Tidal Industry Seal Project

Tidal Industry Seal Project

Managing the consenting risk of harbour seal collision in the Scottish tidal energy industry

XODUS

EMEC
THE EUROPEAN MARINE ENERGY CENTRE LTD

MEYGEN
THE TIDE OF CHANGE IN CAITHNESS

nova

ORBITAL
MARINE POWER

TIDAL INDUSTRY SEAL PROJECT

Managing the consenting risk of harbour seal collision in the Scottish tidal energy industry

Ewan Edwards[1], Ian Davies[2], Gianlucca Gerich[3], Millie Green[4], Donald Leaver[4], James McKie[5], Abi McLean[4], Patrick Munro[6], James Murray[7], Kate Smith[8].

[1] Xodus Group Ltd
[2] Carronside Consultancy Ltd
[3] SAE Renewables Ltd
[4] European Marine Energy Centre Ltd
[5] Eurona Consultancy Ltd
[6] Burges Salmon LLP
[7] Orbital Marine Power Ltd
[8] Nova Innovation Ltd

This work was funded by Crown Estate Scotland and Highlands and Islands Enterprise.

A01	02/05/25	Issued for Use	SB	EE	KC
REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED

CONTENTS

GLOSSARY AND DEFINITIONS

TERM	DEFINITION
AA	Appropriate Assessment, a stage of the Habitats Regulations Appraisal process
AR 4/5/6	Allocation Round 4/5/6 of the Contract for Difference scheme
CES	Crown Estate Scotland
CfD	Contract for Difference, a UK Government mechanism to guarantee a strike price for energy generation to incentivise investment in renewable energy
CRM	Collision Risk Model
DA	Domoic Acid, a biotoxin produced by algae
EIA	Environmental Impact Assessment
EMEC	European Marine Energy Centre
EPS	European Protected Species
ERM	Encounter Rate Model
ETPM	Exposure-Time-Probability Model
GW	Gigawatt
GWh	Gigawatt-hours
Habitats Regulations	The suite of regulations that transpose the EU Habitats and Birds Directives into UK law
HES	Historic Environment Scotland
HRA	Habitats Regulations Appraisal
INTOG	Innovation and Targeted Oil and Gas electrification; an offshore wind leasing round in Scotland
IROPI	Imperative reasons of over-riding public interest
MCA	Maritime and Coastguard Agency
MD-LOT	Marine Directorate Licensing Operations Team
MRE	Marine renewable energy
MPA	Marine Protected Area
MSA 2010	Marine (Scotland) Act 2010
MW	Megawatt
NatureScot	The primary Statutory Nature Conservation Body for Scotland, previously known as Scottish Natural Heritage
NERC	Natural Environment Research Council
NLB	Northern Lighthouse Board

TERM	DEFINITION
NM	Nautical mile
NPF4	The Fourth National Planning Framework
PBR	Potential Biological Removal
PEMP	Project Environmental Monitoring Plan
PFOW	Pentland Firth and Orkney Waters
Photo-ID	Photographic identification, a technique to identify individual animals through recognition of distinctive marks or patterns
PTS	Permanent Threshold Shift, a change in hearing sensitivity
PVA	Population viability analysis, an approach to population modelling
RIAA	Report to Inform an Appropriate Assessment, a requirement of the Habitats Regulations Appraisal process
S36	Section 36 of the Electricity Act 1989
SAC	Special Area of Conservation
SAE	Simec Atlantis Energy
SCOS	Special Committee on Seals
ScotWind	The ScotWind offshore wind leasing round
SEPA	Scottish Environment Protection Agency
SMA	Seal Management Area
SMASS	Scottish Marine Animals Strandings Scheme
SMEEF	Scottish Marine Environmental Enhancement Fund
SMRU	Sea Mammal Research Unit
STX	Saxitoxin, a biotoxin produced by algae
TCE	The Crown Estate (England and Wales)
TISP	Tidal Industry Seal Project
TWh	Terawatt-hours

1 FOREWORD

We are pleased to present this report, made possible through the valued support of Crown Estate Scotland and Highlands and Islands Enterprise; the first report of the Tidal Industry Seal Project (TISP). Their commitment to Scotland's renewable future is vital, and we appreciate their role in advancing the potential of the tidal stream energy industry. This TISP report is the culmination of three months of detailed analysis, careful consideration, and meaningful engagement with stakeholders and interested parties.

The report addresses the critical consenting challenges faced by Scotland's tidal stream energy industry, particularly concerning the declining harbour seal population in the key resource area in the North of Scotland. The urgency of resolving these challenges stems from the growing threat of the climate crisis, which drives the escalating demand for clean power by 2030, as well the continued importance of energy security. This growth must occur while balancing the conservation of a protected species and promoting sustainable environmental stewardship.

The recommendations in this report reflect our efforts to listen to stakeholders' views, aiming to deliver ambitious but balanced recommendations that are proportionate to the risks. While this report marks an important step forward, it also acknowledges the challenges we face. These challenges must be addressed fairly, and with the support of the tidal stream industry, the Scottish Government and other stakeholders, whilst using the best current scientific research and evidence. We gratefully recognise the substantial investment in tidal stream energy in Scotland from both the public and private sector to date and hope that this will continue, enabling the industry to become an integral part of Scotland's renewable future.

It is clear from the feedback received during our discussions that, whilst recognising the need to deliver a green recovery and meet our ambitious targets for net zero and build our Blue Economy, our waters offer significant potential to maximise these opportunities for Scotland.

Many challenges still lie head, and we regard this report to be the beginning of a process, not the end. In the coming months, we will work with TISP partners and other stakeholders across the board to set out further details of actions that we believe are now required.

Tidal Industry Seal Project
March 2025.

2 EXECUTIVE SUMMARY

Introduction

The Tidal Industry Seal Project (TISP) addresses the critical consenting challenges faced by Scotland's tidal stream energy industry, particularly concerning the declining harbour seal population. The urgency of resolving these challenges is driven by the escalating demand for clean, renewable energy and the need for energy security while balancing the conservation of a protected species. The Pentland Firth and Orkney Waters (PFOW) region, with its powerful tidal currents, holds substantial potential for tidal stream energy, which is crucial for the UK's renewable energy future.

Tidal Energy Potential and Developments

The PFOW region is renowned for its tidal energy resources, attracting significant investment in the European Marine Energy Centre and pioneering project developments. Notable projects include MeyGen, the world's largest tidal stream array, and innovations by companies like Nova Innovation and Orbital Marine Power. These projects have demonstrated the viability of tidal power generation, contributing significantly to renewable electricity production.

Environmental and Regulatory Challenges

A key challenge for tidal energy development is securing environmental consent, particularly concerning the risk of collision between turbine blades and marine fauna, including harbour seals. The decline of the harbour seal population in the PFOW region complicates consenting processes. Despite extensive monitoring, there is no concrete evidence of turbine-seal collisions, but regulatory concerns persist due to the vulnerability of this regional population.

Governmental Policy and Support

National and regional policies support tidal energy development, emphasizing sustainable marine economy and climate change mitigation. Recent policy documents reinforce the commitment to renewable energy and the transition to a net-zero economy. However, the consenting process remains complex, requiring comprehensive environmental assessments and effective risk mitigation strategies.

Industry Collaboration and the TISP Initiative

Leading industry stakeholders, including EMEC, MeyGen, Orbital Marine, and Nova Innovation, have launched the TISP to address consenting challenges. The project aims to facilitate consenting of utility-scale tidal turbine arrays while ensuring environmental stewardship. The report examines the effectiveness of current collision risk models, regulatory frameworks, and potential solutions, including regional strategic ecosystem monitoring and proportionate compensation mechanisms.

Recommendations

Towards the end of this report (Section 9.8), TISP have set out a series of recommendations that should be considered, commencing immediately. These are summarised here:

<u>Collaboration and engagement on next steps</u>

1. Roundtable discussion to be arranged: Convene a roundtable with key stakeholders to discuss the report's outputs during Q2 2025.
2. Develop a roadmap to reduce risk: A high-level, collaborative, strategic plan for the industry, introducing the steps needed to enable further tidal stream energy development.

3. Regional Advisory Group to be established: PFOW developers to form a group for regional/strategic environmental assessment and monitoring.
4. Collaborative cumulative effects assessment: PFOW developers to conduct cumulative effects assessment in a collaborative way.

A fit-for-purpose policy and regulatory framework

5. Policy review: Scottish Government to review policy frameworks and regulatory processes to support tidal stream energy development.
6. Strategic planning resources: Scottish Government to allocate resources for strategic planning of tidal stream energy.
7. Seal management: Review the management of seal populations and consider alternative approaches to assessment of significant effects.
8. Evidence gaps: Review ScotMER evidence map prioritisation through tidal stream industry representation in expert groups to reflect industry research needs.

Application of up-to-date methodologies and use of best available evidence in environmental assessment

9. Collision evidence and risk assessment tools: Review and update NatureScot guidance on collision risk assessment based on current evidence..
10. Expert opinion: Questions relating to tidal energy to be put to SCOS via regulator and advisers.

Proportionate and feasible monitoring

11. Review scope of future monitoring: Conduct testing and validation of new monitoring technologies; assess scalability and cost-effectiveness of these methods; continue collaboration to share insights and data.
12. Strategic monitoring and research: Collaborative planning of strategic monitoring and research

Ecological enhancement and compensation

13. Ecological enhancement and compensatory measures: Conduct feasibility study on ecological enhancement and compensatory measures for harbour seal impacts, with due consideration given to plan-level compensation.

Project-level recommendations

14. Consent applications: Include collision risk estimates and consider presenting alternatives to PBR, such as population viability counterfactual assessments, in Section 36 applications
15. Derogation cases: Include derogation cases in applications interacting with Sanday SAC.
16. PBR assessment: Consider the most appropriate assessment unit (population) for PBR assessment, e.g. the wider Scottish harbour seal population
17. Planning acceptability: Consider compensatory measures for planning acceptability of developments.

Conclusion

Unlocking the full potential of tidal stream energy is imperative for securing a resilient, sustainable energy future for Scotland and the UK. This TISP report highlights the need for a streamlined, science-led regulatory framework that balances environmental protection while enabling industry development. Resolving consenting challenges is crucial to avoid stagnation and ensure the growth of this vital renewable energy sector.

3 INTRODUCTION

Scotland's tidal stream energy industry stands at a decisive crossroads. Without swift resolution of consenting challenges, particularly those concerning the harbour seal, the sector cannot realise its full potential within the UK's energy strategy. Delay is not an option; inaction now risks forfeiting Scotland's leadership in a world-class industry.

The urgency is driven by an escalating demand for clean, renewable energy, compounded by the climate crisis, net-zero targets, and the need for energy security at local, national, and global levels. While wind and solar remain crucial to the UK's energy mix, they alone may fall short of meeting long-term diversity requirements to meet electricity demands, making alternative sources indispensable (Grantham Research Institute on Climate Change and the Environment, 2023). The UK's marine renewable energy sector offers substantial potential for tidal stream energy, centred on the Pentland Firth and Orkney Waters (PFOW) in northern Scotland. The PFOW region is arguably the world's most concentrated tidal energy resource (Neil, Roberts, & Houghton, 2017). Unlike wind and solar, tidal stream energy delivers consistent, predictable generation, positioning it as a critical component of the UK's renewables mix for the future, backed by recent UK Government support through the Contract for Difference (CfD) process.

Unlocking the full potential of tidal stream energy is not just necessary; it is imperative to securing a resilient, sustainable energy future for Scotland and the UK.

3.1 From Currents to Kilowatts: the world's tidal stream energy frontier

The Pentland Firth, a strait separating the northern coast of mainland Scotland from the Orkney Islands, and the surrounding waters of Orkney, including channels such as the Westray Firth, are renowned for their powerful tidal currents, among the fastest in the world (Scottish Government, 2016). These currents, driven by the movement of water between the Atlantic Ocean and the North Sea, create an environment with exceptional hydrodynamic energy, making both the Pentland Firth and Orkney waters (PFOW) key areas for tidal stream energy.

For Scotland, the PFOW is not just a geographical region; it is a cornerstone of a thriving marine energy sector, powering the nation's ambition to be a leader in the green and blue economies. The region has long been recognised for its potential to become a global hub for marine renewable energy, and has attracted significant attention and investment in tidal stream energy projects, creating real opportunities for job growth and economic transformation. As noted by Elaine Hanton, Head of Energy Transition and Net Zero Team at Highlands and Islands Enterprise, Scotland is well-positioned to remain a world leader in marine energy, with abundant natural resources, innovative companies, and a robust maritime and subsea expertise base.

According to the "*Economic Review of Tidal Stream Energy in Scotland*" (Noble *et al.*, 2025a [1]), the tidal stream energy sector could contribute up to £1.4 billion to the Scottish economy by 2030, providing thousands of high-value jobs, particularly in the north of Scotland. The sector is also expected to play a vital role in achieving Scotland's low-carbon future, with large-scale deployment creating both direct and indirect employment opportunities, alongside the development of a skilled workforce across various sectors. The "*Future Economic Potential of Tidal Stream and Wave*

[1] https://www.scottish-enterprise.com/media/u4rerwb0/economic-review-of-tidal-stream-energy-in-scotland.pdf

Energy in Scotland" (Noble *et al*., 2025b [2]) report estimates the wave and tidal sector could ultimately unlock over £8 billion in economic benefit to the Scottish economy, and support over 15,000 high-value jobs, by 2050, with Orkney and the Highlands positioned as key locations for manufacturing, testing, and deployment of next-generation turbines. The tidal stream sector alone could generate over £4.5 billion in economic benefit for Scotland by 2050 (Noble *et al.*, 2025a). These opportunities align closely with Scotland's goals to strengthen its green and blue economies by integrating renewable energy technologies into the wider industrial landscape, fostering economic resilience in coastal and island communities.

The PFOW region is home to pioneering developments in tidal stream technology with companies and research institutions working to harness its immense energy resources (Figure 3-1).

One of the most notable developments is MeyGen, the world's largest tidal stream array in terms of exported energy to date, located in the Inner Sound of the Pentland Firth. Developed by SAE Renewables (formerly SIMEC Atlantis Energy, previously Atlantis Resources), MeyGen has successfully deployed four 1.5 MW tidal turbines, demonstrating the viability of array-scale tidal power generation. The project has already exported >70 GWh of renewable electricity to the grid, marking a major milestone for the sector. Other key players in the north of Scotland include Nova Innovation, known for its world-leading tidal energy technology which has been successfully deployed in Shetland and with major future development proposals at EMEC Fall of Warness, Orkney. Orbital Marine Power ('Orbital') is recognised for its innovative floating tidal turbines which have been tested at EMEC Fall of Warness. Orbital plan larger scale deployments in the Westray Firth and at Duncansby Head. Additionally, the European Marine Energy Centre (EMEC), based in Orkney, has played a crucial role in testing and advancing tidal energy technology and plan to continue their grid-connected testing facilities, further solidifying the region's position at the forefront of the industry. The EMEC Fall of Warness tidal energy test site has been instrumental in establishing the industry. A brief history of the tidal stream energy sector's development in the PFOW can be found in Section 4.

[2] *https://www.policyandinnovationedinburgh.org/uploads/3/1/4/1/31417803/future_economic_potential_of_tidal_stream_and_wave_energy_in_scotland.pdf*

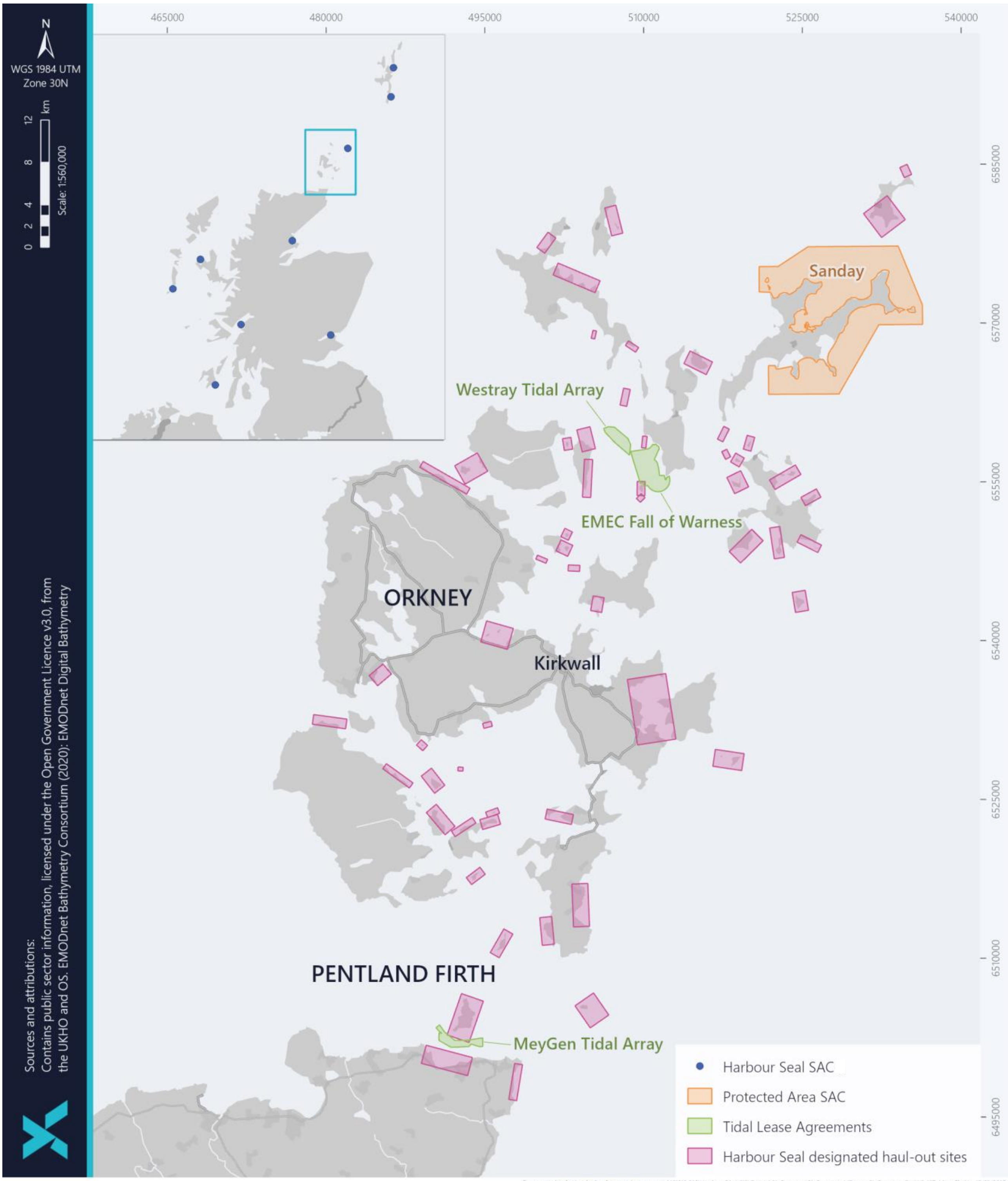


Figure 3-1 The Pentland Firth and Orkney in the North of Scotland, showing locations of tidal projects and harbour seal Special Areas of Conservation (SACs) and designated haul-out sites.

Beyond its renewable energy prospects, the PFOW region is also of ecological, cultural and economic importance. It supports a diverse range of marine life, including seabirds, marine mammals, and commercially valuable fish species. The region has historically served as an important maritime route, with strong currents influencing navigation and local fishing industries. The region's unique blend of ecological richness and energy potential offers a blueprint for balancing environmental protection with economic opportunity, fostering a sustainable future for local communities and the entire nation.

These marine assets provide the perfect foundation for nurturing a new generation of energy innovators, manufacturers, and researchers, linking Orkney and the Highlands to global supply chains. Gillian Martin MSP, Acting Cabinet Secretary for Net Zero and Energy, also reinforced Scotland's strategic position, noting the country's leading tidal stream project and policy support, which provide a competitive edge to harness the global market for marine energy (Wave energy Scotland, 2025). Alistair Carmichael, MP for Orkney and Shetland, highlighted that tidal stream and wave energy hold vast growth potential for quality jobs, particularly in Scotland's islands communities, urging full government backing to maintain the UK's competitive edge in marine renewables (Wave Energy Scotland, 2025).

As the demand for sustainable energy solutions grows, the PFOW continue to be a focal point for innovation in tidal stream energy, aligning with Scotland's ambitions to transition to a low-carbon, energy-secure future. Tidal stream energy is positioned to play a central role in the decarbonisation of Scotland's electricity grid, contributing significantly to national and global climate goals.

3.2 Sector growth and environmental stewardship

Over the past two decades, advancements in tidal stream technology, coupled with increasing UK government support through Contracts for Difference (CfD) allocations (Department for Energy Security and Net Zero, 2022, 2023, 2024), have positioned the sector to transition from demonstration and small-scale commercial projects to utility-scale tidal turbine generator arrays. But while the future is bright, challenges remain.

A significant barrier to scaling up the industry is the uncertainty around environmental impacts. For developers, securing consent requires navigating complex regulatory processes (Section 5), conducting comprehensive environmental assessments, and demonstrating effective risk mitigation strategies, which have to date involved technical and complex monitoring programmes. A review of current consenting approaches of PFOW tidal stream developers is included in Section 6. However, environmental uncertainties, particularly the risk of protected species colliding with turbines, continue to constrain the pace of further development.

Key consenting challenges persist across the renewable energy sector. A balance must be struck between fostering industry growth and maintaining environmental stewardship, to deliver an approach that recognises and addresses the global climate, biodiversity and energy security crises. Identifying pragmatic and sustainable solutions will requiring recognition among regulators and continuing collaboration with environmental agencies, industry, and researchers to address these crises. Their collective role in balancing development with environmental protection is critical, as is ensuring that monitoring efforts fill knowledge gaps to enable the industry to progress.

3.3 The harbour seal consenting risk: potential barrier to tidal stream energy expansion

A key regulatory concern for the tidal energy industry is the potential risk of collision between rotating turbine blades and marine fauna, including diving birds, larger fish and marine mammals such as pinnipeds (seals), which could result in injury or death (Wilson *et al.*, 2007, NatureScot, 2016).

The potential for collisions resulting in injury or mortality to harbour seal (*Phoca vitulina*) within the PFOW is a particular concern for regulators, due to the ongoing decline of the regional population (SCOS, 2022), and the associated 'unfavourable condition' of the species as a feature of protected sites (Special Areas of Conservation) in the region. This presents a challenge to consenting of tidal projects at a regional and project level. Section 7 offers a detailed review and analysis of the PFOW harbour seal population, its decline, impact thresholds, collision risk assessment tools, alternative approaches to assessing collision risk, and recommendations for improving collision risk assessment methods.

Despite two decades of research, the principal drivers of this decline remain unclear (see Section 7.2). Meanwhile, the grey seal (*Halichoerus grypus*) population in the same region has been thriving, and harbour seal numbers have increased in other regions, i.e., around Scotland's western and southwestern coasts (SCOS, 2022). Despite no collisions or near misses between tidal turbines and seals having been detected in extensive monitoring over the past decade (see Section 8), the risk cannot yet be completely dismissed. However, given the current, spatially limited scale of the tidal stream energy industry, it is highly unlikely to be the cause of the decline of the regional population.

The status and impact assessment of Special Areas of Conservation (SACs) in PFOW for which harbour seal is a designated feature are critical considerations for regulators and advisory bodies in marine spatial planning and renewable energy development (SMRU Ltd, 2011, Marine Scotland, 2020). SACs are protected sites that were designated under the EU Habitats Directive to safeguard habitats and species of European importance. They form part of the UK site network, ensuring the conservation of vulnerable ecosystems and biodiversity (European Commission, 2023), and continue to be protected under domestic legislation post-Brexit (Scottish Government, 2020). The Conservation Objectives of SACs focus on maintaining or restoring the favourable status of designated species and habitats.

Assessment under the Habitats Regulations (known as Habitats Regulations Appraisal, or HRA) examines how proposed projects or activities such as tidal energy developments might affect the integrity of sites in the UK network, including SACs (NatureScot, 2024). Sanday SAC, the only harbour seal SAC within the PFOW, is located in the northeast of the Orkney archipelago and was home to Scotland's largest single-site harbour seal population. The breeding groups, which use intertidal haul-out sites scattered along the coastline, accounted for 4% of the UK's harbour seal population in 2011 (SMRU Ltd., 2011). However, the Sanday population has experienced a notable decline, with the SAC now only accounting for about 5% of the total North Coast and Orkney Seal Management Area, down from roughly 19% in 1993 (SCOS, 2022).

Seal population management more widely in Scotland is guided by Seal Management Areas (SMAs), initially established to regulate licensed seal culling for the protection of fisheries and fish farms (Scottish Government, 2018a). The Potential Biological Removal (PBR) threshold helps determine sustainable limits to removals from the target population (SCOS, 2022), typically in response to anthropogenic mortality. In the context of tidal energy, regulators primarily assess risks to seals on the basis of collision estimates derived from numerical modelling procedures such as collision risk modelling (CRM; Band *et al.* 2012) and encounter rate modelling (ERM; Wilson *et al.*, 2007), adapted from bird collision models used in wind farm assessments (Band *et al.*, 2000; Band *et al.*, 2012, NatureScot, 2016). These models evaluate potential threats, and predicted impacts can be compared against PBR thresholds (SCOS, 2022). However, given the already low harbour seal numbers in the region and the precautionary modelling assumptions made in earlier assessments (such as the MeyGen Environmental Statement, 2012 (MeyGen, 2012)), the modelled risk to populations from tidal energy projects remain high. These modelled (hypothetical) risks create notable challenges in securing development consent for future tidal developments in the region.

3.4 Legal framework and policy landscape

The expansion of tidal energy generation in the PFOW must align with the relevant environmental legislation, as well as national and regional planning policies, which are key considerations for the Scottish Ministers when determining applications under the Electricity Act. This report includes a high-level review (see Section 10) of pertinent legislation, alongside relevant national and regional policies, highlighting their in-principal support for tidal energy development.

The legal framework for consenting tidal energy projects in Scotland is underpinned by several key legislations. The Electricity Act 1989 requires consent for generating station in the Scottish territorial sea (developments over 1 MW) or the Scottish Offshore Region (development over 50 MW), with decision-making processes that consider environmental impacts and other material factors. The EIA Regulation 2017 mandate Environmental Impact Assessment (EIA) for significant developments, ensuring the consideration of biodiversity, including seals, and addressing uncertainties through appropriate forecasting methods. The Habitats Regulations require competent authorities to ensure that no adverse effects occur on protected sites. If adverse effects cannot be ruled out, consent can only be granted if there are no alternatives, an imperative reason of overriding public interest (IROPI) exists, and compensatory measures are implemented. This process, known as derogation, allow for consent to be granted even when there are adverse effects on protected species or habitats, provided the conditions outlined in the regulations are met.

Additionally, the Marine (Scotland) Act 2010 requires marine licences for certain activities within Scottish water, with decision-making processes that consider environmental protection, human health, and legitimate uses of the sea.

Where collision risk modelling shows thresholds are breached, consent may be granted under derogation, provided that there are no alternatives, IROPI exists, and compensatory measures are in place. Compensation may be strategic or non-species specific, such as contributions to the Scottish Marine Environmental Enhancement Fund (SMEEF).

While the legislative framework establishes the parameters for consenting renewable energy projects, it is complemented by national and regional policies that guide the strategic development in Scotland. These policies ensure alignment with both regulatory requirements and long-term goals for sustainable energy generation and environmental protection.

The UK Marine Policy Statement provides a framework for marine planning and decision-making, emphasising sustainable marine economy and climate change mitigation through offshore renewables. The National Marine Plan of Scotland, adopted in 2015, supports renewable energy development within the Scottish marine area, including tidal generation, while ensuring the protection of legally protected species.

The Pilot Pentland Firth and Orkney Waters Marine Spatial Plan and the Draft Orkney Islands Regional Marine Plan further support sustainable tidal energy development, balancing environmental protection with community wellbeing. Additionally, the Climate Change Act 2008 and the Climate Change (Scotland) Act 2009 set legally binding targets for reducing greenhouse gas emissions, with tidal energy contributing to these goals.

Recent policy documents, such as the Fourth National Planning Framework (NPF4), the Draft Energy Strategy and Just Transition Plan, and the Green Industrial Strategy, reinforce the commitment to renewable energy and the transition to a net-zero economy. In the case of offshore wind developments, this is supported through a Sectoral Plan for Offshore Wind Energy in Scotland, which is currently going through an Iterative Plan Review that takes into account not only the 30 gigawatts (GW) of development leased through the ScotWind leasing round, but also the additional 5.5 GW awarded through the Innovation and Targeted Oil and Gas (INTOG) leasing round. While policies provide strong support for tidal energy as a critical component of Scotland's renewable energy strategy, the development of the industry would be assisted by the publication of a similar sectoral plan for tidal stream energy. A draft tidal energy sectoral plan was produced in 2013. It is recommended that Scottish Government established arrangements for the review of this draft Plan and to take forward a revised Sectoral Plan to adoption and publication, either at a Scotland or regional (PFOW) level.

3.5 Consent or Stagnation: The Scottish Tidal Stream Energy Imperative

Over the past decade, the commercial viability of tidal stream energy has been proven, with projects like MeyGen generating over 70 GWh of electricity to date, enough to power thousands of homes (SIMEC Atlantis Energy, 2024). The UK, home to half of Europe’s tidal stream energy resource, has the potential to generate 34 TWh per year, equivalent to nearly 11% of the UK’s current electricity demand (Coles *et al.*, 2021), while creating highly skilled jobs and opportunities in rural areas (ORE Catapult, 2021). However, one of the barriers to sustainable growth in the sector remains securing environmental consent.

Despite growing investor confidence in the sector, and vast potential, the industry faces a critical roadblock. Therefore, it is imperative that the industry can operate within a science-led and proportionate regulatory framework that balances environmental protection, energy security and industry development, If not there is a risk that investment will be withdrawn. This could lead to stagnation or the collapse of this vital renewable energy sector in one of the most energetic tidal stream areas of the world. Failing to resolve these challenges could squander a multi-billion-pound economic opportunity and hinder achieving Scotland and the UK’s net-zero targets and energy security goals.

Recognising the urgent need to resolve these challenges, key industry stakeholders in the PFOW tidal industry, including EMEC, MeyGen (SAE Renewables), Orbital Marine Power, and Nova Innovation, have come together to launch the Tidal Industry Seal Project (TISP). TISP was formed in light of discussions with NatureScot and the Scottish Government Marine Directorate, with support from The Crown Estate Scotland (CES) and Highlands and Islands Enterprise (HIE) with consultancy support from Xodus Group Ltd (Dr Ewan Edwards), Carronside Consultancy Ltd (Dr Ian Davies) and Eurona Consultancy Ltd (James McKie), all of whom have many years of experience in renewables consenting and research.

This report, from TISP, will help establish investor confidence, by tackling a regional issue from a multi-developer perspective. The report considers how utility-scale tidal turbine arrays could be consented in a way that supports the growth of this sustainable renewable energy industry in light of the best available evidence on the impact of tidal energy on harbour seals. The report describes uncertainties surrounding this impact, and assesses the effectiveness of current collision risk models, regulatory frameworks, and legal requirements. The report also explores potential solutions to the consenting challenge, including consent pathways, regional strategic ecosystem monitoring, and proportionate compensation mechanisms, ensuring industry growth while maintaining responsible environmental stewardship. Key recommendations and next steps are provided in Section 9.

4 DEVELOPMENT HISTORY

4.1 History of Tidal Stream Energy Development in Pentland Firth and Orkney Waters

The origin of tidal stream project development in the Pentland Firth and Orkney Waters (PFOW) can be traced to a recommendation made in 2001 by the House of Commons Science and Technology Committee to establish a wave and tidal energy test facility to kick start a marine energy industry in the UK.

4.1.1 European Marine Energy Centre

The European Marine Energy Centre (EMEC) was established in 2003. A wave test site was established at Billia Croo, Orkney in 2004 followed by a tidal test site at Fall of Warness, Eday in 2006. Since then, many full-scale prototype power generators have been installed for grid connected testing, including OpenHydro, Orbital (formerly Scotrenewables), Proteus Marine Renewables (formerly Atlantis), TGL and Andritz Hydro Hammerfest.

From 2007, tidal stream also received UK revenue support towards pilot array development under the Renewables Obligation Framework 'emerging' band at 2 ROCs/MWh, subsequently increased to 5 ROCs/MWh in 2012 for projects of up to 30 MW. However, this ringfenced support was withdrawn in 2017 as part of the transition to the Contracts for Difference (CfD) revenue support framework.

In 2010, the first competitive seabed leasing round for wave and tidal projects in the UK was run in PFOW to support scaling of the sector. Through this leasing round, the Crown Estate provided agreement for leases for 11 wave and tidal sites with a total potential capacity of 1600 MW.

While the development of most of these sites was hampered due to grid connection challenges and technology readiness, the MeyGen project received planning consent for the phased deployment of 86 MW capacity in 2013. It has deployed four 1.5 MW turbines under this consent, operated since March 2018 and generated 71 GWh to date (November 2024), more than 80 per cent of UK tidal stream generation

As technologies matured over this time, there was a renewed need for project sites to support the development of the sector. While sites were developed elsewhere in the UK with less grid capacity limitations, the extensive and powerful tidal resource in PFOW meant that there was an ongoing need to reduce development barriers to support the emerging of the sector.

In March 2018, Scottish Hydro Electric Transmission submitted a Final Needs Case to Ofgem for a proposed Orkney transmission project; a 220 MW subsea cable between Orkney and the Scottish mainland that would support the establishment of tidal stream (and wind projects) on the islands. This was fully approved in July 2023, significantly reducing grid connection blockers.

Nova Innovation plans two major tidal projects in the Fall of Warness site at EMEC, building on the success of its Shetland Tidal Array (the world's first offshore tidal array) which has been powering homes, businesses, and the Shetland grid since 2016. Nova's SEASTAR and OCEANSTAR projects will be 4 MW and 10 MW arrays of its proven seabed based tidal turbine technology and will represent a step change for Nova and the sector, scaling up from single devices and small arrays to multi-turbine arrays. This will enable industrial-scale manufacturing and operational techniques from design to deployment, driving down the cost of tidal energy.

In November 2021, a technology specific ringfence was announced for tidal stream under the CfD Allocation Round (AR) 4 and this ringfence has been subsequently retained for ongoing annual allocation rounds. Both Nova and Orbital secured CfDs for pilot projects at EMEC in AR4, 5 and 6.

This policy support also provided the basis for Orbital to secure an option agreement for a tidal array project in the Westray Firth, Orkney in 2023 with environmental surveys ongoing and a scoping opinion request submitted for 170 MW capacity, e.g. 70 devices.

In response to developer need for pilot array projects, including Nova Innovation's SEASTAR and OCEANSTAR arrays and Orbital's EURO-TIDES, EMEC is in the process of also commenced environmental surveys to support seeking a consent application to expand the Fall of Warness consent capacity from 10 MW to 50 MW.

4.1.2 MeyGen

MeyGen is progressing with an application to vary its 86 MW consent to incorporate technological advancements and an improved understanding of site conditions and array layout. The application aims to increase capacity to ~200 MW, moving closer to its total leased capacity of 398 MW, while retaining the same number of turbines specified in the existing consent — a total of 61 turbines for this phase. This increase is enabled by the deployment of more efficient turbines, designed by Proteus Marine Renewables, each rated at 3.3 MW. It is expected that the consent and variation applications for all three projects - EMEC expansion, MeyGen variation and Westray, will be submitted to Marine Directorate for determination by Scottish Ministers in 2025. These projects will be critical for the development of the tidal stream energy sector in the UK.

MeyGen secured a total of 59 MW across AR4/AR5/AR6 CfD rounds, with 28 MW, 22 MW, and 9 MW awarded in each respective round.

4.2 Need for Consents and Marine Licences

The consenting and licensing requirements for tidal stream, and other marine energy projects are described in detail in the Marine Directorate Licensing Guidelines[3]. The text below is based upon the Marine Directorate guidelines, which should be consulted directly for more detailed explanations.

Those planning to construct, extend, or operate a marine renewable energy (MRE) generating station in Scottish waters or the Scottish Renewable Energy Zone (REZ) require Scottish Ministers' consent under section 36 of the Electricity Act 1989. Applications are considered by Scottish Ministers if the generating capacity exceeds 1 MW within 12 nautical miles from the shore or exceeds 50 MW in the offshore region (12 to 200 NM). This includes both applications for new stations and for modifications to existing ones.

[3] Marine licensing and consenting: offshore renewable energy projects - gov.scot

The decision process balances applicants' interests with energy policy, community interests, and environmental considerations. Applications must be accompanied by an Environmental Impact Assessment (EIA) report detailing potential environmental impacts. The application and EIA report are publicly available, and stakeholders can provide input, which is considered by Scottish Ministers.

The Marine Directorate - Licensing Operations Team (MD-LOT)[4] administers the application process for section 36 consents, marine licences, European Protected Species (EPS) licences, and safety zones, as may be applicable to individual projects. Before deciding, Scottish Ministers consider all environmental information, consultation feedback, and public representations. Decisions are made by MD-LOT under executive powers, or by Scottish Ministers based on MD-LOT recommendations. Small-scale projects needing only a marine licence are likely determined directly by MD-LOT. Recommendations regarding other MRE projects are made by MD-LOT to the Minister for Climate Action, who may call a Public Local Inquiry before making a determination.

Consents and licences are normally issued with conditions that place obligations on developers, for example to employ particular mitigations, or undertake specific monitoring. Conditions are not used to shortcut processes or applied purely as precautions. They must be effective, necessary, and specific. Scottish Ministers ensure that planning conditions are necessary, relevant to planning, relevant to the development, enforceable, precise, and reasonable. Conditions should be clear and concise with reasons provided.

[4] Prior to June 2023, the Scottish Government Marine Directorate was known as Marine Scotland. The Licensing Operations Team (MD-LOT) was previously known as MS-LOT.

5 PROCESS TO GAIN CONSENTS

This Section provides a general overview of key requirements and considerations within the Tidal Energy consenting process. An authoritative description of Scotland's consenting and licensing processes for marine activities can be found on the Scottish Government's website [5]. Additionally, in 2018, tidal energy applications were provided with specific guidance in the form of a manual (Scottish Government, 2018b [6]) and more recently through updated sections on the Scottish Government website (Scottish Government, 2023 [7]). It is also important to consult Section 10 (and Annex 1) of this report for an overview of the consenting legal framework.

Please consult the links provided in the text for additional detail and clarity, and for full information on specific regulatory / legislative requirements.

5.1 Key Contacts within Consenting Process

5.1.1 MD-LOT

Marine Directorate-Licensing Operations Team (MD-LOT) has regulatory responsibility for assessing and determining marine licence and section 36 (Electricity Act 1989) applications on behalf of the Scottish Ministers. It further acts as a "one stop shop" for all consenting and licensing processes and related interactions in Scotland. Licensable marine activities are not permitted within Scottish waters (inshore under the Marine (Scotland) Act 2010 (MSA 2010), and offshore under the Marine and Coastal Access Act 2009) unless a marine licence is granted by MD-LOT. In addition, MD-LOT has regulatory responsibility for assessing and determining other relevant licences and consents such as Basking Shark licences, European Protected Species licences, safety zone and decommissioning applications, etc.

5.1.2 Crown Estate Scotland

Crown Estate Scotland (CES) manages the Scottish Crown Estate on behalf of Scottish Ministers, including most of the seabed off Scotland's coasts.

5.1.3 Statutory Consultees

There are several statutory consultees who are engaged with during the consenting process. For marine license applications (under the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017), consultees include NatureScot[8] (previously known as Scottish Natural Heritage; SNH), the Scottish Environment Protection Agency (SEPA), Historic Environmental Scotland (HES), and any relevant local or additional authorities. Additionally (under the Marine Licensing (Consultees) (Scotland) Order 2011), the Northern Lighthouse Board (NLB) and the Maritime and Coastguard Agency (MCA) – and any regional delegate – must also be consulted. Furthermore, the

[5] https://www.gov.scot/collections/marine-licensing-and-consent/
[6] Marine Scotland Consenting and Licensing Manual
[7] https://www.gov.scot/publications/marine-licensing-applications-and-guidance/
[8] *NatureScot is the operating name for the body formally called Scottish Natural Heritage (SNH). It was rebranded in 2022. While some historic documents referenced in this report bear the original affiliation "SNH", for the avoidance of confusion they are always cited as NatureScot.*

four principal statutory consultees for section 36 applications are NatureScot, SEPA, HES, and (if required) any EEA state significantly impacted by the proposed development.

5.2 Relevant Licences and Consents

5.2.1 Seabed lease

Applicants for tidal energy projects must acquire a lease from CES – or any other rights holder if present – for use of areas within both inshore and offshore regions. CES will initially grant an Agreement for Lease which will allow a developer to satisfy certain conditions including obtaining section 36 consent whilst exercising an option over a specific seabed area (within an expected timeframe). If these are met, a full lease of the seabed will be awarded.

5.2.2 Marine Licences

To obtain a marine licence, it is necessary to submit sufficient information regarding the proposed works to MD-LOT to enable determination. Marine licence application forms relevant to the project/works are available from the Marine Directorate website (Scottish Government, 2023 [9]). It is also necessary to supply supporting documentation covering detailed information on the project, potential environmental and navigational risks, structural verification of the infrastructure and proposed decommissioning methodology.

5.2.3 Section 36

In addition to a marine licence, tidal energy developments require consent under section 36 of the Electricity Act 1989 if the development will include the construction, extension, or operation of a generating station with a capacity which exceeds 1 megawatt (MW) within the Scottish inshore region, or 50 MW in offshore waters. Environmental Impact Assessments (EIA), Habitat Regulations Appraisals (HRA), and Marine Protected Area (MPA) assessments may be required to support section 36 applications as well as those for marine licences.

5.2.4 European Protected Species

Some activities within renewable developments will require an additional European Protected Species (EPS) licence to disturb such species, alongside marine licence and section 36 applications due to the requirements of the Habitats Regulations. EPS are those species listed on Annex IV of the EU Habitats Directive, which are transposed in Schedule 2 of the Habitats Regulations, and include all whales, dolphins and porpoises in Scottish waters. Seals, including harbour seal, are not EPS, but are listed on Annex II of the Habitats Directive requiring the designation of Special Areas of Conservation (SAC) (section 7.1.3).

---

[9] *https://www.gov.scot/publications/marine-licensing-applications-and-guidance/*

5.3 Environmental Impact Assessment

The EIA Directive (European Union, 2014 [10]), as implemented through the EIA Regulations (UK Government, 2017 [11]; UK Government, 2007 [12]; UK Government, 2017 [13]; Scottish Government, 2020 [14]) requires applicants for certain tidal energy developments to be subject to EIA as defined within the regulations. This acts as a systematic assessment to ensure that the competent authority for granting the required consent is fully informed of any likely significant effects (LSE) from proposed projects before making their decision.

If an EIA is required prospective applicants should consider the pre-application timescales required for the EIA process.

5.3.1 Screening

Offshore renewable energy projects, including tidal energy projects, whether they require both a section 36 and marine licence or only a marine licence are required to comply with the various EIA regulations [9,10,11,12]. It is important to note the different requirements of each legislation and the need to distinguish whether a project lies within or out with 12 NM. The application process for consents therefore includes a screening stage to determine whether an EIA is required for the described project by establishing if the project meets criteria set within the regulations or will significantly affect environmentally sensitive areas.

Unless an applicant has already decided to submit an EIA Report alongside an application, schedule 2 works must be screened to determine if an EIA is required. A screening opinion from Scottish Ministers may be requested from applicants by providing information on the project's proposed location and description, environmental receptors and protected sites (e.g. MPA, SAC, etc.) likely to be affected, and the predicted consequences of those effects as detailed within the relevant legislation [9,10,11]. This process may take a minimum of nine weeks which includes a consultation period of three weeks, and Scottish Ministers must notify applicants of any insufficiencies in the information that has been provided.

5.3.2 Scoping

In addition to obtaining a screening opinion from Scottish Ministers, applicants may also conduct a scoping exercise. Although this is not mandatory it is recommended by MD-LOT. The scoping process, which can take a minimum of five months, for EIAs which identify aspects of projects that may give rise to significant environmental effects. A request to Scottish Ministers for a scoping opinion must be supported by a report which must include information as required under the EIA Regulations [9,10,11,12]. Including, but not limited to the project's design parameters and activities within its installation, operation, and decommissioning phases; and any EIA methodology proposed to enable an

[10] DIRECTIVE 2014/52/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
[11] http://www.legislation.gov.uk/ssi/2017/115/contents/made
[12] https://www.legislation.gov.uk/uksi/2007/1518/contents
[13] http://www.legislation.gov.uk/ssi/2017/101/contents/made
[14] https://www.gov.scot/publications/eu-exit-habitats-regulations-scotland-2/

accurate response. Any remaining uncertainty will be scoped into the EIA. When an EIA Report is submitted it must be based on the scoping opinion.

The Habitats Regulations Appraisal (HRA) screening can also be undertaken alongside scoping (See below).

5.3.3 EIA Report

The EIA Report provided by applicants and based on the scoping opinion identifies and assesses all the projects effects which are likely to be significant, whilst also establishing any process limitations (e.g., data availability, etc.) and any residual impacts after proposed mitigation measures have been implemented.

Evidence and additional information may be requested through supplementary materials by Scottish Ministers if they do not feel satisfied with the initial submission. The initial report, and any further information provided, is published and available for consultation with statutory and other consultees.

5.3.4 Project Design Envelope

Applicants for offshore renewable energy projects, including tidal energy projects, often have difficulty in providing specific final design and process details early in the consenting process due to progressive technological etc developments within the sector. Therefore, applicants may choose to use a project design envelope approach (Scottish Government, 2022 [15]). Within such, a complete description of the applicant's potential range of design parameters (and potential impacts) of the project is covered in the EIA etc. and thereby highlight possible implications in a more flexible level than is the case with projects that can be precisely defined at an early stage. The design envelope should be established at the pre-application stage so that it can be fully taken into account in the EIA process and enable assessment of the scale of the proposed project envelope's potential impact and worst-case scenarios on various receptors.

5.3.5 Cumulative Effects

Further to identifying specific effects of a proposed development, the EIA regulations noted above also emphasise the importance of addressing cumulative effects with other projects, activities, etc. within an EIA. Past, present, and foreseeable future activities combined with the proposed development are considered at different levels (local, regional, national, international), and can occur both synergistically, antagonistically, and additively.

Which parameters and activities within the project, and which relevant external activities should be cumulatively considered (e.g., fishing and aquaculture, oil and gas, harbours, onshore projects, etc.) is usually established through scoping, if conducted. Otherwise, which effects to address are agreed upon with the regulator and relevant consultees before completing a cumulative assessment as part of the EIA report. The scope and methodology of cumulative impact assessments should be established at the pre-application stage, and the applicant is subsequently responsible for completing the assessment.

[15] https://www.gov.scot/publications/guidance-applicants-using-design-envelope-applications-under-section-36-electricity-act-1989/

5.4 Supporting Processes

During the pre-application stage: applicants usually engage with MD-LOT to determine what should be included in their supporting documentation. MD-LOT will additionally seek advice from external parties (i.e. NatureScot), additional regulators, and those with interest in the proposed development). It is therefore advisable that applicants engage directly with relevant stakeholders, including statutory consultees and others (e.g., the public, community groups, etc.) to identify and address any concerns and issues that may arise during the consenting process. For proposed developments in Scottish inshore waters the statutory Pre-Application Consultation [16] also applies.

5.4.1 Habitats Regulations Appraisal

'Competent authorities' (defined under the Habitats Regulations [17,18]) must conduct an Appropriate Assessment (AA) to appropriately assess the impact of a proposed plan or project on European Sites (one or more Special Areas of Conservation or Special Protection Areas), if that plan or project could have likely significant effects on the qualifying interests of a European Site. The AA is based upon information provided by the applicant in the form of the Report to Inform Appropriate Assessment (RIAA) submitted alongside the application. Engagement with stakeholders is necessary during the pre-application stage to advise on which information will be necessary to include in the RIAA (HRA Screening). The HRA process considers:

a) If the plan or project is directly connected or necessary to site management for nature conservation; and
b) If the plan or project, either alone or in combination with other plans or projects, is likely to significantly affect a European site.

If it cannot be ascertained that the plan or project will not have any likely significant effects, either alone or in combination with other plans or projects, then an AA is required. Scottish Ministers will use information from the RIAA, NatureScot, MD-LOT, and other relevant consultees to undertake the AA to ascertain if it can be concluded that there will be no adverse effect on the integrity of the sites in question. If, following the assessment, an adverse effect on site integrity cannot be ruled out, the proposed development may only be able to gain consent if there are no alternative solutions, that there are 'imperative reasons of overriding public interest to grant consent' and appropriate compensatory measures can be put in place*.

*(Note: If an adverse effect on site integrity of any European Site is determined then this process is known as a 'derogation').

5.4.2 Other mitigation and management plans

A series of additional assessments, mitigation protocols and management plans are typically required to support applications for S36 consent and/or Marine Licences. Some examples are provided in Table 1.

[16] https://www.legislation.gov.uk/ssi/2013/286/contents/made
[17] https://www.legislation.gov.uk/uksi/2017/1012/contents/made
[18] https://www.gov.scot/publications/eu-exit-habitats-regulations-scotland-2/

Table 1 List of appendices, including monitoring and management plans which may be required as part of applications for S36 Consent/Marine Licences.

Document name	Description
Environmental Management plan (EMP)	The EMP will provide the over-arching framework for on-site environmental management during the construction and operation of the offshore Project. It may cover aspects such as marine pollution, waste management, and invasive/non-native species management.
Decommissioning Plan [19]	An accurate and appropriately costed Decommissioning plan which addresses how a relevant object will be removed at their end of life.
Navigational Risk Assessment	A Navigational Risk Assessment is used to evaluate the implications of proposed developments within marine spaces used by other users.
Protocol for Archaeological Discoveries	A Protocol for Archaeological Discoveries outlines mitigating and reporting steps that must be taken if archaeological remains are found during the course of project surveys.
Marine Protected Area (MPA) Assessment	An assessment of the relevant impacts on Marine Protected Areas designated under the Marine (Scotland) Act 2010.
Fisheries Mitigation and Management Strategy [20]	A Fisheries Mitigation and Management Strategy sets out the approach for fisheries liaison and mitigation during the offshore Project construction and operation and maintenance.
Navigational Safety/Vessel Management Plan	A Navigational Safety / Vessel Management Plan provides information on vessel management and navigational safety for the construction and operations and maintenance stages of the offshore project.
Marine Mammal Mitigation Protocol	A Marine Mammal Mitigation Protocol presents a protocol for the implementation of mitigation measures which aim to reduce the risk of permanent threshold shift (PTS; auditory injury) in marine mammals during the course of project activities.

[19] https://www.gov.scot/publications/marine-licensing-and-consenting-decommissioning-programmes-overview/
[20] https://www.gov.scot/publications/marine-licensing-and-consenting-offshore-renewable-energy-projects/pages/mitigation

5.5 Application, Determination and Post-Consent

5.5.1 Application Contents

Applications for section 36 consents and marine licences should be submitted to MD-LOT and should include a gap analysis and all relevant documentation as per MD-LOT checklist (Scottish Government, 2025 [21]).

Public notices are required for offshore renewable energy projects requiring an Environmental Impact Assessment (EIA). MD-LOT provides a template for the notice, and this should be completed and submitted with the application for approval in line with the relevant legislation. It should be noted that hard copies of the documents must be available in public locations such as libraries, as agreed with MD-LOT.

For section 36 applications, the relevant planning authority must make a notice available for public inspection.

5.5.2 Determination and Decision Notice

Scottish Ministers will make decisions on applications for tidal energy projects which exceed 1 MW within Scottish inshore region (<12 NM), or 50 MW in offshore waters (>12 NM) based on MD-LOT's recommendations. Although in some specific circumstances, usually where only a marine licence is required, MD-LOT may make the decision. Scottish Ministers may call a Public Local Inquiry before making their decisions. Applications not meeting the standards of Scottish Ministers may be refused. MD-LOT will inform applicants of the reasons for refusal and how to improve for resubmission.

High quality applications, made at the right time, will support MD-LOT in meeting target determination times, allow stakeholders to make informed representations and reduce the risk of requiring additional information.

EIA consent decisions for offshore marine developments must be publicised by the applicant, indicating availability on the Public Register and in newspapers or other media.

5.5.3 Post Consent Compliance

On successful and positive determination of a consent and/or licence application, a consent and/or licence will be awarded. Several conditions may be associated with the award, and these are typically split into standard conditions and project-specific conditions. In some cases, installation of part or all of the development may be dependent on the developer meeting conditions in their consents and/or licences.

5.6 Process Timeline

No formal timeline for the consenting and licence processes currently exists, although in the past, one was included within the manual for offshore wind, wave, and tidal applications (Scottish Government, 2018b [22]) and has been

[21] MD-LOT Checklist
[22] https://www.gov.scot/publications/marine-scotland-consenting-licensing-manual-offshore-wind-wave-tidal-energy-applications/

highlighted below for illustrative purposes only (Figure 5-1). It is important for all applicants to discuss timelines with MD-LOT at the appropriate point in the process.

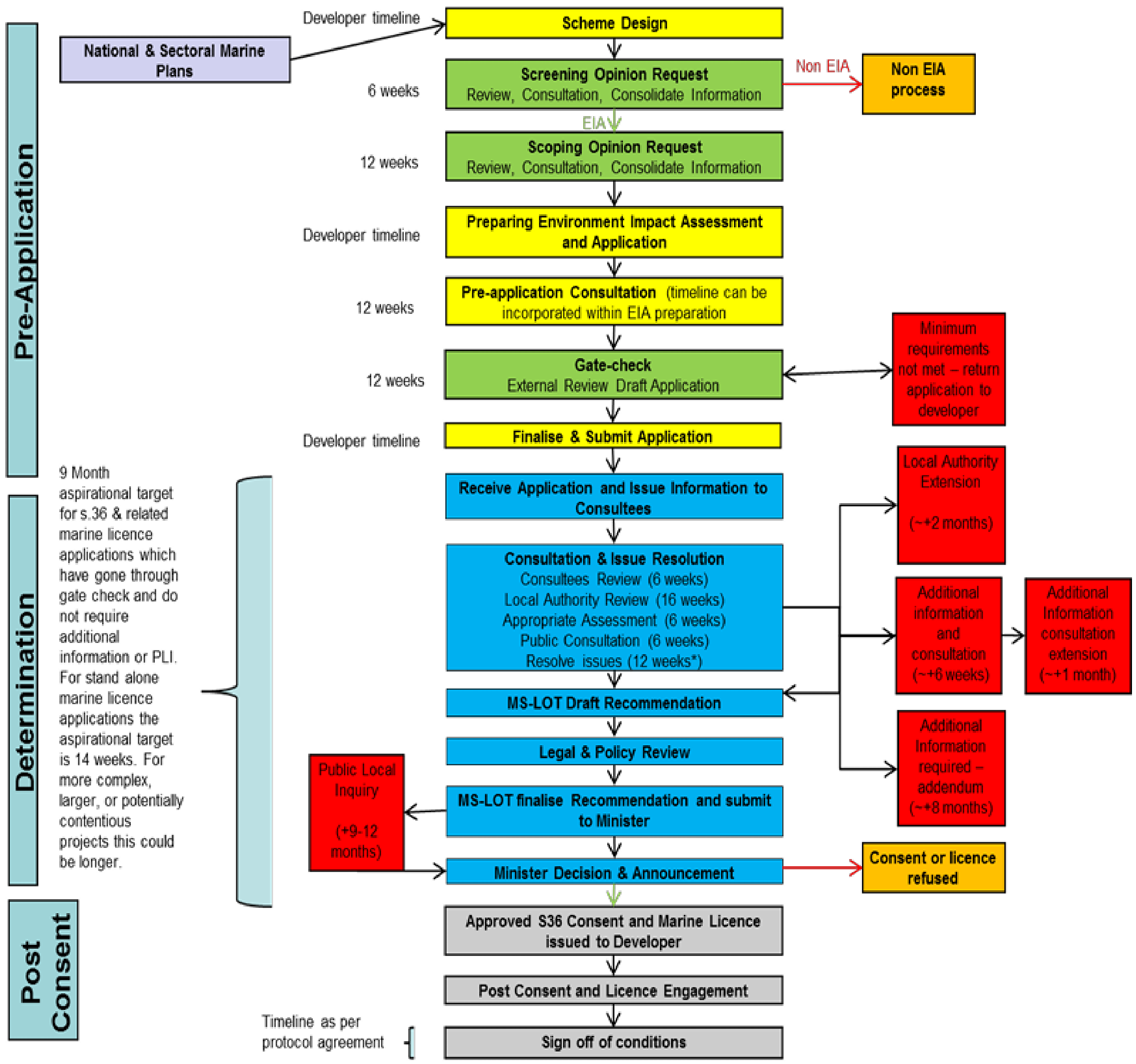


Figure 5-1 Consenting and licensing process timeline as described by Marine Directorate in 2018.

It is clear from previous experience and from recent discussions with the regulator and advisors that critical steps in the application and risk assessment processes described above for projects in the key resource area of PFOW is the consideration of the potential interactions between tidal turbines and harbour seals. Harbour seals are known to occur throughout the PFOW area, and to feed and move through areas of high tidal flow that are the current locations of tidal turbines, or which have been identified as areas for developments. The future of the tidal energy industry in PFOW (and more widely in Scotland) is dependent on solving this problem in a way that meets the needs of nature, industry and Government.

5.6.1 Useful links:

- Marine environment: licensing and consenting requirements - gov.scot
- National marine planning - Marine planning - gov.scot
- Pilot Pentland Firth and Orkney Waters Marine Spatial Plan - Regional Locational Guidance - gov.scot
- Wave and tidal energy - Marine renewable energy - gov.scot

6 CURRENT APPROACHES TO CONSENTING

The Pentland Firth and Orkney Waters (PFOW) region has long been recognised as the primary area of tidal stream energy resource in Scotland (and probably in Europe). The area was identified in the draft sectoral plan for tidal energy and supported through the Orkney Islands Regional Marine Plan. The concentration of supporting infra-structure, such as the European Marine Energy Centre, illustrates the initiatives of successive Governments for tidal energy development. Recent success in Contract for Difference (CfD) rounds indicates policy objectives to establish and expend fully commercial tidal energy projects to the north of Scotland (Table 2).

The ability of project developers to deliver against these objectives is contingent on their being able to gain the necessary Consents and licences, particularly the s36 Electricity Act consent (as described in section 2.2 above). Key within that is the management of the perceived risk that marine animals (particularly harbour seals in the case of PFOW) will be harmed by colliding with rotating turbine blades. As for the analogous risk to birds at wind farms, this risk remains a significant barrier to the consenting of tidal energy projects, despite several years of operational experience and environmental monitoring.

Project developers must take full account of this potential risk in their approach to project design and implementation plans, and thereby to gaining the necessary consents. Developers need to consider not only their own projects, but also the potential cumulative effects of their activities and other similar activities that may affect the same receptor populations, or designated sites, at a regional scale.

To gain an understanding of the potential regional scale effects arising from the grouping of tidal energy projects in the Pentland and Orkney area, and to meet the requirements of the consenting process, it is necessary to have an overview of development ambitions and of current approaches to collision risk assessment. and to meeting the demands of the consenting process. Industry project partners (TISP) have been provided relevant information from existing project consents and licences, and from current/future consent applications. This contributes to the background context within which to assess the effectiveness of current approaches to consenting and to consider the applicability of any alternative approach.

Tidal energy project developers in the TISP group were asked, by structured questionnaire, to provide information on:

- Environmental consent conditions;
- Technology type, generating capacity, blade details;
- Environmental assessments;
- Pre-, post-, or operational monitoring and mitigation;
- CRM;
- Consideration of IROPI and compensation measures; and
- Proposed routes to consenting.

All project developers (MeyGen, Orbital, Nova) and site operators (EMEC) responded to the questionnaire on their current stage of development/utilisation, and on their ambitions for future development of tidal energy in the Orkney and Pentland area. The responses are summarised in Table 3. Information was provided on five projects distributed from the Westray Firth in the north to the Pentland Firth Inner Sound in the south. All are seeking to take advantage of the tidal energy resource in the PFOW region (conditions that are not replicated on the same scale or power anywhere else in Scotland and which are rare on the European scale) and of the EMEC test site at the Fall of Warness to the west of the island of Eday.

All the proposed developments cited in this report are making use of horizontal axis turbines, with 2 or 3 blades. The MeyGen and Nova developments plan to secure their turbines on the seabed, while Orbital and Magallanes turbines are mounted below structures floating on the sea surface. In all cases, the turbines and associated systems have been thoroughly tested in the Orkney/Pentland area or elsewhere. For example, the four-turbine system currently deployed at MeyGen has been generating for six years and has fed >70 GWh into the UK electricity grid. Nova installed the world's first offshore tidal energy array at Bluemull Sound in Shetland and has been powering the Shetland grid since 2016.

All developers plan to install arrays to move more firmly into the commercial scale of production, and to take advantage of awards under recent CfD allocation rounds. The planned array sizes for installation within the next 10 years (Table 2 below) demonstrate the huge opportunity that these tidal energy projects present for the Pentland/Orkney area and for Scotland nationally.

Table 2 Current and planned tidal stream projects in the Pentland Firth and Orkney Waters region

DEVELOPMENT NAME	CURRENT INSTALLED GENERATING CAPACITY - MW	PLANNED GENERATING CAPACITY - MW
MeyGen	6	200
Orbital Westray Tidal Array	0	170
EMEC, including:	3.5	50
(Nova OCEANSTAR)	(0)	(10)
(Nova SEASTAR)	(0)	(4)
(Orbital EURO-TIDES)	(0)	(9.6)
Total	**9.5**	**420**

A total of 420 MW installed capacity is planned for over the next decade, and several of these projects have secured financial support in the form of CfD. However, there are further undeveloped tidal streams in PFOW and the longer-term potential of tidal energy in the region is far greater than this lookahead suggests.

In all cases, the developers need to operate under the various appropriate consents and licences. The scale of development cannot be accommodated within existing consents, particularly Consents under Section 36 of the Electricity Act (s36 Consent). MeyGen plans to seek a variation of its current s36 Consent. Orbital plans to apply for a new s36 Consent for its site in Westray Firth. Nova and Orbital are dependent for their projects on EMEC increasing their s36 Consent capacity at the Fall of Warness to accommodate both the commercial needs of the projects and the continuing test facilities operated by EMEC themselves.

All operators and project developers will be required to assess the potential impact of their developments on harbour seals as part of their impact assessments. All will have to consider potential impact on the harbour seal population in the North Coast and Orkney Seal Management Unit MSA 2010). EMEC, Orbital (and Nova) will also have to consider potential effects on the Special Area of Conservation on Sanday for which a breeding harbour seal population is a primary reason for selection of the site (JNCC, 2017).

The current concern for harbour seals is the potential for harmful collision between seals and rotating turbine blades. Most turbines rotate at 12 – 16 rpm when generating, with smaller diameter turbines rotating at up to twice that rate. In most cases, project developers have not yet undertaken definitive assessment of the risk of collisions of the full array developments, although the risk has been assessed for the current scale of developments (including the single Orbital device at EMEC).

All projects plan to model the potential for collisions in detail using the methods specified by NatureScot, primarily their Collision Risk Model (CRM) and Encounter Risk Model (ERM). Preliminary modelling using the "standard" model parameters and assumptions indicates clearly that there is a hypothetical risk of collisions with harbour seals from the Sanday SAC, and risk of collisions with harbour seals in excess of the PBR for the wider population in the North Coast and Orkney Seal Management Unit. Experience indicates that the regulator is very unlikely to grant consent for the projects in these circumstances.

The mismatch between the modelled predictions of collision risk for current projects in Pentland/Orkney and elsewhere, and the lack of any observed or inferred collisions between seals and tidal turbines suggests that there is considerable uncertainty in the reliability of the outputs of the modelling and a greater application of precaution in their application than is supported by experience. This has been reflected in consent conditions which in some case (e.g. MeyGen) have required project development to proceed in phases/stages. In most other cases, conditions have required intensive monitoring of turbines for collisions using technologies such as turbine-facing cameras, and seabed platforms using active multibeam sonars, cameras, passive acoustics, etc. primarily targeted at describing/parameterising seal behaviour around turbines and detecting collisions. The results from monitoring and research projects associated with this issue have been regularly reviewed and discussed by nature conservation advisers (NatureScot) and the regulator (MD-LOT), and questions have been posed to the Special Committee on Seals (SCOS) to obtain further advice on the avoidance rate or the *retirement* of the risk of collision. While the evidence base has increased, as yet the evidence that collisions do not occur is lacking, and there remains uncertainty associated with limitations and gaps in coverage of monitoring undertaken to date.

A Project Environmental Monitoring Plan (PEMP) is required for all projects that have been awarded s36 consent and/or Marine Licences. Some Marine Licences are pending approval of a PEMP, and in some case the implementation of the PEMP is overseen by a Project Advisory Group. However, it is not clear to project developers how to proceed to obtain future consents, given the apparent risk to harbour seals, from either the Sanday SAC or the wider Seal Management Unit. While staged/phased development may seem an attractive regulatory option, experience has shown that staging/phasing can be very damaging to commercial viability and can lead to poorly defined delays in granting permissions for subsequent stage/stages to progress. Staged development is therefore not seen as a generally viable way forward.

Developers recognise the potential value in an approach based on regional or strategic monitoring, and potentially other actions in relation to harbour seals that may emerge during the consenting process, such as the implementation of measures to offset or compensate for potential impacts. Developers also recognise the desirability of improving the monitoring methods that have been used to date in the Pentland/Orkney area, particularly to automate the interpretation of monitoring data collected in the immediate vicinity of turbines. However, what constitutes "sufficient evidence" to provide a wholly data-based shift in the regulatory approach to collision risk may never be forthcoming, given the scale of monitoring required combined with the analytical and statistical methods needed to produce that evidence.

Table 3 Tidal projects in Pentland Firth and Orkney Waters.

Q	DESCRIPTION	EMEC	MEYGEN	ORBITAL	NOVA OCEANSTAR	NOVA SEASTAR	ORBITAL EURO-TIDES
4	Development name	EMEC test centre	MeyGen	Westray Tidal Array	OCEANSTAR	SEASTAR	EURO-TIDES
5	Location	Fall of Warness	Pentland Firth Inner Sound	Orkney waters (Westray Firth)	Fall of Warness	Fall of Warness (EMEC)	Fall of Warness (EMEC)
4	Single device or array?	Array. One Magallanes, plus one Orbital (covered in Orbital response)	Array	Array	Array	Array	Array
7	Consenting status	In process	Consented	Proposed	Marine Licence in place, awaiting s36 variation	Marine Licence in place, awaiting s36 variation	Marine licences in place. s36 requires variation.
14	Support structure	Surface	Seabed	Surface	Seabed	Seabed	Surface
10	Technology/turbine type	Horizontal axis	Horizontal axis	Horizontal axis	Horizontal axis	Horizontal axis	Horizontal axis
11	Device rating	1.5 – 2.4 MW	1 – 3.3 Mw	2.4 Mw	0.5 MW	0.25 MW	2.4 MW
12	Development capacity: Current	4 MW	6 Mw	N/A	10 MW (Marine Licence)	4 MW (Marine Licence)	N/A
8	Construction status	Partly built	Partially constructed	Not built	Not built	Not built	Not built
9	Generating status	Generating	Generating	Not ready	Not ready	Not ready	Not Ready
15	Rotor details	Magallanes: 2 counter-rotating 3 blades, (Orbital: 2 blades, 26m diam, 12 rpm)	3 blades, 16-26m diam., 12 – 14 rpm	2 blades, 24m diam, 12 rpm	2 blades, 13.5m diam, mean 10 – 16 rpm	2 blades, 7.5m diam., mean 20 – 29 rpm	2 blades, 24m diam, 12 rpm
12	Development capacity: Consented	10 MW	86 MW	N/A	N/A	N/A	Consented

Q	DESCRIPTION	EMEC	MEYGEN	ORBITAL	NOVA OCEANSTAR	NOVA SEASTAR	ORBITAL EURO-TIDES
12	Development capacity: Planned	50 MW	~200 MW	170 MW	10 MW	4 MW	9.6 MW
17	Future ambitions for the site/project	50 MW s36	61 turbines giving ~200 MW	170 MW at Westray Tidal Array, and support EMEC to expand Falls of Warness to 50 Mw. Potential future 30Mw plus at Duncansby Head.	20–25-year operation at EMEC	20–25-year operation at EMEC	170 MW at Westray Tidal Array
13	Will the development be phased?	Not proposed	Required under current consent	Likely	2025: One turbine 2027: 19 turbines	All installed 2026	All installed 2027
16	Modelling of risk to harbour seals	Magallanes pending ERM for Orbital	CRM and ERM for phased development	ERM for single device. Not yet complete for full array.	Semi-quantitative collision risk assessment using Copping's nested probability approach. Operating noise provides acoustic warning to seals. EMMP includes mitigation and monitoring near the turbine, project phasing, extended commissioning period, use of best evidence to avoid collisions.	CRM covered by EMEC applications for 10MW and 50MW consents and Fall of Warness. Semi-quantitative collision risk assessment using Copping's nested probability approach. Operating noise provides acoustic warning to seals. EMMP includes mitigation and monitoring near the turbine, project phasing, extended commissioning period, use of best evidence to avoid collisions.	CRM covered by EMEC applications for 10MW and 50MW consents and Fall of Warness.
18	Is an adaptive management scheme applied?	Not as yet	Future development under current consent requires Ministerial approval based upon	Not yet active	Not yet active	Not yet active	Not yet active

Q	DESCRIPTION	EMEC	MEYGEN	ORBITAL	NOVA OCEANSTAR	NOVA SEASTAR	ORBITAL EURO-TIDES
			monitoring of harbour seals and Atlantic salmon.				
19a	Consent conditions mitigating collision risk	Tidal devices at EMEC typically require the following conditions: -Acoustic characterisation, using PAM. Drifting hydrophones near device. -Collision risk modelling, no data collection involved	Staging ECoW EMP emphasising mammals PEMP monitoring for collisions Project Advisory Group		Monitoring under Marine Licence conditions using turbine-facing cameras, and remote platform with subsea cameras and multibeam sonar.	Turbine-mounted rotor facing cameras (one per turbine) Remote Observation Platform (ROP) with 3 subsea cameras and a multibeam sonar.	PEMP submitted for expansion at EMEC. Includes monitoring with active sonar and optical cameras. To be tested in 2025.
19b	Is a PEMP/EMP applied?	Yes as part of Marine Licence	In place	Not yet	In place	In place	Draft submitted for consultation
19c	Is monitoring of harbour seal distribution undertaken?	50 MW EIA two years ESAS surveys including marine mammals and haul-out counts.	At-sea and vantage-point surveys in pre-application monitoring. Haul-out monitoring under consideration.	Westray EIA 2 years ESAS surveys including mammals at sea, plus haul-out counts at 10 locations	Post construction monitoring of nearfield interactions only, using subsea cameras and MBS	None Post construction monitoring of nearfield interactions only, using subsea cameras and MBS	None Post construction monitoring of nearfield interactions only using imaging sonar and subsea cameras
19d	Mitigation measures for harbour seals during construction and operation	Adhere to SMWWC	SMRU data indicates seals avoid operating turbines.	Not yet defined	Visual. Minimise disturbance at sea. Subsea cameras etc during operation.	Visual. Minimise disturbance at sea. Subsea cameras etc during operation.	Visual. Minimise disturbance at sea.
19e	Specific environmental monitoring for seals	Not yet defined.	Concentrates on collision risk and behaviour close to turbines. HiCUP platform.	Not yet defined	Subsea video monitoring and use of MBS on ROP (collision risk) Marine mammal observers during all	Subsea video monitoring and use of MBS on ROP (collision risk) Marine mammal observers during all	Subsea imaging sonar and cameras for monitoring of nearfield interactions

Q	DESCRIPTION	EMEC	MEYGEN	ORBITAL	NOVA OCEANSTAR	NOVA SEASTAR	ORBITAL EURO-TIDES
					offshore operations (disturbance)	offshore operations (disturbance)	
20	Proposed routes to consent	Seeking advice and support to develop route to consent	Seeking advice and support to develop route to consent	Seeking advice and support to develop route to consent	Supporting joint industry work to identify route to consent and make best use of available evidence.	Supporting joint industry work to identify route to consent and make best use of available evidence	
20	a) Staged development	Avoid staged development.	Maybe	Any phasing must be commercially viable	Yes Single device 2025, remaining devices 2027	No	No
20	b) Compensation and/or IROPI	Under consideration	Under consideration	Not yet defined	Not yet considered Under consideration by EMEC	To be considered Under consideration by EMEC	To be considered
20	c) Further monitoring/research	Orbital and Nova committed to environmental monitoring as part of FORWARD2030, EURO-TIDES, OCEANSTAR, and SEASTAR projects. Focus on active and passive acoustics, and collision risk	Yes	Not yet defined	Yes	Committed to joint industry projects that aim to de-risk other projects.	Committed to joint industry projects that aim to de-risk other projects.
20	d) Industry level monitoring	Committed to joint industry initiatives	Yes, particularly if linked to regional/strategic action, such as Compensatory Measures		Committed to joint industry initiatives. AI and machine learning may present valuable new opportunities.	AI and machine learning techniques are required to process and analyse monitoring data.	Committed to joint industry initiatives.
21	Advice from regulator and SNCB	Not definitive. Compensation of interest, but not specified.	Conversations with NatureScot. Emphasis on regional and	Carry out CRM and ERM modelling and compare to PBR. HRA	Discussions with MDLOT and NatureScot leading to marine licence.	No specific advice on collision risk as this is covered in EMEC's EIA for 50MW s36	No specific advice on collision risk as this is covered in EMEC's EIA for 50MW s36

Q	DESCRIPTION	EMEC	MEYGEN	ORBITAL	NOVA OCEANSTAR	NOVA SEASTAR	ORBITAL EURO-TIDES
			strategic mitigation, industry level collaboration and compensatory measures.	for seals and relevant SACs.	Collision risk to be covered by EMEC s36 application for 50MW at Fall of Warness.		
22	Constraints consequential of an HRA	HRA being drafted now.	Staged deployment linked to potential PBR exceedance. Strategic research and monitoring at turbines.	Not yet defined	Not clear if HRA was part of Marine Licence application	Not clear if HRA was part of Marine Licence application	

7 COLLISION RISK IN HARBOUR SEALS

7.1 The harbour seal population

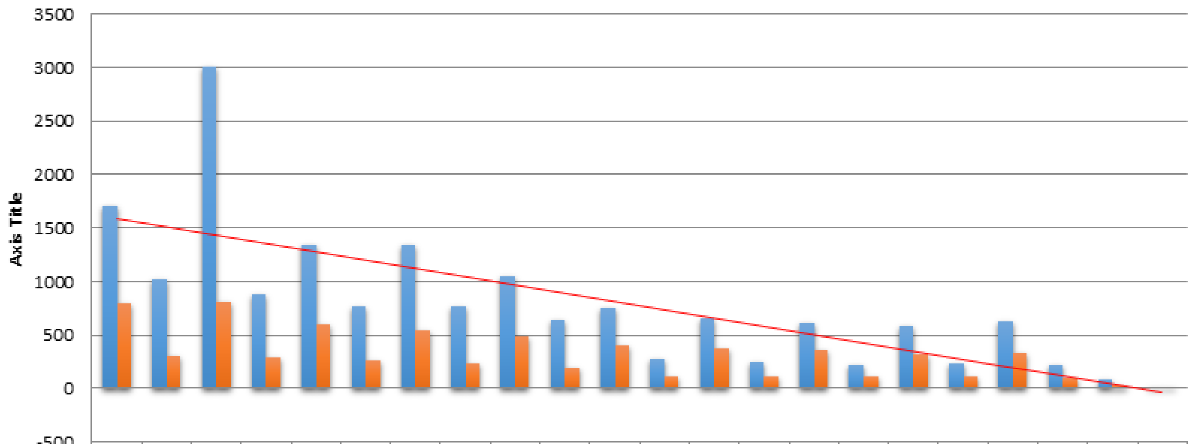
The harbour (also known as common) seal is one of two breeding phocid (true) seal species in Scotland. It is widespread across the Northern Hemisphere and around 100,000 harbour seals occur in Europe. Around 30% of this population is found in UK waters, and the majority of these are in Scottish waters. The UK harbour seal population is counted from aircraft during the month of August, with different areas of the UK coast being surveyed each year when most harbour seals are ashore to moult. Based on surveys between 2016-2023, the latest UK population estimate is around 41,000 harbour seals, and the Scottish population is thought to be ca. 34,000 individuals (SCOS, 2024). This is based on the survey counts, scaled to account for the proportion of animals likely to be at sea (and thus not countable) during the surveys (approx. 28%).

The population has undergone two significant epizootic events in the last 30 years, with phocine distemper virus (PDV) resulting in the death of around 23,000 harbour seals in 1988 and 30,000 harbour seals in 2002 (Härkönen *et al.*, 2006). However, since the most recent of these epizootic episodes, the harbour seal population has increased, but with significant regional differences in population trends. Some Seal Management Areas (SMA; section 7.1.1) appear to have a stable population after significant declines (East Scotland, Moray Firth). In some areas, the population appears to be either stable or increasing (West Scotland, Western Isles); but in the North Coast and Orkney SMA, the harbour seal population continues a >20-year decline.

The current population estimate for harbour seal in Scotland is ca. 2% lower than the estimate calculated previously (SCOS, 2024; SCOS, 2022). The latest estimate is ca. 16% smaller than the historical highs of harbour seal abundance in the late 1990s (SCOS, 2024).

7.1.1 Seal Management Areas

Seal Management Areas are designated regions around the Scottish coast, which were established under the MSA 2010 to manage and protect seal populations. The Scottish coast is divided into seven Seal Management Areas: East Scotland, Moray Firth, North Coast and Orkney, Shetland, Western Isles, West Highlands, and South-West Scotland. These areas were principally identified for purposes of the management of seals (shooting) under licence, such as to prevent damage to fisheries or fish farms, with the number of seals for which shooting licences could be issued determined annually based on population data and trends. In recent years the Scottish Government position on seal shooting has changed, with no seal licences being issued to shoot seals at aquaculture sites, and across Scotland, very few harbour seal licences have been issued altogether (and only in exceptional circumstances; Scottish Government, 2025; Figure 7-1). The Potential Biological Removal (PBR; Wade *et al.*, 1998) method is used to determine the number of seals that can be removed from a population by anthropogenic means without population impact (depletion). PBR is discussed in more detail in section 7.3.1.



	2011 Application	2011 Granted	2012 Application	2012 Granted	2013 Application	2013 Granted	2014 Application	2014 Granted	2015 Application	2015 Granted	2016 Application	2016 Granted	2017 Application	2017 Granted	2018 Application	2018 Granted	2019 Application	2019 Granted	2020 Application	2020 Granted	2021 Application	2021 Granted
Grey Seals	1706	1025	3008	878	1347	774	1337	765	1046	642	759	283	656	245	608	228	587	232	634	226	86	0
Common Seals	794	314	812	289	602	265	547	240	485	197	399	115	377	113	363	108	322	111	335	103	25	0

Figure 7-1 Seal licence application and number of licences granted, 2011-2021 (Source: Scottish Government)

7.1.2 North Coast and Orkney Seal Management Area

The harbour seal population in the North Coast and Orkney Seal Management Area has seen some of the most notable declines in Scotland, and this decline appears to continue. The proportion of the Scottish harbour seal population in this area has decreased notably. In the late 1990s, around 30% of Scotland's harbour seals were found here, but this figure dropped to about 5% by 2016-2019. Whereas this area was once considered the historic stronghold for the harbour seal in Scotland, the population has declined by approx. 85% in recent decades, and more than 15 years of dedicated research into this decline has failed to identify a definitive reason driving this (SCOS, 2022). When last counted, during the survey period 2016-2019, 1,405 harbour seals were observed, which is scaled up to a regional population (accounting for seals at sea) of ca. 1,950 harbour seals, representing 4.5% / 5.3% of the UK / Scottish population (SCOS, 2022; Figure 7-2). The next round of aerial counts for both Orkney and Shetland are due to be undertaken in August 2025. Correspondingly, the PBR for the North Coast and Orkney Seal Management Area has fallen from 17 in 2013, to eight harbour seals based on the 2019 count (SCOS, 2024).

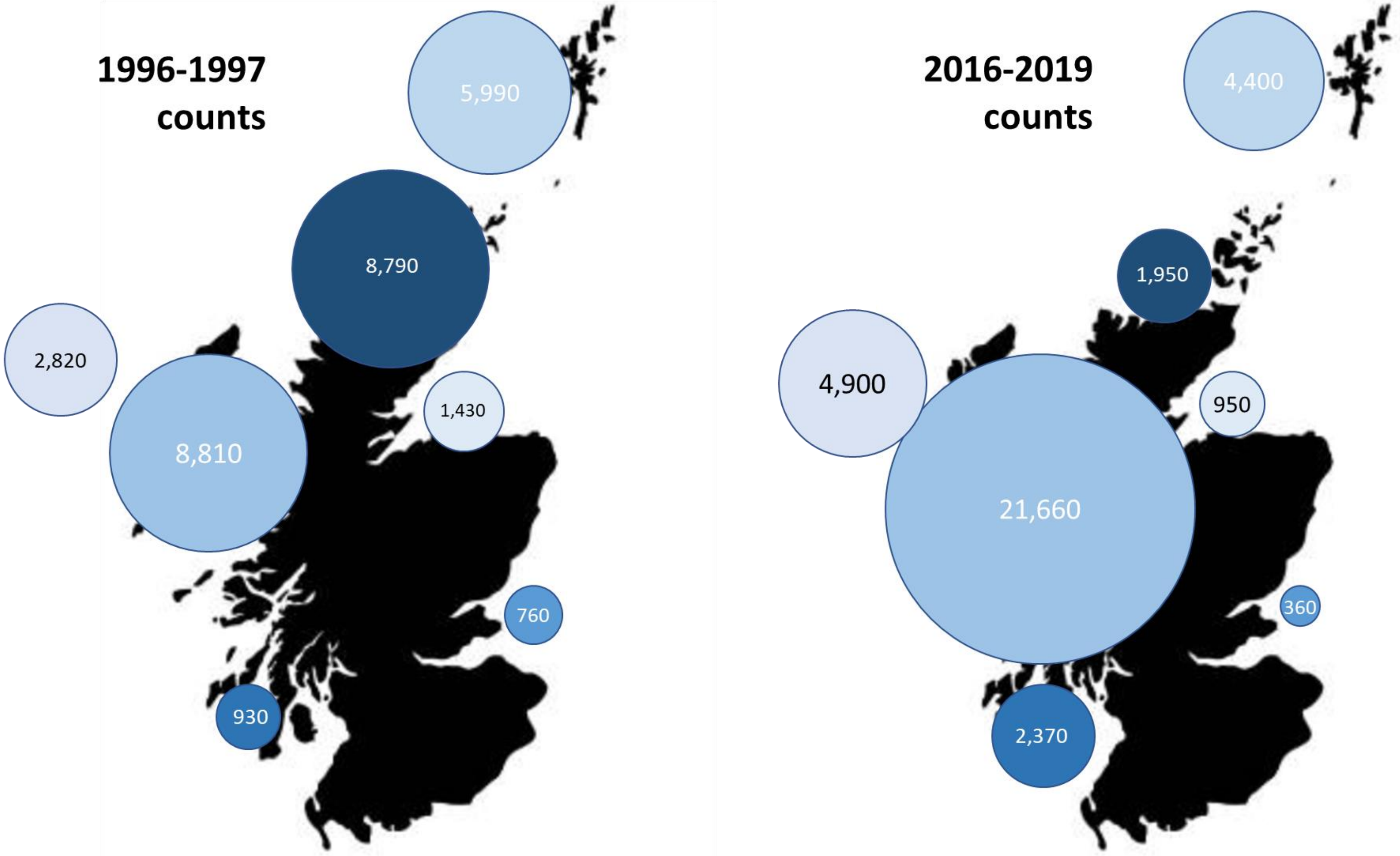


Figure 7-2 Approximate Seal Management Area population sizes based on August aerial counts. Area of coloured circles is proportional to population estimate.

7.1.3 Sanday Special Area of Conservation

Harbour seals are one of four marine mammal species occurring in Scotland listed on Annex II of the EU Habitats Directive (transposed into UK law as a suite of regulations known as the Habitats Regulations). Species on Annex II are considered to be in need of strict protection due to their vulnerability or declining populations, EU Member States are required to designate SACs for the protection of these species. These protected sites are managed to ensure the Favourable Conservation Status of the species. There are nine SACs in Scotland where harbour seal is a designated feature.

Sanday SAC is the only designated site for harbour seal in the North Coast and Orkney Seal Management Area. Sanday is located in the north-east of Orkney, and the SAC surrounds the eastern side of the island of Sanday. It lies approx. 13 km from EMEC Fall of Warness, 17 km from Westray Firth (Orbital), and 72 km from the Inner Sound (MeyGen). This was an important breeding site for harbour seals and previously supported the largest group of harbour seals at any single site in Scotland (approximately 4% of the total UK population of harbour seals) (JNCC, 2025). Historic counts reported over a thousand individuals; around 19% of the regional population. However, during the last count in 2019, only 77 harbour seals were observed (compared with 99 in 2013, 196 animals in 2012 and 116 animals in 2010; NatureScot, 2013), and it appears from recent counts that the decline in the SAC (a 96% decline since 1992) significantly outpaces the wider regional decline. Sanday SAC now represents only 5% of the North Coast and Orkney harbour seal population.

When last assessed (2019), the status of the harbour seal population of Sanday SAC was *Unfavourable Declining*, although no specific pressures were identified (NatureScot, 2019). However, as discussed further in Section 7.2 it is thought that the declines observed in the wider Seal Management Area, nor specifically in relation to Sanday SAC, are driven by natural causes, rather than acute anthropogenic impacts. Changes in the distribution and use of the site by harbour seal, which are brought about by natural processes, either directly or indirectly, are normally considered compatible with the Conservation Objectives of the SAC[23], whereas the potential for adverse effects resulting from developments (plans and projects) are assessed through the Habitats Regulations Appraisal (HRA) process.

In the Sanday SAC conservation objectives, NatureScot guidance on interactions between renewable energy developments and the Sanday SAC harbour seals is to *reduce or limit pressures (e.g. collision risk, auditory injury, entanglement, displacement or barrier effects) associated with new marine renewable energy proposals, by implementing appropriate mitigation based on existing and recommended best practice guidelines*.

7.2 The harbour seal decline

There have been major declines in harbour seal populations throughout the northeast of Scotland and Orkney in recent decades, with surveys of harbour seal presence and abundance within Scottish waters highlighting a ca. 85% regional decline in harbour seals within Orkney since the year 2000 (SCOS, 2022). Unfortunately, the latest planned August aerial survey (2024) was not completed due to equipment malfunction.

[23] https://www.nature.scot/sites/default/files/special-area-conservation/8372/conservation-and-management-advice.pdf

7.2.1 Summary from Harbour Seal Decline Project

For around 10 years, the Scottish Government has funded the Sea Mammal Research Unit (SMRU) to investigate the potential drivers behind the regional declines of harbour seal populations in Scottish waters. During spring and summer months, data is collected via photo-identification, ground counts, individual covariates, seal scat samples and seal carcasses, with additional aerial surveys undertaken during the harbour seal moult season in August (Harbour Seal Decline Project, 2025). Within the Year 4 Harbour Seal Decline Project Report (2019), data gathered throughout the four-year project lifecycle were integrated into a harbour seal population model to simulate population trends and analyse populations sensitivities and identify potential drivers behind population decreases (Arso-Civil *et al.*, 2019).

Analysis of pregnancy rates from live capture-release studies for each marine region within Scotland concluded that sampled female harbour seals within the Orkney region exhibited a lower percentage of the pregnancy hormone (69%) than female harbour seals within the Moray Firth (83%), the Pentland Firth (88%) and Skye (83%) (Arso-Civil *et al.*, 2019). While it was acknowledged that these results may arise due to small sample size and regional variability, it was concluded that regional fecundity estimates may indicate a lower reproductive rate in regions of harbour seal population decline (Arso-Civil *et al.*, 2019).

A study which made a comparison of serum and plasma samples from harbour seals on the Isle of Skye and Orkney reported through principal component analysis (PCA) that clinical chemistry parameters (including calcium, lactate, urea, total protein, cholesterol and glucose) were clinically normal for animals at both locations, with no evidence of captured seals experiencing nutritional stress or malnourishment (Arso-Civil *et al.*, 2019).

During the 2018-2019 assessment of stranded seals, 162 carcasses were recorded in total (133 of which were reported in Orkney). Of the 162 carcases, 123 were identified as grey seals, 19 as harbour seals and 20 for which species could not be identified. The proximal cause of death was determined for 26 carcasses, 25 of which were possible cases of grey seal attack (including three harbour seals) (Arso-Civil *et al.*, 2019).

7.2.2 Predation by killer whales

Killer whales have been documented as preying upon a range of fish and marine mammal species. In 2017, Jourdain *et al*. presented 29-years of photographic and observational data of killer whales predating on seals in Norwegian coastal waters (Jourdain *et al.*, 2017). A total of 23 predation events by killer whales on seals were recorded during the survey campaign, 19 of which resulted in seal mortality and four were an unsuccessful chase (Jourdain *et al.*, 2017). Both young and adult harbour and grey seals were observed as part of these predation events.

In 2024, Julia Sutherland published a PhD thesis on killer whale predation of seals in the inshore waters of Shetland in the context of ecological drivers and the consequences of predator-prey interaction (Sutherland, 2024). The thesis studied the predator-prey interactions between killer whales and seals in inshore Shetland through a series of land-based field research and community-led monitoring efforts. This PhD research highlights the importance of nearshore foraging areas for killer whales, with harbour seals found to have a higher probability of capture and consumption than grey seals (Sutherland, 2024). Harbour seals, particularly females, were considered more vulnerable to predation by killer whales immediately pre- and post-partum through compromised movement and agility and depleted bodyfat storage due to the energetic demands of pregnancy and lactation (Sutherland, 2024). Overall, Sutherland concluded that killer whale predation of harbour seals have contributed/be contributing to declining harbour seal populations in Shetland (Sutherland, 2024).

There is documented evidence of killer whales predating on harbour seals in Orkney, so it is therefore likely that there will be some mortality of Orkney-based harbour seals arising from predation by killer whales.

7.2.3 Competition with and predation by grey seals

Throughout the North Atlantic over the last two decades, a number of dead seals washing up on coastlines have exhibited spiral lesions (Brownlow *et al*., 2016). While these lesions were initially attributed to ship (ducted) propellors or shark attacks, recent evidence points towards grey seal predation as a more likely cause (Brownlow *et al*., 2016). In 2016, Brownlow *et al*. observed an adult male grey seal catching, killing and eating five weaned grey seal pups off the Isle of May in Scotland, resulting in spiral lesion injuries which were indistinguishable from carcasses previously attributed to propeller collisions (Brownlow *et al*., 2016). Brownlow *et al*. therefore proposed that seal carcasses displaying spiral lesions within UK waters were likely to be a result of grey seal predation.

Research published by van Neer *et al* (2015) on grey seal predation of harbour seals on the island of Helgoland, Germany, observed a young male grey seal preying upon young harbour seals within the region. Post-mortem examinations of several harbour seal carcasses within the region identified severe traumatic lesions consistent with predation (van Neer *et al*., 2015). This study concluded that interspecific predation interactions between grey and harbour seals may play a crucial role in observed population declines and/or trends in species migration (van Neer *et al*., 2015).

The Scottish Marine Animal Stranding Scheme (SMASS) Annual Report 2023 (SMASS, 2023) documented 929 standings across 22 marine species, 474 of which were pinnipeds and 104 of which were harbour seals. Eighty-two pinnipeds were reported with evidence of trauma consistent with grey seal predation (approximately 17.2% of all documents stranded seals), 13 of which were harbour seals (approximately 12.5% of all harbour seal strandings identified as part of the annual report; SMASS, 2023). These incidents were reported from various locations throughout Scotland, including Orkney. Physical trauma from a possible grey seal attack was the most dominant cause of death of harbour seals reported in 2023 (SMASS, 2023). Dead harbour seals with spiral lesions had been observed in Orkney as long ago as the late 1980s, and although the cause was unknown, it now seems likely that these were also caused by predation by grey seals.

Some recent scientific research has indicated that grey seal interactions (competition and predation) could be a significant contributing factor in the harbour seal decline, and/or in the failure of populations to recover in some areas (SCOS, 2024).

7.2.4 Biotoxins

Research published by Hall & Frame (2010) considers the exposure of marine mammals to domoic acid (DA) biotoxins from harmful algae. Through the examination of faces and urine of live captured harbour seals, this study concluded that harbour seals in Scotland are exposed to DA at low to high levels during August and September (Hall & Frame, 2010).

The observations of Hall and Frame (2010) are supported by research published by Jensen *et al* (2015) which considered the potential link between the regional decline in harbour seal populations and toxins from harmful algae. The concentrations of two groups of toxins (DA and saxitoxins; STX) were measured in the excreta of live captured harbour seals (n=162), stranded animals (n=23) and faecal samples collected from seal haul-out sites (n=214) between 2008 and 2013 (Jensen *et al.*, 2015). Results concluded that the proportion of toxin positive samples in the excreta was significantly higher in areas where harbour seal abundance is in decline (Jensen *et al.*, 2015). Jensen *et al* suggested that harbour seals are exposed to DA and STXs through the consumption of contaminated prey at potentially lethal levels.

Hall *et al.* (2024) published the results of a risk assessment exercise carried out to investigate the potential population consequences of the levels of biotoxin exposure estimated for Scottish harbour seals. The results varied depending on toxin type and persistence, the foraging strategy of the seal and the age class of seals. STX exposure was unlikely to result in any mortality. DA exposure was predicted to result in lethal doses to up to ~4% of exposed juveniles and ~5% of exposed adults. When considered alongside the findings of Jensen *et al.* (2015), the analysis of Hall *et al.* (2024) indicates that exposure to domoic acid cannot be ruled out as a potential factor in the decline of harbour seals.

7.2.5 Redistribution

A potential cause of the decline of harbour seal numbers in PFOW is redistribution. It is not likely that seals are redistributing locally (i.e. within Orkney) and are being missed in the surveys because SMRU surveys the entire coastline of the North Coast and Orkney on a periodic but regular (ca. 5-year) basis, covering all known seal haul-outs in the Seal Management Area. Therefore, this suggests that if redistribution has happened (historically) or is occurring (currently), it would have occurred to a location (or locations) outwith the North Coast and Orkney Seal Management Area. Given the stability and (in some areas) increases in the harbour seal population in the West Scotland and Western Isles Seal Management Areas, this is not necessarily implausible. However, telemetry studies have not detected widespread movement or permanent relocation of harbour seals to other areas, either through historic (2003-2005; Jones *et al.*, 2013) or more recent (2011-2017; Carter *et al.*, 2022) telemetry tracking, although small numbers of animals have been observed moving between other Seal Management Areas; for example, between Orkney and Shetland, and the Moray Firth and Orkney.

While there is limited historic evidence of emigration from the North Coast and Orkney population to other Seal Management Areas from genetic studies (Olsen *et al.*, 2017; Carroll *et al.*, 2020), tracking redistribution of seal populations requires dedicated photo-identification (photo-ID) campaigns to capture/recapture individuals at haul-out sites (Cordes and Thompson, 2015). Although there has been a dedicated individual-based study using photo-ID at one major breeding site at Loch Fleet, Sutherland, for over 15 years now, there has been little effort to match seals between regions.

Between 2016 and 2020, photo-ID was undertaken at three locations as part of the Scottish Government-funded Harbour Seal Decline project (SMRU, pers. comm.). These locations, in Scapa Flow, Orkney; Loch Dunvegan, Skye; and the Kintyre Peninsula, were surveyed from the shore or from small boats during the summer months (June and

July). This time period was selected as it encompassed the harbour seal breeding season and would mean that pup birth and survival could be recorded. No photo-ID matches have been reported between survey sites in Orkney, Skye and Kintyre, although by surveying these discrete colonies during the breeding season for a small number of years it is unlikely that redistribution of seals would have been detected, not least because detecting redistribution would require baseline observations from the North Coast and Orkney prior to any emigration. As these studies commenced at a time when the North Coast and Orkney harbour seal population had already declined by as much as three-quarters of its historic size, it is not likely that photo-ID would detect inter-regional matches, given that inter-regional movement may already have been missed.

Studies which explored recent or historic linkages between Seal Management Area populations through genetics have suggested that the harbour seal population from Northern Ireland to SE Scotland, encompassing Orkney and Shetland, functions as a single metapopulation, distinct from the metapopulation of southern England and the North Sea coast of mainland Europe. While the samples analysed by Carroll *et al.* (2020) suggest little recent emigration, they used data collected 2003-2012, and did report genetic evidence of historic migration from the North Coast/Orkney/Moray Firth cluster.

In summary, three research methods outlined here have failed to demonstrate redistribution of harbour seals from Orkney to other Seal Management Areas, but each have associated caveats: while tracking of individuals observed no movement between the North Coast and Orkney and western Scotland, telemetry targets only a small sample of animals; photo-ID is highly time-consuming and has been undertaken at only a small number of harbour seal breeding sites; and the genetic data used in the most comprehensive recent study were collected prior to 2012. Although it is evident that the North Coast and Orkney population does not mix openly with other Seal Management Areas, the possibility that some harbour seals have emigrated to other regions should not be wholly overlooked. This is similar to the situation in south-east England, where the population has declined significantly and it is possible that these animals have relocated to the much larger Wadden Sea population in the Netherlands/Germany (SCOS, 2022).

7.2.6 Potential anthropogenic causes

Harbour seals could be susceptible to several potential sources of anthropogenic impact. These include impacts that cause mortality, such as culling (licensed or unlicensed), collision (e.g. with vessels or tidal turbines), or bycatch in fisheries; and impacts that cause sub-lethal effects which can lead to reduced survival or reproductive success with longer term population consequences, such as acoustic disturbance (e.g. construction or vessel sound), reduction in food availability (e.g. a reduction in prey availability due to commercial fishing pressure) or disturbance at seal haul-out sites.

It is not likely that regulated human activities, including marine construction and development are the driver of harbour seal declines. Similarly, it is not likely that the effects of commercial fisheries, and other anthropogenic stressors on harbour seals, are significantly greater in the North Coast and Orkney Seal Management Area, than in many other areas around Scotland. For this reason, it appears unlikely that human causes are a principal driver of the decline in this region, adding further weight to the inference that it is primarily due to natural processes.

7.2.7 Summary

While there has been a lengthy programme of research into the various drivers behind harbour seal population declines within Scotland[24], a definitive singular cause cannot be concluded. It is likely that the causes for the decline are not limited to a single stressor, and there could be regional differences between the factors driving declines (SCOS, 2024). Despite several funded research studies, Marine Scotland (2020) consider that a lack of understanding of the drivers of the decline remains a key knowledge gap (Marine Scotland, 2020).

Further work is underway to monitor the decline in harbour seal populations throughout Scotland, with various public appeals made in recent years to help researchers and policy makers understand why the Scottish and UK harbour seal population has experienced such steep decline[25].

It must be noted that while the proximate causes of the decline (e.g. predation, competition, biotoxin) could be considered "natural", it is plausible that the ultimate causes relate to environmental changes induced by anthropogenic activity, including changes to ecosystems and food availability, and climate change. Nevertheless, there is no evidence that the risk of collision with tidal stream energy infrastructure, at its current level of deployment, is a major driver of the decline in the North Coast and Orkney Seal Management Area.

7.3 Thresholds of impact

There are two main ways to estimate what constitutes an acceptable level of anthropogenic mortality, or 'take', from a population: rule-based methods, and predictive modelling methods. Both rule-based and predictive modelling will use similar estimates or ranges of demographic parameters, and similar assumptions about population structure. It is therefore likely that they will predict similar population responses to removal of set numbers of individuals. However, one such rule-based method, the Potential Biological Removal (Wade, 1998) has been recommended by the Natural Environment Research Council (NERC) Special Committee on Seals (SCOS) for use in the management of seal populations in the UK.

7.3.1 Assessing significant mortality: Potential Biological Removal

The safe level of anthropogenic mortality for each Seal Management Area is based on the Potential Biological Removal (PBR) method (Wade, 1998). PBR is a metric that estimates the maximum number of animals that can be removed from a population without adversely affecting its sustainability. It is calculated using the formula:

$$PBR = N_{min} \times \left(\frac{R_{max}}{2}\right) \times F_R$$

where N_{min} is the minimum population estimate; R_{max} is the maximum population growth rate; and F_R is a recovery factor, which ensures a conservative approach and accounts for regional uncertainty. PBR limits are set annually by SCOS for each Seal Management Area in the UK, based on the latest population estimates. Due to the declines

[24] https://harbourseals.wp.st-andrews.ac.uk/
[25] https://news.st-andrews.ac.uk/archive/st-andrews-researchers-appeal-for-the-public-to-help-them-understand-why-uk-harbour-seals-are-in-steep-decline/

observed in some Seal Management Areas, including the North Coast and Orkney, a highly precautionary approach is employed for harbour seals, using the August moult count as a proxy for N_{min}, which is likely to be 28% smaller than the actual population size (accounting for seals at sea when counts of seals on land are made; SCOS, 2022).

The recovery factor, a value between zero and one, is determined for each Seal Management Area based on the observed population trajectory. For stable or increasing harbour seal populations, such as the Western Isles Seal Management Area, the recovery factor is set to 1.0; however, for declining or very small populations that show no signs of recovery (including the North Coast and Orkney SMA), the recovery factor is set to 0.1.

In setting PBR thresholds for harbour seals, SCOS use a highly precautionary approach whereby the August moult count is used as a proxy for N_{min}, rather than estimating the lower 20th percentile of the population estimate which is recommended (Wade *et al.*, 1998). This means that the PBRs calculated for UK harbour seals, as presented in SCOS reports, are approximately 28% lower than estimates based on the 20th percentile (SCOS, 2022).

7.3.2 Regional or national PBR

The PBR method was developed to manage anthropogenic impacts on discrete functional population units. However, considering individual Seal Management Areas as such discrete population units violates the assumption that these populations are closed. While this assumption is particularly problematic for grey seals, which range widely beyond their breeding sites (Carter *et al.*, 2022), it is also known from telemetry tracking of harbour seals that there is movement between Seal Management Areas, such as several harbour seals tagged in Loch Fleet (Moray Firth Seal Management Area) travelling to Orkney.

As discussed in Section 7.2.7, the specific local factors that have driven/are driving the declines observed in the North Coast and Orkney, Moray Firth and East Scotland Seal Management Areas have not been definitively identified following over a decade of dedicated research through the Scottish Government-funded Harbour Seal Decline project. However, although there cannot be certainty over unlawful or unreported takes, it remains unlikely that anthropogenic mortality is one of the principal causes of these declines. There has been a cessation of licensed shooting of harbour seals in these regions over the past decade; and bycatch in commercial fisheries in the region is not thought to be a major issue, at least historically (Pierce *et al.*, 2002), although more recent data on rates of bycatch in active fishing or ghost gear are lacking.

Furthermore, anthropogenic disturbance due to marine infrastructure development is managed at levels considered to be *not significant* through the Environmental Impact Assessment and Habitats Regulations Appraisal processes. It is extremely unlikely that the tidal turbines currently deployed are causing significant mortality, especially as the population declines pre-date any tidal energy developments. Therefore, it is probable that natural causes are driving the observed declines. For example, it appears that competition with grey seals for key prey species could be a factor in recent declines (Wilson and Hammond, 2019).

Meanwhile, in the neighbouring West Scotland Seal Management Area, the latest trend indicates a population growth rate of +2.48% *per annum*, and +6.27% in the Western Isles Seal Management Area (SCOS, 2022). While it has proved challenging to determine the reasons for precipitous declines in one region but a stable or growing population nearby, the emigration of animals from e.g. Orkney to West Scotland/Western Isles cannot be ruled out.

Similar population changes have been observed in the southern North Sea, whereby declines in The Wash have occurred concurrent with growth of the harbour seal population in the Wadden Sea. If this were to be the case, basing an assessment of potential anthropogenic impacts on a Seal Management Area with an assumed closed population would not be appropriate. Indeed, there is genetic evidence of limited historic emigration from the Moray Firth/North Coast and Orkney region to the Northwest region encompassing the western Scottish mainland and Western Isles, and the harbour seal population in Scotland and Northern Ireland was identified as a northern metapopulation based on genotype, distinct from southern Britain (Carroll *et al.*, 2020). Furthermore, it appears that harbour seals from the Pentland Firth area are genetically more closely related to harbour seals in the Outer Hebrides than to those in Orkney (Olsen *et al.*, 2017).

Given that the declines do not appear to be acutely driven by anthropogenic impacts (shooting, bycatch, acoustic disturbance or collisions with tidal turbines), it is highly likely that the declines observed in the North Coast and Orkney Seal Management Area would continue even at current levels of tidal development and without any further management. Indeed, it is plausible that a combination of factors, including potentially redistribution of animals to other areas (i.e. emigration) could lead to certain Seal Management Area populations becoming functionally extinct.

As the growth of the West Scotland, and more recently the Western Isles, populations has occurred concurrent with the declines in northern and eastern Scotland, the population of harbour seals at a Scotland-wide level has remained relatively stable over the last 20 years. While a single UK-wide PBR approach would preclude management of localised issues, an assessment made against the Scottish population, and undertaking assessments based on the PBR estimate for the seven Scottish Seal Management Areas combined, is one method of subdividing the UK national PBR in a more appropriate way for managing seals on a regional basis. For example, basing assessments on the northern metapopulation of Scotland and Northern Ireland (Carroll *et al.*, 2020), and a PBR appropriate for this wider population, would capture the changes (increases and decreases) in harbour seal populations in the national population estimate (and provide protection for the population whilst local changes (at the North Coast and Orkney level) would not constrain an industry that is not thought to be a major risk to the local or national population.

7.3.3 Alternatives to PBR: Population Viability Analysis

There are essentially two types of alternative population modelling approaches for assessing anthropogenic impacts: rule-based methods (such as PBR), and predictive modelling methods. One widely used predictive modelling method is population viability analysis (PVA), a process of quantitative risk assessment developed in the field of conservation biology to estimate the probability that a population would go extinct within a given time frame.

Both rule-based and predictive modelling will use similar estimates or ranges of demographic parameters, and all involve similar assumptions about population structure. It is therefore likely that they will predict similar population responses to removal of set numbers of individuals. The scale of allowable removals will likely be influenced heavily by the degree of precaution applied by the user and the way in which density dependence is implemented in the models.

One benefit of PVA over simple rule-based methods like PBR is the possibility to forecast future trends. Given the recent trajectory of the harbour seal population in the North Coast and Orkney Seal Management Area, it is plausible that PVA may forecast this population to trend to near-extinction over the coming decades, even without additional impacts from tidal developments. However, while a flexible population dynamics model has been developed for the

Moray Firth where there are long time series of data on both population size and pup production, the capacity to extend such models to harbour seal populations around the rest of Scotland, including the North Coast and Orkney Seal Management Area, is currently limited by a lack of data.

It is recommended that the current approach to management of seal populations of Seal Management Areas through the Potential Biological Removal method is reviewed, taking account of the underlying assumptions regarding Seal Management Area populations as discrete functional population units, the genetic structure of the Scottish harbour seal population, and the opportunities for alternative management approaches that reflect the ecology of the harbour seal in Scotland. This is discussed further in section 6.6.

7.4 Collision Risk Assessment tools

7.4.1 Introduction to collision risk

A key part of the consenting process is an assessment of the likelihood of significant effects on habitats and species (often referred to as *receptors*) at a relevant scale of interest. This scale could be the individual, but more commonly ecological receptors are managed at the level of a relevant management population. In the case of marine mammals, regional management units (IAMMWG, 2023; Scottish Government, 2014) have been established, which act as the population units for impact assessment. Seal Management Areas in Scottish waters were defined principally to facilitate licensed seal management, usually to avoid damage to fisheries for fish farms. The delineation of Seal Management Areas, established under the Marine (Scotland) Act 2010, is a pragmatic compromise that attempts to balance: current biological knowledge; distances between major haul-outs; environmental conditions; the spatial structure of existing data; practical constraints on future data collection; and management requirements (SCOS, 2022).

The risk of collision between seals (and other wildlife) and tidal turbines remains a significant constraint on the development of marine renewable energy and is one impact pathway that continues to command thorough assessment at the Environmental Impact Assessment (EIA) stage. The primary risk involves seals colliding with the rotating blades of underwater turbines, which could lead to injury or even mortality. Several approaches have been developed to seek to estimate and quantify the risk of collision, although there remains substantial uncertainty associated with several of the parameters that need to be used within these collision risk assessment approaches. Furthermore, as sentient animals with highly developed senses, seal behavioural ecology in energetic tidal streams remains poorly understood, and even less so with respect to the presence of novel, man-made structures with moving parts. Nevertheless, although there has now been well over a decade of tidal energy development in Scotland and other areas of the world with pinniped populations, there is no evidence, to date, of any collisions between seals (or other marine mammals) and tidal turbine rotors.

Evidence acquired at currently operational tidal stream energy developments has not yet provided the evidence required for regulators, advisers or the research community to recommend the complete retirement of the risk of collision, nor has sufficient evidence been presented to date to recommend a less conservative avoidance rate to be used alongside modelling frameworks. However, there is a consensus that the “traditional” Collision Risk Modelling (CRM) approach has significant limitations, not least because it does not take into account the influence of animal behaviour on the risk of collision. A study by Band *et al.* (2016) explored a series of increasingly complex refinements to the approach which could be considered in an attempt to add to the accuracy and realism of modelled estimates.

7.4.2 Encounter Rate Model (Wilson *et al.*, 2007)

The Encounter Rate Model (ERM), developed by Wilson *et al.* (2007), is based on a model originally used to estimate interactions between marine predators and their prey (Gerritsen & Strickler, 1976). Initially, it was applied to predict potential encounters between marine mammals, such as harbour porpoises, and fish, like herring. The authors also suggested that the model could be adapted for diving birds.

The ERM focuses on the volume of water swept by each turbine blade over a given time. An encounter is defined as any situation where the paths of marine animals and turbine blades intersect, assuming the animals do not take any evasive actions. This includes not only avoiding the rotors but also avoiding the site altogether or being swept away by water currents. The model considers the volume swept by the rotor blades (acting as 'predators') and the number of marine animals (acting as 'prey') within that volume. It assumes that animals swim in random directions relative to the water body, which may not fully represent actual swimming patterns in tidal channels. The encounter rate is expressed as the number of animals that would encounter a turbine per month or year.

7.4.3 Collision Risk Model (Band *et al.*, 2012)

The Collision Risk Model (CRM) is a widely used method for estimating the risk to birds flying through wind farms. This model has been adapted to assess the risks of underwater collisions involving tidal turbines. The CRM evaluates the number of animals likely to pass through each rotor and the probability of collision for each passage.

A key aspect of the CRM is the 'no-avoidance collision rate,' which assumes that animals do not take any evasive actions to avoid the turbines. Animals are modelled as swimming directly towards the rotor, meaning their movement is perpendicular to the rotor plane. This assumption simplifies the calculations by ignoring any vertical or parallel components of the animals' speed, such as the dive speed of diving animals. When calculating the risk of collision during a single transit, only the component of velocity directly towards the rotor, which is taken as the mean current speed, is considered. However, any component of animal speed in the vertical direction (e.g. diving speed of diving animals) can influence the time they are at risk and, consequently, the number of transits they make through the rotor area. This model helps in understanding and mitigating the potential risks posed by tidal turbines to marine wildlife.

The CRM estimates how many times animals pass through a rotor over a period, like a year, using a similar formula to the ERM but for entire rotors instead of individual blades. Even if the animal might pass through without hitting the rotor, this number is then adjusted by the probability of a collision during a single pass. In the first stage of the model for collision rate during a single transit:

$$C_{CRM} = D \times B\pi\,(R+0.5W)^2 \times V \times pcoll$$

Where *D* is the density of the species (individuals per volume); π is the cross-sectional area of each turbine through which animal transits; *R* is the rotor radius; *W* is the animal breadth (for animals not clearing the blade tips); *V* is the animal velocity; and P_{coll} is the mean risk of collision during single transit. The 'no-avoidance rate' can be scaled to account for behavioural avoidance of tidal devices, or evasion of the blades, through the application of an avoidance rate as a correction factor. During the consenting of EMEC Fall of Warness and MeyGen Phase 1, NatureScot (2013) advised that an avoidance rate of 98% was reasonable and incorporates a degree of precaution. More recently, uncertainty around the avoidance rate is reflected in advice from NatureScot, supported by SCOS (2024), which requests that a range of avoidance rates are presented.

Currently, the published Band model (NatureScot, 2016) for estimating collision risk to marine mammals requires the use of a mean operational turbine speed (outside times where the device is non-operational), and a mean speed of approach relative to the turbine, taken as the mean current speed. The use of mean values for current and operational turbine speeds are simplifications which may have a significant effect on overall collision rate estimates, as they do not take into account the non-linear variation of collision rate with current and turbine speeds over the tidal cycle, nor the behaviour of species in tidal environments at differing current speeds (Band *et al.*, 2016).

A research project provided improved assessments of the level of mortality to harbour seals potentially caused by tidal turbines in the Pentland Firth and Orkney Waters region, using recently available information from a number of areas of work (Band *et al.*, 2016). These include the consequences of collision for individuals, detailed information on tidal flow, updated tidal turbine parameters and data on temporal and spatial variation of harbour seals within the water column. Specifically, this project was developed to review the assessment process to determine areas where inputs could be refined to improve estimates in the short term; and attempted to use the outputs of these reviews to generate an updated model that is fit for use to estimate the no-avoidance collision rates between seals and tidal turbines. This updated model was tested with an agreed envelope of consented tidal energy projects in the Orkney and Pentland Firth region (MeyGen Phase 1a and EMEC Fall of Warness). The study found that the parameters most influencing the magnitude of predicted collision rates were seal density, incorporation of a threshold collision velocity for mortality, incorporation of transit speeds derived from seal tracking data, incorporation of dive profile derived from telemetry, and incorporation of a blade thickness parameter. Where relevant data are available, several of these factors could be included in the NatureScot (2016) CRM.

7.4.4 Probabilistic risk of collision

For a marine animal to experience a mortal or fatal injury from collision with a tidal turbine, a series of sequential conditions must be met. This can be described in the form of a probabilistic model whereby each step has an associated probability of occurrence (Copping *et al.*, 2023). An animal must be present in the vicinity of a turbine (condition 1), at the depth of the rotor (condition 2). The turbine must be rotating during operational flow velocity (condition 3) and the animal must not be avoiding the turbine or evading the rotor blades (condition 4). The animal is not deflected due to flow conditions within the rotor disc (condition 5) and thus the animal must collide with a blade (condition 6) where the collision is sufficient to cause injury or mortality (condition 7). As each condition will have an associated probability of between 0-1, the likelihood of harm (injury or mortality) is the product of seven probabilities (*Figure 7-3*).

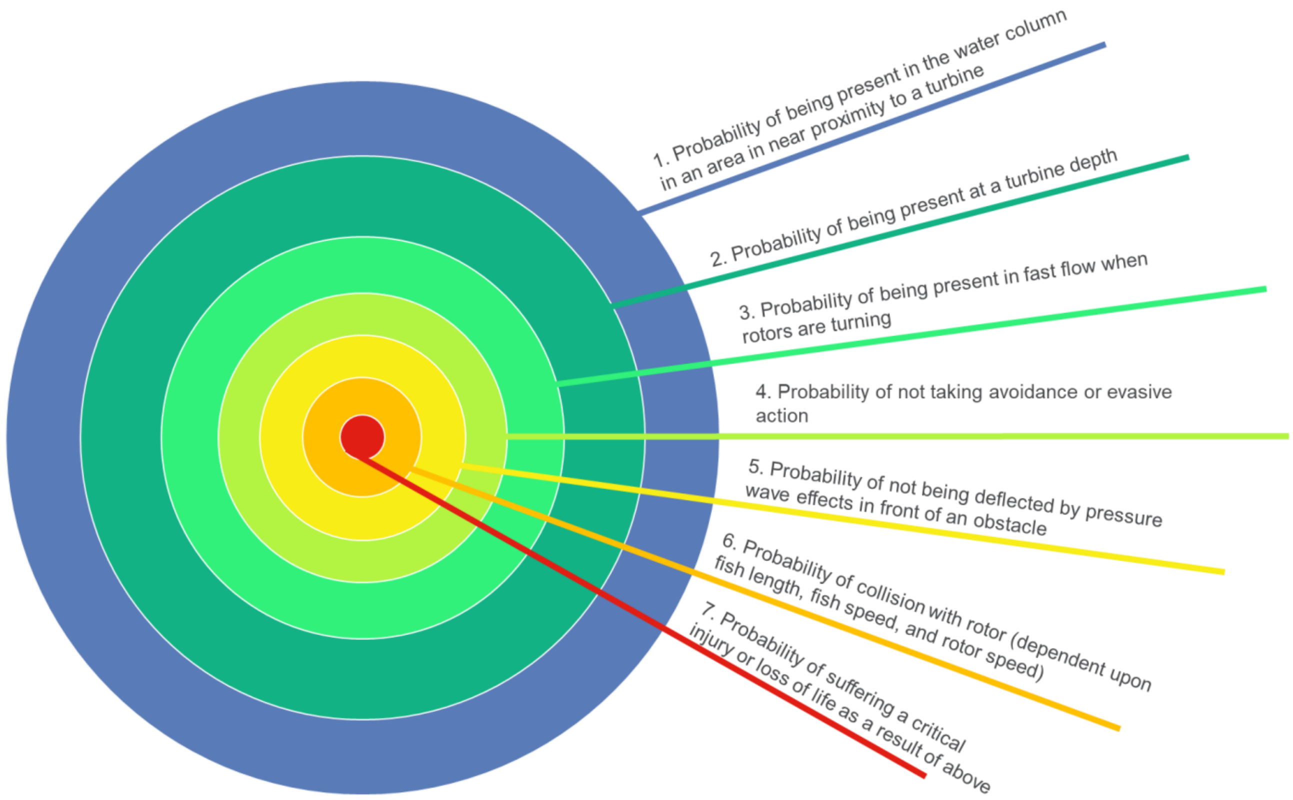


Figure 7-3 Conceptual probabilistic framework describing the likelihood of a collision between a marine animal and a tidal turbine. Recreated from Copping et al. (2023).

Even if the probability of every condition is as high as 0.9 (90%), the product of each probability combined results in an overall probability of 0.48. If any one of these probabilities is a very small number, then the overall probability decreases dramatically (Table 4). This model (Copping *et al.* 2023) helps to illustrate that, even if seals commonly occurred within a short distance of a tidal turbine (condition 1), this does not necessarily mean that a collision is highly likely.

Table 4. An illustration of the effect on overall probability of changing probabilities at each of seven sequential conditions required to be met for a collision to occur.

PROBABILITY CONDITION 1	PROBABILITY CONDITION 2	PROBABILITY CONDITION 3	PROBABILITY CONDITION 4	PROBABILITY CONDITION 5	PROBABILITY CONDITION 6	PROBABILITY CONDITION 7	OVERALL PROBABILITY
0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.478
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.210
0.8	0.8	0.1	0.8	0.8	0.8	0.8	0.026
0.8	0.5	0.1	0.3	0.9	0.6	0.5	0.003

It would be possible to populate each of the seven conditions in this theoretical framework with data. While this would require a range of project-specific data to undertake a comprehensive impact assessment, the Copping *et al.* (2023) model can be used in generic terms to demonstrate the concatenation of circumstances that would need to be met for a fatal or serious collision to occur.

7.4.5 Linking the Copping *et al.* (2023) model to collision risk modelling

The Copping *et al.* (2023) probabilistic model can be considered in parallel to the ERM/CRM approaches recommended by NatureScot (NatureScot, 2016). In the spreadsheet-based ERM and CRM tools that accompany the NatureScot (2016) collision risk assessment guidance, input parameters include a density of animals at the site (representing condition 1), a density at risk depth (representing condition 2), and animal length, swim speed and rotor RPM (representing condition 6). In effect, the ERM/CRM approaches assume that a collision will only occur if those conditions are met (i.e. conditions 1, 2 and 6 = 1.0). However, this leaves four of the conditions (3, 4, 5 and 7) poorly represented in the ERM/CRM framework, and each of those conditions is likely to have a value <1.

Condition 3: probability of not being present in fast flow when rotors are turning

The native ERM/CRM is intended to be run for a one-year time period, and "non-operational" time is input as a single value representing the proportion of time where turbines are not operational. This can account for time when the turbines are shut off for maintenance, time when the rotors are not rotating because the current velocity is too low, or it could even account for time when the rotors are rotating but at speeds where fatal or injurious collisions would not occur (Onoufriou *et al.*, 2019). However, this one-year time period does not allow for the potential for variability in seal occurrence (density) at different tidal states. Onoufriou *et al.* (2021) investigated the change in seal presence at four different tidal states (peak ebb, peak flood, high water, low water) in the Inner Sound of the Pentland Firth, using telemetry data from harbour seals tagged on the north Caithness coast. The study reported that there was notable variability with different tidal states. This variability could lead to a differing degree of risk for harbour seals during periods of high (peak ebb/flood) or low (high/low water) flow velocity. While the Onoufriou *et al.* (2021) data are relevant to MeyGen and can be used to refine estimates of collision rate, they are specific to telemetry data from the Inner Sound, and therefore there remains significant uncertainty around this parameter at sites outside the Inner Sound.

These findings were supported at a finer scale by the results from sonar monitoring at one of the MeyGen turbines, reported by Montabaranom *et al.* (2025), who showed a 77% reduction in seal detections at high flow rates (although this study was unable to differentiate between grey and harbour seals). This is explored further in section 7.5.2. The combination of broad scale array-scale (Onoufriou *et al.*, 2019) and finer scale individual turbine (Montabaranom *et al.*, 2025) avoidance suggests that the distribution and behaviour of seals changes depending on the current speed, which may be a direct response to the physical presence or sound generated by operational turbines.

Condition 4: probability of not taking avoidance or evasive action

In consenting MeyGen Phase 1, NatureScot (previously Scottish Natural Heritage) proposed that an avoidance rate of 98% could be used within the CRM/ERM frameworks as a suitably precautionary level of behavioural avoidance/evasion (NatureScot, 2013). This was in line with earlier environmental assessments, including EMEC Fall of Warness and the Sound of Islay tidal array. An avoidance rate of 98% was attributed to expert judgment (including discussion with Marine Directorate (previously Marine Scotland) Licensing Operations Team (MD-LOT), Marine Directorate Science, Evidence, Data and Digital division (MD-SEDD; previously Marine Scotland Science) and Marine Directorate policy officials, together with seal experts from the Sea Mammal Research Unit (SMRU); although a formal scientifically derived basis for that judgment has not been presented. It is not clear whether NatureScot ever intended this avoidance rate to be analogous to condition 4 of the Copping *et al.* (2023) model ("probability of [not] taking avoidance or evasive action"). Nevertheless, if in line with earlier expert judgment, behavioural avoidance is indeed close to 98% (or, conversely, a probability of 0.02 for *not* taking avoidance/evasive action), then when included with estimates of the other conditions (3, 5 and 7) that are not represented within the ERM/CRM methods, the likelihood of a collision will be considerably lower than the 98% avoidance rate suggests. Current advice from SCOS (2024) recommends that a range of avoidance rates are presented in impact assessments.

Because seals have highly developed senses of hearing, eyesight and touch (through their vibrissae), it is likely that they are very aware of the presence of turbine rotors and may perceive them as a threat. Recent evidence from monitoring at the MeyGen array suggests that seals can and do exhibit avoidance and evasive action. Although the study was not able to determine a definitive rate of avoidance, there was a notable decrease in seal presence close to the monitored turbine during times of high flow when the turbines were rotating fastest (Montabaranom *et al.*, 2024). Furthermore, the authors of this study advised that they did not have evidence to suggest that any collisions *had* occurred (J. Montabaranom, D. Gillespie and G. Hastie, pers. comm.).

Condition 5: probability of not being deflected by pressure wave effects in front of an obstacle

When an obstacle is introduced into a laminar flow, it can significantly alter the flow characteristics. For example, the obstacle introduces a resistance to the flow, leading to a pressure drop across the obstacle which can affect the overall pressure distribution in the surrounding flow field. Flows are modified around the obstacle, with deceleration of flow immediately upstream, reduced velocity downstream and accelerated flow around the sides of the obstacle, creating a turbulent wake which can vary spatially, and in intensity. Although currents in energetic tidal streams in the Pentland Firth and Orkney are not strictly laminar, and are likely turbulent even without disturbance, they have a clear dominant directionality during the flood and ebb phases. These near field changes to the flow regime occur with obstacles such as natural features such as boulders, or static man-made structures, as well as around the moving rotor of a tidal turbine. It is likely that even without any behavioural effects, the passage of a passive particle would be influenced by such changes on the flow field. Although an actively-swimming, large marine animal does not behave as a passive particle, these physical effects in close proximity to the rotor could nevertheless have an influence on the probability of a serious collision, although the effect would likely be far more pronounced on smaller animals such as fish. Micro-scale changes in swim speed, direction and orientation as a result of pressure waves and highly localised regions of complex turbulent flow close to the turbine could nevertheless be the difference between a less-damaging glancing blow and a serious direct impact. However, as there is no evidence that this would have a notable effect on large animals, it is not considered to be a relevant parameter in influencing the risk of collision for harbour seals.

Condition 7: probability of causing a critical injury or loss of life as a result of conditions 1-6

Assuming all other conditions are met and a collision occurs, the consequences of that collision remain uncertain. A strike to the head of a harbour seal from a fast-moving blade tip could have different consequences if the contact was made closer to the hub where the impact velocity was correspondingly lower. The same tip collision may have different consequences if the collision occurred with the neck, shoulders, torso or hind flippers, owing to the sensitivity of underlying tissues or structures, or the level of protection afforded by blubber and skin. The ERM/CRM approach is unable to apportion the severity of injury; and adopts the naïve assumption is that all collisions are equal. It is highly unlikely that all possible collisions would cause head injury or severe skeletal or organ damage. As previously observed (Condition 5), a glancing blow will have different consequences to a direct hit. This uncertainty is not taken into account in ERM/CRM outputs.

Onoufriou *et al.* (2019) undertook field trials using a simulated turbine blade colliding with seal carcases at varying speeds. The study found that collisions at velocities >5.1 m s^{-1} are likely to cause serious or fatal injury, but collisions at lower velocities might not have such severe consequences. The NatureScot ERM/CRM package does not consider the consequences of impact velocity (i.e. the collision rate should not be interpreted as a serious injury/mortality rate). Because turbine rotation speed (and thus blade velocity) varies with the tidal cycle, the consequences of a potential collision is likely highly variable within a given tidal cycle or day. Therefore, the velocity of impact is a hard-to-predict factor that is likely to determine how a collision rate translates into an estimate of additional mortality rate.

Further evidence for factors influencing collision rates

It is likely that further numerical and statistical modelling studies could help refine estimates for the rate and consequences of collisions. For example, computational fluid dynamics approaches could explore the influence of pressure differences in close proximity to a turbine rotor on the probability of a collision. An approach to CRM where seals can approach the turbine from all directions, rather than a simplistic linear path through the rotor disc, could lead to improved estimates of collision rate (Horne *et al.*, 2021) and mortality (Horne *et al.*, 2022). Building stochasticity into the CRM in a similar manner as has been done recently for seabird CRM approaches could also better represent the variability in tidal currents (and thus turbine operational parameters) through a tidal cycle. However increasingly complex approaches can still produce similar results to more simplistic methods (Horne *et al.*, 2023) and the element that is most challenging to represent in any model, whether simplistic like ERM and CRM or simulation-based approaches, is that of the behaviour of the animals.

Harbour seals are intelligent, sentient and highly mobile mammals that inhabit a highly dynamic environment. Fully understanding their behaviour to the extent that would be required to accurately model the likelihood of collision will not be possible in a timescale required to unlock further tidal energy development. However, it is worth thinking beyond the influence of behavioural avoidance alone and considering the other factors that contribute to the removal of an individual from the population.

7.4.6 Parameterising the Copping *et al.* (2023) model

In a CRM-style model, conditions 1, 2 and 6 of the Copping *et al.* (2023) framework are estimated and included. For a collision to occur, a seal must be present in the area (condition 1; addressed through a seal density input), must occur at risk depth (condition 2; estimated from the seal dive profile) and must collide with a moving blade (condition 6; the CRM based on biological and physical parameters).

Conditions 3, 4, 5 and 7 are the remaining uncertainties within this framework and are not captured in the CRM as they are far more difficult to quantify. Condition 4 is a rate of behavioural avoidance, which as discussed above, is only one element influencing the likelihood of a serious (fatal or injurious) collision and has historically been a *post hoc* correction to the predicted collision rate.

To simplify the application of the Copping *et al.* (2023) framework, it is assumed that the probability of conditions 1,2 and 6 = 1.0 (100%). For further simplicity, it can be assumed that the NatureScot (2013) advised avoidance rate of 98% applies in condition 4; i.e. 98% avoidance equates to a 2% (0.02) probability of a seal not avoiding a collision through behavioural avoidance.

There remain three conditions (condition 3, probability of presence in fast flow with rotors turning; condition 5, probability of not being deflected by the rotor pressure wave; and condition 7, probability of a collision that causes fatal or serious injury) all of which will carry a probability of 1.0 (100%) or less. Estimating, or using data to derive a value for these three probabilities is the missing link between a rate of behavioural avoidance, and a rate of avoiding a fatal or serious collision.

The effect of changing these variables is demonstrated in Table 5. When assuming that the probability of each of conditions 3, 5 and 7 is 1.0 (100%) the risk of serious/fatal collision is equal to the behavioural avoidance rate (0.02, or 98%). However, if one or more of conditions 3, 5 and 7 is <1.0 (<100%), the risk of serious/fatal collision falls. As an example, assuming that the probability of each of these conditions is 0.5 (50%), the resulting risk of serious/fatal collision is 88% smaller than assuming behavioural avoidance is the only factor driving the collision rate.

Table 5 The influence of changes to conditions 3, 5 and 7 (Copping et al., 2023) on an avoidance rate that takes into account these factors

PROBABILITY CONDITION 1*	PROBABILITY CONDITION 2*	PROBABILITY CONDITION 3	PROBABILITY CONDITION 4**	PROBABILITY CONDITION 5	PROBABILITY CONDITION 6*	PROBABILITY CONDITION 7	AVOIDANCE OF SERIOUS/FATAL COLLISION RATE
1.0	1.0	1.0	0.02	1.0	1.0	1.0	0.02 (98.0%)
1.0	1.0	0.9	0.02	0.9	1.0	0.9	0.01458 (98.5%)
1.0	1.0	0.7	0.02	0.7	1.0	0.7	0.00686 (99.3%)
1.0	1.0	0.5	0.02	0.5	1.0	0.5	0.0025 (99.75%)
1.0	1.0	0.3	0.02	0.3	1.0	0.3	0.00054 (99.95%)
1.0	1.0	0.1	0.02	0.1	1.0	0.1	0.00002 (99.99%)

*** In this example, Conditions 1, 2 and 6 are assumed to be 100% likely to be met**
**** In this example, Condition 4 is analogous to a behavioural avoidance rate of 98%**

PROBABILITY CONDITION 1*	PROBABILITY CONDITION 2*	PROBABILITY CONDITION 3	PROBABILITY CONDITION 4**	PROBABILITY CONDITION 5	PROBABILITY CONDITION 6*	PROBABILITY CONDITION 7	AVOIDANCE OF SERIOUS/FATAL COLLISION RATE
(NatureScot (2013); i.e. a rate of *not* avoiding or evading collision = 0.02)							

Is it currently possible to estimate, or derive, the probabilities of conditions 3, 5 and 7? One might consider evidence from several recent scientific publications to aid this estimation of risk. For example, Montabaranom *et al.* (2025) reported a 77% mean reduction in seal presence at the highest flow speeds (condition 3). Onoufriou *et al.* (2019) reported that only collisions >5.1 m/s are likely to cause mortality or serious injury (condition 7), and it would be possible to calculate the proportion of the blade moving at a velocity greater than this, e.g. 80% (Band *et al.*, 2016), with the probability of this collision occurring on the head or spine of the seal leading to serious injury being somewhat smaller. There could be additional reduction in mortality if potential collisions are with the trailing, rather than leading edge of the blade, due to fine-scale behaviour or hydrodynamic perturbation.

To our knowledge there is no evidence of deflection of a seal due to the pressure wave at the rotor (condition 5), but it is indeed likely that fine scale hydrodynamics could influence the likelihood of collision and the probability is likely to be <1.0, however for the purposes of this example this probability is held at 1.0.

Based on these exemplar values the probability of a fatal/serious collision is:

$$0.23\ (condition\ 3) \times 0.02\ (condition\ 4) \times 1.0\ (condition\ 5)\ \times 0.8\ (condition\ 7) = 0.00368$$

which equates to an effective rate of avoiding fatal/serious injury of 99.6 %.

Although it may not be possible at this time to use data to accurately estimate values for conditions 3, 5 and 7 to derive a risk of fatal/serious collision in place of a behavioural avoidance rate, even using conservative values to represent the other conditions of the Copping *et al.* (2023) model suggests that the likelihood of fatal/serious collisions occurs at a rate of less than 98% of 'no-avoidance' collisions. Furthermore, the Copping *et al.* (2023) approach highlights the limitations with the CRM/ERM modelling approach, where although a rate of behavioural avoidance can be applied, they do not accommodate other important parameters.

7.4.7 Consequences of repeating the MeyGen Phase 1 assessment approach

As shown in Chapter 4 above, several tidal stream energy project developers wish to establish or expand operations in the Pentland Firth and Orkney Waters area. All will require the necessary consents and licences, and the associated environmental impact assessments will consider the potential impact of the projects on harbour seals. At the time when the MeyGen project was consented in 2013, the harbour seal PBR limit for the North Coast and Orkney Seal Management Area was 17 harbour seals. This resulted in a six-turbine permissible first stage of the development, on the basis that the modelled collision rate would be below this limit. The overarching conditions used to determine the level of acceptable risk were:

- a behavioural avoidance rate of 98%;
- the North Coast and Orkney Seal Management Area being the reference population; and
- a seal density derived from harbour seal telemetry data (Russell *et al.*, 2013).

Since 2013, the continued decline in the population has resulted in a much-reduced population estimate, and a correspondingly smaller PBR, currently eight harbour seals (SCOS, 2024).

If the conditions that were used to determine the permissible build-out of MeyGen in 2013 were applied in current circumstances, with a smaller reference population size and reduced PBR limit (SCOS, 2022), an updated seal density estimate (Carter *et al.*, 2022), and applying the same 98% avoidance rate, modelling the collision risk from an expanded MeyGen project would very quickly exceed the PBR (Table 6). Even moving to a less precautionary 99% avoidance rate would not permit the expansion of the array to a scale which could achieve a rated capacity in line with the Contracts for Difference (CfD) held by MeyGen.

Table 6 Collision risk estimates (NatureScot, 2016) for an array of 20-metre diameter tidal turbines for one year.

COLLISION RISK MODEL (NATURESCOT, 2016) FOR AN ARRAY OF 20-METRE TURBINES OVER A ONE-YEAR TIME PERIOD									
Number of turbines in array	1	5	10	15	20	30	40	50	60
(approx. MW)	(2)	(10)	(20)	(30)	(40)	(60)	(80)	(100)	(120)
Predicted collision rate (98% avoidance)	0.82	4.12	8.24	12.35	16.47	24.71	32.94	41.18	49.41
Predicted collision rate (99% avoidance)	0.41	2.06	4.12	6.18	8.24	12.35	16.47	20.59	24.71
PBR limit = 8 harbour seals									
This model is based on 20-metre diameter, three-bladed rotors; 32 metre water depth; 2.5 m/s mean current speed; 10 RPM; and a harbour seal density of 0.2 individuals per km^2. NB this is presented as an indicative estimate for illustrative purposes and is not for use in Environmental Impact Assessment.									

When considering a cumulative scenario with other tidal developments within the North Coast and Orkney Seal Management Area, the incompatibility of the estimated collision rate with the PBR is further emphasised. The predicted collision rate for even a limited (ca. 10 turbine) expansion of one or more projects in the region would exceed the PBR for this region.

7.4.8 How might this be overcome?

Several attributes of the standard modelling and assessment tools could be updated, to present a quantitative collision risk assessment for the projects that would be more likely to be considered consentable.

The avoidance rate

For example, as previously discussed, the 98% avoidance rate advised by NatureScot (2013) in determining the MeyGen Phase 1 consent application was considered to be precautionary. Following several monitoring campaigns, notably at Bluemull Sound (underwater video) and MeyGen (active sonar), based on data analysed to date, it does not appear that collisions are regularly occurring (if at all) at the monitored devices, and scientific studies indicate that seals show avoidance behaviour at the kilometre (Onoufriou 2021) and tens-of-metres scales (Montabaranom 2024). It is probable that behavioural avoidance exceeds 98% (i.e. a frequency of one collision per 50 modelled encounters with a turbine rotor), due to a combination of highly local perception of the rotor leading to fine-scale evasion, and due to the acoustic signal generated by the turbine acting as a deterrent within the audible range.

Furthermore, as discussed in Section 7.4.3, the behavioural avoidance rate does not take into account various other parameters that contribute to the overall probability of a fatal or injurious collision occurring. Therefore, even if behaviour brings a seal into the rotor swept area, there are other contributing factors influencing the severity of any collision with part of the rotor.

While future developments should continue to present a range of avoidance rates (e.g. between 95%-99.9%) to support applications for consent [26] (Table 7) in line with SCOS (2024) advice, definitive proof that collisions do not happen cannot be provided at this time, in spite of years of research and monitoring. Furthermore it is unlikely that evidence that zero collisions occur will ever be obtained, due to the scarcity of near-field interaction between turbines and marine animals, and the major resource that would be required to deliver continuous monitoring of every deployed device and analyse the resulting data, and the philosophical and statistical impossibility of proving that no collision will ever occur.

Table 7 Collision rate for a 60-turbine array (20 metre rotors) when applying an avoidance rate between 98%-99.9%.

AVOIDANCE RATE	98%	99%	99.1%	99.2%	99.3%	99.5%	99.75%	99.9%
60 x 20 m turbines: collisions per year	49.41	24.71	22.23	19.76	17.29	12.35	6.18	2.47

This model is based on 20-metre diameter, three-bladed rotors; 32 metre water depth; 2.5 m/s mean current speed; 10 RPM; and a harbour seal density of 0.2 individuals per km^2. NB this is presented as an indicative estimate for illustrative purposes and is not for use in Environmental Impact Assessment.

[26] *SCOS (2024) advise that there is insufficient scientific basis at this time to move away from the NatureScot (2016) recommendation to present a range of avoidance rates.*

Proportion of time at sea

The seal density maps used to describe the spatial distribution of seals for impact assessment purposes are presented as the proportion of the population likely to be present in a grid cell. In the case of the Carter *et al.* (2022) seal habitat preference distribution maps, the grid cells are 5x5km, and the study presents two possible distributions: (a) the total UK population distribution, and (b) a distribution for each seal SAC (including Sanday SAC in Orkney). These can be scaled to obtain an at-sea harbour seal density (seals per km^2) by multiplying the proportion of the respective population in each grid cell by the reference population (e.g. 42,900 harbour seals in the UK; SCOS, 2022). However, this assumes that 82.36% of the reference population is at sea, at any one time (Russell *et al.*, 2015). This does not account for the breeding season/moult period when harbour seals spend a greater proportion of time hauled out, and nor does it account for time when seals are resting (and not diving) at sea.

Accounting for periods of the year when the proportion of the harbour seal population hauled out is higher (i.e. breeding, moult) would reduce the at-sea density used within collision risk modelling substantially, which in turn reduce the modelled collision rate. However, even a correction to the harbour seal occurrence at sea would not allow for large-scale array expansion, due to the small local PBR limit.

The harbour seal reference population

Seal Management Areas were identified primarily for the management of seals in the context of licensing of seal shooting. These management areas consequently became used for marine renewable energy environmental assessments. Although harbour seals are generally site-faithful and make more limited movements than grey seals (Carter *et al.*, 2022), there is evidence of some movement of individuals between Seal Management Areas[27] (Figure 7-4).

[27] *Trips that begin and end in different Seal Management Areas were excluded from the recent habitat preference modelling of Carter et al. (2022, 2025)*

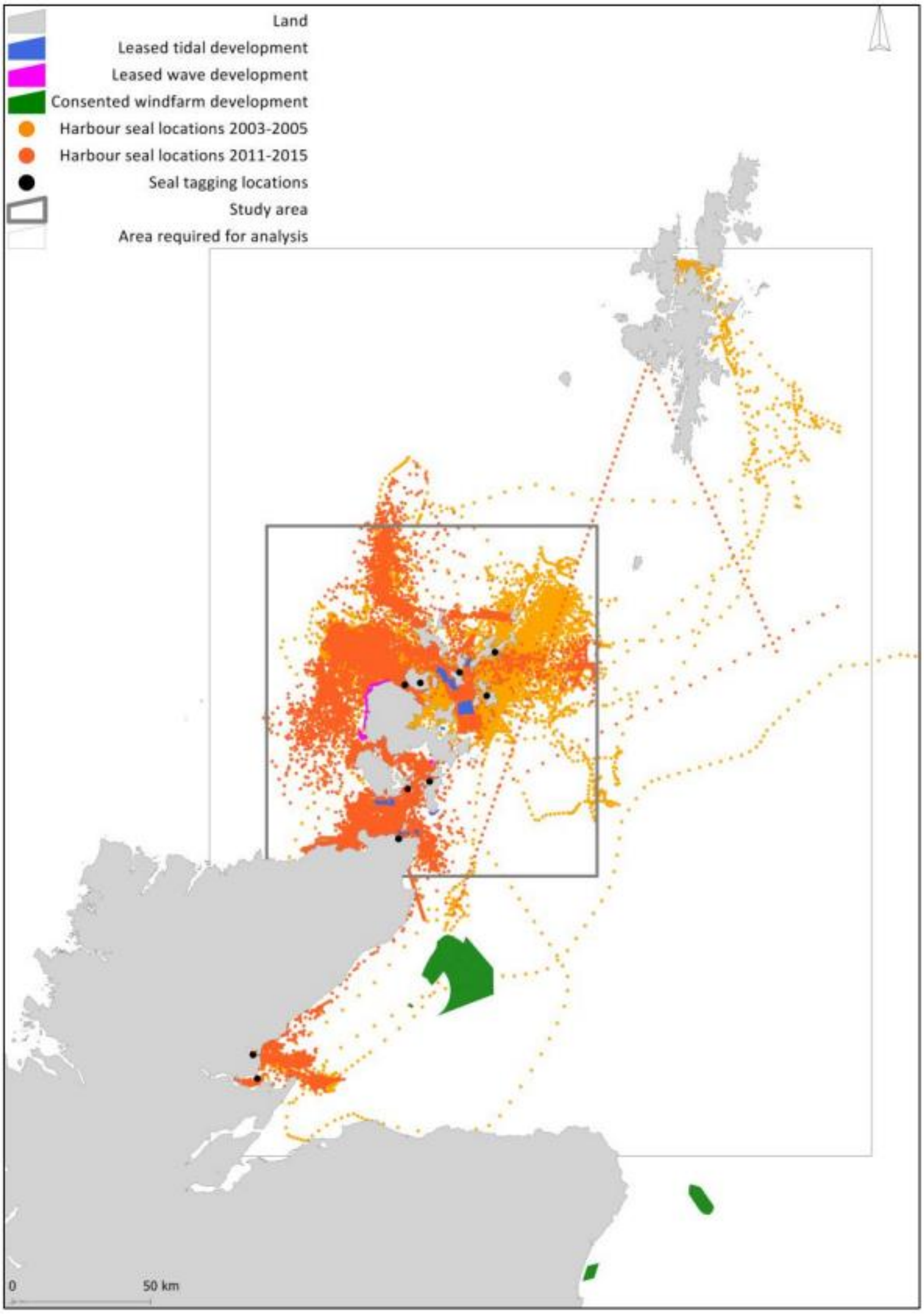


Figure 7-4 Map showing the tracks of 54 animals included in the analysis (orange circles), their tagging locations (black circles), proposed offshore marine renewable developments (blue, pink, green areas). Included to illustrate the limited movement of harbour seals between North Coast and Orkney, Shetland, and Moray Firth Seal Management Areas.

(Reproduced from Jones *et al.*, 2017)

Although the Seal Management Areas are not strictly closed populations (Carroll *et al.*, 2020; thus violating one of the fundamental assumptions of the PBR method for determining significant effects) there is a large degree of regional fidelity observed in harbour seals. Using a single UK-wide PBR approach assumes that the population is fully mixed, but there is evidence to suggest that the harbour seals of southern England and eastern shore of the North Sea are genetically distinct from the northern metapopulation (Olsen *et al.*, 2017; Carroll *et al.*, 2020). Pooling a subset of Seal Management Areas to address specific wide-scale issues could overcome the difficulties in managing such issues using the individual Seal Management Area approach.

One such "pooled" approach could be to present assessments at two scales: one based on the North Coast and Orkney population in isolation; and one using a PBR estimated for the North Coast and Orkney and either its neighbouring Seal Management Areas, or possibly for the whole of the northern metapopulation (Carroll *et al.*, 2020). These approaches do not wrongly assume a fully mixed UK population but do account for the possibility of limited movement to other areas (*Table 8*). This has the advantage of allowing assessments against a wider reference population. This accepts that, during periods of population perturbation harbour seals can and do move between regions, thus acting as sources and sinks for a wider population. While it is evident that the North Coast and Orkney population shows a degree of biological isolation from, for example, the West Scotland or Western Isles Seal Management Areas, that is not necessarily an argument for not accepting any level of putative human impact, not least when there is no evidence that this impact is occurring at the current level of tidal energy deployments, and that the North Coast and Orkney population decline is not thought to be driven by direct anthropogenic causes.

Table 8. The PBR for each Scottish Seal Management Area, plus two pooled values: one for the North Coast and Orkney plus neighbouring Seal Management Areas; and one for all Scottish Seal Management Areas combined. (Adapted from SCOS, 2022).

SEAL MANAGEMENT AREA	2016-2021 COUNT (N_{MIN})	RECOVERY FACTOR (F_R)	PBR
Southwest Scotland	1,709	0.7	71
West Scotland	15,600	1.0	936
Western Isles	3,532	0.5	105
North Coast and Orkney	1405	0.1	8
Shetland	3180	0.1	19
Moray Firth	690	0.1	4
East Scotland	262	0.1	1
NEIGHBOURING SMAs (Moray Firth, North Coast and Orkney, Shetland, West Scotland)	20,875		967
SCOTLAND TOTAL (all Seal Management Areas pooled)	26,378		1,144

Basing assessments on a PBR for a larger region than just the North Coast and Orkney Seal Management Area would allow for a much greater level of removal at a northern Scotland/Scotland-wide scale. Based on the exemplar turbine scenario in Table 7, above, a cumulative deployment of 60 turbines in Orkney and the Pentland Firth would have a predicted collision rate far below the PBR for the North Coast and Orkney and neighbouring Seal Management Areas (Moray Firth, Shetland, and West Scotland), based on a precautionary 98% avoidance.

This change in the basis of assessments would require acceptance by regulators and advisors that the risk to harbour seals in the tidal streams around Orkney and the Pentland Firth could be greater than the local population could sustain, but given that the current rate of decline in this region is not thought to be attributable to tidal developments at present, and density dependence does not appear to be taking effect, it is likely that this regional population will continue to decline even without future tidal developments. Whether this decline is due to adult mortality, low juvenile survival, emigration, or a combination of factors remains unclear; but it is also unclear is why the tidal industry, not thought to be driving these declines, should be constrained by an assessment metric that is not wholly fit for purpose. Alternative approaches, such as examination of counterfactuals (with/without tidal stream developments) in a population viability analysis approach may better take into account ongoing population declines.

7.4.9 Precaution in collision risk modelling approaches

As discussed in Section 7.4.4 in relation to the Copping *et al.* (2023) probabilistic framework, traditional encounter rate/collision risk modelling approaches omit an estimation of several of the conditions that should be met for a collision to occur and have detrimental consequences (mortality or serious injury). These are: the likelihood of a seal being present during periods when the blades are moving at speeds where a collision would be dangerous; the effect of fine scale fluid dynamics on the likelihood or severity of a collision; and the likelihood of a collision causing serious injury (e.g. spinal damage, concussion) or death, as opposed to less serious injury such as recoverable soft-tissue damage or an oblique, "glancing" impact.

Overcoming some elements of precaution that have previously not been measurable could be done. In the case of seal presence/absence at different states of a tidal cycle. Onoufriou *et al.* (2021) observed differences in seal presence in the Inner Sound of the Pentland Firth at four tidal states (high water; low water; peak ebb; peak flood). Breaking down the tidal cycle into different periods, and allowing seal density to change per period, could refine collision risk modelling. This could be further supplemented by varying a range of other parameters including the turbine RPM and current velocity, for different times of the tidal cycle. However, to run ERM/CRM-type models at a finer temporal resolution to allow for flexibility in the seal density input requires not only the hydrodynamic and turbine data to be available at those resolutions but also requires sufficient data to estimate the changes in seal density through the tidal cycle. Onoufriou *et al.* (2021) used data from a campaign of harbour seal telemetry tracking at haul-out sites around the Pentland Firth to produce their density estimate at four states of the tide. Those data do not exist for all tidal streams, and therefore further harbour seal tracking would be required; or at the very least, reanalysis of historic data. Harbour seal tagging is challenging and costly and has human health and safety and animal welfare considerations. While the results of tracking studies could demonstrate, hypothetically, that harbour seals to some extent avoid tidal streams during periods of fast flow (as demonstrated by Onoufriou *et al.*, 2021) they may not have the three-dimensional (longitude, latitude and depth) resolution to describe how this affects the "density at risk depth" and thus the potential collision rate. Seal tracking is unlikely ever to provide a "quick win" and should be considered and planned in the context of how the data could provide meaningful evidence to improve our understanding of harbour seal ecology in tidal stream environments.

The influence of fluid dynamics on a harbour seal at close-quarters to moving rotors could be modelled in computer-based simulations, or even in an experimental flume using a physical model. While this could be highly informative, it again omits the influence of animal behaviour resulting from the seal's perception of the threat posed by a moving rotor/blade. It is plausible that even a seal detecting the turbine in very close proximity could make a sudden movement in any direction: up, down, left, right or even a rotational movement within the water column. These movements would be very difficult to simulate in a way that would be reliably realistic.

Finally, the consequences of a collision, can be estimated through the simulation-based approaches (SBA) described by Horne *et al*. (2021; 2022; 2023). The evidence from Onoufriou *et al*. (2019) suggested that collisions between turbine blades and seals at a velocity of <5.1 m/s are unlikely to be fatal or to cause serious injury; however it is plausible that a direct blow to the skull at 5 m/s could have greater consequences than a glancing blow to the torso at 8 m/s. Newer SBAs to model collision risk have attempted to model velocity of impact and angle of approach in a more sophisticated fashion, generating generally similar collision rates to the existing ERM/CRM approaches although sometimes with striking differences, particularly when reflecting the approach vector (e.g. a seal diving from above). The collision severity is influenced by where on the blade the collision occurs (close to hub, vs. close to tip), the rotational speed (RPM) of the rotor, and the same animal behavioural aspects which, as described previously, are very difficult to model.

However, these SBAs are not yet published in guidance from NatureScot; the authors of these models have a proprietary right to them (rather than open-source availability), and they can be considerably more time consuming, computationally expensive, and difficult to set up than the existing spreadsheet-based tools (NatureScot, 2016). Furthermore, SBAs are no more supported by validation/verification in the field than the current tools, and therefore could be considered an increasingly complex method to estimate the risk of an event occurring, yet still without being able to quantitatively implement avoidance/evasive behaviour which is very likely the biggest determinant of a collision happening/not happening.

While there are aspects of these three previously unconsidered Copping *et al.* (2023) conditions that could be estimated or parameterised with data, this either requires significant future work or an increasingly complex modelling approach. It remains the fine scale behavioural aspect that is the most difficult element to either demonstrate experimentally, or to model. It is not likely that the scientific community, together with the tidal industry, will be able to sufficiently develop collision risk modelling approaches in a timescale that is appropriate for the tidal industry. Greater complexity in models does not always mean that the models are better, especially when dealing with large, sentient and intelligent agents like harbour seals, with highly developed senses and a high propensity to react and move when faced with danger. It is generally more helpful to use a simpler, parsimonious approach, while acknowledging the residual uncertainty, and basing management decisions around precautionary yet reasonable assumptions.

7.5 Alternative approaches to assessing collision risk

A third approach to estimating the risk of collision is included in the NatureScot (2016) package of guidance, alongside the ERM/CRM. The Exposure-Time-Probability Model (ETPM) aims to estimate the potential collision risk by evaluating the time that each individual animal within a population is at risk of collision with tidal turbines. This framework is recommended by NatureScot for assessing the collision risk of diving birds with tidal turbines but could equally be applied to marine mammals.

7.5.1 ETPM

The ETPM calculates the time for which each bird in the population is exposed to the cylindrical volume of water swept by the rotor of a turbine (i.e., the volume of water within which the individual animal is at risk of colliding with a turbine) based on the species' population and the proportion of time each individual spends within the Project area.

Alongside the ETPM, a population model is run to assess the predicted critical additional mortality due to collisions which would cause an adverse effect to a population. The output of this population model is an estimate of the minimum number of individual animals that would have to be removed from a population by an activity (e.g., operating tidal turbines) for significant population level effects to occur. For example, that level of critical mortality can be set to reflect the PBR limit.

The ETPM then combines the number of individuals that would have to be removed from the population to cause a significant population level effect, with the time each individual in the population is likely to be exposed to the turbines, in order to estimate the collision rate for each individual within the rotor-swept volume which would be sufficient to cause an adverse effect on the identified population.

Once that theoretical collision rate has been defined, the next stage of the assessment process is to consider how that species is using the Project area to determine whether such a collision rate would be likely to occur (i.e., a qualitative judgement is made on whether such a collision rate is likely).

It should be noted that the ETPM works in the opposite way to the ERM/CRM approach. ERM/CRM predicts the number of collisions per year and asks the question of whether that will cause a significant impact at the population level; whereas the ETPM works out how many collisions would cause a population level effect and asks whether or not that number of collisions is likely to occur at the site.

Where the ETPM can be particularly useful is in comparison with monitoring results, such as the sonar (MeyGen) or camera (Nova Innovation) monitoring carried out in recent years, to better estimate the likelihood of a predicted collision rate being observed.

The ETPM approach can be used in conjunction with monitoring data to test the following questions:

- Does monitoring data at operational tidal turbines demonstrate a rate of seal observations that reflects the seal density used to parameterise the ETPM, or does the monitoring indicate that avoidance at the tens-of-metres scale means that the do these models overestimate the occurrence of seals in close proximity to turbines?
- Do turbine operational parameters (e.g. RPM) influence the occurrence or proximity of seals within the area being monitored? (e.g. do seals stay further from the turbines when they are considered to be most dangerous?).

- Does monitoring data demonstrate a rate of exposure that could cause the level of mortality required to have significant population level effects?

7.5.2 Comparing the ETPM to data: a MeyGen case study

Based on a harbour seal density of ca. 0.25 seals per km^2, it could be expected that one harbour seal is present within the MeyGen Phase 1 area at any given time. With a local population of 99 harbour seals (SMRU, 2019 count data), this indicates that 1% of the population is present at the MeyGen site at any given time. As harbour seals are understood to spend ca. 58% of their time at turbine rotor depth, based on dive profiles from harbour seals in this region, the ETPM estimates that *annually*, each harbour seal in the population spends just over six seconds in the rotor-swept volume of a single MeyGen turbine.

Scaled to the Inner Sound population (n=99), this indicates that harbour seals will spend ca. 600 seconds (10 minutes) within the rotor-swept volume of a single turbine over a one-year period. Furthermore, to bring about a mortality rate of eight harbour seals (i.e. the PBR limit), there would be one collision for every 80 seconds that harbour seals occur within the rotor-swept volume of that turbine (noting that this example is based on a single turbine, and not an array).

SMRU used two Gemini active sonars to monitor a single MeyGen turbine for a period of roughly one year. Over the monitoring period, an average of 2.93 seals per day were observed at the meso- (10s of metres) scale to the turbine, although the highest probability of a seal being detected occurred at the lowest tidal flow velocities (*Figure 7-5*; Montabaranom *et al.*, 2025).

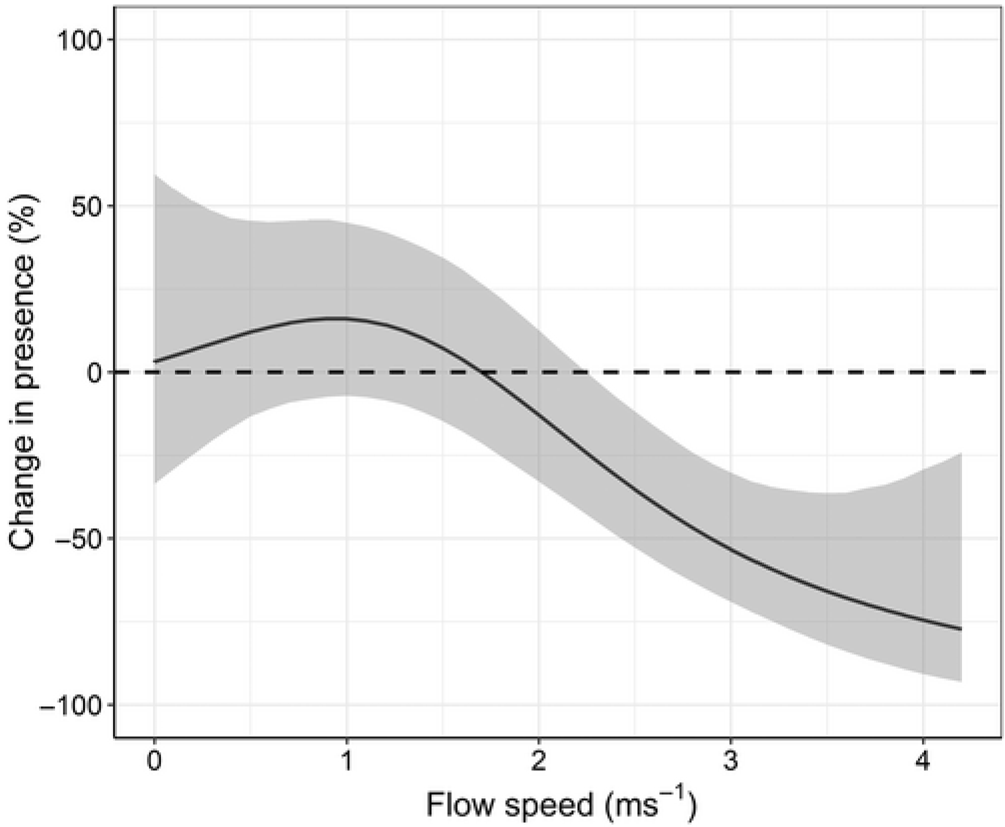


Figure 7-5 The relationship between seal presence at meso-scales from an operational tidal turbine, and flow speed, indicating that the highest likelihood of seal presence is when flow speed was low. (From Montabaranom *et al.*, 2025).

Furthermore, the sonar monitoring could not distinguish between harbour seals and grey seals, and it is very likely that grey seals outnumber harbour seals in the Inner Sound and so it is likely that many of the seals being observed by the sonar are grey seals. The published study did not describe the number of seals observed within the rotor-swept volume, but discussions with the researchers around the results observed indicated that very few seal observations occurred within 1-2 metres of the rotor (SMRU, pers. comm.).

Thus, it appears very unlikely that the rate of collisions required (by the ETPM) to effect a significant impact on the population is occurring, on the basis of the rate of seal detections from the active sonar monitoring at one turbine; bearing in mind that the observed rate of seal detections does not distinguish between grey and harbour seals.

7.5.3 Utilisation of field monitoring data in collision risk assessment

There has been significant investment in novel technology at some tidal energy projects in monitoring the occurrence and behaviour of seals in the vicinity of turbines. Technologies applied have included optical cameras (section 8.2.1), and multibeam sonar devices (section 8.2.3). The underlying driver has been to attempt to quantify the avoidance rate (for application in models such as the ERM and CRM models), and also to directly measure the collision rate for seals with the turbine rotors.

Experience with multibeam sonar (Tritech Gemini 720) at the MeyGen site (the HiCUP project, led by SMRU) over a year of almost continuous observation at one turbine has been that there is no clear evidence that any collisions between the turbine and seals have occurred. Direct measurement of collision rate has therefore not been possible. However, it has been possible to identify a number (N) of close encounters between the rotor and seals, in which seals have approached to within two metres of the volume swept by the turbine rotors.

The primary conservation concern is in relation to the potential impact on harbour seals. The HiCUP sonar data cannot distinguish between harbour and grey seals. It is therefore necessary to apportion the number of observed close encounters between the two species. This can be done by considering the outputs from ERM and/or CRM models for the site. The NatureScot CRM and ERM model outputs for grey and harbour seals provide expressions of the relative risk to individuals of the two species at the MeyGen site. The total relative risk of collision to all seals (RC_{Seals}) is the sum of the relative risks to grey seals (RC_{Hg}) and to harbour seals (RC_{Pv}):

$$RC_{Seals} = RC_{Hg} + RC_{Pv}$$

The observed risk of close encounters for all seals from a single turbine can be measured by HiCUP observation to be N per year. The proportion of this number that can be apportioned to harbour seals can be estimated as:

$$N(Pv) = N * RC_{Pv} / RC_{Seals}$$

This can provide an estimate of the number of close encounters between rotors and harbour seals, N(Pv), based upon field monitoring data and risk modelling. The number of collisions that may lead to mortality of harbour seals can then be addressed through the probabilistic framework presented above through application of Conditions 4, 5, 6 and 7 to the estimated number of close encounters for harbour seals N(Pv).

It must be emphasised, however, that a close encounter does not equate to a fatal or serious collision, and fine-scale behavioural avoidance and uncertainty around the location of impact of blade and seal will influence the severity of the outcome of an encounter.

7.6 PVA counterfactual assessment

As previously discussed within this report (section 7.3.1), the Scottish Government policy to date has been the use of the PBR method to assess whether the modelled mortality of seals in the North Coast and Orkney SMA due to collision (or other human activities, such as licensed shooting) is within acceptable limits. While PBR is mathematically simple to estimate acceptable annual “takes”, it is not designed to forecast mortality thresholds, especially where a population is undergoing a decline (where the causes of that decline cannot be determined), and particularly where potential impacts from tidal stream developments may continue over the 25-year planned lifetime of that development (SCOS, 2016). Concerns have been raised about the appropriateness of the PBR metric to estimate a sustainable level of impact in renewables consent decisions (SCOS, 2016).

In a workshop hosted by the Scottish Government in 2016, a consortium of ecologists, statisticians, consultants, regulators and advisers gathered to debate the limitations of the PBR approach and what alternatives might be available. In discussion, it was suggested that PBR could be retained for the purposes of licensing of seal shooting;

but that an alternative assessment method could be used for renewables developments. There was broad agreement that an assessment that estimated effects and their cumulative impact upon the populations of interest using population viability analysis (PVA) would be the most appropriate assessment tool.

PVAs (section 7.3.3) use demographic rates (principally survival and reproduction) in a model to forecast future population trajectory, either under currently prevailing circumstances or because of an impact, such as disturbance or harvest. In the case of tidal stream energy developments in PFOW, collisions with tidal developments could constituteis perceived as one such impact. Running PVA models many times (thousands) allows for estimates of the likely range (statistical distribution) of population consequences given a degree of environmental stochasticity.

The strength of PVAs lies not in predicting absolute values of viability or costs of management but rather in evaluating the relative effects of different management scenarios (Perkins, Vickery & Shriver 2008). The ratios of the difference between population outcomes with and without an impact are referred to as counterfactuals in impact assessments (Jitlal *et al*., 2017). They can be presented for many different aspects of populations (e.g. population size, probability of extinction, change in population growth rate). As an example, a PVA could be run to compare the population of the North Coast and Orkney Seal Management Area with and without predicted collisions from tidal stream developments, to examine the change in population size, or the probability of extinction at a series of time points (e.g. 5, 10, 20 years).

Accurately obtaining demographic rates to parameterise a PVA requires long term monitoring of populations. Arso Civil *et al*. (2018) reported preliminary results from an integrated population model of the North Coast and Orkney Seal Management Area using simulated data sets, including moult and pup counts, to explore the effect of different demographic rates on population trajectories. The inclusion of an additional 0.15 (15%) adult mortality per annum, beginning after the population began declining, was sufficient to reproduce the observed population trajectory in the region in recent years. Sinclair *et al*. (2020) recommend that the values presented by Arso Civil *et al*. (2018) are used in population modelling for the North Coast and Orkney Seal Management Area (Table 9).

Table 9 Harbour seal demographic parameters for a declining population. Derived by Arso Civil et al. (2018); presented in Sinclair et al. (2020).

Scenario	Age that calf becomes independent	Age of first birth	Calf survival	Juvenile survival	Adult survival	Fertility	Population growth rate
North Coast and Orkney SMA – declining population	1	4	0.24	0.86	0.80	0.90	0.8956

Using these results within a PVA (such as the interim Population Consequences of Disturbance (iPCoD) framework; Harwood & King, 2014) results in a population trajectory which demonstrates a similar rate of decline to that which has been observed in this region over the past 20 years. This can then be compared to a population with additional mortality due to predicted collisions with tidal turbines (Figure 7-6).

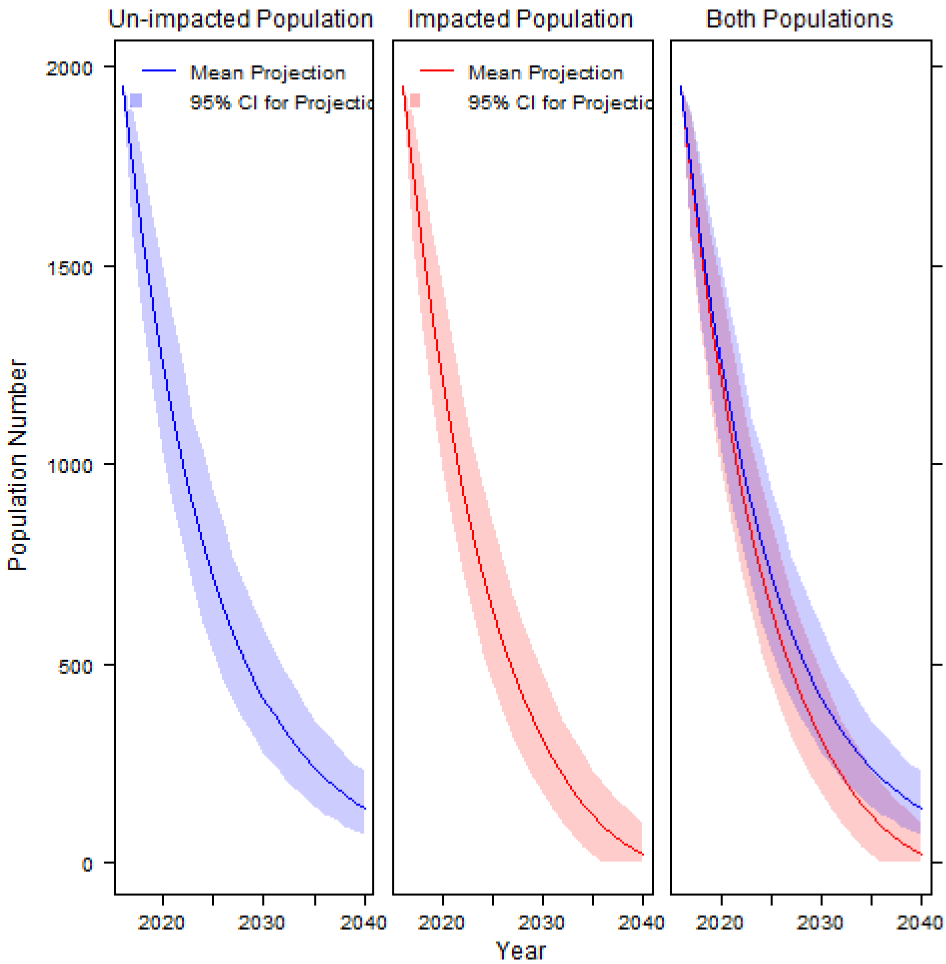


Figure 7-6 An example of outputs from a PVA (using the iPCoD code) for the North Coast and Orkney harbour seal population.

The example above (Figure 7-6) uses a starting population of 1,951 harbour seals (based on the August counts for the year 2019), the demographic parameters estimated by Arso Civil *et al*. (2018), and the "impacted" population experiences 16 collisions per year. It can be observed that the "impacted" population after 25 years is perceptibly smaller than the "unimpacted" population, although there is overlap in the confidence intervals. What can also be observed, however, is that after the 25-year scenario that was modelled, both impacted and unimpacted populations are severely depleted (<10% of the current population size) and could be approaching a situation of functional extinction. Note that in this example, the collision rate of 16 harbour seals per year continues throughout the 25-year scenario, which is likely to be highly precautionary as in CRM the collision rate is related to at-sea density of harbour seals, which is likely to reduce as the population declines.

There has been a long-standing awareness that PBR has limitations for licensing of tidal energy developments; limitations which are exacerbated by the continuing declines in the North Coast and Orkney harbour seal population. To date, no tidal stream project has presented an alternative, such as PVA, to compare the consequences of an additional level of mortality that is predicted to arise based on collision risk modelling, although recent offshore wind assessments do present iPCoD results [28, 29]. Given an acceptance that an alternative to PBR is required, it is advisable that developers consider presenting PVA counterfactuals to support their harbour seal impact assessments.

7.7 Recommendations concerning collision risk assessment

It is recommended that the 2016 NatureScot guidance on collision risk assessment for tidal turbines is reviewed in the light of improvements in scientific understanding of the factors affecting the risk of fatal collision with a view to updating the guidance.

It is recommended that the impact assessment approaches, currently based strongly on the 2016 Guidance, are expanded to include alternative approaches, such as approaches that take account of field data on occurrence and behaviour of mammals, fish and diving birds in the vicinity of turbines, and a more complete suite of factors affecting the probability of additional mortality arising from the operation of tidal turbines.

[28] *West of Orkney Wind Farm EIA - iPCoD assessment*
[29] *Cenos Wind Farm EIA - iPCoD assessment*

8 RESEARCH AND MONITORING

The first commercial-scale tidal turbine deployment in UK waters was the Marine Current Turbines (MCT) SeaGen turbine in Strangford Lough, Northern Ireland, in 2008. Over the last 17 years there has been a range of monitoring and research into the effects of tidal energy installations on marine mammals, including harbour seals.

8.1.1 Tidal energy research summary

In 2014 and 2017, Sparling *et al.* published research into the behavioural effects of the SeaGen tidal turbine in Strangford Lough on harbour seals (Sparling *et al.*, 2014 and Sparling *et al.*, 2017).

Thirty-six harbour seals were fitted with electronic telemetry tags which collected GPS location data on an animal's location and information on diving and haul-out behaviour in 2006 (April-July, pre-installation), 2008 (March-July, during installation and commissioning) and in 2010 (April-July, operation). All harbour seals tagged were a mix of male and female adults, weighing between 66 and 104 kg. Of the 36 tags that were deployed, 32 lasted longer than ten days and were taken forward for analysis by Sparling *et al.* (2017). The study examined 2,772 days of seal telemetry data, with a mean transit rate in/out of Strangford Lough of 0.36 transits per day between 2006-2010.

This study provided the first detailed assessment of harbour seal behaviour close to a commercial-scale tidal turbine, concluding that while the turbine did not prevent the transit of animals through the Strangford Narrows channel (i.e., no evidence of a barrier effect), animals did exhibit a behavioural (avoidance) response to the turbine while it was operational (Sparling *et al.*, 2017). Tagged animals passed through the location of the device more frequently during periods of slack water then during current flows. In 2010, the frequency of harbour seal transits reduced by 20% during periods when the turbine was operational, relative to when the turbine was turned off (Sparling *et al.*, 2017). This effect was more pronounced during periods of daylight, with harbour seal transits reduced by 57% while the turbine was operational.

Seal tracks past the turbine were estimated based on linear interpolation between GPS locations when the seals were at the surface. This method of assessment introduces a degree of uncertainty in the position and timing of seal transits through the tidal array. Furthermore, this study looked only at a single turbine, rather than a broad scale array. Additionally, mitigation measures in place at the SeaGen turbine (i.e. the turbine being turned off when seals were observed in the vicinity) limited the ability to determine close range interactions between harbour seals and the turbine.

A comprehensive review of potential collision between tidal stream devices and marine animals was published by Natural Resources Wales (Frost *et al.*, 2020). This study collated and reviewed any available data from monitoring campaigns at in situ tidal devices for collision interactions between marine mammals, seabirds, and fish to determine the impacts of operational tidal turbines on the spatial-temporal distributions of marine mammals (including harbour seals).

This review presented the findings of Sparling *et al.* (2014) and Sparling *et al.* (2017) (as summarised above), collision risk models (e.g., Band *et al.*, 2000; Grant *et al.*, 2014) and monitoring and modelling studies for harbour and grey seals in Scotland and harbour seals in the USA (Onoufriou *et al.*, 2019; and Copping *et al.*, 2017, respectively).

Frost *et al.* (2020) concluded that, for all studies and data collated as part of the review, no monitoring studies had recorded a direct collision between marine mammals (including harbour seals) and any tidal device. While this review may reflect a true absence of collisions between marine mammals and tidal turbines, it is acknowledged that these findings may result from limitations in data collection or analysis (including device shutdown, incomplete analysis of available data and/or no monitoring of direct collisions). Frost *et al.* (2020) also highlighted the key knowledge and evidence gaps identified as part of the review, namely highlighting that further research is required into avoidance or encounter rates, in addition to seeking to confirm if an actual collision has occurred. Other key gaps highlighted include the potential implications of collision mortality at a population level and the cumulative effects of deploying multiple tidal devices, both at the scale of a single array or multiple arrays in a region.

8.2 Recent research and monitoring from tidal projects in Scotland

8.2.1 Shetland Tidal Array, Bluemull Sound

The Nova Innovation Shetland Tidal Array is located within the Bluemull Sound, between the islands of Yell and Unst. Up to six turbines have been installed in Bluemull Sound, although currently only three turbines are in operation. This location was chosen in discussion with NatureScot as it was thought there would be lower incidence of harbour seal occurrence.

The Smith *et al.* (2020) Shetland Tidal Array monitoring report: Vantage point surveys (EnFAIT-0347) presented the findings of the monthly land-based marine mammal survey over a nine-year period (2010-2019) for the Shetland Tidal Array area and a buffer zone. Statistical modelling was used to generate the encounter probabilities for marine mammals and the turbines in the Shetland Tidal Array, based on these visual surveys (Smith *et al.*, 2020). All surveys were conducted during daylight hours only.

Harbour seals were the most frequently recorded marine mammal species during the nine-year survey campaign, observed in 12% of the 3120 survey scans. Most of these observations were recorded within the buffer zone, with only nine individual harbour seals recorded within the Shetland Tidal Array Area itself over the nine-year survey campaign (Smith *et al.*, 2020). The modelled proximity probability for harbour seals (i.e., the probability of a harbour seal occurring within the array area) was negligible. The survey concluded that the modelled probability of near-field encounters between harbour seals and the Shetland Tidal Array turbines was extremely small, and far lower than those predicted by CRMs based on broader scale harbour seal density estimates (Smith *et al.*, 2020).

The Miguez *et al.* (2025) ‘Underwater acoustic characterisation and modelling of a tidal stream array’ presents the results of an assessment of the underwater acoustic footprint of the six turbines within the Shetland Tidal Array. Field measurements were collected using a buoyed hydrophone system tethered to a drifting support workboat. Measurements were collected during various tidal states and were categorised into four zones around each turbine during sequential and multiple turbine deactivations. Acoustic models were developed to represent the noise generated by the three direct-drive and three geared turbines against recorded sound pressure levels (SPLs).

The median broadband sound levels recorded close to turbines operating a full power ranged from 118 to 131 dB re 1 µPa dB (SPLrms) (Miguez *et al.*, 2025). The modelled sound field for the Shetland Tidal Array showed a 0.03 km^2 area around the centre of the array within which the Level B harassment (disturbance) threshold for continuous sound

(120 dB re 1 μPa SPLrms) is exceeded, extending to a distance of 150 m from the centre of the array at its furthest extent (Miguez *et al.*, 2025). The findings of the study indicated that the Shetland Tidal Array generated an SPL that can be detected by marine mammals at some distance from the turbines and may serve as a deterrent for animals, therefore reducing the potential for collision, whilst not being so high as to introduce a source of temporary or permanent acoustic injury to marine mammals (Miguez *et al.*, 2025).

Continuous subsea video monitoring[30] of wildlife interactions with turbines has been attempted at the Shetland Tidal Array since 2016 using turbine-mounted cameras directed towards the rotor-swept area. There have been issues with biofouling which have meant that the cameras have not been usable in recent months. Key findings to date are that no collision or near-misses have been observed across any of the analysed video footage. Thirteen harbour seal observations have been recorded in video footage to date, all of which occurred during shutdown periods when the turbines were not operating. Despite the conclusions of this monitoring campaign, the risk of collisions having occurred cannot be completely discounted owing to limitations in methodology (i.e., all subsea video monitoring was limited to daylight hours) and any limitations in video footage as a result of biofouling on cameras. Furthermore, only a subsample of the video has been analysed to date (around 25 % of the full dataset), and analysis of the data is still underway.

In summary, harbour seals appeared to avoid the array area when the turbines were present, possibly due to the acoustic signature of the turbines acting as a deterrent, and harbour seal underwater observations occurred during periods of low flow when the turbines were not rotating, noting that the location was selected to avoid high levels of harbour seal occurrence.

8.2.2 European Marine Energy Centre Fall of Warness

A Drifting Acoustic Recorder and Tracker (DART) survey was undertaken during April and July 2021 within the EMEC Fall of Warness test site when a Magellanes turbine was deployed, and at a reference site to the north of the test site in an area with similar current speeds and bathymetry but no devices present. The results of the survey demonstrated that under low wind conditions and a current drifting speed of between 2.5 to 3.5 m/s, the acoustic signal from tidal devices were detectable at frequencies between 10 to 100 Hz. Differences in median SPL of 20 to 30 dB above ambient noise conditions were recorded within the EMEC Fall of Warness test site compared to ambient noise conditions at the reference site.

A DART survey, completed during July and August 2021, was undertaken within the EMEC Fall of Warness test site when an Orbital Marine Power turbine was deployed, and at a reference site which was considered to represent baseline conditions. The result of the survey demonstrated that under low wind conditions and current drifting speeds between 2.5 to 3.5 m/s, an operational turbine (generating at 25% capacity) was clearly detectable at frequencies between 10 and 1000 Hz (with a difference in median SPL of 40 dB above ambient noise recorded at the reference site and within the EMEC Fall of Warness test site itself during periods of device shutdown).

Underwater video monitoring of the EMEC Fall of Warness test site (using six Vivotek colour cameras) observed environmental interactions between an operational turbine and marine mammals, fish and bird species within the test site. Strain gauges were also installed in the blades for collision detection. Of 44 reviewed sample clips, wildlife

[30] https://marine.gov.scot/node/23283

was observed within twelve clips, with no collision events recorded. However, image quality meant it was not possible to identify the type of animal observed (e.g., mammal, fish or bird). Possible animal receptors were observed marginally more frequently during periods of blade rotation than during static periods. All possible animal receptors were observed moving with (rather than against) the current. While accelerometers were installed in the blade tips to detect any abnormalities in blade speed that may arise in a collision event, it was concluded that the accelerometers lacked the required sensitivity to detect potential collisions. The volume of data and the high number of 'spikes' produced by the strain gauge result in difficulty distinguishing between spikes caused by potential animal collisions and surges in tidal turbulence.

In summary, acoustic monitoring of turbines at Fall of Warness have demonstrated the acoustic signature of two turbine models deployed there, indicating that these devices are likely to be audible to seals at some distance, potentially giving opportunity for avoidance behaviour. In addition, a range of monitoring technologies have been used to assess marine animal presence and monitor for collisions with blades. While the camera monitoring produced mixed results, monitoring of collisions using strain gauges/accelerometers was deemed not to be sufficiently sensitive to detect animal collisions.

8.2.3 MeyGen Tidal Array

The MeyGen tidal array (as deployed) comprises four 1.5 MW turbines located within the Inner Sound of the Pentland Firth.

In 2011, MeyGen presented findings from a series of pre-consent boat and land-based surveys within the Inner Sound and wider Pentland Firth and Orkney waters. The densities of marine mammals within the vicinity of the MeyGen tidal array were generated using the DISTANCE software from boat-based surveys and were tabulated for land-based surveys. Acoustic surveys were also undertaken which were considered relevant to the assessment of harbour sea density within the MeyGen tidal array. Throughout the two-year survey campaign the number of harbour seal sightings was very low (particularly when compared to observed densities of grey seals).

Onoufriou *et al.* (2021) published a study on the effects of an operational tidal turbine array on the distribution of harbour seals in the Inner Sound. The study assessed the distribution of harbour seals through the tagging of 14 harbour seals in 2011 and 2012 and 40 harbour seals in 2016, 2017 and 2018. The study concluded a significant reduction in harbour seal abundance (ca. 27%) at the 1-2 km scale during the period when the turbine array was operational.

In 2025, research was published from the May 2022- June 2023 multibeam sonar monitoring campaign of a single operational turbine within MeyGen tidal array (Montabaranom *et al.*, 2025). The research, which utilised the methodology described by Gillespie *et al.* (2022), comprised two high-frequency multibeam active sonar to track animals in three dimensions within a swath approx. 50 x 50 x 30 metres. The campaign observed 704 seal encounters at the mesoscale (10s of metres) from the operational turbine, with the number of seal encounters quantified and the likelihood of seal presence over an annual cycle estimated. The result of the monitoring campaign demonstrated that the probability of seal presence within close range of an operational turbine was higher during periods of slack water, at night and during the winter months (mean of approximately three seals per day), although the sonars could not differentiate between harbour and grey seals. Modelled seal densities predicted a decrease in seal density during periods of turbine operation in flow speeds of ≥2.3 ms−1 (mean reduction of 77% at the highest flow speed), meaning that when the rotors were rotating fastest in the highest flow velocities, the presence of seals was significantly reduced.

Furthermore, although the Montabaranom *et al.* (2025) study did not attempt to quantify collisions or near-misses, the authors have advised that the occurrence of seals within 2 m of the rotor was significantly lower than in the wider swath, and there was no clear evidence that any collisions had occurred (SMRU, pers. comm.).

In summary, the MeyGen site was shown to have a generally low density of harbour seals prior to construction, although there are some local haul-outs around the north Caithness coast. Harbour seal telemetry prior to and post-construction of MeyGen Phase 1a (four turbines) has demonstrated a reduction in seal presence within 1-2 km of the turbines during the operational period, and variability with tidal state. Recent monitoring of one of the turbines using active sonar showed that seals demonstrate reduced presence in the vicinity of the turbine during the highest flow velocities, and although seals were detected in the sonar swath on average almost three times per day, this encompassed both seal species as the sonar is not able to distinguish harbour seals from grey seals.

8.2.4 Summary of monitoring at operational Scottish tidal developments

Several studies have helped to build the evidence base with respect to harbour seal ecology and behaviour around tidal energy developments. Although the data reported by these studies cannot prove that zero collisions have occurred, nor can they provide a definitive value for an avoidance rate, there is no evidence that collisions between harbour seals (or any other marine animal) and tidal turbines have occurred based on the monitoring undertaken by Nova, EMEC and MeyGen thus far.

.

8.3 Other scientific contributions

8.3.1 Harbour seals avoid tidal turbine noise (Hastie *et al.*, 2017)

Hastie *et al.* (2017) measured the behavioural response of harbour seals in response to simulated acoustic playbacks of an operational tidal turbine within a narrow coastal channel characterised by strong tidal currents (Kyle Rhea, Wester Ross, Scotland). The study used data from animal-borne GPS tags and shore-based observations which were analysed to determine the behavioural response of harbour seals to the simulated tidal turbine sound. The acoustic signal of the simulated tidal turbine was based on recordings of a 1.2 MW tidal energy convertor (SeaGen, Strangford Lough, Northern Ireland) with a broadband source sound pressure level (SPLRMS) of 175 dB re 1 µPa @ 1 metre, which was considered to reflect the estimated source sound level of a real tidal turbine (Hastie *et al.*, 2017). Each acoustic playback consisted of a 12-hr period within which 6 hr of turbine sound was played, with 6 hr where no sound was played. While results showed that the playback state of the simulated tidal turbine was not a significant predictor of the overall number of seals observed within the coastal channel, tagged harbour seals exhibited significant spatial avoidance of the simulated sound (a reduction in usage of between 11-41% at the playback location; Hastie *et al.*, 2017). Results also demonstrated that a reduction in harbour seal usage of between 1-9% was observed up to 500 m from the playback location.

8.3.2 Harbour seal severe trauma from collision with tidal turbine blades (Onoufriou *et al.*, 2019)

Onoufriou *et al.* (2019) attempted to determine the pathological consequences of direct collisions with tidal turbines, using seal carcasses and physical models to quantify severe trauma at a range of impact speeds. A dose-response model was developed (with associated uncertainty) to determine an impact speed threshold which may result in severe trauma to seals for use in future collision risk models. Pathological indicators of seal mortality were only predicted to occur at collision speeds greater than 5.1 m/s, which varied with the body condition of the seal (i.e., increased blubber depth reduced the likelihood of severe trauma to the seal) (Onoufriou *et al.*, 2019). This suggests that a collision with a blade moving at a velocity of <5.1 m/s may not be fatal or cause serious injury. This highlights one limitation of the ERM/CRM approach which does not attempt to model the collision velocity, either due to the rotational speed (RPM) of the turbine nor as a function of where the seal collides with the blade (i.e. close to the hub, where the velocity is slower, or at the blade tip where the velocity is greatest).

8.3.3 Observation of injured seals and carcasses

While no observed collisions between marine mammals and the four operational tidal energy developments in Scottish waters (Shetland Tidal Array, EMEC Fall of Warness, MeyGen Phase 1a) have been recorded, modelling indicates that the potential for such collisions exists.

The Scottish Marine Animal Strandings Scheme (SMASS) is responsible for recording and reporting marine megafauna strandings in Scotland. SMASS facilitates public reporting and manages a network of trained volunteers who collect photographic evidence, biometric data, and biological samples from stranded animals. Samples from a subset of cases are also recovered for diagnostic necropsy by veterinary pathologists.

Over the past 18 years of tidal energy development in the PFOW region, SMASS has found no conclusive or circumstantial evidence linking marine mammal strandings (<20 km from a tidal array) to collisions with tidal turbines. However, the absence of evidence does not confirm the absence of such events. Factors such as limited survey coverage, challenging beach access, and the likelihood of negatively buoyant carcasses failing to reach shore reduce the probability of detecting collision-related mortalities via strandings data.

Furthermore, none of the seals handled by Caithness Seal Rehab & Release showed injuries that are thought to be consistent with collision with tidal turbine rotors, although it is unknown what sort of injuries may be sustained in a collision, and whether these injuries would be superficially visible. Seals with visible injuries are recovered for rehabilitation, and these injuries may plausibly originate from a number of causes, including killer whale attacks, grey seal attacks, or anthropogenic causes (e.g. entanglement in nets) or even collision injuries that occur naturally (e.g. impact with rocks during a storm). Although this rehabilitation centre does not believe they have observed any injuries due to turbine collisions, this cannot be fully discounted.

In summary, this lack of evidence from data on both stranded carcasses and injured seals recovered for rehabilitation provides additional context, supporting the low rates of collision inferred from field studies and estimates of behavioural avoidance.

8.3.4 Summary of Relevant Sections of OES-Environmental State of the Science Report 2024

The OES-Environmental 2024 State of the Science Report (Garavelli *et al.*, 2024) provides an international overview of the current understanding of the environmental effects associated with marine renewable energy (MRE) around the world. This report builds upon the foundations laid by previous reports in 2016 and 2020, particularly focusing on the risk of collision posed by tidal turbines to various marine organisms, including seals.

Field studies to date have not recorded any instances of direct contact between marine mammals and tidal turbines. The sensory capabilities of these animals suggest that collisions are likely to be rare (Onoufriou *et al.*, 2021). Numerical models are extensively used to assess collision risks, driven by the necessity to estimate the probabilities of encounters or collisions to inform regulatory decisions during the consenting process and for post-construction monitoring and management. These models factor in variables such as the size and location of the device, environmental conditions, and the animal's ecology and behaviour.

The risk of collision for seals, as reported by Garavelli *et al.* (2024), depends on the design and operation of the turbine, environmental factors, and the behavioural patterns of seals at the turbine's location. The report highlights the need for realistic parameterisation of seal behaviour in models for both bladed turbines and tidal kites.

Copping *et al.* (2023) developed a conceptual framework to quantify the collision process, organising device, environmental, and receptor data to assess the likelihood of collisions through a "bullseye" approach. This methodology involves concentric circles of probabilities, with the worst-case scenario (serious injury or death) as the central circle. If any step in the framework has a near-zero probability, the overall risk is also near zero. This framework can pinpoint higher-risk steps, allowing for targeted mitigation efforts. However, full quantitative application of the framework is limited by current knowledge, as several steps are project and species-specific.

Garavelli *et al.* (2024) also note that numerical models' outputs are highly dependent on assumptions about animal behaviour, such as their ability to detect or avoid turbines and the potential consequences of collisions. Despite extensive monitoring at several sites over the last decade, there have been no recorded instances of marine mammals or diving seabirds coming into direct contact with turbine blades. The technical difficulties of observing marine animals near turbines make it challenging to estimate collision risk accurately.

An increase in monitoring data from single devices and small arrays (ORJIP Ocean Energy, 2022; Smith, 2021) is a step toward better understanding collision risks. Long-term continuous monitoring by video or acoustic telemetry can significantly contribute to this understanding, although the low number of deployments and the rarity of encounters will continue to pose challenges.

In conclusion, Garavelli *et al.* (2024) suggest that while the likelihood of collision events appears very low, the potential consequences for the animals and their populations remain uncertain. To address these uncertainties, the MRE community should focus on high-priority research needs:

- Provide sustainable funding support for targeted research and dissemination of the results;

- Encourage developers through incentives to provide access to their turbines for monitoring and make public their non-proprietary datasets and metadata on device monitoring studies.

8.3.5 Conclusions

Monitoring of potential interactions between harbour seals and tidal turbines has been ongoing throughout the UK for over 15 years. Across *in situ* and desk-based modelling assessments, results demonstrate that harbour seal distribution and behaviour changes in the presence of operational tidal turbines (including avoidance behaviour and a reduced presence within tidal channels during high flows). While there was no evidence of collisions between harbour seals and tidal turbines within any of the studies presented above, it cannot be definitively concluded that no collisions have occurred historically or will not occur in the future. However, as a minimum, results to date indicate that collisions are rare events; and the general patterns of behaviour indicate that seals demonstrate avoidance of operational turbines at both the kilometre- and tens-of-metres scale. While it is unclear how seals perceive these devices and know to avoid them, it is likely that the acoustic signal produced by the turbine is audible to seals and may act as a warning. It has also been demonstrated that seal collisions with tidal turbine devices are unlikely to be fatal at velocities <5.1 m/s, which highlights a level of inherent precaution in collision risk modelling approaches which do not attempt to distinguish between serious and benign collisions. As all the work to date has been based on monitoring at single turbines or small arrays, there is also uncertainty of how this risk will change as much larger arrays are deployed.

It is important to acknowledge that while existing, new and emerging novel monitoring technologies show good promise, their long-term functionality and efficacy have, we believe, not yet been fully demonstrated. Further testing and validation will be necessary to ensure they perform reliably over time and under varying operational conditions. Additionally, there is still a considerable level of uncertainty regarding the financial feasibility of scaling monitoring technologies for use across array-scale tidal stream turbine deployments. The integration of these technological solutions at an array scale presents significant challenges, not only in terms of technical viability but also in terms of cost-effectiveness. It will be essential to carefully assess these factors to ensure that the benefits outweigh the potential risk and investment.

9 POTENTIAL ROUTES FORWARD FOR THE TIDAL ENERGY INDUSTRY

The tidal energy industry is poised to make a significantly increased contribution to UK and Scottish energy security, and to mitigation of the climate change crisis. Several commercial utility-scale projects are in active development, taking advantage of the proven technologies and practical expertise that have been developed in Scotland. The key development areas are in the Pentland Firth and Orkney Waters, where opportunity is recognised for growth of the industry, supported by the European Marine Energy Centre test facilities.

Development cannot take place without resolution of the relevant environmental issues, and the granting of various consents and licences, for example under s36 of the Electricity Act for a generating station, and Marine Licences to undertake activities to develop a tidal energy site including pre-production works on the seabed etc. The key environmental issue presenting the single greatest challenge in consenting processes for tidal projects in the PFOW region is the potential interactions (collisions) between rotating tidal turbines and harbour seals. Harbour seal populations at the Sanday SAC in Orkney have declined dramatically in recent decades, as has the wider population in the waters of Orkney and the North Coast. In neither case is there any evidence that the declines are related to the tidal energy industry. Indeed, there have been no reported examples of collisions between harbour seals and tidal turbines, despite monitoring of turbines at sites in Scotland and elsewhere, and the activity of the Scottish Marine Animal Stranding Scheme (SMASS) monitoring carcases stranded on the foreshore of Scotland.

In order to estimate the potential effect of collisions on the vulnerable populations, it is necessary to quantify the risk presented by tidal turbines, either individually e.g. at a test site) or as a group/array of turbines (e.g. MeyGen in the Pentland Firth, or Fall of Warness and Westray Tidal Array in Orkney). The risk is quantified as a potential number of collisions (per year). Detailed guidance on reaching this quantification is provided by NatureScot (2016) as a spreadsheet with extensive explanatory notes. The regulatory system expects that applicants will use the NatureScot guidance when making their applications. The spreadsheet contains some flexibility for configuration to reflect conditions at specific development sites (e.g. in seal density), but rather less flexibility in aspects of seal behaviour (e.g. dive frequency, dive profile, times at depth, etc) including speed and angle of approach to rotating turbines. Specific note is made of the application of a range of avoidance rates from 0 – 99% which describe the ability of seals to avoid/evade turbines with which they might otherwise collide. Historically, NatureScot has adopted an avoidance rate of 98% when making their recommendations to the regulator, although they currently recommend presenting modelled collision risk against a range of avoidance rates.

The standard application of the NatureScot models of collision risk to the known development ambitions for tidal energy in PFOW area clearly indicates that the predicted numbers of encounters/collisions will be greater than that which might be immediately acceptable to the regulator and their advisers. The condition of the harbour seal population at the SAC in Sanday is assessed as "unfavourable, declining" and therefore has very limited capacity to absorb impacts. The population in the wider North Coast and Orkney Seal Management Area is also declining, and a Potential Biological Removal (PBR) of 8 animals per year is currently applied.

The potential for interactions between harbour seals and tidal turbines is a critical factor for the future development of the industry. The "standard" risk assessment and consenting methods as currently applied will seriously constrain the growth of the industry. If the industry is to move forward, alternative approaches need to be considered.

9.1 Adaptive management and the Survey, Deploy and Monitor policy approach

Adaptive management is a structured, iterative process of decision making in the face of uncertainty, with an aim to use monitoring results to reduce uncertainty over time. Decision making progressively accrues information needed to improve future management and long-term management outcomes. A key challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge.

Key features of adaptive management include iterative decision-making (evaluating results and adjusting actions on the basis of what has been learned), and recognition of the need to engage with uncertainty and risk in development of management actions. However, adaptive management systems can be vulnerable to various process failures related to information feedback which can prevent effective adaptive management decision making. Monitoring may be incompletely executed, or data not analysed. Results may be inconclusive or not used in any subsequent decision-making.

In the context of tidal stream energy, an adaptive management approach known as the Survey, Deploy and Monitor (SDM) policy has been applied historically by the Scottish Government. The intention of the policy was to provide regulators, and developers, with an efficient risk-based approach for taking forward wave and tidal energy proposals. It distinguished between those proposed developments for which there were sufficient grounds to seek determination on a consent application based on a minimum of 1 year of wildlife survey effort and analysis to develop site characterisation pre-application, and those where a greater level of site characterisation was required. This provided an assurance that those developments that were larger in scale or in more environmentally sensitive areas were based upon an evidence-based understanding of the impacts of the devices and allow licensing and statutory advisors to base any licensing decisions on greater awareness and knowledge.

Developers were required to undertake assessments as part of the statutory licensing and consenting process, such as the provision of Environmental Impact Assessments and other procedures necessary for compliance with conservation legislation. The policy was based upon 3 main factors:

1. Environmental Sensitivity (of the proposed development location)
2. Scale of Development; and
3. Device (or Technology) Classification.

Importantly, consent for development would include monitoring conditions designed to provide the new information on environmental interactions that would be necessary for expanded or new developments.

In the context of tidal stream energy, the SDM policy, managed by Marine Scotland (now known as the Marine Directorate) was a success in that it recognised that the “standard” requirements for pre-development environmental monitoring placed a disproportionate burden on small developers, or developers wishing to undertake small demonstrator projects. The SDM policy reduced that burden and enabled some foundational projects to go ahead in carefully chosen locations where environmental sensitivity was considered to be relatively low.

The main difficulties with the SDM policy were encountered in the associated adaptive management framework. Regulators introduced conditions into Consents that required developments to be progressed in phases, with the progression from one phase to the next being dependent on the outcomes of monitoring of the previous phase. In some cases, the monitoring required was dependent on methods and equipment that did not exist or had not been field tested. While considerable academic efforts and funding were applied to the objectives and progress has been made, the condition introduced unmanageable uncertainties in the technological aspects of projects, and particularly in the unpredictability of the timing of requirements for development funding, and in the forecasting of revenues. The SDM policy has not been applied for some years.

The SDM policy when introduced was welcomed as a step forward for small scale deployments and was found to be a useful tool by regulators and advisors. It is currently considered unrealistic to apply SDM (or a close derivative) to the fully commercial scale developments now being planned for PFOW. Responsibility for the SDM policy has recently been relinquished by the Marine Directorate and it is our understanding has been transferred to NatureScot to be operated on a case-by-case basis. It is not clear how NatureScot will interpret or implement their new responsibility, or how it might be linked to other initiatives such as compensatory measures, or biodiversity enhancement.

9.2 Is the risk of collision a real risk?

Tidal turbines have now been operating for several years in PFOW, Shetland and other parts of the world (Garavelli et al, 2024). In some cases, there has been targeted monitoring of the turbine blades and their immediate surroundings using a variety of instruments including optical cameras, and acoustics (sonars). In no case has any clear evidence of a collision been found. For example, standard modelling at MeyGen predicted 6 collisions at the 4 turbines deployed per year, i.e. a total of 48 collisions during the 8 years of MeyGen Phase 1a. Intensive sonar monitoring at one of the MeyGen turbines over a period of 12 months provided no evidence of collisions. General foreshore monitoring of the Pentland Firth and surrounding area found no examples of seals with injuries that might be consistent with collision with tidal turbines rotors. None of the seals handled by the Caithness Seal Rehabilitation and Release showed injuries that they considered might be consistent with collision with tidal turbines rotors either.

The operation of a tidal turbine in Strangford Lough, Northern Ireland, by MCT (Marine Current Turbines) for a period of 8 years produced no evidence of collisions between the two rotors and seals. The primary observation was that seals tended to avoid the turbines (swim closer to the side of the channel) when the turbines were operating.

Garavelli *et al.* (2024) noted that nowhere have field studies to date recorded any instances of direct contact between marine mammals and tidal turbines. The sensory capabilities of these animals suggest that collisions are likely to be rare (Onoufriou *et al.*, 2021).

In the absence of any examples of collision between tidal turbines and marine mammals, including seals, obtained either through direct observation of turbines or of shoreline strandings, the risk appears to be much smaller than current modelling approaches suggest. Therefore, it could be argued that it is unreasonable to seek management of an unproven risk which appears to be grossly over-estimated by current “standard” assessment models.

9.3 Do the "standard" collision risk models reflect best current science and evidence?

Numerical models are extensively used to assess collision risks, driven by the perceived necessity to estimate the probabilities of encounters or collisions to inform regulatory decisions during the consenting process and for post-construction monitoring and management. The modelled risk of collision, as reported by Garavelli *et al*. (2024), depends on the design and operation of the turbine, environmental factors, and the behavioural patterns of seals at the turbine's location. Garavelli *et al*. (2024) also note that numerical models' outputs are highly dependent on assumptions about animal behaviour, such as their ability to detect or avoid turbines and the potential consequences of collisions. The report highlights the need for realistic parameterisation of seal behaviour in models of tidal turbines.

Guidelines for the use of "standard" models of collision risk for tidal turbines in Scotland were published by Scottish Natural Heritage (as was) in 2016. These NatureScot guidelines reflect knowledge at that time, and the need to have assessment tools for use in consenting and associated processes. The models need to be parameterised to suit specific locations, equipment, etc and generally there is provision within the mandated spreadsheet to accommodate details of the turbines being used (rotor diameter, blade shape, speed of rotation at full operation, surface and seabed clearance etc). Parameters related to location include water depth (which influences seal dive profiles and timing), and average current velocity (which governs speed of approach of seals to turbines).

However, a dominant factor in Collision Risk Modelling (CRM) is the Avoidance Rate (AR). As emphasised by Garavelli *et al*. (2024), the outputs from risk modelling are highly dependent on the assumptions made regarding the behaviour of seals in relation to tidal turbines. Specifically, the output is dominated by the assumed Avoidance Rate, which can be conceptualised as the probability that a seal which would otherwise pass into the plane of the rotors would be able to take action to avoid or evade the potential collision. The NatureScot spreadsheet covers AR values from 0% to 99%, with 98% typically being used in regulatory advice/decisions. The value of 98% was selected by expert opinion approximately 10 years ago and has been supported by NatureScot and the Sea Mammal Research Unit since that date.

The dominance of the AR in CRM for advisory/regulatory purposes has led to considerable research and monitoring effort being expended to attempt to refine the assumed value. Approaches have included research into the wider ecology of tidal stream areas, for example on the distribution of fish that act as prey for seals and other predators, studies of the variation of the distribution of seals over small distances, with tidal state etc, and direct observations of seals (and other large predators) in the close vicinity of turbine rotors using multibeam sonars, light cameras, passive acoustics etc.

These studies are producing new information that is relevant to site specific CRM, and which often cannot readily be accommodated in the standard NatureScot spreadsheet. However, there has been only limited progress towards the quantification of avoidance rates.

The concept of Avoidance Rate was originally established in relation to wind farms and birds in flight and was subsequently applied in relation to underwater turbines. There has been a large (and costly) research effort over the last 10 – 15 years to parameterise collision risk models for birds and windfarms, and debate continues in this area. It has proved very difficult to establish robust behavioural parameters for birds, despite the relative ease of their observation, the observable examples of collision, and the equally dominant role of the avoidance rate in assessments. A mechanistic approach to modelling of sea birds has therefore proved very difficult to achieve. It can be argued that such an approach for underwater collisions is an impossible research objective, given the difficulty of observation, the low numbers of interactions, and the apparent great rarity of collisions. Whilst collision risk modelling may continue to have a role to play within regulatory processes and environmental assessment, as a tool to inform impact assessment, it is essential that its limitations are properly accounted for in the overall conclusion. If regulatory decisions are taken primarily on consideration of collision risk modelling based on the NatureScot spreadsheet as currently formulated, that could lead to unreasonable decisions, with outcomes governed largely by the choice of avoidance rate. That is likely to result in overly precautionary conclusions.

9.4 Update to the "standard" collision risk assessment

As indicated above, scientific knowledge relevant to tidal energy projects has been improving over the years through efforts of project developers and others. For example, knowledge is available for some locations to refine the parameterisation of seal behaviour and distribution in areas where tidal turbines are located, or which are being put forward as development areas. The inclusion of best current scientific knowledge in risk assessments is appropriate and in keeping with the general approach taken advisors/regulators in consenting/licensing over the years.

It is therefore recommended that applicants develop, and present collision risk estimation models based upon the NatureScot spreadsheet that take account of current knowledge in parallel to the outputs from the "standard" spreadsheet.

Furthermore, it is recommended that the NatureScot (2016) collision risk guidance is reviewed in the light of experience and new evidence, and that the review should also consider opportunities for the application of alternative risk assessment tools.

9.5 Probabilistic risk of collision

Copping *et al.* (2023) developed a conceptual framework (see Section 7.4.4 above) to quantify the collision process, organising device, environmental, and receptor data to assess the likelihood of collisions through a probabilistic "bullseye" approach. This methodology involves concentric circles of probabilities, with the worst-case scenario (serious injury or death) as the final central circle. If any step in the framework has a near-zero probability, the overall risk is also near zero. This framework can pinpoint higher-risk steps, allowing for targeted mitigation efforts. Quantitative application of the framework requires some project and species-specific information.

For a marine animal to experience a mortal or fatal injury from collision with a tidal turbine, a series of sequential conditions must be met. This can be described in the form of a probabilistic model whereby each step has an associated probability of occurrence (Copping *et al.*, 2023). An animal must be present in the vicinity of a turbine (condition 1), at the depth of the rotor (condition 2). The turbine must be rotating during operational flow velocity (condition 3) and the animal must not be avoiding or evading the rotor (condition 4). The animal is not deflected due to flow conditions within the rotor disc (condition 5) and thus the animal must collide with a blade (condition 6) where the collision is sufficient to cause injury or mortality (condition 7). As each condition will have an associated probability of between 0-1, the likelihood of harm (injury or mortality) is the product of seven probabilities (Figure 9-1).

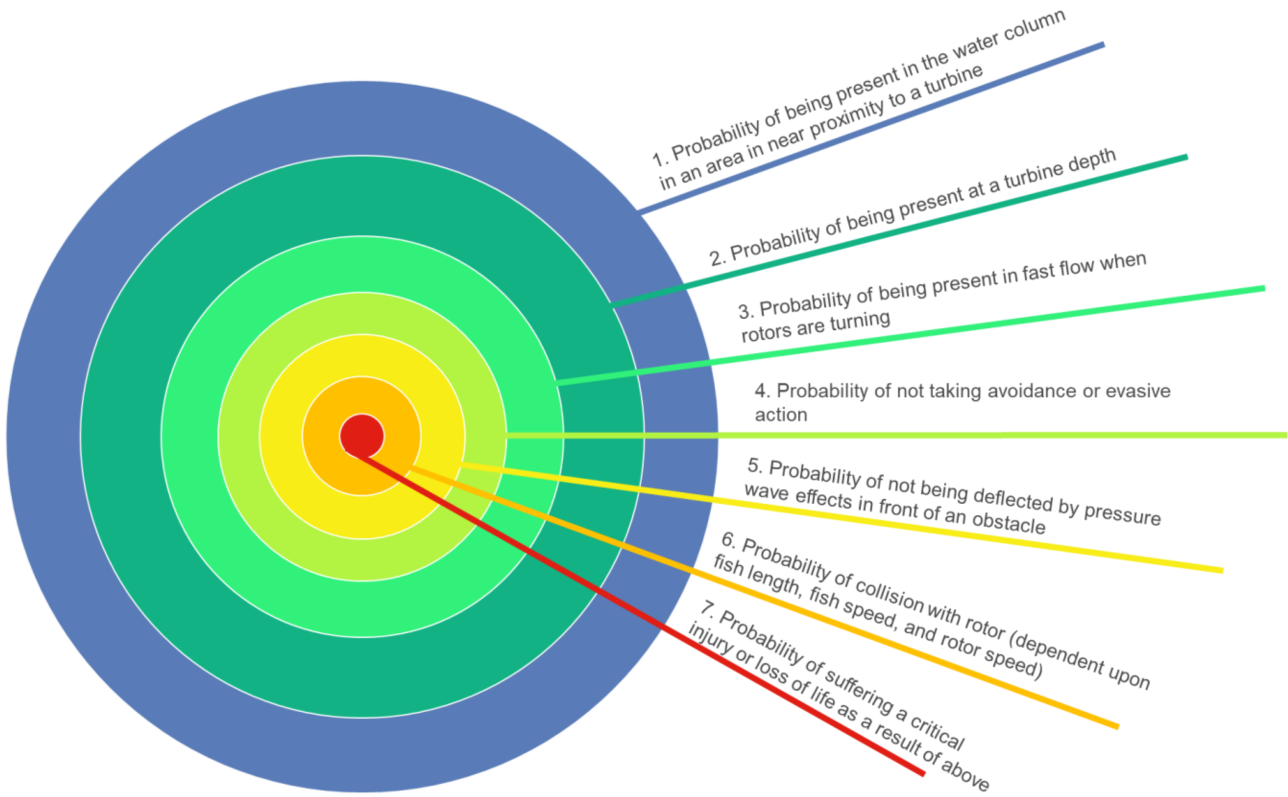


Figure 9-1 Conceptual probabilistic framework describing the likelihood of a collision between a marine animal and a tidal turbine. Recreated from Copping et al. (2023).

Even if the probability of every condition is as high as 0.9 (90%), the product of each probability combined results in an overall probability of 0.48. If any one of these probabilities is a very small number, then the overall probability decreases dramatically. This model (Copping *et al.* 2023) helps to illustrate that, even if seals commonly occurred within a short distance of a tidal turbine (condition 1), this does not necessarily mean that a collision is highly likely.

The Copping *et al.* (2023) probabilistic model can be considered in parallel to the ERM/CRM approaches recommended by NatureScot (NatureScot, 2016). In the spreadsheet based ERM and CRM tools that accompany the collision risk assessment guidance, input parameters include a density of animals at the site (representing condition 1), a density at risk depth (representing condition 2), and animal length, swim speed and rotor RPM (representing condition 6). In effect, the ERM/CRM assume that a collision will only occur if those conditions are met (i.e. conditions 1, 2 and 6 = 1.0). However, this leaves four of the conditions (3, 4, 5 and 7) poorly represented in the ERM/CRM framework. These are the probabilities of not being present when rotors are turning, not avoiding/evading the rotors, not being pushed aside by the rotor pressure wave, and incurring a critical injury by collision. Each of these conditions is likely to have a value <1.

This probabilistic approach brings together, in a structured way, a wide range of factors that are currently not well addressed in the “standard” NatureScot guidance and spreadsheets. It rationalises the observation that the outputs from the NatureScot spreadsheets are overly precautionary in that the predicted rates of interaction/collision have not been realised in the field.

Given that knowledge has progressed since the NatureScot guidance note on "Assessing collision risk between underwater turbines and marine wildlife (2016)" was published, tidal energy developer s36 Consent applications should include collision risk estimates based upon the NatureScot 2016 guidance and should also include alternative "developer" assessments based upon best current knowledge and using an appropriate risk assessment tool such as a derivative of the NatureScot 2016 spreadsheet, and/or a nested probabilistic approach (Copping, 2024).

9.6 Thresholds of impact on protected populations

The seal populations in PFOW have two fundamental forms of statutory protection. Firstly, the harbour seals that comprise the population the uses the coastal areas of Sanday as breeding grounds are protected through being a primary reason for the designation of Sanday as a Special Area of Conservation under the Habitats Regulations. Secondly, the wider population of harbour seals in the North Coast and Orkney Seal Management Area are protected from intentional or reckless killing under the MSA 2010.

9.6.1 Interactions with SAC populations

The Sanday SAC is the only SAC for harbour seals in the Pentland Firth and Orkney Waters area. The area has in the past supported large breeding populations, but these have declined in recent decades. The SAC population is assessed as being in unfavourable, declining[31] condition. Tidal energy development sites in the north of the current project area are sufficiently close to the Sanday SAC that a project EIA that identified potential interactions between turbines and seals from the SAC would conclude that there was a Likely Significant Effect on the population, and would trigger a formal HRA, and subsequent Appropriate Assessment. In that context, advisers are likely to conclude that there is the potential that adverse effects on site integrity cannot be ruled out and will advise regulators appropriately.

The Habitats Regulations include a provision whereby projects that are predicted to have Adverse Impact on Site Integrity can be approved in very limited circumstances. These circumstances are identified through a process that determines whether continuation of the project is necessary for Imperative Reasons of Over-riding Public Interest (IROPI) and potentially leads into the need for Compensatory Measures.

The legal advice in this project (0) indicates that, subject to the details of any single project, there can be some confidence in the ability of tidal stream projects to establish that there are IROPI for them to proceed. Indeed, MeyGen has been granted licences under the Habitats Regulations for the disturbance of EPS in the past on the grounds of IROPI.

Given that the consideration of collision risk (using the NatureScot 2016 guidance) in Appropriate Assessments for proposed tidal energy developments in Orkney Waters has the potential to indicate that Adverse Effect on Site Integrity cannot be excluded in relation to the Sanday SAC, applications for projects deemed to interact with the Sanday SAC should include cases for a derogation under the Habitats Regulations. Individual developers may choose

[31] https://sitelink.nature.scot/site/8372

to submit such a case on a "without prejudice" basis if the conclusions of the assessment supporting the application demonstrates that adverse effects on integrity can be ruled out, but there is considered potential for disagreement with NatureScot or other advisory bodies. Submitting a case at the outset reduces the likelihood of delay in determining the application.

9.6.2 Interactions with Seal Management Area populations

Seal Management Areas were established under the MSA 2010 to provide a structure for the management of seal populations, particularly in the context of licensing the shooting seals to protect fisheries and aquaculture. The latter purpose is no longer accepted, and the number of seals licences issued has declined to small numbers.

The safe level of anthropogenic mortality per Seal Management Area (SMA) is based on the Potential Biological Removal (PBR) method (Wade, 1998). PBR is a metric that estimates the maximum number of animals that can be removed from a population without adversely affecting its sustainability. Due to the declines observed in some Seal Management Areas, including North Coast and Orkney and other east coast areas, a highly precautionary approach is employed for harbour seals in these areas. On the other hand, harbour seal populations are increasing in the Western Isles and the west of Scotland. The net result is that the Scottish population is relatively stable. None of these changes are thought to be linked to the tidal energy industry, rather that they arise from natural processes, such as competition with grey seals, effects of biotoxins, migration of seals from one SMA to another, or predation by killer whales.

The PBR method was developed to manage anthropogenic impacts on discrete functional population units. However, assuming that individual Seal Management Areas are such discrete closed population units (and applying the PBR method) is somewhat contra-indicated by studies which have shown the harbour seal population of northern Scotland to be one metapopulation (Carroll *et al.*, 2020).

The significance of impact, when considered against PBR thresholds (i.e. assuming a closed population) reduces when the management population is larger, because the PBR threshold is (generally) higher when the reference population used in the PBR calculation (N_{min}) is larger. Population fluctuations in larger assessment units are less likely to vary as greatly as those in the smaller assessment units. Undertaking assessments based on the PBR estimate for the seven Scottish Seal Management Areas combined is one method of subdividing the national PBR in a more appropriate way for managing seals on a regional basis while retaining focus on the management of the Scottish population at Favourable Conservation Status. Using a Scotland-wide population/PBR limit would capture the changes (increases and decreases) in the harbour seal population at the Scotland scale (and PBR limit) whilst not requiring localised population changes (i.e. at the North Coast and Orkney level) to wholly constrain an industry that based upon available evidence to date, is not thought to be a major driver of local population changes. It is therefore suggested that tidal industry proposals should be assessed against a population impact threshold based upon the whole Scottish harbour seal population, rather than the small proportion now thought to be resident in PFOW.

Given that the harbour seal population of the North Coast and Orkney Seal Management Area does not meet the ecological criteria necessary the application of the PBR approach to management, all project applications for developments in PFOW should include an argument that the relevant PBR against which to assess the application is a PBR for harbour seals in a wider area than the North Coast and Orkney SMA, for example the entire Scottish harbour seal population.

9.6.3 Interactions with the Marine (Scotland) Act 2010

The MSA 2010 provides the statutory basis for the protection of seals in Scotland, including the establishment of Seal Management Areas and the management of populations through a system of Seal Licensing. The latter provides derogation for the otherwise illegal actions of intentionally or recklessly injuring or killing seals.

In the context of tidal energy projects in PFOW, those in the Pentland Firth are unlikely to require an HRA for potential impact on the Sanday SAC because of the distance to Sanday, but all projects would have to assess their effect on the wider seal population through the EIA process.

It is likely that projects that hold s36 Consent would not be at risk of prosecution under MSA 2010 should a turbine be shown to have injured a seal, as the injury is unlikely to be either intentional or reckless. However, projects seeking new or extended s36 Consents may be at risk of refusal if their predicted impact exceeds the PBR for the SMA (or wider grouping).

As in the Habitats Regulations, the seal conservation part of the MSA 2010 contains an IROPI clause under which a Seal Licence may be issued for imperative reasons of over-riding public interest. Such a licence might appear to give protection to a project operator whose EIA (e.g. through the NatureScot collision risk model) predicted an impact that would exceed the applicable PBR. However, the seal licensing provisions within MSA 2010 are ill suited to ongoing operational activity of a tidal stream generating station. This section of the Act is not well- targeted at this form of activity as being the intentional or reckless killing of seals and therefore does not provide a route to resolution of the harbour seal issue.

9.7 Strategic approach to seal conservation

As noted above, projects approved under the Habitats Regulations on the grounds that continuation of the project is necessary for Imperative Reasons of Over-riding Public Interest (IROPI), potentially lead into the need for Compensatory Measures to maintain the integrity of the network of European protected sites. Similarly, if the EIA process reveals impacts on seal populations (e.g. in the North Coast and Orkney seal management area, or more widely) that cannot be satisfactorily avoided or minimised, there may be a requirement for ecological enhancement (also known as compensation or offsetting) for the residual impact.

While developers would clearly hold their own consents/licences for their own developments, their interactions with the same protected populations of seals (e.g. the population linked to the Sanday SAC, or regional Seal Management Area populations) strongly suggests that a collaborative approach between developers could be advantageous to both the protected seals and the developers through the establishment of a coordinated programme of compensation measures. Projects granted seal licences under the IROPI provisions in the MSA 2010 do not carry such a direct requirement for Compensatory Measures, nor for maintenance of the coherence of the network of SACs.

The application of the NatureScot (2016) guidance to planned tidal energy developments in PFOW is likely to conclude there would be a significant impact (in EIA terms) on the harbour seal population of the North Coast and Orkney SMA or more widely. It may be necessary for developers to propose Compensatory Measures to support the wider conservation of seals, in addition to any requirement arising from interaction with the Sanday SAC population, as part of their application to make the development acceptable in planning terms.

Effective and deliverable Compensatory Measures will be an essential element of consenting if projects are considered to be necessary under IROPI, or potentially through planning regulations. However, the authors are not aware of any examples in Scotland where Compensatory Measures have been applied to harbour seals, or any guidance as to what could/should be included in such measures.

In the case of offshore wind development in Scottish waters, there has been a recognition that some impacts, notably on seabirds, cannot be satisfactorily mitigated through project design, e.g. location, turbine spacing, turbine design, etc. Wide-ranging species such as seabirds from coastal colonies are likely to interact with more than one windfarm, and therefore several projects may affect the same breeding colony (or colonies), many of which are protected as SPAs. The commonality of interest between projects (and linked assessments of cumulative or in-combination effects) has led to exploration of the potential for compensation measures to be applied at Sectoral Plan level, rather than at individual project level. There are clear parallels between the situation for wind farms and seabirds with that for tidal energy and seals. However, the continuing draft status of the Scottish Government Sectoral Plan for Tidal Energy [32],[33], and lack of current timetable to complete the Plan, suggests that a collaborative, regional approach to compensation measures for potential impacts will therefore need to be implemented by a different mechanism, which currently has not been established.

Considerable work has been undertaken on the opportunities for compensation measures for impacts on seabirds. These generally concentrate on measures designed to increase survival of adults, and to increase breeding productivity. Typically, proposed measures include improvement to breeding or foraging habitats, reducing disturbance or predation at breeding sites, managing other causes of additional mortality, or increasing the availability of prey species. In the case of harbour seals in PFOW, the situation needs to be considered in the context of regional declines in numbers, which have been occurring for some cover two decades. Ideally, compensatory measures would be directed at the processes that are causing the declines, but intensive research has currently been unable to identify a single dominant cause (section 7.2.7). Compensatory measures need to be targeted at the species of concern, effective, and practically deliverable. It is likely that an effective approach to compensation measures for seals will include several different approaches making incremental improvement, rather than concentrating on a single action. The NatureScot conservation objectives document for Sanday SAC [34] may provide some indications of the likely risks to seals that might be addressed through compensatory measures.

The design and evaluation of compensatory measures is outside the scope of the current project report. However, there is an urgent need for a feasibility study on compensatory measures for potential impacts from tidal energy developments on locally declining harbour seal populations, including measures that could be delivered collaboratively at a strategic level. This feasibility study should consider measures directly targeted at harbour seal conservation; measures to improve the wider environment, some of which will have consequential positive impacts for harbour seals; as well as research and monitoring to address knowledge gaps and improve the evidence base

[32] https://www.gov.scot/policies/marine-renewable-energy/wave-and-tidal-energy/

[34] https://www.nature.scot/sites/default/files/special-area-conservation/8372/conservation-and-management-advice.pdf

relating to the status of the harbour seal population in Scotland. This study should consider experience of seal conservation outside Scotland (for example, measures taken to conserve the Hawaiian monk seal *Monachus monachus*, Harting *et al.*, 2014), how these measures might apply in Scotland, and opportunities to build on current monitoring programmes to assist in the assessment of the consequences of compensatory measures.

9.8 Conclusions and recommendations

9.8.1 TISP recommendations

The significant potential of the tidal stream energy industry in Scotland, both economically and in contributing to climate change mitigation and energy security, was recently emphasised in a report commissioned by Scottish Enterprise (SE) and Wave Energy Scotland (WES) and published by the University of Edinburgh School and Engineering. However, the benefits will not be attained unless commercial-scale projects can gain the necessary consents and authorisations. Currently, projects in the key resource area of the Pentland Firth and Orkney Waters (PFOW) are severely constrained by risk assessments of the potential for protected harbour seals to suffer fatal collisions with rotating turbines with resulting impacts on populations.

All the tidal energy project developers engaged with TISP have plans for significant new or expanded projects in the PFOW area, to be installed within the next 5 – 10 years. It is essential that all stakeholders in the tidal stream industry consider the steps that can be taken to facilitate the sustainable expansion of the tidal stream industry, in support of Scottish Government and UK Government policy ambitions.

TISP consider that the following should be headline areas of focus:

a. There are roles for Scottish Government-led marine planning, and developer-led regional collaboration. It is a reasonable ambition that within the next five years a sectoral plan should be developed that will support the longer-term future of the industry. In the short term, tidal developers propose to continue the collaboration which has been crucial through producing this report, and convene a regional developer group, following a similar model to the offshore wind Regional Advisory Groups, to progress with collaborative regional assessment and post-consent monitoring plans.
b. The methodologies historically used for assessing collision risk impacts (e.g. the NatureScot (2016) spreadsheet) should be reviewed in light of the best scientific evidence now available. For the reasons set out in this report, it is considered that these historic methodologies result in overly precautionary unrealistic outcomes.
c. Exploratory work should be undertaken on future strategic monitoring and ecological enhancement/compensatory measures for potential impacts on harbour seal populations from tidal energy developments. This should take a collaborative approach and should consider compensation targeted at specific sites, and wider strategic measures of benefit to the Scottish harbour seal population as a whole.

In order to alleviate the consenting blockage and facilitate industry development while contributing to the conservation of harbour seal populations, the Tidal Industry Seal Project has prepared recommendations as follows (Table 10).

Table 10 TISP recommendations

Objective	Lead stakeholder	Recommendation	Sub-recommendations	Actions and timescale
Collaboration and engagement on next steps	All / Scottish Renewables	1. Roundtable Discussion to be arranged: Convene a roundtable with key stakeholders to discuss the report's outputs, during Q2 2025.	Outputs from this report are considered and_discussed at a roundtable discussion convened by Scottish Renewables to include representatives from the Scottish Government, Scottish Renewables, Crown Estate Scotland, Highlands and Islands Enterprise, NatureScot, the tidal stream energy industry and other interested parties The roundtable should seek to agree key next steps and facilitate a collaborative approach to resolving the issue involving all key stakeholders.	- Scottish Renewables to arrange roundtable to follow presentation at All Energy 2025 - Short term – suggestion to take place May 2025
	All / developer-led	2. Develop a roadmap to reduce risk: A high-level, collaborative, strategic plan for the industry, introducing the steps needed to enable further tidal stream energy development.	The tidal stream energy industry works with key stakeholders to develop a roadmap by which the industry can develop and achieve its ambitions while having due regard to the conservation of protected species and habitats.	- TISP to develop risk-register prior to roundtable discussion and finalise following that meeting. - Short term – suggestion to take place May/June 2025
	Tidal stream industry developers	3. Regional Advisory Group to be established: PFOW developers to form a group for	PFOW tidal stream developers convene along the lines of the Regional Advisory Group model (c.f. FTRAG, MFRAG), to progress with regional/strategic	- Short term – Tidal stream industry developers form group commencing Q3 2025

		regional/strategic environmental assessment and monitoring.	assessment and monitoring plans and to jointly address broader issues.	
	Tidal stream industry developers; (NatureScot to be engaged as key stakeholders)	4. **Collaborative cumulative effects assessment**: PFOW developers to conduct cumulative effects assessment in a collaborative way.	It is evident that the applications for consent currently in preparation will require alignment over their assessment of cumulative effects, particularly with respect to harbour seals. It is proposed that the collaborative approach promoted by TISP is the best way to achieving a realistic and aligned assessment of cumulative effects. A single cumulative assessment would be carried out, capitalising on the efficiencies presented by projects working together.	- Short term – Tidal stream industry developers to meet to discuss approach Q2 2025.
A fit-for-purpose policy and regulatory framework	Scottish Government	5. **Policy Review**: Scottish Government to review policy frameworks and regulatory processes to support tidal stream energy development.	The review should address both immediate and long-term needs, and in doing so to encourage the collaboration between government, tidal stream energy industry, stakeholders and interested parties which is crucial for the future of the sector. Specifically, the final draft of National Marine Plan 2 (NMP2) should clearly reflect government support for the tidal stream energy industry. These steps would support the continuation of the tidal	- Short/Medium Term – for final publication of NMP2

			stream energy industry's development in Scotland and help cement Scotland's position as a marine renewable energy leader.	
	Scottish Government; Crown Estate Scotland, Scottish Renewables	6. **Strategic Planning Resources**: Scottish Government to allocate resources for strategic planning of tidal stream energy.	The Scottish Government allocates sufficient resource to take forward strategic planning for tidal stream energy, either as a national-scale sectoral plan, or possibly as a regional-scale PFOW tidal stream energy plan, to support the long-term development of the industry.	- Medium Term. Scottish Renewables to recommend the inclusion of strategic planning for tidal energy in the next Scottish Programme for Government.
	Scottish Government; Tidal stream industry developers NatureScot	7. **Seal Management**: Review the management of seal populations and consider alternative approaches to assessment of significant effects.	The current approach to management of seal populations of Seal Management Areas through application of Potential Biological Removal is reviewed, taking account of the underlying assumptions regarding Seal Management Area populations as discrete functional population units, the genetic structure of the Scottish harbour seal population, and the opportunities for alternative management approaches that better reflect the ecology of the harbour seal in Scotland. This should consider the appropriate management population (e.g. the wider Scottish harbour seal population vs. the North Coast and Orkney Seal	- Short term – commencing with forthcoming environmental assessments for PFOW projects - Medium term – NatureScot and/or Marine Directorate commission a review of the management of Scottish seal populations to reflect the dominant natural processes affecting seal numbers, the negligible importance of seal shooting in recent years, and the relative significance of other anthropogenic pressures on seals.

			Management Area in isolation) and should also consider population viability analysis and impacted: unimpacted population counterfactuals to be presented as an alternative to/alongside PBR-based assessment.	
	Scottish Government; Tidal stream industry developers Scottish Renewables	8. **Evidence Gaps**: Review ScotMER evidence map prioritisation through tidal stream industry representation in expert groups to reflect industry research needs.	The tidal stream industry should seek to have effective representation on relevant ScotMER expert groups (e.g. Marine Mammals) to ensure that the prioritisation assigned to knowledge gaps reflects the research needs of the industry and supports its growth potential.	- Short term – ScotMER group representation should be established during 2025
Application of up-to-date methodologies and use of best available evidence in environmental assessment	NatureScot	9. **Collision Evidence and risk assessment tools**: Review and update NatureScot guidance on collision risk assessment based on current evidence.	Recommendation that nature conservation advisers undertake a review and update to the NatureScot (2016) guidance on "Assessing collision risk between underwater turbines and marine wildlife" to take account or best current experience and scientific understanding. This would include review of collision risk assessment methodologies in the light of new evidence and to include alternative risk assessment tools, such as approaches to collision risk modelling or risk assessment frameworks (e.g. Horne *et al.*,	- Medium term – instigate a review of the NatureScot (2016) guidance.

			2022; Copping *et al.*, 2023) which collectively might present a more accurate assessment.	
	Tidal stream industry developers; with support from Scottish Government / NatureScot	10. Expert opinion: Questions relating to tidal energy to be put to SCOS via regulator and advisers.	The PFOW tidal stream developers collaboratively, as a consortium, direct specific questions to the NERC Special Committee on Seals (SCOS) related to assessment of the risk that tidal turbines may present to harbour seals. These questions might be directed via NatureScot and/or Scottish Government.	- Short term – this could commence for SCOS 2025.
Proportionate and feasible monitoring	Scottish Government; NatureScot; Tidal stream industry developers	11. Review scope of future monitoring: Conduct testing and validation of new monitoring technologies; assess scalability and cost-effectiveness of these methods; continue collaboration to share insights and data.	Future monitoring should focus on understanding the risk to harbour seals presented by arrays of devices rather than at individual device scale. This should include consideration of scalability, long-term efficacy and cost-effectiveness of monitoring technologies under a range of operational conditions. All parties, including stakeholders, regulators, advisers and developers, involved in the tidal stream industry should continue to collaborate to share insights and data on monitoring technologies and should investigate the most effective mechanism for doing this, e.g. provision of data to the Marine Data Exchange.	- Short term – consideration will be needed in conjunction with forthcoming environmental assessments for tidal energy projects in PFOW.

	Scottish Government; NatureScot; Crown Estate Scotland; Tidal stream industry developers	12. **Strategic monitoring and research**: Collaborative planning of strategic monitoring and research.	The Scottish Government, NatureScot and industry work together to consider the role of future monitoring that may be required at a strategic (regional) level to provide a path to future development. Conduct thorough financial feasibility analysis to assess the scalability of the monitoring technologies. This will help determine the cost-effectiveness of the deployment of monitoring systems across an entire array. This should also consider mechanisms to fund technological development. The tidal stream industry in PFOW, together with government, advisers and technical experts (e.g. SMRU) should consider the feasibility of a regional monitoring approach.	- Short/medium term - consideration will be needed in conjunction with forthcoming environmental assessments for PFOW projects, but there may be aspects of strategic monitoring which require longer-term planning and funding.
Ecological enhancement and compensation	Tidal stream industry developers; NatureScot	13. **Ecological enhancement and compensatory measures**: Conduct feasibility study on ecological enhancement and compensatory	TISP considers that ecological enhancement measures to ameliorate adverse effects on the harbour seal population may be appropriate. Such measures may be required to compensate for adverse effects on a	- Short term – TISP to initiate high-level review of ecological enhancement/ compensatory measures relevant to harbour seals, Q2 2025 - Workshop required once this scoping of potential

		measures for harbour seal impacts.	European site, or to restore or offset significant effects arising in EIA terms. Compensation or enhancement at a strategic (plan) level is likely preferable and more effective than single-project efforts.	enhancement/compensation is complete to discuss practical feasibility with NatureScot and Scottish Government

Consent applications for forthcoming new or expanded tidal stream energy projects in the PFOW should consider the following specific recommendations (Table 11).

Table 11 Project-level recommendations

Objective	Recommendations	Sub-recommendations
Project-level assessments and consent applications	14. Consent Applications: Include collision risk estimates and alternative assessments in Section 36 applications.	Section 36 Consent applications should include collision risk estimates based upon the NatureScot (2016) guidance and, where site-specific information is available, should consider whether to also include alternative "developer" assessments based upon best current knowledge and using an appropriate risk assessment tool such as a derivative of the NatureScot (2016) spreadsheet, and/or a nested probabilistic approach (Copping *et al.*, 2024). Where relevant this should also consider alternatives to the PBR approach, for example, the use of population viability analysis and counterfactuals to describe predicted levels of impact.
	15. Derogation Cases: Include derogation cases in applications interacting with Sanday SAC.	Applications for projects deemed to interact with the Sanday SAC should consider the inclusion of either a derogation case, or a 'without prejudice' derogation case, as part of the information to inform the Habitats Regulations Appraisal within their application.

	16. **PBR Assessment:** Consider the most appropriate assessment unit (population) for PBR assessment, e.g. the wider Scottish harbour seal population.	All project applications for developments in PFOW should undertake assessments against the regional (North Coast and Orkney SMA) and wider Scottish harbour seal population, if considered relevant.
	17. **Planning Acceptability:** Consider compensatory measures for planning acceptability of developments.	Given that application of the NatureScot (2016) guidance to planned tidal energy developments in PFOW is likely to conclude there would be a significant impact in EIA terms on the harbour seal population of the North Coast and Orkney SMA, all applications for tidal energy developments in PFOW should consider whether ecological enhancement, or compensatory measures, are required to make the development acceptable in planning terms. This ties to recommendations 12 and 13, above, requiring a collaborative approach, likely with NatureScot and possibly with Marine Directorate. This may be one element considered within a regional advisory group (recommendation 9).

10 LEGAL REVIEW

As outlined in more detail elsewhere in this report, there is an opportunity for the tidal industry to expand the scope of existing operations, as well as implement new tidal projects in the coming years. As part of the consent applications for any expansion of tidal Stream Energy projects, the relevant regulators will need to consider the potential effects of developments on the environment. One key factor considered within that assessment is the potential impact of tidal stream projects on seals, including through collision risk.

Annex 1 of this note contains a legal advice note prepared by Burges Salmon LLP that considers, at a high level, the legal framework for consenting of tidal stream projects in Scotland, with a particular focus on (i) the role of collision risk modelling in the consent system, and (ii) the undertaking of environmental compensation and its relevance in the overall legal and policy context. The advice note is intended to provide an overview of the legal framework within which the other chapters of this Report can be considered and applied.

Section 2 of the advice note considers the legal framework for decision-making framework for a number of legal regimes that will apply to future applications for consent to construct expanded or new tidal stream projects in Scottish waters. Key conclusions of that section are:

Collision risk modelling does not have a special legal status under the EIA Regulations, or the Habitats Regulations.

Under current guidance, collision risk modelling will be a relevant factor in determining the predicated environmental impacts of a project. Those identified impacts and would therefore be a relevant consideration for the Scottish Ministers in determining an application under the Electricity Act 1989.

Collision risk modelling will be considered as part of an assessment under the Habitat Regulations, where the project (either alone or in combination with other plans/projects) has the potential to have a likely significant impact on a site in the national site network where seals are one of the conservation features of the site. The collision risk modelling will be part of the overall ecological assessment that determines whether or not an adverse effect on site integrity can be ruled out.

A Habitats Regulations Assessment needs to be undertaken with regard to the best available scientific evidence to reach a conclusion of whether an adverse effect on integrity can be ruled out "beyond reasonable scientific doubt". This is a matter of judgement for the decision maker, and the Courts have held that it does not require a standard of absolute certainty.

Section 3 of the advice note considers at a high level the extent to which proposals for the expansion of tidal energy generation in the Orkney and Pentland Firth align with national and regional planning policies and guidance, as this will be a key factor in the planning balance when determining if future applications should be granted. This notes that there is in-principal support for such development, but this will need to be balanced against the potential adverse effects on the environment.

Section 4 considers the application of certain methodologies within an environmental assessment context. Key conclusions in this chapter are:

Through ongoing monitoring of tidal stream energy projects there is a considerably greater evidence base on the likelihood of impacts than there was when the initial round of consents were obtained and when the relevant SNCB guidance referred to above was published. That is relevant to the proper application of the precautionary principle, which should take account of any updated evidence and certainty as it becomes available. Once a sufficient evidence base is built, then it may justify a change in prevailing guidance to reflect the new evidence available. Even before that point, up to date ecological evidence can provide important context when deciding what level of precaution ought to be applied and deciding preferred methodologies or thresholds. This is particularly the case where applying a degree of precaution to every aspect of an assessment can result in an unrealistic and overly conservative conclusion.

Guidance and methodologies can change over time, and any one methodology does not have a specific status within the legal regimes. The advice of statutory consultation bodies will need to be afforded considerable weight in decision making, with clear and cogent reasons given if their advice is not to be followed.

Section 5 considers the possibility of obtaining consent for tidal stream energy on the basis of a 'derogation', with a focus on the requirements of the Habitats Regulations. This section of the advice note sets out some factors that tidal steam developers may consider in formulating a derogation case on the basis that there are imperative reasons of overriding public interest for a tidal stream project to proceed, notwithstanding its impact on designated sites. A key recommendation following this advice is that applications for projects deemed to interact with the Sanday SAC should strongly consider submitting either a derogation case, or a 'without prejudice' derogation case under the Habitats Regulations as part of their application.

Section 6 of the advice note considers the legal and policy requirements to provide environmental compensation as part of either the EIA or HRA regimes, and how this might be applied by tidal stream developers. This section also considers the potential for developers to deliver compensatory measures on a strategic or collaborative basis. The differences between the compensatory duty under the EIA and HRA regimes is noted. A key conclusion of this section is that it would not be necessary to have legislative change to facilitate delivery of compensatory measures by tidal stream projects at a strategic level, or on a collaborative basis. However, having a clear legal mechanism available would be beneficial. Recognising that legislative change of that nature will take time, this section recommends that tidal stream developers, along with stakeholders such as NatureScot, the Marine Directorate and the Crown Estate consider the ecological and practical merits of any strategic compensation within the context of the existing legal and policy framework.

11 REFERENCES

Arso Civil, M., Smout, S., Duck, C., Morris, C., Cummings, C., Langley, I., Law, A., Morton, C., Brownlow, A., Davison, N. and Doeschate, M. (2018). Harbour seal decline-vital rates and drivers. Report to Scottish Government HSD2. Sea Mammal Research Unit, University of St Andrews. Available online at: https://www.smru.st-andrews.ac.uk/files/2018/07/HSD-2-annual-rep-yr3-V3-Final.pdf

Arso Civil, M., Langley, I., Law, A., Hague, E., Jacobson, E., Thomas, L., Smout, S.C., Hewitt, R., Duck, C., Morris, C., Brownlow, A., Davison, N., Doeschate, M., McConnell, B., and Hall, A.J. (2019). Harbour Seal Decline HSD2 Annual Report Harbour seal decline – vital rates and drivers. Available online at: https://www.smru.st-andrews.ac.uk/files/2020/02/HSD2-yr4_annual-rep_web.pdf

Band, B. (2000). Windfarms and birds: calculating a theoretical collision risk assuming no avoiding action. Scottish Natural Heritage Guidance Note.

Band, B. (2012). Using a collision risk model to assess bird collision risks for offshore windfarms. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. SOSS Website. www.bto.org/science/wetland-and marine/soss/projects

Band, B, C Sparling, D Thompson, J Onoufriou, E San Martin and N West (2016). Refining estimates of collision risk for harbour seals and tidal turbines. Scottish Marine and Freshwater Science Vol 7 No 17, 123pp. DOI: 10.7489/1786-1

Brownlow, A., Onoufriou, J., Bishop, A., Davison, N., Thompson, D. (2016). Corkscrew Seals: Grey Seal (Halichoerus grypus) Infanticide and Cannibalism May Indicate the Cause of Spiral Lacerations in Seals. Available online at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0156464

Carroll, E., Hall, A., Olsen, M., Onoufriou, A., Gaggiotti, O., Russel, D. (2020). Perturbation drives changing metapopulation dynamics in a top marine predator. Available online at: https://royalsocietypublishing.org/doi/pdf/10.1098/rspb.2020.0318

Carter, M., Boehme, L., Cronin, M., Duck, C., Grecian, W., *et al.* (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. Frontiers in Marine Science. 20. Available online at: https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2022.875869/full

Carter, M. I. D, Bivins, M., Duck, C. D., Hastie, G. D., Morris, C. D., Moss, S. E. W., Thompson, D., Thompson, P. M., Vincent, C., Russell, D. J. F. (2025). Updated habitat-based at-sea distribution maps for harbour and grey seals in Scotland. Sea Mammal Research Unit, University of St Andrews, Commissioned Report to Scottish Government.

Copping, A., Hasselman, D., Bangley, C., Culina, J., Carcas, M. (2023). A Probabilistic Methodology for Determining Collision Risk of Marine Animals with Tidal Energy Turbines. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Copping_et_al_2023.pdf

Coles, D., Angeloudis, A., Greaves, D., Hastie, G., Lewis, M., Mackie, L., McNaughton, J., Miles, J., Neill, S., Piggott, M., Risch, D., Scott, B., Sparling, C., Stallard, T., Thies, P., Walker, S., White, D., Willden, R., & Williamson, B. (2021). A review of the UK and British Channel Islands practical tidal stream energy resource. Proceedings of the Royal Society a Mathematical Physical and Engineering Sciences, 477(2255). https://doi.org/10.1098/rspa.2021.0469

Cordes, L.S. and Thompson, P.M. (2015). Mark-resight estimates of seasonal variation in harbor seal abundance and site fidelity. Population Ecology, 57, pp.467-472.

Department for Energy Security and Net Zero. (2022). Contracts for Difference Allocation round 4 Results. Department for Business, Energy and Industrial Strategy. https://assets.publishing.service.gov.uk/media/65b1463d160765000d18f834/contracts-for-difference-cfd-allocation-round-4-results.pdf

Department for Energy Security and Net Zero. (2023). Contracts for Difference Allocation Round 5 results. https://assets.publishing.service.gov.uk/media/64fa0473fdc5d10014fce820/cfd-ar5-results.pdf

Department for Energy Security and Net Zero. (2024). Contracts for Difference Allocation Round 6 results.

European Commission. (2023). The Habitats Directive. Retrieved February 11, 2025, from https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive_en

European Union (2014). Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1400054241343&uri=CELEX:32014L0052

Garavelli, L., Hemery, L. G., Rose, D. J., Farr, H., Whiting, J. M., and Copping, A. E. (2024). Marine Renewable Energy: Stressor-Receptor Interactions. In L. Garavelli, A.E. Copping, L. G. Hemery, and M. C. Freeman (Eds.), OES-Environmental 2024 State of the Science report: Environmental Effects of Marine Renewable Energy Development Around the World. Report for Ocean Energy Systems (OES). (pp. 26-102). doi:10.2172/2438589

Gerritsen, J. & Strickler, R. (1976). Encounter probabilities and community structure in zooplankton: a mathematical model. Journal of the Fisheries Research Board of Canada 34, 73-82

Graham, I. M., A. Farcas, N. D. Merchant, and P. Thompson. (2017). Beatrice Offshore Wind Farm: An interim estimate of the probability of porpoise displacement at different unweighted single-pulse sound exposure levels. Prepared by the University of Aberdeen for Beatrice Offshore Windfarm Ltd.

Grantham Research Institute on Climate Change and the Environment. (2023). Sustainable growth opportunities from tidal stream energy in the UK. London School of Economics and Political Science.

Hall, A.J., Frame, E. (2010). Evidence of domoic acid exposure in harbour seals from Scotland: A potential factor in the decline in abundance? Harmful Algae (9:5). pp. 489-493. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S1568988310000272

Hall, A.J., Kershaw, J.L., Fraser, S., Davidson, K., Rowland-Pilgrim, S., Turner, A.D. and McConnell, B. (2024). Estimating the risks of exposure to harmful algal toxins among Scottish harbour seals. Harmful Algae, 136, p.102653.

Harbour Seal Decline Project (2025). The Project. Available online at: https://harbourseals.wp.st-andrews.ac.uk/the-project/

Härkönen, T., Dietz, R., Reijnders, P., Teilmann, J., Harding, K., Hall, A., Brasseur, S., Siebert, U., Goodman, S.J., Jepson, P.D., Rasmussen, T.D., Thompson, P. (2006). The 1988 and 2002 phocine distemper virus epidemics in European harbour seals. Available online at: https://pubmed.ncbi.nlm.nih.gov/16532603/

Harting, A.L., Johanos, T.C. and Littnan, C.L. (2014). Benefits derived from opportunistic survival-enhancing interventions for the Hawaiian monk seal: the silver BB paradigm. Endangered Species Research, 25(1), pp.89-96.

Harwood, J., & King, S. (2014). The sensitivity of UK marine mammal populations to marine renewables developments. SMRU Marine, St Andrews.

Horne, N., Culloch, R.M., Schmitt, P., Lieber, L., Wilson, B., Dale, A.C., Houghton, J.D. and Kregting, L.T. (2021). Collision risk modelling for tidal energy devices: A flexible simulation-based approach. Journal of Environmental Management, 278, p.111484.

Horne, N., Culloch, R.M., Schmitt, P., Wilson, B., Dale, A.C., Houghton, J.D. and Kregting, L.T. (2022). Providing a detailed estimate of mortality using a simulation-based collision risk model. PLOS one, 17(11), p.e0276757.

Horne, N., Schmitt, P., Culloch, R., Wilson, B., Houghton, J.D., Dale, A. and Kregting, L. (2023). Comparability of outputs between traditional and simulation-based approaches to collision risk modelling. Journal of Marine Science and Engineering, 11(12), p.2359.

IAMMWG (2023). Review of Management Unit boundaries for cetaceans in UK waters (2023). Available online at: https://hub.jncc.gov.uk/assets/b48b8332-349f-4358-b080-b4506384f4f7

Jensen, S., Lacaze, J., Hermann, G., Kershaw, J., Brownlow, A., Turner, A., Hall, A. (2015). Detection and effects of harmful algal toxins in Scottish harbour seals and potential links to population decline. Toxicon (97). pp. 1-14. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S0041010115000331#:~:text=Toxin%20exposure%20could%20be%20driving%20the%20harbour%20seal,as%20possible%20causes%2C%20including%20toxins%20from%20harmful%20algae

Jitlal, M., Burthe, S., Freeman, S., and Daunt, F. (2017). Testing and Validating Metrics of Change Produced by Population Viability Analysis (PVA). Final report to Marine Scotland Science September 2017 Scottish Marine and Freshwater Science Vol 8 No 23. Available online at: https://data.marine.gov.scot/sites/default/files/SMFS%200823.pdf

JNCC (2025). Sanday SAC. Available online at: https://sac.jncc.gov.uk/site/UK0030069

Jourdain, E., Vongraven, D., Bisther, A., Karoliussen, R. (2017). First longitudinal study of seal-feeding killer whales (Orcinus orca) in Norwegian coastal waters. Available online at: https://pubmed.ncbi.nlm.nih.gov/28666015/

Jones, E.L., Smout, S., Blight, C., Sparling, C., McConnell, B. (2016). Fine-scale harbour seal at-sea usage mapping around Orkney and the North coast of Scotland. Sea Mammal Research Unit, University of St Andrews, Commissioned Report to Scottish Government. Available online at: https://data.marine.gov.scot/sites/default/files//SMFS%200727_0.pdf

Marine Scotland. (2020). Seals. Scotland's Marine Assessment 2020. Retrieved February 11, 2025, from https://marine.gov.scot/sma/assessment/seals

Marine Scotland (2013). The Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013. Available online at: https://www.legislation.gov.uk/ssi/2013/286/made

Marine Scotland (2020). Healthy and Biologically Diverse Species: Seals. Available online at: https://marine.gov.scot/sma/sites/default/files/sma2020_-_seals_-_healthy_and_biologically_diverse.pdf

Montabaranom, J., Gillespie, D., Longden, E., Rapson, K., Holoborodko, A., Sparling, C., Hastie, G. (2025). Seals exhibit localised avoidance of operational tidal turbines. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Montabaranom-et-al-2025.pdf

NatureScot. (2016). Assessing collision risk between underwater turbines and marine wildlife. https://www.nature.scot/doc/assessing-collision-risk-between-underwater-turbines-and-marine-wildlife

NatureScot. (2024). Conservation and Management Advice Sanday SAC March 2024. https://www.nature.scot/sites/default/files/site-special-scientific-interest/1678/sssi-citation.pdf

NatureScot (2025). Sanday SAC. Available online at: https://sitelink.nature.scot/site/8372

Neill, S., Roberts, C., & Houghton, R. (2017). The wave and tidal resource of Scotland. Retrieved from https://tethys-engineering.pnnl.gov/sites/default/files/publications/Neill-et-al-2017.pdf

Noble, D. R., Grattan, K, and Jeffrey, H. (2025a). Economic Review of Tidal Stream Energy in Scotland, The University of Edinburgh, Jan. 2025. Available online at: https://www.scottish-enterprise.com/media/u4rerwb0/economic-review-of-tidal-stream-energy-in-scotland.pdf

Noble, D. R., Grattan, K. and Jeffrey, H. (2025b). Future economic potential of Tidal Stream & Wave Energy in Scotland, The University of Edinburgh, Jan. 2025. Available online at: https://www.policyandinnovationedinburgh.org/uploads/3/1/4/1/31417803/future_economic_potential_of_tidal_stream_and_wave_energy_in_scotland.pdf

Olsen, M., Islas, V., Graves, J., Onoufriou, A., Vincent, C. Brasseur, S., Frie, A., Hall, A. (2017). Genetic population structure of harbour seals in the United Kingdom and neighbouring waters. Available online at: https://research-repository.st-andrews.ac.uk/bitstream/handle/10023/10596/Olsen_et_al_2017_Genetic_AquaConserv_CC.pdf?sequence=1

Onoufriou, J., Brownlow, A., Moss, S., Hastie, G., Thompson, D. (2019). Empirical determination of severe trauma in seals from collisions with tidal turbine blades. Available online at: https://research-repository.st-andrews.ac.uk/bitstream/handle/10023/19936/Onoufriou_2019_JAE_EmpiricalDetermination_AAM.pdf

Onoufriou, J., Russel, D., Thompson, D., Moss, E. (2021). Quantifying the effects of tidal turbine array operations on the distribution of marine mammals: Implications for collision risk. Available online at: https://www.researchgate.net/publication/354025155_Quantifying_the_effects_of_tidal_turbine_array_operations_on_the_distribution_of_marine_mammals_Implications_for_collision_risk

ORE Catapult (2021). Unleashing the Power of the Tides. ReEnergise #5. https://cms.ore.catapult.org.uk/wp-content/uploads/2021/11/ReEnergise-Tidal-Energy-compressed.pdf

Perkins, D.W., Vickery, P.D. and Shriver, W.G. (2008). Population viability analysis of the Florida Grasshopper Sparrow (*Ammodramus savannarum floridanus*): testing recovery goals and management options. The Auk, 125(1), pp.167-177.

Pierce, G., Dyson, J., Kelly, E., Eggleton, J., Whomersley, P., Young, I., Santos, M., Wang, J., Spencer, N. (2002). Results of a short study on by-catches and discards in pelagic fisheries in Scotland (UK). Available online at: https://www.cambridge.org/core/journals/aquatic-living-resources/article/abs/results-of-a-short-study-on-bycatches-and-discards-in-pelagic-fisheries-in-scotland-uk/F7963D5EDEB75C737CC77FD677529E7E

Russell, D., Jones, E., Morris, C. (2013). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Available online at: https://data.marine.gov.scot/dataset/updated-seal-usage-maps-estimated-sea-distribution-grey-and-harbour-seals

SAE Renewables. (2024). MEYGEN - SAE Renewables. SAE Renewables. https://saerenewables.com/tidal-stream/meygen/

SCOS (2016). Scientific Advice on Matters Related to the Management of Seal Populations: 2016. Available online at: https://www.smru.st-andrews.ac.uk/files/2017/04/SCOS-2016.pdf

SCOS (2022). Scientific Advice on Matters Related to the Management of Seal Populations: 2022. Available online at: https://www.smru.st-andrews.ac.uk/files/2023/09/SCOS-2022.pdf

SCOS (2024). Scientific Advice on Matters Related to the Management of Seal Populations: 2024. Available online at: https://www.smru.st-andrews.ac.uk/scos/scos-reports/index.html

Scottish Government (2012). Environmental Statement – MeyGen Tidal Energy Project. Available online at: https://marine.gov.scot/data/environmental-statement-meygen-tidal-energy-project

Scottish Government (2016). Pilot Pentland Firth and Orkney Waters Marine Spatial Plan. Available online at: https://www.gov.scot/binaries/content/documents/govscot/publications/factsheet/2016/03/pilot-pentland-firth-orkney-waters-marine-spatial-plan/documents/00497299-pdf/00497299-pdf/govscot%3Adocument/00497299.pdf

Scottish Government. (2018a). Offshore wind, wave and tidal energy applications: consenting and licensing manual. https://www.gov.scot/publications/marine-scotland-consenting-licensing-manual-offshore-wind-wave-tidal-energy-applications/pages/5/

Scottish Government. (2018b). Seal Management Areas. Retrieved 2025, from https://marine.gov.scot/information/seal-management-areas

Scottish Government. (2020). EU Exit: Habitats Regulations in Scotland. Retrieved February 11, 2025, from https://www.gov.scot/publications/eu-exit-habitats-regulations-scotland-2/pages/2/

Scottish Government. (2023). Marine consenting: Section 36 consent. https://www.gov.scot/publications/marine-licensing-and-consent-section-36 -consent/

Scottish Government (2018). Offshore wind, wave and tidal energy applications: consenting and licensing manual. Available online at: https://www.gov.scot/publications/marine-scotland-consenting-licensing-manual-offshore-wind-wave-tidal-energy-applications/

Scottish Government (2020). EU Exit: habitats regulations in Scotland. Available online at: https://www.gov.scot/publications/eu-exit-habitats-regulations-scotland-2/

Scottish Government (2022). Electricity Act 1989 – section 36 applications: guidance for applicants on using the design envelope. Available online at: https://www.gov.scot/publications/guidance-applicants-using-design-envelope-applications-under-section-36-electricity-act-1989/

Scottish Government (2023). Marine licensing: applications and guidance. Available online at: https://www.gov.scot/publications/marine-licensing-applications-and-guidance/

Scottish Government (2024). Marine licensing and consenting - decommissioning programmes: overview. Available online at: https://www.gov.scot/publications/marine-licensing-and-consenting-decommissioning-programmes-overview/

Scottish Government (2025). Marine environment: licensing and consenting requirements. Available online at: https://www.gov.scot/collections/marine-licensing-and-consent/

Scottish Government (2025). Marine licensing and consenting: offshore renewable energy projects. Available online at: https://www.gov.scot/publications/marine-licensing-and-consenting-offshore-renewable-energy-projects/documents/offshore-renewable-energy-marine-license-and-section-36-consent-application-checklist/

Scottish Government (2025). Marine licensing and consenting: offshore renewable energy projects. Available online at: https://www.gov.scot/publications/marine-licensing-and-consenting-offshore-renewable-energy-projects/pages/licensing-and-consenting-requirements/

Scottish Government (2025). Seal licensing. Available online at: https://www.gov.scot/collections/marine-licensing-seal-licensing/

Sinclair, R.R., Sparling, C.E. and Harwood, J. (2020). Review of demographic parameters and sensitivity analysis to inform inputs and outputs of population consequences of disturbance assessments for marine mammals. Scottish Marine and Freshwater Science, 11(14).

SMASS (2023). The Scottish Marine Animal Stranding Scheme (SMASS) Annual Report 2023. Available online at: https://strandings.org/wp-content/uploads/2025/01/SMASS-Annual-Report-2023-version-for-upload-1.pdf

SMRU Ltd (2011). Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney waters. Scottish Natural Heritage Commissioned Report No. 441

St Andrews University. 2025. St Andrews researchers appeal for the public to help them understand why UK Harbour seals are in steep decline. Available online at: https://news.st-andrews.ac.uk/archive/st-andrews-researchers-appeal-for-the-public-to-help-them-understand-why-uk-harbour-seals-are-in-steep-decline/

Sutherland, J.C. 2024. Killer whale predation of seals in the inshore waters of Shetland: investigating the ecological drivers and consequences of an apex predator-prey interaction. Available online at: https://research-repository.st-andrews.ac.uk/handle/10023/30686

UK Government. 2007. The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) (relevant to projects from 12-200nm). Available online at: https://www.legislation.gov.uk/uksi/2007/1518/contents

UK Government. 2017. The Conservation of Habitats and Species Regulations 2017. Available online at: https://www.legislation.gov.uk/uksi/2017/1012/contents/made

UK Government. 2017. The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended) (relevant to projects requiring s.36 consent). Available online at: https://www.legislation.gov.uk/ssi/2017/101/contents

UK Government. 2017. The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects from 0-12 nautical miles (nm)). Available online at: https://www.legislation.gov.uk/ssi/2017/115/contents

Van Neer, A., Jensen, L.F., Siebert, U. 2015. Grey seal (Halichoerus grypus) predation on harbour seals (Phoca vitulina) on the island of Helgoland, Germany. Journal of Sea Research (97). pp. 1-4. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S1385110114002160

Wilson, B. Batty, R. S., Daunt, F. & Carter, C. (2007) Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA. https://tethys.pnnl.gov/sites/default/files/publications/Wilson-et-al-2007.pdf

Wilson, J., Hammon, P. (2019). The diet of harbour and grey seals around Britain: examining the role of prey as a potential cause of harbour seal declines. Available online at: https://research-portal.st-andrews.ac.uk/en/publications/the-diet-of-harbour-and-grey-seals-around-britain-examining-the-r

ANNEX 1 LEGAL REVIEW

Burges Salmon

Tidal Industry Seal Project

Advice on the legal framework for the application of collision risk modelling and undertaking environmental compensation

64364.4
Classification: Confidential

Contents

1 BACKGROUND AND CONTEXT

1.1 It is estimated that Scotland's marine area contains 25% of Europe's tidal energy resource, with around 32 TWh per year of potentially exploitable tidal stream resource. Currently there is 12.6 MW of operational tidal stream turbines globally, with 9.8 MW of that in Scotland.[1]

1.2 There is a potential opportunity for the tidal industry to expand the scope of existing operations, as well as implement new tidal projects in the coming years.

1.3 As part of the consent applications for any expansion of tidal stream energy projects, the relevant regulators will need to consider the potential effects of developments on the environment. One key factor considered within that assessment is the potential impact of tidal stream projects on seals, including through collision risk.

1.4 Collision risk modelling for seals is underpinned by a range of assumptions relating to seal behaviour, potential risk of turbines and the impact that can result at a population level if seals are harmed or killed. The precautionary principle has been applied where there are data gaps, and conservative modelling approaches adopted. To date, Potential Biological Removal ("PBR") values have been used by regulators, including NatureScot as statutory nature conservation body, as a key metric in reaching conclusions on the acceptability of potential impacts.

1.5 Since the deployment of the first tidal stream projects in Scottish waters, a range of data have been collected during the operation of tidal projects. To date, there is no evidence that a seal or other marine mammal has ever been harmed or killed through a collision with a tidal stream turbine.[2]

1.6 Notwithstanding that, if the historic modelling parameters are used, it is likely that the expansion of tidal projects in Scotland could exceed PBR for the harbour seal at both a regional population ("Seal Management Area") level, and also at the scale of protected sites designated for conservation of the breeding populations of seals i.e. Special Areas of Conservation (SACs).[3]

1.7 This note considers the following questions in relation to obtaining the necessary consents for such an expansion.

(a) How does collision risk modelling of impacts on seals factor into the decision-making process under:

(i) the Electricity Act 1989,

(ii) the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (the "EIA Regulations"),

(iii) the Conservation (Natural Habitats, &c.) Regulations 1994 (commonly known as the "Habitats Regulations"), and

---

[1] https://www.scottish-enterprise.com/media/u4rerwb0/economic-review-of-tidal-stream-energy-in-scotland.pdf
[2] https://tethys.pnnl.gov/publications/state-of-the-science-2024
[3] We have been advised that because of the large and stable/increasing size of the grey seal *Halichoerus grypus* population, this issue is principally one for the harbour seal, *Phoca vitulina*, where some populations are declining. We note this for completeness, but it does not change the advice in this note.

(iv) the Marine (Scotland) Act 2010.

(b) To what degree do proposals for the expansion of tidal energy generation in the Orkney and Pentland Firth area align with national and regional planning policies and guidance?

(c) What is the legal basis, if any, for the use of PBR values to be taken into account within the consenting process?

(d) If the collision risk modelling shows a certain threshold has been breached, can consent be granted on the basis of a ‘derogation’? If yes, when should such a case be produced within the consenting process?

(e) If environmental compensation is necessary, can this legally be done:

(i) Strategically across the industry / wider programmes (e.g. plan level compensation); and / or

(ii) As non-species specific measures (e.g., Scottish Marine Environmental Enhancement Fund).

2 LEGAL FRAMEWORK FOR DECISION-MAKING AND COLLISION RISK MODELLING

2.1 This section considers the decision-making framework for a number of legal regimes that will apply to future applications for consent to construct expanded or new tidal stream projects in Scottish waters.

Electricity Act 1989

2.2 Any proposal to construct, extend or operate a generating station situated in the:

(a) Scottish territorial sea (out to 12 nautical miles (NM) from the shore), with a generation capacity in excess of 1 MW; or

(b) Scottish Offshore Region (12 to 200 NM), with a generating station in excess of 50 MW

will require consent under section 36 of the Electricity Act.

2.3 The basis for decision making on an application under section 36 of the Electricity Act is that set out in schedule 9 of the Act. The Scottish Ministers are obliged to have regard to the desirability of the matters mentioned in paragraph 3(1)(a), being *"the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest"*.

2.4 In contrast to planning applications under the Town and Country Planning (Scotland) Act 1997, there is no policy or development plan that has legal primacy in the decision-making process.[4] The Scottish Ministers will require to take account of all relevant material considerations in the overall planning balance. That exercise will include considering relevant national and local policy, as well as the predicted environmental impacts of the development proposed. The weight to be given to the competing factors in the overall planning balance will ultimately be a matter for the Scottish Ministers to determine.

2.5 Under current guidance, collision risk modelling will be a relevant factor in determining the predicated environmental impacts of a project and would therefore be a relevant consideration for the Scottish Ministers under paragraph 3 of schedule 9. It is, however, just one factor to take into account in the overall decision.

EIA Regulations

2.6 The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (the "EIA Regulations") apply to applications under section 36 of the Electricity Act and set out the legislative requirements of the EIA process.

2.7 Developments falling within a description in Schedule 1 to the EIA Regulations always require an EIA. Developments listed in Schedule 2 to the EIA Regulations also require an EIA if the development is likely to have significant effects on the environment by virtue of factors such as its nature, size, or location. Schedule 2 includes carrying out development to provide a generating station, or any change to or extension of a generating station.

2.8 If a development is "EIA Development", and falls within the scope of the EIA Regulations, then any application for section 36 cannot be granted unless an environmental impact

[4] In contrast to section 25 of the Town and Country Planning (Scotland) Act, which sets out the decisions must be made in accordance with the development plan unless material considerations indicate otherwise.

assessment is undertaken and taken into account by the Scottish Ministers.[5] Amongst other things, an EIA must:

(a) identify, describe and assess in an appropriate manner, in light of the circumstances relating to the proposed development, the direct and indirect significant effects of the proposed development on biodiversity. In particular this must include assessment of effects on species protected under the Habitats Regulations. The EIA must consider operational effects, where relevant.

(b) include a description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved.

2.9 As part of these requirements, an EIA Report prepared to accompany an application for a new or expanded tidal stream energy project would need to include an assessment of the potential effect on seals, including from the operation of the development. It would need to also set out details of the evidence or methods that underpinned the assessment and any uncertainties of those methods.

2.10 Under current guidance, collision risk modelling will be a relevant consideration as part of those requirements, as it will assist in determining the likely impacts of a development on seals.

2.11 A key part of the EIA process is that it facilitates consultation with relevant consultees and the public. NatureScot are a consultation body for the purposes of the EIA Regulations and will be consulted by the Scottish Ministers on the content of an EIA Report and application prior to making a decision on whether to grant consent. Through that process, NatureScot will provide advice to the Scottish Minsters on the acceptability of identified impacts from a project.

2.12 The EIA Regulations are procedural in nature and do not set out what level of environmental impact is acceptable. The purpose of an EIA is that it enables the decision maker to make an informed decision on what whether to grant consent, with a detailed understanding of the likely environmental effects that would arise.

2.13 The content of an EIA Report, and any advice from consultation bodies, will therefore be one relevant consideration to weigh in the overall planning balance, as set out in the section above on decision making under the Electricity Act 1989.

Habitats Regulations

2.14 The EU Habitats Directive[6] has been transposed into Scottish (and UK) law by the following regulations:

(a) The Conservation (Natural Habitats, &c.) Regulations 1994;

(b) The Conservation of Habitats and Species Regulations 2017; and

(c) The Conservation of Offshore Marine Habitats and Species Regulations 2017

[5] Reg.3 of the EIA Regulations
[6] Council Directive 92/43/EEC

2.15 These regulations remain in force (subject to certain amendments) following the UK's withdrawal from the EU. The regulations are in substantively the same terms for the purposes of this note and are referred to together as "the Habitats Regulations".

2.16 Under the Habitats Regulations, a "competent authority" is required to exercise its functions in accordance with the requirements set out in the regulations. In respect of section 36 consent and marine licence applications, the competent authority will need to carry out an 'appropriate assessment' to determine the potential impact of the project on any protected sites in the national site network before it can grant the consent or licence. If the competent authority cannot conclude that the project will have no adverse effect on the integrity ("AEOI") on any site in the network, then the authority can only grant consent if it is satisfied that there is a case for a 'derogation'.

2.17 The test that the competent authority must consider when reaching its conclusion on the appropriate assessment is whether an adverse effect on integrity can be ruled out "beyond reasonable scientific doubt".[7] That does not require absolute certainty. Lord Carnwath in the UK Supreme Court decision of *R (Champion) v North Norfolk DC*[8] highlighted paragraph 107 of the Advocate General's opinion in the *Waddenzee* case:

> *"the necessary certainty cannot be construed as meaning absolute certainty since that is almost impossible to attain. Instead, it is clear from the second sentence of article 6(3) of the Habitats Directive that the competent authorities must take a decision having assessed all the relevant information which is set out in particular in the appropriate assessment.* ***The conclusion of this assessment is, of necessity, subjective in nature.*** *Therefore, the competent authorities can, from their point of view, be certain that there will be no adverse effects even though,* ***from an objective point of view, there is no absolute certainty****."* [emphasis added]

2.18 Lord Carnwath went on to summarise this stating: *"… while a high standard of investigation is demanded, the issue ultimately rests on the judgement of the authority".*

2.19 The Court of Appeal in England has held that *"the conclusion to be reached under an 'appropriate assessment'…cannot realistically require ascertainment of absolute certainty that there will be no adverse effects"*.[9] To reach a conclusion that an adverse effect on integrity cannot be ruled out there must therefore be a real risk, not a merely hypothetical one.

2.20 A good example of this judgement being reached in practice by the competent authority is the section 36 consents granted for four offshore wind farms in the Firth of Forth and the subsequent judicial challenge, ultimately determined by the Inner House of the Court of Session in *RSPB v Scottish Ministers* [2017] CSIH 31.

Case study - *RSPB v Scottish Ministers* [2017] CSIH 31

The Royal Society for the Protection of Birds raised an action for judicial review in respect of section 36 consents granted for four proposed offshore wind farm projects in the Firth of Forth and Firth of Tay - Neart na Gaoithe, Inch Cape, Seagreen Alpha and Seagreen Bravo. The Scottish Ministers approved the projects in October 2014. The RSPB had

[7] See decision of the Court of Justice of the European Union in *Waddenzee* (C-127/02)
[8] R (Champion) v North Norfolk District Council [2015] 1WLR at para. 41
[9] *Smyth v Secretary of State for Communities and Local Government* [2015] EWCA Civ 174, as quoted and affirmed in *R. (on the application of Mynydd y Gwynt Ltd) v Secretary of State for Business, Energy and Industrial Strategy* [2017] Env. L.R. 14

raised objections in relation to the risk posed to the resident and migratory seabirds as a result of the projects.

Each of the applications for section 36 consent was accompanied by an Environmental Statement that concluded that the level of potential impact on certain special protected areas (SPAs) would be of a magnitude that it could affect the integrity of those sites. As such, an adverse effect on integrity for the purpose of the Habitats Regulations could be ruled out. Through the consultation undertaken by the Scottish Ministers on the applications, there was a range of disagreements between Marine Scotland Science, the statutory nature conservation bodies, and the RSPB on the application of data and methodology applied. The SNCBs and the RSPB had reached a conclusion that an adverse effect on integrity could not be ruled out. All parties were advancing alternative expert views.

Ultimately, Marine Scotland Science considered that sufficient levels of precaution had been built into their preferred methodology and thresholds that they advised, and that the risk of adverse effects on integrity could be ruled out beyond reasonably scientific doubt. The Scottish Ministers agreed with the Marine Scotland Science advice and granted the consents.

The Court upheld the decision of the Scottish Ministers, stating:

"[The Scottish Ministers] were entitled to make the scientific judgment that the methods which they had adopted were the best available in the circumstances. In the Appropriate Assessment, MS-LOT applied the correct precautionary principle that a development could only be authorised if no reasonable scientific doubt remained that the integrity of the sites would not be adversely affected. Due regard was paid to the SNCBs' advice. The Appropriate Assessment expressly noted the differences between the SNCBs and MSS on the modelling, but MS-LOT preferred option 3. That was an evaluative judgment which they were, as experts in the field, entitled to make in concluding, as a matter of fact, that no reasonable scientific doubt remained. There is no sound basis in law for reviewing that finding."[10]

2.21 If the competent authority cannot reach a conclusion of AEOI, then it must refuse consent, unless it is satisfied that the requirements for a 'derogation' can be met.

2.22 Where a developer seeks a derogation under the Habitats Regulations, there are three requirements that they must satisfy in turn, in order for a consent to be granted:

(a) There are no alternative solutions to the project.

(b) There are imperative reasons of overriding public interest ("IROPI") for consent to be granted for the project.

(c) Compensatory measures can be secured that ensure the overall coherence of the National Site Network is protected.

2.23 Collision risk modelling will be considered as part of an assessment under the Habitat Regulations, where the project (either alone or in combination with other plans/projects) has the potential to have a likely significant impact on a site in the national site network where seals are one of the conservation features of the site. The collision risk modelling

[10] Paragraph [214]

will be part of the overall ecological assessment that determines whether or not an AEOI can be ruled out.

Marine (Scotland) Act 2010 – marine licensing

2.24 A marine licence is required to undertake certain activities in the Scottish marine area, which would include the development of extended or new offshore renewable energy infrastructure, including tidal stream projects.[11]

2.25 Any decision on whether to grant a marine licence must be taken in accordance with the appropriate marine plans, unless relevant considerations indicate otherwise.[12] The "appropriate marine plans" are any national marine plan which is in effect, and any regional marine plan which is in effect for the region that the marine licence relates to.

2.26 In determining an application for a marine licence, the Scottish Ministers must also have regard to:[13]

(a) The need to protect the environment;

(b) The need to protect human health;

(c) The need to prevent interference with legitimate uses of the sea; and

(d) Any other such matter as the Scottish Ministers consider relevant.

2.27 The policies set out within appropriate marine plans are therefore the starting point for any decision by the Scottish Ministers on whether to grant a marine licence. Overall compliance with those policies will, to some extent, require consideration of the potential impact that a development would have on the environment, including seals.

2.28 The marine licence obtained for a tidal stream energy project will authorise the works to be undertaken in the marine environment for the installation of the project. Collision risk modelling is unlikely to be a direct consideration in that application (as it is an operational impact), although we would note as a matter of practice that marine licence applications are often considered alongside section 36 applications.

Marine (Scotland) Act 2010 – conservation of seals

2.29 The Marine (Scotland) Act 2010 ("Marine Act") sets out a seal licensing system, providing a regulated and monitored context for seal management in Scotland.

2.30 Under section 107 of the Marine Act, it is an offence to intentionally or recklessly kill, injure, or take any seal except under specific licence or for animal welfare reasons to alleviate suffering.

2.31 There are a number of exceptions to the offence listed in section 109 of the Marine Act. This includes that it is not an offence to (a) kill or take a seal in accordance with a seal licence, or (b) to do anything in accordance with a licence granted under section 44 of the Habitats Regulations.

Seal Licence

[11] Section 21, The Marine (Scotland) Act 2010.
[12] Section 15(1) of the Marine (Scotland) Act 2010
[13] Section 27, The Marine (Scotland) Act 2010.

2.32 A 'seal licence' may be granted by The Scottish Ministers authorising the killing or taking of seals for a number of reasons set out in section 110 of the Marine Act, including for imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.[14]

2.33 A seal licence must specify the method which the licensee must use to kill or take seals,[15] and must impose the following conditions:[16]

(a) specifying the maximum number of seals which may be killed or taken, and

(b) specifying steps which must be taken in relation to any seal injured when attempting to kill or take it in accordance with the seal licence in order to reduce the risk of it suffering unnecessarily.

2.34 The Marine Act specifies that a seal licence which authorises the killing of seals by shooting must impose conditions:[17]

(a) specifying the type of firearm which must be used;

(b) specifying the weather conditions in which a person may attempt to shoot a seal;

(c) specifying how close a person must be to a seal before attempting to shoot it;

(d) prohibiting a person from attempting to shoot a seal from an unstable platform; and

(e) about the recovery of carcases.

2.35 Other conditions may also be imposed and for example, can specify:[18]

(a) the area in which seals may be killed or taken;

(b) the species of seal which may be killed or taken;

(c) the circumstances in which seals may be killed or taken; and

(d) any period during which seals may not be killed or taken, for example, when females of the species of seal for which the licence has been issued are likely to be in an advanced stage of pregnancy or have dependent pups.

2.36 If a seal licence is granted, licence holders are required to submit returns for each seal killed under licence. Returns must be completed within 48 hours of killing the seal, in addition to quarterly returns. Licensees are also be required to recover the seal carcass, where possible, and report it to Scottish Marine Animal Stranding Scheme for collection.

2.37 The Scottish Ministers also have the power to designate an area as a "seal conservation area" where they consider it necessary to do so in order to ensure the proper conservation of seals.[19] The Scottish Ministers must not grant a seal licence authorising the killing or taking of seals in a seal conservation area unless they are satisfied (a) that there is no satisfactory alternative way of achieving the purpose for which the licence is granted, and (b) that the killing or taking authorised by the licence will not be detrimental to the

[14] Section 110(g) Marine (Scotland) Act 2010
[15] Section 111, Marine (Scotland) Act 2010.
[16] Section 112(1), Marine (Scotland) Act 2010.
[17] Section 112(2), Marine (Scotland) Act 2010.
[18] Section 112(4), Marine (Scotland) Act 2010.
[19] Section 118 of the Marine (Scotland) Act 2010

maintenance of the population of any species of seal at a favourable conservation status in their natural range (within the meaning of Article 1(e) of the Habitats Directive).[20]

Habitat Regulations - European Protected Species Licence

2.38 The Marine Act also specifies that it is not an offence to kill or take a seal in accordance with a licence granted under regulation 44 of the Habitat Regulations.[21]

2.39 Regulation 41 of the Habitat Regulations prohibits certain methods of killing (listed in Schedule 3A[22]) in relation to species listed in Schedule 3, which includes seals. It is also an offence to use, for the purpose of taking or killing any such wild animal, any other means of taking or killing which is indiscriminate and capable of causing the local disappearance of, or serious disturbance to, a population of seals.[23]

2.40 However, regulation 44 stipulates that a licence can be granted for the taking or killing of Harbour Seals as set out in regulation 41 for a number of reasons, including that there are imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment.

2.41 A licence must specify the area within which and the methods by which the wild animals may be killed. Conditions may also be included with the licence.[24] A licence cannot be granted for a period of more than two years.[25]

2.42 Before granting a licence, the relevant authority (Marine Scotland, in this case) must be satisfied that:[26]

(a) there is a licensable purpose (which are those listed in reg 44);

(b) there is no satisfactory alternative; and

(c) the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range.

---

[20] Section 119 of the Marine (Scotland) Act 2010
[21] Section 109(d), Marine (Scotland) Act 2010.
[22] [22] The methods listed in Schedule 3A include:
(a) the use of blind or mutilated animals as live decoys; (b) tape recorders; (c)electrical and electronic devices capable of killing or stunning; (d) artificial light sources; (e) mirrors and other dazzling devices; (f) devices for illuminating targets; (g) sighting devices for night shooting comprising an electronic image magnifier or image converter; (h) explosives; (i) nets which are non-selective according to their principle or their conditions of use; (j)traps which are non-selective according to their principle or their conditions of use; (k) crossbows; (l) poisons and poisoned or anaesthetic bait; (m) gassing or smoking out; and (n) semi-automatic or automatic weapons with a magazine capable of holding more than two rounds of ammunition.
[23] Regulation 41(2)(c).
[24] Regulation 45(1)(c), Habitats Regulations.
[25] Regulation 45, Habitats Regulations.
[26] Regulation 44(3), Habitat Regulations. See also NatureScot, Guidance note - for application for a licence relating to European Protected Species. Available here.

3 ALIGNMENT WITH PLANNING POLICIES

3.1 National and regional planning policies are relevant considerations for the Scottish Ministers when determining applications under the Electricity Act. The extent to which proposals for the expansion of tidal energy generation in the Orkney and Pentland Firth align with national and regional planning policies and guidance will therefore be a key factor in the planning balance when determining if future applications should be granted.

3.2 We have set out a high-level review of the relevant plans with a view to noting relevant policy documents that will be relevant to decision making, and specific policies within them that would support development of tidal energy generation. This is not a comprehensive list, nor a full consideration of the planning merits of any individual proposed development.

3.3 We have included in Appendix 1 an extract of various aspects of relevant policy documents, with summaries set out within this section.

National Marine Policy

UK Marine Policy Statement (2011)

3.4 The UK Marine Policy Statement ("UK MPS") is the UK-wide framework for preparing marine plans and taking decisions affecting the marine environment. It outlines the UK Administrations' vision for the UK marine area, general principles for decision making, and the high-level approach to marine planning. It sets out the policy objectives for the key activities taking place in the marine environment, including renewable energy generation. Marine plans need to align with and contribute to delivery of the policy objectives, and marine plan authorities and decision-makers need to consider pressures and impacts associated with the key activities.

3.5 The UK MPS is a relevant consideration in determining Electricity Act applications in the marine environment, and is an appropriate marine plan for the purposes of the Marine Act.

3.6 The UK MPS sets out a range of high-level marine objectives. Many aspects of those objectives are supportive of tidal energy generation, with a key ambition being to achieve a sustainable marine economy. The objectives note that marine planning also has an important role to play in facilitating climate change mitigation, through actions such as deployment of offshore renewables. However, the impacts of marine businesses on the environment are also key to the objectives, with a general principle that development should aim to avoid harm to marine ecology, biodiversity and geological conservation interests (including geological and morphological features), including through location, mitigation and consideration of reasonable alternatives. Where significant harm cannot be avoided, then appropriate compensatory measures should be sought.[27]

3.7 The UK MPS also notes in relation to renewable energy that the marine planning process will need to be flexible in responding to emerging evidence about the impacts of new technologies; in particular the monitoring and review arrangements for plans will be important in this.[28]

3.8 Those high-level objectives flow down into specific policy objectives in the plan. of support to tidal development is recognition of the role that renewable energy has to achieving net

[27] Paragraph 2.6.1.3, The UK Marine Policy Statement
[28] Paragraph 3.3.18, The UK Marine Policy Statement

zero targets, with tidal technologies noted as having “significant potential in the medium to long term”.[29]

3.9 The UK MPS directs decision makers to take account of the national level of need for energy structure as set out in the National Planning Framework for Scotland (see further below), the positive wider environmental, societal and economic benefits that low carbon electricity generation can bring to the UK. It notes that certain renewable energy resources can only be developed where the resource exists and where economically feasible.

3.10 Whilst there is in-principle policy support within the UK MPS, it notes that wave and tidal development may pose potential risks to the environment if inappropriately sited. At the time that the UK MPS was published it stated tidal technology was in early stages of development and impacts were uncertain at that time.

National Marine Plan (2015)

3.11 Scotland’s first National Marine Plan (“NMP”) was adopted and published in March 2015, and sets out strategic policies for the sustainable development of Scotland's marine resources out to 200 nautical miles. It provides a framework for managing developments in Scotland’s marine area by setting out high-level objectives and policies, including sector specific policies for offshore marine renewable energy.

3.12 The NMP is a relevant consideration in determining Electricity Act applications in the marine environment, and is an appropriate marine plan for the purposes of the Marine Act. The NMP contains in-principle support for the renewable energy development within the Scottish marine area, including tidal generation. High-level general policies in the NMP include the goal of achieving a sustainable economy, and a presumption in favour of sustainable development. The NMP also recognises that renewable energy activities are a key growth area in Scotland.

3.13 Chapter 11 sets out the objectives and policies for offshore wind and the marine renewable energy sector. Key objectives include sustainable development of tidal renewable energy in the most suitable locations and that economic benefits of wave and tidal energy developments are maximised by securing a competitive local supply chain.

3.14 However, the NMP also notes that the presence of legally protected species is an important consideration and that any impacts must be fully considered prior to the determination of an application for development.

National Marine Plan 2 Position Statement (2024)

3.15 The NMP was reviewed in 2018 and 2021 by the Scottish Ministers in line with statutory requirements. In response to the recommendations as part of those reviews, work began in 2022 to update the NMP. A Planning Position Statement (“PPS”) summarising the work to date on the National Marine Plan 2 (“NMP2”) has been published by the Scottish Government and includes proposed policy ideas to be included in the NMP2.

3.16 The NMP2 intends to support Scotland’s blue economy vision, help tackle both biodiversity loss and climate change, and realise the opportunities from the transition to net zero.

[29] Paragraph 3.3.3, The UK Marine Policy Statement.

3.17 As the PPS is currently out for consultation and the NMP2 has not yet been implemented, it can only be given limited weight. However, it is useful to note that the NMP2 intends to continue support for sectoral planning for marine renewables and proposes to give significant weight to the climate change crisis. The NMP2 also intends to respond to the biodiversity crisis and may include a requirement for nature positive use and development which would encourage measures that go beyond the mitigation hierarchy (such as supporting a species or habitat enhancement project) to support this.

Regional Marine Policy

Pilot Pentland Firth and Orkney Waters Marine Spatial Plan (2016)

3.18 The Pilot Pentland Firth and Orkney Waters Marine Spatial Plan (the "Marine Spatial Plan") sets out an integrated planning policy framework to guide marine development, activities and management decisions, whilst ensuring the quality of the marine environment is protected. The geographical extent of the Marine Spatial Plan comprises the territorial waters from mean high water springs out to 12 nautical miles and encompasses the full extent of the Orkney and North Coast Scottish Marine Regions.

3.19 The Marine Spatial Plan contains general objectives which provide in-principle support for tidal energy, including supporting long-term productivity in the marine environment as well as providing support for marine development and infrastructure that mitigates and is resilient to the effects of climate change.

3.20 In addition to the general objectives, the Marine Spatial Plan also provides a specific sectoral policy for renewable energy generation, which sets out when the plan will support proposals for renewable energy.

3.21 While supportive of renewable energy, the Marine Spatial Plan contains policies which support the protection of European Protected Species.

3.22 The Marine Spatial Plan will be a material consideration in the determination of marine licensing and section 36 consent applications within the Pentland Firth and Orkney Waters area. As the Marine Spatial Plan is non-statutory, marine licensing decisions will not have to be made in accordance with the pilot Marine Spatial Plan.

Draft Orkney Islands Regional Marine Plan (2024)

3.23 The Draft Orkney Islands Regional Marine Plan intends to support sustainable management of Orkney's marine environment and help decision makers to guide sustainable development to the right places, whilst safeguarding our marine environment and quality of life for Orkney communities. The draft plan contains policies to protect the environment, support community wellbeing, and facilitate sustainable development. Objectives in the plan are supportive of the transition to a low carbon economy so as to achieve net zero. Other high-level objectives require development to be managed with an ecosystem approach, to protect and enhance the biology of the marine environment.

3.24 Specifically in relation to tidal energy, the draft plan sets out that decision-makers, when considering wave and tidal development, need to consider effects on protected species and biodiversity.

3.25 Public authorities are required by the Marine Act to take authorisation or enforcement decisions in accordance with the appropriate marine plans, unless relevant considerations indicate otherwise.

3.26 A draft Plan was consulted on between 1 August to 25 October 2024. Consultation responses will now be considered by the Orkney Islands Council and any changes made before it is submitted to the Scottish Government's Marine Directorate for approval.

3.27 As the plan is still in draft, at this point it can only be afforded limited weight, however the draft Plan provides policy support for wave and tidal energy generation.

<u>Other relevant Scottish and UK Law and Policy</u>

Climate Change Act 2008 and Climate Change (Scotland) Act 2009

3.28 The Climate Change Act 2008 sets a legally binding target for the UK of achieving 100% reduction in greenhouse gases by 2050 compared to 1990 levels. The 2008 Act also established the Climate Change Commission (now named the 'Climate Change Committee' - CCC) which advises the UK Government on emissions targets, and reports to Parliament on progress made in reducing GHG emissions. The produces legally binding 'carbon budgets' act as stepping-stones toward the 2050 target.

3.29 The Climate Change (Scotland) Act 2009 sets a legally binding target for the Scottish Government to reach 'net zero' by 2045.

3.30 Tidal stream energy production, as a form of renewable energy, can make a contribution towards the Scottish and UK Governments meeting those targets, which is a relevant consideration in the determination of any application for consent.

The Fourth National Planning Framework (NPF4) (2023)

3.31 NPF4 was adopted in February 2023. NPF4 sets out the Scottish Minister's vision for working towards a net zero Scotland by 2045 through planning. NPF4 signals the key priorities for 'where' and 'what' development should take place at a national level and is combined with national planning policy on 'how' development planning should manage change.

3.32 NPF4 applies directly to planning applications for terrestrial areas as part of the statutory development plan. However, it is also a relevant consideration for marine planning applications, as setting out the Scottish Government's policy on energy development. The UK MPS direct that the NPF should be considered as part of marine decision making in Scotland. In addition, it is a recent statement of national policy which is very supportive of renewable energy generation. Policies within NPF4 give weight to tackling the climate and nature crises, and promotes and facilitates all forms of renewable energy development, including tidal.

Draft Energy Strategy and Just Transition Plan (2023)

3.33 The draft Energy Strategy and Just Transition Plan was published for consultation on 10 January 2023 and sets out the Scottish Government's vision for an energy system that delivers affordable, resilient and clean energy supplies. The strategy sets out policy positions and a set of actions to 2030.

3.34 In relation to tidal energy, the draft marine vision consults on a new ambition for marine deployment and presents the opportunities for the sector, and potential actions to enable the continued growth of both wave and tidal energy. This will support the delivery of a secure and low carbon energy system and a new industrial opportunity for Scotland.

3.35 The draft plan notes that tidal energy is highly predictable and can complement intermittent sources of energy, smoothing the overall power supply from renewables. The draft plan recognises that wave and tidal energy has the potential to support the delivery of a secure and low carbon energy system while providing a new industrial opportunity and being part of Scotland's response to the global climate emergency.[30]

3.36 The consultation on the draft Energy Strategy and Just Transition Plan closed on 22 May 2023. While the final is yet to be published, the draft provides strong policy support for renewable energy development, including tidal energy generation and has been referred to by the Scottish Ministers when making decisions on section 36 consents for energy development.

Green industrial strategy (2024)

3.37 The green industrial strategy identifies areas of strength and opportunity for Scotland to grow globally competitive industries in the transition to net zero. Its mission is to ensure that Scotland realises the maximum possible economic benefit from the opportunities created by the global transition to net zero.

3.38 The strategy provides strong policy support for renewable energy and will be a positive consideration in the planning balance.

Overarching National Policy Statement for energy (EN-1) (2023)

3.39 This National Policy Statement ("NPS") sets out the UK government's national policy for energy infrastructure. Its main purpose is to form the basis for decisions made by the Secretary of State (in England and Wales) for applications under the Planning Act 2008. However, the NPS also notes that energy policy is generally a matter reserved to UK Ministers, and therefore the NPS may be a relevant consideration in planning decisions in Scotland.[31] The Scottish Ministers have had regard to the terms of NPS EN-1 in decision making for offshore wind farms in Scotland.[32]

3.40 The NPS recognises that there is a role for tidal energy in meeting the UK's need for new electricity infrastructure. The NPS also sets out a definition of 'critical national priority (CNP) infrastructure'. The NPS recognises that there is an "urgent need' for CNP infrastructure. Where a development would be CNP infrastructure, it benefits from a presumption that the urgent need for CNP Infrastructure to achieving our energy objectives, together with the national security, economic, commercial, and net zero benefits, will in general outweigh any other residual impacts not capable of being addressed by application of the mitigation hierarchy. CNP infrastructure includes any offshore electricity generating station that has a capacity of more than 100MW.

3.41 Where a tidal project came within the thresholds of NPS EN-1, it would benefit from being within the definition of CNP infrastructure and benefit from the in-principle support afforded by the NPS.

National Policy Statement for renewable energy infrastructure (EN-3) (2023)

3.42 As with NPS EN-1 above, whilst this policy statement does not directly apply to decision making in consent applications in Scotland, the NPS notes that as energy policy is generally a matter reserved to UK Ministers, the NPS may therefore be a relevant consideration in planning decisions in Scotland.

---

[30] 3.1.3 Marine energy (wave and tidal).
[31] At paragraph 1.4.2
[32] See for example, the derogation case for Green Volt Offshore Wind Farm (available here)

3.43 Section 2.11 of NPS EN-3 sets out the policy requirements for tidal stream projects with capacity of over 100MW in England. It sets out the expectations of what applicant's will include in their assessment, mitigation expectations and how the Secretary of State should determine an application.

3.44 NPS EN-3 provides in-principle support to such development, subject to consideration of the project-specific impacts.

Clean Power 2030 Action Plan (2024)

3.45 Clean Power 2030 Action Plan sets out the UK Government's strategy to deliver clean power by 2030. It provides broad support to renewables technologies. It notes that the UK Government's expectation is that "emerging renewable technologies", such as tidal stream, are expected to play a limited role in the 2030 energy mix, but the UK's ability to deploy them at scale could be important to the YK's achievement of longer-term decarbonisation objectives. It also states that *"Emerging technologies could also provide broader system benefits, including by enabling renewables deployment in a wide range of locations or power generation that is uncorrelated with other energy sources, such as tidal stream."*

Orkney Local Development Plan 2017

3.46 The Orkney Local Development Plan 2017 sets out a vision and spatial strategy for the development of land in Orkney over the next ten to twenty years.

3.47 The Development Plan provides policy support for renewable energy development where there are no significant adverse effects.

4 USE OF POTENTIAL BIOLOGICAL REMOVAL VALUES WITHIN THE CONSENTING PROCESS

Legal context

4.1 The legal framework for decision making on consent applications is considered in more detail within section 2 above. As outlined within that section, a key aspect of determining an application for consent under the various legal regimes is for the decision maker to have sufficient environmental information to make reasoned conclusions on what the impacts of a development will be on the environment. That allows the decision maker to determine overall policy compliance and weight the potential negative impacts of the development against the potential benefits.

4.2 It is recognised within the legal framework for decision making that, as part of an environmental impact assessment, there may be limitations in the evidence base or methods of assessment.[33] Those limitations should be set out within the environmental assessment to allow the decision maker to be able to reach their own conclusion on the likely impacts of a development.

4.3 The legal framework as set out in section 2 does not specify the detail of how environmental assessment should be undertaken. The EIA Regulations, for example, set out what procedure must be undertaken as part of the EIA process, what an EIA must include and what consultation must be undertaken. But the regulations do not specify methodologies that should be adopted and applied as part of that assessment, or the thresholds of impact of what will be considered ‘acceptable’.

4.4 The evidence base for an assessment and the appropriate methodologies to be applied are matters that vary across industries. These will often be informed by the advice of regulatory bodies, such as the Marine Directorate, or advisory bodies such as NatureScot. NatureScot, for example, is the “appropriate nature conservation body” for Scotland under the Habitats Regulations and has a key role advising Scottish Ministers on consent decisions. The Inner House of the Court of Session has set out that a decision-maker ought to afford the views of a statutory consultation body considerable weight when they take them into account, and give clear and cogent reasons if that advice is not going to be followed.[34]

4.5 The ‘precautionary principle’ is a term often referred to as a key legal principle of environmental law, particularly that derived from the EU. As it relates to the environment, it was defined in the UN Rio Declaration on Environment and Development 1992 as:

> *“where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”.*

4.6 The precautionary principle can be applied in individual decision making where there is a degree of scientific uncertainty. It directs decision makers towards taking preventive action to prevent potential environmental damage, without a need to see if the harm will actually occur in practice. Statutory guidance published by the Scottish Minsters[35] states:

> *“Where there is uncertainty as to the likelihood or extent of potential environmental damage, but there is evidence indicating significant hazards and*

[33] See for example paragraph 6 of schedule 4 of the EIA Regulations

[34] *Royal Society for the Protection of Birds v Scottish Ministers* 2017 SC 552 at para [228]. See case study in section 2 above.

[35] Scotland’s Guiding Principles on the Environment: Statutory Guidance (August 2023)

associated high risks of harm, cost-effective measures can be put in place to address the risk of harm through regulation of activities or products, further research or public information. Application of the precautionary principle will reflect the nature of the individual decision and measures should be proportionate to the desired level of protection. Decision makers should generally not seek to achieve zero or near zero risk, something which rarely exists when balanced against the social and economic impact of measures."

4.7 The Guidance goes on to state that consideration of the precautionary principle should be informed by:

- a robust evaluation of the available evidence and the degree of scientific uncertainty;
- a risk evaluation and an assessment of the potential consequences of inaction;
- the participation of all interested parties in the study of precautionary measures, once the results of the scientific evaluation and/or the risk evaluation are available.

4.8 The exercise of the precautionary principle therefore requires a degree of judgement on what is an appropriate level of precaution to apply. A useful explanation of this in practice was detailed within the consideration of the Firth of Forth offshore wind farms (see case study above and extract below).

Case study – Firth of Forth Wind Farms – Extract letter

The case study in section 2 above sets out the context of the consideration of consent applications for four proposed offshore wind farm projects in the Firth of Forth by the Scottish Ministers and the disagreement between expert bodies on the extent of ecological impacts. A meeting was held between the various parties to discuss matters, with SNH (now NatureScot) following up by letter of 11 July 2014 stating *'there was agreement between our advisers on the vast majority of the issues raised . . . and in particular on protected species of seabird'*. On the matter of precaution, the letter went on to state:

"We noted that there were precautionary elements in the approaches taken and the models recommended by SNH and JNCC, and by [MSS]. What level of precaution is appropriate is not a matter that can be determined precisely, and judgements have to be made. We also noted that the development proposals have evolved since they were originally submitted, partly as a response to concerns about seabird impacts.

Our advice, and MSS's, is based on thresholds. These thresholds are indicative, not absolute, and we advise that they should not be used as strict limits. Rather, we have based our advice on the principle that the closer effects are to the thresholds the greater the risk of adverse effects. SNH & JNCC concluded that, for a small number of species, levels of predicted impact were such that we are unable to conclude beyond reasonable doubt that there would be no effect on the integrity of the SPAs, based on the models we have used. [MSS] reached a different conclusion using the same data, but a slightly different modelling approach. We noted that this is a new and fast developing area of scientific study and that approaches are continually developing and being tested. Many of the methods underpinning assessment (such as collision risk modelling) are based on assumptions for which it may take a long time to get field data to provide verification. So *again judgements have to be made where empirical analysis is unable to provide certainty.*

We discussed the issue of whether decisions should be based on a conclusion that thresholds should not be exceeded or whether an additional element of precaution should be applied to take account of uncalculated elements such as non-breeding mortality or to allow ''headroom'' for future development. I note that [MSS] consider that sufficient other elements of a precautionary nature are built in when setting the thresholds. Setting a ''safety margin'' on a threshold would also have to be a matter of judgement and not calculation, so all we can say is that the level of risk that populations will be impacted increases the closer you approach the threshold level.

We also discussed whether, if [the Scottish Ministers] judged that on balance it was appropriate to consent these developments, the risks could be reduced further through additional measures. Because of the limitations to our knowledge and understanding of the effects of wind farms on seabirds it is difficult to prescribe very detailed and sophisticated mitigation measures, but we can discuss this further if you wish.

Post-consent monitoring

The Forth & Tay is a unique area hosting an enormous richness of seabird diversity. It could be seen as a flagship for renewable energy generation and a world class opportunity to develop the science and plug evidence gaps in this complex and fast moving area of study. We therefore advise that any consents are made in a way that facilitates effective monitoring and we have provided [MS] with recommended conditions relating to an environmental monitoring programme and for an expert panel to oversee this work. We think that establishing this approach is a high priority"

Collision risk modelling and impact thresholds for tidal stream

Methodologies

4.9 Collision risk modelling for tidal stream energy generation projects is an area where there is inherent uncertainty in the evidence base and impacts of the technology. That evidence base has increased over time since the deployment of the first projects in Scottish waters, but it remains the case that a number of assumptions must be undertaken.

4.10 NatureScot has published guidance on assessing collision risk between underwater turbines and marine wildlife.[36] The guidance was written for developers and their consultants, and for regulatory bodies, with the aim of promoting approaches to collision risk assessment which are as far as possible standardised. The guidance sets out three models that can be used as the 'starting point' for an assessment, with any view on actual collision risk also requiring to be informed by assumptions made on the likely levels of avoidance and attraction, and the potential for serious injury or death resulting from collisions.

4.11 As guidance published by the statutory nature conservation body, it would need to be given appropriate weight by Scottish Ministers when reaching a view on the overall impacts of a proposed development, however they are not bound to follow it. If a developer presented an alternative methodology, or used different assumptions, then

[36] Scottish Natural Heritage, Guidance note: Assessing collision risk between underwater turbines and marine wildlife (May 2016)

provided there was a reasonable basis to do so the Scottish Ministers could accept the developer's approach.

4.12 In the offshore wind industry, for example, it is not uncommon that developers and statutory nature conservation bodies disagree on key assumptions that are to be applied as part of collision risk modelling. It will then ultimately be for the decision maker to reach a conclusion based on all evidence before it what the appropriate methodology should be for the purposes of the assessment.

Example 1 – Green Volt Wind Farm Appropriate Assessment

Green Volt Offshore Windfarm was granted section 36 consent on 19 April 2024 for a 35 turbine wind farm and associated infrastructure. Within the application, the Applicant company presented two different methodological approaches where it disagreed with advice from the statutory nature conservation bodies. These were presented as the "SNCB Approach" and the "Applicant Approach" and different input parameters in collision risk modelling and mortality and displacement rates used in the matrix method for estimating displacement impacts.

Section 9 of the Appropriate Assessment[37] sets out a discussion in the differences between the two methodologies presented and is an example of how a decision maker can consider different methodologies as potentially appropriate. At paragraph 9.3.5, the appropriate assessment states:

"The AA determines that there are limitations to both the SNCB recommended data and that preferred by the Company … however the recommended references from NatureScot continue to be the preferred and consistent approach until such times as research on flight speeds informs updated guidance. The AA reaches conclusions based on flight speeds recommended by NatureScot in the SNCB Approach, but does where possible, consider for context the information provided in the Applicant Approach"

At paragraph 9.5.2, for example, it was recognised that the recommended literature for flight speeds used in collision risk modelling was dated and that the guidance would benefit from being updated. This paragraph went on to conclude, however, that:

"Given the high sensitivity of flight speed in collision risk models (Cook et al. 2016) the AA determines it is suitable to consider the SNCB Approach parameter values in its conclusions until more robust evidence from Scottish waters is considered and presented within SNCB guidance."

Example 2 – Hornsea Four Offshore Wind Farm

Hornsea Four Offshore Wind Farm was granted development consent on 12 July 2023 for an offshore wind farm in English Waters. Within the application and Examination process, the Applicant presented its preferred methodology and assumptions alongside the approach recommended by Natural England as statutory nature conservation body.

By way of example, one area of disagreement was the displacement rate to be applied to guillemot. Section 5.7.7 of the appropriate assessment[38] includes consideration of that. Natural England submitted that a realistic mortality rate of 5% for a displacement rate of 70% would reflect the heightened sensitivity of the area. This would result in a

[37] Available here
[38] Available here

Project alone impact of 1,131 adults per annum, which would lead to a population decline at a growth rate of 1% per annum. The Applicant disagreed with Natural England's approach.

Whilst the Examining Authority and Secretary of State accepted Natural England's general methodology, they considered it appropriate to apply a 70% displacement rate and a 2% mortality rate, resulting in 452.3 annual mortalities and a reduction in population growth rate of 0.46% per annum.

4.13 As noted above, through ongoing monitoring of tidal stream energy projects there is a considerably greater evidence base on the likelihood of impacts than there was when the initial round of consents were obtained and when the relevant SNCB guidance referred to above was published. That is relevant to the proper application of the precautionary principle, which should take account of any updated evidence and certainty as it becomes available.

4.14 Once a sufficient evidence base is built, then it may justify a change in prevailing guidance to reflect the new evidence available. Even before that point, up to date ecological evidence can provide important context when deciding what level of precaution ought to be applied and deciding preferred methodologies or thresholds. This is particularly the case where applying a degree of precaution to every aspect of an assessment can result in an unrealistic and overly conservative conclusion.

Thresholds of acceptability

4.15 As noted above, advice and guidance published by regulatory and advisory bodies will set the general parameters of what might be acceptable, or tolerable, environmental impacts on a species or designated site. Those thresholds may differ depending on the legal and policy context that is being considered.

4.16 In respect of the Habitats Regulations, the legal test in the appropriate assessment is whether adverse effect on integrity can be ruled out. As set out in NatureScot Guidance on Habitats Regulations Assessments, the appraisal under that legal regime should consider the potential impacts on each qualifying interest of the site and their conservation objectives, including the magnitude and duration of effects and any cumulative effects from other plans or projects.[39] The guidance goes on to state: *"The integrity of the site only applies to the qualifying interests and is directly linked to the conservation objectives for the site. If a plan or project does not undermine the conservation objectives, then the integrity of the site should be maintained or, where relevant, have the ability to be restored. Conversely, if any of the conservation objectives could be undermined, it would not normally be possible to ascertain that the integrity of the site would not be adversely affected."*

4.17 The relevant thresholds in a Habitats Regulations Assessment will therefore have regard to the conservation objectives of the site and the level of impact that would result in those objectives being undermined.

4.18 In respect of the EIA Regulations, these do not include a definition of what level of effect should be considered "significant". The below extract from guidance issued by the

[39] https://www.nature.scot/professional-advice/planning-and-development/environmental-assessment/habitats-regulations-appraisal-hra (at stage 4)

Chartered Institute of Ecology and Environmental Management sets out how this might be applied in an ecological impact assessment.

Extract from 'Guidelines For Ecological Impact Assessment in the UK and Ireland', CIEEM

Significance is a concept related to the weight that should be attached to effects when decisions are made. For the purpose of EcIA, 'significant effect' is an effect that either supports or undermines biodiversity conservation objectives for 'important ecological features' or for biodiversity in general. Conservation objectives may be specific (e.g. for a designated site) or broad (e.g. national/local nature conservation policy) or more wide-ranging (enhancement of biodiversity). Effects can be considered significant at a wide range of scales from international to local.

A significant effect is an effect that is sufficiently important to require assessment and reporting so that the decision maker is adequately informed of the environmental consequences of permitting a project.

In broad terms, significant effects encompass impacts on structure and function of defined sites, habitats or ecosystems and the conservation status of habitats and species (including extent, abundance and distribution).

4.19 The relevant thresholds for what constitutes a 'significant' effect in an EIA will be a matter of judgement, having regard to the ecological sensitivity of the receptor being considered and the magnitude of impact on it. That will be informed by guidance and practice, as well as advice from SNCBs and regulators.

4.20 When assessing ecological impacts on a species, an assessment will often consider the population level consequences of the impact of a development. A report commissioned by JNCC describes two main approaches that have been taken in marine mammal impact assessment to assess the population level effects.[40] The first is the use of a rule-based method which results in a threshold for the number of deaths that should not be exceeded. The second is the use of a Population Viability Analysis (PVA) or predictive modelling approach.

4.21 One form of rule-based method is Potential Biological Removal (PBR), which is a method for assessing whether current or predicted levels of man-made mortality are consistent with reaching or exceeding a specific target population size. We understand that is the preferred method that NatureScot use to determine acceptability of impacts on population size when considering impacts within a Seal Management Area. From a strictly legal perspective, PBR does not have to be followed as an appropriate threshold for determining acceptability of impacts. It may be a relevant factor as informing what could constitute a significant effect under the EIA Regulations, but for the reasons set out above there is no legal reason that it would be determinative.

4.22 As set out above, guidance and methodologies can change over time, and any one methodology does not have a specific status within the legal regimes outlined in section 2. It is possible for developers and their consultants to put forward an alternative approach

[40] JNCC, Guide to Population Models used in Marine Mammal Impact Assessment (August 2017)

and for that to be followed by a decision maker, provided they could give clear reasons for departing from the advice of the statutory nature conservation body.

5 DEROGATION CASE WHERE COLLISION RISK MODELLING SHOWS A CERTAIN THRESHOLD IS REACHED

Derogation under the Habitats Regulations

5.1 As set out in section 2 of this note, where a competent authority is undertaking an appropriate assessment for the purposes of the Habitats Regulations and is unable to conclude that the proposal will not adversely affect the integrity of a site in the national site network, then consent can only be granted the decision maker is satisfied that there is a basis for a 'derogation'.

5.2 Under the Habitats Regulations, decision-makers may grant consent for a project notwithstanding that AEOI cannot be ruled out if the requirements for a 'derogation' have been met. There are three requirements that must be satisfied in turn:

(a) There are no alternative solutions to the project.

(b) There are imperative reasons of overriding public interest ("IROPI") for consent to be granted for the project.

(c) Compensatory measures can be secured that ensure the overall coherence of the National Site Network is protected.

Stage 1 – no alternative solutions

5.3 The first test is for the decision-maker to satisfy itself as to the absence of alternative solutions. Guidance from the European Commission[41] sets out that this must give consideration to *"all feasible alternative solutions that meet the plan/project aims".* Guidance issued by Defra states that "*alternatives need to meet the original objectives of the proposal. An alternative solution is acceptable if it: (i) achieves the same overall objective as the original proposal (ii) is financially, legally and technically feasible and (iii) is less damaging to the European site and does not have an adverse effect on the integrity of this or any other European site."*[42]

5.4 An alternative solution within the context of the derogations is therefore one which delivers the objective of the proposed development, whilst being financially, legally and technically feasible.

5.5 Project objectives would need to be determined on a project-specific basis, but we consider that the following could apply to tidal projects:

(a) **Decarbonisation:** To generate low carbon electricity from tidal stream in support of the decarbonisation of the Scottish electricity supply;

(b) **Security of supply:** To export electricity to the Scottish electricity grid to support Scottish commitments for renewable electricity generation and security of supply;

(c) **Sector growth**: Facilitating socio-economic development within the tidal stream sector – delivering project skills and employment for Scotland and the UK and supporting investment in the Scottish economy through the supply chain.

---

[41] European Commission (2018): Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.

[42] https://www.gov.uk/guidance/habitats-regulations-assessments-protecting-a-european-site

5.6 We consider there is a good argument that alternative forms of renewable energy technologies do not need to be considered, as they would not achieve the same objectives. This is consistent with decision making for derogation cases for other technologies, for example the decision of the Scottish Minsters in the derogation case for Green Volt Offshore Windfarm did not consider alternative renewable technologies as alternatives.[43]

5.7 We consider that the following would likely need to be considered in any alternatives assessment:

(a) Tidal stream development located outside of Scottish Territorial waters

(b) Tidal stream development located within Scottish Waters

(c) Alternative scale or design of the project

5.8 Item (a) could be discounted as not meeting the project objectives outlined above. Item (b) would need some consideration based on the specifics of the project, however there is guidance on the assessment of alternatives set out in UK National Policy Statement EN-1 that states that for low carbon infrastructure falling within the definition of "critical national priority" (CNP) infrastructure, alternative locations are unlikely to be suitable alternatives. That policy was relied on within the Green Volt decision and tidal stream development with a capacity in excess of 100MW would fall within the scope of CNP infrastructure under NPS EN-1.

Stage 2 - IROPI

5.9 In accordance with Article 6(4) of the Habitats Directive, as implemented by regulation 49 of the Habitats Regulations, once it is established that there are no feasible alternative solutions, it is necessary to show that there are imperative reasons of overriding public interest (IROPI) why the project must go ahead.

5.10 This note does not consider a detailed IROPI case for tidal stream development, which is beyond its scope and would need to be considered on a project-specific basis. Key principles are set out below, as well as comment on whether in principle it could apply to tidal stream development.

5.11 The parameters of IROPI are set out in guidance provided by Defra and the European Commission, which identify the following principles:

(a) **Imperative:** Urgency and importance: There would usually be urgency to the objective(s) and it must be considered "indispensable" or "essential" (i.e., imperative). In practical terms, this can be evidenced where the objective falls within a framework for one or more of the following:

(i) Actions or policies aiming to protect fundamental values for citizens' life (health, safety, environment);

(ii) Fundamental policies for the State and the Society; or

(iii) Activities of an economic or social nature, fulfilling specific obligations of public service.

[43] Se paragraph 3.2 of the derogation case, available here

(b) **Public interest**: The interest must be a public rather than a solely private interest (although a private interest can coincide with delivery of a public objective);

(c) **Long-term**: The interest would generally be long-term; short-term interests are unlikely to be regarded as overriding because the conservation objectives of protected sites are long term interests.

5.12 **Overriding**: The public interest of development must be greater than the public interest of conservation of the relevant protected site(s). When considering IROPI, the decision-maker will have to have regard to the project objectives, as considered at the alternatives stage. The key question is whether those objectives meet the requirements for IROPI. If the aims of the project are fixed too narrowly, whilst this will make it more straightforward for a project to pass the 'no alternatives' test, it will make it more difficult to overcome the test of IROPI.

Is the development and expansion of tidal stream projects being undertaken for imperative reasons?

5.13 Development and expansion of tidal energy projects would contribute to meeting the Scottish Government's legally binding targets under the Climate Change (Scotland) Act 2009 to reach Net Zero Scotland by 2045. At a UK level, the UK Climate Change Act binds the UK to achieving 100% reduction in greenhouse gas emissions by 2050 compared to 1990 levels. Tidal development and expansion are afforded considerable support in National Policy (as set out in more detail in section 3). It would contribute to achieving several of the Scottish Government's policy objectives for Marine Renewable Energy. National Planning Policy support for renewable energy was strengthened through National Planning Framework 4.

5.14 Tidal development also provides economic benefit and enhances the UK's energy security.

5.15 It can therefore be argued that through its contributions to Scotland and the UK's Net Zero targets, and through its contribution to meeting national planning policy objectives, tidal development and expansion of existing developments should be considered to be undertaken for impetrative reasons.

Are those reasons in the long-term public interest?

5.16 The imperative reasons above and enabling the growth in renewable generation to assist decarbonisation of the UK and Scottish energy networks, are reasons which are in the long-term public interest. Tidal development and expansion can make an important contribution to serving the national public interest, reflecting the clear and urgent need for reducing carbon emissions as swiftly as possible.

Are those reasons overriding?

5.17 On the basis that the reasons to proceed are both imperative and in the long-term public interest, the Scottish Ministers must still be satisfied that those reasons override the protection afforded to the qualifying interests. This is a balancing exercise for the Scottish Ministers.

5.18 The balancing exercise involves the assessment of the weight of the IROPI (and the existence of less harmful alternatives, if any) against the harm being caused. The potential impact on the environment needs to be carefully considered and mitigated as far as reasonably possible.

5.19 This conclusion can ultimately only be determined once the impacts of the project are known, however we consider that in-principle the reasons noted above could constitute reasons of overriding public interest.

5.20 We would also note that the inextricable link between climate change and the nature crises has been recognised in decision making when reaching a conclusion on this test, with the Scottish Ministers stating in the Green Volt Derogation Case that they *"also note that the public interest inherent in tackling the climate crisis is also served by the fact that mitigation of the climate crisis will in turn alleviate the nature crisis, given that many of the pressures exerted by the nature crisis emanate from the climate crisis."*[44]

Stage 3 – compensatory measures

5.21 The third stage set out in the Habitats Regulations states that where a project is agreed to, notwithstanding a negative assessment of the implications for a site in the national site network, the appropriate authority shall secure that any necessary compensatory measures are taken to ensure that the overall coherence of national site network is protected.

5.22 This is considered in more detail in section 6 below, however we would note that the language of the legislation is broader than requiring the compensation to be specific to the site in the network that would be harmed by the project. The test is to ensure that the "overall coherence" of the network is protected.

Derogation under the Marine (Scotland) Act 2010 and EPS licences

5.23 As noted in section 2, the Marine (Scotland) Act 2010 provisions relating to the conservation of seals also contain an IROPI consideration for various matters related to the conservation of seals. The Habitats Regulations also contains an IROPI provision as one of the basis on which a European Protected Species (EPS) Licence can be granted.

5.24 Guidance published by the Marine Directorate[45] in relation to seal licenses notes that:

(a) the public interest should be overriding, therefore not every kind of public interest of a social or economic nature would be sufficient; and

(b) the public interest may only be overriding if it is a long-term interest; short term economic interests or other interests which would only yield short-term benefits for the society may not appear to be sufficient to outweigh the long-term interests.

5.25 Guidance issued by NatureScot[46] in relation to licences under the Habitat Regulations notes that the following objectives are relevant to the assessment of establishing IROPI:

(a) the interests of national security and defence;

(b) where there is clear and demonstrable direct environmental benefit on a national or international scale;

(c) where it is shown that there is a vital contribution to strategic economic development or regeneration;

---

[44] At paragraph 7.4 (available here)
[45] Seal licensing: application form and guidance (available here)
[46] EPS Licensing (available here)

(d) where failure to proceed would have unacceptable social and/or economic consequences

(e) where the project is of national importance, or, possibly, regional importance.

5.26 We would note that the provisions of the Marine (Scotland) Act 2010 and within the Habitats Regulations relating to EPS licensing do not specify a legal requirement for compensation in the same way as provided for as part of a derogation where an adverse effect on the integrity of a designated site cannot be ruled out.

EIA significant effects

5.27 An EIA does not have a ‘derogation’ requirement in the same way as the Habitats Regulations. However, as a matter of policy a developer will be expected to apply the mitigation hierarchy (see section 6 below). Where a developer has taken all reasonable mitigation possible and there is still the potential for residual significant effects on the environment, they may propose compensatory measures be taken to offset those residual effects and make the level of impact acceptable to the ultimate decision maker.

6 APPROACH TO ENVIRONMENTAL COMPENSATION

Legal and Policy Requirements

6.1 This section of this note is not intended as a full statement of the law and practice of the application of environmental compensation measures, but sets out some of the key principles that would need to be considered as part of any Electricity Act application.

6.2 The duty to provide compensation for an environmental impact differs between the EIA regime and the HRA regime. As part of an EIA, the EIA Report will need to contain a description of the mitigation measures that are proposed as part of the development. It is a well understood EIA practice and planning policy that such measures should follow the mitigation hierarchy, which sets out the order in which impacts of a development should be addressed:

- first, avoid - by removing the impact at the outset wherever feasible;
- second, minimise – by reducing the impacts that are unavoidable;
- third, restore – by repairing and enhancing damaged habitats and disturbed species; and
- fourth, offset – by compensating for the residual impact that remains, with preference to on-site over off-site measures

6.3 The purpose of mitigation measures in an EIA context is to remove so far as possible any adverse significant effects on the environment. As set out in section 2 of this note, there is no set legal threshold for what will be acceptable. Guidance on ecological impact assessment issued by the CIEEM states:

> *"As a general rule, compensation should be focused on the same type of ecological features as those affected and equivalent levels of ecological 'functionality' sought. There will be cases when it is not possible to achieve ecological equivalence through compensation. Any replacement area should be similar in terms of ecological features and ecological functions that have been lost or damaged, or with appropriate management have the ability to reproduce the functions and conditions of those ecological features. Compensation should be provided as close as possible to the location where effects have occurred and benefit the same habitats and species as those affected."*[47]

6.4 The compensation duty under the Habitats Regulations where a project is consented on the basis of a derogation is for the appropriate authority to *"secure that any necessary compensatory measures are taken to ensure that the overall coherence of national site network is protected."*

6.5 That duty is broader than simply repairing the specific damage that is caused to an ecological feature of a designated site. Defra guidance for developing compensatory measures in relation to Marine Protected Areas recognises that developing like-for-like measures can be difficult in the marine environment.[48] The guidance sets out a hierarchy for developing measures in the marine environment, stating:

[47] Chartered Institute of Ecology and Environmental Management, Guidelines for Ecological Impact Assessment In The UK And Ireland (September 2024)

[48] Paragraph 45 of Defra, Best practice guidance for developing compensatory measures in relation to Marine Protected Areas (July 2021)

> *"The underlying principle is that compensatory measures that benefit the same feature which is impacted by the development will be the most preferable as they balance the damage caused by the development. Each step down the hierarchy moves away from like for like measures and therefore may decrease the certainty of success, and therefore increase the extent of compensation required."*[49]

6.6 The hierarchy of measures sets out the following in order of preference:

(a) Address the specific impact caused by the permitted activity in the same location (within the site boundary)

(b) Provide the same ecological function as the impacted feature; if necessary, in a different location (outside of the site boundary)

(c) Provide ecological functions and properties that are comparable to those that originally justified the designation in the same location as the impact

(d) Provide ecological functions and properties that are comparable to those that originally justified designation; if necessary, in a different location (outside of the site boundary)

6.7 An example of compensation measures under the Habitats Regulations being delivered at a different location than the affected SPA is the Sheringham Shoal and Dudgeon Extension Offshore Wind Farm projects:

Example 3 – Sheringham Shoal and Dudgeon Extension Projects

The Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and the Dudgeon Offshore Wind Farm Extension Project (DEP) were proposed offshore wind farms to be located off the Norfolk coast. As part of their application documents, the developer stated that it could not rule out an adverse effect on integrity on the Sandwich tern qualifying feature of the North Norfolk Coast Special Protection Area / Greater Wash Special Protection Area. The developer applied for a derogation under the Habitats Regulations, including compensation measures.

The developer had identified a compensation requirement of 12 – 17 adult Sandwich terns per annum. The developer proposed a package of compensation measures, with the principal one for Sandwich tern being creation of a new habitat at Loch Ryan in Scotland, comprising a new inland lagoon for nesting and predator prevention measures. This was not like-for-like compensation, but intended to provide compensation that ensures the coherence of the National Site Network as a whole. The developer's application documents[50] noted:

"A major benefit of this compensation measure is to recover lost breeding range of Sandwich tern. Restoring Sandwich tern breeding in the west of Scotland will not only allow growth in breeding numbers in the population as a whole, but also provides greater resilience by spreading the breeding distribution over a wider geographical area. This helps to counter the long-term trend of Sandwich tern nesting in fewer sites with an increasing proportion in just two or three large SPA populations. It will therefore help to reduce the high vulnerability of Sandwich tern to potential catastrophic impacts on the sites holding high proportions of the entire population. In this sense the measure goes

[49] Paragraph 46 and 47
[50] See EN010109-000438-5.5.2 Appendix 2 Sandwich Tern Compensation Document.pdf at paragraph 143

beyond the requirement to maintain the coherence of the network by significantly improving and restoring the geographical coherence of the Sandwich tern breeding range in Britain and Ireland."

Natural England were supportive of the proposals on the basis that it was likely to be ecologically effective, had the potential to restore a sandwich tern colony in part of its previous range, increase the number of recruits into the wider sandwich tern population and support a sufficient quantum to compensate for the adult mortalities identified.

The Secretary of State agreed that this was an appropriate compensation measure in accordance with the Habitats Regulations, stating:

"The Secretary of State agrees with Natural England that the accrual of any material benefit to the National Site Network (unless the Loch Ryan site is ultimately incorporated into the National Site Network) will be indirect, and quantifying such benefits is unlikely to be possible. Natural England advised that it is not opposed to the implementation of seabird compensation at a species bio-geographic population scale, but the likely level of benefit to the National Site Network should be carefully considered in conjunction with uncertainty around method effectiveness and Project impacts when appraising the proposed scale of the compensatory measures. The Secretary of State agrees with Natural England that whilst like-for-like (i.e. same species, same protected site population) compensation is most favourable in accordance with the 'compensation hierarchy', compensation for the same species at a remote location at a bio-geographic population scale is acceptable where the Applicant demonstrates that like-for-like is not possible or feasible. The Secretary of State has taken account of the remoteness of the measures when considering the scale of compensation required to compensate for the predicted mortality, although agreeing with Natural England that quantifying benefits is likely to be challenging."[51]

The Secretary of State ultimately concluded that the case for a derogation had been made out by the developer and granted consent for the offshore wind farms.

6.8 When determining an Electricity Act application, the Scottish Ministers will be the 'appropriate authority' that has the legal duty to ensure compensatory measures are undertaken. The legal mechanism that has been used to secure this is to include a suspensive condition within the consent issued to the developer. By way of example, in the Green Volt Offshore Wind Farm consent required the following steps to be undertaken before the construction of the wind farm could commence:

(a) The Licensee was required to submit a Detailed Seabird Compensation Plan to the Scottish Ministers for approval. The plan was to be based on an outline version submitted with the application;

(b) The Licensee was to implement the measures as set out in the Detailed Seabird Compensation Plan;

(c) The Scottish Ministers had to confirm in writing that the success criteria set out in the compensation plan had been met and that the compensatory measures taken are effective.

[51] Habitat Regulation Assessment (available here) at section 9

6.9 In terms of the timing for implementing compensation, the CIEEM guidance[52] recognises that in some cases compensation measures will need to be in place and 'functioning' before the significant harm occurs. This is particularly likely where the effect is on designated sites or legally protected species. In some of the examples noted above for offshore wind farms, the compensatory measures have been proposed to be delivered a number of breeding seasons prior to the predicted impact from the development (i.e. when it became operational).

Strategic compensation

6.10 The offshore wind sector has had a number of recent consents granted across the UK on the basis of a derogation under the Habitats Regulations, with compensatory measures being required. That industry is continuing to grow, with many more projects proposed. The UK and Scottish Governments have recognised that if that industry continue to grow as anticipated, a more strategic approach to delivery of ecological compensation would be required.

6.11 There have been a number of law and policy changes to facilitate delivery of strategic compensation for offshore wind. Part 13 of the Energy Act 2023 facilitates the creation of a 'marine recovery fund' as a mechanism for strategic compensation for offshore wind farms to be delivered. Developers would make payment into the marine recovery fund, with the funds ingathered from a number of projects then used to compensated for adverse environmental effects of relevant offshore wind activities.

6.12 If compensatory measures are required for the expansion of the tidal steam industry, then in our view there is no legal reason why that could not be undertaken on a strategic or collaborative basis. We consider that this could be legally secured within a consent in a similar way to project-specific measures, through the use of a suspensive condition. That condition could set out that a development could not commence until an appropriate contribution had been made towards the strategic project. In our view it would not be necessary to have legislative change in the same manner as was implemented through Part 13 of the Energy Act 2023 for offshore wind, although having a similar legal mechanism available to tidal stream would clearly be beneficial.

6.13 If the need for compensation was triggered under the Habitats Regulations, and the impact that would occur on designated sites, then the strategic compensation to be delivered should be targeted at ensuring the overall coherence of the national site network is maintained. That will require consideration of the ecological and practical feasibility of any measure proposed, similar to the exercise that the Scottish Government has recently undertaken to review strategic ornithological compensatory measures for the offshore wind industry.[53]

6.14 If the need for compensation was as a result of predicted significant effects within an EIA that could not be mitigated, then in our view that could also lawfully be delivered at a strategic level. The key considerations for the Scottish Ministers as decision maker would be the same, that there is a measure proposed that is ecologically and practically feasible, and that there is a mechanism available for the developer to make a contribution towards that strategic approach.

6.15 We have been asked to consider if a contribution to the Scottish Marine Environmental Enhancement Fund ("SMEEF") could be a mechanism for the delivery of ecological

[52] Chartered Institute of Ecology and Environmental Management, Guidelines for Ecological Impact Assessment In The UK And Ireland (September 2024) at paragraph 6.19
[53] Available here

compensation for tidal stream projects. A contribution to SMEEF or a similar fund might be appropriate, but only if the contribution was going to be used towards delivery of compensatory measures that were designed to offset the impact that tidal stream projects would have. If the compensatory measures were not targeted in that manner, then we do not consider that the relevant legal duties would be suitably addressed.

6.16 We note that recent legislative proposals have been introduced to the Scottish Parliament in the Natural Environment (Scotland) Bill which, amongst other things, would give powers to the Scottish Ministers to modify the EIA and HRA processes. Within the Policy Memorandum that accompanied the Bill, it is noted that the powers introduced in the Energy Act 2023 relate to offshore wind only, and that without new legislation the Scottish Government could not apply them to benefit "emerging sectors, such as wave energy". We consider that legislative reform that supported a more flexible approach to compensatory measures would be clearly beneficial in this regard. However, it will take considerable time to implement such measures, and they will not be available to tidal stream developers in the short term.

6.17 We would therefore recommend that the tidal stream developers, along with stakeholders such as NatureScot, the Marine Directorate and the Crown Estate consider the ecological and practical merits of any strategic compensation within the context of the existing legal and policy framework.

Appendix 1

1 RELEVANT POLICY EXTRACTS

1.1 The following is a list of relevant policy that could be considered a relevant consideration in the determination of section 36 applications for tidal stream generation stations. This is not intended as an exhaustive list. We have then included relevant extracts below.

National Marine Policy

- UK Marine Policy Statement (2011
- National Marine Plan (2015)
- National Marine Plan 2 Position Statement (2024)

Regional Marine Policy

- Pilot Pentland Firth and Orkney Waters Marine Spatial Plan (2016)
- Draft Orkney Islands Regional Marine Plan (2024)

Other relevant Scottish and UK Law and Policy

- Climate Change Act 2008
- Climate Change (Scotland) Act 2009
- Declaration of Climate Emergency (2019)
- British Energy Security Strategy (2022)
- The Fourth National Planning Framework (NPF4) (2023)
- Draft Energy Strategy and Just Transition Plan (2023)
- Overarching National Policy Statement for energy (EN-1) (2023)
- National Policy Statement for renewable energy infrastructure (EN-3) (2023)
- Green industrial strategy (2024)
- Clean Power 2030 Action Plan (2024)

Other relevant local policy

- Orkney Local Development Plan 2017

UK Marine Policy Statement

1.2 The UK MPS sets out high-level marine objectives the following of which are relevant to tidal energy generation:

(a) Achieving a sustainable marine economy[54]

(i) Infrastructure is in place to support and promote safe, profitable and efficient marine businesses.

(ii) The marine environment and its resources are used to maximise sustainable activity, prosperity and opportunities for all, now and in the future.

(iii) Marine businesses are taking long-term strategic decisions and managing risks effectively. They are competitive and operating efficiently.

(iv) Marine businesses are acting in a way which respects environmental limits and is socially responsible. This is rewarded in the marketplace.

(b) Living within environmental limits[55]

(i) Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.

(ii) Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.

(iii) Our oceans support viable populations of representative, rare, vulnerable, and valued species.

(c) As a general principle, development should aim to avoid harm to marine ecology, biodiversity and geological conservation interests (including geological and morphological features), including through location, mitigation and consideration of reasonable alternatives. Where significant harm cannot be avoided, then appropriate compensatory measures should be sought.[56]

(d) The marine plan authority should ensure that development does not result in a significant adverse effect on the conservation of habitats or the populations of species of conservation concern and that wildlife species and habitats enjoying statutory protection are protected from the adverse effects of development in accordance with applicable legislation.[57]

(e) Marine planning also has an important role to play in facilitating climate change mitigation, through actions such as offshore renewables and carbon capture and storage.[58]

1.3 The UK MPS further sets out policy objectives for the key activities that take place in the marine environment. Marine plans should align with, and contribute to, the delivery of these policy objectives. The following policy objectives are relevant to tidal energy generation:

[54] Chapter 2, page 11, The UK Marine Policy Statement.
[55] Chapter 2, page 11, The UK Marine Policy Statement.

[56] Paragraph 2.6.1.3, The UK Marine Policy Statement.
[57] Paragraph 2.6.1.6, The UK Marine Policy Statement.
[58] Paragraph 2.6.7.6, The UK Marine Policy Statement.

(a) Conservation objectives to protect important habitats and species is incorporated into marine planning and decision-making.[59]

(b) The marine environment will make an increasingly major contribution to the provision of the UK's energy supply and distribution. This contribution includes the oil and gas sectors which supply the major part of our current energy needs, and a growing contribution from renewable energy and from other forms of low carbon energy supply in response to the challenges of tackling climate change and energy security. Contributing to securing the UK's energy objectives, while protecting the environment, will be a priority for marine planning.[60]

(c) A significant part of the renewable energy required to meet these targets and objectives will come from marine sources. Offshore wind is expected to provide the largest single renewable electricity contribution as we move towards 2020 and beyond. Wave and tidal stream technologies also have significant potential in the medium to long-term.[61]

(d) When decision makers are examining and determining applications for energy infrastructure and marine plan authorities are developing Marine Plans they should take into account:[62]

  (i) The national level of need for energy infrastructure, as set out the National Planning Framework for Scotland;

  (ii) The positive wider environmental, societal and economic benefits of low carbon electricity generation and carbon capture and storage as key technologies for reducing carbon dioxide emissions;

  (iii) That the physical resources and features that form oil and gas fields or suitable sites for gas or carbon dioxide storage occur in relatively few locations and need first of all to be explored for and can then only be exploited where they are found. Similarly, renewable energy resources can only be developed where the resource exists and where economically feasible;

  (iv) The potential impact of inward investment in offshore wind, wave, tidal stream and tidal range energy related manufacturing and deployment activity; as well as the impact of associated employment opportunities on the regeneration of local and national economies. All of these activities support the objective of developing the UK's low carbon manufacturing capability.

(e) Marine Plans should take account of and identify areas of potential for the deployment of different renewable energy technologies. Measures should be taken to prevent, mitigate, and where that is not possible compensate, for any potential negative impacts in line with legislative requirements. Marine Plans and the marine planning process will need to be flexible in responding to emerging evidence about the impacts of new technologies; in particular the monitoring and review arrangements for plans will be important in this.[63]

[59] Paragraph 3.1.1, The UK Marine Policy Statement.
[60] Paragraph 3.3.1, The UK Marine Policy Statement.
[61] Paragraph 3.3.3, The UK Marine Policy Statement.
[62] Paragraph 3.3.4, The UK Marine Policy Statement.
[63] Paragraph 3.3.18, The UK Marine Policy Statement.

(f) Research by organisations such as the Carbon Trust81 and Renewable UK82 has suggested that up to 20% of the UK's current energy demand could be supplied by wave and tidal energy. There is potential to produce wave and tidal energy throughout the UK; and there are examples of sector progress across the UK83. The technology to enable wave and tidal energy generation is at an earlier stage of development than offshore wind. However, it is anticipated that the amount of wave and tidal energy being generated will increase markedly up to and beyond 2020. It is important for marine planning to take account of appropriate locations for such developments alongside more established uses of marine space and to recognise the timescales and stages against which the sector is likely to progress, including the lead time for grid and infrastructure development. For example, pre-commercial demonstration deployments will need to manage the potential environmental impacts in relation to the scale of risks and legislative requirements while recognising that not all uncertainties can be addressed in the early life of this technology.

(g) It should be recognised that the potential benefits and adverse effects of renewable energy developments will vary greatly, depending for example on the technology type and their size, structure and geographical location.[64]

(h) Renewable energy offers the potential for significant broad-scale environmental benefits through mitigating greenhouse gas emissions from energy production. In addition there are a number of potentially significant socio-economic benefits from the sector including employment opportunities, export business and energy security. As yet, the potential for benefits such as introduction of artificial reef structures, which can yield biodiversity benefits and fishing opportunities around wind farm sites, have not been fully explored. These should be considered further in the context of marine planning, and for individual developments.[65]

(i) Renewable energy developments can potentially have adverse impacts on marine fish and mammals, primarily through construction noise and may displace fishing activity and have direct or indirect impacts on other users of the sea, including mariners. Certain bird species may be displaced by offshore wind turbines, which also have the potential to form barriers to migration or present a collision risk for birds. Their foundation designs are likely to have an effect on hydrodynamics and consequent sediment movement. This includes potential scouring of sediments around the bases of turbines. These and other potential adverse impacts, together with potential mitigation measures, are considered in the National Policy Statement for Renewable Energy Infrastructure (EN-3).[66]

(j) Marine energy deployments, that is wave and tidal deployments, may pose potential risks to the environment if inappropriately sited. However, the level of risk and ecological significance is largely unknown since, in particular, tidal stream and wave technologies are at a relatively early stage of development. Studies of tidal range technologies, including barrages, have indicated that these structures can have adverse impacts on migratory fish and bird species and on the hydrodynamics of the estuarine environments in which they are situated. To underpin the marine planning process further research is needed to develop a better understanding of the potential impacts that marine technologies might have on potentially sensitive environmental features. For example, adaptation and

[64] Paragraph 3.3.22, The UK Marine Policy Statement.
[65] Paragraph 3.3.23, The UK Marine Policy Statement.

[66] Paragraph 3.3.24

mitigation methods for such impacts may be supported by detailed monitoring programmes and co-ordinated research initiatives, including post deployment of devices.[67]

National Marine Plan

1.4 Scotland's first NMP was adopted and published in March 2015, and sets out strategic policies for the sustainable development of Scotland's marine resources out to 200 nautical miles. It provides a framework for managing developments in Scotland's marine area by setting out high-level objectives and policies, including sector specific policies for offshore marine renewable energy.

1.5 The NMP notes at paragraph 2.15 that "*[t]his Plan and future regional plans must be taken into account when licensing applications are considered. The marine licensing process will also consider specific aspects of proposed developments and use, reaching a balanced view on whether an individual project should be consented*."

1.6 The Marine Act also specifies that authorisation decisions (which includes the determination of applications which affect any part of the Scottish marine area, including extensions and variations of authorisations) must be made in accordance with the appropriate marine plans.[68]

1.7 Accordingly, the NMP forms that basis of decision-making under the Marine Act, and therefore the NMP policies have an enhanced status.

1.8 The NMP sets out the following planning policies which are relevant to tidal energy development:

(a) GEN 2 Economic benefit: Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.

(b) GEN 3 Social benefit: Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.

(c) Objective 1: Sustainable development of offshore wind, wave and tidal renewable energy in the most suitable locations.

(d) Objective 2: Economic benefits from offshore wind, wave and tidal energy developments maximised by securing a competitive local supply chain in Scotland.

(e) Objective 5: Contribute to achieving the renewables target to generate electricity equivalent to 100% of Scotland's gross annual electricity consumption from renewable sources by 2020.

(f) Objective 6: Contribute to achieving the decarbonisation target of 50g CO_2/ kWh by 2030 (to cut carbon emissions from electricity generation by more than four-fifths).

(g) RENEWABLES 2: Sites with agreements for lease for wave and tidal energy development in the Pentland Firth Strategic Area must be taken into account by

67 Paragraph 3.3.25

68 Section 15, Marine (Scotland) Act 2010.

marine planners and decision makers if alternative use of these areas, or use which would affect access to these areas, is being considered. Proposals are subject to licensing and consenting processes. Regional Locational Guidance and the Pentland Firth and Orkney Waters Marine Spatial Plans should also be taken into account when reaching decisions.

(h) RENEWABLES 4: Applications for marine licences and consents relating to offshore wind and marine renewable energy projects should be made in accordance with the Marine Licensing Manual and Marine Scotland's Licensing Policy Guidance.

(i) RENEWABLES 5: Marine planners and decision makers must ensure that renewable energy projects demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements.

National Marine Plan 2 Position Statement

1.9 The NMP was reviewed in 2018 and 2021 by the Scottish Minister in line with statutory requirements. In response to the recommendations as part of those reviews, work began in 2022 to update the NMP. A Planning Position Statement summarising the work to date on the National Marine Plan 2 ("NMP2") has been published by the Scottish Government and includes proposed policy ideas to be included in the NMP2.

1.10 The Planning Position Statement proposes the following changes which are relevant to tidal energy generation:

(a) To include dedicated policies on climate change mitigation and adaptation, setting out specific implementation criteria to guide decision makers. This may include a translation of NPF4 Policy 1, giving significant weight to the climate and nature crises.

(b) To include a requirement for nature positive use and development to support action on tackling the biodiversity crisis. Beyond application of the mitigation hierarchy (avoid, minimise and mitigate impacts) for use and developments, this policy could encourage the delivery of positive measures for nature, such as, but not limited to, supporting a species or habitat enhancement project, supporting monitoring and research to progress towards marine nature enhancement outcomes, innovation projects or ocean literacy projects.

(c) To maintain support for sectoral planning for marine renewables and a plan-led approach to leasing.

Pilot Pentland Firth and Orkney Waters Marine Spatial Plan

1.11 The Pilot Pentland Firth and Orkney Waters Marine Spatial Plan (the "Marine Spatial Plan") sets out an integrated planning policy framework to guide marine development, activities and management decisions, whilst ensuring the quality of the marine environment is protected. The geographical extent of the Marine Spatial Plan comprises the territorial waters from mean high water springs out to 12 nautical miles and encompasses the full extent of the Orkney and North Coast Scottish Marine Regions.

1.12 The Marine Spatial Plan is used by the Marine Directorate as a material consideration in the determination of marine licensing and section 36 consent applications within the Pentland Firth and Orkney Waters area. As the Marine Spatial Plan is non-statutory, marine planning decisions will not have to be made in accordance with the pilot Marine Spatial Plan.

1.13 The following objectives in the Marine Spatial Plan are supportive of tidal energy generation:

(a) Objective 1: Support long-term productivity in the marine environment that provides benefits and prosperity for local communities and wider stakeholders.

(b) Objective 2: Support the transition to a low carbon economy.

(c) Objective 3: Encourage a sustainable coexistence and synergies between existing and new marine activities and developments, to the mutual benefit of multiple stakeholders.

(d) Objective 9: Support management of the marine environment, marine development and infrastructure that mitigates and is resilient to the effects of climate change.

(e) Objective 14: Provide a clear strategic direction and greater certainty for prospective developers, investors and local communities in the Pentland Firth and Orkney Waters area.

1.14 All of the general policies in the Marine Spatial Plan apply to developments and activities. The following general policies in the Marine Spatial Plan are relevant to tidal energy generation:

(a) **General Policy 3: Climate change**

Development(s) and/or activities will be supported by the Plan where the proposal can demonstrate appropriate:

- measures to mitigate the effects of climate change
- measures taken to adapt to climate change
- resilience has been built into the project over its lifetime

All proposals for development(s) and/or activities must minimise, as far as practicable, emissions of greenhouse gases and clearly demonstrate mitigation measures taken.

(b) **General Policy 4B: Protected species:**

The Plan will not support development(s) and/or activities that would be likely to have an adverse effect on a European Protected Species unless the relevant consenting or planning authority is satisfied:

- there is no satisfactory alternative;
- the development(s) and/or activities are required for preserving public health or public safety or there are other imperative reasons of overriding public interest; and

- the development(s) and/or activities would not be detrimental to the maintenance of the population of a European Protected Species concerned at a favourable conservation status in its natural range.

Where the impacts of development(s) and/or activities on an internationally or nationally protected species are uncertain, but there are good scientific grounds that significant irreversible damage could occur, the precautionary principle will apply.

Development(s) and/or activities will only be permitted where they comply with any licence granted by the appropriate authority required for the purpose of species protection.

Development(s) and/or activities likely to have an adverse effect on other species protected under current wildlife legislation, individually and/or cumulatively will only be permitted if those effects can be mitigated to the satisfaction of the relevant consenting or planning authority, or if they are satisfied that legislative requirements to proceed can be met.

(c) **General Policy 7: Integrated coastal and marine development**

For development(s) and/or activities that require multiple licences, permissions and/or consents, applicants should undertake early preapplication engagement with the consenting authorities and relevant stakeholders.

For development(s) and/or activities that require an Environmental Impact Assessment and multiple licences, permissions and/or consents, applicants should produce a Consultation Strategy at the scoping stage.

Where appropriate, proposals for construction projects should be supported by a construction environmental management plan which covers both the terrestrial and marine environment.

MS- LOT and other relevant consenting authorities should consult one another at an early stage to improve the efficiency of the consenting process and, where appropriate, coordinate and streamline the various consenting requirements.

1.15 The Marine Spatial Plan also provides a specific sectoral policy for renewable energy generation. It states:

(a) **Sectoral Policy 4: Renewable energy generation**

All proposals for offshore wind and marine renewable energy development are subject to licensing and consenting processes.

The Plan will support proposals when:

- proposals for commercial scale developments are sited in the Plan Option areas identified through the Sectoral Marine Plan process. These are considered the preferred location for the sustainable development of offshore wind and marine renewables
- the potential for co-existence in, and multiple use of, Plan Option areas and Agreement for Lease areas by other marine users has been discussed with stakeholders and given due consideration

- due regard has been paid to relevant factors in Regional Locational Guidance
- connections to shore and National Grid connections have been considered against the appropriate policies in the relevant Local Development Plan(s)
- early and effective communication and consultation with all affected stakeholders has been established to avoid or minimise adverse impacts
- any adverse impacts are satisfactorily mitigated

<u>Draft Orkney Islands Regional Marine Plan</u>

1.16 The Draft Orkney Islands Regional Marine Plan intends to support sustainable management of Orkney's marine environment and help decision makers to guide sustainable development to the right places, whilst safeguarding our marine environment and quality of life for Orkney communities. The draft plan contains policies to protect the environment, support community wellbeing and facilitate sustainable development.

1.17 Public authorities are required by the Marine Act to take authorisation or enforcement decisions in accordance with the appropriate marine plans, unless relevant considerations indicate otherwise.

1.18 Key provisions which are relevant to tidal generation in the draft plan include:

(a) Objective 2: Development, activities, and use are managed within an ecosystem approach, to protect and, where appropriate, enhance the biological, chemical and physical functioning of the marine and coastal environment, including the management of cumulative impacts.

(b) Objective 3: A rapid and just transition to a low-carbon economy is supported to achieve net-zero commitments

(c) Objective 8: Spatial planning and data are provided, enabling sustainable coexistence and synergies between existing and new marine development, activities, and use, and the environment.

(d) General Policy 5: Safeguarding natural capital and ecosystem services Proposals for development and/or activities should:

i. demonstrate that any significant disturbance and/or degradation of coastal and marine natural capital and/or ecosystem services has been avoided, minimised and/or appropriately mitigated.

ii. include, where appropriate, measures to maintain and enhance natural capital and ecosystem services.

iii. have regard to the Orkney Islands Marine Region: Natural Capital and Ecosystem Services Guidance, where available.

(e) **General Policy 9c: Protected areas**

Internationally designated sites

(i) Proposals for development and/or activities that could affect a European site (Special Area of Conservation and Special Protection Areas) must comply with the relevant legislation.

Nationally designated sites

(ii) Proposals for development and/or activities that could affect a SSSI must comply with the relevant legislation for these protected areas.

(iii) Proposals for development and/or activities that could affect a Nature Conservation MPA (NC MPA) must comply with the relevant legislation for these protected areas.

Seal haul-out sites

(iv) Proposals for development and/or activities that could affect a designated seal haul-out site should demonstrate that they will not result in harassment of seals. Regard should be given to the Harassment at Seal Haul-out Sites: Guidance

Local Nature Conservation Sites

(v) Proposals for development and/or activities that could affect a Local Nature Conservation Site should have regard to the Orkney Local Development Plan.

(f) **Sector Policy 5b: Wave and tidal energy**

(i) When considering proposals for wave and tidal energy development and/or activities, public authority decision makers should have regard to:

(A) net economic impact, including local social and economic benefits such as employment, associated business and supply chain opportunities;

(B) the scale of contribution to renewable energy targets and effect on greenhouse gas emissions reduction targets; and c

(C) cumulative impacts, taking into account the cumulative impact of existing and consented energy development;

(ii) Proposals for wave and tidal energy development and/or activities should avoid, minimise or appropriately mitigate significant adverse impacts on:

(A) landscape and/or seascape character and visual amenity;

(B) nature conservation designations, protected species, and the wider biodiversity, including Priority Marine Features;

(C) seal haul-out sites;

(D) water quality and the benthic environment;

(E) historic environment assets;

(F) aviation and/or defence interests;

(G) coastal processes including those caused by erosion, flooding and wider coastal change;

(H) other coastal and marine users including, but not limited to, commercial fishing, shipping and navigation, ports and harbour infrastructure/operations, aquaculture sites, tourism, recreation, and sport and leisure activities; and

(I) amenity, including consideration of road traffic, noise, light, access, vibration and litter impacts.

1.19 While the plan is still in draft, the draft Plan provides policy support for wave and tidal energy generation.

The Fourth National Planning Framework (NPF4)

1.20 NPF4 was adopted in February 2023. NPF4 sets out the Scottish Minister's vision for working towards a net zero Scotland by 2045 through planning. NPF4 signals the key priorities for 'where' and 'what' development should take place at a national level and is combined with national planning policy on 'how' development planning should manage change.

1.21 While NPF4 generally only applies to terrestrial areas rather than marine, it is a recent statement of national policy which is supportive of renewable energy generation. The following policies are relevant to tidal energy generation:

(a) Policy 1 tackling the climate and nature crises – gives significant weight to the global climate emergency and the nature crises to ensure that they are recognised as priorities in all plans and decisions.

(b) Policy 4 – natural places - development proposals that are likely to have an adverse effect on species protected by legislation will only be supported where the proposal meets the relevant statutory tests.

(c) Policy 11 – energy - encourages, promotes and facilitates all forms of renewable energy development. The objective is expansion of renewable, low-carbon and zero emissions technologies. New local development plans prepared by local authorities are to seek to realise their area's full potential for electricity and heat from renewable, low carbon and zero emission sources by identifying a range of opportunities for energy development.

(d) Strategic renewable electricity generation including offshore (>50MW), transmission infrastructure, and pumped hydro storage, are identified by NPF4 as national developments.

Draft Energy Strategy and Just Transition Plan

1.22 The draft Energy Strategy and Just Transition Plan was published for consultation on 10 January 2023 and sets out the Scottish Government's vision for an energy system that delivers affordable, resilient and clean energy supplies. The strategy sets out policy positions and a set of actions to 2030.

1.23 In relation to tidal energy, the draft marine vision consults on a new ambition for marine deployment and presents the opportunities for the sector, and potential actions to enable the continued growth of both wave and tidal energy. This will support the delivery of a secure and low carbon energy system and a new industrial opportunity for Scotland.

1.24 The draft plan notes that tidal energy is highly predictable and can complement intermittent sources of energy, smoothing the overall power supply from renewables. The draft plan recognises that wave and tidal energy has the potential to support the delivery of a secure and low carbon energy system while providing a new industrial opportunity and being part of Scotland's response to the global climate emergency.[69]

1.25 Annex G of the draft plan sets out the draft marine and solar visions for Scotland. It notes the views of the Scottish Marine Energy Industry Working Group who state that a strong domestic market for marine renewables is critical for maintaining the current high level of local content and enabling the Scottish sector to play a substantial role in the future global market. It is proposed that further and larger scale tidal stream deployments over the next five years are essential to enable tidal energy to continue along the cost reduction pathway and to embed the necessary skills and expertise in Scotland.

1.26 While the final is yet to be published, the draft Energy Strategy and Just Transition Plan provides strong policy support for renewable energy development, including tidal energy generation.

Green industrial strategy

1.27 The green industrial strategy identifies areas of strength and opportunity for Scotland to grow globally competitive industries in the transition to net zero. Its mission is to ensure that Scotland realises the maximum possible economic benefit from the opportunities created by the global transition to net zero.

1.28 The strategy provides strong policy support for renewable energy and will be a positive consideration in the planning balance.

Orkney Local Development Plan 2017

1.29 The Orkney Local Development Plan 2017 sets out a vision and spatial strategy for the development of land in Orkney over the next ten to twenty years.

1.30 Key provisions which are relevant to tidal generation in the draft plan include:

(a) Policy 7 C: All Renewables and Low Carbon Energy Developments

(i) The development of renewable and low carbon energy schemes, including the onshore infrastructure and/or buildings required for offshore marine renewable energy developments, and related transmission infrastructure, will be supported where it has been demonstrated that the proposal will not result in significant adverse effects on known constraints, either individually or cumulatively. Sufficient supporting information must be submitted with any planning application to enable a full assessment to be made of the likely effects of the development.

[69] 3.1.3 Marine energy (wave and tidal).

www.burges-salmon.com

One Glass Wharf, Bristol BS2 0ZX **T** +44 (0)117 939 2000 **F** +44 (0)117 902 4400

Atria One, 144 Morrison Street, Edinburgh EH3 8EX **T** +44 (0)131 314 2112 **F** +44 (0)131 777 2604

6 New Street Square, London EC4A 3BF **T** +44 (0)20 7685 1200 **F** +44 (0)20 7980 4966

Burges Salmon LLP is a limited liability partnership registered in England and Wales (LLP number OC307212, SRA ID 401114), and is authorised and regulated by the Solicitors Regulation Authority. It is also regulated by the Law Society of Scotland. Its registered office is at One Glass Wharf, Bristol, BS2 0ZX. A list of the members may be inspected at its registered office. Further information about Burges Salmon entities, including details of their regulators, is set out on the Burges Salmon website at www.burges-salmon.com.