

Ireland's Strategy for Marine Research, Knowledge and Innovation, 2025-2030

The Ocean Knowledge 2030 Strategy is currently in advanced draft form. The Ocean Knowledge 2030 conference on 20th-21st of November is providing a final opportunity for stakeholder engagement, allowing strategic insights and ideas to be gathered from a diverse national ocean community. It is intended to finalise and publish the strategy in early 2025.

DRAFT

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GLOSSARY OF ACRONYMS

ABP: An Bord Pleanála

BIM: Bord Iascaigh Mhara

CARO: Climate Action Regional Office

CSO: Central Statistics Office

DAFM: Department of Agriculture,
Food and the Marine

DECC: Department of Environment,
Climate and Communications

DETE: Department of Enterprise,
Trade and Employment

DFA: Department of Foreign Affairs

DHLGH: Department of Housing,
Local Government and Heritage

DoT: Department of Transport

EI: Enterprise Ireland

EPA: Environmental Protection Agency

FI: Fáilte Ireland

GSI: Geological Survey Ireland

JPI Oceans: Joint Programming Initiative on
Healthy and Productive Seas and Oceans

ICES: International Council for
the Exploration of the Sea

IL: Irish Lights

IMDO: Irish Maritime Development Office
(Marine Institute)

INS: Irish Naval Service

INSS: Irish National Seabed Survey

IODP: International Ocean Discovery
Programme (ocean drilling)

LGMA: Local Government Management Agency

MARA: Maritime Area Regulatory Authority

MaREI: Research Ireland Centre for Energy,
Climate and Marine

MÉ: Met Éireann

MI: Marine Institute

MIIN: Marine Ireland Industry Network

MRFF: Marine Research Funders' Forum

MSO: Marine Survey Office

NMS: National Monuments Service

NPWS: National Parks and Wildlife Service

RKI: Research, Knowledge and Innovation

OECD: Organisation for Economic
Co-operation and Development

ORE: Offshore Renewable Energy

PPWS: Potentially Polluting Wrecks

SEAI: Sustainable Energy Authority of Ireland

TRL: Technology Readiness Level

UCH: Underwater Cultural Heritage

UnG: Údarás na Gaeltachta

UG: University of Galway

WIID: Wreck Inventory of Ireland Database

EXECUTIVE SUMMARY

The period up to 2030 is a critical time for Ireland as an ocean state with a large maritime area. Ambitious climate targets linked to the planned expansion of Offshore Renewable Energy puts us on a pathway towards a major transformation in how we use our ocean space. Recent and forthcoming national and EU legislation in respect of marine spatial planning, marine protected areas, biodiversity protection and nature restoration will also have major implications for the use and protection of marine space and ecosystems.

At the same time, climate change and the effects of greenhouse gas emissions are resulting in warming seas, rising sea levels, altered ocean chemistry, increasingly frequent extreme weather events and changing biodiversity and ecosystems. Robust data, knowledge and expertise are essential to navigate these environmental, sectoral, policy and legislative pressures and their societal and economic impacts, and to deliver effective policy and management decisions.

Ocean Knowledge 2030 is Ireland's marine research, knowledge and innovation strategy for the period 2025-2030. The strategy identifies some of the most critical marine scientific and societal challenges that Ireland is facing and also the enormous opportunities presented by our extensive maritime domain and its rich resources. It also documents the existing, recent or forthcoming legislation and policy developments, whether at national or EU level, that will require a knowledge-based response and the associated questions that should be the focus of our research programming and investments over the coming six years.

Ocean Knowledge 2030 Vision:

Marine research, knowledge and innovation play a pivotal role in accelerating the transition to a sustainable and climate-neutral blue economy, maintaining a healthy marine environment, and fostering a society that positively coexists with the ocean.

High-level Objectives:

1. Guide, align and coordinate research & innovation investments in line with national, EU and international strategic priorities.
2. Ensure marine and maritime research, innovation and knowledge deliver maximum impact and value to users and stakeholders, while prioritising ocean health and sustainability as foundational principles.
3. Help realise the Impact 2030 action to 'position Ireland as a leader for marine research and technology'.

Ocean Knowledge 2030 is structured to address firstly the research and knowledge needed to better understand the natural coastal, marine and oceanic environment that surrounds Ireland. It reflects the increasing need to understand how this important environment is being impacted by climate change and human activities and how we can inform and evolve our response to these changes (Chapter 2 – Living with a Changing Ocean). Chapter 3 focuses on Ireland's Ocean economy and identifies the research, and knowledge needs to support economic development and sustainability across five key ocean economy sectoral areas. Chapter 4 looks at the elements of the research, knowledge and innovation system that are key 'enablers' to ensure we can progress all aspects of the strategy, addressing systemic aspects such as human capacities, research infrastructures, data, partnerships, funding and research-industry collaboration. Chapter 5 provides an overview of the structures and processes that will be utilised to underpin and monitor the implementation and impact of the strategy, which will be key to measure progress and optimise decision-making and success.

The development of Ocean Knowledge 2030 is the result of a comprehensive and collaborative process that engaged a wide range of stakeholders across the marine research and innovation ecosystem. It has been shaped through extensive consultations with government departments and agencies, researchers, industry, environmental organisations, and the public, while ensuring alignment with national and EU priorities such as those set out in the National Research and Innovation Strategy, Impact 2030. Ocean Knowledge 2030 sets out 51 actions that will be progressed during the initial two years of the strategy cycle and reviewed/updated with the input of key stakeholders.

Looking ahead to 2030, it is essential that Ireland has access to knowledge, evidence and expertise to address complex and interconnected challenges related to the sustainable management of our oceans and coasts and the development of a sustainable ocean economy. This strategy is central to advancing this national imperative.

1. INTRODUCTION

1.1 Context and Setting

The United Nations has designated the period from 2021 to 2030 as the Decade of Ocean Science for Sustainable Development. This reflects a global acceptance that a healthy and productive ocean is critical for planetary health, and for human health and well-being. Moreover, the Decade recognises the important role of science and knowledge in helping us to achieve “the Ocean we need for the future we want”.

This decade is also a critical time for Ireland as an ocean state with a large maritime area. We are on a pathway towards the largest transformation in how we use our ocean space in the history of the State. Ambitious national climate and energy targets require a major transition to renewable sources of energy. A national target of 5GW of installed offshore wind energy by 2030 requires the substantial accommodation of wind farm developments within our maritime area. This will impact on the environment and ecosystems in the vicinity of these developments but also on other established maritime sectors such as seafood production (fisheries and aquaculture), port activities and shipping.

Recent and forthcoming national and EU legislation in respect of marine spatial planning, marine protected areas, biodiversity protection and nature restoration will also have major implications for the use and protection of marine space and ecosystems. At the same time, climate change and the effects of greenhouse gas emissions are resulting in warming seas, rising sea levels, altered ocean chemistry, increasingly frequent extreme weather events and changing biodiversity and ecosystems.

Robust data, knowledge and expertise are essential to navigate these environmental, sectoral, policy and legislative pressures and their societal and economic impacts, and to deliver effective policy and management decisions.

The COVID-19 pandemic demonstrated the critical importance of having the necessary national capacity and knowledge base to address a generational societal challenge. While COVID represented an acute situation and required a rapid mobilisation, it was the establishment of expertise and a robust research base over many preceding years that enabled government policy decisions and actions to be informed by the best available scientific knowledge and advice.

The same principle applies to the management of our vast ocean territory and resources. **The National Marine Research & Innovation Strategy 2017-2021** provided a framework to guide policy-oriented marine and maritime research to optimise the beneficial impact of research and knowledge investments nationally. The building of national capacity across fifteen thematic areas was the central goal of the strategy, which used a 'Research Capability Maturity Model' to define and measure national capability by theme in relation to human capacity, infrastructures and networks.

There has been significant investment in Ireland's marine research and innovation sector over the past three decades. This has not only built considerable capacity and expertise in a wide range of marine and ocean topics, but it has also delivered national infrastructures such as laboratories, research vessels and the world leading, open-access marine maps and databases delivered and maintained by the Marine Institute and Geological Survey Ireland.

Looking ahead to 2030, a further increase in capacity and coordination is required to ensure Ireland has access to knowledge, evidence and expertise to address complex and interconnected challenges related to the sustainable management of our oceans and coasts and the development of a sustainable ocean economy. This strategy is central to advancing these national imperatives.

1.2 Ocean Knowledge 2030 Vision and Objectives

Vision:

Marine research, knowledge and innovation play a pivotal role in accelerating the transition to a sustainable and climate-neutral blue economy, maintaining a healthy marine environment, and fostering a society that positively coexists with the ocean.

High-level Objectives:

1. Guide, align and coordinate research & innovation investments in line with national, EU and international strategic priorities.
2. Ensure marine and maritime research, innovation and knowledge deliver maximum impact and value to users and stakeholders, while prioritising ocean health and sustainability as foundational principles.
3. Help realise the Impact 2030 action to 'position Ireland as a leader for marine research and technology'.

1.3 About this Document

Ocean Knowledge 2030 is Ireland's marine research, knowledge and innovation strategy for the period 2025-2030. The strategy has been developed under the coordination of the Marine Institute, in line with its mandate '*to co-ordinate, to promote and to assist in marine research and development*¹'. As a national strategy, it has been created in partnership with - and is collectively owned by - the multiple government departments, state agencies and other stakeholder bodies that set, inform or implement marine policy and associated policy domains (e.g. environment, economic development, energy, food, natural and cultural heritage, etc.) and/or fund, coordinate and manage marine-related research and innovation.

The strategy identifies some of the most critical marine scientific and societal challenges that Ireland is facing and also the enormous opportunities presented by our extensive maritime domain and its rich resources. It also documents the existing, recent or forthcoming legislation and policy developments, whether at national or EU level, that will require a knowledge-based response and the associated questions that should be the focus of our research programming and investments over the coming six years.

¹ Marine Institute Act, 1991

Ocean Knowledge 2030 is a sectoral implementation mechanism that aligns directly with the national research and innovation strategy, **Impact 2030**. It will help to coordinate the actions and investments needed to realise the Impact 2030 action to '*position Ireland as a leader for marine research and technology*'. It also aligns and integrates with a broader suite of sectoral and Research and Innovation strategies and policies at both national and EU level. It presents a set of targeted actions with associated implementing actors to be advanced over the first two years of the strategy cycle (2025-2026). It is intended that a periodic review in late 2026 will inform an updated set of actions for the next phase of implementation from 2027.

A key implementing mechanism for the strategy is the **Marine Research Funders' Forum**, a forum of departments, agencies, funders and stakeholders that was established in 2018 under the previous strategy, the **National Marine Research & Innovation Strategy 2017-2021**. A review on the effectiveness and impact of that strategy² was a key starting point to guide the development of Ocean Knowledge 2030. The Marine Research Funders' Forum has played a key role in steering the new strategy and will be an important structure to guide and mobilise action on its implementation.

A national database of marine research investments established in 2020 with data provided routinely by the MRFF partners, is also a key tool to inform research and innovation programming, coordination and investment across the research system.

Ocean Knowledge 2030 is structured to address firstly the research and knowledge needed to better understand the natural coastal, marine and oceanic environment that surrounds Ireland. It reflects the increasing need to understand how this important environment is being impacted by climate change and human activities and how we can inform and evolve our response to these changes (Chapter 2 – Living with a Changing Ocean). Chapter 3 focuses on Ireland's Ocean economy and identifies the research, and knowledge needs to support economic development and sustainability across five key ocean economy sectoral areas. Chapter 4 looks at the elements of the research, knowledge and innovation system that are key 'enablers' to ensure we can progress all aspects of the strategy, addressing systemic aspects such as human capacities, research infrastructures, data, partnerships, funding and research-industry collaboration. Chapter 5 provides an overview of the structures and processes that will be utilised to underpin and monitor the implementation and impact of the strategy, which will be key to measure progress and optimise decision-making and success.

To remain relevant, Ocean Knowledge 2030 will be adaptable in its implementation and aligned with evolving governmental priorities and economic governance framework. Within its implementation framework, priorities, actions and KPIs will be regularly assessed and adjusted to ensure alignment with policy, economic, technological, environmental, and other developments. This implementation approach, coupled with open communication and a commitment to shared goals, will optimise the strategy's impact and allow it to flexibly support new government initiatives, keeping Ocean Knowledge 2030 both resilient and responsive.

²Indecon International Economic Consultants, (2021). **Interim Review of the National Marine Research & Innovation Strategy 2017-2021**, Marine Institute, Ireland

Throughout the strategy the term 'research, knowledge and innovation' abbreviated to 'RKI' is used to encompass the breadth of scope of many of the identified gaps, challenges and proposed actions. 'Research' focuses on the generation of new knowledge through original investigation utilising systematic experimental or empirical methodology, while 'innovation' refers to the application of such knowledge to deliver new solutions, products, or services to real-life challenges, whether in a commercial setting or supporting outcomes in the public interest. 'Knowledge' is included to take account of the enormous bank of existing knowledge that already exists within the system, whether in research or technical publications and reports, or in the expertise of researchers in our academic institutions and public research bodies. As the title suggests, Ocean Knowledge 2030, is about applying knowledge, whether new or existing, to advance Ireland's ambitions in developing a productive and sustainable ocean economy, and in safeguarding and managing our extensive maritime area and marine resources.

End-users, beneficiaries and stakeholders of this strategy include, but are not limited to:

- Government and policy makers who rely on marine data for evidence-based decision making and developing policies related to climate action, environmental protection, resource management, and economic development
- Industry actors, including those in offshore renewable energy, fisheries, aquaculture, and shipping, who use, produce and/or depend upon innovations to enhance sustainability, competitiveness, and economic performance.
- Coastal communities and the public (citizens) who benefit from a healthy marine environment, climate resilience measures, and the long-term sustainability of Ireland's blue economy.
- Research and academic institutions who contribute to advancing scientific knowledge and fostering innovation that drives real-world solutions.
- NGOs and conservation groups who are focused on marine biodiversity and environmental stewardship.

These stakeholders will continue to be engaged throughout the strategy's implementation to ensure that marine research, knowledge and innovation translate into tangible outcomes that align with their needs, deliver public benefit, and support Ireland's climate resilience and sustainability objectives.

The guiding principles for the implementation of the strategy will include:

- Maintaining sustainability and stewardship of marine resources;
- Pursuing scientific excellence and innovation;
- Ensuring evidence-based decision making;
- Growing collaboration and partnerships;
- Enhancing stakeholder engagement;
- Fostering climate action and resilience,
- Safeguarding public good and societal impact.

2. LIVING WITH A CHANGING OCEAN

2.1 The Ocean-Climate Nexus: Ocean Physics and Chemistry

The seas and oceans that surround Ireland are part of a global ocean that covers 71% of the earth's surface and is changing on human timescales. Ocean processes, ecosystems and biodiversity are being impacted by human activities and human-induced climate change, most notably the continuing emissions of greenhouse gases (GHG) into the atmosphere. By absorbing more than a quarter of human-generated Carbon Dioxide (CO₂) and about 90% of the heat generated by the effect of greenhouse gases, the ocean has limited the warming of the planet and provided a buffer against the impacts of climate change. But this has come with consequences.

³ IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, et al (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–35. <https://doi.org/10.1017/9781009157964.001>.

⁴ **A sea of change: Europe's future in the Atlantic realm** (2021). Report of the European Academies Science Advisory Council (EASAC).

⁵ Nolan, G., Cusack, C., Fitzhenry, D. (Eds.) (2023). **Irish Ocean Climate and Ecosystem Status Report**. Marine Institute, Galway, Ireland, pp 192.

⁶ Thorne, P. et al, 2023, **Ireland's Climate Change Assessment: Synthesis Report**. Environmental Protection Agency, Ireland, 36 pp

Since 1993 the rate of ocean warming has more than doubled while marine heatwaves have doubled in frequency since the early 1980s and are increasing in intensity. Global sea level has risen by 0.2m since 1900 and the rate of global sea-level rise is accelerating³. The ocean has undergone increased acidification while ocean deoxygenation is becoming more widespread.

Several studies have suggested that the Atlantic Meridional Overturning Circulation (AMOC), a system of ocean currents, including the Gulf Stream, that transports warm, shallow water northwards, and returns cold deep water to the south, has weakened in recent decades. However, this is not yet confirmed as a trend, nor has a similar weakening been observed in the Gulf Stream. Neither is it yet clear how to distinguish any trends from underlying inter-annual to decadal variability. Nevertheless, a weakening of around 20% in the AMOC is expected by the end of this century and collapse remains a possibility in the longer term beyond 2100⁴, with profound implications for Europe's climate.

The changes in the seas around Ireland in many cases reflect those at regional (NE Atlantic) and global scale and are comprehensively synthesised in Irish Ocean Climate and Ecosystem Status Report 2023⁵. The detailed overview of the current status of climate and climate science in this report, and the EPA's Ireland's Climate Change Assessment Synthesis Report⁶, are of the highest societal and policy relevance.

Global mean figures can mask local and regional trends in key climate and ocean variables. Sea-level around Ireland has risen by 2-3mm per year since the early 1990s. Sea surface temperatures off Ireland's North Coast (Malin Head) were 0.47°C higher over the last 10 years compared to the period 1981-2010, while Irish surface coastal waters have become more acidic since the early 1990s, at a rate that is higher than the global average^{3,4}.

In response to these observed ocean and climate changes, substantial progress has been made nationally to advance legislation and to promote actions for climate mitigation and adaptation. The Climate Action and Low Carbon Development Act of 2015 (the Climate Act) subsequently amended in 2021, is the legislative basis for multiple climate plans, policies and new implementation structures, including the annually updated **Climate Action Plan** (CAP), the **National Adaptation Framework**, the **Climate Change Advisory Council**, the **National Framework for Climate Services** (coordinated by Met Éireann) and the establishment of four **Climate Action Regional Offices** (CAROs).

The successful implementation of the growing suite of national climate plans, policies and actions depends on robust scientific research, data and evidence. It is critically important for coastal States like Ireland to support ocean and coastal observing and research programmes and to monitor and understand changes that are taking place at an appropriate scale. Tracking a range of 'Essential Ocean Variables' (EOVs) and monitoring our changing coastline is essential to provide the data and evidence needed to inform policy and planning and to enable society and impacted economic sectors to adapt, mitigate and manage climate related impacts.

With the ambitious climate targets, policies and plans that are now in place, it is important that future research and technological innovations are targeted at the most critical knowledge gaps and at building national capacity for the long-term sustainable monitoring of essential ocean (including coastal) and climate variables. Research should be policy- and solutions-focused and address potential specific mitigation mechanisms such as blue carbon and marine carbon dioxide removal technologies, including research into their relative impacts and benefits.

The Framework to Guide Climate and Climate-Related Strategic Research and Innovation, established under the Climate Action Plan 2024, is a key mechanism to achieve this imperative. There is also a need to coordinate the increasingly complex research system that supports ocean, coastal and climate research across multiple programmes and investments. This will also ensure that Irish-based researchers can compete effectively for international research funding and foster a robust pipeline of research talent and expertise in collaboration with international partners.

Key Actions 2025-2026

Action	Implementation
<p>1. Ensure ocean and climate research challenges, including those identified in the Irish Ocean Climate and Ecosystems Report 2023, are incorporated in the annual Climate Action Plans and the outputs of the forthcoming Framework to Guide Climate and Climate-Related Strategic Research and Innovation.</p>	<p>DECC, MI, MÉ, GSI</p>
<p>2. Invest and build national capacity in ocean, seabed and coastal modelling, the development of sector-specific digital twins⁷, and the advancement of digital products and innovation to underpin national climate and planning policy and the provision of climate services.</p>	<p>MI, MÉ, GSI, DECC, DAFM, DHLGH</p>
<p>3. Establish an implementation and monitoring framework for the multiple research recommendations made in the Irish Ocean Climate and Ecosystem Status Report 2023 and a mechanism and resourcing to secure future updates of this national assessment at appropriate intervals.</p>	<p>MI, MÉ</p>
<p>4. Advance Ireland’s leadership role in international climate-related ocean and coastal research initiatives, including the Horizon Europe Missions, JPI Climate and JPI Oceans, World Meteorological Organisation marine and coastal programmes, and the contribution of Irish experts to the IPCC assessment process.</p>	<p>MI, EPA, MÉ</p>

⁷ In this strategy, digital twins refer to evolving digital models and tools that integrate real-time data and simulations to enhance the understanding, management, and sustainability of marine environments. As the technology advances, these tools will be utilised in diverse ways, from monitoring marine ecosystems to optimising offshore infrastructure, ensuring they meet the needs of the research and operational objectives.

2.2 Marine Geology, Seafloor and Coastal Change

Ireland has a coastline more than 7,500 Km in length and a maritime territory (Exclusive Economic Zone and extended continental shelf) of 488,762 Km², seven times its landmass. Since 1999 seafloor morphology and shallow geology has been systematically mapped through INSS and INFOMAR programmes. This a highly valuable state asset that directly addresses many research and innovation challenges, as laid out in Ireland's National Development Plan 2021-2030. Although initial mapping is scheduled for completion in 2026, there is still a need to enhance this data resource and maintain and grow expertise in order to build on the requirements of Action MA/24/3 of the government's Climate Action Plan 2024 and meet Ireland's obligations under SOLAS, the International Convention for the Safety of Life at Sea.

Seafloor composition and sub-seafloor information provide an underlying baseline for chemical, biological and human activity in the ocean, and reflect the changes in climate and oceanographic conditions experienced by Ireland. Further data collection and research is needed to improve understanding of sediment dynamics and transport systems both at open seas and coastal areas.

The biological dimension - including marine ecosystems and biodiversity - also plays a crucial role in shaping seafloor and coastal environments. Collaboration between geologists and biologists is essential to fully understand and manage these interconnected systems, such as joint research initiatives to study, for example, the interactions between marine organisms and sediment dynamics, the role of habitats such as coral reefs and seagrass meadows in stabilising coastal zones, and the impact of climate change on both geological and biological processes.

Rising sea levels and more frequent extreme sea level events (ESLs), combined with coastal erosion, are projected to have profound impacts on communities and infrastructure. It is also projected that much of this impact is expected to occur over the next decades and could potentially affect up to 2 million people, all the major cities, and much of the country's industry, infrastructure and utilities⁸. The Department of Housing, Local Government and Heritage established the **National Coastal Change Management Strategy** with a view to coordinated action through an integrated, whole-of-Government approach.

⁸ Report of the Inter-Departmental Group on National Coastal Change Management Strategy

Key Actions 2025-2026

Action	Implementation
5. Support capacity-building measures to enhance the future pipeline of talent and expertise in the areas of marine geology, geophysics, hydrography and coastal change.	GSI, MI, Research Ireland
6. Invest in national capacity in ocean mapping, geological and paleoclimate research, coastal behaviour, and the advancement of digital products and innovation to underpin national policies.	GSI, MI, DECC
7. Advance Ireland’s leadership role in international ocean mapping and coastal research, including the Horizon Europe, EMODnet and International Ocean Discovery Programme (IODP).	MI, GSI
8. Advance national coordination and data life-cycle management in ocean mapping and coastal change.	GSI, MI

2.3 Marine Biodiversity and Ecosystem Functioning

Ireland's marine habitats include deep offshore continental shelves and canyons, and a range of inshore coastal habitats from steep cliff faces to sandy and rocky sea shores, kelp forests, estuaries and salt-marshes. Ireland's marine ecosystems are home to a rich and diverse range of marine mega- and macro-fauna, including 24 species of cetaceans (whales, dolphins and porpoises), two seal species, 24 resident seabirds, 35 species of shark and more than 150 species of marine fish. In addition, our waters and seafloor sediments have abundant smaller invertebrates, algae, plants and micro-organisms which comprise an enormous diversity and biomass and are essential components in marine food webs and ecosystems.

However, the impacts of climate change and human activities pose substantial threats to marine biodiversity and the health and functioning of marine ecosystems. In recent decades, scientists have observed and documented changes in the geographical range and seasonal activities for many marine species resulting in altered species composition and abundance, and biomass production of ecosystems, from the equator to the poles.

In 2020, Ireland published its updated assessment to the EU's **Marine Strategy Framework Directive** (MSFD) which aims to protect and conserve the health of the EU's coasts, seas and ocean. It showed that five out of eleven descriptors had achieved good environmental status (GES) with three descriptors partially achieving GES (an updated assessment was initiated in 2024). Knowledge gaps and challenges remain, however, for the full and effective implementation of the MSFD including, for example, establishing appropriate monitoring methodologies for marine micro-litter.

The European Union's 2030 Biodiversity Strategy sets ambitious targets and commitments for 2030 to designate 30% of our maritime territory as Marine Protected Areas (MPAs), in line with equivalent commitments under the UN Convention on Biological Diversity (Kunming Montreal targets, 2021) and currently being transposed into national legislation via the forthcoming MPA bill.

Currently, Ireland has designated just under 10% of its maritime area as protected in the form of Special Protected Areas (SPA) and Special Areas of Conservation (SAC). The MPA bill will set out provisions regarding roles and responsibilities for the identification, designation and management of further MPA sites.

The recently agreed EU Nature Restoration Law will add another layer of legislation, aiming to strengthen progress in halting biodiversity loss and in restoring degraded ecosystems. The Horizon Europe Mission, Restore Our Oceans and Waters by 2030⁹, is also an important framework for EU Research & Innovation to progress science-based measures to protect and restore ecosystems, with measurable targets.

Protecting and conserving our marine biodiversity relies on essential research, data and evidence to understand both baseline conditions and patterns of change linked to climate change, the direct impacts of human activities or to natural variability. Ireland has a well-coordinated research community that is active in national and international research projects and programmes in the area of marine biodiversity and ecosystems research. The substantial research effort across the Higher Education Institutes is underpinned and augmented by statutory and science-driven marine monitoring programmes carried out by government bodies linked to EU Directives and other international commitments.

These programmes are crucial parts of the evidence base. However, there is potentially a deficit in the pipeline of talent and expertise in the area of marine biodiversity, taxonomy and ecosystems that will be needed to support the step-change in the requirements for scientific advice linked to the development of ORE, the establishment of a substantially larger network of MPAs, and other nature restoration efforts.

Key Actions 2025-2026

Action	Implementation
9. Support capacity-building measures to enhance the future pipeline of talent and expertise in the areas of marine biodiversity, taxonomy, ecology and ecosystems research.	MI, Research Ireland
10. Enhance Ireland’s leadership and participation in the second phase of the Horizon Europe Mission, Restore our Ocean and Waters by 2030.	MRFF, MI

⁹ Protect at least 30% and strictly protect 10% of EU’s Sea areas and achieve Marine nature restoration targets (incl. degraded seabeds, coastal ecosystems).

2.4 Offshore and Maritime Cultural Heritage

Underwater cultural heritage (UCH) within Ireland's maritime area is rich and diverse. Some 18,000 wrecks are recorded in the National Monuments Service's (NMS) Wreck Inventory of Ireland Database (WIID).¹⁰ Wrecks and other underwater archaeological sites and objects provide significant opportunities for research as they are the most abundant type of underwater archaeological site found in our maritime and coastal area¹¹.

A critical tool is the information contained in WIID, and its online companion, the NMS' Wreck Viewer (which provides information on the wrecks with known locations). WIID is an essential research tool for archaeologists, historians, developers, planners, marine leisure users, visitors to Ireland and many others. As new discoveries emerge or with the acquisition of new information on existing wrecks, it is also an ever-expanding resource.

Many of these sites also represent a shared heritage, whether it is the flag state or the nationality of those who were on board, or those who lost their lives. This common cultural heritage tells a far greater story than just the site itself. Many sites too, over time, become natural havens for marine life. Research opportunities, therefore, can range from the cultural, natural, social and historical, to development of new technologies to map and investigate.

Underwater heritage sites, including many wrecks found in deeper waters, are continually at risk from the impacts from human activities and climate change. The National Monuments Service is in the process of drafting a National Strategy on the Management and Protection of Ireland's Underwater Cultural Heritage, which will include defined high-level objectives and actions, including a proposal for a future research framework for UCH in Ireland.

Capacity building, particularly within our educational and academic institutions, will be of particular importance. There is also a need to continue expanding on existing collaborative approaches by statutory bodies, not least the continued combining of the data in WIID with the mapping of known wrecks and discovery of new wrecks by INFOMAR.

¹⁰ <https://www.archaeology.ie/underwater-archaeology/wreck-viewer>

¹¹ Advice to the Public on Ireland's Underwater Archaeological Heritage

One of Ireland's World Heritage properties is Sceilg Mhichíl, an offshore pinnacle of rock rising out of the Atlantic off the coast of County Kerry. Scelig's Outstanding Universal Value, inscribed in 1996 on UNESCO's World Heritage List, includes both the cultural and natural heritage. The National Monuments Service's draft World Heritage Strategy contains a strategic objective to develop a research framework, focused on innovation and international collaboration (Goal 6).¹²

NMS and INFOMAR have undertaken marine mapping to build knowledge of Sceilg's place within its maritime context. Notably, Ireland's first marine park, Páirc Náisiunta na Mara, Ciarraí (National Marine Park, Kerry), was established in 2024, covering an area of 280 Km2 of land and sea. Sceilg is now also located within the newly established marine park which enables a greater focus on conservation and opportunities for research, widening our scope of understanding the geology, biology, archaeology and seabed morphology located in the waters around it.¹³

Key Actions 2025-2026

Action	Implementation
11. Support capacity-building measures to enhance future research on Underwater Cultural Heritage (UCH) within the public and private sectors and educational institutions.	NMS, GSI, MI
12. Support existing and develop new research frameworks for UCH & World Heritage marine areas across multiple stakeholders.	NMS, GSI, MI
13. Build on existing and develop new ways of raising awareness of the importance, value and benefit of UCH as a key part of our marine environment, responsible ocean protection and sustainable blue economy.	NMS, GSI, MI

¹² <https://www.gov.ie/en/consultation/bd4cb-public-consultation-on-strategy-for-world-heritage-in-ireland-2024-2034/>

¹³ <https://www.nationalparks.ie/kerry-seas/#:~:text=Our%20Marine%20National%20Park,Heritage%20Property%20of%20Sceilg%20Mhich%C3%ADL>

2.5 Ocean Governance and Law

Ocean governance addresses the legal, planning and policy frameworks that seek to manage and regulate multi-dimensional and interconnected human activities in the ocean space. Ocean governance is applied at multiple geo-political and temporal scales; there is no single policy, institution or actor that has exclusive authority in this realm. There are routine challenges faced by policymakers in Ireland to integrate EU and international commitments into national policy and management frameworks. However, the last five years have seen substantial changes in national policy, planning and legislation pertaining to the usage of maritime space and commercial activities at sea which also have implications for the conduct of marine scientific research and data collection.

The **Maritime Area Planning Act 2021** represents the biggest reform of marine governance since the foundation of the State. This critical piece of legislation brings marine planning and consenting up to date and, in particular, enables the state-led planned expansion of Offshore Renewable Energy (ORE), all managed within the **National Marine Planning Framework** (Ireland's Marine Spatial Plan) and operationalised through the establishment of a new authority, the **Maritime Area Regulatory Authority** (MARA).

Forthcoming legislation on Marine Protected Areas will provide the legal basis for Ireland to meet its EU and international commitments to designate 30% of its maritime area as MPA by 2030. Given the scale of legislative reform, challenges are expected in relation to cross-compliance and conflicts may arise from complex interactions between legal and policy instruments. In this context, there is a greater need to ensure that Ireland retains and builds its national capacity and expertise in maritime law, ocean governance and integrated marine policy and planning. At the same time, Ireland has responsibilities to contribute to international ocean governance through participation in multiple EU and UN assessments, working and advisory bodies, including initiatives under the United Nations Convention on the Law of the Sea, UN Safety of Lives at Sea, the International Maritime Organisation, the International Seabed Authority and the International Oceanographic Commission of UNESCO.

The 2023 **UN Agreement on Marine Biodiversity Beyond National Jurisdiction** (BBNJ) is expected to enter into force in the coming years. The BBNJ Agreement, in broad terms, aims to close significant gaps in global ocean governance by providing a framework to enhance protection of the marine environment. A crucial feature of the Agreement is a global mechanism for establishing marine protected areas (MPAs) in areas beyond national jurisdiction, namely the high seas and international seabed. These areas comprise two thirds of global ocean space but only 1% is presently protected by MPAs, far short of what is envisaged by the "30 by 30" target of the Kunming-Montreal Global Biodiversity Framework agreed at the Convention on Biodiversity COP15 in December 2022. In addition to its provisions on MPAs, the Agreement will strengthen the global regime for the conduct of environmental impact assessments (EIAs) for activities that may have an impact on the marine environment in areas beyond national jurisdiction. Furthermore, the Agreement makes provision for a benefit sharing mechanism in respect of marine genetic resources (MGRs) and contains provisions on capacity building and technology transfer to support developing countries.

In 2023, the Government announced its support for a precautionary pause of deep-sea mining on the international seabed, which is regulated by the International Seabed Authority, of which Ireland is a member. Ireland's position is that no deep-sea mining should take place until such time as a robust regulatory framework is in place to protect the marine environment and the scientific knowledge base is sufficient to allow for informed decision-making. Similarly, the government's [Policy Statement on Mineral Exploration and Mining](#) (December 2022) provided that mining activity should not take place on the Irish seabed until such time as sufficient data is available to adequately assess the potential impacts.

Key Actions 2025-2026

Action	Implementation
<p>14. Coordinate the necessary research, skills and capacity assessments required to inform the ongoing development of the State's planning, consenting and regulatory functions and the associated mechanism to ensure provision of relevant data and evidence to inform their activities.</p>	<p>DECC, MARA, DHLGH, ABP, DAFM, MI</p>
<p>15. Commission a desk-based study to ascertain the national impacts and implications of the BBNJ Agreement, and to examine how Ireland can best contribute to achieving the objectives of the Agreement through marine research, and through related capacity building and transfer of marine technology activities to assist developing countries.</p>	<p>MI, DFA, DHLGH</p>
<p>16. Contribute to BBNJ-related capacity building and transfer of marine technology activities to assist developing countries, including through the provision of training/placement opportunities to scientists from developing countries.</p>	<p>MI, DFA, DHLGH</p>
<p>17. Support and contribute to marine research relating to deep-sea ecosystems and related matters to help to inform the work of the International Seabed Authority, and support and contribute to relevant capacity building activities to assist developing countries.</p>	<p>MI, DFA, DHLGH</p>

2.6 The Ocean's Benefit and Service to Society

There are multiple ways that people benefit either directly or indirectly from the ocean. Marine ecosystem services are the services provided by the processes, functions and structure of the marine environment that directly or indirectly contribute to societal welfare, health and economic activities¹⁴. Ireland's marine resources provide a range of ecosystem services and benefits that contribute to societal welfare, health and economic activities. This includes provisioning services, regulation and maintenance services, and cultural services that can have both market and non-market values.

Marine biodiversity, for example, plays an important role in providing ecosystem services such as fisheries, aquaculture, biotechnology and an arena for tourism and recreation. The many shipwrecks and submerged archaeological sites which have been documented and mapped by the National Monuments Service¹⁵ and the INFOMAR¹⁶ programme in Ireland's territorial waters are an important part of our maritime cultural heritage and the object of archaeological study. Our marine environment also provides a number of regulating services such as carbon sequestration¹⁷. Ireland's stock of coastal, shallow water and tidally influenced blue carbon ecosystems such as seagrass beds and saltmarshes are estimated to store at least 9.2 Mt of carbon. The market values of these services can be quantified in monetary terms by the economic methodologies. Non-market values can also be quantified in monetary terms and further research is needed to advance consistent approaches in quantifying these ecosystem service monetary values.

The relationships between people and the ocean have been the subject of the ocean literacy movement for more than a decade and national efforts are now coordinated under the **Irish Ocean Literacy Network** (IOLN). About 40% of the Irish population lives within 5km of the coast, and coastal communities and businesses are intimately connected to their coastal and marine landscape and infrastructures but are also on the front line of climate change and extreme weather events. Understanding the attitudes and perceptions of citizens in relation to the role of the ocean in their lives and their own impacts on the ocean is an important field of social study in its own right. Building our national capacity in social and economic research linked to the ocean's relationship with society will be important to enable some of the major developments that are planned over the next decades, including the installation of offshore renewable energy infrastructure.

¹⁴ Austen M.C., et al (2019) **Valuing Marine Ecosystems - Taking into account the value of ecosystem benefits in the Blue Economy**. Future Science Brief 5 of the European Marine Board, Ostend, Belgium. 32pp. ISBN: 9789492043696 ISSN: 4920-43696 DOI: 10.5281/zenodo.2602732

¹⁵ <https://www.archaeology.ie/underwater-archaeology/wreck-viewer>

¹⁶ www.infomar.ie

¹⁷ Cott, G. M., Beca-Carretero, P., and Stengel, D. B. (2021). **Blue Carbon and Marine Carbon Sequestration in Irish Waters and Coastal Habitats**. Marine Institute, Ireland.

¹⁸ Garcia-Soto, C., et al. (2017) **Advancing Citizen Science for Coastal and Ocean Research**. Position Paper 23 of the European Marine Board (EMB), Ostend, Belgium. 112pp. ISBN: 978-94-92043-30-6

In addition, citizen science is a research methodology which, if used correctly, offers huge potential to further scientific knowledge and to influence the environmental impacts of society through behavioural education. Marine citizen science also empowers citizens to engage constructively in the development and implementation of truly fit-for-purpose and evidence-based maritime policy¹⁸.

Key Actions 2025-2026

Action	Implementation
18. Advance national coordination and capacity in marine socioeconomics, environmental and ecosystem accounting and ocean economy measurement, making further progress towards an ocean economy satellite account for Ireland.	DECC, MARA, MI
19. Establish a biannual ‘Ocean Barometer’ survey on citizen attitudes and perceptions on ocean health, policies, issues and impacts.	MI, DFA, DHLGH
20. Investigate opportunities for a funding mechanism enabling bottom-up citizens’ initiatives, complementary to existing funding instruments in this area (e.g. Community Climate Action Programme) and local government interventions.	MI, DFA, DHLGH

3. TOWARDS A SUSTAINABLE OCEAN ECONOMY

Across multiple sectors, from seafood production, to shipping and ports, or coastal and marine tourism, the future ocean economy will be data and knowledge-driven and employ advanced technology and engineering. This new ocean economy 'puts science and predictive capabilities to work in a way that can fill critical, fast-rising needs across sectors. This economy is entrepreneurial and environmentally responsible, collaborative and competitive¹⁹.'

¹⁹ Spinrad, R.W. (2016). The New Blue Economy: A Vast Oceanic Frontier

The ocean economy is defined as any economic activity that directly or indirectly uses the sea as an input or produces an output for use in a sea-specific activity. It includes a range of established and emerging sectors that provide essential employment in coastal regions. Since 2016, the Marine Institute and the Socio-Economic Marine Research Unit in the University of Galway have co-produced an annual report on Ireland's Ocean Economy which provides a periodic update and trends analysis on the ocean economy across three main economic indicators: turnover, gross value added (GVA) and employment (full-time equivalents or FTEs).

The 2023 report²⁰ provides the most recent figures for the reporting year 2022. In terms of direct impact, the ocean economy generated €7.01 billion in turnover, a GVA of €2.85bn and supported 33,452 jobs (FTEs). This time-series data tells us that the ocean economy has approximately doubled in size across all three indicators in the fifteen-year period since 2007. While this is positive, there is potential for this steady state growth to be replaced by a much greater rate of growth in the next decade, driven largely but not exclusively by the expansion of offshore renewable energy and associated value chain activity.

There are multiple Research, Knowledge and Innovation (RKI) needs and opportunities, to address critical knowledge gaps, underpin technology development, address policy, planning and governance challenges and underpin innovation in the development of new products, processes and business models.

Here we identify the key RKI priorities that need to be addressed to underpin sectoral growth and development, along with key actions to facilitate progress, in five key sectors:

- Sustainable food from the ocean
- Energy from the ocean
- Greener and smarter ports and shipping
- Tourism in coastal and marine areas
- Safe and secure seas.

²⁰ Reilly, K., O'Leary, J., Hynes, S., and Clancy, K. (2023). Ireland's Ocean Economy, 2023. SEMRU, University of Galway and Marine Institute

3.1 Sustainable Food from the Ocean

The rapid rise in global population and challenges associated with land-based food production mean that food from the ocean is becoming increasingly important for nutrition, livelihoods and global food security. Fisheries and aquaculture products are an important source of protein and can form a crucial component of a healthy diet. The world's consumption of fish or seafood has risen from a per capita average of 9 kg in the 1960s to 20.2 kg in 2022, with an EU average in 2019 of 25 kg per capita. In order to maintain this level of consumption in 2050, aquatic food production would need to grow by 22% globally (14% in Europe) (FAO, 2023)²².

Recent reports indicate that the ocean could provide six times as much food as it does today, in particular through growth in low-impact, regenerative aquaculture²³. Globally, therefore, a key challenge is to reconcile the required increase in production, with challenges such as declining fishery resources, inadequate governance frameworks, illegal unregulated and unreported (IUU) fishing, marine ecosystem degradation, competition for ocean space, and the impacts of climate change.

Achieving a sustainable supply of safe, secure and nutritious seafood requires a holistic food systems and circular bioeconomy approach, taking account of the full value chain from catch/production to consumption and management of waste streams. The pandemic, and increased geo-political tensions, have interfered with global supply chains and threatened food supply. The increasing focus within Europe on strategic autonomy also supports food sovereignty for EU Member States and emphasises increased importance of local production systems.

The seas around Ireland are among the most productive and biologically sensitive areas in EU waters. Fisheries, aquaculture and seafood processing are established sectors for Ireland's ocean economy, with a combined Gross Value Added (GVA) of €360m in 2022. In the same year, total production (fisheries and aquaculture) of marine fish and shellfish by volume amounted to 309,100 tonnes with a first sale value of €637m. The seafood sector employed approximately 8,145 FTEs with a further 7,528 jobs provided through downstream, value-chain enterprise²⁴, providing important employment opportunities in peripheral regions around the Irish coast.

²² FAO State of World Fisheries and Aquaculture 2022

²³ Costello, C., L. Cao, S. Gelcich et al. 2019. *The Future of Food from the Sea*. Washington, DC: World Resources Institute. Available online at www.oceanpanel.org/future-food-sea

²⁴ Source: *The Business of Seafood 2023*. Numbers include landings of non-Irish vessels in Irish ports

Seafood forms part of the broader focus on Ireland's ambition to become a world leader in sustainable food systems, as outlined in Food Vision 2030²⁵. Food security and nutrition are key components of Sustainable Food Systems, particularly the link between food and health. In line with national and EU²⁶ and international²⁷ policy objectives, Ireland's seafood sector needs to accelerate its development towards low impact, knowledge-driven, high-tech and climate neutral production, optimising opportunities for equitable employment, innovation, food security, and sustainable economic growth in coastal areas.

A key challenge will be to continue to develop the seafood sector in the context of a rapidly changing use of marine space that will result from the planned expansion of Offshore Renewable Energy (ORE) and meeting EU and international commitments for conservation of marine ecosystems and biodiversity (including the designation of 30% of Ireland's maritime area as Marine Protected Area by 2030).

Research, Development and Innovation (RDI) are central to addressing these complex challenges and to creating knowledge and opportunities for development of a sustainable and climate-neutral seafood sector. Research impact can be strengthened by embedding co-creation and co-implementation practices, involving industry, coastal communities and other stakeholders.

²⁵ Food Vision 2030 – A World Leader in Sustainable Food Systems

²⁶ EU Farm to Fork Strategy.
https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

²⁷ FAO Blue Transformation Roadmap 2022-2030.

Research, Knowledge and Innovation Priority Areas

New tools, technologies and business opportunities

Continued development and application of new tools and technologies (Aquatech and Biorefinery) in support of sustainable seafood production and processing, including land-based Recirculating Aquaculture Systems (RAS), novel feed solutions, digital tools, Artificial Intelligence (AI), marine engineering, fish health and genetics.

Support for marine biotechnological research to support innovation in the development of high-value non-food products and services (e.g. marine proteins), promoting the use of side streams and other biomass and advancing circular bioeconomy principles.

Investigation and assessment of the potential for lower-trophic level, mesopelagic biomass as a target for fisheries, including understanding of the potential impacts on food chain dynamics, oceanic carbon-cycling and ecosystem functioning and the viability of associated seafood products for domestic and international markets.

Transition to low impact, climate-neutral and sustainable seafood production

Further development of low-impact, non-fed aquaculture, in particular seaweed and molluscs; integrated multi-trophic aquaculture; and opportunities for co-location of aquaculture with other developing offshore activities (e.g. offshore wind developments).

Adaptation of seafood production (capture fisheries and aquaculture) to the impacts of climate change including warming seas, sea-level rise, ocean acidification, extreme weather events and transitioning to a 'green' supply chain (fishing fleets, production, processing, transport, etc.) and circular blue bioeconomy²⁸.

Increase research, knowledge and expertise on emissions and resource use by the seafood sector balanced against carbon sequestration and other ecosystem service provision by the sector and how this is regulated for optimum outcomes.

Governance aspects and coexistence with other activities

Further development of frameworks for and application of Integrated Ecosystem Assessments in the context of ecosystem-based fisheries management, to inform policy and management decisions taking account of ecological, social and economic factors.

Fish welfare, seafood safety and traceability in support of producers and consumers

Advancing science-based measures to detect, monitor and address fish/shellfish disease and contamination, fish welfare, seafood safety and traceability in support of producers and consumers.

²⁸ Ireland's Bioeconomy Action Plan 2023-2025

Societal benefit and health aspects of seafood

Increased RDI capacity and activity on the role and importance of seafood in terms of nutrition, health, and well-being both nationally and globally, and the value consumers place on the sustainability of seafood products.

Developing and applying marine economics and socioeconomics (including Natural Capital Accounting), social sciences and humanities applications for sustainable seafood sectoral development. (e.g. social licence, measurement of economic activity, links to ecosystem service provision).

Key Actions 2025-2026

Action	Implementation
<p>21. Design and implement a dedicated RDI programme on ‘Sustainable Food from the Ocean’ with coordinated funding and multi-annual calls linked to the RDI priorities set out above. The programme should target tangible and measurable impacts in advancing all stages of the seafood value chain, taking account of barriers linked to markets and regulation to deliver a world-class seafood production that is sustainable, circular, safe, secure and supporting innovation across the value chain.</p>	<p>MI, DAFM, BIM, Teagasc</p>
<p>22. Align cross-programme opportunities to support research in the blue bioeconomy leveraging national funding mechanisms and EU programmes including the European Maritime Fisheries and Aquaculture Fund and the Sustainable Blue Economy Partnership (SBEP) and Circular Biobased Europe (CBE JU), promoting the transition to sustainable, low-carbon, low impact seafood production.</p>	<p>MI, BIM, Research Ireland, DAFM</p>

3.2 Energy from the Ocean

The EU Green Deal sets Europe on course to be the first climate neutral bloc globally by 2050. This is matched with ambitious targets for climate action and decarbonisation of our energy systems. The move away from fossil fuels, initially driven by climate and sustainability factors, is now also an imperative for Europe's energy security in light of the Russian invasion of Ukraine and other global geo-political factors, influencing a move towards greater strategic autonomy for the continent.

In successive Climate Action Plans since 2021, Ireland has matched the ambition of the EU in setting a target to become a zero emissions economy by 2050, with a specific target to reduce GHG emissions to 51% of 1990 levels by 2030²⁹. Our transition to renewable sources of energy will be a substantial component of the change needed to meet these climate targets. The largest and most important arena for building a renewable energy infrastructure is our 490,000 km² maritime area with wind and wave conditions that make it a significant potential resource for energy generation.

Ireland has set specific targets for offshore renewable energy which has required a transformation of our regulatory and planning regime and modification of our governance and institutional arrangements. These targets require that we will achieve 5 GW of offshore wind energy production by 2030, rising to 20 GW in 2040 and 37 GW by 2050 through the construction of offshore wind developments off our eastern, southern and western coasts³⁰. Achieving our 2050 target could enable Ireland to become a net exporter of renewable electricity to our European neighbours.

Building a new offshore energy infrastructure at scale brings with it complex and interconnected technological, environmental and social challenges. The offshore energy transition will be State and plan-led and will require a substantial knowledge and evidence base to aid policy, planning and management. The development of ORE installations will also significantly impact existing maritime activities, including for example, fisheries, aquaculture and maritime transport. These sectors are vital for coastal economies, food security, and cultural heritage. Potential conflicts and synergies between ORE and these traditional marine industries need to be carefully studied and managed.

A major enabler for ORE development is the provision of data and digital products and services to establish baseline conditions, including for example the high-resolution INFOMAR marine maps provided by the Marine Institute and Geological Survey Ireland. These are critical to de-risk investments, to aid decisions on where to locate developments, and to avoid, mitigate and minimise impacts on the physical and biological components of the offshore ecosystem, as well as potential impacts in other areas including underwater cultural heritage.

²⁸ <https://www.gov.ie/en/publication/79659-climate-action-plan-2024/>

²⁸ <https://www.gov.ie/en/publication/0566b-future-framework-for-offshore-renewable-energy/>

While technological advances continue to be made, offshore wind energy generation has been at commercial deployment stage for two decades in Ireland. Nonetheless, there remain significant RDI challenges to reduce cost, optimise efficiency and lifecycle and to understand, manage and mitigate impacts on the environment and on other maritime sectors. Prototype technologies for wave and tidal energy have not progressed to commercialisation at the rate that had been anticipated 20 years ago, and there remains a continued need to reinvigorate the advancement of these technologies as well as the potential for other ORE generators in the future.

The national capacity for ORE RDI was deemed to be at a mature level in the ex-post evaluation of the previous National Marine Research & Innovation Strategy, with a high level of expertise across the RDI ecosystem, support in place for MaREI as a Research Ireland Centre, and advanced research infrastructures and a RDI community that is well networked internationally³¹. Building upon this national capacity will be essential to support further RDI in the future, while integrating EU and international programmes and knowledge, such as the work of the European Space Agency through e.g. satellite-based monitoring, precise positioning, climate data and programmes such as Copernicus and Galileo.

³¹ Indecon International Economic Consultants, (2021). **Interim Review of the National Marine Research & Innovation Strategy 2017-2021**, Marine Institute, Ireland.

Research, Knowledge and Innovation Priority Areas

There have been many assessments internationally of RDI needs in relation to ORE and offshore wind energy in particular. The European Marine Board identified critical policy and research needs in its 2022 Future Science Brief, *European Offshore Renewable Energy: Towards a Sustainable Future*³². These needs are almost all relevant and applicable to the Irish context. Domestic economic opportunities which have been identified in the sector will be leveraged through strategic plans to promote technological innovation. There are 40 actions set out in *Powering Prosperity: Ireland's Offshore Wind Industrialisation Strategy*³³ and 29 actions set out in the *Future Framework for ORE Policy Statement*³⁴, which both include specific RDI-focused actions necessary to the effective delivery of our national targets.

Given the complexity of the challenge to establish an entirely new energy generation system in exposed offshore environments, the RDI needs are multi- and interdisciplinary and cross-sectoral. An aggregated set of RDI priorities is presented here under the four general categories of technological, environmental, governance and planning, and economic and social.

Technology and engineering for generation technologies, station keeping, turbine optimisation and grid integration.

Offshore Wind: Continue support to further advance wind technologies, particularly for floating wind platforms, in relation to anchoring systems and foundation designs suitable for Ireland's challenging offshore environment. Design for optimised offshore wind farm layouts, grid integration, and the impact of offshore wind on marine ecosystems. National supports should be targeted at advancing value chain products and services that offer opportunities for domestic companies to innovate and grow their businesses.

Wave Energy: Consider the support for developing efficient wave energy converters (WECs) that can withstand harsh marine conditions, improve power conversion efficiency, and reduce maintenance costs. Research can also explore the integration of wave energy converters into existing and future offshore infrastructure including wind farm arrays.

Tidal Energy: Support further development of innovative tidal turbine technologies, optimised rotor designs, and advanced monitoring systems. Additionally, research can explore the environmental impact of tidal energy installations and potential strategies to mitigate any negative effects on the receiving environment.

Energy Storage and Grid Integration: Support advanced energy storage systems, grid management solutions to address the connection of offshore renewables to the onshore grid/network and demand-response mechanisms to address the capacity to manage intermittent generation sources with dispatchable types of energy generation to ensure a stable and reliable power supply.

³² Soukissian, T. et al (2023) *European offshore renewable energy: Towards a sustainable future*. Future Science Brief No. 9 of the European Marine Board, Ostend, Belgium. ISSN: 2593-5232. ISBN: 9789464206173. DOI: 10.5281/zenodo.7561906

³³ <https://enterprise.gov.ie/en/publications/powering-prosperity.html>

³⁴ <https://www.gov.ie/en/publication/0566b-future-framework-for-offshore-renewable-energy/>

Understanding and managing environmental impacts

Support integrated research and monitoring studies to better understand the impacts (both negative and positive) of ORE installations and infrastructure development on marine biodiversity, ecosystems and habitats, including collision risk, underwater sound, electromagnetic fields, habitat impacts, marine refugia potential, and artificial reef effects and their expected future dynamics in the context of climate change.

Support integrated research to better understand potential impacts of ORE installations and infrastructure development on underwater cultural heritage, in areas of scour, erosion, sand movements, and climate change.

Knowledge for optimum governance, policy and planning

Investigate alignment and cross-compliance across diverse marine and coastal legislative and planning instruments to integrate ORE within a wider policy environment.

Provide rapid response instruments to support specific knowledge needs for policy proposals being developed by competent government departments and the Offshore Wind Delivery Taskforce³⁵.

Identify and address gaps in national datasets and regulatory processes to inform evidence-based policy and decision making for planning, consenting and environmental permitting to better enable project delivery, identify benefits and mitigate ecological and socioeconomic impacts of ORE.

Economics, socioeconomics, social and cultural

Social and behavioural research to support societal and local community understanding and the social license to operate for essential ORE projects.

Research to track and predict impacts of ORE deployment on other maritime sectors (notably seafood and maritime transport) as well as impacts on other users, while optimising potential co-benefits and minimising potential for conflicts.

³⁵ <https://www.gov.ie/en/publication/c8749-offshore-wind-delivery-taskforce/>

Key Actions 2025-2026

Action	Implementation
<p>23. Increase and improve national coordination in providing targeted RDI supports to ORE value chain SMEs through existing and new programmes and calls. Maximise the value of research and innovation activities, where relevant, through business coaching, facilitating collaboration and wider enabling support. Ensure close coordination and alignment of different national RD&I programmes, and engagement with international, EU and European Space Agency programmes and coordination forums.</p>	<p>SEAI, EI, MI, Research Ireland, DETE, MÉ</p>
<p>24. Accelerate progress on agreed actions under Powering Prosperity (Actions 26, 27, 28) and the Future Framework for ORE (Actions 3, 4) to plan, promote, support engagement with and use of existing marine test & demonstration facilities/sites and explore feasibility of additional marine test site (e.g. for Floating Wind).</p>	<p>SEAI, DETE, DECC, MI</p>
<p>25. Develop a focused ORE Research & Innovation Strategy for Ireland with clear objectives, building on the ORE Technology Roadmap, and addressing gaps in support and monitoring ongoing technology developments and innovations³⁶.</p>	<p>SEAI</p>

³⁶ Action included in the SEAI ORE Technology Roadmap

3.3 Greener and Smarter Ports and Shipping

Maritime transport is responsible for moving 90% of Ireland's external trade³⁷. Virtually all sectors of the Irish economy rely on maritime transport within their supply chains. As a result, shipping routes between Ireland and our international markets are critical arteries for trade and Irish ports represent infrastructures of strategic national importance. Ireland's supply chains are also inextricably interconnected with the global supply chain system. The twin shocks of Brexit and COVID-19 resulted in renewed emphasis on improving Ireland's maritime connectivity to international markets, building additional resilience into our ports and shipping services and driving efficiency and competitiveness throughout the maritime industry.

Shipping is one of the least carbon-intensive ways to transport goods, generating 2.9% of global anthropogenic CO₂ emissions in 2018. In the EU, ships generated 13.5% of all greenhouse gas (GHG) emissions from transport in that year, substantially less than road transport (71%) and aviation (14.4%)³⁸. As a heavy transport sector and one of the most internationalised of industries, sustainability and the need to deliver a better environmental performance is, nonetheless, a key driver of change in the maritime sector.

The 'Fit for 55' package, a set of legislative measures introduced in 2023 under the EU Green Deal, includes the FuelEU regulation, which seeks to transition the EU maritime sector towards carbon neutrality. This transition is already underway and will have significant implications for ship size and design; for ports and shoreside power infrastructure; and for skills and training of existing workers and new entrants to the sector. The inclusion of 2GW of Green Hydrogen in Ireland's climate targets and the potential for this to be exported in large volumes on vessels specifically constructed or adapted for that purpose, could also open a new opportunity for increased maritime transport business.

The need for the maritime transport sector to transition more broadly to a sustainable, resilient, efficient and digital future is reflected equally in the development needs for Ireland's ports. Ports play a crucial, yet often overlooked, role in facilitating economic growth and prosperity. As an island nation we depend on the quality and efficiency of our port services to a much greater degree than many of our trading partners³⁹. There are particular opportunities linked to the development of smart ports, including introducing digital systems and processes for trade and shipping services that increase efficiency, while reducing costs and negative environmental impacts.

³⁷ https://www.imdo.ie/Home/sites/default/files/IMDOFiles/IMDO_Docs/IMDO%20IMTE%20VolI%2020%202023.pdf

³⁸ European Maritime Transport Environmental Report 2021. European Environment Agency (EEA)

³⁹ The National Ports Policy 2013

Ports, in particular regional ports, also provide substantial potential to diversify and to become clusters of blue economy business and activity, enhancing their traditional activities and attracting and hosting new business linked to evolving sectoral demands (e.g. ORE, aquaculture) and associated supply chains. Currently, there is insufficient consensus in the shipping industry in relation to fuels of the future to enable ports to invest in future infrastructure with confidence. Economic and social analysis will be key to inform policy and planning in relation to the growth in regional port capacity, port infrastructure development (e.g. for ORE, alternative fuels), the establishment of Green Shipping Corridors, and the development of ports as blue economy hubs.

The Irish Maritime Transport Economist⁴⁰ has tracked the development of the industry for more than 20 years and has established the correlation between the growth of the industry and that of the national economy. According to the Ireland's Ocean Economy Report, 2023, Shipping and Maritime Transport was the largest ocean economy sector in 2022 in terms of direct turnover, which amounted to €2.45bn in that year. The sector generated €664m in Gross Value Added and directly employed 4,728 FTEs. There are challenges and opportunities for the future development of this critical national sector that will require research, knowledge and expertise. These can be supported through coordinated capacity building measures within the Irish RDI system but also through integrating better and delivering greater impact through participation in EU and international programmes.

Research, Knowledge and Innovation Priority Areas

Research can improve Ireland's responses to complex questions in areas such as maritime economics, management of port infrastructure and investment, digital transformation, the achievement of climate neutrality, and cyber security. The importance of these questions calls for a co-ordinated research response that will ensure the Irish maritime industry remains fit for purpose and knowledge, data and evidence are employed to deliver a competitive advantage across all parts of the maritime transport sector.

Understanding indigenous and exogenous drivers and pressures affecting the sector

Economic, technical and policy analyses to define a baseline understanding of the current status and future development needs of Ireland's maritime transport ecosystem in an international context.

RDI to assess potential impacts and implications for maritime transport and port capacity of developments in other marine and maritime sectors, notably the impending rapid development and expansion of Offshore Renewable Energy (ORE).

Green and smart shipping

Developing innovations in ship design, technology, operations and efficiencies to meet sustainability and climate change challenges through cleaner fuels and efficiency, noise and vibration impacts on the environment, pollution (including ballast water and alien species) and impacts of extreme weather conditions on sector operations.

⁴⁰ Irish Maritime Transport Economist (Irish Maritime Development Office)

There are questions to be answered in relation to the particular fuels and vessel types that will be used in the Irish shipping market. Research is needed to answer these questions and to inform port investments and policy decisions.

Consider expanded opportunities for vessel participation in marine environmental observing programmes such as Voluntary Observing Ship and Ship of Opportunity programmes.

Smart ports

RDI to inform policy and practice linked to the diversification of business activity for Irish ports and their potential to act as hubs for both primary and related services and activities such as logistics, distribution, training and education, marine technologies, coastal and marine environmental monitoring, and coastal tourism.

RDI to inform the advancement of digitalisation across Ireland and Europe's ports and maritime transport system and develop a suite of port performance metrics, unique to the circumstances that prevail in each port. Such analyses will enable evaluation of how ports are delivering and when and if ports need to add capacity.

Economic and social analysis will be key to inform policy and planning in relation to the growth in regional port capacity, port infrastructure development (e.g. for ORE, alternative fuels), and the development of ports as blue economy hubs.

Fostering resiliency across all parts of the sector

Multi-disciplinary research to understand the threats and challenges to successful transition of the maritime transport sector (ports and shipping) and its workforce in the face of climate change and climate action impacts and the transition to a low-carbon, digital future to inform policy and practice, underpinning resilience across all aspects of the sector.

Key Actions 2025-2026

Action	Implementation
26. Engage with strategic partners in the UK and EU to identify opportunities for joint transnational investments and projects in greener and smarter ports and shipping, leveraging international funding streams.	MI, DoT
27. Undertake a maritime RDI capacity assessment to determine capability within the system and critical gaps in knowledge and expertise that should be addressed through capacity building investments.	MI

3.4 Tourism in Coastal and Marine Areas

Coastal and marine tourism constitutes approximately 50% of all global tourism, equal to US\$4.6 trillion or 5.2% of global gross domestic product (GDP). It is a vital component of the economy of small islands and coastal communities⁴¹. In 2022 marine and coastal tourism in Ireland generated an estimated turnover of €1.3bn, a direct GVA of €535m and employed 18,325 FTEs⁴². It was the third largest marine and maritime sector in terms of turnover and GVA (after maritime transport and oil and gas exploration), but by a considerable margin the largest and most important sector in terms of the employment it provides. A sizeable fraction of these businesses and jobs are located in peripheral coastal regions where alternative employment options can be limited, adding to the sector's importance as a regional economic driver.

The establishment in 2013 of the **Wild Atlantic Way** has demonstrated the potential value of applying innovation in branding Ireland's tourism assets in a manner that has been transformational. Almost 2m more tourists visited the Wild Atlantic Way in 2023 compared with 10 years earlier, while tourism revenue on the route increased by 59% to €3bn and jobs by more than 40% in the same ten-year period.⁴³ Understanding the drivers of this success is key to ensuring continued innovation in the tourism sector.

Previous studies by the Socio-Economic Marine Research Unit (SEMURU) at the University of Galway not only provide an important understanding of the sector but also offer definitions that distinguish between coastal tourism, marine tourism and water-based activity tourism^{44,45} (in these reports international cruise tourism is considered a separate maritime sector). This categorisation is important as it enables a systematic approach to understanding the sector as a whole and more targeted supports and interventions to be devised to support the development of each activity.

There are specific characteristics that set tourism in coastal and marine areas apart from other maritime sectors. The sector includes a large number of micro-SMEs and family businesses, inherent seasonality, access to labour, insecure employment, and often tight margins. Among other pressures, many of these businesses are increasingly exposed to the impact of climate change and extreme weather events which can directly impact their cost-base, viability and in extreme cases, their survival. Tourism businesses are not generally set up to support in-house research and innovation in the way, for example, a high-tech start-up might be. Determining the research knowledge gaps and needs can, therefore, be challenging, but there are undoubtedly opportunities for businesses to innovate, to leverage data and information, to apply technologies to reduce costs and increase efficiencies, and to move towards more sustainable and resilient business models. By collaborating and sharing knowledge, businesses and communities can accelerate progress even further.

⁴¹ Northrop, E. et al., 2022. **Opportunities for Transforming Marine and Coastal Tourism: Towards Sustainability, Regeneration and Resilience**. Special report of the High-Level Panel for a Sustainable Blue Economy.

⁴² Ireland's Ocean Economy, 2023. <http://hdl.handle.net/10793/1882>

⁴³ **10 Years of the Wild Atlantic Way. A Decade of Transformational Tourism Impact on the West Coast of Ireland.**

⁴⁴ **A Survey of Domestic Coastal and Marine Tourism and Leisure Activity in Ireland.**

⁴⁵ **A Survey of Marine and Coastal Overseas Tourism Activity in Ireland.**

The mid-term review of the previous National Marine Research & Innovation Strategy (2017-2021)⁴⁶ demonstrated a low level of investment in the theme Tourism and Leisure, one of 15 marine thematic areas covered by the strategy. The national research capability was also reported to be low, with a limited number of active researchers/experts within the national system, and those that were active were not well coordinated or networked internationally. The level of RKI investment was also relatively low, with no dedicated calls or programmes and no national infrastructures or testbeds in place. In short, the level of RDI capacity and investment support of one of our most important marine sectors is minimal, limiting in turn the opportunities for innovation and sectoral development.

Research, Knowledge and Innovation Priority Areas

A core goal for this strategy must be to raise the national capacity and level of investment in RKI supporting coastal and marine tourism. Research in this area is needed to guide policy and planning to support a just and efficient transition towards more low-impact, regenerative tourism. This will require greater coordination between development agencies and research funders and the establishment of specific targets in relation to programming, funding, expertise and capacity build. Some of the key areas where RKI is needed are outlined below.

Increasing resilience

RKI to enable coastal tourism operators to make evidence-based decisions and investments on protecting infrastructure and assets, early warning and appropriate response to extreme weather events and planning for the longer-term impacts of climate change.

Research to understand how unique coastal ecosystems are impacted by and interact with pressures from coastal and marine tourism activities and businesses, combining natural and social science expertise.

⁴¹ Interim Review of the National Marine Research & Innovation Strategy 2017-2021. <http://hdl.handle.net/10793/1692>

Understanding the sector and its drivers

Consumer-focused research to assess views, attitudes and behaviours of domestic and overseas tourists to understand consumer expectations, perceptions and guide innovation in future tourism offerings.

Research on marketing Ireland as an attractive tourism destination (e.g. recent 10-year anniversary report on the success and sustainability of the Wild Atlantic Way).

Research to better understand the drivers and pressures facing those operating tourism businesses and their outlook for future development of their businesses.

Further assessment of the economic output of the sector and its constituent activities, at national and sub-national (regional or county level) to guide public policy, governance, planning and investment programmes.

Innovating for new opportunities

RDI to inform the development of new tourism products, for example the further development of eco-tourism and citizen science activities which provide attractive touristic offerings and leverage the value of Ireland's extensive natural capital, and maritime and cultural heritage.

Working with established and emerging sectors to provide tourism opportunities linked to offshore energy installations, aquaculture operations, fisheries, and ports.

Research to understand better the social, cultural and historical connections between Ireland's offshore islands, their distinctive biodiversity and archaeology, and the opportunities they provide for more integrated tourism.

Exploiting marine data, products and services, and new technologies

Using the availability of open access marine data, data products (e.g. visualisation, maps) and services (live data portals) to inform tourism operations (e.g. tidal and wave conditions, areas vulnerable to coastal hazards such as landslides, erosion or accretion).

Use data, data products and data services to enable new or previously unexploited opportunities for example in eco-tourism, wildlife tracking, and maritime heritage, including the extensive information on shipwrecks provided through the INFOMAR seabed mapping programme and the National Monuments Service's Wreck Inventory of Ireland Database (WIID).

RDI to explore the establishment of digital platforms to enable tourism operators and coastal businesses to share knowledge, skills and best practices and enable collaborative product development.

Transition to sustainable zero carbon business models

Solutions-focused RDI to enable marine and coastal tourism providers to reduce the environmental impact of their operations and transition to sustainable business models, in line with the Fáilte Ireland Climate action programme⁴⁷. This can include, for example, the electrification of ground transportation and recreational vessels, reduction of waste streams and improving coordination between operators and co-existence between activities and sectors.

Key Actions 2025-2026

Action	Implementation
<p>28. Establish a dedicated cross-agency research programme to address key challenges linked to a just and efficient transition to a sustainable, climate-neutral and resilient coastal and marine tourism (in line with broader coordination efforts in coastal policy set out in the report of the Inter-Departmental Group on National Coastal Change Management Strategy⁴⁸).</p>	<p>FI</p>
<p>29. Promote the development of a specific work stream on coastal and marine tourism within EU programmes with corresponding support to transnational calls and RDI investment.</p>	<p>MI</p>
<p>30. Conduct an assessment of the energy usage and needs across marine and coastal tourism and propose viable policy and strategies and measures for reducing sectoral energy use and green-house gas emissions.</p>	<p>MI, FI, MRFF</p>

⁴⁷ <https://www.failteireland.ie/climateactionprogramme.aspx>

⁴⁸ Report of the Inter-Departmental Group on National Coastal Change Management Strategy (October 2023)

3.5 Safe and Secure Seas

The period up to 2050 will see a potentially five-fold increase in the usage of Europe's maritime space by offshore installations for energy and food production⁴⁹. This rise in activity will bring with it increased risks to safety of navigation, pollution incident risk, increased demands on search and rescue services, and vulnerability to nefarious interference. Protection of strategic maritime interests, natural and other resources, and maritime infrastructure is fundamental to the sustainable development of a maritime economy and the meaningful assertion of sovereignty as a coastal state.

The major planned expansion of Ireland's offshore renewable energy sector, in particular, will lead to a significantly greater number of strategically, economically and environmentally important assets and critical national infrastructures off Ireland's coasts that must be protected from harm. If we meet our 2030 and 2050 renewable energy targets, Ireland also has the potential to become a major generator of clean energy for the European continent, raising further risk of interference, damage or attack by rogue actors.

Even in advance of the large-scale deployment of offshore renewable energy installations, there is an imperative to provide effective oversight and security of existing offshore assets, particularly those on the seabed such as energy pipelines, interconnectors, and power and telecommunications cables⁵⁰. Ireland's strategic position as a gateway from northern Europe to the Atlantic means that around three-quarters of all telecommunications cables in the northern hemisphere pass through or near Irish waters⁵¹. The associated security requirements also present legal and governance challenges, as subsea cables generally have shared ownership and are not the property of a single state.

Monitoring the maritime domain – including the air, surface and subsea - is a critical enabler to provide government, state agencies and other organisations with data, knowledge and intelligence to support effective management and decision-making for maritime safety and security purposes. Our maritime space is already subject to substantial monitoring through operational programmes linked, for example, to weather and climate services; EU marine, water and nature directives; intergovernmental commitments such as **OSPAR**; and scientific programmes; but Ireland's capabilities in this area are currently fragmented and are operating in a governance, legal and regulatory environment that is unclear.

⁴⁹ S S Pettersen et al 2023 J. Phys.: Conf. Ser. 2507 012005

⁵⁰ <https://www.hybridcoe.fi/>

⁵¹ Robert McCabe & Brendan Flynn (2024) Under the radar: Ireland, maritime security capacity, and the governance of subsea infrastructure, *European Security*, 33:2, 324-344, DOI: 10.1080/09662839.2023.2248001

Substantial opportunities exist, both for the state and for private sector actors, in the areas of maritime security, cybersecurity, advanced ocean technologies, offshore engineering, navigation technologies, data exchange and data analytics, metocean monitoring and forecasting, seabed and coastal monitoring, and digital products and services. Ireland already holds extensive expertise in its technology sector. As of 2024, 16 of the top 20 global tech companies and the top three enterprise software providers are located in Ireland, as well as six of the top ten cybersecurity firms (2021). There is, therefore, an opportunity to leverage the value of these Irish-based technology companies and expertise to apply cutting edge technologies and advancements to multiple safety, surveillance and security challenges. Progress in meeting all of these challenges and opportunities should be supported by RDI across these technical and engineering domains but also in the natural sciences, climate science, ocean policy and governance, marine/environmental economics, social sciences and humanities.

Research, Knowledge and Innovation Priority Areas

Response to cyber and hybrid threats to offshore and coastal infrastructures

Assessments of and response options to cyber and hybrid threats to offshore and coastal infrastructures, essential safety infrastructure and assets to ensure safe navigation, to inform prevention and emergency response planning.

Assessment of threats and response options for the protection of critical national and underwater infrastructure to act as a deterrent or to mitigate potential risks and challenges in the maritime domain.

Advanced computational, modelling and predicative tools

Increased oceanographic modelling and predictive tools and capacities to inform optimum deployment of offshore installations, ship routing, operational and maintenance support and search and rescue.

Enhanced capacity for using big data analytics approaches supported by high-performance computing to inform complex interactions between environmental, climate and sectoral activities.

Managing increasing intensity in the use of marine space

Increased research in the areas of ocean governance, policy and planning, focusing for example on trade-offs, scenario building and testing to inform decision-making on marine spatial planning, consenting, licencing and co-existence of sectoral activities, maritime safety, surveillance, and search and rescue functions.

Assessment of the cumulative impact of ORE development and Offshore Wind Farms (OWF) on navigation, safety and sea traffic management.

Harmonisation and interoperability of maritime information and navigation technologies

Exploration of future systems to integrate radio navigation, radio communication and emerging technologies including further harmonisation and interoperability of maritime information and navigation technologies to ensure maritime safety, efficient transport and environmental protection.

RDI focused on understanding the risks and impacts arising from climate change and extreme weather and sea state conditions on surface, water column, seabed and sub-seabed installations. and associated adaptation mechanisms.

Application to maritime safety and security goals of a shared data-centric High-Performance Computing (HPC) Platform coupled with federated data spaces with advanced analytical tools that will enable digital twin approaches to addressing maritime safety and security challenges and threats.

Research to better understand public attitudes towards maritime safety and security threats

Social science and humanities research to better understand public attitudes towards safety and security threats and acceptance of the substantial change in the use of marine space and coastal ports and infrastructures.

Key Actions 2025-2026

Action	Implementation
<p>31. Evolve and expand the provision of land-based, near- and offshore test and demonstration facilities. Optimise applications and use of existing platforms such as offshore marine observation and data buoys and aids to navigation.</p>	<p>SEAI, MI, IL, INS, MÉ</p>
<p>32. Assess newly emerging risks and technical mitigations linked to deployment of ORE in Ireland's maritime area. Develop tools, models and analysis to understand how new wind farm developments will impact on maritime risk.</p>	<p>DECC, MI, IL, SEAI, MARA</p>

4. ENABLERS FOR OCEAN KNOWLEDGE

Successful implementation of the actions set out in this strategy will require sufficient capacity and capability across the research and innovation system. Impact 2030, as the over-arching national Research and Innovation strategy, addresses a wide range of strategic challenges and goals linking the growth and development of our national research and innovation system, structures and processes to delivery of research excellence and beneficial societal impact. As marine and maritime forms a subset of the broader national R&I effort, many systemic issues addressed in Impact 2030 (e.g. PhD training, challenge-based funding, open research) are fully relevant in the context of achieving the goals of this strategy and will not be repeated here.

Ocean Knowledge 2030 focuses on those aspects of the public R&I system and structures that are specifically relevant to marine and maritime R&I. In particular, there is a need to identify gaps and future needs for an efficient and impactful R&I system linked to marine policy and sectoral demands and to set out a limited set of strategic actions to ensure that these are addressed within the broader framework of Impact 2030. These are framed here as 'Enablers' as they are critical to enabling delivery of the Ocean Knowledge 2030 Strategy, and are presented under five headings:

- Training, Talent and Expertise
- Marine Research Infrastructures
- Data and Digitalisation
- Partnerships, Networks and Connectivity
- Research-Industry Collaboration
- Funding and Investment

4.1 Training, Talent and Expertise

Human capacities are critical to underpin an effective and responsive RKI system. Human capacity refers to the development of and access to researchers and domain knowledge and expertise within the system, capable of responding to current and future RKI challenges. This can range from successful internship programmes for third-level students to leveraging the knowledge of leading academics and experts. The COVID-19 pandemic illustrated the importance of building and retaining human capital with critical knowledge and expertise within the national system, both to conduct research needed to address future challenges, and to ensure that there is a knowledge-based response to societal and economic challenges.

Across multiple marine and maritime sectors, employment, careers and skills opportunities are evolving rapidly, with the planned installation of offshore renewables as one notable driver. The forthcoming changes in how we utilise our marine space will require multi-disciplinary solutions and graduates with knowledge and skill sets to meet the needs of employers and to solve complex challenges that cut across areas such as marine ecology, marine environment and metocean monitoring and assessment, physical oceanography, marine engineering, maritime law and governance, underwater cultural heritage, data science, social and economic sciences and more. It will also require a greater number of graduates with the right qualifications to meet the growing demand and drive innovation across sectors such as blue bioeconomy, offshore renewable energy, marine engineering, marine ecology or marine archaeology. Our graduates of the future need to be provided with multi-disciplinary training, combining specialist learning in one discipline with a broad understanding of ancillary subject areas that enable problem-solving, innovation and entrepreneurship. Further development of e-learning approaches will enable cost-effective delivery of training programmes at scale and improve access to learning opportunities internationally.

A key consideration is the perception of marine and maritime as a legitimate and recognised career pathway that appeals to school-leavers and early career professionals alike. Greater national coordination in the provision of placement and internship opportunities within marine companies and public bodies will also be important to give hands-on experience to students in secondary and tertiary education and to guide and inspire their career choices.

Key Actions 2025-2026

Action	Implementation
<p>33. Investigate opportunities to strengthen and promote career pathways for students and graduates interested in pursuing a career in marine and maritime sectors, with a focus on gender equality, and aspects such as internships and placements, career days, supporting entrepreneurship, online access to training information, and options for a professional marine designation.</p>	<p>MI, BIM, EI, DEFE, DECC</p>
<p>34. Examine and advance options for a new cohort-based MSc training programme in marine sciences.</p>	<p>MI</p>
<p>35. Develop and deliver, through hybrid and e-learning approaches, further postgraduate level material on Seabed Mapping and Coastal Change – to effectively support capacity-building & enhance the future talent and expertise in related marine sciences.</p>	<p>GSI, MI</p>

4.2 Marine Research Infrastructures

The ocean is an exposed and unpredictable research arena that is costly to access. Research infrastructures provide the mechanism for scientists to interact with and study the marine environment and are an essential enabler for marine and maritime research and innovation⁵². *In situ* ocean observing infrastructures such as data buoys, Argo floats, cabled observatories, deepwater moorings, GLOSS⁵³ and tide gauges enable the collection of oceanographic, climate and metocean data and information, underpinning scientific research and evidence-based policy and management. Laboratories, test and demonstration facilities and digital infrastructures are also part of the national stock of marine research infrastructures. The research vessels, the RV *Celtic Explorer*, RV *Tom Crean* (Marine Institute), RV *Keary*, RV *Mallet* (GSI), and a range of smaller inshore vessels are critical to providing access to coastal and oceanic environments for academic and government scientists.

The Marine Institute's *Compendium of Marine Research Infrastructures in Ireland* report (2022)⁵⁴ provides a catalogue of 164 national infrastructures and large equipment owned and operated by 21 different organisations, including government bodies and Higher Education Institutions. A key challenge is to ensure that infrastructures, observing platforms and large equipment are available to researchers in a way that promotes research excellence and impact. Impact 2030 recognises the importance of research infrastructures as 'a critical element of an enabling R&I environment' and emphasises the need to make them as accessible as possible to researchers across the system. It commits to a number of actions leading to a framework for future capital investment in research infrastructure. It will be important to ensure that the specific challenges and opportunities for future advancement of marine research infrastructures are well reflected in this broader exercise.

Ireland also engages proactively with EU projects and policy platforms on (marine) research infrastructures which are important to support knowledge exchange and best practice in the development, operation and management of strategically important infrastructures and to provide opportunities for access of Irish researchers to international infrastructure platforms and of overseas researchers to access Irish facilities (examples include European Multi-disciplinary Seafloor Observatory; the International Ocean Discovery (Drilling) Programme⁵⁵; and the Horizon Europe project, Aquarius⁵⁶).

⁵² Data and e-infrastructure are addressed in Section 4.3

⁵³ <https://gloss-sealevel.org/> Global Sea Level Observing System

⁵⁴ *A Compendium of Marine Research Infrastructures in Ireland*. Marine Institute, 2022. ISBN 978-1-902895-77-2

⁵⁵ <https://www.iodp.org/>

⁵⁶ <https://aquarius-ri.eu/>

Looking ahead to 2030 some particular challenges include enabling optimum access conditions for researchers to national and international research infrastructures; ensuring that the research infrastructure base takes advantage of technological advancements (e.g. underwater robotics and autonomous underwater vehicles, machine-to-machine learning, eDNA monitoring technology, marine biodiscovery etc.); and ensuring that planning and permitting for test and demonstration facilities enables their rapid deployment in response to identified needs. A notable goal is the development of the planned Offshore Wind Centre of Excellence, a specific action under *Powering Prosperity*⁵⁷.

Key Actions 2025-2026

Action	Implementation
36. Prepare a draft strategic framework for future needs for marine research infrastructures and their operations as a sectoral contribution to the Impact 2030 national Research Infrastructure framework.	MI, MRFF
37. Advance planning to secure Government approval for a new national marine research vessel to replace the RV <i>Celtic Explorer</i> .	DAFM, MI
38. Maintain a fit for purpose national fleet capacity for inshore and shallow draft research.	GSI, DECC

⁵⁷ Ireland’s Offshore Wind Industrialisation strategy:
<https://enterprise.gov.ie/en/publications/powering-prosperity.html>

4.3 Data and Digitalisation

Ireland's national digital strategy, *Harnessing Digital – The Digital Ireland Framework*, was launched in 2022 to drive and enable the digital transition across Ireland's economy and society. Data and digitalisation are central to the delivery of government and public services and to the generation of new opportunities for enterprise and innovation.

An ever-increasing flow of marine data from *in situ* ocean observing platforms, automated sampling and smart sensors provides opportunities to transform the way we study and understand the ocean and offers new approaches for the management of marine resources⁵⁸. In addition, the volume and breadth of space (satellite) data, freely available through our membership of both the EU and the European Space Agency, offers significant opportunities. Space enabled technology and datasets can provide policy makers and maritime businesses with critical information and evidence in areas such as navigation, weather, maritime safety and security.

Since the development of the Irish National Seabed Survey (2002-2006) and its successor programme INFOMAR⁵⁹ (2007-2026), Ireland has been leading internationally in the quality and quantity of seabed data and offshore and nearshore marine mapping. These marine programmes were initiated to survey the shelf and coastal waters and to deliver a free, accessible, seamless baseline bathymetry data set to underpin the future management of Ireland's marine resource. This high-quality data has been used to delineate Ireland's marine territory but also to de-risk marine operations and increase safety in areas such as transport, fisheries, offshore energy, and marine telecommunications cables. It has also helped in our understanding of marine ecosystems, coastal change, marine heritage and climate studies impacting vulnerable coastal communities and infrastructure.

While substantial data systems and assets are in place, it is becoming clear that there is a deficit in the required coordination across organisations and programmes both at national level and in terms of Ireland's participation in international data and observation programmes. A coordinated and federated national marine evidence base, with usable scientifically validated marine data and associated digital capabilities, is now needed to support research, innovation and decision making for marine policy and management (e.g. mapping opportunities and constraints for Designated Marine Area Plans or DMAPs).

⁵⁸ Guidi, L., et al. (2020) *Big Data in Marine Science*. Future Science Brief 6 of the European Marine Board, Ostend, Belgium. ISSN: 2593-5232. ISBN: 9789492043931. DOI: 10.5281/zenodo.3755793

⁵⁹ <https://www.infomar.ie/irish-seabed-mapping>

Realising a national, open-access marine evidence base requires access to high-quality marine data from a wide range of sources, combined with the expertise and technologies to analyse, interpret the data and convert it into usable information. This requires data integration; data analyses and product development; data management and quality control; and user-focused visualisation and analyses tools. The application of new data standards and tools (e.g. cloud-optimised data lakes), and enhanced user-focused analytics tools (e.g. 3D spatial tools), allow for this data to be more readily applied to policy making, for marine management and for a broader understanding of our marine environment. The need for updated technologies (for e.g. collection of benthic imagery), clearer and more robust guidelines (e.g. updates to Epibiota 2016 guidelines), and greater data standardisation is also acknowledged. Addressing these gaps will help ensure that data collection methods are aligned with international best practices, improving the overall quality and usefulness of marine data.

Gaps in the data and information (e.g. data on inshore fisheries) also need to be identified and addressed, while other data which has high potential value e.g. aerial remote sensing data, can be difficult for stakeholders to access and use.

With the increasing application of artificial intelligence tools, there is also potential to better understand what is happening in our marine space through enhanced analysis of “big data” including very large data sets, the enhancement of predictive models, and the analysis of streaming data (e.g. video or acoustics). The adoption of artificial intelligence capabilities is dependent on well-defined processes, artificial intelligence models and underpinning trusted data.

This broadening of access to usable and trusted marine information will become increasingly important for marine planning, licensing and development, for marine operations, for environmental management, and for climate adaptation.

Key Actions 2025-2026

Action	Implementation
<p>39. Convene a multi-agency forum to examine the full range of national marine and maritime monitoring and observing programmes and capacities and data holdings for multiple purposes. The forum should identify critical data gaps, synergies, areas for potential cooperation and define a pathway to greater integration, federation, accessibility and use of data and associated products and services for marine environmental, climate monitoring, sectoral activities, safety and security purposes, in line with the Public Service Data Strategy. Links to international data programmes and networks should be considered as an integral part of this work.</p>	<p>MI, MRFF</p>
<p>40. Develop a national Marine Data Service with end-user digital services, an underpinning data hub, with standards, guidelines and quality assurance, enabled through partnership across key organisations.</p>	<p>DAFM, MI</p>
<p>41. Support: (i) further development in the application of Artificial Intelligence (AI) for automated analyses of marine data, predictive models for climate, coastal change, seabed dynamics, oceanography and ecosystems (e.g. flooding, climate, marine operations); (ii) advancement of data visualisation, including development and adoption of increasingly sophisticated toolsets, with related models and multidisciplinary 4-dimensional data presented in user-focused ways and (iii) advancement of innovation in monitoring technologies (e.g. sensors, autonomous systems, and AI).</p>	<p>GSI, DECC</p>

4.4 Partnerships, Networks and Connectivity

Partnerships and networks provide a mechanism for individual researchers, research groups, institutions or the State to participate in and interact with peers and counterparts at multiple spatial scales (sub-national, national, regional/sea basin, EU and international). Across the marine R&I and ocean policy system, there is a complex array of such networks and partnerships, both formal and informal, with a diversity of scope and functions including the exchange of knowledge and best practice, direct collaboration on research projects and programmes, joint training, influencing and setting research policy and agendas, co-funding of research, and/or delivery of tangible products and services to advance common RKI goals.

At sea basin, EU and international level, Ireland already participates in numerous networks and partnerships and such participation delivers benefits which can sometimes be explicit and measurable but are often less tangible but no less valuable. The term 'science diplomacy' has emerged in recent years to encapsulate the value of international engagement, dialogue and cooperation through science and by scientists (also relevant for non-scientific disciplines). The deployment of Ireland's political influence and scientific strengths and competencies as an island nation have been used very effectively to date.

It will be critical for Ireland to remain influential in the international arena by ensuring pro-active and targeted participation and leadership by experienced personnel with a clear mandate to act on behalf of the State. Increased recognition of the role and expertise of a national cohort of research and ocean policy professionals based in government departments and agencies is important to ensure that early career professionals see the value of these positions as attractive career opportunities.

Our researchers are key in developing and maintaining influence and cooperation through partnerships and networks at a national and international level and should be provided where possible with programmatic support to travel and participate. Competitive award schemes that provide small sums of money to support travel and networking are often highly impactful in underpinning research cooperation and the building of partnerships. Under Impact 2030, a number of flagship initiatives are included on “All-Island, EU and Global Connectivity” including Ireland’s participation in the European Research Area (ERA). The All-Island and UK-Ireland dimensions are of particular importance given the marine science and management challenges that are shared by neighbouring jurisdictions and the impact of Brexit on the lost opportunities for cooperation through EU programmes such as Interreg.

Key Actions 2025-2026

Action	Implementation
42. Develop a Shared Island collaborative marine R&I strategy to promote greater cooperation in marine and climate research and to identify and foster new funding opportunities for collaborative research.	MRFF
43. Establish an inventory of marine R&I and ocean policy networks and partnerships and the representatives that participate in an Irish context to enable the full influence and impact of these activities to be better understood and communicated.	MRFF

4.5 Research-Industry Collaboration

Ireland's Ocean Knowledge 2030 Strategy envisions a thriving Sustainable Blue Economy, built on the foundation of marine research, knowledge and innovation. As Ireland seeks to become a global leader in marine RKI, fostering strong linkages between research institutions and industry is crucial for research valorisation, accelerating innovation and bringing new technologies to market, therefore enhancing Irish competitiveness in the global Blue Economy, while attracting investment and creating jobs in coastal regions.

Research-industry collaboration is a cornerstone of a thriving marine innovation ecosystem, already championed in Ireland by the technology gateways such as CREDIT and SFI Centres, such as MaREI, and facilitated through funding mechanisms, such as e.g. Enterprise Ireland Innovation Vouchers and Partnerships, InterTradelreland Innovation Boost, as well as the Marine Institute's Industry-led Awards scheme.

The private sector brings practical experience in deploying innovations at scale. By enhancing partnerships between public research institutions and marine industries, this strategy can bridge the gap between scientific discovery and market applications.

Clusters play a pivotal role in fostering research-industry collaboration, driving innovation, and accelerating the commercialisation of marine technologies. By creating ecosystems where businesses, research institutions, and government bodies interact in close proximity, clusters facilitate the exchange of knowledge, resources, and expertise. In the marine sector, where technologies like offshore energy systems, marine robotics, and sustainable aquaculture often require extensive testing and validation, clusters can facilitate access to the necessary infrastructure and networks to move innovations from concept to market.

Successful examples of this model include the Maritime UK South-West⁶⁰ cluster in the UK and Norway's Ocean Autonomy Cluster⁶¹, which have proven that proximity between academia and industry encourages dynamic partnerships. These clusters enable businesses, particularly start-ups and SMEs, to leverage testing facilities, share data resources, and engage in joint R&D projects. By doing so, they accelerate technology readiness levels (TRLs) and attract foreign direct investment (FDI) in cutting-edge marine innovations.

Ireland has already laid the groundwork for such collaborative success through the Marine Ireland Industry Network (MIIN)⁶², which brings together companies, research organisations, and state bodies involved in the marine sector. To build on this momentum, formalising a national marine cluster could further support sustained innovation. Such a cluster could potentially facilitate companies with access to marine testbeds, facilitate collaborative research projects, and offer business development services to drive higher TRL development and the commercialisation of marine technologies.

⁶⁰ <https://maritimeuksw.org/>

⁶¹ <https://oceanautonomy.no/>

⁶² <https://marine-ireland.ie/>

Marine Innovation hubs are also vital for fostering industry-research collaboration, serving as physical and digital spaces where academia, businesses, and government interact to drive technological development and commercialisation. These hubs often bring together researchers and entrepreneurs to work on joint projects, leveraging shared resources such as labs, testbeds, and data infrastructures. By facilitating access to research infrastructure, innovation hubs reduce the barriers to entry for start-ups and SMEs, enabling them to test and validate technologies in real-world conditions. They also create networks for knowledge exchange, enabling businesses to apply cutting-edge academic research to commercial projects in areas such as marine biotechnology/biodiscovery, offshore energy, and autonomous systems and acting as catalysts for public-private partnerships (PPPs).

Structured innovation pathways in the marine sector are essential for transforming research into practical solutions for challenges like sustainable seafood, biodiversity conservation, and ocean energy. These frameworks help Irish researchers and companies transition technologies from R&D to deployment, ensuring stronger collaboration between research institutions and industry. Without clear pathways, delays in adoption could hinder Ireland's Blue Economy growth and sustainability goals. A structured approach ensures marine innovations are both environmentally responsible and commercially viable, advancing Ireland's leadership in marine research and development.

In an era marked by rapid technological advancements and unprecedented environmental challenges, effective marine research and innovation require a strategic approach that anticipates future trends and disruptive technologies. Technology foresight, a systematic exploration of the long-term futures of science and innovation, provides a critical framework for shaping research agendas and guiding public and private investments in marine technologies. By leveraging foresight methods (early identification of weak signals and emerging trends, engaging a diverse panel of marine experts and visionary thinkers in shaping the future of ocean research) Ocean Knowledge 2030 aims to ensure that ocean research remains ahead of emerging challenges while harnessing breakthrough opportunities.

The integration of private sector knowledge into these foresight tools will bridge the gap between research and application, ensuring that innovations not only address long-term societal and environmental challenges but also have the potential for rapid commercialisation and widespread adoption. This approach will align with key international frameworks, such as the European Green Deal and the United Nations Decade of Ocean Science for Sustainable Development, by promoting innovations that enhance both the health of the oceans and the resilience of marine-based industries.

Other mechanisms to strengthen industry-research collaboration in Ireland's marine sector, include integration of existing and new funding mechanisms, increasing access to research and innovation marine infrastructure, increasing co-investment and diversity of public-private partnerships, etc. These are further explored under Enabler 4.6, Funding and Investment.

Key Actions 2025-2026

Action	Implementation
<p>44. Structure and implement an innovation audit focusing specifically on marine innovation hubs, following a systematic approach, gathering comprehensive data to assess the current ecosystem, identify gaps, and propose solutions for enhancing innovation capacity and establish a need (or otherwise) for Innovation Hubs with expertise in e.g. marine automation, marine data and monitoring technologies, and smart ports.</p>	<p>MI, MRFF</p>
<p>45. Conduct a feasibility study on the formalisation and development of a national marine cluster, building on the successes of Marine Ireland Industry Network (MIIN) and other related initiatives.</p>	<p>EI, MI, MRFF</p>
<p>46. Use technology foresight methodologies to identify emerging trends and opportunities in marine technology to pinpoint key areas where technology transfer can be accelerated, ensuring that innovations meet commercial realities and global challenges like sustainable ocean resource management. Engage private sector experts to provide insights into market-ready technologies and offer industry-standard adaptation strategies.</p>	<p>MI, MRFF</p>
<p>47. Develop a Marine Technology Knowledge Transfer and Innovation Roadmap as a means of a structured pathways to transition marine innovations from research to market, ensuring industry adoption of new technologies. This holistic roadmap will consolidate the marine R&I and technology development potential and will be facilitating collaboration across all marine industries, as well as helping identify further knowledge transfer and technology transfer needs.</p>	<p>MI, MRFF</p>

4.6 Funding and Investment

Through collaborative funding efforts, commercialisation pathways, and research infrastructure support, Ocean Knowledge 2030 will ensure that Ireland remains at the forefront of global excellence in marine research and innovation while adhering to its core mission of promoting economic development and protecting the marine environment.

Diversified and synergistic funding and investment is vital to facilitate the overall strengthening of the marine innovation ecosystem, creating an enabling environment for enterprise innovation while protecting the marine environment. Additionally, engaging with the broader innovation and enterprise ecosystem ensures that the marine sector benefits from policies, initiatives, investments, and technologies stimulated through other complementary mechanisms (such as e.g. Enterprise Ireland supports, Marine Ireland Industry Network, and industry-research collaboration led by other organisations), making marine innovation more sustainable, competitive, and impactful.

The Shared Island Initiative, as outlined in the National Economic and Social Council (NESC) report⁶³, emphasises the importance of cross-border collaboration between Ireland and Northern Ireland in addressing shared challenges, particularly in areas such as climate action, biodiversity conservation, and regional development. For the marine sector, this initiative presents a significant opportunity to foster joint research and innovation efforts that can benefit the entire island, for example through integrated marine ecosystem management, climate resilience projects, and sustainable ocean energy solutions. An all-island marine research and innovation programme could be developed to foster a consistent approach to shared research challenges by aligning supports across both jurisdictions.

⁶³ http://files.nesc.ie/nesc_reports/en/157_shared_island_comprehensive.pdf

Central to this endeavour will be the Marine Research Funders' Forum (MRFF), coordinating the multi-stakeholder funding efforts. By acting as a platform that brings together government departments, agencies, and private sector investors, the MRFF will drive a progressive approach to investment and funding, by:

- Coordinating with national and All-Island funding priorities, ensuring that different funding agencies work toward a unified vision. By aligning research funding priorities, commitments and investments across agencies, the Forum can ensure that marine research funding supports both strategic research projects, as well as marine innovation.
- Identifying opportunities to combine national and international funding sources, private and public funds, and generally, collaboration on initiatives targeting research and innovation ecosystem enablers, exploring co-funding opportunities, alternative funding mechanisms and new funding models, thus maximising Ireland's marine research potential.
- Ensuring alignment with and responsiveness to global trends in the research and innovation for ocean policy and the blue economy, being sensitive and adaptive to evolving challenges and opportunities, advancing an effective and efficient funding and investment framework.
- Mainstreaming marine innovation into the national and international innovation frameworks, allowing for cross-sectoral collaboration, which is essential for addressing complex challenges such as climate change and sustainability. By connecting with sectors such as energy, transport, and biotechnology, marine research can leverage innovations in these fields, driving advancements in areas like offshore renewable energy and sustainable aquaculture.

Analysis of available data clearly indicates that countries with strong investments in marine research and innovation, such as Norway and Denmark, consistently outperform others across various dimensions, including public-private partnerships, R&D output, marine digitalisation, and offshore renewable energy. OECD's The Ocean Economy in 2030⁶⁴ report notes that "consistent and substantial investment in research, innovation, and marine infrastructures drives competitive advantages, particularly in countries with long-term strategies for ocean-related industries".

This data reinforces the importance of strategic investment in driving marine innovation leadership, particularly in emerging sectors. Internationally recognised approaches such as the OECD STIP Compass⁶⁵, are provide comparative information and data across research, industry, and government sectors and highlight co-relation to levels of public budgetary expenditure in the marine sector. By instituting regular benchmarking, Ireland can identify gaps in investment and adjust its strategies to align with global best practices, ensuring that national policies are responsive to the evolving marine innovation landscape.

A benchmarking framework for Ireland, would offer transparent, comparative insights into how investment directly correlates with research and innovation performance, ensuring that Ireland leads in marine research and technology.

⁶⁴ https://www.oecd.org/en/publications/the-ocean-economy-in-2030_9789264251724-en.html

⁶⁵ <https://stip.oecd.org/>

Key Actions 2025-2026

Action	Implementation
<p>48. Pursue further diversification and sustainability of funding and investment mechanisms in targeted marine research (including co-funding and collaborative funding), facilitated by the MRFF, as well as initiating and facilitating, access to and engagement with, current and future opportunities through EU and international funding and investment frameworks (including alternative and new models), while ensuring alignment with national, global, sectoral and other relevant policies, objectives and priorities.</p>	<p>MRFF</p>
<p>49. Investigate and pursue opportunities to establish and fund a multi-disciplinary, and multi-institutional national ocean research centre of excellence.</p>	<p>MI, MRFF, Research Community</p>
<p>50. Explore, promote, initiate and coordinate All-Island funding and investments approaches, crucial for shared marine research, marine innovation and marine knowledge and technological development (e.g. through the All-island Climate and Biodiversity Research Network, and the North South Research Programme, or a dedicated joint research funding stream).</p>	<p>MRFF</p>
<p>51. Instigate a benchmarking framework for Marine Research and Innovation, tracking the investment and R&I performance of 2-3 comparable marine nations to assess and review Ireland’s positioning as leader in Marine Research knowledge and Innovation (baseline and progress). Track past, current and future marine sector budget expenditure data for Ireland to co-relate with trends in marine research and innovation.</p>	<p>MI, MRFF</p>

5. OPTIMISING IMPLEMENTATION AND IMPACT

The development of Ocean Knowledge 2030 is the result of a comprehensive and collaborative process that engaged a wide range of stakeholders across the marine research and innovation ecosystem. It has been shaped through extensive consultations with government departments and agencies, researchers, industry, environmental organisations, and the public, while ensuring alignment with national and EU priorities such as those set out in the National Research and Innovation Strategy, Impact 2030, Ireland's National Development Plan 2021-2030 and the European Union's Green Deal and digitalisation agenda.

This consultative process was critical in identifying the key opportunities and challenges facing Ireland's marine sectors and in formulating a strategy that reflects national and international commitments to sustainability, climate action, and a thriving blue economy supporting sustainable jobs across multiple marine and maritime sectors. By integrating diverse perspectives, the strategy is designed to foster a more cohesive and impactful approach to marine research and innovation, with the aim to position Ireland as a leader in the global marine landscape.

As Ocean Knowledge 2030 sets the strategic direction for Ireland's marine research, innovation, and knowledge systems from 2025 to 2030, ensuring its successful implementation requires a clear, structured framework focused on tangible outcomes and measurable impacts.

The implementation and impact of Ocean Knowledge 2030 will involve the following core tenets:

- Providing key implementation framework, linked to effective oversight, progress monitoring and evaluation mechanisms
- Aligning investments and resources
- Building cross-sectoral synergies, stakeholder engagement and partnerships
- Maintaining adaptability to evolving challenges and opportunities.

Below is a suggested Monitoring and Evaluation framework designed for effective oversight of the strategy, aligned with international best practices in marine and innovation sectors.

Focus	Implementation Body	Membership
Oversight Level – Strategic Vision and Direction Meets once a year	Marine Research & Innovation Oversight Group	Representatives of relevant Departments and Research Ireland
Steering Level – Orchestration, Monitoring of Objectives Meets Biannually (minimum)	Marine Research Funders' Forum (MRFF)	Participating agencies and departments, chaired by MI
Working level – Action – level Meet as needed	Marine Institute	Ocean Knowledge 2030 Programme Manager and personnel

The complex, multi-dimensional nature of marine challenges calls for cross-sectoral collaboration. Implementing Ocean Knowledge 2030 requires leveraging synergies across various sectors, including fisheries, offshore renewable energy, coastal tourism, and marine biotechnology and this is reflected within the implementation framework.

Continuous engagement will be vital to this approach, including a broad range of stakeholders, such as the public sector, coastal communities, NGOs, and industry players, throughout the implementation phase. A Programme Manager, based at the Marine Institute, will report and work under the general direction of the MRFF and will facilitate and service the steering activities along with ensuring positive collaboration and engagement with the broad range of relevant stakeholders, both state agencies and private business, driving the delivery of the actions contained in Ocean Knowledge 2030.

Ocean Knowledge 2030 implementation activities will align with relevant **Regional Enterprise Plans'** working group fora, reflecting the **Smart Specialisation Strategy for Innovation 2022-2027**, helping to foster and encourage innovation and enterprise in coastal regions that support local economies through job creation, particularly in emerging marine sectors such as offshore wind, aquaculture and green shipping, as well as with National Development Plan 2021-2030 which acknowledges the research and innovation as a key economic and social differentiator.

The ultimate success of Ocean Knowledge 2030 will depend on its ability to inform policy and create positive societal outcomes. An effective implementation framework begins with defining Key Performance Indicators (KPIs) that are aligned with national and international goals (including Impact 2030 System Impact review outcomes⁶⁶) and this strategy will be accompanied by an implementation and impact framework that will detail specific metrics that will help capture progress and impact of Ocean Knowledge 2030. Regular monitoring and reporting against these KPIs will help ensure that Ocean Knowledge 2030 is achieving its intended impact and will allow for course corrections where necessary. Ongoing progress monitoring will take place at working level, within the action sub-groups, by implementation partners, in ongoing liaison with the Programme Manager. An informal progress report will be made to the MRFF twice per annum, ensuring the steering of the strategy. An annual progress report will be published to report on the advancement of the Ocean Knowledge 2030 strategic objectives and actions, along with a progress presentation being presented at oversight level.

Given the dynamic nature of marine environments and the evolving landscape of marine research, Ocean Knowledge 2030 must remain adaptable. A bi-annual term progress review (every 2 years for the duration of the strategy) will be essential to reassess priorities, adjust actions and KPIs, and ensure alignment with new economical, technological, environmental and other developments, as well as evolving governmental policies and priorities, always ensuring alignment. This continuous feedback loop will allow the strategy to remain relevant and impactful.

⁶⁶ Improve how R&I impact is defined, driven and monitored. <https://hea.ie/assets/uploads/2017/04/Impact-2030-Progress-Report-May-23.pdf>

At the end of the strategy’s term in 2030, an ex-post evaluation will be undertaken, to ensure that best practices and lessons learned generated during its implementation are effectively captured to inform future strategies, as well as reflecting on its impact. The formal evaluation will assess effectiveness, determining whether the strategy achieved its goals, and efficiency, examining how resources were utilised and evaluate the relevance of the strategy in addressing the evolving needs of the R&I marine sector and stakeholders and the external environment.

The frequency and mechanisms for monitoring and reporting are summarised in the table below:

Progress Monitoring Frequency	Mechanism	Medium
Ad-Hoc/ongoing (Working Level)	Action Sub-Groups	Informal discussions (meetings and roundtables)
Twice a year (Steering level)	MRFF	Progress presentation at the Forum
Once a year (Oversight Level)	Marine Research & Innovation Oversight Group	Progress presentation with the Oversight Group
Once a year (Public)	Programme Manager, with inputs from MRFF and Oversight Group	Written report publication
Once every 2 years (action term review)	Programme Manager, with MRFF and input from Oversight Group	Progress presentation to MRFF and Oversight Group including supplement to the Written progress publication.
At the end of Strategy term (2030)	External Evaluator	Evaluation Report for open publication

APPENDIX A

Key Actions 2025-2026

Action	Implementation
Living with a Changing Ocean	
The Ocean-Climate Nexus: Ocean Physics and Chemistry	
<p>1. Ensure ocean and climate research challenges, including those identified in the Irish Ocean Climate and Ecosystems Report 2023, are incorporated in the annual Climate Action Plans and the outputs of the forthcoming Framework to Guide Climate and Climate-Related Strategic Research and Innovation.</p>	DECC, MI, MÉ, GSI
<p>2. Invest and build national capacity in ocean, seabed and coastal modelling, the development of sector-specific digital twins⁷, and the advancement of digital products and innovation to underpin national climate and planning policy and the provision of climate services.</p>	MI, MÉ, GSI, DECC, DAFM, DHLGH
<p>3. Establish an implementation and monitoring framework for the multiple research recommendations made in the Irish Ocean Climate and Ecosystem Status Report 2023 and a mechanism and resourcing to secure future updates of this national assessment at appropriate intervals.</p>	MI, MÉ
<p>4. Advance Ireland’s leadership role in international climate-related ocean and coastal research initiatives, including the Horizon Europe Missions, JPI Climate and JPI Oceans, World Meteorological Organisation marine and coastal programmes, and the contribution of Irish experts to the IPCC assessment process.</p>	MI, EPA, MÉ

⁷ In this strategy, digital twins refer to evolving digital models and tools that integrate real-time data and simulations to enhance the understanding, management, and sustainability of marine environments. As the technology advances, these tools will be utilised in diverse ways, from monitoring marine ecosystems to optimising offshore infrastructure, ensuring they meet the needs of the research and operational objectives.

Action	Implementation
Marine Geology, Seafloor and Coastal Change	
5. Support capacity-building measures to enhance the future pipeline of talent and expertise in the areas of marine geology, geophysics, hydrography and coastal change.	GSI, MI, Research Ireland
6. Invest in national capacity in ocean mapping, geological and paleoclimate research, coastal behaviour, and the advancement of digital products and innovation to underpin national policies.	GSI, MI, DECC
7. Advance Ireland's leadership role in international ocean mapping and coastal research, including the Horizon Europe, EMODnet and International Ocean Discovery Programme (IODP).	MI, GSI
8. Advance national coordination and data life-cycle management in ocean mapping and coastal change.	GSI, MI
Marine Biodiversity and Ecosystem Functioning	
9. Support capacity-building measures to enhance the future pipeline of talent and expertise in the areas of marine biodiversity, taxonomy, ecology and ecosystems research.	MI, Research Ireland
10. Enhance Ireland's leadership and participation in the second phase of the Horizon Europe Mission, Restore our Ocean and Waters by 2030.	MRFF, MI
2.4 Offshore and Maritime Cultural Heritage	
11. Support capacity-building measures to enhance future research on Underwater Cultural Heritage (UCH) within the public and private sectors and educational institutions.	NMS, GSI, MI
12. Support existing and develop new research frameworks for UCH & World Heritage marine areas across multiple stakeholders.	NMS, GSI, MI
13. Build on existing and develop new ways of raising awareness of the importance, value and benefit of UCH as a key part of our marine environment, responsible ocean protection and sustainable blue economy.	NMS, GSI, MI

Action	Implementation
Ocean Governance and Law	
<p>14. Coordinate the necessary research, skills and capacity assessments required to inform the ongoing development of the State's new planning, consenting and regulatory functions and the associated mechanism to ensure provision of relevant data and evidence to inform their activities.</p>	<p>DECC, MARA, DHLGH, ABP, DAFM, MI</p>
<p>15. Commission a desk-based study to ascertain the national impacts and implications of the BBNJ Agreement, and to examine how Ireland can best contribute to achieving the objectives of the Agreement through marine research, and through related capacity building and transfer of marine technology activities to assist developing countries.</p>	<p>MI, DFA, DHLGH</p>
<p>16. Contribute to BBNJ-related capacity building and transfer of marine technology activities to assist developing countries, including through the provision of training/placement opportunities to scientists from developing countries.</p>	<p>MI, DFA, DHLGH</p>
<p>17. Support and contribute to marine research relating to deep-sea ecosystems and related matters to help to inform the work of the International Seabed Authority, and support and contribute to relevant capacity building activities to assist developing countries.</p>	<p>MI, DFA, DHLGH</p>
The Ocean's Benefit and Service to Society	
<p>18. Advance national coordination and capacity in marine socioeconomics, environmental and ecosystem accounting and ocean economy measurement, making further progress towards an ocean economy satellite account for Ireland.</p>	<p>DECC, MARA, MI</p>
<p>19. Establish a biannual 'Ocean Barometer' survey on citizen attitudes and perceptions on ocean health, policies, issues and impacts.</p>	<p>MI, DFA, DHLGH</p>
<p>20. Investigate opportunities for a funding mechanism enabling bottom-up citizens' initiatives, complementary to existing funding instruments in this area (e.g. Community Climate Action Programme) and local government interventions.</p>	<p>MI, DFA, DHLGH</p>

Action	Implementation
Towards a Sustainable Ocean Economy	
Sustainable Food from the Ocean	
<p>21. Design and implement a dedicated RDI programme on 'Sustainable Food from the Ocean' with coordinated funding and multi-annual calls linked to the RDI priorities set out above. The programme should target tangible and measurable impacts in advancing all stages of the seafood value chain, taking account of barriers linked to markets and regulation to deliver a world-class seafood production that is sustainable, circular, safe, secure and supporting innovation across the value chain.</p>	<p>MI, DAFM, BIM, Teagasc</p>
<p>22. Align cross-programme opportunities to support research in the blue bioeconomy leveraging national funding mechanisms and EU programmes including the European Maritime Fisheries and Aquaculture Fund and the Sustainable Blue Economy Partnership (SBEP) and Circular Biobased Europe (CBE JU), promoting the transition to sustainable, low-carbon, low impact seafood production.</p>	<p>MI, BIM, Research Ireland, DAFM</p>
Energy from the Ocean	
<p>23. Increase and improve national coordination in providing targeted RDI supports to ORE value chain SMEs through existing and new programmes and calls. Maximise the value of research and innovation activities, where relevant, through business coaching, facilitating collaboration and wider enabling support. Ensure close coordination and alignment of different national RD&I programmes, and engagement with international, EU and European Space Agency programmes and coordination forums.</p>	<p>SEAI, EI, MI, Research Ireland, DETE, MĒ</p>
<p>24. Accelerate progress on agreed actions under Powering Prosperity (Actions 26, 27, 28) and the Future Framework for ORE (Actions 3, 4) to plan, promote, support engagement with and use of existing marine test & demonstration facilities/sites and explore feasibility of additional marine test site (e.g. for Floating Wind).</p>	<p>SEAI, DETE, DECC, MI</p>
<p>25. Develop a focused ORE Research & Innovation Strategy for Ireland with clear objectives, building on the ORE Technology Roadmap, and addressing gaps in support and monitoring ongoing technology developments and innovations³⁶.</p>	<p>SEAI</p>

³⁶ Action included in the SEAI ORE Technology Roadmap: [ORE Technology Roadmap](#)

Action	Implementation
Greener and Smarter Ports and Shipping	
26. Engage with strategic partners in the UK and EU to identify opportunities for joint transnational investments and projects in greener and smarter ports and shipping, leveraging international funding streams.	MI, DoT
27. Undertake a maritime RDI capacity assessment to determine capability within the system and critical gaps in knowledge and expertise that should be addressed through capacity building investments.	MI
Tourism in Coastal and Marine Areas	
28. Establish a dedicated cross-agency research programme to address key challenges linked to a just and efficient transition to a sustainable, climate-neutral and resilient coastal and marine tourism (in line with broader coordination efforts in coastal policy set out in the report of the Inter-Departmental Group on National Coastal Change Management Strategy ⁴⁸).	FI
29. Promote the development of a specific work stream on coastal and marine tourism within EU programmes with corresponding support to transnational calls and RDI investment.	MI
30. Conduct an assessment of the energy usage and needs across marine and coastal tourism and propose viable policy and strategies and measures for reducing sectoral energy use and green-house gas emissions.	MI, FI, MRFF
Safe and Secure Seas	
31. Evolve and expand the provision of land-based, near- and offshore test and demonstration facilities. Optimise applications and use of existing platforms such as offshore marine observation and data buoys and aids to navigation.	SEAI, MI, IL, INS, MĒ
32. Assess newly emerging risks and technical mitigations linked to deployment of ORE in Ireland's maritime area. Develop tools, models and analysis to understand how new wind farm developments will impact on maritime risk.	DECC, MI, IL, SEAI, MARA

⁴⁸ Report of the Inter-Departmental Group on National Coastal Change Management Strategy (October 2023)

Action	Implementation
Enablers for Ocean Knowledge	
Training, Talent and Expertise	
<p>33. Investigate opportunities to strengthen and promote career pathways for students and graduates interested in pursuing a career in marine and maritime sectors, with a focus on gender equality, and aspects such as internships and placements, career days, supporting entrepreneurship, online access to training information, and options for a professional marine designation.</p>	<p>MI, BIM, EI, DE TE, DECC</p>
<p>34. Examine and advance options for a new cohort-based MSc training programme in marine sciences.</p>	<p>MI</p>
<p>35. Develop and deliver, through hybrid and e-learning approaches, further postgraduate level material on Seabed Mapping and Coastal Change – to effectively support capacity-building & enhance the future talent and expertise in related marine sciences.</p>	<p>GSI, MI</p>
Marine Research Infrastructures	
<p>36. Prepare a draft strategic framework for future needs for marine research infrastructures and their operations as a sectoral contribution to the Impact 2030 national Research Infrastructure framework.</p>	<p>MI, MRFF</p>
<p>37. Advance planning to secure Government approval for a new national marine research vessel to replace the <i>RV Celtic Explorer</i>.</p>	<p>DAFM, MI</p>
<p>38. Maintain a fit for purpose national fleet capacity for inshore and shallow draft research.</p>	<p>GSI, DECC</p>

Action	Implementation
Data and Digitalisation	
<p>39. Convene a multi-agency forum to examine the full range of national marine and maritime monitoring and observing programmes and capacities and data holdings for multiple purposes. The forum should identify critical data gaps, synergies, areas for potential cooperation and define a pathway to greater integration, federation, accessibility and use of data and associated products and services for marine environmental, climate monitoring, sectoral activities, safety and security purposes, in line with the Public Service Data Strategy. Links to international data programmes and networks should be considered as an integral part of this work.</p>	MI, MRFF
<p>40. Develop a national Marine Data Service with end-user digital services, an underpinning data hub, with standards, guidelines and quality assurance, enabled through partnership across key organisations.</p>	DAFM, MI
<p>41. Support: (i) further development in the application of Artificial Intelligence (AI) for automated analyses of marine data, predictive models for climate, coastal change, seabed dynamics, oceanography and ecosystems (e.g. flooding, climate, marine operations); (ii) advancement of data visualisation, including development and adoption of increasingly sophisticated toolsets, with related models and multidisciplinary 4-dimensional data presented in user-focused ways and (iii) advancement of innovation in monitoring technologies (e.g. sensors, autonomous systems, and AI).</p>	GSI, DECC
Partnerships, Networks and Connectivity	
<p>42. Develop a Shared Island collaborative marine R&I strategy to promote greater cooperation in marine and climate research and to identify and foster new funding opportunities for collaborative research.</p>	MRFF
<p>43. Establish an inventory of marine R&I and ocean policy networks and partnerships and the representatives that participate in an Irish context to enable the full influence and impact of these activities to be better understood and communicated.</p>	MRFF

Action	Implementation
Research-Industry Collaboration	
<p>44. Structure and implement an innovation audit focusing specifically on marine innovation hubs, following a systematic approach, gathering comprehensive data to assess the current ecosystem, identify gaps, and propose solutions for enhancing innovation capacity and establish a need (or otherwise) for Innovation Hubs with expertise in e.g. marine automation, marine data and monitoring technologies, and smart ports.</p>	<p>MI, MRFF</p>
<p>45. Conduct a feasibility study on the formalisation and development of a national marine cluster, building on the successes of Marine Ireland Industry Network (MIIN) and other related initiatives.</p>	<p>EI, MI, MRFF</p>
<p>46. Use technology foresight methodologies to identify emerging trends and opportunities in marine technology to pinpoint key areas where technology transfer can be accelerated, ensuring that innovations meet commercial realities and global challenges like sustainable ocean resource management. Engage private sector experts to provide insights into market-ready technologies and offer industry-standard adaptation strategies.</p>	<p>MI, MRFF</p>
<p>47. Develop a Marine Technology Knowledge Transfer and Innovation Roadmap as a means of a structured pathways to transition marine innovations from research to market, ensuring industry adoption of new technologies. This holistic roadmap will consolidate the marine RKI and technology development potential and will be facilitating collaboration across all marine industries, as well as helping identify further knowledge transfer and technology transfer needs.</p>	<p>MI, MRFF</p>
Funding and Investment	
<p>48. Pursue further diversification and sustainability of funding and investment mechanisms in targeted marine research (including co-funding and collaborative funding), facilitated by the MRFF, as well as initiating and facilitating, access to and engagement with, current and future opportunities through EU and international funding and investment frameworks (including alternative and new models), while ensuring alignment with national, global, sectoral and other relevant policies, objectives and priorities.</p>	<p>MRFF</p>
<p>49. Investigate and pursue opportunities to establish and fund a multi-disciplinary, and multi-institutional national ocean research centre of excellence.</p>	<p>MI, MRFF, Research Community</p>
<p>50. Explore, promote, initiate and coordinate All-Island funding and investments approaches, crucial for shared marine research, marine innovation and marine knowledge and technological development (e.g. through the All-island Climate and Biodiversity Research Network, and the North South Research Programme, or a dedicated joint research funding stream).</p>	<p>MRFF</p>
<p>51. Instigate a benchmarking framework for Marine Research and Innovation, tracking the investment and RKI performance of 2-3 comparable marine nations to assess and review Ireland's positioning as leader in Marine Research knowledge and Innovation (baseline and progress). Track past, current and future marine sector budget expenditure data for Ireland to co-relate with trends in marine research and innovation.</p>	<p>MI, MRFF</p>