectors in Orkney indicate varying levels of growth and decreasing values for economic contribution, employment and production. This must be viewed with a caveat of the impacts of Covid19, which are currently unknown. As outlined in Section 6.1, the majority of the data for this assessment was prepared prior to the outbreak. Table 32 below provides an assessment summary derived from the information considered in Sections 6.2 to 6.9.

Freediver, Orkney © Ian Rendall

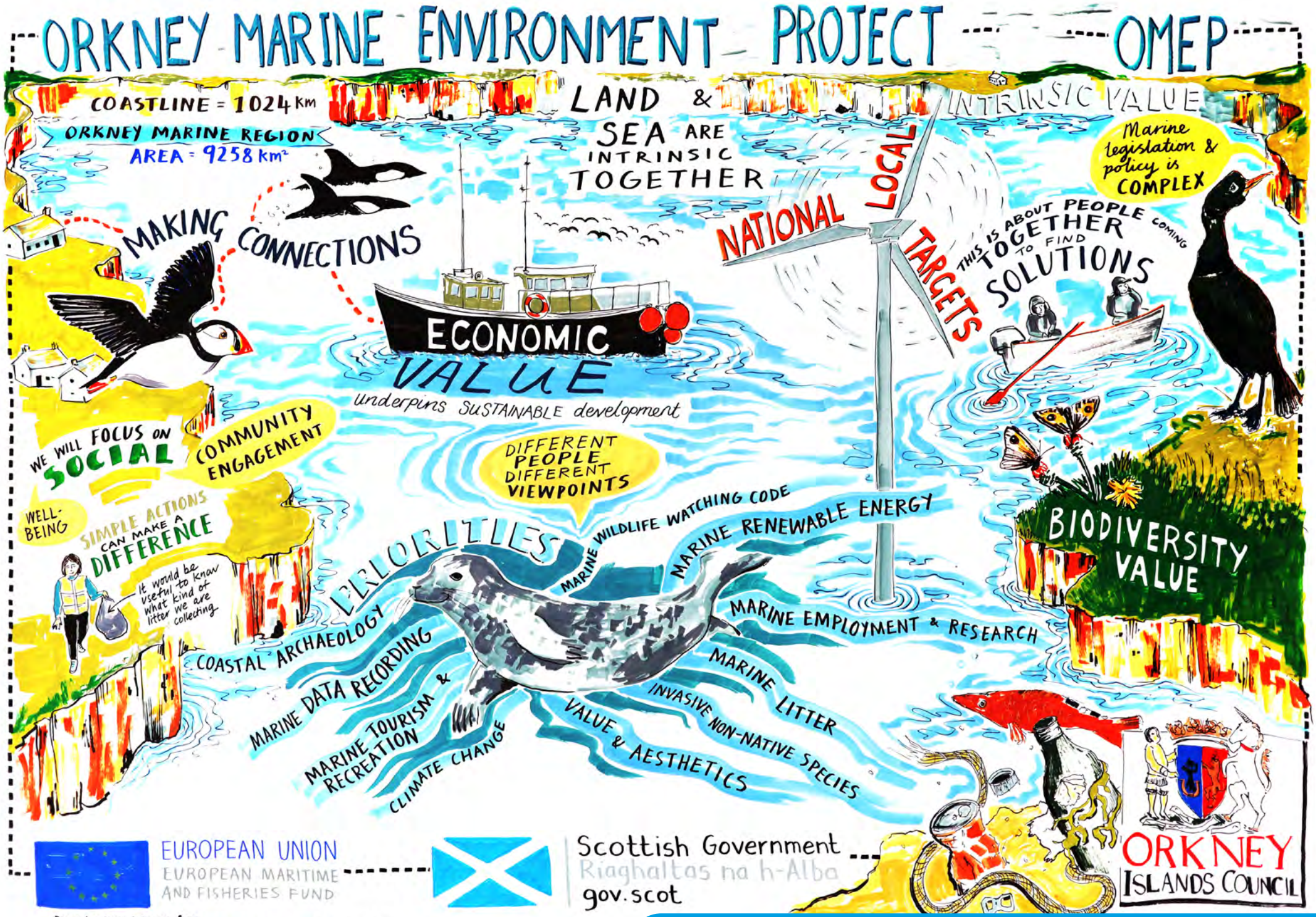
6.10 Summary of Productive Coasts and Seas Assessment

Table 32 Assessment Summary of marine economic sectors in Orkney

Topic	Economic contribution	Employment	Production	Data confidence
Commercial Fisheries	Increasing	Stable	Decreasing	High
Aquaculture	Increasing	Increasing	Increasing	High
Harbours, Port, Shipping and Marine Transport	Increasing	Stable	Stable	High
Offshore Wind Energy	Unknown	Unknown	Not applicable	Not applicable
Wave and Tidal Energy	Stable	Stable	Stable	Medium
Oil and Gas	Stable	Stable	Decreasing	High
Marine Supply Chain, Research and Services	Unknown	Unknown	Unknown	Not applicable
Tourism, Recreation, Sport and Leisure	Increasing	Increasing	Increasing	High

Section 7: Social and Community Value

PHOTO CREDIT: ENJOYING THE SEA AT INGANESS BAY © SUSAN SHEARER



Visual Minute from community workshop in Kirkwall © MoreThanMinutes

7.1 Summary / Introduction

Summary

- There are deep-rooted cultural connections between people and the sea in Orkney that can be seen in livelihood, family history, storytelling, historic global maritime connections and traditional industries.
- Nobody in Orkney lives more than five miles from the sea.
- Fishing is of particular cultural and social significance; an industry with a strong cultural identify and intergenerational knowledge.
- The social data collected as part of this assessment found that the majority of respondents considered the quality of Orkney's marine environment to be good.
- Concerns were expressed over the future quality and functioning of marine ecosystems and many of these concerns were related to climate change.
- Stakeholders expressed the hope that marine planning would be a useful tool to help manage and mitigate potential adverse environmental impacts, safeguard environmental assets and the quality of life enjoyed by local communities.

Introduction

Orkney, as an island community, has strong social and cultural connections with its coastal and marine environment. The sea and its resources make a significant contribution to the wellbeing of local communities and form an inherent part of identity in Orkney. Part of the reason for this is that the seas around Orkney are intertwined within day to day life, supporting the local economy, jobs, transportation and opportunities for recreation. Nobody in Orkney lives more than five miles from the sea (see Figure 34).

Fun on the shore, Scapa Flow © Susan Shearer

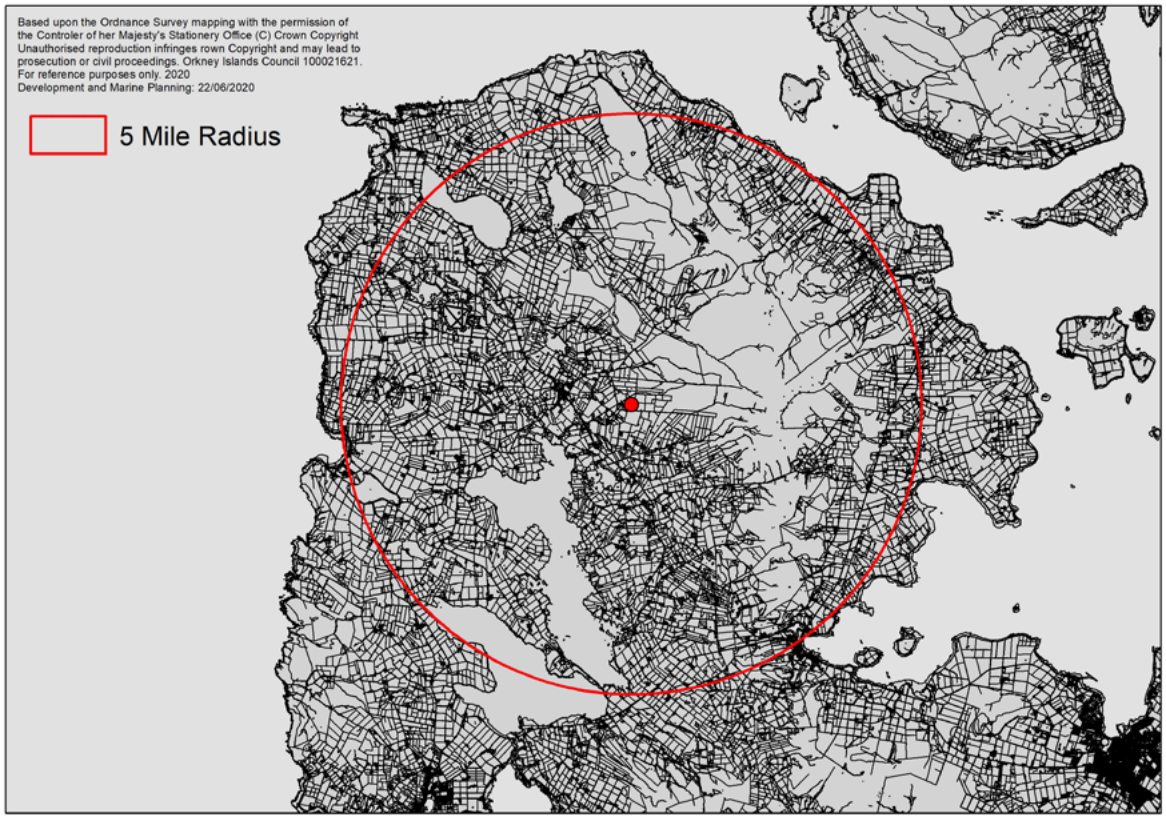


Figure 34 Map illustrates a maximum 5 mile distance from the sea in Orkney.

The deep-rooted cultural connections between people and the sea can be seen in livelihood, family history, storytelling, historic global maritime connections and traditional industries. Fishing is of particular cultural and social significance in this context; it is an industry with strong cultural identity and intergenerational knowledge. More recently, the exploitation of oil and gas resources, the development of aquaculture, along with emerging sectors such as renewable energy, continue to provide social and economic connections to marine resources. Traditional maritime sectors paired with new, emerging sectors have continued to embed this intrinsic link between the local community and the seas around Orkney.

7.2 Community Engagement Summary

As part of the early stages of preparing this State of the Marine Environment Assessment, community engagement was undertaken to better understand local people's relationship with the sea and what the ocean means to local identity and lifestyle. Whilst there was no requirement to undertake consultation on this assessment, previous experience during the preparation of the Pentland Firth and Orkney Waters Marine Spatial Plan (see Section 1.5) demonstrated the value of wider stakeholder engagement at the earliest opportunity. To support this process, a questionnaire was publicised, workshops with documented visual minutes were held, along with one-to-one interviews and community presentations. A summary of the outputs and outcomes from this community engagement is outlined below.

Marine Spatial Planning Challenge, Stromness © Rebecca Kavanagh

Community Questionnaire

A questionnaire was prepared to collect data on which aspects of the Orkney marine environment were valued by the local community considering environmental, cultural and economic factors. The perceived quality of the marine environment and views on environmental pressures were also considered. Views were also sought on opportunities for economic growth and any data participants were able to share to help inform the state of the environment assessment. 101 people responded to the survey. The questionnaire contained 12 questions and was available in three formats including on paper, PDF download for print or email return and an online survey called 'Smart Survey'.

Respondents were asked which aspects of the marine environment they valued. The value of wildlife was the most frequent response, followed by economic value and aesthetic value as detailed in Figure 35. Participants were also asked whether they interact with the marine environment as part their employment or studies. Approximately 60% stated interaction with the marine environment formed wholly or part of their employment.

Respondents were asked for their opinion on the quality of the marine environment in Orkney, responses are presented in Figure 36. The majority of participants stated that the Orkney marine environment is in a good state. There were however concerns expressed over the future quality and functioning of marine ecosystems and many of these concerns were related to climate change. It is acknowledged that the categories were not mutually exclusive as the marine environment could contain elements that were good but others that are in decline.

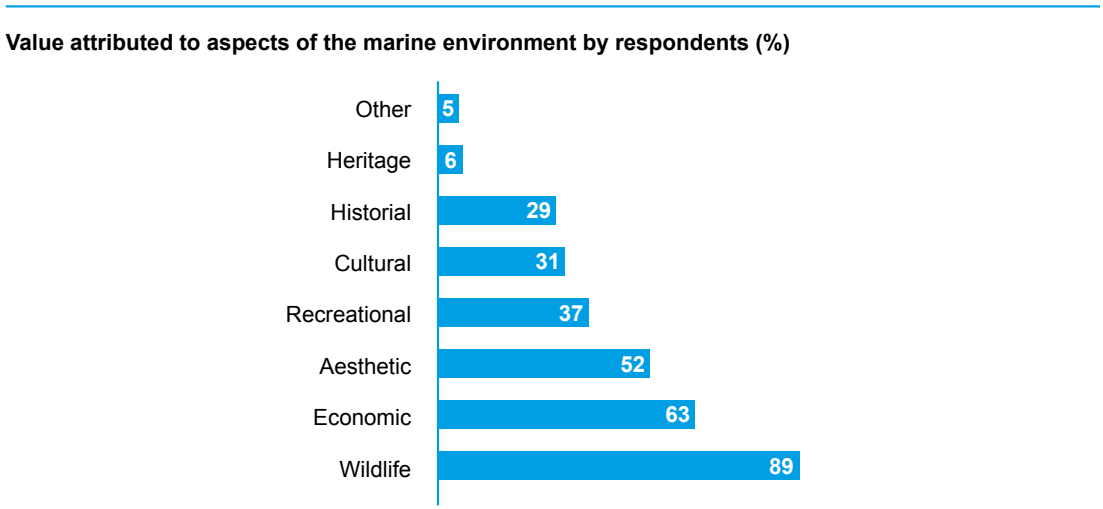


Figure 35 Percentage value attributed to the marine environment by respondents

Respondents were asked whether there are any coastal areas of Orkney that have a particular 'sense of place'. A sense of place was defined as the extent to which people identify with and feel positively attached to a specific place. Approximately 84% responded positively to this question. Some examples of the locations identified as having a particular sense of place were Warbeth, Birsay, Churchill Barriers, Yesnaby, Scapa Flow and the Shapinsay coastline. Many of these places were identified numerous times by respondents and some respondents provided reasoning for their choices. For example, one participant identified Yesnaby for its wildness and ruggedness, Birsay for its sunsets and Stromness for its harbour and views over Hoy.

Perceived quality of the marine environment by respondents

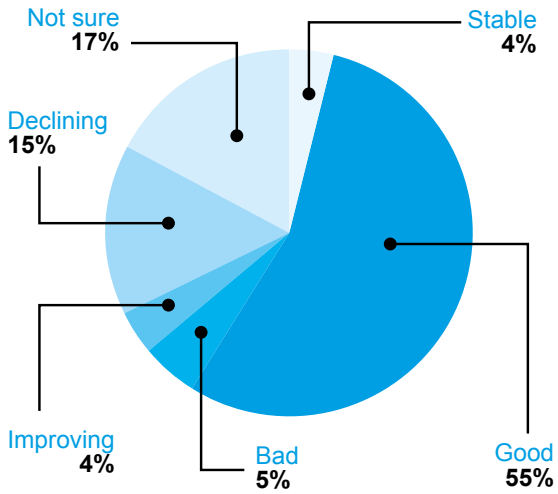


Figure 36 Perceived quality of the marine environment by respondents

Community Workshops and Visual Minutes

Interactive public workshops were held in Kirkwall and Stromness in September 2019 to engage local stakeholders with the Orkney Marine Environment Project and gather information to inform this assessment. These workshops were designed to help the participants to gain a greater understanding of the project, wider marine planning issues and for participants to share their extensive local knowledge on the Orkney's marine environment. These sessions were recorded visually by two artists who collated the key points raised by stakeholder in engaging graphics called visual minutes; one of these visual minutes is depicted at the start of this section of the report.

Workshop participants were invited to play the Marine Spatial Planning Challenge Game. This is a table-top interactive game that engages participants with hypothetical marine planning development and management scenarios. The game aims to help participants gain insights into the multiple tradeoffs made when planning marine development and activities, and the multiple interests of users of the marine environment. This enabled participants to explore the impact of human activities and the potential environmental, social and economic benefits that can be achieved through effective planning.

Community meetings with presentations were held in North Ronaldsay, Rousay and Westray to raise awareness of marine environmental issues and marine planning, and to gather information for this assessment.

Community Interviews

Semi-structured interviews were conducted with members of the local community that have a stake in the marine environment including local development trusts and seafarers. These interviews followed a semi-structured format, with open-ended indicative questions. In summary, the importance of maintaining healthy waters for the future was a key theme that emerged from respondents. Some concerns over the status of commercial shellfish species, and the conservation status of birds and wider species were raised. A key theme that emerged was the hope that marine planning would be a useful tool to help manage and mitigate potential adverse environmental impacts, safeguard environmental assets and the quality of life enjoyed by local communities.

Complementary Projects

Alongside the Orkney Marine Environment Project, the Scottish Wildlife Trust have undertaken the Oceans of Value project. This project aims to explore the connections between a healthy marine environment and human prosperity, and investigate how combining two different ways of valuing the marine environment can collectively provide useful insights for decision makers and marine planners.

The research project includes comprehensive stakeholder engagement, using the successful Community Voice method. This technique focuses on identifying key similarities and differences between the views of groups such as fishermen, salmon farmers and recreational groups including divers. It has been shown to be an effective way to address the polarisation that can often be experienced between economic and environmental values in coastal communities.

The second part of the Oceans of Value project is a natural capital valuation for the Orkney marine region. This approach is the first of its kind and will focus on the value of ecosystem services provided by the marine environment, such as healthy and diverse habitats, coastal protection, carbon sequestration, and wave and tidal energy. More information about this project can be found on the Scottish Wildlife Trust's website[194]. When the project is completed in 2021, the outputs will inform the preparation of the Orkney Islands Regional Marine Plan.

Community workshops © Rebecca Kavanagh

7.3 Pressures and Trends

Orkney has a strong sense of place and identity as a maritime and island community. The social research undertaken as part of this assessment identifies that the marine and coastal environment makes a significant contribution towards the health and wellbeing of local communities, as well as delivering significant cultural and socio-economic benefits. Understanding a place, and its influence on people and communities, is essential for effective planning. It is important to understand what makes a place work well and what makes a place special, in order that these features can be protected and enhanced.

Development and change can affect culture, identity and place in many ways. Changes in the marine economy in Orkney have taken place over many centuries from the boom and bust of the kelp and herring industries, to oil and gas in the 1970s to the emerging renewable energy sector. These changing economies bring social and cultural change as well changing impacts on the environment. It is important to understand social and cultural factors, and to recognise the influence these factors have on values, views and attitudes within local communities. These values, views and attitudes in turn influence how the marine environment is managed and the priorities for marine planning at the local level.

Orkney, and other Scottish islands, face socio-economic challenges due in part to geographical location and remoteness from traditional economic, population and government centres. The Islands (Scotland) Act 2018 recognises that islands are geographically, culturally and economically distinct from the Scottish mainland. These special circumstances necessitate an 'islands approach' to coastal and marine planning, addressing the unique circumstances in Orkney.

The islands approach recognises the importance of sustaining thriving islands within the Orkney Islands. The more fragile North and South Isles communities face significant challenges including population decline, accessing employment, digital connectivity, training and services. Future development needs to ensure that positive social, economic and environmental benefits are enjoyed across all our island communities.

The climate change related pressures on Orkney's physical environment, historic assets and biodiversity will significantly affect Orkney communities. Climate change pressures including sea-level rise, coastal erosion and potential increases in storminess are likely to increase impacts on coastal infrastructure, property and services.

7.4 Assessment Summary

There is no assessment of the social chapter; it would not be appropriate to measure these social and cultural factors in similar terms to the physical, biodiverse or productive coasts and seas chapters.

Section 8: Data Gaps and Next Steps

PHOTO CREDIT © JO PORTER

8.1 Research and Data Gaps

Research and data gaps have been identified as part of this assessment. Future projects or initiatives may seek to address these identified gaps in knowledge and data. Research is often most effectively carried out by forming partnerships between interested stakeholders. The ability to address data gaps is greatly affected by capacity and funding constraints. Table 33 identifies the key research and data gaps that have emerged as part of this assessment.

Table 33 Research and data gaps identified for the Orkney Islands Marine Region

Ecosystem Services	Limited data are available on the mapping and assessment of ecosystem services in the Orkney marine region, along with the cumulative impacts on ecosystem functioning.
Air Pollution	Whilst the current limited land-based monitoring shows air quality to be good, more robust data are required to understand maritime air pollution and how it could be measured and recorded. Further studies are required to understand the full impact of existing (baseline) and future marine developments and activities.
Marine Litter	More data are required on the presence and source of plastics and other marine litter in the coastal and marine environment in Orkney. Seabed and water column analysis is required, along with data on microplastics within the coastal and marine environment in Orkney. Greater knowledge is required on the biological responses to plastic and impacts on food webs and the human food chain.
Noise	Insufficient data are available about levels of noise, changes in levels of noise over time or impacts on marine species in Orkney.
Climate Change	Impacts on marine ecosystems, particularly changes in acidity and on ecosystem services provision are poorly understood for the Orkney marine region. Sea-level rise and associated modelling of impacts on coastal resources, assets and infrastructure is required to inform future coastal planning and infrastructure development. Climate related impacts on species distribution including commercial fisheries required further research.
Biodiversity	More data required regarding how wave and tidal renewable energy technologies interact with species in relation to collision risk, disturbance and displacement.
Birds	Improved data are required on the population distribution of birds of conservation importance in Orkney waters, along with data on the location and extent of their foraging habitats and any effects of renewable energy.
Cetaceans	There is a lack of information in relation to population abundance, seasonality of presence, distribution and habitat use in the Orkney marine region for all cetacean species.

Sea Trout and Sea lice Interactions	The Orkney Local Biodiversity Action Plan (OLBAP) 2018 – 2022 identifies actions to better understand the interaction between fish farming and Sea trout populations in Orkney. The OLBAP actions include undertaking a review of available literature on the pressures affecting Sea trout populations and a population study to increase understanding of the abundance and distribution of Sea trout in Orkney coastal waters. A further action is to design and undertake a research study, which will help determine how sea lice burdens in wild Sea trout are influenced by proximity to farmed salmonid species in Orkney waters.
Fishing interactions	Marine development proposals need to be informed by data on the fishing, nursery and spawning grounds that deliver value for the fishing industry but these data are generally lacking.
Marine Economy	There is a need for more robust, reliable and locally specific economic data for the marine economic sectors in Orkney.

8.2 Next Steps

This Orkney Islands Marine Region: State of the Marine Environment Assessment identifies baseline data, the current status of the marine economic sectors, key environmental pressures and trends to inform future marine planning and management in Orkney.

The next stage in this process will be the preparation of a statutory Orkney Islands Regional Marine Plan. This stage can proceed when OIC has received the formal delegation of functions from Scottish Ministers to set up the Orkney Marine Planning Partnership (OMPP) and deliver regional marine planning functions (see Section 1).

Following the delegation of functions, OIC will proceed to formally establish the OMPP Advisory Group, consisting of a range of environment, economic, recreational and community experts to provide input and guidance. The Advisory Group will be steered by formal Terms of Reference and accompanying Principles of Engagement guidance to ensure a transparent and inclusive approach to governance.

A Statement of Public Participation (SPP) will be required to outline how the Orkney Islands Regional Marine Plan will be prepared and identify opportunities for stakeholders to participate and engage in the plan making process. It will provide an indicative timetable for the various stages of plan preparation (see Table 34) and provide information on how, where and when local communities and stakeholders can contribute.

OIC has a database of over 300 marine planning stakeholders to communicate regular updates and disseminate information. Stakeholders are encouraged to contact the OIC Development and Marine Planning to provide and receive information. In addition, there will be continuous engagement with the Advisory Group members and via the OIC website.

Once the Orkney Islands Regional Marine Plan has been adopted by Scottish Ministers, the OIC Development and Marine Planning team aim to work with partners to monitor,

evaluate and implement the Plan. Subject to funding and resourcing, there is further potential to deliver marine planning and management projects to address key issues and opportunities in collaboration with partners.

The information gathered to inform this assessment will be supplemented by new research, data and information that emerges during the regional marine plan making process. It is anticipated that a revised Orkney Marine Region: State of the Environment Assessment will be published following the adoption of the Orkney Islands Regional Marine Plan and before the commencement of a subsequent plan making cycle.

Table 34 Stages required to prepare the Orkney Islands Regional Marine Plan. Stages with the same number will be produced concurrently.

Stage	Output	Comment
1	State of the Environment Assessment	This report is the assessment.
2a	Establish governance arrangements for the Advisory Group and set up/administer group	Terms of Reference and Guiding Principles of Engagement will be prepared.
2b	Statement of Public Participation	Outlines how the plan–making process will work and indicative timescales.
3	Scoping for the Strategic Environment Assessment	This will define the key areas to be assessed to determine any environmental impacts of the Plan.
4a	Draft Regional Marine Plan	12-week consultation
4b	Draft State of the Environment Assessment	
4c	Draft Habitats Regulations Appraisal	
4d	Draft Equality Impact Assessment	
4e	Draft Business and Regulatory Impact Assessment	
4f	Draft Children's Rights and Wellbeing Impact Assessment	

Stage	Output	Comment
5	Consultation report	The Consultation Report will present stakeholder responses to the consultation and how these responses have helped to shape the final plan.
6	Final draft submitted to Scottish Ministers for approval	If required, the Plan may be subject to independent investigation prior to adoption.
7	Consideration by Scottish Ministers	Adoption and publication.
8	Review, monitor and report	Update plan as required.

EDIBLE CRAB ON MIXED SANDY SUBSTRATES AMONGST SEAWEEDS, ORKNEY © NATURESCOT

Section 9: Appendices

Appendix 1: List of Nature Conservation Designated Sites in Orkney

Special Protected Areas	Proposed Special Protection Areas	Special Areas of Conservation	Sites of Special Scientific Interest	Nature Conservation Marine Protected Areas
Auskerry	Scapa Flow	Loch of Isbister	Auskerry	Wyre and Rousay Sounds
Calf of Eday	North Orkney	Loch of Stenness	Bay of Skaill	Papa Westray
Copinsay		Faray and Holm of Faray	Calf of Eday	North-west Orkney
East Sanday Coast		Hoy	Central Sanday	
Hoy		Stromness Heaths and Coasts	Copinsay	
Marwick Head		Sanday	Cruaday	
Papa Westray			Denwick	
Orkney Mainland Moors			Doomy and Whitamaw Hill	
Pentland Firth Islands			East Sanday Coast	
Rousay			Eynhallow	
Sule Skerry and Sule Stack			Faray and Holm of Faray	
Switha			Glimps Moss and Durkadale	
West Westray			Holm of Papa Westray	

Special Protected Areas	Proposed Special Protection Areas	Special Areas of Conservation	Sites of Special Scientific Interest	Nature Conservation Marine Protected Areas
			Hoy	
			Keelylang and Swartaback Burn	
			Loch of Banks	
			Loch of Isbister and the Loons	
			Lochs of Harray and Stenness	
			Marwick Head	
			Mill Bay	
			Mill Loch	
			Muckle Head and Selwick	
			Muckle and Little Green Holm	
			North Hill	
			Northwall	
			Orphir and Stenness Hills	
			Pentland Firth Islands	
			Rousay	

Special Protected Areas	Proposed Special Protection Areas	Special Areas of Conservation	Sites of Special Scientific Interest	Nature Conservation Marine Protected Areas
			Stromness Heaths and Coast	
			Sule Skerry	
			Sule Stack	
			Switha	
			Ward Hill Cliffs	
			Waulkmill	
			West Mainland Moorlands	
			West Westray	

Appendix 2: Internationally and nationally designated sites and site condition in Orkney (June 2020)

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Auskerry SSSI/SPA	Breeding storm petrel, breeding Arctic tern.	Arctic tern unfavourable declining (2018). Storm petrel favourable declining (2018).	Breeding storm petrel, breeding Arctic tern.	Arctic tern unfavourable declining (2018). Storm petrel favourable declining (2018).
Bay of Skaill SSSI	Palaeozoic palaeobotany (fossil plants).	Favourable maintained (2012).	N/A	N/A
Calf of Eday SSSI/SPA	Breeding cormorant.	Cormorant favourable maintained (2016).	Breeding cormorant; breeding fulmar; breeding great black-backed gull; breeding kittiwake breeding guillemot; breeding seabird assemblage.	Cormorant breeding favourable recovered (2016). Fulmar breeding favourable maintained (2016). Great black backed gull unfavourable declining (2016). Guillemot breeding unfavourable declining (2016). Kittiwake breeding unfavourable declining (2016). Seabird assemblage breeding unfavourable declining (2016).

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Central Sanday SSSI	Coastal geomorphology of Scotland (coastal sedimentary landforms); saltmarsh; machair; sand dunes.	Machair unfavourable no change (2013) Sand dunes unfavourable no change (2013). Saltmarsh favourable maintained (2012). Coastal geomorphology of Scotland favourable maintained (2010).	N/A	N/A
Copinsay SSSI/SPA	Breeding seabird colony; breeding guillemot; breeding kittiwake.	Guillemot unfavourable no change (2015). Kittiwake unfavourable declining (2015) Seabird colony, breeding unfavourable no change (2015).	Breeding seabird assemblage; breeding fulmar; breeding great black-backed gull; breeding guillemot; breeding kittiwake	Fulmar breeding favourable maintained (2015). Great black backed gull unfavourable declining (2015). Guillemot unfavourable no change (2015). Kittiwake unfavourable declining (2015). Seabird assemblage, breeding unfavourable no change (2015).
Cruaday quarry SSSI	Silurian - Devonian chordata (fossil fish).	Silurian-Devonian chordata favourable maintained (2009)	N/A	N/A
Denwick SSSI	Quaternary of Scotland (multiple glacial till Section).	Quaternary of Scotland favourable maintained (2017).	N/A	N/A

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Doomy and Whitemaw Hill SSSI	Breeding Arctic skua; breeding whimbrel.	Arctic skua breeding unfavourable declining (2016). Whimbrel breeding unfavourable no change (2016).	N/A	N/A
East Sanday coast SSSI/SPA/ Ramsar site	Non-breeding ringed plover, non-breeding bar-tailed godwit, non-breeding purple sandpiper, non-breeding sanderling, non-breeding turnstone; passage turnstone; rocky shore; sandflats; Harbour seal; vascular plant assemblage.	Rocky shore favourable maintained (2008). Sandflats favourable maintained (2008). Harbour seal unfavourable declining (2013). Vascular plant assemblage favourable maintained (2006). Bar-tailed godwit non-breeding favourable maintained (2015). Purple sandpiper non-breeding favourable maintained (2015). Ringed plover non-breeding favourable maintained (2015). Sanderling non-breeding favourable maintained (2015). Turnstone non-breeding favourable maintained (2015). Turnstone passage favourable maintained (2016).	SPA - Non-breeding bar-tailed godwit; non-breeding turnstone; non-breeding purple sandpiper. Ramsar – Non-breeding purple sandpiper; non-breeding	SPA Bar-tailed godwit non-breeding favourable maintained (2015). Purple sandpiper non-breeding favourable maintained (2015). Turnstone non-breeding favourable maintained (2015). Ramsar Purple sandpiper non-breeding favourable maintained (2015). Turnstone non-breeding favourable recovered (2015).
Eynhallow SSSI	Harbour seal.	Harbour seal unfavourable declining (2013).	N/A	N/A
Faray and Holm of Faray SSSI/ SAC	Grey seal.	Grey seal favourable maintained (2014).	Grey seal.	Grey seal favourable maintained (2014).
Glims Moss and Durkadale SSSI	Raised bog; Hydro morphological mire range; valley fen.	Hydromorphological mire range favourable maintained (2014). Raised bog favourable maintained (2004). Valley fen favourable maintained (2004).	N/A	N/A

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Holm of Papa Westray SSSI (also forms part of Papa Westray (North Hill and Holm) SPA)	Breeding black guillemot.	Black guillemot breeding unfavourable no change (2013).	Papa Westray SPA Breeding Arctic skua; breeding Arctic tern.	Papa Westray SPA Arctic skua breeding unfavourable declining (2015). Arctic tern breeding unfavourable no change (2017).

Hoy SSSI/SPA/SAC	Breeding seabird colony; breeding Arctic skua, breeding fulmar, breeding great skua, breeding guillemot. Breeding bird assemblage; breeding peregrine, breeding red-throated diver, breeding great black-backed gull; blanket bog.	Upland oak woodland favourable maintained (2009). Blanket bog favourable maintained (2014). Dystrophic loch favourable maintained (2013). Breeding bird assemblage favourable maintained (2013). Non-marine Devonian favourable maintained (2003). Old Red Sandstone igneous favourable maintained (2003). Quaternary of Scotland favourable maintained (2003). Coastal geomorphology of Scotland favourable maintained (2003). Upland assemblage favourable recovered (2014). Arctic skua unfavourable declining (2019). Fulmar breeding unfavourable no change (2017). Great skua breeding unfavourable declining (2019). Great black backed gull unfavourable declining (2019). Guillemot breeding unfavourable no change (2017). Peregrine breeding favourable maintained (2013). Red-throated diver favourable maintained (2007). Seabird colony breeding favourable maintained (2000).	SPA - Breeding seabird assemblage; breeding Arctic skua; breeding great skua; breeding great black-backed gull; breeding guillemot; breeding kittiwake; breeding peregrine; breeding red-throated diver; breeding fulmar; breeding puffin. SAC – Blanket bog; dry heaths; wet heathland with cross-leaved heath; base-rich fens; hard-water springs depositing lime; plants in crevices in base-rich rocks; Alpine and subalpine heaths; acid peat-stained lakes and ponds; vegetated sea cliffs.	SPA Arctic skua breeding unfavourable declining (2019). Fulmar breeding unfavourable no change (2017). Great black-backed gull breeding unfavourable declining (2019). Great skua breeding unfavourable declining (2019). Guillemot breeding unfavourable no change (2017). Kittiwake breeding unfavourable declining (2017). Peregrine breeding favourable maintained (2013). Puffin breeding unfavourable declining (2004). Red-throated diver breeding favourable maintained (2007). Seabird assemblage breeding unfavourable declining (2019). SAC Acid peat-stained lakes and ponds favourable maintained (2014). Alpine and subalpine heaths favourable maintained (2014). Base rich fens favourable maintained (2014). Blanket bog favourable maintained (2014). Dry heaths favourable maintained (2014). Hard-water springs depositing lime favourable maintained (2006).

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Keelylang and Swartaback Burn SSSI (also forms part of Orkney Mainland Moors SPA)	Breeding hen harrier; breeding bird assemblage; upland habitat assemblage (mosaic).	Breeding bird assemblage favourable maintained (2003). Hen harrier breeding favourable maintained (2013). Upland habitat assemblage favourable maintained (2016)	Orkney Mainland Moors SPA Breeding hen harrier, breeding short-eared owl and breeding red-throated diver; non-breeding hen harrier.	Orkney Mainland Moors SPA Hen harrier breeding favourable maintained (2013). Hen harrier non-breeding favourable maintained (2013). Red-throated diver breeding favourable maintained (2007). Short-eared owl breeding favourable maintained (2004).
Loch of Banks SSSI	Non-breeding hen harrier; breeding bird assemblage; basin fen.	Basin fen unfavourable no change (2013). Breeding bird assemblage favourable maintained (2019). Hen harrier non-breeding unfavourable no change (2014).	N/A	N/A

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Loch of Isbister and The Loons SSSI Loch of Isbister SAC	Breeding pintail; breeding bird assemblage; basin fen.	Basin fen favourable maintained (2012). Breeding bird assemblage favourable maintained (2007). Pintail breeding favourable maintained (2012).	Loch of Isbister SAC Very wet mires often identified by an unstable 'quaking' surface; Otter; Naturally nutrient-rich lakes or lochs which are often dominated by pondweed.	Naturally nutrient-rich lochs often dominated by pondweed unfavourable declining (2014). Otter favourable maintained (2011). Very wet mires often identified by an unstable quaking surface favourable maintained (2012).
Lochs of Harray and Stenness SSSI Stenness SAC	Non-breeding goldeneye, non-breeding pochard, non-breeding scaup, non-breeding tufted duck; saline lagoon; freshwater nerite snail (Theodoxus fluviatilis); a caddis fly; eutrophic loch.	Eutrophic loch unfavourable no change (2010). Saline lagoon favourable maintained (1999). Freshwater nerite snail favourable maintained (2013). Goldeneye non-breeding unfavourable declining (2013). Pochard non-breeding unfavourable recovered (2013). Scaup non-breeding favourable maintained (2013). Tufted duck non-breeding unfavourable no change (2013). Caddis fly favourable maintained (2013).	Loch of Stenness SAC Lagoons.	Lagoons favourable maintained (2013).

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Marwick Head SSSI/SPA	Breeding seabird colony; breeding guillemot; breeding kittiwake.	Guillemot breeding unfavourable declining (2017). Kittiwake breeding unfavourable declining (2015). Seabird colony breeding unfavourable declining (2015).	Breeding seabird assemblage; breeding guillemot; breeding kittiwake.	Guillemot breeding unfavourable declining (2017). Kittiwake breeding unfavourable declining (2015). Seabird assemblage breeding unfavourable declining (2015).
Mill Bay SSSI	Quaternary of Scotland (exposed shelly till).	Quaternary of Scotland favourable maintained (2014).	N/A	N/A
Mill Loch SSSI	Breeding red-throated diver.	Red-throated diver breeding favourable maintained (2012).	N/A	N/A
Muckle Head and Selwick SSSI	Quaternary of Scotland.	Quaternary of Scotland favourable maintained (2002).	N/A	N/A
Muckle and Little Green Holm SSSI	Grey seal.	Grey seal favourable maintained (2014).	N/A	N/A
North Hill SSSI (also forms part of Papa Westray SPA)	Breeding Arctic skua; breeding Arctic tern; maritime cliff	Maritime cliff favourable maintained (2012). Arctic skua breeding unfavourable declining (2015). Arctic tern breeding unfavourable no change (2017).	Papa Westray SPA Breeding Arctic skua; breeding Arctic tern	Arctic skua breeding unfavourable declining (2015). Arctic tern breeding unfavourable no change (2017).
Northwall SSSI	Machair loch; machair.	Machair loch favourable maintained (2004). Machair favourable maintained (2012).	N/A	N/A

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Orphir and Stenness Hills SSSI (also forms part of Orkney Mainland Moors SPA)	Breeding hen harrier; breeding bird assemblage; Upland habitat assemblage (mosaic).	Breeding bird assemblage favourable maintained (2012). Upland habitat assemblage favourable maintained (2006). Hen harrier breeding favourable maintained (2013).	Orkney Mainland Moors SPA Breeding hen harrier, breeding short-eared owl and breeding red-throated diver; non-breeding hen harrier.	Orkney Mainland Moors SPA Hen harrier breeding favourable maintained (2013). Hen harrier non-breeding favourable maintained (2013). Red-throated diver breeding favourable maintained (2007). Short-eared owl breeding favourable maintained (2004).
Pentland Firth Islands SSSI/SPA	Breeding Arctic tern; Vascular plant assemblage.	Vascular plant assemblage favourable recovered (2019). Arctic tern breeding unfavourable no change (2018).	Breeding Arctic tern.	Arctic tern breeding unfavourable no change (2018).

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Rousay SSSI/SPA	Breeding Arctic tern, breeding guillemot, breeding kittiwake; breeding seabird colony; breeding Arctic skua; breeding bird assemblage; blanket bog; subalpine wet heath; mesotrophic loch; maritime cliff.	Subalpine wet heath favourable recovered (2008). Blanket bog favourable maintained (2014). Mesotrophic loch unfavourable declining (2014). Maritime cliff unfavourable recovering (2008). Vascular plant assemblage favourable maintained (2009). Breeding bird assemblage favourable maintained (2002). Arctic skua breeding unfavourable no change (2015). Arctic tern breeding unfavourable declining (2007). Guillemot breeding unfavourable declining (2016). Kittiwake breeding unfavourable declining (2016) Seabird colony breeding unfavourable declining (2016).	Breeding seabird assemblage; breeding guillemot; breeding Arctic skua; breeding Arctic tern; breeding fulmar; breeding kittiwake.	Arctic skua breeding unfavourable no change (2015). Arctic tern breeding unfavourable declining (2007). Fulmar breeding favourable maintained (2016). Guillemot breeding unfavourable declining (2016). Kittiwake breeding unfavourable declining (2016). Seabird assemblage unfavourable declining (2016).
Sanday SAC	N/A	N/A	Reefs; subtidal sandbanks; intertidal mudflats and sandflats; Harbour seal.	Harbour seal unfavourable declining (2013). Intertidal mudflats and sandflats favourable maintained (2008). Reefs favourable maintained (2008). Subtidal sandbanks favourable maintained (2008).

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Stromness heaths and Coast SSSI/SAC	Subalpine dry heath; coastal geomorphology; non-marine Devonian stratigraphy; maritime cliff.	Subalpine dry heath favourable maintained (2008). Maritime cliff favourable maintained (2012). Non-marine Devonian partially destroyed (2017). Coastal geomorphology of Scotland favourable maintained (2013).	Dry heaths; base-rich fens; vegetated sea cliffs.	Base rich fens favourable maintained (2014). Dry heaths favourable maintained (2008). Vegetated sea cliffs favourable maintained (2012).
Sule Skerry SSSI Part of Sule Skerry and Sule Stack SPA	Breeding seabird colony; breeding puffin; breeding shag; breeding storm petrel.	Puffin breeding favourable declining (2015). Shag breeding unfavourable declining (2015). Storm petrel breeding favourable declining (2018). Seabird colony breeding favourable maintained (2015).	Sule Skerry and Sule Stack SPA Breeding gannet; breeding storm petrel; breeding seabird assemblage; breeding guillemot; breeding Leach's petrel; breeding puffin; breeding shag.	Sule Skerry and Sule Stack SPA Gannet breeding favourable maintained (2013). Guillemot breeding favourable maintained (2015). Leach's petrel breeding unfavourable declining (2018). Puffin breeding favourable declining (2015). Seabird assemblage breeding favourable maintained (1998). Shag breeding unfavourable declining (2015). Storm petrel breeding favourable declining (2018).
Sule Stack SSSI Part of Sule Skerry and Sule Stack SPA	Breeding gannet.	Gannet breeding favourable maintained (2013).		

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
Switha SSSI/SPA	Non-breeding Greenland barnacle goose.	Greenland barnacle goose non-breeding favourable maintained (2013).	Non-breeding Greenland barnacle goose.	Greenland barnacle goose non-breeding favourable maintained (2013).
Ward Hill Cliffs SSSI	Maritime cliff.	Maritime cliff favourable maintained (2012).	N/A	N/A
Waulkmill SSSI	Saltmarsh; golden-rod case-bearer moth; maritime cliff.	Saltmarsh favourable maintained (2012). Golden-rod case-bearer moth favourable maintained (2014) Maritime cliff favourable maintained (2012).	N/A	N/A
West Mainland Moorlands SSSI (also forms part of Orkney Mainland Moors SPA)	Breeding hen harrier, breeding short-eared owl and breeding red-throated diver; breeding bird assemblage; upland assemblage (mosaic); blanket bog.	Blanket bog unfavourable recovering (2014). Breeding bird assemblage favourable maintained (2015). Upland assemblage unfavourable recovering (2014). Hen harrier breeding favourable maintained (2013). Red-throated diver breeding favourable maintained (2007). Short-eared owl breeding not assessed.	Orkney Mainland Moors SPA Breeding hen harrier, breeding short-eared owl and breeding red-throated diver; non-breeding hen harrier.	Orkney Mainland Moors SPA Hen harrier breeding favourable maintained (2013). Hen harrier non-breeding favourable maintained (2013). Red-throated diver breeding favourable maintained (2007). Short-eared owl breeding favourable maintained (2004).

Site	SSSI qualifying features	SSSI Site Condition	SPA/SAC/Ramsar qualifying interests	SPA/SAC/Ramsar Site Condition
West Westray SSSI/SPA	Breeding guillemot; breeding seabird colony; breeding Arctic skua; breeding Arctic tern; breeding kittiwake; breeding razorbill; maritime cliff.	Maritime cliff favourable maintained (2012). Arctic skua breeding unfavourable declining (2017). Arctic tern breeding unfavourable no change (2017). Guillemot breeding unfavourable declining (2017). Kittiwake breeding unfavourable declining (2017). Razorbill breeding favourable recovered (2017). Seabird colony breeding unfavourable declining (2017).	Breeding guillemot; breeding seabird assemblage; breeding Arctic skua; breeding Arctic tern; breeding fulmar; breeding kittiwake; breeding razorbill;	Arctic skua breeding unfavourable declining (2017). Arctic tern breeding unfavourable no change (2017). Fulmar breeding favourable recovered (2017). Guillemot breeding unfavourable declining (2017). Kittiwake breeding unfavourable declining (2017). Razorbill breeding favourable recovered (2017). Seabird assemblage breeding unfavourable declining (2017).

Site	Nature Conservation Marine Protected Area (NCMPA) qualifying features	Conservation Objectives	NCMPA Site Condition
Wyre and Rousay Sound	Kelp and seaweed communities on sublittoral sediment; maerl beds; Marine Geomorphology of the Scottish Shelf Seabed – forms part of the Orkney carbonate production area...	Conserve in favourable condition or bring into, and maintain, in favourable condition.	Required measures were implemented in 2016 and the features are considered to be achieving their objectives
Papa Westray	Black guillemot; Marine Geomorphology of the Scottish Shelf Seabed – forms part of the Orkney carbonate production area...	Conserve in favourable condition or bring into, and maintain, in favourable condition	Black guillemot declining since site designation. The implementation of fisheries management measures should improve feature status. Geodiversity features achieving their objectives.
North-west Orkney	Sandeels; Sand banks, sand wave fields and sediment wave fields representative of the Fair Isle Strait Marine Process Bedforms Key Geodiversity Area	Conserve in favourable condition or bring into, and maintain, in favourable condition.	The protected features are considered to be in favourable condition

Proposed SPA	**proposed Special Protection Area (pSPA) qualifying interests**
North Orkney	Breeding Red-throated diver; Non-breeding Common eider, European shag, Great northern diver, Long-tailed duck, Red-breasted merganser, Slavonian grebe and Velvet scoter.
Scapa Flow	Breeding red-throated diver Non-breeding Black-throated diver, Common eider, Common goldeneye, European shag, Great northern diver, Long-tailed duck, Red-breasted merganser, Slavonian grebe.
Orkney Inshore Waters	Breeding red-throated diver Non-breeding black-throated diver, common eider, European shag, great northern diver, long-tailed duck, red-breasted merganser, Slavonian grebe.

Appendix 3: List of Priority Marine Features recorded within 12 nm of Orkney

Blue Mussel Beds	1.*Mytilus edulis* on littoral sediments
Flame shell beds	
Horse mussel beds	1. *Modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata 2. *Modiolus* beds on open coast circalittoral mixed sediment 3. *Modiolus* beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata 4. *Modiolus* beds with Chlamys varia, sponges, hydroids, and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata
Intertidal	
Kelp and seaweed communities on sublittoral kelp beds	1. *Laminaria hyperborea* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock 2. *Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock 3. *Laminaria hyperborea* on tide-swept, infralittoral rock 4. *Laminaria hyperborea* on tide-swept infralittoral mixed substrata 5. *Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock
Low or variable salinity habitats	1. Kelp in variable or reduced salinity 2. Submerged fucoids, green or red seaweeds (Low salinity infralittoral rock) 3. Bird's nest stonewort – *Tolypella nidifica* 4. Baltic stonewort – *Chara baltica* 5. Small brackish water snail – *Hydrobia acuta neglecta*
Maerl beds	1. Maerl or coarse shell gravel with burrowing sea cucumbers
Native oysters	1. *Ostrea edulis*
Seagrass beds	1. *Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand 2. *Ruppia maritima* in reduced salinity infralittoral muddy sand

Tide-swept algal communities	1. Fucoids in tide-swept conditions 2. *Halidrys siliquosa* and mixed kelps on tide-swept infralittoral rock with coarse sediment 3. Kelp and seaweed communities in tide-swept sheltered conditions 4. *Laminaria hyperborea* on tide-swept infralittoral mixed substrata
Tide-swept coarse sands with burrowing bivalves	
Low or limited mobility species	1. Northern feather star – *Leptometra celtica* 2. Fan mussel - *Atrina fragilis* 3. Ocean quahog – *Arctica islandica*

Mobile species	1. European spiny lobster – *Palinurus elephas* 2. European eel – *Anguilla* 3. Atlantic salmon - *Salmo salar* 4. Sea lamprey – *Petromyzon marinus* 5. Sea trout - *Salmo trutta* 6. Sparling – *Osmerus eperlanus* 7. Angler fish – *Lophius piscatorius* 8. Atlantic halibut – *Hippoglossus* 9. Atlantic herring – *Clupea harengus* 10.Atlantic mackerel – *Scomber scombrus* 11.Cod – *Gadus morhua* 12.Greenland halibut – *Reinhardtius hippoglossoides* 13.Horse mackerel – *Trachurus* 14.Ling – *Molva* 15.Norway pout – *Trisopterus esmarkii* 16. Round-nose grenadier – *Coryphaenoides rupestris* 17.Saithe – *Pollachius virens* 18.Sandeels – *Ammodytes marinus and Ammodytes tobianus* 19.Sand goby – *Pomatoschistus minutus* 20.Whiting – *Merlangius merlangus* 21.Basking shark – *Cetorhinus maximus* 22.Common skate – *Dipturus batis complex* 23.Porbeagle shark – *Lamna nasus* 24.Spiny dogfish – *Squalus acanthias* 25.Atlantic white-sided dolphin – *Lagenorhynchus acutus* 26.Bottlenose dolphin – *Tursiops truncates* 27.Fin whale – *Balaenoptera physalus* 28.Harbour porpoise – *Phocoena* 29.Killer whale – *Orcinus orca* 30.Long-finned pilot whale – *Globicephala melas* 31.Minke whale – *Balaenoptera acutorostrata* 32.Northern bottlenose whale – *Hyperoodon ampullatus* 33.Risso's dolphin – *Grampus griseus* 34.Short-beaked common dolphin – *Delphinus delphis* 35.Sowerby's beaked whale – *Mesoplodon bidens* 36.Sperm whale – *Physeter macrocephalus* 37.White-beaked dolphin – *Lagenorhynchus albirostris* 38.Harbour seal – *Phoca vitulina* 39.Grey seal – *Halichoerus grypus* 40.Otter – *Lutra lutra*

Appendix 4: Air quality monitoring report for Orkney

Site ID	NO_2 Mean Concentrations (µg/m3)													
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual Mean	
													Raw Data	Bias Adjusted (1)
KW	20.8	18.1	14.0	13.0	17.6	10.8	12.1	15.5	13.6	14.6	18.2	14.5	15.2	14.6
SN	14.2	12.6	7.4	8.1	8.5	8.2	11.4	8.3	6.1	9.2	14.3	14.0	10.2	9.8
SM	6.3	2.3	3.3	2.1	4.9	3.7	4.7	3.4	1.9	4.2	6.6	7.3	4.2	4.1
WM	5.3	2.8	3.7	3.2	4.6	3.0	3.6	2.9	1.7	2.7	4.8	3.2	3.5	3.3
HE	4.4	2.7	1.7	2.3	3.2	1.6	2.6	2.5	<1.0	1.9	3.2	2.1	2.6	2.3
MH	5.7	3.1	4.4	5.3	5.8	3.9	5.8	4.3	2.5	4.4	4.4	3.8	4.5	4.3
FT	11.7	12.6	10.0	9.5	11.9	9.0	9.9	9.9	6.5	9.6	13.5	9.4	10.3	9.9
PD	-	9.0	5.4	4.5	5.2	3.7	4.1	4.9	4.1	5.6	6.3	6.9	5.4	5.2

Appendix 5: Sule Stack and Sule Skerry

- Sule Stack and Sule Skerry are uninhabited and are adjoined by seas that form a significant proportion of the Orkney Islands marine region.

Introduction

Sule Stack and Sule Skerry have large populations of birds and seals.

Physical aspects

With a surface area of 14.2 ha (35 acres) and rising in the centre to 15m (45 feet) above water, Sule Skerry is almost out of sight of all land. The rocky outcrop comprises banded gneiss with a shallow soil base in the centre. It lies in the track of vessels passing through the Pentland Firth on passage to or from the Iceland seas and northern shipping routes. The surrounding waters are a relatively deep water location with depths of over 100 metres.

The Sule Skerry lighthouse is Britain's most remote lighthouse, lying 40 miles west of Orkney. It was built by David and Charles Stevenson in 1895 and is therefore a category A listed building. It is unmanned, since becoming fully automatic in 1982.

Approximately four miles away from Sule Skerry rises Sule Stack, some 40m (140 feet) high. The stack is divided into two halves, each rising to 40m at the highest points. Together, these two Sections of rock cover around 2.5 ha (6 acres). The seabed sediments are largely muddy sand and sandy mud (see Figure 8). Unsurprisingly, the water quality for the area is high, given the distance from potential pollution sources and the level of water circulation around the area.

Biological status

The Sule Skerry and Sule Stack area is an important breeding area for Grey seal (*Halichoerus grypus*), designated as a breeding colony Seal Haul-out site, as well as supporting a variety of seabirds. The Sule Skerry and Sule Stack Special Protection Area (SPA), which covers approximately 3,900 ha, is made up of two square sites of similar size (see Figure 21). It is designated for its breeding populations of Gannet (*Morus bassanus*), Guillemot (Uria aalge), Leach's petrel (*Oceanodroma leucorhoa*), Storm petrel (*Hydrobates pelagicus*), Puffin (*Fratercula arctica*), Shag (*Phalacrocorax aristotolis*) and the seabird assemblage. Sule Skerry Site of Special Scientific Interest (SSSI) is designated for breeding populations of Puffin, Shag, Storm Petrel, and its seabird colony, whilst Sule Stack SSSI is designated for its breeding populations of Gannet. The first detailed ornithological records date back to 1896 when James Tomison, the resident light-keeper, started to document them.

The boundary of the Solan Bank Reef SAC is situated adjacent to the12nm boundary of the Orkney Islands marine region at the western edge. The SAC is designated for reefs, but no negative pressures have been identified, nor has the condition of them been assessed, therefore limited information is available on the status of the SAC.

The Sule Skerry bird ringing group spend several weeks on the island every four years and have a considerable amount of data on seabirds. There is a landing point on the islands, which has deteriorated over the years but is still present as well as old railway tracks leading to the coastal edge.

Appendix 6: List of Figures

Appendix 7: List of Tables

Appendix 8: Reference List

No.	Reference	Summary
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Orkney Islands Council

For more information contact

Development and Marine Planning
Orkney Islands Council
School Place
Kirkwall
KW15 1NY
United Kingdom

Email: marine.planning@orkney.gov.uk

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