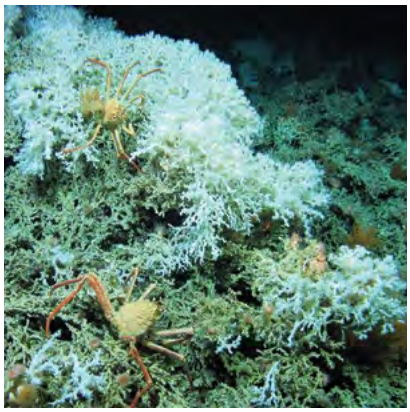
Foras na Mara
Marine Institute



ANNUAL REPORT
2019

BUILDING OCEAN KNOWLEDGE; DELIVERING OCEAN SERVICES

To the Minister for Agriculture, Food and the Marine

In accordance with the requirements of the Marine Institute Act, 1991, I have the honour of presenting the Annual Report and Financial Statements of the Marine Institute for the year ended 31 December 2019.

Dr John Killeen,
Chairman

The Marine Institute is a national agency with the following mission:

The Marine Institute provides government, public agencies and the maritime industry with a range of scientific, advisory and economic development services that inform policy-making, regulation and the sustainable management and growth of Ireland's marine resources. The Institute undertakes, coordinates and promotes marine research and development, which is essential to achieving a sustainable ocean economy, protecting ecosystems and inspiring a shared understanding of the ocean.

Our Vision:

The Marine Institute, as a global leader in ocean knowledge, empowering Ireland and its people to safeguard and harness our ocean wealth.

Photo credits

Front cover
Photo 1 – Andrew Downes
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Photo 3 – Gerard McCarthy (also on Page 52)
Photo 4 – Tomas Szumski (also on Page 43)
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Other photos – Marine Institute and stock imagery

Foras na Mara
Marine Institute

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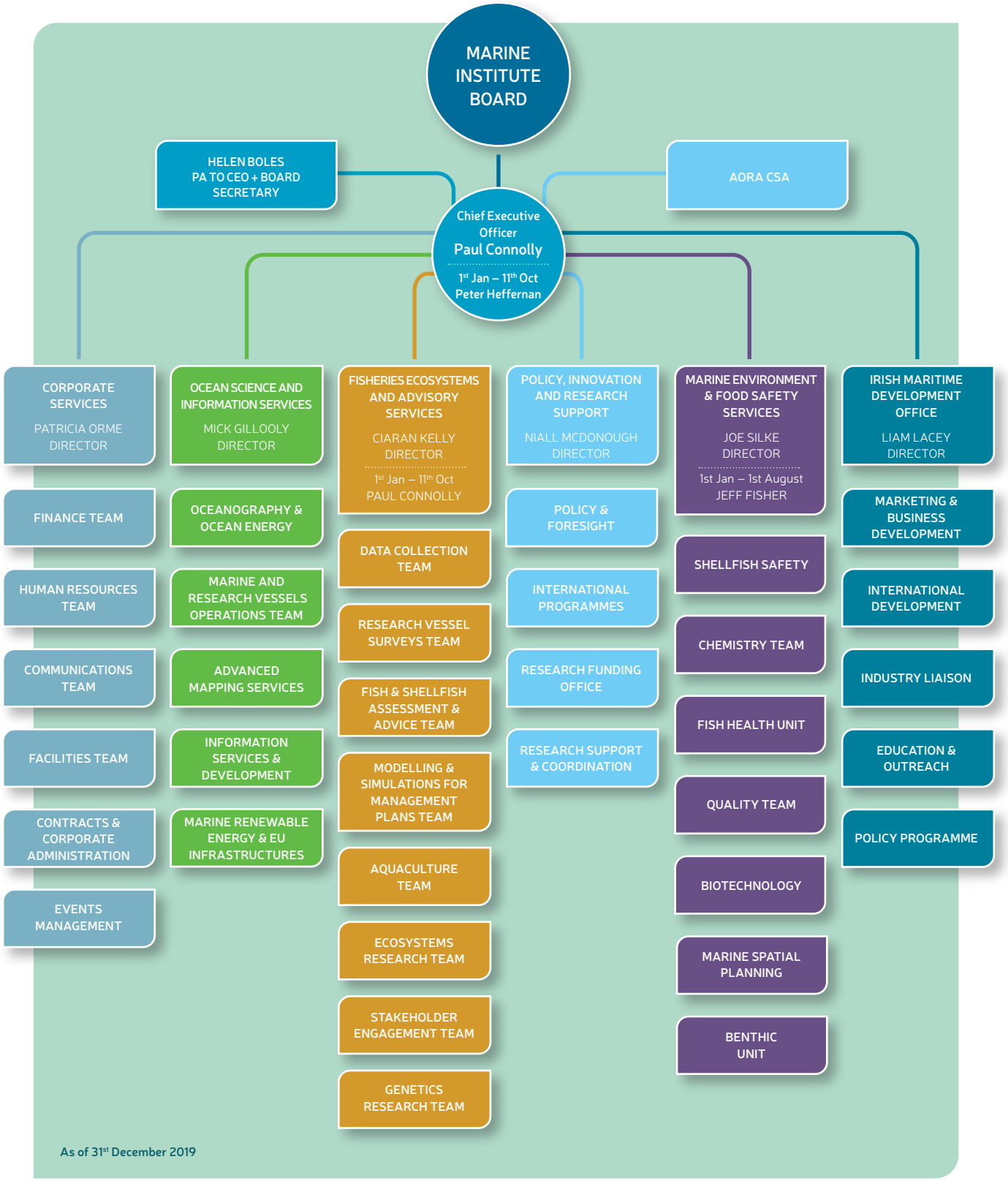
The Marine Institute Annual Report is available in Irish and can be downloaded from **www.marine.ie**

MARINE INSTITUTE ORGANISATIONAL STRUCTURE



As of 31st December 2019

Marine Institute Headquarters, Galway. Photographer Laoise Dillon

INTRODUCTION, ORGANISATIONAL STRUCTURE AND STRATEGIC FRAMEWORK

The Marine Institute is the national agency for marine research, technology, development and innovation. It seeks to assess and realise the economic potential of Ireland's marine resource, promote sustainable development of marine industry through strategic funding programmes and essential scientific services, as well as safeguard Ireland's natural marine resource through research and environmental monitoring.

Ireland has a marine area of approximately 880,000km^2 under the sea, which is over 10 times its land area, representing an enormous seabed and marine resource. The Marine Institute promotes the sustainable development of this vast resource through research, the application of new technologies and by providing credible science-based advice to industry, the Government and the EU.

The Institute provides essential marine research services including:

- National research and development funding programmes
- Fish stock assessment and management advice
- Fish health services
- Marine food safety monitoring
- Environmental monitoring
- Research vessel operations
- Seabed mapping
- Data management
- Maritime development services

The Marine Institute has six service areas and the Office of the CEO. The service areas are:

- Corporate Services
- Ocean Science and Information Services
- Marine Environment and Food Safety Services
- Fisheries Ecosystems Advisory Services
- Irish Maritime Development Office
- Policy, Innovation and Research Support Services

The organisation has established a culture which is characterised by:

- Ethical behaviour throughout
- A clear vision
- Teamwork
- Clear communication; and
- Being a place where people can flourish

That culture provides the platform on which our Strategic Plan has been founded.

Since its establishment in 1991, the Marine Institute has been a key component of a national effort to grow our maritime economy, to create new marine business opportunities and jobs and to generate a greater knowledge and understanding of the seas and oceans. This Annual Report highlights the key deliverables and progress made towards our vision during 2019.

STRATEGIC FRAMEWORK

The Marine Institute has developed *Building Ocean Knowledge - Delivering Ocean Services*, a strategic plan for the period 2018 – 2022.

The process required extensive input from clients, external stakeholders, the Marine Institute Board, the management team and staff. This engagement process with stakeholders was used to inform how the Institute is performing and how the organisation can serve their current and future needs more effectively.

The Strategic Plan ensures that the Institute continues to meet national needs and international challenges, opportunities and commitments. It sets a strong strategic vision and a clear plan for the journey ahead.

In line with the strategic framework in the plan, this Annual Report is organised into four Strategic Focus Areas and four Strategic Enablers. The six service areas of the organisation (outlined on the previous page) feed into these eight sections of the report.

THESE ARE THE STRATEGIC FOCUS AREAS:

- Scientific Advice & Services
- Forecasting Ocean & Climate Change
- Research & Innovation
- Ireland's Ocean Economy

THESE ARE THE STRATEGIC ENABLERS:

- Our People
- Infrastructure
- Data & IT
- Engagement & Education

To deliver on our vision requires strategic enhancement of our organisational strengths and this is where Strategic Enablers are so vital. Our people, our infrastructure, our data and IT capabilities and our engagement and education capabilities all work towards enabling the Strategic Focus Areas and their respective goals.

BOARD MEMBERS

DR JOHN KILLEEN (2014 – 2019)

Dr Killeen is an engineer and a native of County Roscommon who became an Honorary Freeman of Galway City in 2012. His career spans working with local government, with a multinational construction company that built the Grand Canal tunnel in Dublin in 1973 and seven years with a Shell International subsidiary. Dr Killeen was President of Engineers Ireland (1995-1996) and was founding President of the Academy of Engineering in Ireland (1996-1998). He is retired CEO of the Colas Group in Ireland and retired Managing Director of Cold Chon Galway Ltd.

In 2009, he was Chairman of the Volvo Ocean Race event in Galway. In 2012, he was President of the Volvo Ocean Race Festival and finale which broke all attendance records for a sporting event in Ireland, valued at approximately €80m in tourism and business income to the city. Dr Killeen is Chairman of the Saolta University Health Care Group and President of the Timoney Leadership Institute – a charity that promotes international leadership training for Irish CEOs.

PROFESSOR PATRICIA BARKER (2013 – 2018),(2018 – 2023)

Professor Barker is a Fellow of Chartered Accountants Ireland and qualified in 1973. Prof Barker completed an MPhil in Gender Studies at Trinity College Dublin. Her PhD developed a paradigm of disclosure of financial information to employees in organisations. She served her articles with Stokes Bros & Pim in Dublin and worked for Peat Marwick Mitchell in Manchester. She later became a partner in an accounting practice in Manchester for six years, and worked in Manchester University as a principal lecturer.

Patricia was appointed lecturer in Dublin City University (DCU) in 1980 and progressed through senior lecturer, Associate Dean (Business School) and University Vice-President (Academic). She has worked as a visiting professor in universities in New York, Boston, Angers, Malawi, Dares Salaam, Sydney and Cape Town and has been an external examiner for universities and professional bodies.

She served as Chairman of Chartered Accountants' Accounting Committee for 20 years and was a member of the Council of Chartered Accountants for four years in the 1990s and again for five years in the 2010s. She represented Ireland on the Accounting Standards Board in London for nine years and chaired the expert group reporting to the European Union on the role, structure and functions of the European Court of Auditors. She had several tours of duty as Election Supervisor for the Organisation for Security and Cooperation in Ireland (OSCE) in Bosnia-Herzegovina, Republika Srpska, South Africa, Kosovo, Kazakhstan, Montenegro, Malawi and Belarus.

Patricia worked as Human Rights Monitor in Israel and Palestine. She has been a member of the Boards of Women's Aid, the Sonas Housing Association, the National Chamber Choir and the Higher Education Authority (chairing the Audit Committees), and was Chairperson of the Irish Blood Transfusion Service for three years.

She is currently a Director of Dublin Bus Ltd and Tallaght Hospital, chairing their Audit Committees. In addition, she is Chair of the Education Board of Chartered Accountants Ireland. In addition, she is Chair of the Audit and Risk Committee for the Marine Institute. She is currently a voluntary counsellor and trainer for the Dublin Rape Crisis Centre. She has written books on group accounting, flexible working in the profession and, more recently, on women who have succeeded in the accountancy profession, as well as on corporate governance and professional ethics.

MR DERMOT CLOHESSY (2015 – 2020)

Mr Dermot Clohessy (BSc Eng.) is an engineer by profession with postgraduate qualifications in both business strategy and finance. He has an extensive understanding of foreign direct investment (FDI) having worked for 28 years with IDA Ireland.

Dermot was the IDA's Executive Director/COO from 2006 to 2015 and was directly involved in the development and successful implementation of the IDA's corporate strategies during this period. His broad responsibilities included expanding the global markets in which Ireland competes for investment and developing new business areas for FDI into Ireland.

Dermot was a member and a sub-committee chairman of the Development Task Force established to support the implementation of *Harnessing Our Ocean Wealth – an integrated marine plan for Ireland.*

He is now a consultant, working internationally on business development strategies for both the private sector and government bodies. He is a strategic advisor with the Ireland-based International Development Ireland (IDI) - IDI works with governments on the practical implementation of projects of national strategic importance which underpin economic development.

PROFESSOR ALAN DOBSON (2015 – 2020)

Professor Dobson studied biochemistry at NUI Galway and following his PhD, worked as a Post-Doctoral Research Fellow at Baylor College of Medicine in Houston, Texas. Prof Dobson then moved to the School of Microbiology at University College Cork (UCC), where he is currently Chair of Environmental Microbiology.

From 2005 to 2014, Prof Dobson was Director of the Environmental Research Institute at UCC. His main research interest focuses on the study of microorganisms in marine and terrestrial environments and their potential biotechnological exploitation. His research group has published numerous scientific papers in this area.

Prof Dobson was a Fulbright scholar in 1992 and was awarded the Royal Irish Academy Medal in Microbiology in 1999. He was subsequently awarded a DSc in Microbiology & Molecular Biology in 2005 from the National University of Ireland, and was elected a Member of the Royal Irish Academy (RIA) in 2013.

Prof Dobson was a member of the European Space Agency's Life and Physical Science Advisory Committee (LPSC) from 2003 to 2005. From 2009 to 2012, he was a member of the panel of experts that advised the then Chief Scientific Adviser to the Irish government, Professor Patrick Cunningham.

He has also been a member of the working group that prepared the European Science Foundation and Marine Board position paper *Marine Biotechnology: A European Strategy* in 2010 and has been a member of External Review Working Group (ERWG), monitoring the quality of the scientific outputs of the European Food Safety Authority (EFSA) (2012-2015). He was a member of the International Advisory Group of the Marine Biotechnology ERA-NET (ERA-MarineBiotech) from 2013-2017 and is currently a board member of the International Marine Biotechnology Association.

DR BERNA GRIST (2015 – 2018),(2018 – 2023)

Dr Berna Grist BL, a barrister and chartered town planner, is Adjunct Professor in the School of Architecture, Planning and Environmental Policy at University College Dublin. She holds a PhD from the University of Ulster on *The Legislative and Regulatory Framework for Development in the Republic of Ireland* and has published widely in the fields of planning and environmental law, public policy and governance. Together with the late James Macken SC, she coedited the *Irish Planning Law Factbook* (2013), which she continues to update annually, and in 2012, published the second edition of *An Introduction to Irish Planning Law*.

Dr Grist was appointed Deputy Chairperson of the Aquaculture Licences Appeals Board on its establishment in 1998. During the period 2001-2006, she served as a member of An Bord Pleanála and in 2013, she was appointed to the expert group advising the Minister for Housing and Planning on a successor to the *National Spatial Strategy 2002-2020*. She has contributed to a number of environmental research projects sponsored by the Environmental Protection Agency and is a member of the Irish Environmental Law Association.

MR DONAL KELLY (2013 – 2018),(2018 – 2023)

Mr Donal Kelly is Managing Director of Fast Fish Ltd, a successful fish sales and oil supply business based in Castletownbere, County Cork. Mr Kelly served on the Celtic Sea Herring Management Committee for 10 years, and on the West Pelagic Committee for three years.

Mr Kelly has served on a number of boards, both in the private and voluntary sector, including the Cork County Community and Voluntary Forum and the Cork County Development Board and has acted as Chairman of Castletownbere GAA Management Committee. He is also a member of Berehaven Golf Club and the Castletownbere Community Development Association.

PROFESSOR J OWEN LEWIS (2015 – 2020)

Professor Lewis is Emeritus Professor of Architectural Science, University College Dublin (UCD). He is President of the Royal Dublin Society, and a member of the Board of the National Gallery of Ireland.

Professor Lewis is a former Chief Executive of the Sustainable Energy Authority of Ireland (SEAI) (2009 – 2012) and was Chair of the inter-departmental and inter-agency Ocean Energy Steering Committee. As a qualified architect, engineer and energy technologist, he has practised professionally in Ireland, England and Zambia. Prof Lewis was Executive Director for Innovation and R&D at Bord na Móna from 2006 to 2008. He was Dean of the Faculty of Engineering and Architecture at UCD and later, Principal of the UCD College of Engineering, Mathematical & Physical Sciences 2001 – 2006; and was Director of the UCD Energy Research Group from 1974 to 2008. He has published about 200 papers and books as author, joint-author or editor. Expert advisor to the European Commission, and coordinator of various European Commission energy R&D projects 1986 – 2003, with sub-contractors in all member states. In 1976, Prof Lewis co-founded the Solar Energy Society of Ireland.

MR DAVID OWENS (2012 – 2018),(2018 – 2023)

Mr David Owens FCA is currently Senior Vice President, Finance and Operations for SolarWinds. Prior to joining SolarWinds, Mr Owens worked for Red Hat Inc., an enterprise software company for over seven years where he served initially as Director of Global Logistics and Production and later as Senior Director of Finance EMEA.

Mr Owens qualified as a chartered accountant with Ernst & Young and is a member of Chartered Accountants Ireland.

MR LORCÁN Ó CINNÉIDE (2010 – 2015),(2015 – 2020)

Mr Lorcán Ó Cinnéide is currently Manager of the OPW owned Blasket Centre (Ionad an Bhlascaoid) and the state lands on the Great Blasket Island off the Dingle Peninsula, Co Kerry. He has had extensive previous involvement in the seafood industry including roles as National Secretary of the Irish Fish Processors and Exporters Association (IFPEA), CEO of the Irish Fish Producers Organisation (IFPO), board member of the European Fish Processors Association (AIPCE), board member of the Aquaculture Licences Appeals Board (ALAB) and a member of various other national and EU fisheries management bodies.

A former fishing vessel owner, Mr Ó Cinnéide has a degree in Economics and Politics from Trinity College Dublin. This is his second term as a board member of the Marine Institute. He is a former chairman of the Institute's Strategy Development Sub-group and of its Internal Audit Committee.

CHAIRMAN'S STATEMENT

The Marine Institute once again retained its Excellence Through People (ETP) accreditation under the NSAI Standard – ETP 1000:2012, which reflects the Institute's investment in its staff who play a key role in maximising the efficiency of the organisation and building key capabilities. In addition, in 2019, the Institute was listed as one of Ireland's best medium workplaces, under the Great Place to Work Programme

Full compliance with the 2016 Code of Practice for Governance of State Bodies, including the relevant aspects of the Public Spending Code, was achieved with six internal audits throughout 2019. This provided governance oversight and high levels of assurance to the Board.

SeaFest, Ireland's national maritime festival, took place in Cork city from 7th to 9th June 2019, with close to 90,000 people enjoying the weekend-long festival. It is a vital outreach event in realising the *Harnessing Our Ocean Wealth* goal of engaging the public with the sea.

Our Ocean Wealth Summit, Ireland's flagship event for the marine sector, attracted more than 750 delegates to City Hall, Cork, on 10th June 2019. The theme for this year's Summit was 'Shared Voices from Small Island States'. The health of our oceans was also firmly on the agenda at the Summit, as demonstrated through former US Secretary of State, John Kerry's inaugural keynote address, delivered to an audience of global leaders and a wider marine industry audience.

Later in the summer, the first ever Atlantic Youth Ambassador Summer School took place in Galway, organised by the Marine Institute AORA (Atlantic Ocean Research Alliance) team. Some 23 Youth Ambassadors from countries connected to the Atlantic Ocean took part in the programme to equip them with the knowledge and skills to engage local communities and champion how important it is to protect and sustainably harness our Atlantic Ocean.

The Institute's first Research Symposium took place in October 2019, bringing together 70 researchers from across the Institute. They gathered to present their work, to brainstorm, and to identify ways to work better together.

The Marine Institute website continues to be a vital information source with 169,478 unique visits to the website during 2019 and a well-received refresh to the homepage during the year. New awareness campaigns were launched through the website, social media and other communication channels.

Between the research vessels RV *Celtic Explorer* and RV *Celtic Voyager*, there were 598 science days during 2019. In addition, ROV Holland I completed 54 days offshore, over three research surveys.

A very significant milestone during 2019 was the retirement of Marine Institute CEO, Dr Peter Heffernan, after 27 years of valued service.

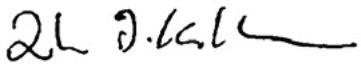
Dr Heffernan oversaw tremendous growth in the Marine Institute and played a fundamental role in developing Ireland's ocean research capacity, increasing collaboration in marine research and innovation in Europe, as well as driving sustainable development across a range of maritime sectors. We thank him for his dedicated leadership and service.

Dr Paul Connolly was appointed CEO of the Institute in October 2019. As former Director of Fisheries and Ecosystems Advisory Services at the organisation, he brings a wealth of experience and knowledge to the role and is dedicated to positioning the Marine Institute as a global leader in ocean knowledge and empowering Ireland to harness our marine resource.

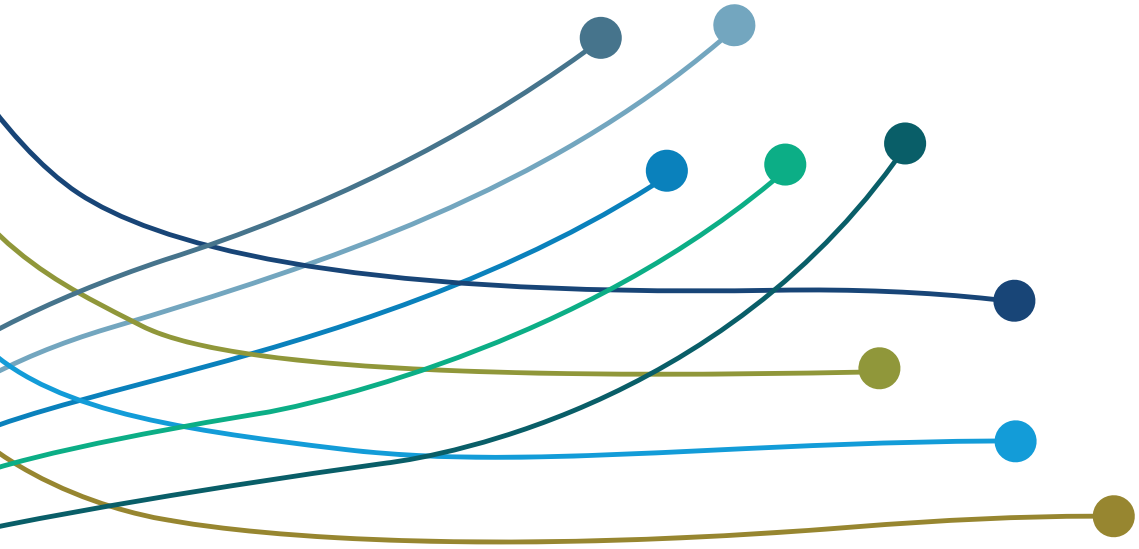
An important achievement during the year was the signing of the contract with Armon Vigo shipyard to build the new marine research vessel for the State, replacing the RV *Celtic Voyager*, which has been at sea for more than 20 years. The new vessel will greatly enhance the Institute's many

research and data gathering activities along with marine operations, such as maintaining and deploying weather buoys.

These achievements show both the abilities and dedication of the people that make up the Marine Institute and I'd like to take this opportunity to acknowledge Dr Paul Connolly and the Marine Institute staff for their achievements this year and their commitment to the delivery of excellence in the services they provide.



Dr John Killeen
Chairman, Marine Institute



CHIEF EXECUTIVE'S REPORT

2019 saw the Marine Institute continue to play a vital role in providing scientific advice to Government and in coordinating, funding, promoting and implementing marine research. This has been driven by the highly experienced, motivated and dedicated staff of the Institute. The range and quality of activities captured in this Annual Report are only made possible due to the diligence and commitment of our staff.

Providing scientific support to the Department of Agriculture, Food and the Marine, along with other departments, agencies and stakeholders, is central to the work and outputs of the Marine Institute.

This work includes programmes on fisheries research, marine environment and food safety, oceanography, data, technology, as well as seabed mapping. Providing expert advice and insight into the impacts of Brexit formed a significant part of the Institute's work during 2019, particularly involving the staff of Fisheries Ecosystems Advisory Services (FEAS) and the Irish Maritime Development Office (IMDO).

As well as providing vital scientific advice and research outputs within a domestic context, the Marine Institute is involved in a large number of international research projects, as the activities in this Annual Report clearly show. We know that countries need to work closely together so that we can collectively deepen our understanding of the ocean, to help us to predict the ocean's influence on our climate and our society.

The UN Decade of Ocean Science for Sustainable Development will begin in 2021 and is born out of the recognition that much more needs to be done to create improved conditions for the sustainable development of our oceans, seas and coasts and to reverse the cycle of decline in ocean health.

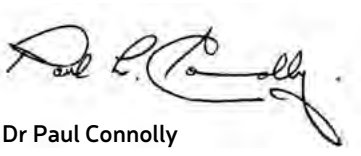
The strong international collaborations that the Marine Institute has built over the past decades are helping us in many areas of our work right across the Institute, but particularly in oceanography, ocean climate and advanced mapping, and we look forward to continuing and adding to these collaborations.

Engagement and education was once again a key strategic priority for the Institute during 2019, including outreach events like SeaFest, Our Ocean Wealth Summit, and various open days. Communications about the ocean through our social media, website and through various other media opportunities enhanced this strategic priority. Significant progress was made in raising awareness of the value of our ocean and getting the public and particularly our youth (the scientists of the future), to engage with it and to embrace how important the ocean is to society and to our wellbeing.

Our Research Funding Office began 2019 on a high point, with the launch of Marine Institute grant awards totalling €2.4 million over three years to 12 marine enterprises (in collaboration with five Higher Education Institutions). The Office also planned and implemented a major capacity-building post-doctoral fellowship call (totalling €3 million) in 2019; a first for the Institute.

The Advanced Mapping Services team and vessels RV *Celtic Explorer* and RV *Celtic Voyager* mapped over 5,136 km^2 of seabed in the Celtic Sea during 92 allocated vessel days in 2019. This involved acquisition of 13,874 survey line kilometres of multibeam data, investigation of 17 shipwrecks and coordinating acquisition of 243 seabed samples.

My sincere thanks to all the staff of the Marine Institute for their continued high standard of service delivery, and to the Board for their diligence and commitment in maintaining the highest standards of corporate governance.



Dr Paul Connolly
Chief Executive, Marine Institute

YEAR IN REVIEW - SNAPSHOT OF 2019 IN THE MARINE INSTITUTE

90,000

Visitors attended SeaFest 2019.

598

Science days undertaken collectively in 2019 by research vessels *Celtic Explorer* and *Celtic Voyager.* The vessels carried out a total of 52 surveys between them during 2019.

5,136km^2

The area of seabed mapped in the Celtic Sea by Marine Institute vessels and the Advanced Mapping Services team, as part of the INFOMAR programme undertaken in partnership with Geological Survey Ireland (GSI).

15

The number of years that the Institute has continuously held the prestigious Excellence Through People (ETP) accreditation. It retained it again in 2019.

€2.23 Billion

The estimated direct economic value of Ireland's ocean economy according to Ireland's Ocean Economy report, published in June 2019.

17

Shipwrecks were surveyed offshore in the Celtic Sea as part of INFOMAR's survey operations.

718,000

Fish/shellfish were measured during the 2019 Data Collection Multiannual Programme (DCMAP).

3,561

Seawater samples were analysed via microscopy for toxic and harmful phytoplankton species by Marine Environment and Food Safety Services.

€8.36 Million

The amount of research investments managed by the Research Funding Office during 2019, including €3 million for ship-time and €5.36 million for research and innovation actions.

31%

The overall reduction in energy consumption by the Institute during 2019, based on 2018 consumption figures.

€1.22 Billion

The contribution of the seafood sector annually to Ireland's Blue Economy (BIM Business of Seafood 2019). Providing the scientific advice that ensures the sustainable exploitation of these resources is a key part of Marine Institute work programmes.

DIRECTORS' STATEMENTS

CORPORATE SERVICES

The Corporate Services team regularly reviews the services provided by our team to ensure that we continue to meet the needs of the organisation, in realising the ambitions set out in our Strategy. Leading the Our People, Engagement and Education and Infrastructure Strategic Enablers are the cornerstone of our contribution to this, as well as ensuring that all activities are underpinned by strong, best practice corporate governance and financial management.

Highlights of 2019 included:

- Retention of Excellence Through People (ETP) accreditation under the NSAI Standard – ETP 1000:2012. ETP is Ireland's only national human resource management scheme dedicated to the role of people and their impact on business. The Marine Institute has held this prestigious award continuously since 2005. It reflects the Institute's investment in our staff who play a key role in maximising the efficiency of our business and building organisational capabilities
- Compliance with the 2016 Code of Practice for the Governance of State Bodies.
- Compliance with the General Data Protection Regulation in 2019 with comprehensive and ongoing training and awareness throughout the organisation
- The Marine Institute supported SeaFest 2019, Ireland's national maritime festival, held in Cork from 7th – 9th June 2019, and event managed by Cork City Council. The weekend festival attracted more than 90,000 visitors and is an important outreach event in realising the *Harnessing Our Ocean Wealth* goal of engaging the public with the sea
- An organisation-wide Get Greener Energy Team has made substantial progress in implementing the Energy Strategy 2016-2020 with energy reductions of 31% in 2019 and a target of a 33% reduction by 2020.
- A strong focus on safety and wellbeing with high safety standards resulting in no significant accidents. Promotion of health and safety and employee wellbeing remains a priority.
- Increased social media engagement over a range of channels including our website **www.marine.ie** which recorded 169,478 unique visits in 2019, which is an increase of 4.5% in new visitors. Supported by a range of online services and easily accessible, user friendly data and information, we continue to optimise our services to ensure we continue to meet users' needs, in a responsive, efficient manner.

We appreciate the support of our colleagues and stakeholders and look forward to continuing to deliver high standard and effective services in 2020. I thank all my colleagues in Corporate Services for their commitment, diligence and expert delivery of our services.

Ms Patricia Orme
Director - Corporate Services

IRISH MARITIME DEVELOPMENT OFFICE (IMDO)

The primary role of the Irish Maritime Development Office (IMDO) is to support the development of Ireland's maritime industry, the strategic importance of which has been well recognised in Government policies. As a trading nation, Ireland relies on maritime transport to a greater extent than any of our trading partners, a reliance that was brought into sharp relief by the challenges posed by Brexit to the efficiency and competitiveness of our ports and shipping services. The IMDO's work programme in 2019 was heavily influenced by these concerns. Throughout the year, the IMDO worked closely with colleagues in the Department of Transport, Tourism and Sport (DTTAS) to model different Brexit scenarios, assess their impacts on the maritime industry, and contribute to the development of new solutions or policies.

While much of the advice offered to DTTAS was based on the analysis of historical trade and shipping data, a significant amount of the work involved developing new industry intelligence to model how Brexit would affect trade patterns, routings, modal choices, and overall market demand.

The IMDO's mandate extends beyond providing advisory services to DTTAS and includes business development activities and the promotion of educational standards within the maritime industry. The IMDO also plays a supportive role in the achievement of a broad range of business development objectives set out in the Government's integrated plan for the marine industry, *Harnessing Our Ocean Wealth*, involving areas as diverse as marine renewable energy and cruise tourism.

Highlights from 2019 include:

- The IMDO engaged with industry through a range of national and international events and conferences and inward trade missions. It arranged industry briefings, worked through the EU Commission, and continued to foster industry collaboration
- The IMDO reported on the Development of Alternative Fuel Infrastructure in Irish Ports (**here**) to DTTAS
- The IMDO is a key contributor to several Strategic Focal Areas and Strategic Enabler 4, all listed later in this report
- The IMDO closely monitors the performance and competitiveness of the maritime industry and reports to DTTAS on a quarterly basis on emerging trends. This work culminated in the publication of the sixteenth edition of the Irish Maritime Transport Economist in 2019 (**here**), continuing an invaluable time series of port traffic and shipping data.
- In 2019, a consortium of ports and shipping companies was created, led by the IMDO, to apply for funding under a Motorways of the Sea call. If successful, the funding will be used to build a port community system for the maritime industry, based on Blockchain technology.
- The IMDO was successful in attracting funding for two important pieces of research during 2019. The first, undertaken by NUI Galway, will investigate the socio-economic value of developing the Irish maritime industry. The second, conducted by a team in Queen's University Belfast and jointly funded by the Marine Institute and the Environmental Protection Agency, will investigate port sustainability. Together, these research awards amount to over €800,000.
- The IMDO joined an international consortium to work with Cypriot interests to create a marine centre of excellence on the island. Through this project, the IMDO will attract more than €1.2m in funding over the seven-year funding period.

In the work highlighted above, the strategic importance of developing the maritime industry is evident. This work could not have been carried out without the commitment and professionalism of the team in the IMDO and the support and collaboration of colleagues in DTTAS and the wider maritime industry. I am indebted to all for their unstinting efforts, encouragement and support.

Mr Liam Lacey
Director - Irish Maritime Development Office

FISHERIES ECOSYSTEMS ADVISORY SERVICES (FEAS)

The Fisheries Ecosystems Advisory Services (FEAS) team provides the scientific advice that supports the sustainable management of our living marine resources. This service underpins Ireland's Seafood Sector, which was worth €1.22 billion in 2019. The key client for our advice is the Department of Agriculture, Food and the Marine (DAFM) and the main delivery mechanism is the Stock Book and the Shellfish Stock Book, which were delivered to DAFM during 2019. The web based interactive application of the Stock Book was launched in November alongside the traditional printed and electronic versions. These Marine Institute advisory services are key components in the delivery of Strategic Focus Area 1 of the Marine Institute's Strategic Plan.

2019 saw the Marine Institute and FEAS engage with the Department of Housing, Planning and Local Government (DHPLG) to deliver assessments in support of Marine Strategy Framework Directive (MSFD). This new aspect of Marine Institute scientific support services was formalised with a Service Level Agreement which was put into place in late 2019, and which will provide the template for service delivery to DHPLG over the next five years.

FEAS continued to innovate ways to integrate and present complex data sets in the delivery of scientific advice to decision makers. In 2019, FEAS provided detailed analysis to support DAFM in key elements of the planning process for Brexit.

Engaging with stakeholders is a very important part of the scientific advisory process. The Irish Fisheries Science Research Partnership (IFSRP) continued in 2019, and FEAS worked through this forum to improve our sea sampling effectiveness. The appointment of a fisheries liaison scientist was mooted through this forum and though only appointed in Q3, had made very good progress in this area by the end of the year. Throughout 2019, quarterly meetings also took place with the environmental NGOs (eNGOs) on the latest scientific advice for our living resources and on marine biodiversity issues.

FEAS continued to leverage Marine Institute influence at international level through the International Council for the Exploitation of the Sea (ICES) which is based in Copenhagen, Denmark. FEAS has a prominent leadership role in ICES and made significant impacts into how this organisation is addressing important issues for Ireland such as the quality and consistency of scientific advice.

Innovative research is crucial to "future proof" the Marine Institute's scientific advisory services. FEAS carried out a broad range of funded research projects that will ensure we meet the needs of our clients in a changing marine landscape.

2019 marked further important milestones in the delivery of the strategy for the Marine Institute Newport Facility. The recirculating aquaculture system (RAS) was completed and now produces fish in support of the externally funded projects. New EU funded aquaculture research projects were secured, and a major milestone was achieved in the delivery of the aquaculture toolbox.

Meeting the needs of decision makers in 2019, through a broad portfolio of scientific advisory programmes, was achieved through great team work within FEAS and within the wider Marine Institute. Our close working relationship with colleagues in OSIS (Infrastructure; Research Vessel Operations; Data), PIRS (Research Funding Support), MEFSS (MSFD; NATURA, Aquaculture) and Corporate Service (People; Finance; Procurement) ensured a very high quality scientific service to our key client (DAFM) and a satisfied customer.

Dr Paul Connolly
Director – Fisheries Ecosystems Advisory Services

MARINE ENVIRONMENT AND FOOD SAFETY SERVICES (MEFSS)

Marine Environment and Food Safety Services (MEFSS) at the Marine Institute comprises of 70 scientific, contracted research staff, students and support staff across our shellfish safety, policy and advisory services, fish health, marine spatial planning, quality management, and marine chemistry units. We provide a range of monitoring and technical services, advice and research in support of the sustainable development and management of the marine environment.

These services and advisory products are provided to the Department of Agriculture, Food and the Marine (DAFM), and other departments, agencies and stakeholders. Our work at MEFSS is fully aligned with the Marine Institute's Strategic Plan 2018 – 2022, which sets out our strategic vision on how we deliver our services to the highest standards of excellence.

In 2019, MEFSS completed a range of statutory monitoring services to support seafood safety and the protection of the marine environment, including the national biotoxin monitoring programme, the national residues (in seafood) control programme, implementation of the EU Fish Health Directive and delivery of essential elements of the Marine Spatial Planning Directive and the Marine Strategy Framework Directive. Monitoring services also included coastal and transitional monitoring aspects of the Water Framework Directive.

Our international role included participation at a wide range of environmental scientific and technical working groups including EU National Reference Labs, International Council for the Exploration of the Sea (ICES), International Oceanographic Commission (IOC) and the OSPAR Commission as national representatives and experts reporting our work to these fora.

2019 also saw a milestone in the delivery of aquaculture licensing advice that facilitated DAFM in clearing a longstanding backlog of shellfish licence decisions over the course of the year. This important delivery was one aspect of our provision of a range of scientific advice on compliance of aquaculture and foreshore lease/licence applications with Natura and Environmental Impact Assessment (EIA) Directives.

Our quality systems in MEFSS have become the way that all our staff carry out their functions, extending throughout the service area to senior management. During the year, MEFSS not only retained its Irish National Accreditation Board (INAB) laboratory accreditation but successfully transitioned to the new ISO17025-2017 standard and extended its scope with a further two test methods, now totalling 35 fully accredited methods. In addition, our Fish Health Competent Authority office also successfully transitioned to a new risk-based/process-flow standard.

The Department of Housing, Planning and Local Government (DHPLG) is the lead department for marine planning and published the National Marine Planning Framework consultation draft in November 2019 with considerable input from the Marine Institute. In September 2019, the Marine Institute, DAFM and DHPLG signed an historic Service Level Agreement. Marine Environment and Food Safety Services will provide scientific advice and services to inform decisions about how marine resources are used sustainably and to ensure Ireland complies with various EU legislation requirements.

I would like to express my appreciation and recognise the efforts of the MEFSS team who collectively completed a challenging, busy and important programme of activities during 2019, and to our wider cast of colleagues throughout the Institute, agencies and government departments who have worked with us in providing our scientific services. The specific highlights and further details from our programmes in 2019 are included in the relevant Strategic Focus Areas and Strategic Enabler sections in this report.

Mr Joe Silke
Director - Marine Environment and Food Safety Services

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

Ocean Science and Information Services (OSIS) was a key provider of a wide range of services throughout 2019, as described in following sections. Operating across the whole data value chain, data was increasingly acquired once and used often. This enabled delivery of quality science-based services to a wide range of internal, national and international clients and stakeholders including Government.

OSIS made a significant contribution to the delivery of the Institute's strategy. OSIS staff participated in a wide range of internal, national, European and international programmes and were again active across a significant number of EU-funded programmes. These improve our technical capacity to deliver to the needs of integrated science programmes that inform cross-sectoral policy advice.

Significant activities included:

- The signing of the contract with Armon Vigo shipyard in December 2019 to build a replacement vessel for the RV *Celtic Voyager*
- An Ocean Energy & Infrastructures Section was established within OSIS in 2019 to manage the significant Marine Institute observing infrastructures and their contribution to national and EU marine research programmes
- The two research vessels *Celtic Voyager* and *Celtic Explorer* delivered 598 science days and the ROV *Holland 1* completed three research surveys (54 days offshore)
- As part of the DCCAE funded INFOMAR programme with partners Geological Survey Ireland, the Advanced Mapping Services team and RV *Celtic Explorer* and RV *Celtic Voyager* mapped 5,136 km^2 of Celtic Sea seabed during 92 vessel days in 2019. This involved acquisition of 13,874km survey line of multibeam data, investigation of 17 shipwrecks, and 243 seabed samples.
- 2019 saw the successful completion of the Offshore Reef Project 'SeaRover'. The three-year multi-partner project was coordinated and led by the Institute and INFOMAR and funded by the EMFF Marine Biodiversity Scheme and the National Parks and Wildlife Service. This extensive assessment of sensitive benthic ecosystems in Irish waters employed the ROV *Holland 1* to record HD video at 152 separate locations at depths ranging from 150 – 3000 metres.
- The Institute oversaw the delivery of 12 reports, as part of the large EU funded AtlantOS project, which ended in September 2019. The Institute also led the delivery of a strategy on Trans-Atlantic cooperation and sustainability and contributed to a report on the AtlantOS observing system.
- The procurement took place of a significant range of observing infrastructure through the EirOOS project funded by Science Foundation Ireland and the Marine Institute to upgrade, replace and acquire new observation equipment.
- A key achievement in the implementation of the Data and IT enabler of the Institute's Strategic Plan, the Data-Management Quality Management Framework for the Marine Institute received accreditation in February 2019 from the International Oceanographic Data and Information Exchange (IODE) of the Intergovernmental Oceanographic Commission of UNESCO. At the time, the Institute was one of only 10 accredited marine data centre globally.
- Institute online services were visited over 76,000 times, with a significant uplift during major events like storms such as Lorenzo in October. The Marine Institute data request service also processed over 180 manual data requests for customised queries.

This wide range of services reflects the dedication, professionalism, technical expertise and fantastic teamwork of the staff of OSIS and the wider Marine Institute and collaborators and contractors. I want to thank and commend the extended group for their efforts.

Mr Michael Gillooly
Director - Ocean Science and Information Services

POLICY, INNOVATION AND RESEARCH SUPPORT SERVICES (PIRS)

The Marine Institute Strategic Plan, *Building Ocean Knowledge, Delivering Ocean Services* (2018-2022), sets ambitious targets for Marine Institute and national research performance as well as optimising the efficiency and impact of our competitive funding programmes.

PIRS began 2019 on a high point with the launch in January by the Minister for Agriculture, Food and the Marine, M ichael Creed TD, of Marine Institute grant awards totalling €2.4 million to 12 marine enterprises (in collaboration with five Higher Education Institutes). The funding is being provided to drive continued innovation in Ireland's ocean economy, a key requirement of the National Marine Research & Innovation (R&I) Strategy.

The Research Funding Office also ran a major capacity-building post-doctoral fellowship call in 2019. Eight post-doctoral awards worth a total of €3 million were approved for funding and will address areas such as port sustainability, fisheries and climate change, marine biodiscovery and chemical pollution in the marine environment. In total, the funding office managed €8.36 million in research investments including €3 million for ship-time and €5.36 million for research and innovation actions.

On behalf of the Government's Marine Coordination Group, the Marine Institute coordinates implementation of the National Marine Research & Innovation Strategy (2017-2022). In support of this, the Marine Research Funders' Forum met twice in 2019 and new members were added, bringing to 22 the total number of bodies engaged in the Forum. Based on data collected from across the national funding system, the Marine Institute presented a first analysis of national Marine R&I investments (totalling €183 million since the beginning of 2017) to the Funders' Forum in November. Work continues into 2020 to develop an online portal with a searchable database for national marine R&I investments.

The International Cooperation Programme works to optimise Ireland's influence and performance in international marine R&I funding. At the end of 2019, the total tally of Horizon 2020 funding to Irish-based researchers for marine R&I stood at €63.8 million, representing 6% of the total funding available. The Marine Institute itself had a very successful year in attracting new Horizon 2020 projects and funding totalling €2.3 million, and bringing the total cumulative H2020 funding to the Marine Institute to over €10 million.

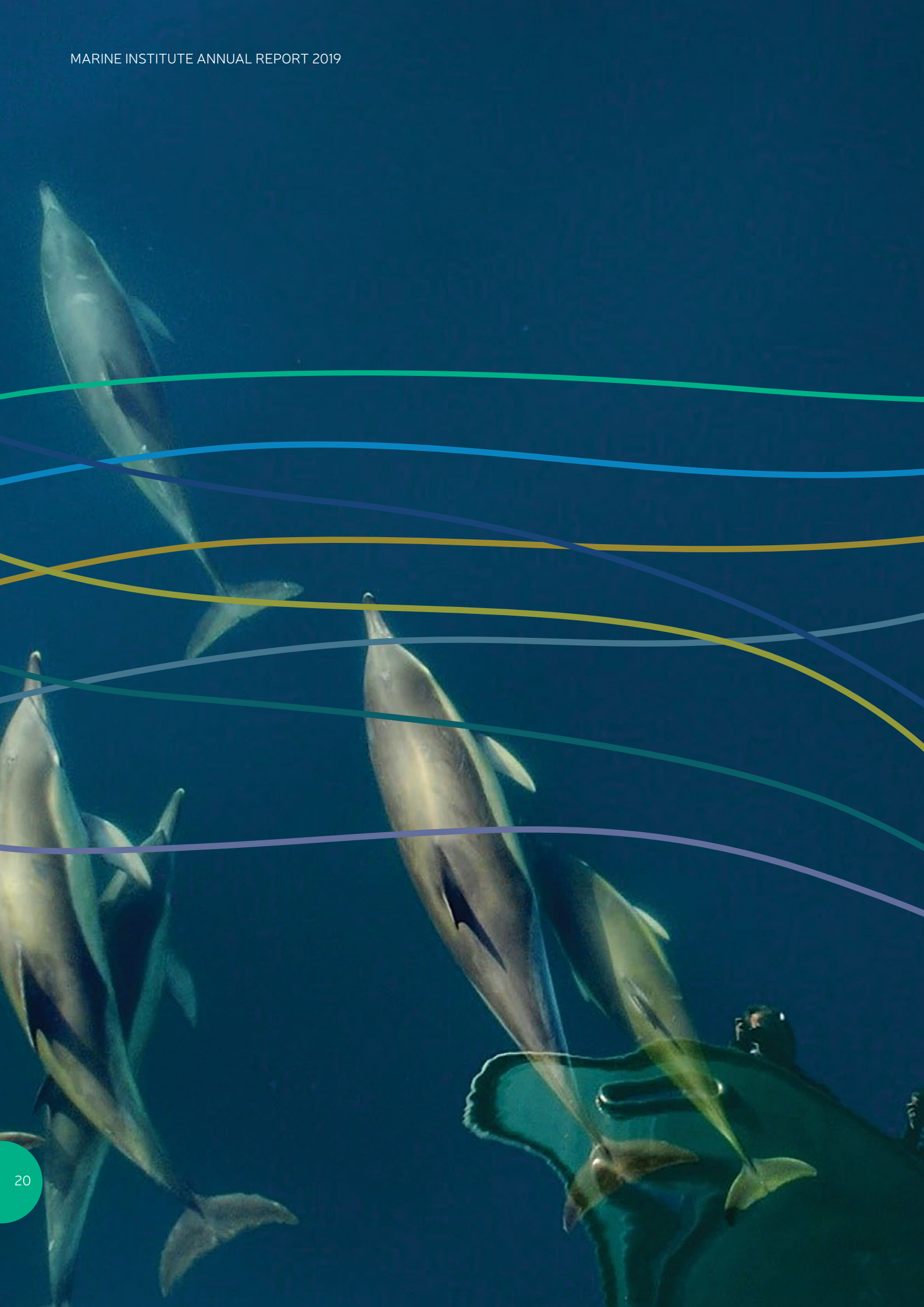
PIRS was central to the establishment of a new Marine Institute Research Committee in 2019. One of the first successes for the Committee, which is chaired by Fisheries Principal Investigator, Prof. Dave Reid was the organisation of an internal Research Symposium on 24th October. 70 researchers from across the Institute gathered to present their work, to brainstorm, and to identify ways to work better together. The Symposium will become an annual event, helping to ensure closer engagement and integration across the research active areas of the Institute.

Finally, a word of congratulations to the AORA (Atlantic Ocean Research Alliance) team who organised a highly successful Atlantic Youth Ambassadors Summer School in Galway in August. 23 young ambassadors from countries from around the Atlantic rim (including two from Ireland) were given masterclasses in communication, campaign development, ocean awareness and developed their own campaigns for Atlantic Ocean action. These are being taken forward to a major All-Atlantic Ocean Research event in Brussels in February 2020.

My sincere thanks to all the dedicated staff of the Policy Innovation and Research Support Services group for their hard work and dedication in 2019.

Dr Niall McDonough
Director – Policy, Innovation and Research Support Services


MOORED DATA

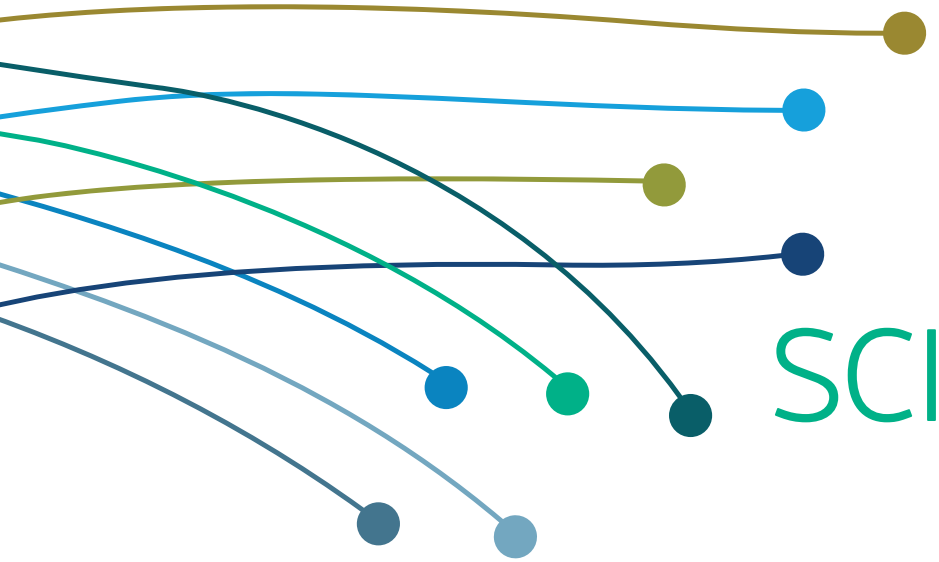


STRATEGIC FOCUS AREAS

STRATEGIC ENABLERS

STRATEGIC FOCUS **AREA 1**

SCIENTIFIC ADVICE AND SERVICES



SCIENTIFIC ADVICE AND SERVICES

The advice and services provided to the Department of Agriculture, Food and the Marine (DAFM) and other government departments, agencies and stakeholders are ongoing requirements mandated to the Marine Institute.

These services are essential to achieving a sustainable ocean economy, protecting and managing our marine ecosystems and meeting EU obligations. Our services support a range of commercial activities and important statutory requirements across fisheries, aquaculture, food safety, maritime transport and environmental compliance. Scientific advice and services are key deliverables for our parent department and main client DAFM, drawing on work in other areas of work in the strategic plan.

The Marine Institute conducts a broad range of data collection and monitoring programmes, including research vessel surveys, seabed mapping and laboratory analyses that provide the basis for our advice and services. These data are also crucial for an increased understanding of our oceans and climate, and provide a foundation for applied research and innovation.

The management of these diverse data sets and the ability to combine and use them in different ways is increasingly important to the delivery and evolution of integrated advice. It also supports implementation of key marine policies and directives such as the Common Fisheries Policy, the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive. Modelling, statistical analysis, spatial analysis and the interpretation of these diverse data sets, enable us to deliver services to our clients and stakeholders.

MARINE ENVIRONMENT AND FOOD SAFETY SERVICES (MEFSS)

Scientific advice and services are provided by MEFSS in the areas of shellfish safety, fish health, marine chemistry, environmental review and marine spatial planning. These advisory products and services are provided to the Department of Agriculture Food and the Marine and other government departments, agencies and stakeholders in order to meet our statutory requirements, protect and manage our marine ecosystems and achieve a sustainable ocean economy. Monitoring conducted by MEFSS is largely driven by EU Directive requirements, which are enacted in Irish law through relevant national statutory instruments. Below is a summary of the scientific advice and services carried out by the scientific and support staff within MEFSS in 2019.

Monitoring Services

Shellfish Safety Monitoring

The Shellfish Safety Unit employs a diverse array and range of biological, chemical and molecular methodologies to fulfil its obligations in ensuring that shellfish from offshore and inshore classified aquaculture production areas which are placed on the market for human consumption are safe to eat, protecting the consumer whilst supporting the quality and reputation of Irish shellfish and its industry. Our work is conducted in close co-operation with the Competent Authorities, Sea Fisheries Protection Authority (SFPA) & Food Safety Authority of Ireland (FSAI) with a strong collaboration with the shellfish industry. Ireland has a diverse and varied production of bi-valve molluscan shellfish species around its coastline, encompassing over 100 classified production areas and including the harvesting of mussels, Pacific and native oysters, clams, cockles, razor clams and scallops.

The remit of the Shellfish Safety Unit is to provide analysis of shellfish and water samples for official control, in the fields of biotoxin, phytoplankton, and microbiological national monitoring programmes, throughout the year, often on a weekly basis. In all these analyses, a rapid result report turnaround and communication to the Competent Authorities and the shellfish industry is essential. In addition, the unit provides a wide range of scientific advice and data to the Competent Authorities, industry, a variety of stakeholders, parent European Union Reference Laboratories (EURLs), EU and European Food Safety Authority (EFSA).

Shellfish Safety is comprised of three disciplines: Microbiology, Phytoplankton and Biotoxins, where all methods employed are accredited to ISO 17025 standards, and are conducted in compliance with and meet the requirements with those as laid down in the relevant EU legislations (mainly Regulation 853/2004, 625/2017 & 627/2019) and the requirements of the Competent Authorities. We are the designated National Reference Laboratories for Ireland for both marine biotoxins and microbiology.

Shellfish Microbiology

Under our obligations as the National Reference Laboratory (NRL) for *E. coli* (shellfish only), we manage the *E. coli* testing programme in support of the annual classification of bivalve shellfish production areas in Ireland. This involves the review of test results and the monitoring of the technical competency of the official control laboratories contracted to undertake the *E. coli* testing in live bivalve molluscs (LBMs).

The vast majority of our laboratory testing relates to norovirus where, as the NRL for foodborne viruses (shellfish only), we provide norovirus testing to the Competent Authorities (SFPA and FSAI) in response to oyster related outbreaks and other work requests. In addition, requests for norovirus testing continued from the oyster industry at home and abroad for our norovirus testing service. However, a significant proportion of norovirus testing (768 samples) in 2019 went towards the Bord Iascaigh Mhara (BIM) funded project which continues until March 2021, to analyse the

impact, management and prevalence of norovirus in a number of production areas around the coast of Ireland. In 2019, the Marine Institute obtained ISO 17025 accreditation for the detection of hepatitis A virus (HAV) in bivalve shellfish and completed a work request for the FSAI on the prevalence of HAV in oysters sampled through the EU baseline survey for norovirus in oysters.

Biotoxins

Marine biotoxins are naturally occurring and are produced by a small number of phytoplanktonic species, which are ingested by filter feeding bivalve molluscs, where these toxins can accumulate within the tissues of the shellfish. Whilst not causing any direct harm to the shellfish, if these intoxicated shellfish are consumed, the ingested toxins can give rise to a number of associated human illness syndromes when above regulatory levels. In Ireland, the four main toxin groups which occur, often on an annual basis, are:

- Amnesic Shellfish Poisoning (ASP)
- Azaspiracid Shellfish Poisoning (AZP)
- Diarrhetic Shellfish Poisoning (DSP)
- Paralytic Shellfish Poisoning (PSP)

For 2019, 2,492 shellfish samples were analysed by chemical methods (LC-MS/MS & UPLC) for the detection and quantification of the above toxin groups and their associated compounds. This number of samples gave rise to 15,761 analyses. A number of samples throughout the year were observed to contain toxin concentrations above regulatory levels for the above toxin groups, which resulted in closure periods where the harvesting of shellfish was prohibited until concentrations were observed to decrease to below regulatory levels, allowing areas to re-open for harvesting. When toxin concentrations are observed above regulatory levels, these closures are a necessary measure to ensure consumer safety and compliance with EU regulations.

In 2019, the following closure periods were observed due to biotoxin concentrations above regulatory levels:

- ASP was detected in mussel samples from the southwest during a two-week period in mid-April affecting a number of production areas across three different bays
- AZP was detected in Pacific oyster samples from the northwest for one week in mid-April
- DSP was detected in mussel and Pacific oyster samples from the southwest from end of May to the start of September, in mussel samples from the west from June to August, and in one sample of surf clams from the south in July
- PSP was detected in mussel samples during June, resulting in one week's closures in the south and the southwest. Whilst PSP above regulatory levels is a usual occurrence in the south during June, this was the first time it was observed outside this production area resulting in a closure

The pattern of toxicity for 2019 was observed to occur at slightly higher concentrations and resulted in longer closures periods when compared to 2017 – 2018. However, the duration of these closures periods and concentrations in shellfish observed, were shorter and lower when compared to the years 2010-2015. The main significant finding was the detection of PSP above the regulatory levels for the first time in the southwest. This will lead to an increase volume of sample testing from 2020 in determining if the observed occurrence is an indication whether PSP toxicity is increasing in its distribution around the Irish coast.

Phytoplankton

A number of phytoplankton species give rise and are known to be the causative organisms of the above mentioned biotoxins. Therefore, we conduct a comprehensive national monitoring programme on a weekly basis, all year round, for the identification and enumeration of these known toxin producing/harmful algal species in seawater samples. This monitoring programme provides valuable information to the Competent Authorities and industry on the presence of these species and the likelihood of their associated toxins occurring and accumulating in shellfish during incoming periods of toxicity, prior to regulatory levels potentially being exceeded and closure periods being enforced.

During 2019, 3,561 seawater samples were analysed via microscopy, a smaller number of these samples were also analysed via molecular methods for species confirmation. The phytoplankton results support the toxic events in shellfish observed and as described above for 2019. The typical known causative organisms which were observed for 2019 include *Pseudo-nitzschia australis* causing ASP, *Alexandrium spp* causing PSP and *Dinophysis acuta* and *Dinophysis acuminata* causing DSP events. For the Water Framework Directive, 201 seawater samples were analysed via microscopy for phytoplankton identification and enumeration, and 200 seawater samples for Chlorophylls during 2019.

The data from the national monitoring programme is used to provide a weekly bulletin report to industry on the prediction and forecasting of the likelihood of any incoming toxin events into production area, therefore giving advance warning to industry of any potential closures. The data is also used to provide information on determining the appropriate frequency of shellfish testing as required during high and low risk periods.

Fish and Shellfish Health Monitoring

Mortality in Pacific oysters associated with infectious diseases continued to be a significant feature of shellfish aquaculture in 2019. During the year, the Fish Health Unit investigated 22 reports of increased mortality events affecting Pacific oysters events. The events were principally associated with the bacterial pathogen *Vibrio aestuarianus* or Ostreid herpes virus-1 µvar (OsHV-1 µvar). However, a number of other bacterial species were also detected during these mortality events and their role in the events remains to be determined. In total, the Fish Health Unit tested 1,557 molluscs for diagnostic, research or surveillance purposes.

The Fish Health Unit tested 2,544 fish for diagnostics, research or surveillance purposes. These were primarily Atlantic salmon (63.4%) but also wrasse (16.4%), lumpfish (9.9%), and trout (5.9%), with other species making up the rest. No diseases listed as being a notifiable in EU Fish Health Regulations were detected in commercial aquaculture production businesses in 2019. However, in May 2019, an isolated outbreak of koi herpesvirus occurred in an enclosed private garden pond in the Midlands. Koi herpesvirus is a notifiable disease in EU Directive 2006/88/EC and Ireland is declared free of this disease. The outbreak was contained, fish culled and the pond disinfected under the supervision of the Competent Authority. The rapid introduction of these control measures allowed Ireland to maintain disease free status for koi herpesvirus.

During the year, reports were received of morbidity and mortality in returning wild Atlantic salmon associated with a rash-like discolouration. Working with Inland Fisheries Ireland, the Marine Institute was able to obtain three salmon that were affected by the condition. These fish were tested by the laboratory for a range of potential pathogens but no aetiological agent was identified. Similar reports were recorded in Scotland and Norway and no conclusive findings were reported from investigations in these countries. The Marine Institute will work with Inland Fisheries Ireland in 2020 to investigate any further incidents of the condition in returning Atlantic salmon.

In 2019, crayfish plague caused by the water mould *Aphanomyces astaci* were confirmed by laboratory analysis in white-clawed crayfish *(Austropotamobius pallipes)* in the River Maigue in Co. Limerick, and the River Slate in Co. Kildare. These outbreaks confirm the continued presence and probable spread of crayfish plague in Ireland following the first confirmed detection in the country in 2015. The spread of crayfish plague poses a significant threat to the white-clawed crayfish population which is a protected species in Ireland. In response to this threat in 2019, the Marine Institute and the National Parks and Wildlife Service continued to implement a two year national surveillance programme to monitor for the presence of crayfish plague. Results from the programme confirms the continued presence and probable spread of crayfish plague in Ireland.

Residues and Contaminants Monitoring in Seafood

The chemistry section of MEFSS carried out the farmed finfish component of the 2019 National Residues Surveillance Programme to ensure compliance with European Commission Directive 96/23/EC and to ensure farmed fish are fit for human consumption and good practices are being followed. Results are reported in the subsequent year e.g. the 2018 results were published in 2019, in which the results of more than 920 tests and 2,611 measurements were presented. This report reflected full compliance with standards and the outcome for aquaculture remains one of consistently low occurrence of residues in farmed finfish.

Additionally, fishery samples from non-EU countries collected at border control posts (BCPs) were tested for contaminants and veterinary residues. Monitoring of Irish shellfish, crustaceans and wild fish for a range of environmental contaminants (e.g. metals, persistent organics) was also undertaken in conjunction with the FSAI and SFPA, demonstrating compliance of Irish seafood with European regulatory limits defined by Regulation 1881/2006, and fulfilling specific reporting requirements under the Marine Strategy Framework Directive. Some additional official testing of seafood destined for export to the Far East was also undertaken. These data are reported to FSAI, SFPA and EFSA.

Pollutants and Water Quality

On behalf of the Environmental Protection Authority (EPA) and the Department of Housing, Planning and Local Government (DHPLG), the Marine Institute conducted environmental monitoring as part of the 2016-2021 cycle of the EU Water Framework Directive (WFD) and OSPAR's coordinated monitoring programme. Selected WFD water bodies and designated shellfish growing waters were sampled for a variety of water quality indicators to determine whether they met 'good ecological and chemical status' as defined in the Directive. Specifically, 415 water samples were analysed for physico-chemical parameters; 324 water and biota samples were collected for determination of a wide range of priority samples and other pollutants; and 216 samples were analysed for phytoplankton.

Additionally, 299 grab samples were collected from 34 water bodies and analysed for benthic macro-invertebrates, particle size analysis and loss on ignition. Of these, 116 samples were taken from nine coastal water bodies collected during the annual winter environmental survey aboard the RV *Celtic Voyager* in January.

Hazardous substances monitoring data was submitted to the International Council for the Exploration of the Sea (ICES) in line with OSPAR monitoring programme and Marine Institute scientists contributed to the annual OSPAR

assessment of pollution status and trends for the North East Atlantic. These assessments are available online at **https://ocean.ices.dk/oat/.** These data contributed to periodic Article 17 assessments under the MSFD.

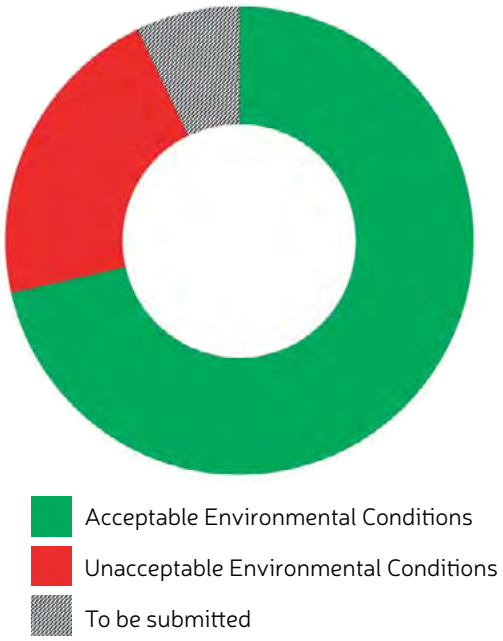
The chemistry section in collaboration with NUI Galway and Dublin Institute of Technology reported the results of a 2018 sampling programme to evaluate the status and temporal trends of imposex in dogwhelks around Irish waters. Tributyl tin (TBT) is a highly toxic and once widely used antifoulant in marine paints, and the degree of imposex, a known androgenic response of female dogwhelks due to exposure to TBT wherein female dogwhelks develop male reproductive organs, provides an effective indicator of TBT pollution. The project was undertaken on behalf of the Department of Housing, Planning and Local Government (DHPLG) and results indicate a substantial improvement with respect to TBT contamination of Irish coastal waters, showing the effectiveness of national, European and global measures to phase out TBT.

Finfish Benthic Monitoring

The Benthos Ecology Group carried out its annual review of reports from finfish operators arising from benthic surveys to examine seabed conditions below fish cages in accordance with DAFM Benthic Monitoring Protocols. A review is prepared annually by the Benthos Ecology Group and is submitted to DAFM. During 2019, 26 reports were received from 28 operational sites with two more reports expected by early February. This will be the first year since 2001 that a benthic monitoring report has been submitted for all operational sites.

Of the 26 sites that produced reports to date, 20 were considered acceptable (i.e. conditions were within the environmental standards stated in 'Monitoring Protocol No. 1 for Offshore Finfish Farms – Benthic Monitoring, 2008'), and six sites were considered to have unacceptable environmental conditions. A review will be submitted to DAFM once all farm reports have been submitted.

Benthic Monitoring 2019



Advisory Services

Shellfish Safety Advice

The EURL/NRL network for the monitoring of bacterial and viral contamination of bivalve molluscs, of which the Marine Institute participated in, ceased to exist in 2019. The various duties associated with this network have been replaced by incorporation into existing NRL structures within the EU. Despite these significant changes MEFSS has continued to provide supportive advice to the Competent Authorities in Ireland and at a European level on microbiological food safety issues associated with bivalve shellfish.

Following the review of *E. coli* monitoring in shellfish production areas by the National Reference Laboratory for *E. coli* (shellfish only) in MEFSS, advice was again provided to the Sea Fisheries Protection Authority (SFPA) to assign appropriate classification to each shellfish production area for 2019. In addition, we support the Competent Authorities in Ireland (SFPA and FSAI) with advice relating to public health issues surrounding contamination of LBMs (live bivalve molluscs) with human pathogenic viruses. We completed the norovirus analysis and data submission from Ireland to EFSA for the EU-wide baseline survey of norovirus in oysters. The final report of which was published in July 2019 and will form the basis for discussions on the introduction of a norovirus standard for LBMs within the EU.

As the NRL for marine biotoxins and shellfish microbiology there are a number of reports which are produced on a regular basis, and also a number of forums where our scientific advice is delivered to Competent Authorities, stakeholders and the shellfish industry. One forum is the Molluscan Shellfish Safety Committee (MSSC) which met three times during 2019, where the Marine Institute has been an integral part advising on microbiological and biotoxin topics and issues. Our reports and presentations have also been presented at the 20th Anniversary of the formation of the FSAI in August 2019 and our own Shellfish Safety Workshop in October 2019. Internationally, we presented the annual ICES conference in September 2019, and through our participation at the ICES Working Groups on harmful algal bloom dynamics and on the Working Group for phytoplankton and microbial ecology. We also report to our respective EURLs on our NRL activities and data sets on an annual basis.

Through our biotoxin and phytoplankton monitoring programmes, our results are reported on a daily basis through our Harmful Algal Blooms (HABs) website, which also presents results in a graphical format which illustrates any patterns or trends in increasing or decreasing toxin concentrations in shellfish and phytoplankton cell numbers during toxic events. We also produce a weekly bulletin which predicts and provides short term forecasts on the likelihood of toxicity occurring in production areas.

We also provide an advisory laboratory service to international laboratories in the provision of prepared samples for the proficiency testing scheme QUASIMEME for the quantification of marine biotoxins in shellfish in the ASP, PSP and DSP toxin groups, and for the first time in 2019 for the Tetrodotoxin (TTX) group of toxins. The International Phytoplankton Intercomparison (IPI) exercise is coordinated through the Marine Institute, in conjunction with the Intergovernmental Oceanographic Commission (IOC), and provides spiked samples of phytoplankton species in seawater to international laboratories for the identification and enumeration of these species. The exercise also incorporates an online taxonomy exercise on phytoplankton through the Ocean Teacher platform, maintained by IODE, containing questions populated by the Marine Institute and IOC.

Competent Authority Advice

The Marine Institute is the Competent Authority in Ireland for the implementation of Council Directive 2006/88/EC. This European Directive and associated national regulation addresses the health of aquaculture animals and lays down specific rules for the prevention and control of certain aquatic animal diseases. The regulations apply to finfish farms, shellfish farms, and put and take fisheries, and require that such aquaculture production businesses (APBs) obtain Fish Health Authorisations (FHA) from the Competent Authority prior to operation. In 2019, 10 new Fish Health Authorisations were granted to APBs in Ireland. The total number of APBs in the State at the end of 2019 was 409. As the Competent Authority, the Fish Health Unit directs and monitors the activities of DAFM Veterinary Inspectors working in the aquaculture field. In 2019, 199 inspections of APBs were completed for health surveillance, export and disease investigation purposes. The Fish Health Unit also processed 2,198 movement applications for live aquatic animals. This included imports, exports and national movements.

Aquaculture Licensing Advice

MEFSS continues to provide advice to DAFM to inform aquaculture licensing decisions that may have implications for marine Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and/or other environmental concerns. 2019 was a particularly busy year, given the Department's goal of making approximately 300 shellfish licence decisions over the course of the year.

In 2019, highlights of MEFSS advice and technical support in this area included:

- Completion of 8 full Appropriate Assessments for 14 marine Natura sites:
  Carlingford Lough SPA, Carlingford Shore SAC, Castlemaine Harbour SAC and SPA, Rutland Island and

Sound SAC, Inner Galway Bay SAC, Galway Bay SPA, Trawbreaga Bay SPA, North Inisowen Coast SAC, Cork Harbour SPA, Great Island SAC, Killala Bay-Moy Estuary SAC, Killala Bay-Moy Estuary SPA and West of Ardara Maas Road SAC

- These assessments will allow the progression of approximately 160 licensing decisions. Of these, revisions on foot of requests from DAFM were provided for 6 Natura sites.
- Ongoing monitoring of mitigation measures in relation to oyster culture and bird interactions continues in Dungarvan SPA and the Bannow Bay SPA and was initiated in Castlemaine Harbour SPA and Carlingford Lough SPA
- Environmental Impact Assessment screening for non-salmonid licence renewal applications in land-based facilities in Offaly, Tipperary and Donegal
- Advice on 248 aquaculture licence applications, covering 259 individual sites. All advice was provided to DAFM within the six-week time frame set out in legislation

Other Advisory Services

- Technical advice to ports on the disposal of dredge material at sea by providing pre-application technical support (n = 10), assessments of sediment suitability, and by providing recommendations to the EPA (n = 6). MEFSS also participated in the EPA's Dumping at Sea Advisory Committee
- The 2018 annual national report on dredging and dumping at sea was compiled and submitted to OSPAR
- Ongoing advice to and collaboration with the Department of Communications, Climate Action and Environment (DCCAE) on the environmental aspects of offshore exploration in relation to OSPAR measures
- Specific advice on chemical use, permit conditions and offshore environment inspection for drilling of Iolar well by CNOOC (China National Offshore Oil Corporation)
- Reporting to OSPAR on the annual discharges, emissions and spills from the offshore oil and gas industry in Irish waters, 2018
- MEFSS staff are delegates to a number of OSPAR, EC and ICES Committees and Expert groups
- Provision of advice to DHPLG and DAFM on 19 applications for foreshore leases/licences. Applications included site investigations related to the potential future development of offshore windfarms in the Irish Sea and Celtic Sea, enhancement of port facilities on the west coast, site investigations related to the development of improved wastewater treatment facilities in a number of coastal areas and the installation of a long sea outfall as part of the development of a new wastewater treatment on the east coast, the installation of a subsea fibre optic cable with landfall on the east coast as well as installation of pontoons for the provision of enhanced marine recreational facilities in a number of coastal areas
- Support and advice to the Department of Communications, Energy and Natural Resources on the implementation of the Offshore Renewable Energy Development Plan through participation in the Steering and Environmental Working Groups

Marine Spatial Planning Advice

The Department of Housing, Planning and Local Government published the draft National Marine Planning Framework (NMPF)[1] in December 2019. This will be a key decision making tool for regulatory authorities and policy makers into the future. Throughout 2019, the Marine Institute collated scientific evidence that will greatly support the implementation of the NMPF.

MEFSS continued the implementation of the technical and scientific programme (2018-2020) for Marine Spatial Planning, funded through the *European Maritime Fisheries Fund (2014-2020) Union Priority 6 - Fostering the Implementation of the Integrated Maritime Policy.* Throughout 2019, the team undertook a detailed data collation exercise. Environmental, social and economic data, including data on all human activities occurring in the marine environment, were processed to generate products to inform the MSP process. Ireland's marine natural capital and ecosystem services were mapped, to identify potential threats and opportunities.

In partnership with the Marine Institute's Information Services & Development (IS&D) team, two projects on data management and information services projects were completed in July 2019. These included the development of processes to ensure that all MSP data are managed to accredited international standards (IODE and INSPIRE).

[1] https://www.housing.gov.ie/sites/default/files/public-consultation/files/draft_national_marine_planning_framework_final.pdf

FISHERIES ECOSYSTEMS ADVISORY SERVICES (FEAS)

The seafood sector is a valuable contributor to Ireland's Blue Economy and contributes €1.22 billion annually (BIM Business of Seafood 2019). Providing the scientific advice that ensures the sustainable exploitation of these resources is a key part of Marine Institute work programmes.

The EMFF (European Maritime and Fisheries Fund) is a very important funding mechanism for the Marine Institute service delivery. The Data Collection Multiannual Programme (DCMAP) is funded under EMFF and is a central part of the scientific advice and technical support services provided by the Marine Institute to the Department of Agriculture, Food and the Marine (DAFM) in relation to the Common Fisheries Policy. The Marine Institute has responsibility for Ireland's DCMAP and successfully completed the 2019 programme which was evaluated by the EU. The 2020 and 2021 National Workplans were submitted and approved by Scientific, Technical and Economic Committee for Fisheries (STECF). These include catch sampling at sea and in ports, internationally coordinated research survey programmes, inshore sampling and surveys and socioeconomic evaluation of the fishing, fish processing and aquaculture sectors.

Over 718,000 fish/shellfish were measured during the 2019 DCMAP programme. Age data were collected from nearly 50,000 individuals across all commercial species sampling programmes to provide data for the aged based models used in stock assessments.

In 2019, under the DCMAP, 17 research vessel surveys were carried out on a variety of commercially exploited species to provide the basic data that supports stock assessment. A total of 2,327 scientist days were spent at sea focused on a broad range of species including mackerel, blue whiting, herring, anglerfish, megrim, Nephrops, cockles, scallop and lobster. New technologies were developed in Ireland and deployed on Nephrops surveys which are at the leading edge of how these surveys are conducted globally.

The annual sampling at sea programme was completed, with observers trained and deployed throughout the Irish fishing fleet and sample data compiled to contribute to 2020 stock assessments. In 2019, Marine Institute staff spent a total of 387 days collecting data on commercial catches. These data sets are used in national and international stock assessment programmes and provide the advice that is central to the sustainable exploitation of these species.

A key development in 2019 was the creation of a fisheries liaison position. This position is a full time member of Marine Institute staff with a role to co-ordinate at sea sampling between contractors, Marine Institute staff and the fishing industry. The role was created in response to a need identified over the past number of years where difficulties were encountered in achieving adequate at sea sampling of commercial catches.

During 2019, the Marine Institute implemented new technology developed with the Irish marine technology company Cathyx Ocean, for underwater TV surveys (UWTV). Nephrops fisheries at €57 million are the most valuable Irish fisheries, and these are assessed annually by means of UWTV surveys. The new system is capable of producing ultra-high definition images and video simultaneously and is illuminated using high-intensity strobe lights.

The Marine Institute has developed a software application to annotate the high quality images that are collected. In addition to greatly enhancing the quality of the UWTV images collected, the system allows for improved validation of the survey results and should allow for further development of automated procedures in the future. The project represented an investment of less than €0.1 million over a number of years, and was successfully trialled and rolled out in 2019. The immediate benefit of this is more precise and consistent abundance estimates of Nephrops, to support sustainable management advice.

The Marine Institute also successfully responded to 29 official DCMAP data calls. These data calls are a key performance indicator for Ireland's DCMAP programme. As well as basic data for stock assessment purposes, data calls also focused on by-catch of endangered species and on Vulnerable Marine Ecosystems, to support decision making under Common Fisheries Policy.

Regional coordination of the DCMAP was achieved through the Regional Coordination Group (RCG) of the North Atlantic through the work of 12 intersessional subgroups.

Providing scientific support to DAFM is central to the work of the Marine Institute. The annual Stock Book was delivered to DAFM in November 2019. This provides the latest scientific advice on over 70 Irish stocks exploited by the Irish fishing fleet and is used in negotiations with the EU on fishing opportunities for 2020 at the December Fisheries Council. The data from the Stock Book was also used to develop the annual sustainability assessment which was presented by the DAFM Minister to the Oireachtas in November 2019. The Stock Book was produced in hard copy format as well as a web based file. In 2019, a Stock Book app was launched at the same time as the printed version.

The Service Register, developed in 2018, was operational in 2019 and provides insight into the kinds of support FEAS delivers and the amount of resources used in providing this support. FEAS serviced 119 requests for DAFM in 2019 of which 25 were Brexit related taking 30 person days, 91 were fisheries related taking 65 person days. There were three requests on other matters which took less than one day.

The Institute developed an iVMS pilot scheme for reporting spatial information from vessels under 12m. This scheme was successful and a scoping document for DAFM and the Sea Fisheries Protection Authority (SFPA) on future options for electronic reporting by vessels under 12m. A risk assessment on the interactions between fisheries wading birds and seabirds was also completed under Article 6 of the Habitats Directive.

The Marine Institute continued to work closely with Inland Fisheries Ireland (IFI) on the newly formed Technical Expert Group on Salmon (TEGS) which provides catch advice on all Irish salmon rivers.

The Marine Biodiversity Scheme is an important component of the EMFF operational programme. This scheme addresses science and policy requirements for species restoration, assessing and mitigating fisheries and aquaculture in Natura sites and supporting implementation of the Marine Strategy Framework Directive (MSFD). In 2019, 15 new projects were approved to run alongside 4 existing projects for completion in 2020. Most comprised Phase 2 of projects completed in 2018 and included vessel monitoring systems on vessels under 12m, bycatch monitoring, ecosystem data collection on fisheries surveys, offshore reef mapping, development of MSY reference points for data poor stocks and informatics for ecosystem based fisheries management. Species and habitat restoration projects continued on oysters, rays and skates, and crayfish. New projects focus on data and assessment requirements to support the MSFD.

Outreach and stakeholder communications are very important elements of the DCMAP and Biodiversity schemes. A dedicated Marine Institute EMFF website is used as an information platform for EMFF project outcomes. Regular update meetings were held with industry and NGOs while progress updates continued to be given at the EMFF Monitoring Committee meetings. In 2019, exhibits at SeaFest, Ireland's national maritime festival, informed on the fisheries and biodiversity data collected and analysed under EMFF with experts explaining their application to the public. In November, output of the Marine Biodiversity Scheme was highlighted at family friendly Science and Technology events in Galway and Castlebar. The stand highlighted marine biodiversity sustainability goals and Irish EMFF funded projects through interactive touchscreen story maps and table displays.

The 2019 Marine Institute Annual Stock Book presented to the Minister for Agriculture, Food and the Marine, Michael Creed TD, by Dr Paul Connolly and Dr Ciaran Kelly, Marine Institute. Photo: Jason Clarke.

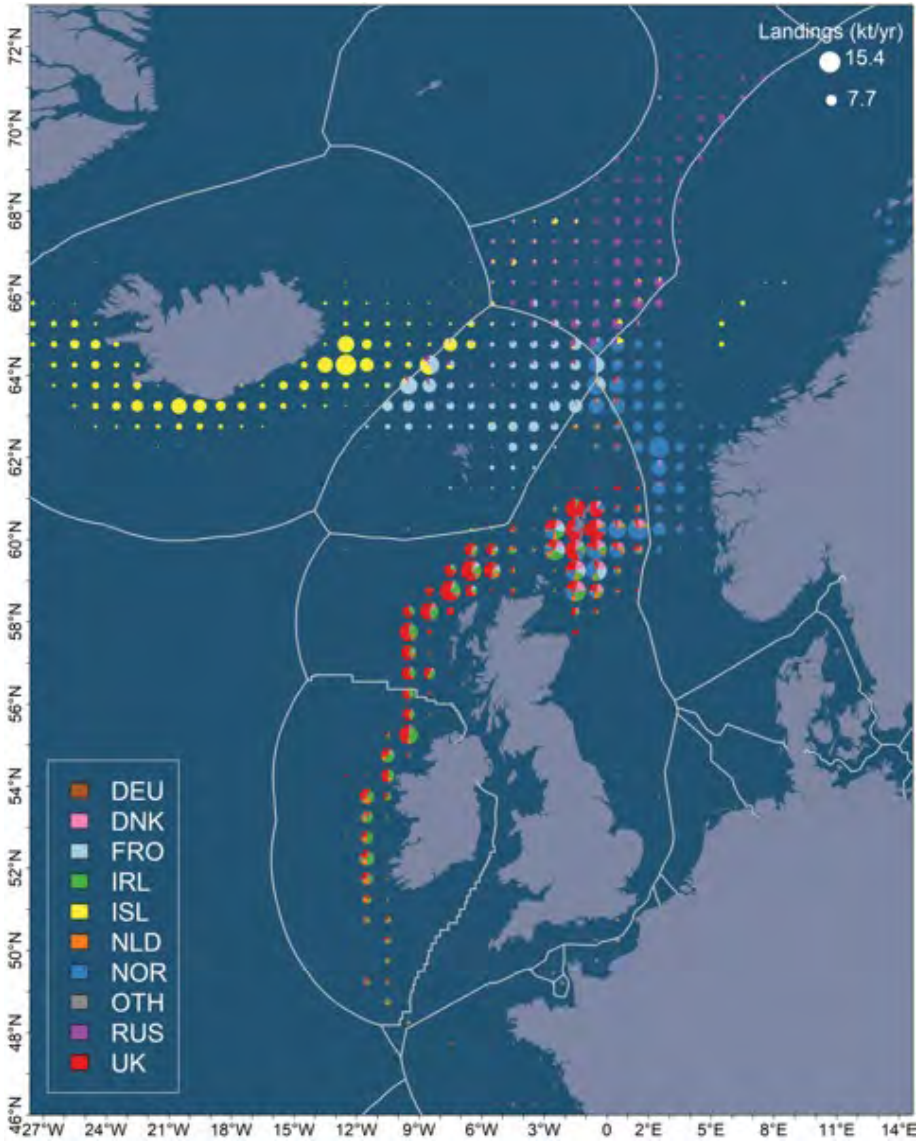
Brexit – Possible impacts on the Irish Seafood Sector

Throughout 2019, the Marine Institute carried out various analyses and provided scientific support to DAFM in relation to Brexit. A broad range of possible scenarios on the impacts of Brexit on the Irish seafood sector were explored. These scenarios focused on access to fishing grounds in UK waters by EU vessels, displacement of EU vessels into Irish waters and changes to the Total Allowable Catch (TAC) shares.

A key consideration in the analyses was the delivery of simple, high impact maps and schematics that summarised the findings in a very visual way. The Marine Institute analyses focused on the following questions:

- Where might vessels be displaced to if they have no access to UK waters?
- How would displacement of fishing effort affect the sustainability of the fisheries?
- Which Irish vessels would be most highly impacted by loss of access to UK waters?
- What are the alternatives for vessels that lose access to UK waters?
- Which criteria might be used in negotiations on TAC shares between the EU and the UK and possibly other coastal states?

The map below gives a flavour of the type of visual output generated to support the analyses. It shows the distribution of mackerel landings by country. While current non-EU members mainly catch mackerel in their own waters, the UK and Ireland currently fish extensively in each other's waters.



Other key Scientific and Advisory Services during 2019:

- Scientific support to DAFM, providing advice on various Brexit scenarios and support for EU fisheries council meeting and at Coastal States meetings
- Completion of Article 17 Assessments for Department of Housing, Planning and Local Government (DHPLG) for Marine Strategy Framework Directive for commercial fish, non-commercial fish, marine foodwebs and sea floor integrity
- Paradigm 3, now implemented and operational for SOP's guidelines and manuals. Team Up introduced to Analyst team to manage sampling events and track metrics
- Continued support to other projects outside of the DCF such as Bluefin Tuna tagging and the EMFF Reef survey
- The new volume of the atlas of fishing activity based on Vessel Monitoring System (VMS) data was published in Q4 2019
- FEAS staff played a central role in developing ICES advice and mixed fisheries forecasts which supported key elements of negotiations at the December Fisheries Council
- Successful completion of the acoustic survey and mackerel egg survey programme
- Genetic analysis of Celtic Sea and north-western herring undertaken for stock identification purposes. Simulation exercises conducted to rationalise the volume of herring required from a limited fishery to support stock assessment
- Bursar scholarship programme successfully implemented with 22 students selected in to 16 different bursaries between June and September

CASE STUDY
WKIrish - operationalising the ecosystem approach to fisheries management

The Workshop on an Ecosystem-based Approach to Fishery Management for the Irish Sea (WKIrish) was a series of six workshops in a multi-year process focusing on improving single-species stock assessments in the Irish Sea (principally cod, haddock, whiting, plaice, herring), incorporating an ecosystem/food web model, and developing the integration of ecosystem aspects and working towards an integrated assessment and advice.

The Workshop was established based on weakness in the stock assessments, and industry concern that fishing effort had been reduced substantially, with no subsequent recovery in the stocks. The members were drawn from fisheries institutes from Ireland (Marine Institute), and the UK (Agri-Food and Biosciences Institute & Centre for Environment, Fisheries and Aquaculture Science), as well as from fishing industry representatives and eNGO stakeholders.

The key task was to develop an ecosystem/food web model that could capture the changes in the Irish Sea and provide advice for management. We used a model system called Ecopath with Ecosim, which is widely used in this role. Much of the data came from scientific sources e.g. surveys, port sampling and wider ecosystem sampling including oceanographic databases. However, the model had a start year in 1973, for which little data were available for some parameters, in particular for fishing effort and what the fish were eating.

This information was developed with fishers and eNGOs through a collaborative co-creation process. Using all these data sources made the model work better to explain the changes seen in the Irish Sea ecosystem. In brief, the changes seen were the result of a combination of long term environmental changes, high fishing pressure, and predator prey effects. The model was built at the Scottish Association for Marine Science (SAMS) under a Cullen Fellowship funded by the Marine Institute. The work was carried out as a PhD project by Jacob Bentley, which successfully concluded at the end of 2019.

WKIrish held its final meeting in November 2019 to finalise the incorporation of ecosystem information into the fisheries stock assessment process and tactical advice for the Irish Sea. It had been agreed prior to the meeting that this would be done by choosing points in the FMSY ranges set by single-species assessments on the basis of ecosystem indicators. Thus if indicators for a stock were "good", that stock could be fished at a higher level within the existing ranges. If the stock indicators were "poor", then fishing would be at a lower level within the ranges. In this way, ecosystem considerations could be reflected without violating existing single-species "precautionary" reference points. The rationale is that if a process of limited scope for doing this in the Irish Sea can gain acceptance and be seen to add value, it may be taken up in other regions and subsequently broadened out.

The workshops are seen as a great example of a co-creation process between scientists and stakeholders. Importantly, the stakeholders remained involved throughout, and were happy with the conclusions and recommendations. The approach is now being tried by ICES in the Baltic Sea, with the involvement of key players from WKIrish.

CASE STUDY

Aquaculture Research at Marine Institute Newport

Since the initiation of the Newport Strategy in 2016, the Marine Institute has secured competitive funding of over €3 million from nine research projects in the field of aquaculture research alone. In 2019, the Marine Institute completed the upgrading and linking of the Lehanagh Pool Marine Research Site at Beirtreach Buí Bay in Connemara, Co. Galway, with the hatchery at the Newport Research Facility. The five year business model (2018 to 2022) developed by the Marine Institute is currently building on a range of funded research projects that address the needs of the aquaculture sector. Lehanagh Pool is an integrated multi-trophic aquaculture (IMTA) research site that allows for the holding of a range of fish, shellfish and seaweed species for research purposes.

At Newport, installation of a new RAS (Recirculating Aquaculture System) was completed in 2019. The RAS is currently supporting two research projects. The first project, Salmson Smolt (an EMFF funded project), will trial the production of larger salmon smolts that will reduce the grow-out time at sea, with the potential to increase production capacity and reduce disease risks. The second project, (HYDROFISH), funded by Enterprise Ireland aims to produce fish protein hydrolysate products for the aquaculture industry to boost the salmon immune system and strengthen the gut to improve resistance to bacterial, fungal and ectoparasitic pathogens (e.g. amoebic gill disease, sea lice).

In 2019, the Marine Institute was involved in two successful EU proposals which will utilise the Lehanagh Pool Marine Research Site and are worth almost €1 million to the Institute. INEVAL, funded under the EU BlueBio call, will investigate the potential of echinoderm aquaculture in Europe with the Marine Institute focusing on sea cucumbers while ASTRAL will further investigate the potential of IMTA with strong links within the project to Africa and South America through the Belem Statement. In addition to this, the Marine Institute continues to partner with Bord Iascaigh Mhara (BIM) and Údarás na Gaeltachta to bring forward initiatives to ensure that the results of the research are transferred to industry and provide practical support to its sustainable development. To achieve this, the Marine Institute is involved in the setting up of the Irish Aquaculture Technology & Innovation Platform (IATiP) and the Páirc na Mara project currently being developed by Údarás na Gaeltachta.

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

Ocean Energy & Infrastructures

Through active involvement as Ireland's representative in both the European Multidisciplinary Seafloor and water-column Observatory (EMSO), Euro-Argo European Research Infrastructure Consortia (ERICs), the Infrastructures team have contributed to the observing efforts for the continuous monitoring of the ocean and provide essential data to help scientists understand oceanic conditions, interactions between the ocean and the atmosphere, as well as long-term climate trends.

The new Argo floats delivered in 2019 have the capacity to measure dissolved oxygen and biogeochemical parameters from the ocean surface down to a depth of 2,000 metres continuously for up to four years providing important information as to the health of the oceans. The recorded data is transmitted in near-real time to publicly accessible web portals. A pCO_2 sensor was delivered in 2019 for deployment on the SmartBay Observatory to monitor carbon concentrations in the waters of Galway Bay, one of the main indicators of climate change with recorded data freely available to the scientific community.

The Science Foundation of Ireland (SFI) co-funded EirOOS ocean observation was a key component of planning for the first scientific mission; supporting the international efforts for monitoring changes to the Gulf Stream through the North Atlantic Current mooring array. This mission links with NUI Galway and NUI Maynooth from Ireland, and the German research centres BSH and University of Bremen. EirOOS Shelf Edge moorings will monitor the European Slope Current and the EirOOS Coastal mooring will monitor both the Irish coastal current and the Irish shelf currents.

The Irish Marine Data Buoy Observation Network (IMDBON)

Since 2001, IMDBON (formally the Irish Weather Buoy Network) has been reporting hourly weather reports consisting of measurements of key near surface marine meteorological data: air temperature, humidity, atmospheric pressure, wind speed and direction, also oceanographic data including sea surface temperature, wave height, and wave period. The extreme western synoptic M6 location is a sentinel European monitoring site.

The budget subhead for the programme (operated via the Department of Agriculture, Food and the Marine) saw a 2018 increase sustained in the core operations and maintenance programme budget for 2019. This is improving overall data delivery.

The significant Science Foundation Ireland (SFI) research infrastructure funding award in 2018 (EirOOS) is in the process of being disbursed, with a small amount of funds (10%) remaining in part to support activities in 2020 to complete the transfer to and deployment of new technologies. The funding provided an essential and urgent capital renewal programme for the network, but also includes additional data acquisition capacity for key climate variables, most notably carbon dioxide exchange across the air-sea boundary. The integration of these capabilities into the platforms will be an active work plan through 2020 and 2021.

The Irish National Tide Gauge Network

Operated by the Marine Institute on a 'best endeavours' basis, the Irish National Tide Gauge Network (INTGN) provides monitoring of tide level around the Irish coast. The increased level of monitoring during 2017 and 2018 means that greater resolution of the tidal harmonic is now possible with tidal predictions from more locations available on **www.irishtides.ie/predict.**

As sea level relative to land level change is a key ECV (Essential Climate Variable) with regards to climate adaptation and coastal resilience, interest in this area is building, with a need identified to establish an advanced capacity. Capital funds for hardware and installation was provided in 2019 under the SFI 'EirOOS' programme to progress two global sea level observing stations (GLOSS).

In terms of the Marine Institute network, 2019 saw progress in three main areas:

i. Extensive land level surveying was undertaken at Union Hall Harbour, Howth Harbour and Galway Port. These surveys will allow land level to be tracked year on year to relate the tide level to changing land level.

ii. High accuracy GPS surveys were undertaken at a range of locations for which historical data exist. These data are feeding into a study led by NUI Maynooth into sea level rise led by Prof Gerard McCarthy.

iii. In 2019, progress was made with wide ranging preparatory activities for the installation of the two global sea level observing stations (GLOSS) in Howth Harbour and Union Hall, with significant progress planned in 2021.

The long-term, ultra-high precision temperature data being collected at Ballycotton (East Cork) and the Portmore Pier (Malin Head) are now well established. These data build on decades of monitoring (at Malin Head) and continue to feed background climatological data into central archives of temperature, the fundamental climate change indicator.

Delivering oceanographic and climate services

The AtlantOS project ended in September 2019. Throughout the year, the Marine Institute as WP8 co-leader of "societal benefits from observing/information systems" oversaw the delivery of 12 WP8 reports. The Marine Institute also led a writing team to deliver a strategy on Trans-Atlantic cooperation and sustainability and contributed to a report on the performance of AtlantOS observing system. Several Marine Institute staff participated in the 'First International AtlantOS Symposium' presenting on ocean observing system costs, interregional cooperation, co-chaired a Session on 'Regional and Coastal Specificities' and actively participated in panel discussions.

The Marine Institute continues to co-ordinate the JPI Climate ERA4CS project CoCliME where social scientists, natural scientists, modellers and economists from seven European countries work together to develop prototype ecosystem climate services. In 2019, the project delivered 12 reports for the mid-term project review.

Advanced Mapping Services

Advanced Mapping Services (AMS) provided support and advice in survey planning, operations, data management and dissemination, research and development, both internally within the Marine Institute, and for industry, government and public stakeholders, in Ireland, and internationally.

As part of the DCCAE funded INFOMAR programme undertaken in partnership with Geological Survey Ireland, the Marine Institute's Advanced Mapping Services team on RV *Celtic Explorer* and RV *Celtic Voyager* mapped over 5,136 km^2 of seabed in the Celtic Sea during 92 allocated

vessel days in 2019. This involved acquisition of 13,874 line kilometres of multibeam data, and coordinating acquisition of 243 seabed samples.

17 shipwrecks were surveyed and large-scale shelf marine ridges up to 30m in amplitude, 3km in width and tens of km in length were mapped. Collaboration with Fisheries Ecosystems Advisory Services (FEAS) enabled the significant sediment sampling effort to be delivered opportunistically during fish stock assessment surveys when time and staffing were available onboard. Sample results will underpin multiple programmes and reporting requirements, including Marine Strategy Framework Directive (MSFD), Habitats Directive, Marine Spatial Planning (MSP) and OSPAR reporting.

By way of scientific support to the National Parks & Wildlife Service (NPWS) and FEAS, Advanced Mapping Services (AMS) co-ordinated and led the third and final leg of the European Maritime and Fisheries Fund (EMFF) and NPWS funded offshore reef habitat assessment project 'SeaRover'. The findings of this extensive ROV benthic survey will contribute to NPWS work on provision of conservation objectives for the offshore Special Areas of Conservation (SAC), contribute to MSFD and MSP reporting, and will fulfil the Department of Agriculture, Food and Marine (DAFM) obligations to map vulnerable fisheries resources.

The successful project involved collaborations across three government departments (DAFM, DCHG & DCCAE), internally within the Marine Institute (AMS, FEAS, MEFSS and RVOPs [Research Vessel Operations]) and externally with agencies, researchers and industry, including NPWS, Geological Survey Ireland, the Commissioner of Irish Lights, P&O Maritime, NUI Galway, Galway-Mayo Institute of Technology, the Marine Biology and Ecology Research Centre at the University of Plymouth, Norwegian Institute of Marine Research, Aquafact and HydroMaster.

Advanced Mapping Services & Marine Operations

Seabed mapping services significantly improve stakeholder access to seabed and habitat data and associated information, which is essential for management, conservation and development. Better mapping enables better modelling and forecasting, and Advanced Mapping Services have been reinforcing and communicating the reliance of modelling on accurate bathymetry data at international conferences and meetings during 2019, including at a key conference Ocean Obs 19, where it was acknowledged as a research priority for the UN Decade of Ocean Science for Sustainable Development.

A significant volume of new data was acquired during 2019 which contribute both to this Strategic Focus Area (Scientific Advice and Services) and also to Strategic Focus Area 2 (Forecasting Ocean & Climate Change) as marine operations carried out by Advanced Mapping Services on the Institute's research vessels incorporate hydrographic, oceanographic, geophysical, geological, and environmental data, all of which are relevant to the study of forecasting ocean and climate change.

For detailed information on modelling, see Strategic Focus Area 2 (Forecasting Ocean & Climate Change).

For an overview of research vessels' operations during 2019, see Strategic Enabler 2 – Infrastructure.

POLICY, INNOVATION AND RESEARCH SUPPORT SERVICES (PIRS)

The Marine Institute provides marine research & innovation policy support and advice to a number of national and international stakeholders including the Department of Agriculture, Food and the Marine (DAFM), the Marine Coordination Group, the Department of Foreign Affairs and Trade and its Maritime Attaché in Brussels. We work closely with the Attaché to coordinate Marine Institute and Irish positions to inform a range of EU marine and maritime policy and strategy development and implementation.

Supporting the CEO, PIRS engages with key national research & innovation fora including the Innovation 2020 Steering Group and the Horizon 2020 High-Level Group hosted by the Department of Business, Enterprise and Innovation (DBEI). We also coordinate input to a range of national consultations and formal returns to Government on research activity and expenditure. Through the Marine Research Funders Forum, the Marine Institute continues to support the implementation of the National Marine Research & Innovation Strategy, also engaging bilaterally with forum members throughout the year. In 2019, the policy advisory activities of PIRS were monitored and quantified through the Service Register, which was developed for all Marine Institute scientific and technical advice.

In 2019, PIRS worked with the Socio-Economic Research Unit in NUI Galway, to deliver an update to Government on trends in Ireland's Ocean Economy as part of the Government's Our Ocean Wealth Annual Report on Progress. DBEI updated their series of briefings on 16 important sectors and the Institute contributed to this process to update the Focus on Marine and Maritime briefing. This is used as a resource both within DBEI, its offices and agencies, and across other government departments and agencies to inform briefing materials, speeches and policy development. A publicly available version of the Sector Briefs is available on the DBEI website.

IRISH MARITIME DEVELOPMENT OFFICE (IMDO)

Irish Maritime Transport Economist (IMTE)

The IMDO's policy advice and related publications are underpinned by economic research conducted within the organisation and informed by the views of industry, which are gathered by continuously engaging with relevant stakeholders. The 2019 edition of the Irish Maritime Transport Economist (IMTE) was made possible by the cooperation of the Irish ports and shipping community and is the culmination of the economic analysis that the IMDO undertakes each year in these important sectors. The IMTE has become a reference document for stakeholders interested in the development of the industry and informs both policy and practice in the industry. Our research found evidence that 2019 has been a relatively successful year for Irish ports and shipping companies. The variances in each transport mode are set out in the table below.

Growth in Roll-on/Roll-off and Lift-on/Lift-off volumes is offset by declines across all bulk sectors. The growth in unitised traffic is closely correlated with growth in consumer demand, while the decline in bulk cargoes is linked to a decline in the demand for commodities in sectors such as agriculture, fossil fuels and construction.

Variances in traffic are also tracked across individual ports and by commodity. Together, this analysis and the underlying research allows the performance of the maritime industry to be evaluated along a variety of important dimensions, allowing trends to be identified and policy advice to be developed. The IMTE formed the bedrock of much of the advice delivered in relation to coping with Brexit challenges.

Growth in trade by mode

Mode	Year - 2018	Year - 2019	Variance
Roll-on/Roll-off freight (units)	1,163,872	1,186,767	22,895 (2%)
Lift-on/Lift-off (TEU)	763,862	808,670	44,808 (6%)
Dry Bulk (tonnes)	17,509,619	15,384,275	-2,206,344 (-12%)
Liquid Bulk (tonnes)	12,201,559	11,806,018	-395,542 (-3%)
Break Bulk (tonnes)	1,540,059	1,595,268	54,309 (4%)

Quarterly Briefings and Ad Hoc Reports

In addition to the publication of the IMTE on an annual basis, the IMDO provides regular economic commentary on the Irish maritime sector through quarterly bulletins, in addition to bespoke reports and submissions that address emerging trends in the industry. These bulletins act as early warning systems that enable the IMDO to alert the Department of Transport, Tourism and Sport (DTTAS) to emerging issues. The information produced in this way was of immeasurable value in tracking shifts in trade patterns in 2019, as importers and exporters sought to insulate their businesses from the potential effects of Brexit. This information and the subsequent analysis assisted in our understanding of the use of the UK Landbridge, and modal shifts from Ro/Ro to Lo/Lo in order to gain direct access to continental ports.

This information also contributed to a series of briefings requested by DTTAS related to potential capacity constraints on certain routes or in certain ports, which were of immeasurable value in understanding the logistical and operational challenges that may be posed by Brexit.

Commissioned Reports

In response to specific requests from DTTAS, the IMDO undertakes pieces of research to advise on particular topics. In 2019, the IMDO delivered the Development of Alternative Fuel Infrastructure in Irish Ports – A Feasibility Study. This study responds EU Directive 2014/94/EU which was developed to reduce the EU's dependency on fossil fuels in transport. To help reduce this dependency and the associated harmful environmental effects, the EU Commission established an alternative fuels strategy. The strategy identified the lack of supporting infrastructure as a key obstacle to the uptake of alternative fuel technology.

As a result, EU Directive 2014/94/EU was developed to address these issues and was published in November 2014. In the maritime sector, the directive obliges Member States to install shore-side electricity (SSE) for seagoing ships in the ports of the TEN-T Core Network 1. In addition, Member States must ensure that an appropriate number of liquefied natural gas (LNG) refuelling points are put in place at maritime ports to enable vessels using LNG to circulate throughout the TEN-T Network. These objectives are to be met by 31 December 2025, unless there is an absence of demand or the relevant costs are disproportionate to the benefits. Motivated by the EU directive, the report had two distinct aims. First, to conduct a feasibility study of SSE for seagoing ships in TEN-T Irish ports and, secondly, to assess the market demand for LNG fuelling facilities in major Irish ports.

The IMDO report concluded that there would be insufficient demand in Irish ports to justify the high capital investment required for alternative fuel infrastructure. The report also found that the increased use of alternative fuels would not be market led and in the absence of a seismic shift in policy at an EU level, compelling the shipping industry to use alternative fuels, emission reduction targets for the Irish shipping industry by 2025 should be set at the lowest allowable levels.

In April 2019, the IMDO published a review of the Irish Ports Offshore Renewable Energy Services (IPORES) Report **(here)**. This review brought the original report, published in 2012 up to date and commented on the preparedness of Irish ports to support the development of an offshore renewable energy industry. Following the creation of necessary regulatory and consenting framework, the report recommended that developers engage directly in commercial negotiations with Irish ports in relation to the provision of the required port infrastructure.

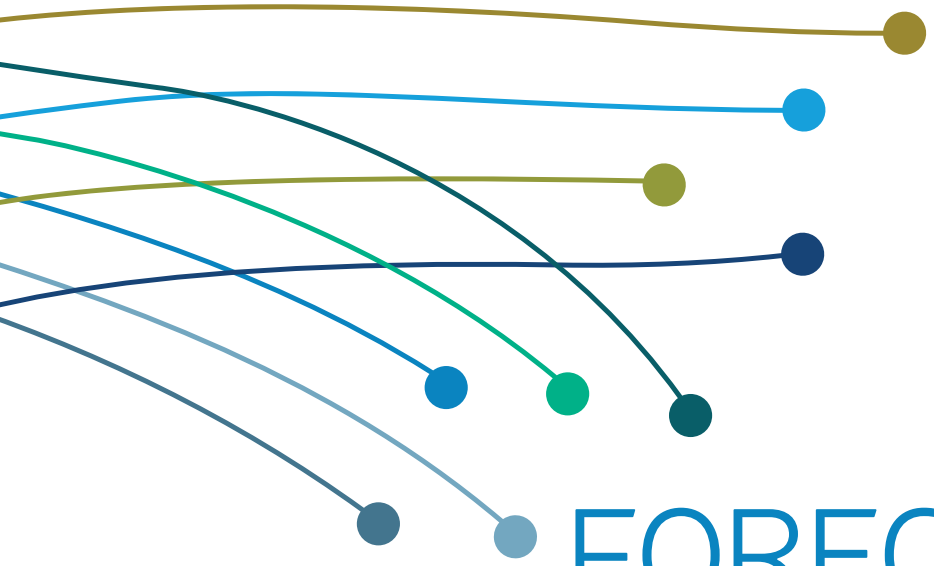
Also at the request of DTTAS, the IMDO commissioned a report into port capacity. The report is being compiled by a consortium led by ARUP Engineering Consultants and EY and will be delivered in 2020. This report investigates the additional capacity that will be required in the Irish ports network to sustain forecasted economic growth to 2040. The report looks at the opportunities that exist in the network to increase capacity through operational efficiencies, projects identified in port masterplans, and major infrastructural development. The report will provide DTTAS with a dashboard that will offer early warnings as existing capacity reaches operational limits and allow adequate time to commence new port developments.

Advice to Industry

The IMDO takes advantage of opportunities to brief the maritime industry on developments and emerging trends. These opportunities arise at events and conferences and at gathering arranged by the IMDO, specifically to engage with industry and offer advice. In 2019, the IMDO presented at 42 such events, addressing groups such as The Irish Ports Association, The Association of French Ports, The Irish Exporters Association's Logistics and Transport Group, the Irish Maritime Law Association, Finance Dublin Conference, London Shipping Week, Our Ocean Wealth Summit, and the Irish Wind Energy Association Conference. The nature of this advice is often to encourage a better understanding of the policies surrounding development in different areas of the maritime industry and to follow up with bespoke advice to meet the needs of particular groups.

STRATEGIC FOCUS **AREA 2**

FORECASTING OCEAN AND CLIMATE CHANGE



FORECASTING OCEAN AND CLIMATE CHANGE

Adapting to a changing climate is one of the greatest challenges facing society, governments and decision makers worldwide. The ocean and climate are inextricably linked and marine ecosystems are changing at an unprecedented rate. There is significant demand for greatly enhanced knowledge and services that will allow us to observe the changes in our oceans, project and model likely future scenarios and support adaptation planning.

Forecasting ocean and climate change are vital activities that support our scientific advice relating to many government policies and research initiatives.

The Marine Institute works with national and international partners to observe and understand how our ocean is changing and to determine how to respond to current and future patterns of change that impact Ireland's economy and people. Robust advice and operational forecasting on projections of our changing oceans and climate are essential for government to make effective policies and management decisions to address a range of issues and challenges. These include changing fish distributions, food security, low carbon economy, sea-level rise, flooding and increasingly, extreme weather events.

Programmes conducted jointly by the Marine Institute and Geological Survey Ireland have mapped much of Ireland's extensive marine territory.

Ireland's 880,000km^2 maritime territory extends far into the Atlantic Ocean. Our climate is regulated by the relatively warm waters of the Atlantic Gulf Stream, protecting us from climatic extremes but leaving us exposed to climate change impacts. Such impacts include rising sea levels, increasingly storm intensity, climate-driven changes in marine ecosystems and the services they provide.

Ireland is uniquely positioned to be at the forefront of efforts to better understand global ocean challenges and to provide essential national services in observing and projecting regional and local impacts.

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

2019 activities in Oceanography and Ocean Climate research

Enhancing ocean observing activities:

- In May 2019, the Marine Institute successfully completed the ocean climate ship-based hydrography section in coastal shelf and deep waters off the west coast of Ireland. This multidisciplinary (physics, chemistry, biology) survey is important nationally because it facilitates the assessment of changes in the North East Atlantic contributing to international efforts of ICES and OSPAR.

  More than 55 CTD (Conductivity, Temperature, Depth) casts, down to depths of more than 3,500 metres, collected measurements of essential ocean and climate variables (e.g. temperature, salinity, oxygen, nutrients, carbonate chemistry variables, CFCs, ocean currents). During the survey, the M6 data buoy was swopped out, a subsurface deep-water mooring was retrieved, a Marine Institute oceanographic glider mission was completed (Interreg Atlantic Area iFADO), and two Argo floats (Ireland's contribution to EuroArgo) and four surface drifters (Interreg Atlantic Area Clean Atlantic project) were successfully deployed.

  Working closely with colleagues in MEFSS chemistry and third level institutions (NUI Galway, NUI Maynooth), data collected on this annually repeated section are delivered to both national (Marine Institute run NODC) and international (ICES, OSPAR, GOA-ON, SOCAT) data centres. The survey also supports several national and international research projects (Marine Institute funded VOCAB project focused on ocean acidification, the Marine Institute funded A4 project, Marine Institute Cullen PhD project on ocean colour with satellite remote sensing support NOAA, USA and the EU IAA iFADO MSFD project, and Clean Atlantic litter projects).
- The Marine Institute continues to be an active member of the ICES WGOH contributing to the ICES Report on Ocean Climate (IROC) 2019 and the GO-SHIP Science Committee (provides scientific leadership and oversight for the development and implementation of the decadal global survey of hydrographic sections operated by national research institutions)
- In 2019, Marine Institute staff actively worked with colleagues in NUI Maynooth, and NUI Galway to develop an operational plan to deploy moorings in 2020 off southwest Ireland. This initiative will support national and international ocean observing efforts investigating North Atlantic changes and thus enhancing the NOAC mooring array, led by Germany (BSH and University of Bremen). These ocean observing activities will deliver important ECV and EOV datasets to the SFI funded EirOOS (led by the Marine Institute) and Marine Institute funded A4 (led by NUI Maynooth) projects. The expected output is to gain a deeper understanding of Atlantic Overturning Circulation, important information on ocean currents at the continental shelf edge and Irish coastal areas and on water properties that influence Ireland's marine ecosystems.

Annual Ocean Climate Survey 2019. Photo: Tomas Szumski

New EU Funded project:

In November 2019, the Marine Institute became one of 55 partners (13 European countries, Brazil and Canada) in the EU funded H2020 Innovation Action project 'EuroSea'. Coordinated by the GEOMAR Centre for Ocean Research Kiel, this €12.6 million funded project aims to integrate and significantly improve ocean observations that will be sustained in the long term. The Marine Institute is involved in work activities related to 'Network Integration and Improvements', the 'Ocean Heath Demonstrator' that will deliver cost-effective actionable information for improved ocean governance and monitoring, and in the area of 'Communication' (Engagement, Dissemination, Exploitation, and Legacy).

Modelling

The modelling team expanded further in 2019 and now comprises six members. The team supports the provision of freely available regular ocean and wave forecasts and hindcasts to a range of end-users. These datasets include three-dimensional currents, temperature, salinity and the sea surface height (including storm surges).

Biogeochemical modelling has also been advanced in 2019 and includes the development of a nutrient cycling model to support research on Integrated Multitrophic Aquaculture in Bertraghboy Bay (Connemara) in the framework of H2020 TAPAS project and the contribution to the EU Copernicus Marine Environment Monitoring Service (CMEMS).

Research and development of coastal scale models has advanced in 2019 and includes the implementation of a scheme in the Connemara model (allows for better representation of bathymetry near coasts and thus improves the predictive skill). The Cullen PhD student funded by the Marine Institute and based at UCD has continued research on coupling wave-hydrodynamic models. Waves impact on currents, and vice-versa, currents impact on waves, and coupling of the two models will lead to improved hydrodynamic and wave predictions in the coastal ocean.

Further refinements of the models includes better representation of freshwater inputs into Galway Bay. Furthermore, the Marine Institute are Associated Partners in CMEMS-funded LAMBDA project that aims at the development of catchment models for European coasts that will provide nowcasts and forecasts of freshwater inputs down the rivers. The first version of the model was released in 2019 and is currently being evaluated.

2019 saw a kick-off of the SEAI-MÉ-Marine Institute funded project awarded to the Irish Centre for High-End Computing (ICHEC) that aims to develop coupled atmospheric-ocean-wave models – the first of its kind in Ireland.

EU-funded projects gained momentum in 2019. Notably, the Institute further developed numerical modelling capacity in support of: tackling marine litter (CleanAtlantic, Interreg Atlantic Area), Marine Strategy Framework Directive implementation (iFADO, Interreg Atlantic Area), building coastal resilience (MyCOAST, Interreg Atlantic Area), management of Marine Protected Areas Networks (COMPASS, Interreg VA), and the development of climate services for aquaculture industry (Co-Clime, JPI Climate ERA4CS).

The Institute is active in a flagship EU operational oceanographic service, the Copernicus Marine Environment Monitoring Service (CMEMS), and provides validation and a scientific expertise for the development of biogeochemical numerical models of the Iberia-Biscay-Ireland region. The Institute collaborates with top oceanographic institutes across the EU in the delivery of this service.

Significant progress has been made towards building the climate modelling capacity, contributing to the implementation of Strategic Focus Area 2 of the Marine's Strategic Plan. The Marine Institute leads a JPI climate funded CoCliME project that is developing a climate service for the aquaculture industry and policy makers related with harmful algal blooms (HABs) in a changing world.

In 2019, a 20 year hindcast (1997-2016) of oceanographic conditions in the south-west of Ireland was completed. Climate simulations have commenced in 2019 with a historical background simulation completed (1975-2005) and an RCP8.5 (i.e. "the worst case scenario") is underway. Modelled essential ocean variables are being analysed for relationships with historical HAB outbreaks and climate services will be developed based on the findings and future predictions. The above simulations use downscaled models of the south-west of Ireland, developed by the Marine Institute.

In December 2019 the Institute held a highly successful workshop 'Advances in tackling marine issues', which brought together stakeholders from Ireland and the CleanAtlantic project involved in governance and policy development, education and awareness raising as well as monitoring and reduction of litter in the sea. The workshop was held adjacent to the CleanAtlantic project meeting and received highly positive feedback.

The Marine Institute continued to support search and rescue activities, primarily through continued maintenance of the Marine Institute-developed web application ADRIFT that had previously been implemented in Galway Bay and has been used by the Royal National Lifeboat Institution (RNLI). In 2019, ADRIFT was rolled-out to cover the North East Atlantic (from the north coast of Spain to Iceland). This development was part of Interreg AA MyCOAST project and several project partners across the Atlantic Arc are interested in adopting ADRIFT as a tool to support search and rescue.

The OSIS team also responded to a high number of data requests including a request from An Garda Síochána related to an incident under investigation and requests for measured and modelled data from aquaculture licence applicants.

New projects funded in 2019 included two H2020 projects, EuroSea and FORCOAST. In the former, the team will provide modelling services for the development of ocean health indicators, whereas in the latter, the team will support native oyster restoration efforts in Galway Bay. Further new projects are under development and are due to kick-off in 2020.

Ocean Energy & Infrastructures

Through active involvement as Ireland's representative in both the European Multidisciplinary Seafloor and water-column Observatory (EMSO), Euro-Argo European Research Infrastructure Consortia (ERICs), the Infrastructures team have contributed to the observing efforts for the continuous monitoring of the ocean and provide essential data to help scientists understand oceanic conditions, interactions between the ocean and the atmosphere, as well as long-term climate trends.

The new Argo floats delivered in 2019 have the capacity to measure dissolved oxygen and biogeochemical parameters from the ocean surface down to a depth of 2,000 metres continuously for up to four years providing important information as to the health of the oceans. The recorded data is transmitted in near-real time to publicly accessible web portals. A pCO_2 sensor was delivered in 2019 for deployment on the SmartBay Observatory to monitor carbon concentrations in the waters of Galway Bay, one of the main indicators of climate change with recorded data freely available to the scientific community.

The Science Foundation of Ireland (SFI) co-funded EirOOS ocean observation was a key component of planning for the first scientific mission; supporting the international efforts for monitoring changes to the Gulf Stream through the North Atlantic Current mooring array. This mission links with NUI Galway and NUI Maynooth from Ireland, and the German research centres BSH and University of Bremen. EirOOS Shelf Edge moorings will monitor the European Slope Current and the EirOOS Coastal mooring will monitor both the Irish coastal current and the Irish shelf currents.

Delivering oceanographic and climate services

The AtlantOS project ended in September 2019. Throughout the year, the Marine Institute as WP8 co-leader of "societal benefits from observing/information systems" oversaw the delivery of 12 WP8 reports. The Marine Institute also led a writing team to deliver a strategy on Trans-Atlantic cooperation and sustainability and contributed to a report on the performance of AtlantOS observing system. Several Marine Institute staff participated in the 'First International AtlantOS Symposium' presenting on ocean observing system costs, interregional cooperation, co-chaired a Session on 'Regional and Coastal Specificities' and actively participated in panel discussions.

The Marine Institute continues to co-ordinate the JPI Climate ERA4CS project CoCliME where social scientists, natural scientists, modellers and economists from seven European countries work together to develop prototype ecosystem climate services. In 2019, the project delivered 12 reports for the mid-term project review.

MARINE ENVIRONMENT AND FOOD SAFETY SERVICES (MEFSS)

Ocean Observations and Biogeochemistry

In May 2019, MEFSS marine chemistry and OSIS teams undertook the southern Rockall Trough oceanographic/climate section survey on board the RV *Celtic Explorer*. Sampling was carried out for a range of essential ocean variables (EOVs). EOVs in coastal and shelf waters were also sampled during Northabout Winter Environmental Survey undertaken by Chemistry and Benthos Ecology teams in January 2019 on the RV *Celtic Voyager*.

A General Oceanics pCO_2 measurement system was installed on the RV *Celtic Explorer* in 2017 and has since been collecting high quality underway ocean surface and atmospheric carbon dioxide data. Data from 11 surveys in 2017 and from 15 surveys in 2018 have now been processed and reported to the Surface Ocean Carbon Atlas (**www.socat.info**) during 2019. These data contribute to the understanding of ocean uptake of CO_2 and ocean acidification.

Marine Spatial Planning

Through a two year EMFF project on Marine Spatial Planning and the impacts of Climate Change (2018-2020), a best practice review was completed, which recommended approaches to deal with climate change through marine spatial planning. Throughout the second half of 2019, work focused on the collation of data and the development of the models to map potential spatial changes to the distribution of Ireland's marine ecosystem services. The final element of this project was an assessment of Sea Level Rise and coastal infrastructure as it relates to Marine Spatial Planning.

STRATEGIC FOCUS **AREA 3**

RESEARCH AND INNOVATION

RESEARCH AND INNOVATION

The Marine Institute's role in relation to marine research and innovation in Ireland is dynamic and multifaceted. It serves a broad client base and is aligned with our provision of scientific advice and services.

The organisation is a national funding agency for marine research, running competitive funding programmes guided by national research and innovation strategies, in particular the National Marine Research and Innovation Strategy 2017-2021. Cross-agency collaboration and joint funding initiatives are important aspects of the marine research landscape. Such programmes involving national and European funding bodies are important in addressing regional and national requirements and in maximising the benefits of research investments.

Another key responsibility of the Marine Institute is contributing to the setting of national and international research policy – ensuring the alignment with Ireland's strategic goals, particularly our Integrated Marine Plan and Ireland's strategy on research and development, Innovation 2020.

The Institute has a crucial role in supporting, coordinating and promoting marine research at national and international levels. It provides targeted assistance to marine researchers in Ireland to help them to build partnerships and successfully compete for EU grant-aid. A key goal of the Institute is to support coherence across the various state funders of marine research, as identified in the National Marine Research and Innovation Strategy.

The Marine Institute is also a research performer, participating in and leading national and international research partnerships that are strategically aligned with and add value to our advice and services. It also partners with academic institutions by hosting scientists that work alongside our scientific and technical staff. This provides essential training, facilitates collaboration and increases the research capacity and knowledge in the Marine Institute.

Marine Institute research covers a wide range of areas such as marine resource management, ecosystem assessments, biodiversity, fish genetics, climate change and its impact on our oceans and catchments, maritime economics, food safety and fish health, biodiversity, seabed mapping and data and spatial technologies. The Institute also generates Intellectual Property arising from the research it funds and performs and from operational programmes it undertakes, allowing the Marine Institute to put publicly-funded research to work for Ireland.

POLICY, INNOVATION AND RESEARCH SUPPORT SERVICES (PIRS)

The Marine Institute's Policy, Innovation and Research Support Services (PIRS) division plays a key role in supporting and promoting marine research and innovation both within the Marine Institute and nationally. The role of PIRS is particularly important in delivering the ambitious goals of Strategic Focus Area 3 of the Marine Institute Strategic Plan, which focuses on Research and Innovation.

Within this Strategic Focus Area, there are three strands of actions - the first of which addresses the Marine Institute's role in coordination and support for marine research in Ireland, addressing national and international research and innovation policy. The two other strands seek to optimise the performance of the Institute both as a research active institute and as a research funder against key performance indicators approved by the Marine Institute's Board.

Strategic Initiative 1: Coordinate and Promote Marine Research & Innovation

One of the key priorities for PIRS was the continued implementation of the National Marine Research and Innovation Strategy (2017-2021). The National Marine Research Funders' Forum (MRFF) is an implementing structure that was set up under the strategy to facilitate cooperation and enhanced coordination between the national and regional research funding agencies and key stakeholders to ensure a coherent national approach to marine research. The MRFF met twice in 2019 and the Marine Institute also engaged bilaterally with forum members throughout the year. In total, a range of government departments, research funding agencies and associated parties continue to actively collaborate on the implementation of the strategy.

A process to collect and analyse national marine research investment data continued during the year with the support of the Marine Research Funders' Forum. In 2019, the development of a public facing platform progressed with a new database planned to be live in 2020. Through this platform, public users will be able to search and download information relating to national and international marine research investments and related projects funded in Ireland.

In 2019, PIRS promoted the use of Small Business Innovation Research (SBIR) as a means to stimulate research and innovation, addressing and implementing action 10 of the National Marine Research & Innovation Strategy. This pre-procurement mechanism is encouraged by the European Commission to promote innovation and collaboration between SMEs and public bodies to solve problems which are referred to as "challenges". In Ireland, Enterprise Ireland is charged by government to promote the use of SBIR by public agencies. As part of this, Enterprise Ireland ran a call in 2019 to select potential challenges for funding. The Marine Institute submitted two proposals under the call in December, one of which was successful and approved for co-funding under the SBIR Challenges for 2020.

A review of the National Marine Research & Innovation Strategy will be undertaken in 2020 to assess progress in achieving the three goals of the strategy.

In addition to the international collaborations carried out by the other services areas in the Marine Institute, PIRS takes the lead in international research coordination and policy support. This function involves representing Ireland at international research fora to ensure that Irish researchers are kept informed and involved in international initiatives and relevant research, technology, development and innovation opportunities.

In conjunction with Department of Agriculture, Food and the Marine (DAFM) representatives, the Marine Institute is National Delegate (ND) to the Programme Committee for Societal Challenge 2 of the EU Horizon 2020 Programme. In 2019, the Institute continued to act in its role as National Contact Point (NCP) for marine aspects of Horizon 2020 funding. Other representation provided by PIRS included the European Marine Board; EurOcean, the Intergovernmental Oceanographic Commission and the Management Board of the Joint Programming Initiative on Healthy and Productive Seas and Oceans (JPI Oceans). The Institute also attended the 30th Session of the IOC Assembly in 2019.

The national results for the single-stage Blue Growth (BG) topics in H2020 were issued in mid-2019. There were very successful results for MaREI for the MUSICA proposal (Multiple-use-of Space for Island Clean Autonomy). The total award to University College Cork (UCC) is €3.2 million and €141,000 for the International Consortium of Research Staff Associations. NeoDyne (SME) is also awarded €713,000 under this proposal. Under a separate proposal to the same call, The Seaweed Company (SME) has been awarded €535,000 for the UNITED project (Multi-Use offshore platforms demoNstrators for boostIng cost-effecTive and Eco-friendly proDuction in sustainable marine activities).

The Marine Institute is a partner in the EuroSea proposal awarded €433,000 - Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans. Finally, Intrigo Ltd will work in the SEALIVE project (Strategies of circular Economy and Advanced bio-based solutions to keep our Lands and seas alIVE from plastics contamination) with an award of €280,000. In total, Ireland was awarded €5.28 million for this single stage call – a drawdown of 8.5% of the available budget, far exceeding the national target of 1.67% and a significant increase on 2018 figures.

A funding profile from the start of H2020 in 2014 to the end of 2019 indicates that €63.84 million in funding has been won for Irish researchers across all pillars and societal challenges of the current framework programme, representing a drawdown of 6% of the total available budget. €15.7 million of this was in 2019 alone with awards for ERC grants, research infrastructures, SME instrument, Marie Skłodowska-Curie Innovation Training Networks, in addition to "traditional" Societal Challenge 2 Blue Growth and Sustainable Food Security topics. A list of projects for 2019 are in Appendix 3.

Strategic Initiative 2: Increasing Marine Institute research capacity and performance

The Marine Institute itself was successful in five projects in 2019, bringing a total European Commission (EC) requested contribution of €2.264 million. The projects were MEESO (Ecologically and economically sustainable mesopelagic fisheries), 5G-HEART (5G HEalth AquacultuRe and Transport validation trials), Maritec-X (a Widening project with Cyprus called Marine and Maritime Research,

Innovation, Technology Centre of Excellence), EuroSea (Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans) and FORCOAST (Earth Observation Services for Fishery, Bivalves Mariculture and Oysterground Restoration along European Coasts). Since the beginning of H2020, the Marine Institute has a high success rate of 40.9% in funded projects (27 projects overall with 66 proposals/submissions).

The Marine Institute and DAFM have been monitoring the development of Horizon Europe in conjunction with partner agencies, government departments and DBEI. Cluster 6 in Horizon Europe has been titled "Food, Bioeconomy, Natural Resources, Agriculture and Environment". At the DG RTD (Directorate-General for Research and Innovation) days in September 2019, the EC held the first meeting of the overarching "Mission Healthy oceans, seas, coastal and inland waters".

DAFM and the Marine Institute have continued to liaise nationally to ensure alignment with existing and future funding initiatives, e.g. through the High Level Group on H2020, the national Mission Board nominees and coordinating nationally on Partnership initiatives for Horizon Europe.

Strategic Initiative 3: Optimise our funding programmes

The Research Funding Office managed €8.36 million in research investments awarded in 2019 under the Marine Institute's Marine Research Programme: €3 million for ship-time on the research vessels and remotely operated vehicle; and €5.36 million on research projects (full details are provided in Appendices 1 & 2).

The ship-time investment funded the research vessels and the remotely operated vehicle for multi-disciplinary marine research and student training in Irish waters and beyond. Under the programme, 105 days were supported for research, 66 days for policy support and 51 days were provided for training on board RV *Celtic Explorer* and RV *Celtic Voyager*.

In August 2019, the Marine Institute launched a new Post-Doctoral Fellowship Programme to build national capacity and raise the maturity level for specified research themes under the National Marine Research & Innovation Strategy 2017-2021. This investment will provide an opportunity for early career researchers to advance their careers and build a programme of research in a marine area of identified strategic importance. The call invited applications for eight fellowships, and 17 proposals were received. The Institute awarded eight fellowships under this call for a total value of €3 million over five years to three Higher Education Institutes. These awards will be co-funded under the European Regional Development Fund (ERDF), resulting in a return to the Irish Exchequer.

Involvement with co-funded programmes continued in 2019, with five new investments totalling €2.07 million concluded as follows:

- EPA Research Call 2019 (Climate and Sustainability Pillars) – one award to be funded jointly by Environmental Protection Agency/Marine Institute and one award to be co-funded with EPA/Marine Institute/Met Éireann and Office of Public Works (OPW), with the Institute's investment amounting to €0.17 million
- JPI Oceans MicroPlastics Call – two projects awarded to two Irish partners funded jointly by Marine Institute/Department of Housing, Planning and Local Government, with the Institute's investment being €0.15 million
- ERA-NET Cofund on Blue Bioeconomy (BlueBio) – Unlocking the Potential of Aquatic Bioresources – five projects funded with 12 Irish partners including three industry partners, with the Institute's investment being €1 million. Science Foundation Ireland and European Commission are also providing co-funding for these projects.
- MarTERA (Maritime and Marine Technologies for a new Era) ERA-NET – one project funded with one Irish partner, with the Institute's investment being €0.15 million
- JPI Climate and JPI Oceans - two projects awarded to three Irish partners funded by an investment of €0.6 million from the Institute

Co-funded awards provide an opportunity to establish national and international research collaborations in areas of strategic importance for Ireland and Europe. Co-funding will continue in 2020 with the second BlueBio call due to open in May for submission of transnational proposals to undertake research in topics related to the *blue bioeconomy*. It is expected that co-funding opportunities will also arise with other national funders, where our research priorities align.

Significant demand for the Networking and Travel Grants Programme continued in 2019, with 147 applications received. There were 116 grants awarded with 101 researchers attending conferences/ workshops or carrying out training/ working visits overseas, together with 15 conferences held in Ireland showcasing Irish marine research. The total cost of the 2019 programme was €0.11 million.

During 2019, the Marine Institute carried out a review of the Cullen Fellowship Programme to examine whether the programme is delivering as intended, identify any issues and recommend changes for future calls. The Institute has made an investment of €2 million from 2014 to 2018 to fund 27 fellowships. Two PhD students completed their thesis and passed their viva during the year, bringing the total to four completed fellowships. The annual Cullen workshop was held on 19th November 2019, with the fellows presenting oral and poster presentations in an impressively diverse range of marine topics (e.g. ocean observation technologies, assessment of finfish/shellfish species, ocean ecosystems & the food web, fish disease control, marine contaminants & toxins, seaweed assessment, etc.).

The review indicates that the Cullen Fellowship Programme has been very successful and is delivering as follows:

- Provides excellent training for the fellows for their future careers
- Creates new capacity, skills, data and knowledge for the marine research sector in Ireland
- Produces high quality research that helps the Marine Institute to deliver scientific and policy advice to government and other stakeholders as part of the Institute's core work programmes
- Creates new collaborations and partners between the Higher Education Sector and the Institute
- Provides Marine Institute supervisors with an opportunity to pass on their knowledge and gain experience as supervisors to enhance their own career development

The Cullen Fellowship Programme will be relaunched in 2020, with revised Terms and Conditions that incorporate the key recommendations from the review.

A report providing details of the 12 projects funded under the 2018 Industry-Led Call was published and is available on the Institute's Open Access Repository. These projects are progressing well, have established new collaborations and leveraged additional grant funding. Five projects are due to complete in 2020.

The Marine Research Programme targets funding under the research themes of the National Research & Innovation Strategy 2017-2021 to raise the research capacity in the marine sector and to maximise the impact nationally through co-operation with other state research funders.

This investment also aligns with the Marine Institute's Strategic Plan 2018-2022 under the four strategic focus areas of 1) Scientific Advice and Services, 2) Forecasting Ocean and Climate Change, 3) Research and Innovation and 4) Ireland's Ocean Economy, by funding the highest quality peer-reviewed research that provides scientific evidence for government, policy makers and relevant stakeholders to inform their decision-making process.

AORA-CSA

The Atlantic Ocean Research Alliance Coordination & Support Action (AORA-CSA) entered its final 12 months of operation in March 2019.

The main achievements by December 2019 were:

- An international pilot campaign #GoAtlanticBlue was created to raise awareness of the Atlantic Ocean and to celebrate it and our connections to it in a highly visible way - in essence, our Atlantic Stories.

  The pilot was launched to coincide with World Oceans Day on 8th June 2019. It was a tremendous success with more than 60 organisations in Ireland and around the world taking part. It trended on social media and it reached c.2.4 million people. The campaign also provided a basis and inspiration for the All-Atlantic Ocean Youth Ambassadors later in August 2019, when developing their #MyAtlanticStory campaigns.
- The activation of the AORA Marine Microbiome Initiative with the first trilateral workshop taking place in Brussels on World Microbiome Day (27th June 2019), followed by a 4-day October workshop in Reykjavik, Iceland, by our partners RANNÍS the Icelandic Centre for research. The first draft of the AORA Marine Microbiome Roadmap resulted from this second workshop.
- In June 2019, the AORA Ecosystem Approach to Ocean Health & Stressors Working Group met in Spain. At the end of this workshop, they launched their Vision Document to promote research to understand the North Atlantic Ocean in support of ecosystem-based management (EBM).
- In August 2019, the AORA-CSA hosted a summer school at the Marine Institute for 23 All-Atlantic Youth Ambassadors from 14 different countries. The programme was developed in conjunction with the European Commission DG Research & Innovation and high level delegates from all around the Atlantic participated in the event.

  The event was opened by Minister of State, Seán Kyne TD, on Saturday 24th August. The first day gave the Youth Ambassadors a strong grounding of the Natural & Changing State of the Atlantic as well as the political cooperation Galway (2013)

The RV *Celtic Explorer* lit up in blue in Cork for Go Atlantic Blue on World Oceans Day 2019. Photo: Gerard McCarthy.

and Belém (2017) Statements on Atlantic Ocean Cooperation. Over the following days, the Youth Ambassadors got a thorough grounding in youth advocacy and activism in order to become actors of change.

The final few days saw the Youth Ambassadors develop three strong campaigns under #MyAtlanticStory: Know the Atlantic, Atlantic Friendly and Culture & Celebrate. This event trended on social media over that weekend reaching an audience of 2.7 million.

More information on AORA can be found in its brochure: **https://www.atlanticresource.org/aora**

MARINE ENVIRONMENT AND FOOD SAFETY SERVICES (MEFSS)

Collectively across the MEFSS sections, 17 papers were published in peer reviewed journals addressing past research, and about 28 presentations and/or posters were given at scientific meetings representing current research projects. This level of research production, on balance with the heavy statutory service support, is a testament to the continued hard work and dedication of the scientists throughout the Marine Institute.

Shellfish Safety

In the area of shellfish safety, research activities in 2019 included:

Research Projects

- FoVira project which concluded in 2019 on method development and investigations for Norovirus, Sapovirus, Hepatitis A & E virus detection and quantification in shellfish intended for human consumption
- Bord Iascaigh Mhara (BIM) funded project which continues until March 2021, to analyse the impact, management and prevalence of norovirus in a number of production areas around the coast of Ireland
- Cullen Fellowship in conjunction with Cork Institute of Technology (CIT) and Teagasc on the application of next generation sequencing to norovirus genotypic diversity in bivalve shellfish and wastewater
- Cullen Fellowship in conjunction with Biodiscovery department, Ryan Institute, NUI Galway on the bioactive and toxin properties from the harvesting of biotoxins of large scale culturing of known toxin producing phytoplankton species in Irish waters
- Cullen Fellowship in conjunction with Sligo Institute of Technology (Sligo IT) on *Azadinium* Biological Oceanography has finished after four years. The PhD thesis and a number of papers

arising from this research fellowship are currently being written.

- During 2019, the three year MARbioFEED project finished. This project has provided a wealth of new information and data in relation to phytoplankton culturing, isotope labelling, marine biotoxin isolation for purification for the production of certified reference materials, which are pre-requisites of biotoxin monitoring programmes.
- Alertox-Net, an Interreg Atlantic Area project is currently progressing and is due to finish in 2020. This project is looking at innovative toxicity alert systems for safe seafood and method development for the detection of novel and emerging biotoxins, in particular Tetrodotoxin (TTX). During 2019, in-house methods are being developed and validated for TTX presence in Irish shellfish species.
- PRIMROSE – Predicting the Impact of Regional Scale events on the Aquaculture sector is an Interreg Atlantic Area project which is due to finish in 2020. This project builds upon our existing dataset, techniques and models for the prediction and forecasting of Harmful Algal Bloom events and development of a data portal for Atlantic Area countries to extract data and information on a variety of biological and oceanographic parameters. The Marine Institute is the lead project coordinator.

Phytoplankton Survey of Irish Coastal Waters (CV19020)

In August 2019, a coastal survey of Irish waters was conducted where the objectives were designed to deliver data to the Irish Harmful Algal Bloom (HAB) modelling effort, continue to map the extent and distribution of *Azadinium* species, a known *Azaspiracid* (AZA) biotoxins producers in Irish waters and to map the physical and phytoplankton characteristics of the coastal current, along the southeast, south and southwest coasts. In addition to on-board microscopy, for the first time on an Irish research vessel, on board qPCR methods and instrumentation were used in the identification and confirmation of *Azadinium*. This methodology was extremely successful in species confirmation presence and abundance in a near real-time scenario.

Shellfish Safety Workshop

The 11th Shellfish safety workshop was held in October 2019 in Athlone with 90+ shellfish producers and processors, scientists, researchers, agencies and stakeholder representatives attending. This workshop enables scientists and regulators to exchange information and discuss the latest research, advances in technology, and forecast any issues for the industry.

Key note speakers from the Marine Institute, Galway-Mayo Institute of Technology (GMIT), Centre for Environment, Fisheries and Aquaculture Services, Marine Scotland Science and Sea Fisheries Protection Agency (SFPA), delivered presentations on a variety of subjects including; 20 years of monitoring biotoxin and algal events in Ireland, the development of the world's first scientific-based shellfish traceability tool, regulated and emerging biotoxins in British shellfish, regional distribution of harmful algal events in North Atlantic area and findings of the report of the EU baseline survey on norovirus.

There were also a series of flash presentations from representatives of the Marine Institute, BIM, SFPA, Food Safety Authority of Ireland (FSAI), Dublin City University (DCU), Sligo IT, and the Health Service Executive (HSE). The proceedings of the workshop are currently being compiled for publication and will be available for download from the Marine Institute's Open Access Repository.

Marine Chemistry Research

In the marine chemistry unit, ongoing research projects in 2019 included:

- As part of the INTERREG COMPASS project (Ireland, Northern Ireland and Scotland), the Marine Institute deployed an array of oceanographic and biogeochemical sensors, on the COMPASS oceanographic buoy off Mace Head. Verification sampling and analysis were carried out regularly and the Marine Institute is working with other partners to improve regional competence for undertaking these observations.
- The MEFSS chemistry team continue to work very closely with NUI Galway on ocean biogeochemistry/acidification research including in support of the VOCAB project (Variability /vulnerability of Ocean Carbon and Biogeochemistry).
- The GMIT-led project to evaluate seabird eggs as higher trophic level indicators of contaminant exposure in Irish marine waters is in its third year.
- Throughout 2019, the chemistry section continued its involvement in the INTERREG funded MONITOOL project while additionally initiating research in the global AQUAGAPS project, both of which are aimed to further develop Marine Institute capacity in the area of passive sampling as novel tools to measure pollutants in water.

- A Co-supervised Trinity College Dublin (TCD) – Marine Institute Cullen Fellowship on the "Vulnerability of life stages of marine calcifiers in Irish coastal waters due to changes in ocean chemistry and other stresses" commenced in 2019.
- The Marine Institute also continues to undertake research into, for example, fate and impacts of contaminants of emerging concern in the marine environment and also arsenic in marine algae

Fish and Shellfish Health Research

In 2019, the Marine Institute's Fish Health Unit, completed year three of the EU funded VIVALDI project **http://www.vivaldi-project.eu/**. This project, led by IFREMER in France, is generating practical solutions aimed at preventing, controlling and managing diseases of farmed bivalve molluscs. The Marine Institute's role in the project has centred around the diseases of most significance for the Irish Pacific oyster industry namely V. aestuarianus and OsHV-1 µvar. The work included a study on management factors associated with mortality and on characterisation of isolates of the two pathogens which have been found in Irish Shellfish.

The Fish Health Unit is collaborating with GMIT through the Cullen Fellowship Programme in a project examining the disease status in velvet crab. The project focuses in particular on the potential impacts of Paramarteilia and microsporidian species. Work in 2019 has focused on supporting GMIT to establish molecular (pathobiome analysis) and histopathological techniques to determine disease prevalence in velvet crab populations. This project is ongoing and will be completed in 2021.

Marine Spatial Planning

Queen's University Belfast and the Marine Institute are partners on an MSP Cullen Fellowship, researching Perceptions and Conflicts of Coastal Landscapes on the West Coast of Ireland. After three years, the work is yielding some interesting results about the different understandings and values associated with blue growth objectives, tourism and communities.

The EMFF (2014-2020) research initiative on marine invasive alien species (IAS) kicked off in 2019. Two postdoctoral researchers based in GMIT, are looking at novel eDNA methods for assessing the presence of IAS in Irish coastal waters. University College Dublin (UCD) was awarded funding to recruit two postdocs to model and map the distribution of IAS in Irish waters.

In June 2019, DAFM approved a new series of research projects, thought the *European Maritime Fisheries Fund (EMFF) Union Priority 6 - Fostering the Implementation of the Integrated Maritime Policy.* These will support the implementation of MSP in Ireland. The first project to be awarded aims to define and classify Ireland's seascapes.

IRISH MARITIME DEVELOPMENT OFFICE (IMDO)

Research undertaken by the IMDO or commissioned externally is highly applied and revolves around tightly defined research questions that relate to the development of Ireland's maritime industry. Our research has focused on four distinct areas:

Economics and Trade

The IMDO monitors trade and port volumes and report quarterly to DTTAS. This work culminates in the annual publication of the Irish Maritime Transport Economist (**here**). This research provides the data to advise DTTAS on changes in trading patterns, trading partners, shipping routes and volume fluctuations and had underpinned much of the research undertaken to advise DTTAS on responses to Brexit challenges.

Port Performance

The IMDO monitors the performance of Irish ports using a suite of metrics that interprets operational and financial efficiency. These metrics are used to benchmark Irish ports against comparable ports within the EU and elsewhere in the world. In 2019, a PhD was awarded for research undertaken by a Cullen Fellow into port performance metrics, that describes a typology of metrics that can be tailored to meet the particular circumstances of a given port.

Smart ports and fast trade lanes are emerging research topics that are of interest to the IMDO from a port performance perspective. These research areas are being monitored by Dr Edel O'Connor (Business Development Manager – IMDO) and Dr Paul Brewster (EU Policy Adviser – IMDO) and resulted in a funding application under the Motorways of the Sea Programme for a pilot project to be undertaken in the Irish maritime industry. In addition, research funding has been committed to NUI Galway for research on the variables that influence port performance and the socio-economic justification of investing in increased port capacity in the maritime industry. Performance and capacity are linked and research in this area is well advanced through the Cullen Fellowship Programme.

Port Sustainability

Research funding was jointly awarded to a research team in Queens University Belfast by the Marine Institute and the Environmental Protection Agency. The research addresses how to develop Irish ports in a sustainable fashion. The research is timely for two reasons. It points to how port development can be undertaken in a way that will contribute to Ireland's emissions reduction targets. Secondly, it creates a stronger foundation for applying for EU funding for the maritime industry, by addressing the decarbonisation agenda, a prerequisite for successful EU funding applications.

Business Development

The IMDO's mandate for business development is explicit in the legislation that established the Office. Based on this mandate and the targets set out in *Harnessing Our Ocean Wealth*, the IMDO has been careful in formulating strategies that attract new business and secure it in the long term. The IMDO's approach is influenced by cluster theory that identifies the benefits of building concentrations of economic activity in specific regions. Not only does this approach generate opportunities for collaboration for cluster members, it also produces interdependencies that may be difficult to replicate elsewhere, securing investments in attracting such businesses in the first instance. This approach was developed by a Cullen Fellow who graduated from NUI Galway with a Masters Degree in Marketing and whose thesis was on cluster theory. This research is being advanced in the IMDO and will be the subject of another Cullen Fellowship application in 2020.

All four research topics are directly related to the objectives set out in Strategic Focus Area 3 of the Marine Institute's Strategic Plan by increasing marine institute research capacity and performance in relevant areas. The IMDO advanced this agenda throughout 2019 in all its research initiatives.

FISHERIES ECOSYSTEMS ADVISORY SERVICES (FEAS)

FEAS undertook many Research and Innovation projects during 2019. Highlights of activities during the year include:

- Analyses of data poor assessment methods were developed with Galway-Mayo Institute of Technology (GMIT) under DAFM funded FishKOSM project - Fisheries Knowledge for Optimal Sustainable Management
- Bio-economic modelling using FLBeia was developed for the Celtic Sea under FishKOSM and ProByFish (Protecting Bycaught Fish) projects
- The WKIrish series of workshops concluded with finalised EwE model, and provided recommendations for fishing mortality reference values for commercial fish species

A grenadier photographed from the ROV Holland I during Sea Rover 3 Survey

- Work continued on the Science Foundation Ireland (SFI) funded RTI project in 2019, moving into final year with management strategy evaluation the next step
- A postdoctoral researcher received funding through a four year SFI Starting Investigator Research Grant – iFISH: Developing information sharing networks in Irish fisheries as a tool to avoid unwanted catches
- FEAS ecosystem research group published seven international peer reviewed papers, and two book chapters, as well as making 19 presentations at international conferences including the ICES ASC, and on five ICES reports
- Under the EMFF Biodiversity Scheme the following were achieved:
  - **iVMS project:** procured equipment and services from a number of suppliers and managed the communication of data from 150 fishing vessels under 12 metres in length. Drafted a scoping document DAFM/SFPA on future options for electronic reporting by vessels under 12 metres
  - **Oyster restoration:** completed oyster spat fall trials in Galway Bay and Lough Swilly and expanded survey data for new areas
  - **Crayfish restoration:** procured and acquired data on catch composition, by catch, fishing effort, iVMS from tangle net vessels. Managed delivery of reef mapping surveys from MERC Consultants. Published by-catch data in collaboration with University College Cork (UCC)
  - **Skate and Ray:** Completed surveys of skates and rays in Tralee Bay and Dingle Bay in Q1
  - **Seabird surveys:** Procured and managed delivery of aerial seabird and wading bird surveys in the north Irish Sea and Dundalk Bay. These data are integrated to advice on bivalve fisheries to DAFM
- FEAS supervises 10 Cullen PhD fellows who started their studies from 2015. Two of these researchers competed their studies in 2019. Data from a sampling programme for genetic tagging and mark recapture data with lobster fishermen was used by a Cullen PhD fellow based at Queen's University Belfast. Four Cullen fellowships in Burrishoole are progressing well and producing peer-reviewed publications.
- The DAFM funded SEERAC project continued research on spatial conservation planning methods with NUI Galway
- Offshore and inshore scallop surveys were completed in the Celtic Sea and Irish Sea under the Bluefish project. This work included a collaboration with Aberystwyth University on genetic population structure of scallop
- The Marine Institute (OSIS and FEAS) is now a partner on a new H2020 project FORCOAST, which began in Q4 2019
- 2019 was a successful year of Burrishoole Long Term Environmental Research data collection in the catchment. Despite some technological issues and poor weather there was an extension to the data collection at Lough Bunaveela
- Externally funded projects underway in Newport include (PROGNOS, Water JPI; **http://prognoswater.org/**; WATExR, Climate JPI **https://watexr.weebly.com/**; MANTEL, MCSA ITN **www.mantel-itn.org**; EIFAAC (European Inland Fisheries and Aquaculture Advisory Commission) funded Norway/Ireland Eel Project). Exploration of methane dynamics in the catchment over the summer was undertaken with the MANTEL project.
- In 2019, an open-source database and archiving system to consolidate and digitise this collection was developed under the Unlocking the Archive, Catchment Cluster programme, and show how this case study infrastructure could be used for other biological sample collections. The system utilises the FAIR (Findable, Accessible, Interoperable and Reusable) open data principles, and includes a physical repository, sample metadata catalogue, and image library. Ongoing time series analyses in relation to changing climate are underway using data from the archive and the long time series of fish census data and coded wire tagging data.
- The 6a herring project completed most sampling in 2019. Preliminary results presented to the Marine Institute in Q4 indicate promising outcomes for stock separation. The final results will ultimately be used to split the stocks to facilitate separate assessments.

CASE STUDY
Bluefin Tuna Tagging

A successful collaboration with the International Commission for the Conservation of Atlantic Tunas (ICCAT), Stanford University California, and Trinity College Dublin consolidated work commenced in 2016 with a total of 53 fish tagged with satellite tags and eight with accelerometer tags. Data transmitted from these tags when they are released from the fish (usually one year after tagging) have indicated the migration route and spawning location of fish taken in the Donegal area and are being used in ICCAT stock assessment models. A contract for funding was awarded by ICCAT for satellite tagging in 2019 while funding for 2020 has been awarded under the EMFF Sustainable Fisheries Programme.

In the early 2000's, bluefin tuna (BFT) became very abundant in the waters around Ireland. They subsequently disappeared as the stock declined in the Atlantic. In 2014, they reappeared in large numbers as the stock recovered. In 2018, there were many reports of large numbers of BFT in the waters around Ireland and while there are no scientific population estimates, there is much anecdotal information on increased sightings and interactions with commercial fisheries. Similar reports of increased BFT numbers came from UK, Norwegian and Danish waters during 2016, 2017 and 2018. As a result of ongoing research efforts and a decision by ICCAT in 2018, a new Irish bluefin tuna catch, tag and release angling fishery was initiated by DAFM and DCCAE in 2019. The Marine Institute is co-ordinating the scientific data collection for this fishery where over 200 fish were taken by 15 vessels between August and November 2019.

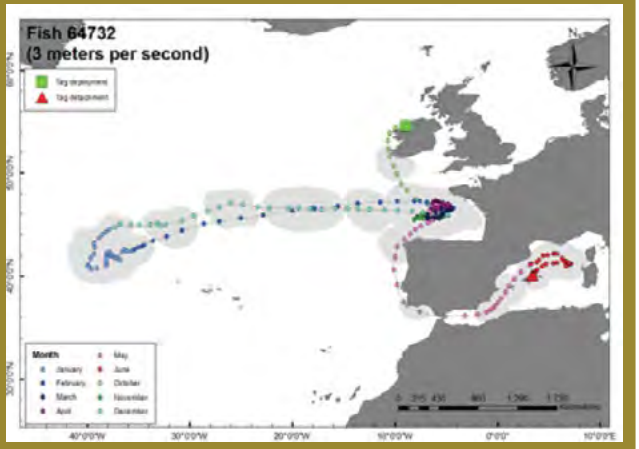


Figure 1: Individual examples of migrations of BFT tagged in Irish waters. Fish one (Left panel) was tagged off Donegal in October, migrated to the Bay of Biscay soon after. Overwintered before travelling to the mid-Atlantic, before leaving and returning to the Bay of Biscay in March. Remained until May before travelling very quickly into the Mediterranean in June to known spawning grounds.

Bluefin tuna is the largest tuna, and one of the largest fish of all. It is a pelagic, fish-eating species, found from the surface to depths of up to 1,000 metres. BFT is distributed in the pelagic waters of the North Atlantic and adjacent seas from Brazil to Newfoundland in the west Atlantic and from the Canary Islands to North Norway in the east Atlantic. After spawning in the Gulf of Mexico and the Mediterranean Sea in spring/summer, many BFT migrate into the Atlantic Ocean for feeding, heading along the continental slope and into the open sea. The main routes in the east Atlantic are along the Iberian Peninsula into the Bay of Biscay and further north along the west of Ireland and as far north as Norway.

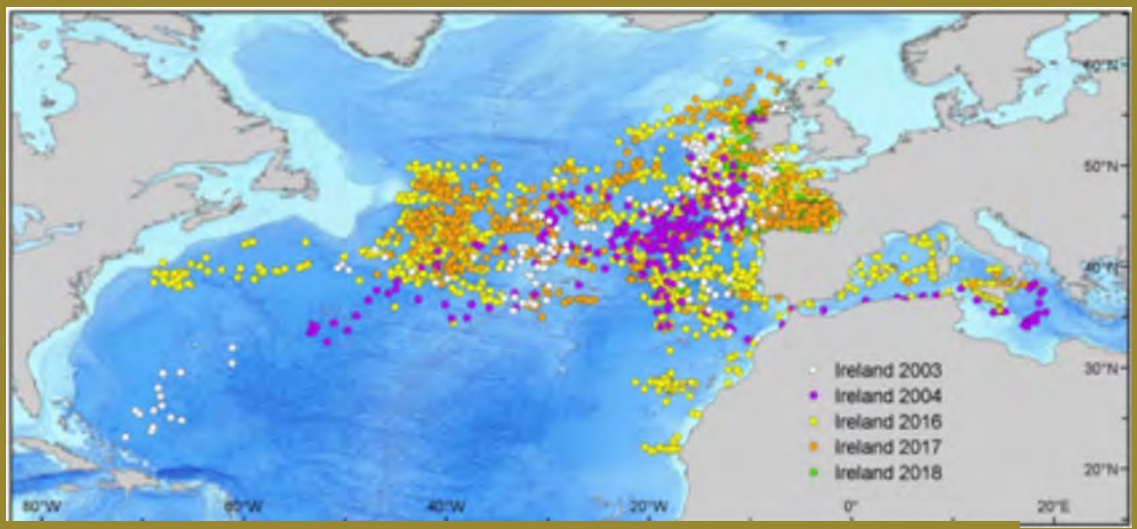


Figure 2: Spatial distribution of BFT migration for fish tagged in Irish waters since 2003 (Figure provided by Stanford University, California, USA, Data from Marine Institute, BIM).

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

Ocean Energy & Infrastructures

The team was involved in a number of H2020 projects in 2019, including ESMO_Dev and EMSO_Link for the design and implementation of ocean observing technology for the European Multidisciplinary Seafloor and water-column Observatory European Research Infrastructure Consortia (EMSO ERIC) and to accelerate the ramp-up of the EMSO ERIC to full European-scale implementation, respectively, and E-ARISE; extending the capabilities of the Euro-Argo network to provide essential ocean observations.

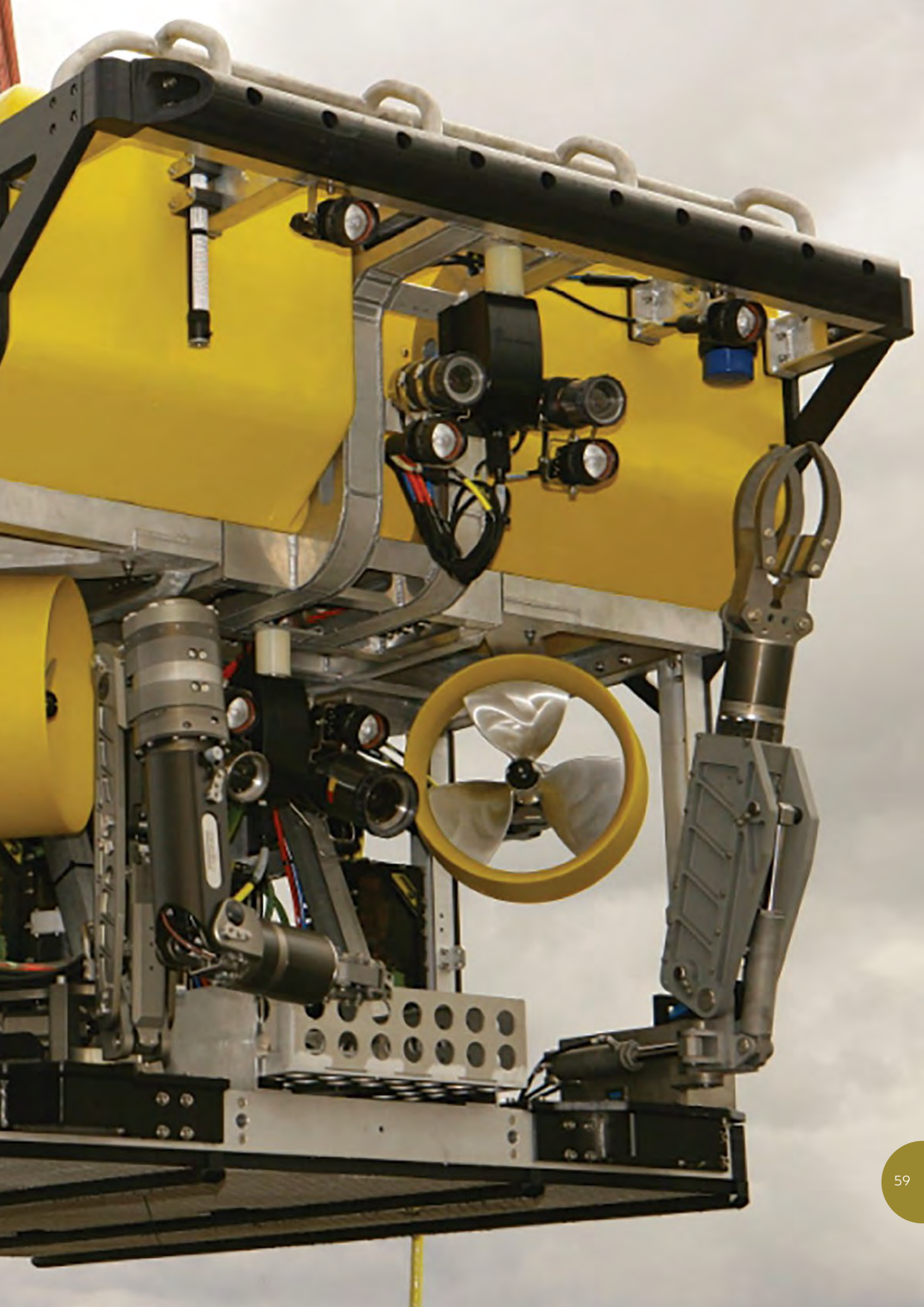
The team also successfully completed JERICO_Next; the Joint European Research Infrastructure of Coastal Observatories extending the EU network of coastal observatories, adding new innovative infrastructures and integrating biogeochemical and biological observations.

The follow-on project to JERICO_Next was awarded in 2019; JERICO-S3, Joint European Research Infrastructure of Coastal Observatories - Science, Service, Sustainability to strengthen the European network of coastal observatories.

In collaboration with international colleagues, the Marine Institute contributed to a number of scientifically peer reviewed ocean observing community white papers. These included contributions by the GO-SHIP, ICES WGOH, Ocean Best Practice, Harmful Algal Bloom, and AtlantOS communities.

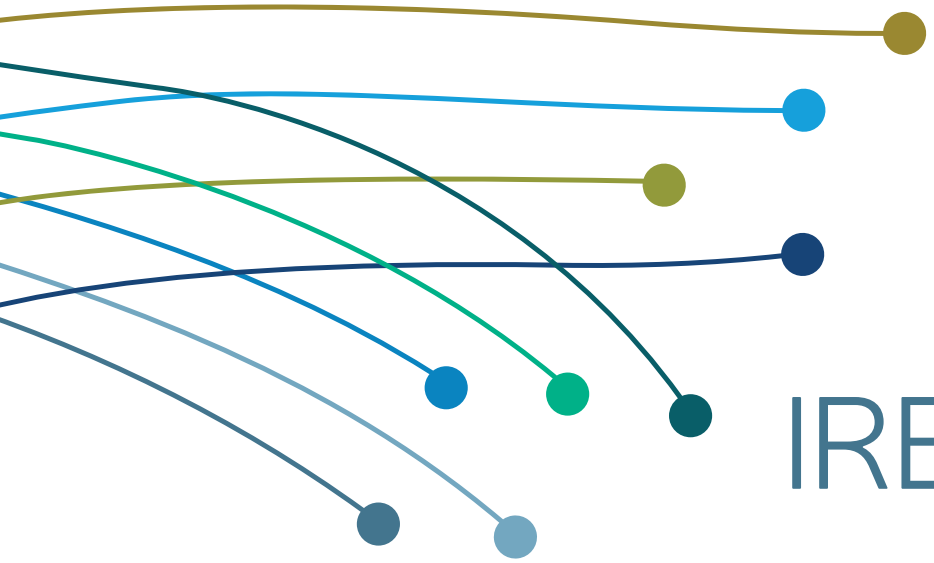
In 2019, we continued to work closely with colleagues in NUI Galway and University College Cork co-supervising two PhD students working on remote sensing projects.

In December 2019, the Marine Institute hosted a CMEMS workshop, 'Copernicus Marine Service Training Workshop for the European Northwest Shelf Seas', run by Mercator Ocean International and UK Met Office.



STRATEGIC FOCUS **AREA 4**

IRELAND'S OCEAN ECONOMY



IRELAND'S OCEAN ECONOMY

The Marine Institute provides services in partnership with other agencies which underpin and promote sustainable economic development and promote sustainable employment. Most of the activities detailed in other areas of this Annual Report also have a significant economic dimension.

The Institute supports Ireland's ocean and coastal economies through its research, ocean knowledge, infrastructure, advisory and regulatory services and maritime development opportunities. This includes the mandate of the Marine Institute's Irish Maritime Development Office (IMDO), providing dedicated development, promotional and marketing support for the shipping and shipping services sector. The IMDO's remit also includes supporting the development of Irish ports and the education and training needs of the maritime transport industry.

Through broader education, engagement and outreach programmes with stakeholders, the Marine Institute helps to develop an informed consensus about the sustainable development of our ocean economy (see Strategic Enabler 4 – Engagement & Education for more on this).

These enabling services support the Government's economic ambitions and targets as captured in the *Harnessing Our Ocean Wealth* programme. The Institute facilitates and funds research that monitors and reports on the *Harnessing Our Ocean Wealth* targets. Building a socio-economic research capability in the Marine Institute and linking this to a strengthened national capacity is key to achieving this.

The achievement of these economic ambitions relies on the combined efforts of Ireland's development agencies. The opportunity for significant additional growth in our blue economy will continue under this strategy, building on the progress made in recent years under the Government's integrated plan for the sector as a whole. Examples of areas with a national focus for growth include nascent and emerging sectors such as marine biotechnology and advanced marine technologies (as outlined in the Report of the Development Task Force).

In 2019, the Marine Institute, in partnership with Enterprise Ireland and with support from SmartBay Ireland, continued to promote Irish marine industry through the activities of the Irish Marine Industry Network (IMIN). This included a regional event in Galway as well as work towards an online presence for the network members.

IRISH MARITIME DEVELOPMENT OFFICE (IMDO)

Throughout 2019, the IMDO continued to discharge it development role by promoting Ireland as a country of enormous opportunity, not only in the maritime sector, but across all sectors of its marine industry, giving strong voice to the message contained in the Government's integrated plan for the development of the marine industry *Harnessing Our Ocean Wealth*, that Ireland is open for marine business. The IMDO played a key role in the business events at Our Ocean Wealth Summit in Cork in 2019. Apart from presenting a trade show event, the IMDO welcomed a trade delegation from the United Arab Emirates and signed a Memorandum of Understanding with the Dubai Maritime City Authority (DMCA) that will allow both parties to pursue mutual interests in port development and maritime commerce.

The IMDO supported the important efforts of Irish ports to attract development funding from EU programmes and participated in EU events in, Italy, Finland, Belgium, Greece, Portugal and Ireland. Participation in these events have twofold benefits, giving Ireland an opportunity to advise on the structure of funding programmes and advance visibility of the timing of funding calls. The IMDO also worked with port and shipping companies on a SmartPorts Initiative/ Fast Trade Lanes that uses data analytics to increase port efficiency and competitiveness. An application for EU funding has been submitted under the Motorways of the Sea Programme that is led by the IMDO, with support from DTTAS and the active participation of Dublin Port and the Port of Cherbourg. This project can have a transformative effect on port logistics and bring about improvements in operational efficiencies for ports, shipping companies and other port users.

Maritime Transport and Maritime Commerce – Harnessing Our Ocean Wealth Targets

Ireland's heavy reliance on international trade means that maritime transport is of significant interest to most industry sectors, drawing the IMDO into diverse, yet related sectors of the Irish economy. The total value of the maritime transport sector was €2.237 billion in 2019, representing 39% of the turnover of the entire marine industry, up from 37% in 2018 (SEMRU – Ocean Economy Report – 2019).

Maritime Commerce/International Shipping Services Centre (ISSC)

Responding to opportunities created by the UK's departure from the European Union, the IMDO intensified its business development activities in the UK in 2019. At London Shipping Week in September 2019, the IMDO hosted an event at conference venue, attended by more than 60 guests, to communicate the attractiveness of Ireland as a centre for maritime commerce and the willingness of Irish firms to creates a cluster of maritime commerce in Ireland. This event highlighted the International Shipping Services Centre (ISSC) project that seeks to create a hub for maritime commerce in the docklands area of Cork City. During 2019, PwC reported on the viability of such a project.

Irish Marine Industry Network (IMIN)

As a founder member of the IMIN, the IMDO continues to build on the benefits of such a network in an effort to spread the message that there are many opportunities for national and international companies promote their respective interest through the network and the take advantage of "marinisation" opportunities that may not have been immediately obvious to companies that are not familiar with the maritime industry. In association with other members of the IMIN steering group, the IMDO will continue to promote the benefits of membership of IMIN and contribute fully to its development.

Marine Renewable Energy / Irish Ports Offshore Renewable Energy Services Report

The IMDO's role in producing the IRORES Report and our involvement in the Offshore Renewable Energy Development Plan (OREDP) were important in positioning the ports industry to participate fully in the development of the Offshore Renewable Energy industry. This emerging industry has enormous potential and strategic importance which is fully understood by the ports industry, whose involvement will be essential during the construction and deployment phase and later in providing bases for operations and maintenance.

Specific Events and Conferences

In all, the IMDO participated in some 26 international events and business development missions to the United Kingdom, Cyprus, United States, Portugal, Belgium. The IMDO hosted international delegations from Wales, the Netherlands, Norway and Canada during the course of the year. In all cases, the IMDO promoted Ireland's maritime sector and took advantage of opportunities to highlight the development potential that exists in other sectors of the broader marine economy. The international events in question included:

Oceanology International, San Diego.

Following the success of the Irish pavilion at Oceanology International in London in March 2018, the IMDO organised a stand at Oceanology International North America in San Diego from 25-27 February 2019. Oceanology International is the world's leading marine science and ocean technology exhibition and conference.

Ocean Business, Southampton

The IMDO hosted an Irish Pavilion at Ocean Business 2019, in collaboration with Enterprise Ireland. Ocean Business is an international tradeshow and conference which took place from the 9-11th April 2019. This is a hands-on ocean technology exhibition and training forum and is firmly established as one of the most important international events in the ocean technology calendar.

Nor-Shipping, Oslo

The IMDO hosted a Marine Ireland stand at Nor-Shipping 4th-7th June 2019. Nor-Shipping is where the maritime and ocean industries meet every two years – a natural hub for key decision makers from across the world to connect, collaborate and do deals to unlock new business opportunities.

Motorways of the Sea Conference – EU Commission

The IMDO organised and presented at the Motorways of the Seas Conference in Dublin in April 2019, This event drew an international audience and created a valuable platform for the Irish maritime industry to advance its views on how the EU should meet the challenges of Brexit. The event attracted more than 120 delegates and was co-hosted by the Department of Transport, Tourism and Sport (DTTAS) and the IMDO.

London International Shipping Week (LISW)

Liam Lacey gave a key note address at the round table debate on "The Importance of Maritime Clusters" at LISW, which took place in September 2019 and featured over 160 official events and networking opportunities. It was attended by leaders across all sectors of the international shipping industry. The events were held by international shipping and marine trade associations and UK Government as well as by official sponsors of the week. An estimated 15,000 industry leaders attended the week.

Digital Transport Days event in Helsinki in October 2019

This event attracted around 750 transport stakeholders to discuss how to achieve smart, sustainable and safe mobility in Europe, relying on the trans-European transport network, as well as investments in transport connectivity.

Collaboration between Ireland and Cyprus on a Maritime Centre of Excellence

The IMDO is a partner in the EU funded project on "Marine and Maritime Research, Innovation, Technology Centre of Excellence (MARiTeC-X)". The European Union's support is aimed at establishing a Centre of Excellence in Cyprus that fosters world-class research, technology development, and innovation activities related to the marine and maritime sector. Dr. Paul Brewster, European Policy Adviser of the Irish Maritime Development Office, attended the inaugural meeting of the Cyprus Foundation of the Sea (CY-FOS), with representatives from industry and academia across the marine sector in Cyprus, and presented some key points of the work carried out within the framework of Ireland's Integrated Marine Plan *Harnessing Our Ocean Wealth*.

The IMDO, the MARiTeC-X partners and the Shipping Deputy Minister in Cyprus, Natasa Pilides, met with President Michael D Higgins at Larnaca Fort during the state visit to Cyprus in October.

Motorways of the Sea

In November 2019, the IMDO attended the Motorways of the Sea seminar on "Financing the maritime sector and MoS", which was organised by the European Coordinators for Motorways of the Sea and the Atlantic Corridor and hosted in Rome by the Italian Ministry of Infrastructures.

Prof Kurt Bodewig and Prof Carlo Secchi presented their report on "Enabling the uptake of the TEN-T project pipeline by the financial market" and stakeholders from across the EU's maritime sector exchanged views on presentations on the wide spectre of funding and financial instruments suitable for the maritime sector.

6th Atlantic Stakeholder Platform Conference, Porto, 12-13 Nov 19

The IMDO participated in a workshop that addressed the topics of "New action plan for the Atlantic and the role of ports" and "network of ports developing an Atlantic Port accelerator"

Motorways of the Sea Forum, Brussels, 21-22 Nov 2019

The IMDO attended the MoS forum along with DTTAS., at which, Prof. Kurt Bodewig, European Coordinator, presented the draft Detailed Implementation Plan (DIP) 2019 and the results of its underlying MoS study. Round table discussion with representatives from all member states focused on the maritime dimension in the new TEN-T guidelines.

Waterborne Industrial Research Advisory Groups meetings, Brussels, 21-23 May and 21-23 Oct 2019

The Waterborne TP is preparing the Technical Research Agenda for the European Waterborne Sector. The IMDO participated in the IRAG group working on the development of the Technical Research Agenda, which covered Ship and Shipping, Blue Growth, Ports and Logistics

Short Sea Shipping Days Conference, Athens, 10-11 June 2019

The IMDO attended the conference, which included a meeting of the European Shortsea Network (ESN).

Research & Innovation Days conference, Brussels, 24-25 Sept 2019

European Research and Innovation Days is the European Commission's annual flagship event, bringing together policymakers, researchers, entrepreneurs and citizens to debate and shape the future of research and innovation in Europe and beyond.

Docks the Future project meetings, Trieste, Italy, 2-4 April 2019

This is an important EU project which seeks to future-proof the development of European ports that links directly into national ambitions to make Irish ports among the most efficient and competitive in the world. The project also aligns with the Fast Trade Lanes Initiative, for which IMDO is seeking EU Motorways of the Sea Funding, and IMDO research into the socio economics of port development and port sustainability.

The national events in question included:

Be Prepared for Brexit Event in Dublin

In preparation for Brexit, the Department of Transport Tourism and Sport (DTTAS), supported by the Irish Maritime Development Office (IMDO), held a workshop in Dublin in September 2019. The aim of the workshop was to allow shipping and port companies, importers and exporters to discuss maritime connectivity, trade patterns and capacity demands in a no-deal Brexit scenario. The workshop took place in Dublin on 4th September in order to create further opportunities for a dialogue between importers, exporters, ports, and shipping and logistics companies.

The workshop was a hugely successful event attended by key people from a number of different industries including the ports, shipping companies, the food and drink industry, the haulage industry, the transport and distribution sectors, and relevant Government Departments. The dialogue on the day was very constructive and everyone who attended was given the opportunity to clearly express their views.

The main issue highlighted on the day is the pressing need for a dialogue to begin between the importers and exports and the shipping companies to establish the demand post-Brexit.

IWEA Offshore Wind Ports Workshop, Athlone, 25 October

The IMDO participated in this workshop along with representatives from Enterprise Ireland, DCCAE, DHPLG, Port of Waterford, Rosslare Europort, Shannon Foynes Port Company, Galway Port, the Carbon Trust and SSE. The IMDO gave a presentation on the IPORES study and EU funding opportunities for ports. The key recommendation from the IMDO was that commercial discussions between wind developers and ports should be encouraged.

Directors Training meeting at Port of Waterford, 2 May 2019

The IMDO gave a presentation on the IPORES study and EU funding, followed by Q&A with the Directors.

Deloitte Marine Blockchain Workshop on 7 Feb

The IMDO and Deloitte organised a workshop on Blockchain attended by Irish ports, DTTAS, Revenue and stakeholders from the transport sector.

Irish Exporters Association Multimodal Group meetings throughout the year

The IMDO participates fully in this important network, which brings interested parties together from the exporting community, transport and logistics sectors, ports and shipping industry, and relevant Government Departments. The Group meets quarterly.

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

Ocean Energy & Infrastructures

The ocean energy test site and the SmartBay cabled observatory hosted a number of projects from Irish researchers and companies supporting the advancement of their technologies along the Technology Readiness Level pathway towards commercialisation.

Dundalk Institute of Technology (DkIT) used the test site to carry out assessments on their Wave Activated Sensor Power (WASP) buoy whose purpose is to measure sea state, vital data when assessing the viability of locations for wave energy farms and to design effective coastal protection measures. A second phase of testing is planned for 2020.

CASE STUDY

Danalto, a Dublin based company, used the test site to trial its prototype LoRa2.4 geo-location device and services in the marine environment. This technology was first designed for terrestrial applications, specifically for the mining and large open campus' in manufacturing and asset management.

The LoRa2.4 technology has now been adapted to go offshore and delivers meter level geolocation and navigational accuracies, for a range of asset and safety critical applications. Speaking of the trials at the test site, David McDonald, CEO of Danalto said:

"The SmartBay test site provides the ideal setting, expertise and test infrastructure for Danalto to test one of our cutting edge massive IoT geolocation services operating in the 2.4GHz unlicensed band. The team in Galway worked closely with us throughout to ensure that we gained maximum value from the testing and gained the necessary insights to assess the potential of our CardinalTM platform and 2,4GHz geo location technology for maritime applications. It has been a great experience - weather and all!"

The DkIT and Danalto projects were two of seven projects awarded under the 2018/2019 National Infrastructure Access Programme funding call. The National Infrastructure Access Programme is funded by the Marine Institute under the Marine Research Programme with the support of the Irish Government.

A Galway based company, Wood, trialled and validated their FlexcomTM Renewables Software at the test site in 2019 to prove the accuracy and value of the technology, as well as demonstrating why it could be adopted within the greater marine renewable energy market. Further validation and acceptance of Flexcom will also support ocean energy device developers to leverage the technology for their own needs so as to optimise their designs and to prove the viability of their concepts to investors, thereby aiding general growth in the marine energy market.

Zunibal, a Spanish company, completed the testing of their directional wave buoy called Anteia used to monitor waves at the test site. This aim of the project was to validate the company's prototype technology against the permanently deployed waverider buoy infrastructure at the test site. Another Spanish company, SmalleTec, successfully trialled and validated its eForcis design at the test site in 2019.

POLICY, INNOVATION AND RESEARCH SUPPORT SERVICES (PIRS)

PIRS continued to fund and work with the Socio-Economic Marine Research Unit (SEMRU) in NUI Galway and colleagues in the IMDO on the ongoing collection and analysis of economic data aimed at valuing Ireland's ocean economy. SEMRU research provides the Marine Institute and policy makers with trends across 13 marine sectors.

The *Ireland's Ocean Economy Report 2019*, published in June, indicates that in 2018, the direct economic value of Ireland's ocean economy was an estimated €2.23 billion or approximately 1.16% of gross domestic product (GDP), which represents an estimated 11% increase on 2016 figures. The report also includes a socio-demographic profile of Ireland's coastal economy and presents the values of a range of marine ecosystem services to Irish society.

PIRS also worked with SEMRU on another research project titled 'Ireland's ocean economy – A regional and rural analysis of Ireland's ocean and coastal economies', which commenced in 2018 and is funded under the Marine Institute Cullen Fellowship Awards. Outputs of the research were incorporated into the 2019 Ocean Economy report published in June.

In 2019, SEMRU also published *A Survey of Marine and Coastal Overseas Tourism Activity in Ireland*, which was carried out with the support of the Marine Institute and was funded under the Institute-funded award – 'Valuing and understanding the dynamics of Ireland's Ocean Economy'.

PIRS liaised with SEMRU to host the 10th Annual Marine Economics and Policy Research Symposium in the Marine Institute, Oranmore, Co Galway, in November. The two day event provided attendees with an update on a wide range of policy topics related to the marine sector in Ireland and further afield. The symposium showcased research from a number of European projects such as ATLAS, MOSES, MERCES, SOPHIE and ALICE and had a host of invited speakers that have been linked to the activity of SEMRU over the last decade.

Irish Marine Industry Network

The Irish Marine Industry Network (IMIN) was established by industry stakeholders, with the support of Enterprise Ireland and the Marine Institute. IMIN brings together many elements of the marine sector in Ireland - from engineering to services, offshore renewables to smart ports and research to public agencies. The network has gone from strength over the past two years and in 2019, it enjoyed an event at the 2019 Our Ocean Wealth Summit and trade show under the banner of Marine Ireland. A new IMIN website carrying the Marine Ireland – Ireland's Blue Edge branding is under development. The website will showcase the network's innovative and diverse marine industry capabilities.

Former US Secretary of State, John Kerry, giving the keynote speech at Our Ocean Wealth Summit 2019. Photo: Claire Keogh

STRATEGIC ENABLER **1**

OUR PEOPLE

OUR PEOPLE

The Marine Institute is committed to supporting a culture of high performance, driven by our people, whose skills, experience and passion for the marine are central to the work we perform for government and other stakeholders.

The Strategic Enabler, Our People, has three strategic initiatives – ensuring agility, diversity and flexibility, cultivating the Institute as a great place to work and, building and retaining the capabilities of our staff.

Our people are central to all of the service areas and strategic focus areas outlined in this Annual Report but a number of core sections key to the Strategic Enabler are outlined below. Human Resources, Finance and Corporate Governance, Communications and Library Services are all part of Corporate Services at the Marine Institute.

HUMAN RESOURCES

The Marine Institute's Human Resource focus in 2019 aligned with our Strategic Plan 2018 to 2022; embracing our values of Commitment, Integrity, Excellence, Innovation, Collaboration and Respect. Our annual programme supported Our People as a Strategic Enabler to the success of our organisation. We seek to enable people to be successful in a culture of high performance; driven by individuals and teams whose skills, experience and passion for the marine remain central to the work that we perform.

Our People focused strategic initiatives for 2019 were ensuring agility, diversity and flexibility; cultivating the Institute as a great place to work and; building and retaining the capabilities of our staff.

46 opportunities were recruited during 2019 across a number of vacancies linked with the replacement of resignations, temporary redeployment, career break and maternity leave cover; as well as a number of EU and alternately-funded temporary project roles. The roles were in administrative, management, scientific and technical disciplines including the role of CEO. Of the 46 roles, 24 were allocated to internal candidates and 22 to external candidates; whilst 15 were filled by males and 31 by females.

So as to build and retain capabilities, we aimed to increase our investment in ongoing professional development and upskilling of our staff in 2019. Reflecting this, the Marine Institute invested €775,916 in Learning and Development related activities to build capacity, develop essential skills, to promote STEM careers at second level and undergraduate level, as well as supporting third level research and postgraduate training. There was an increase of €28,292 in direct staff training investment from 2018-2019. The focus for Learning and Development in 2019 included building leadership capability through leadership, management, innovation and change programmes. Project delivery, technical training to bolster existing application development and analytical capabilities, as well as extensive Health and Safety training to better equip sea based, port based and land based staff with necessary health and safety knowledge were also a focus.

The Marine Institute was listed as one of Ireland's best Medium Workplaces in 2019, under the Great Place to Work programme. Our internal Great Place to Work Champions continued to build on their successful initiatives relating to Trust, Staff Engagement, Communications, Career & Personal Development and Sports & Social activities.

In August 2019, we retained our Gold Standard Excellence Through People Certification NSAI (National Standards Authority of Ireland) Standard ETP 1000:2017. As part of this, we had an independent assessor visit all of our locations to ensure that the standard was being applied across the Marine Institute to the benefit of all of Our People.

The Marine Institute welcomed 22 transition year students to our fifth annual TY Training week (25th February – 1st March 2019) at the Marine Institute's headquarters in Galway. Students from counties Galway, Mayo, Clare, Roscommon, Dublin and Waterford engaged in a range of activities to experience what it is like to work in the marine sector.

They shadowed scientists and staff at the Marine Institute, learning about marine science, technology and related disciplines; engaging in a range of presentations and interactive activities related to fisheries science, marine chemistry, seabed mapping, food safety, research vessel operations, shipping and maritime development, oceanography and marine climate, data, applications development, teambuilding and communications with poster presentations.

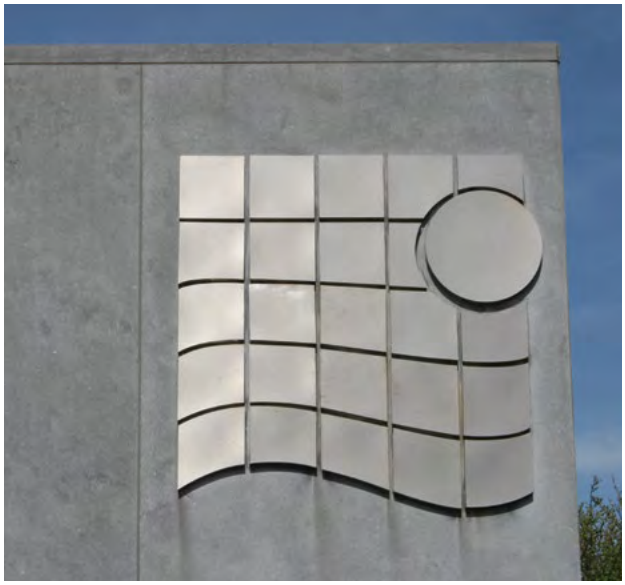
The Marine Institute Health & Safety (H&S) Committee representing all locations and programmes held seven meetings in 2019 issuing nine H&S reports to the CEO and Board. There were 19 annual Risk Assessments completed across all locations. In addition to ensuring implementation of all of our Safety Procedures and Standards; some of our H&S related projects included a review of sea going activities, training and personal protective equipment; implementing a bespoke Laboratory Safety Training Workshop; consideration of a Text Alert System for use in emergencies; delivery of three Health, Safety & Wellbeing week long promotions – with a continued focus on mental health and building resilience.

Internally, we logged three minor accidents and incidents and sixteen near misses in 2019, continuing our promotion of safety awareness and the importance of safe working environments. Safety related training included Laboratory Safety, Induction and Safety Awareness, Sea Going Training, First Aid Response, Supporting Mental Health and Resilience, Port Safety and Risk Assessment.

FINANCE AND CORPORATE GOVERNANCE

The Marine Institute operates to best practice corporate governance principles in line with the 2016 Code of Practice for the Governance of State Bodies. The Marine Institute has in place a range of procedures, policies and guidelines to ensure compliance with the Code and it is the policy and practice of the Marine Institute to support the development and strengthening of an effective control environment, risk management system and internal audit function.

An Audit and Risk Committee, a sub-committee of the Board, is in place to oversee and advise the Board on matters relating to financial, operating and governance risks, including overall risk management and the effectiveness of the internal controls and risk management within the Marine Institute. In line with the internal audit programme, the Internal Audit and Risk Committee met 10 times in 2019 including two meetings with the Comptroller and Auditor General.



The three year rolling internal audit plan considers the risks identified in the Marine Institute Risk Register, requirements of the Code of Practice for the Governance of State Bodies, the recommendations of the Comptroller and Auditor General and the views of the Audit and Risk Committee. The System of Internal Control is reviewed on an annual basis by the outsourced internal auditors. Internal audits included an internal financial controls audit, audits of the procurement process associated with the acquisition of a new research vessel, a Code of Practice audit and an audit of contractor charges. All internal audit recommendations arising were actioned and reported to the Audit and Risk Committee.

The Marine Institute has an appropriate public procurement process which is compliant with the current value thresholds for the application of EU and national rules. Centralised purchasing and the use of the Office of Government Procurement has proved to be an efficient and effective means of reducing costs and generating savings and will continue into 2020.

It is Marine Institute policy to ensure that all invoices are paid promptly within the terms of the Prompt Payment of Accounts Act, 1997 and the European Communities (Late Payment in Commercial Transactions) Regulations 2012. Systems and procedures are in place enabling invoices to be tracked and to ensure that payments are made in a timely and efficient manner. Procedures are also in place to ensure that late interest is paid, if required.

In line with Risk Management and Business Continuity Policies (BCP), the Board and its Audit and Risk Committee, with the Executive and Risk Officers, reviewed and signed off on the appropriate policies and processes in 2019. The Risk Register and Risk and BCP reports were reviewed quarterly throughout 2019. Nine business critical processes had their continuity plans reviewed or tested in 2019.

COMMUNICATIONS

Our Communications team is responsible for all of the Marine Institute's official communications including media relations, online communications, marketing, engagement and education, events, management of Marine Institute Sea Science Galleries and library services. Education and engagement with all of our stakeholders was a focus for us in 2019 as we continue to implement our strategy with the ambition of increasing awareness, participation and strengthening our communications across all platforms.

Education and engagement programmes that the Communications team were involved in or led during 2019 included Our Ocean Wealth Summit, SeaFest, Explorers Education Programme, open days and science and technology events. More details on these activities, along with media, public relations and digital communications, can be found in Strategic Enabler 4 – Engagement and Education.

The Communications team worked with colleagues in the Marine Institute to highlight news, research areas and events both internally and externally during 2019. Amongst these activities, included a Faces of the Sea campaign which showcased a wide range of people who have a connection with the ocean. The campaign profiled 12 staff members, highlighting their career experience and work at the Marine Institute, and 52 'Faces of the Sea' were shared on social media channels.

LIBRARY SERVICES

The Oceanus Library supports staff in their research, by providing access to publications and increasing their research impact through Open Access and promotion.

In 2019, the Marine Institute established a new dual role entitled Library Services and GDPR Executive. This position was filled, with the Librarian now supporting staff in library, as well as dealing with personal data protection matters.

The librarian works in a cross functional role, collaborating with all departments enabling our strategic plan:

- With the communications team to promote the research output of the Marine Institute and host 'Maximising your Research', a regular lunchtime information series for staff
- With the Data Protection Officer (DPO), the Librarian coordinates and provides training on GDPR, and is a key point of contact for personal data protection matters
- The Librarian works with the data privacy team to establish, update and amend policies and procedures surrounding data protection. The team consists of data coordinators from all departments, Risk Officers, the DPO, and members of data management and IT
- With our scientists and staff to provide them with all their library information needs including; articles, books, periodicals, training on reference management, publication, promotion and research impact
- With Fisheries Ecosystems Advisory Services (FEAS) in a team effort to digitise and catalogue a special resource for the fisheries team, through the hiring and training of two bursar students
- In another project with FEAS, the library is digitising and making available our country's most valuable historical archive collection of fisheries resources dating from 1894: Report of the Inspectors of Irish Fisheries, and Sea and Inland Fisheries Scientific Investigations
- With Policy, Innovation and Research Support Services (PIRS), to support our staff in their research, as well as delivering results on the measure and performance of that research

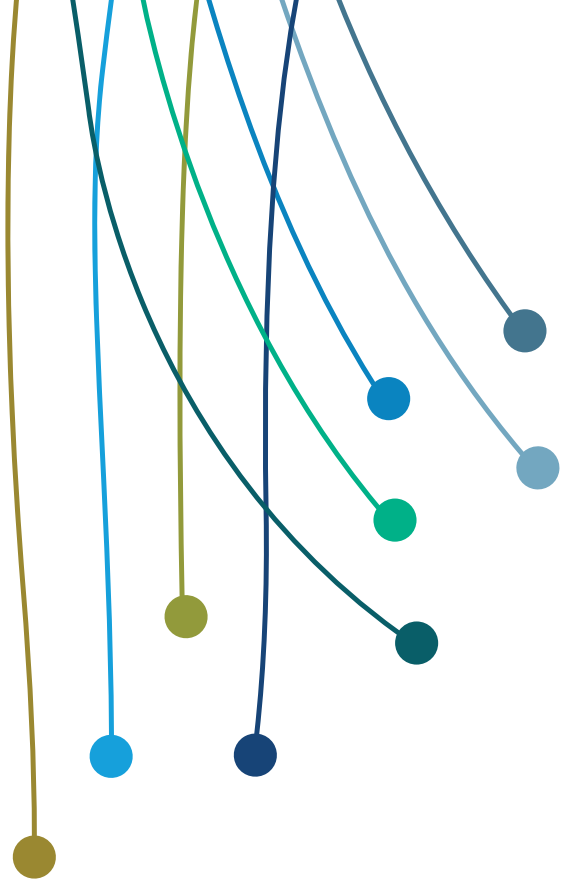
The library also supports queries and visits from interested external researchers as well as training staff on self-archiving on our Open Access Repository (**http://oar.marine.ie/**). The Open Access Repository provides free online access to over a thousand Marine Institute publications and had 14,430 visitors from every continent in 2019. The library is a member of the National Open Research Forum board whose mandate is to deliver an Irish agenda for open research.

The library continues to maintain close relationships with key organisations and collaborates with external libraries when opportunity arises. During 2019, the Librarian represented the Marine Institute at the 45th annual International Association of Aquatic and Marine Science Libraries and Information Centers and attended key conferences on data protection.

See Appendices 4 & 5 for information on Marine Institute Publications and Scientific Papers and Publications in 2019.

STRATEGIC ENABLER **2**

INFRASTRUCTURE



INFRASTRUCTURE

The Marine Institute operates national infrastructures that provide essential platforms for its government services, national and international research and early technology development. These national assets include nine Marine Institute facilities nationwide that accommodate staff and laboratory facilities, including the Institute's headquarters in Oranmore, Co Galway, and a research facility in Newport, Co Mayo.

Other infrastructure includes: two multi-purpose research vessels (RV *Celtic Voyager* and RV *Celtic Explorer*), a deep water Remotely Operated Vehicle (ROV), IT infrastructure and data, mobile and fixed oceanographic equipment as well as test and demonstration platforms such as the Galway Bay Observatory.

The Institute also provides technical services and equipment to other national infrastructure operators, which includes supporting ocean energy test sites, the Irish Marine Data Buoy Observation Network (IMDBON), as well as coastal protection and flood risk management programmes.

All public bodies are monitored and tracked to achieve a 33 per cent reduction in energy usage by 2020 (from 2009) in line with Ireland's third National Energy Efficiency Action Plan (NEEAP 3). 18 energy goals continue to be targeted through the Institute's Energy Reduction Strategy and Policy 2016-2020, focusing on the operation of the National RV fleet, laboratories, Office/IT equipment and facilities. See the General Administration section for further details on energy efficiency.

FACILITIES

The Facilities team's outputs and deliverables are strongly linked to the Infrastructure Strategic Enabler, in that our goal is to optimise and invest in infrastructure that is energy efficient, enhances our integrated advice and service delivery, and enables blue growth.

From a Facilities perspective, behavioural change is also key to the success of the programmes, policies and initiatives we are involved in. Modifications to existing plant and equipment, the use of innovative mechanisms and advanced energy efficiency and renewable products, will assist the delivery of measurable savings and the achievement of targets relating to energy reduction and sustainable practices.

The Facilities team's main deliverable is to enable our staff, contractors and partners to carry out their research in a safe, efficient, well maintained environment throughout all Marine Institute sites. The services we provide include Reception, Stores, Maintenance (general and specialist), Procurement and Energy Management, along with the management of cleaning, catering, grounds maintenance and security service contracts. The operational budget and contract management for all sites is with the Facilities remit and is reviewed on an ongoing basis.

One of the core responsibilities in 2019 was the relocation of the Marine Institute Dublin office from Wilton Park House to Three Park Place. This involved the procurement and

management of the project team to undertake the design and construction of the new office space within budget and on time. This culminated in the physical move into the new state of the art building in mid-October, alongside IDA Ireland, Sustainable Energy Authority of Ireland (SEAI) and Science Foundation Ireland (SFI).

Procurement advice and training are another key element of the team's work. Two members of the team are instrumental to the administration and management of the process throughout the organisation. 56 tenders were advertised in 2019.

Energy reduction and chairing the Get Greener team are also within the remit of Facilities. The Get Greener team continue to grow and engage with staff to promote efficiency in energy usage and encourage more sustainable operating practices in all areas of the Institute. The 2019-2020 Resource Efficiency Action Plan was submitted to the Department of Agriculture, Food and the Marine, which outlines the achievements and goals of the Get Greener programme. Further details on this are provided in the General Administration: Energy Efficiency Reporting section.

MARINE OPERATIONS (RESEARCH VESSELS)

2019 highlights included:

- The successful integration and trials of University of Limerick's new ROV *Étaín*, which is a key piece of national research infrastructure funded by Science Foundation Ireland, onto RV *Celtic Explorer*
- The successful long term deployment of ROV-adapted lander systems to investigate coral reef systems was undertaken using ROV *Holland 1* for the first time
- Five internationally renowned artists embarked onboard the RV *Celtic Explorer* as part of the Galway 2020/Marine Institute art-science collaboration, Aerial/Sparks
- Overall, between the two vessels, there were 598 science days. In addition, the ROV *Holland 1* completed 54 days offshore, over three research surveys

RV *Celtic Explorer*

The first survey of 2019 was a hugely successful ROV trials period, led by researchers from the University of Limerick (UL). Dr Gerard Dooley and his team started the ROV *Étaín* integration in December 2018, ahead of the Christmas break. The integration involved the set up of specialist laser imaging, 3D sonar, high definition video, precision subsea navigation and the manipulator arms. Following on from the integration, the team successfully completed offshore trials from the 4th – 14th January 2019. The field trials took place at sea mounds, unidentified wrecks, gas pipeline sites and wellhead infrastructure.

After finishing up the trials period in Cork the vessel sailed for Hamburg to carry out the BSH (Federal Maritime and Hydrographic Agency) oceanographic and environmental survey in the Baltic and North Sea. The crew of the RV *Celtic Explorer* are well used to working with BSH science teams as the vessel has been chartered for at least one annual survey since 2009. The scientific survey included CTD (Conductivity, Temperature, Depth) casts along a pre-determined track.

The vessel returned to Galway from Kiel in order to carry out the mackerel egg survey led by Marine Institute fisheries scientist, Brendan O'Hea. The mackerel egg survey occurs every three years and forms part of a series of mackerel and horse mackerel surveys which are coordinated by the International Council for the Exploration of the Seas (ICES).

The series of surveys stretches from the Faroe Islands, down the north eastern Atlantic to Gibraltar, taking place between January and July. The Marine Institute February survey carried out sampling at stations to the west of Scotland, west of Ireland, the Celtic Sea and the Bay of Biscay.

Fisheries surveys continued into March and April with the annual 'Irish Anglerfish and Megrim Survey' (IAMS) being carried out over two legs. The IAMS survey collects biomass and abundance data for anglerfish (*Lophius piscatorius* and *L. budegassa*) and megrim (*Lepidorhombus whiffiagonis* and *L. boscii*) in areas 6a (south of 58°N) and 7 (west of 8°W). The two legs were not consecutive in the RV *Celtic Explorer*'s survey with a three week 'Blue whiting acoustic survey' being carried out in between. The pelagic acoustic survey tracked 2,800 nautical miles and carried out 28 CTDs.

The first ROV survey of 2019 took place in late April into mid-May, and was carried out by a team of scientists from Ulster University. The 'Backscatter and Biodiversity on Shelf Sea Habitats (BaBioSSH)', survey, led by Dr Christopher McGonigle, used emerging and novel methods to gather biological and geophysical data in six priority marine ecosystems to the north and north east of Ireland. The data generated will be used to enhance the level of knowledge

on species diversity within the targeted marine protected areas. One method used was the deployment of baited remote underwater cameras (BRUVs) to gather data on the scavenger communities. In addition, the ULS-500 Pro underwater laser scanner was attached to the ROV *Holland 1* to carry out fine scale habitat mapping within the area.

The following survey was also a ROV survey, which was broken up into two legs, one taking place for 11 days in May and the other for seven days at the end of July. Led by Dr Aaron Lim, the key objective of the 'MOnitoring CHAnge in Submarine CANyon Coral Habitats (MoCha_SCan)' survey was the deployment of eight novel, ROV-adapted, lander systems which would operate as sediment traps in the Porcupine Bank Canyon (PBC) coral habitats (coral reefs, mounds and gardens).

In addition to gathering data on the sediment type, the other survey objectives included using the ROV to collect particulate organic matter (POM) and water samples around each lander site. The eight landers were successfully deployed on the May leg within a range of coral habitats throughout the PBC. The ROV collected HD video footage and carried out bio-sampling with the manipulator arm in order to characterise key coral habitats within the canyon. The eight landers were successfully retrieved at the end of July on the second leg of the MoCha_SCan survey.

The annual Rockall oceanography survey, led by Marine Institute scientist, Dr Caroline Cusack, took place in May/June 2019. The Rockall survey usually takes place in January or February, however, having the survey later in 2019 was a welcome change as the team of oceanographers and chemists experienced some turbulent years in terms of weather conditions encountered in previous years. The 14-day Rockall survey involved a collaboration between Institute scientists and NUI Galway (NUIG) scientists. It was a very successful survey with the collection of 55 CTDs, the deployment of two argo floats and four surface drifters and the completion of a glider mission, with a dive depth of up to 1,000 metres. The M6 weather buoy was successfully swapped out also.

Dr Rachel Cave, NUIG, was the principal investigator onboard for the VOCAB project which is carrying out research into ocean acidification. Hyperspectral radiometers recorded light and bio-optical data in both air and water also as part of the VOCAB project. The Rockall survey finished up in Cork and there was a change from survey operations for SeaFest activities. It was another hugely successful event with 7,400 visitors taking part in the vessel tour over the three open days for its first year in Cork city.

In order to carry out maintenance on the sub bottom profiler (SBP), the vessel sailed from Cork to Falmouth for a three-day dry dock period, before the commencement of the annual Western European Shelf Pelagic Acoustic Survey (WESPAS), led by Institute scientists. The objective of the survey is the use of acoustic techniques to gather stock assessment data on herring, boarfish and horse mackerel over a six-week period in the Celtic Sea. WESPAS was a hugely successful survey with over 6,500 nautical miles of fisheries echosonar track covered from the Celtic Sea up to North of the Hebrides. The science team also carried out 45 fishing tows, 87 CTDs and several plankton tows.

Following on from the University College Cork (UCC) lander retrieval expedition was the third instalment of the SeaRover expedition, the extensive offshore reef survey of Ireland's northwest continental margin. The programme was commissioned in 2017 by National Parks and Wildlife Service (NPWS) and funded by the European Maritime and Fisheries Fund (EMFF). The survey was coordinated by Marine Institute scientist, David O'Sullivan, and the team included scientists from the Marine Institute, NUIG and Plymouth University.

The survey was a huge success with 52 ROV dives, capturing HD footage of the reef ecosystem within the Goban Spur, around the edges of the Porcupine Seabight and within the Whittard Canyon. In addition, biological samples (primarily sponges) and push cores were taken at several locations to gather a more in-depth picture of the reef ecosystems. Once the 'SeaRover3' survey completed its operations, the vessel sailed back to Galway for the demobilisation of ROV *Holland 1* and prepared for the passage to German waters to complete its second and final BSH survey of 2019. A team of scientists from BSH spent 23 days onboard the RV *Celtic Explorer*, carrying out oceanographic operations in the North Sea.

The RV *Celtic Explorer* then sailed to Cork for the INFOMAR deepwater seabed mapping survey, which carried out operations in the Celtic Sea. Weather downtime and strong winds did impact survey operations quite heavily during this survey. However, the team of hydrographers did capture c. 1,360km^2 of multibeam echosounder data.

Operations in the final few months of 2019 reverted to fisheries with the delivery of the annual Marine Institute Celtic Sea Herring Acoustic survey in October. The survey covered 3,700 nautical miles and carried out 21 trawls. Ancillary operations included 39 CTD casts and 32 sediments grabs, making it a hugely multidisciplinary survey.

The final fisheries expedition was the annual Irish Groundfish Survey (IGFS) with the four survey legs running consecutively from the end of October to mid-December. The year ended in Galway Port with a long maintenance period from mid-December through to mid-January 2020.

RV *Celtic Voyager*

Similar to previous years, the RV *Celtic Voyager* schedule commenced with the annual 'Winter Environment survey' with benthic and oceanographic operations being carried out on the northabout route. Following on from the environmental survey was an offshore, 24-hour operations, student training survey, led by Dr Joanne O'Brien, Galway-Mayo Institute of Technology (GMIT). The training survey had students from the new MSc Conservation Behaviour course and the aim of the survey was for the team to undertake marine mammal observations along a predetermined track from Cork to Galway.

The team examined cetacean behaviour, distribution and abundances using visual and acoustic techniques. In addition, the students collected CTD data and carried out plankton tows in order to get a picture of the ecology around the sightings. Unfortunately, weather conditions did hamper the original track and survey plan and subsequently the team had to modify and adapt to the rough conditions encountered, along with some downtime alongside in Cork. The team had two days of visual surveying and carried out passive acoustic monitoring (PAM) at night, when possible. The oceanographic and plankton tow elements of the student training were carried out at night also.

The next survey subject matter was the hugely topical issue over the last few years – microplastics. 'IMP.act.sea1 – Assessment of microplastic hotspots in Galway Bay' was led by Dr Joao Frias from GMIT. The aim of this survey was to continue identifying and mapping microplastic hotspots within Galway Bay and its environs, to fill some gaps from a previous sampling survey which was also led by Dr Joao Frias, onboard the RV *Celtic Voyager* in 2017. The 2019 survey was multidisciplinary and operations included CTDs, beam trawls, manta net trawls and sediment sampling using the day grab and box corer. Although rough weather conditions were encountered throughout the five-day survey the chief scientist collected sufficient data to fill in the gaps to assess microplastic pollution in Galway Bay and its environs.

The vessel had a week long maintenance period and then passaged back to Cork for National Maritime College of Ireland (NMCI) student training and SMART Sea school student training, with students taking part from NUIG, and the Marine and Renewable Energy Ireland (MaREI) centre, NUI Cork. Once the training was finished, the vessel sailed back to Galway to continue with student training for GMIT undergraduates. The final student training survey of the spring season took place early-mid April, with John Boyd, head of the SMART sea school programme, carrying out a four day 'Science@Sea' programme with participants from a mix of careers/disciplines.

Within the spring student training period, there were also two new research surveys and two first time chief scientists onboard the RV *Celtic Voyager*. The first survey was 'IMMErSE – Irish Marine Mammals Ecosystem Based SurvEys', led by PhD candidate Cynthia Barile, GMIT. The key objective of the survey was to address a gap in knowledge on the distribution of deep diving species (e.g. beaked whales, sperm whales and pilot whales), in offshore Irish waters. The primary survey's methods would include visual observations in conjunction with passive acoustic monitoring (PAM) operations. Once again, weather did impact on survey tasks for the GMIT science team and of the seven days of ship-time allocated only three days of visual and acoustic surveying was carried out. Ancillary operations included CTD deployments when possible and seabird surveying.

The next survey was geological in nature with Siobhán Burke, UCC PhD candidate, carrying out multibeam data acquisition activities in Clew Bay, Co. Mayo. The 'Quantifying Irish Marine Placer Resources II (QuIMPeR II)' survey involved the mapping of a series of areas in Clew Bay with the RV *Celtic Voyager's* EM2040 multibeam echosounder. The objective was to gather detailed backscatter and bathymetry maps, in conjunction with sediment sampling, in the specified areas in order to locate, delineate and sample heavy mineral sands offshore. The survey provided data to the SFI-funded iCRAG (Irish Centre for Research in Applied Geosciences) project FLIPeR (Formation of Littoral and Offshore Irish Placer Resources).

Once the QuIMPeR II survey finished in Galway Bay, the vessel was mobilised for the underwater TV (UWTV) trials which took place in Galway Bay, in order to ensure the new Cathyx high-definition camera system would be ready for the busy UWTV season ahead. The first INFOMAR leg of the season took place in the Celtic Sea before the vessel set sail for the Ifremer UWTV Nephrops norvegicus burrow counting survey.

After 14 days carrying out UWTV tows in the Bay of Biscay, the vessel returned to Cork to mobilise the hydrographers for the second INFOMAR survey of the season. There were four INFOMAR surveys in total on the RV *Celtic Voyager* in 2019. Weather conditions did hamper the operational activity on three out of the four surveys. However, the experienced team of hydrographers did manage to achieve their overall 2019 multibeam mapping coverage objective.

Each year, the RV *Celtic Voyager* carries out three dedicated Marine Institute *Nephrops* UWTV surveys, at targeted sites in the Aran and Porcupine grounds, Slyne head and the Celtic Sea (functional units 17, 19, 22 & 2021). The approach has been that the Aran-Porcupin e grounds are completed on the first survey, followed by the Celtic Sea stations on legs two and three. Weather did impact on the sequence of

surveying, with the vessel carrying out the vast majority of stations in the Celtic Sea on the first and second leg, followed by the completion of the Porcupine grounds on the third leg.

The Cathx HD camera was used on each survey leg and when required, the team reverted to the original composite camera system. A number of stations were selected for a comparative study between the video and images collected using the original composite camera system and the new Cathx HD camera system.

A new survey took place on the vessel on the 21st June, 'Ocean Sampling Day', which was led by Professor Louise Allcock. Ocean Sampling Day is a simultaneous sampling campaign of the biodiversity of the world's oceans using metagenomics. Institutions across Europe concentrated on the collection of marine microbial communities, the smallest fraction of the marine invertebrate community, on this particular date. The NUIG science team used the RV *Celtic Voyager* as a platform to collect water samples around the Galway Bay Observatory. The filtered water samples were sent to a lab in HMRC Greece for molecular analyses.

At the start of July, it was good to see Dr Robin Raine back on the vessel to continue on with his toxic phytoplankton research in the Celtic Sea. The scientists onboard the 'Dino19' survey carried out an investigation into the origins, distribution and the physical oceanographic control of the distribution of several species of toxic phytoplankton, but primarily targeting *Dinophysis*. The results will be used in the development of predictive models for describing patterns in population formations; essential information for the shellfish industry.

A novel research survey took place at the start of August, with Irish Whale and Dolphin Group (IWDG) scientist, Sean O'Callaghan, leading the team. The 'Marine Top Predators on the 100m contour' was a multidisciplinary survey which carried out CTD casts, passive acoustic monitoring lines, plankton tows, pelagic fishing and visual observations for marine mammals and seabirds. The team was investigating the biodiversity and oceanography along the 100m contour line between Cork and Galway. Some of the key sightings over the eight-day survey included fin whale, minke whale, bottlenose dolphin and the common dolphin.

Two new chief scientists embarked on geophysical surveys later in the year. The first was led by Dr Jared Peters, who had a team of scientists from his own department in UCC and MaREI, carrying out research at sites along the west and south west coast of Ireland. The 'De-risking Offshore Wind Energy Development Potential in Irish Waters (DOWindy)' research cruise was motivated by interest from offshore wind energy developers and the need for further investigations into the geology of selected sites for potential wind farm development. The 'DOWindy' team collected multibeam echosounder measurements of seabed bathymetry; sediment grabs for seabed surface geology; a core for characterising the deeper stratigraphy of the selected site and seismic sub-bottom profiles that reveal the composition of the bedrock layers.

A similar survey took place in late October, stretching into early November, by Dr Mark Coughlan, from iCRAG (Irish Research Centre for Applied Geosciences), in collaboration with scientists from Ulster University. The 'Geohazard Investigation in the Irish Sea using Seismic and Seabed Mapping Techniques (GIST)' survey involved the collection of seabed and sub-seabed data with the aim of producing integrated maps showing changes in marine sediments at selected sites, primarily surrounding shipwrecks. The team of scientists mapped six shipwreck sites using the multibeam echosounder, sub bottom profiler and acoustic doppler current profiler, in order to determine seabed changes due to hydrodynamic forces. Other activities included the collection of 390 kilometres of seismic lines, the collection of sediment cores and the deployment and subsequent recovery of passive acoustic monitoring devices.

Student training dominated activities in the latter part of the year with John Boyd, SMART Sea school coordinator, carrying out offshore training with students from NUIG, Maynooth University and UCC. The UCC Marine Biology Masters programme also chartered the RV *Celtic Voyager* for their annual two-day training programme. The last survey of the year was the Marine Institute led northwest herring pelagic fishing survey which ended in Killybegs to allow for the commencement of the refit period.

For more information on the research vessel programme 2019, see Appendix 6.

OCEAN ENERGY AND INFRASTRUCTURES

The team managed the test and demonstration facilities at the ocean energy test site in Galway Bay. The team also provided continued operational services at the AMETS wave energy test site in Belmullet, Co. Mayo, and the WestWave wave energy demonstration zone off Killard, Co. Clare, under a Service Level Agreement with the Sustainable Energy Authority of Ireland (SEAI). The Galway Bay ocean energy test site has hosted a number of projects in 2019 from both Irish and international researchers and companies including; Danalto, Wood, Dundalk Institute of Technology (DkIT), Zunibal and SmalleTec. Many more projects at various stages of readiness are in the pipeline for using the test site.

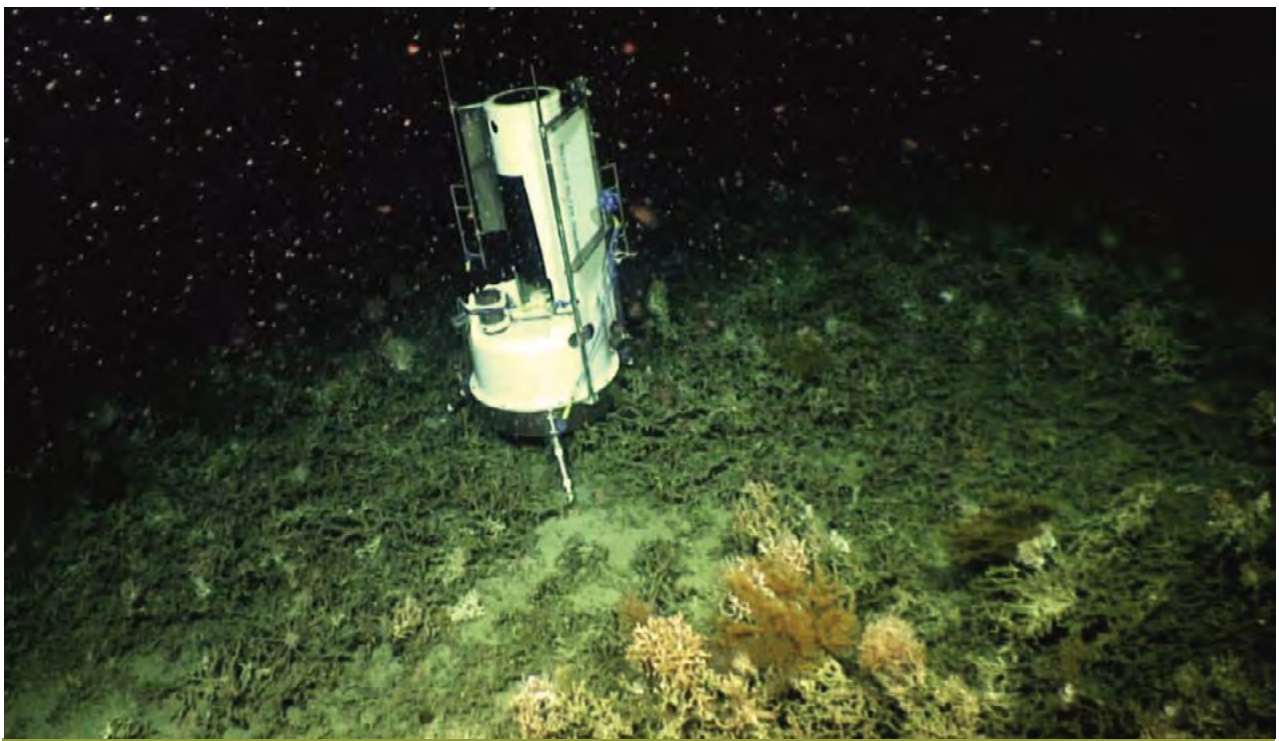
The SmartBay cabled observatory, located within the ocean energy test site in Galway Bay, includes fibre optic data and power connectivity allowing scientific experiments and novel marine sensors and equipment to be tested in a real marine environment with real-time monitoring of performance. The observatory is a regional node of the European Multidisciplinary Seafloor and water-column Observatory European Research Infrastructure Consortium (EMSO ERIC), a legal framework created for pan-European large-scale research infrastructures.

In 2019, seven successful applicants were awarded funding under the Marine Institute's SmartBay National Infrastructure Access Programme (NIAP) following the 2018/2019 funding call to connect to and access the SmartBay observatory, and analyse the many data feeds which are collected on site every day. Over the past seven years, more than 50 projects have been awarded funding, facilitating a wide range of multi-disciplinary marine research, development and innovation at this national facility.

Ireland is now an established member of the Euro-Argo ERIC and the participation of the Marine Institute, as Ireland's representative, allows Ireland to build national capacity in the ocean observation sphere and to leverage substantial opportunities in EU research and infrastructure funding mechanisms.

It also places Ireland at the centre of global efforts to measure the potential impacts of climate change. The Marine Institute's commitment is to deploy three Argo floats per year. Floats are procured via the Euro-Argo ERIC centralised tender which continues to provide significant value for money as well as time saving to member states. The Marine Institute deployed two floats in the North Atlantic from the RV *Celtic Explorer* in May 2019 and another float was deployed near the Equator from a vessel-of-opportunity in December 2019.

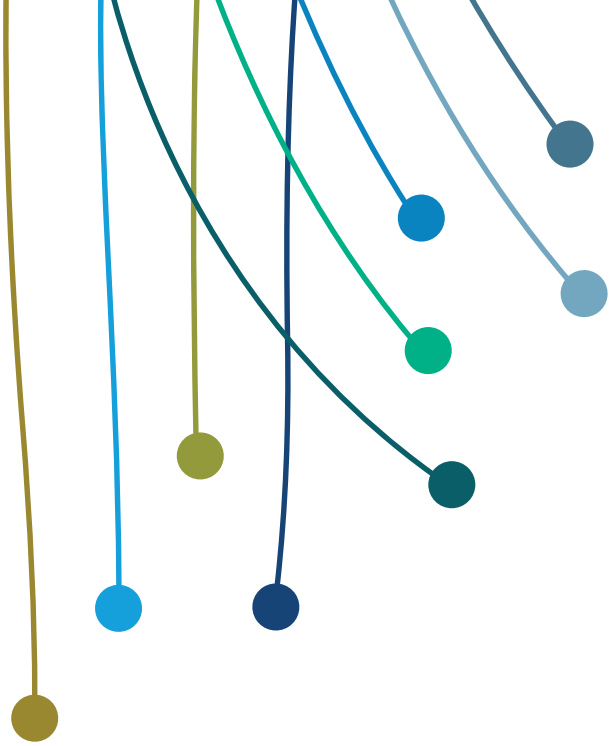
Following the award of significant SFI (Science Foundation Ireland) research infrastructure funding in late 2018 for the EirOOS ocean observing system, 2019 involved the procurement and delivery of the physical infrastructure; two new gliders for autonomous and adaptive observations of physical and biogeochemical parameters in the ocean, two new Global Sea Level Observing System (GLOSS) tide gauges to provide long-term, high quality, verifiable records of sea level contributing to global studies of sea level rise and climate change impacts, five new buoys for the upgrade of the IMDOBN (weather buoy network), four new shelf moorings and two new shelf edge moorings for monitoring the circulation southwest of Ireland to close a key gap in the international NOAC (North Atlantic Change) programme, along with the associated sensors and instruments for the above platforms.



UCC monitoring station deployed on degraded coral reefs in Porcupine Bank Canyon.
Photo: Aaron Lim, UCC

STRATEGIC ENABLER **3**

DATA AND IT



DATA AND IT

Digital technologies and data integration represent both challenges and opportunities that have a profound effect on innovation, competitiveness and scientific research. This is of huge relevance to the Marine Institute and its services as it generates a vast amount of data through data collection, monitoring and research programmes. Data is the foundation for the Institute's evolving integrated advice and services portfolio and how it supports integrated maritime policy at national, EU and international levels.

The Marine Institute develops and promotes open access to national datasets, data integration, online data and information services. This results in the optimal re-use and sharing of data. Open access to data also promotes research and innovation and stimulates new commercial products and services.

MARINE ENVIRONMENT AND FOOD SAFETY SERVICES (MEFSS)

MEFSS continues to progress data management and quality operations, and promote appropriate IT systems to support the efficient production of data and advice. Data stewards from each unit have actively participated in mapping data process flows in accordance with the Marine Institute-wide Data Management Quality Management Framework and have achieved accreditation through the International Oceanographic Data and Information Exchange (IOC - IODE). Other data and IT actions specific to unit operations have also been greatly progressed in 2019 in support of MEFSS Quality Management System and in view of providing improved customer satisfaction. Highlights of these actions are summarised below.

Data Requests

Much of the advice provided by MEFSS integrates current data with expert opinion and is provided as written advice through data requests and by accessing websites. The majority of our data is provided online and we continue to work with our Ocean Science and Information Services (OSIS) colleagues to develop public interfaces to our data.

To facilitate the rapid provision of data to the customer, our Marine Chemistry team continued to undertake a data project in 2019 with a focus towards automating field and laboratory data collection, quality checking, upload and reporting of complex datasets. Similarly, the Fish Health Unit currently employ several databases and is working on a redevelopment of these to improve the services to our customers. Additional modules of the new shellfish safety database (HABS^2) were deployed in 2019 including a new Phytoplankton and Biotoxin Chemistry system. These were incorporated into improved and redesigned public facing websites to provide the latest data and status to regulatory and industry customers in a clear format.

Other data requests are for access to large data sets for tangible development purposes (e.g. EIS – Environmental Impact Statements), regulatory or academic use. Customers accessing the data are mostly Government or other state bodies but consultancies and academics are frequently represented. In 2019, a considerable amount of data was requested by the Non Governmental Organisation (NGO) sector for fish health data by way of Access to Information on the Environment (AIE) or Freedom of Information (FOI) requests. The decisions on all of these requests were turned around and made available to the requestors in accordance with the FOI and AIE legislation.

Harmful Algal Blooms Website and Database Redevelopment

The Harmful Algal Blooms (HABs) database and website (**webapps.marine.ie/habs**) is an integral component and at the forefront of advisory services of the Shellfish Safety team, particularly in the areas of result dissemination from the national monitoring programmes for marine biotoxins and phytoplankton to the Competent Authorities and industry.

In 2019, there were several significant enhancements deployed to the website including the production of a current status map per species displaying open and closed production areas and the availability of data to be downloaded directly from the website. During 2019, the HABs website was accessed by 3,985 users which gave rise to a total of 77,798 page views from 17,333 sessions.

As regards the HABs database, an additional improvement was made with the launch of the biotoxin module, which has enabled analysts to upload biotoxin results into the database in a shorter time frame replacing manual data input. This has also improved a number of processes which are now streamlined and has led to a number of efficiencies throughout the biotoxin section.

The ICES Harmful Algal events database, which is managed through the IOC-IODE is updated on a regular basis and records both biotoxin and algal events which cause closures in the North Atlantic area coastal countries, and incorporates the Irish data sets from the 1990s. The data in this database from 2000 onwards was extracted and was regularly presented throughout 2019 through international forums and conferences.

MEFS Data Quality Management System Improvements

Data produced by MEFSS are mostly generated by laboratory services that are subject to our Quality Management Systems (ISO 17025-2017, ISO9001 and IODE Quality Management Framework). 2019 saw significant development of the Quality Management Systems which are at the core of ensuring rigorous high standards and ensuring quality of our lab generated data products. A stringent ongoing and independent accreditation of our methods is required and in MEFSS, this is carried out by INAB (Irish National Accreditation Board) on an annual basis, and data QMF is certified by IODE. Maintenance of these accreditations is ongoing and there is a constant effort required to improve both the laboratory and data quality management in the service area, in line with our Strategic Plan.

The Marine Institute labs now have 35 Test Methods on the scope of accreditation by INAB and are also accredited for residues sampling in the field under ISO 17025. Further opportunities to integrate Standard Operating Procedures (SOPs) and allow further efficiencies were also progressed in 2019 and MEFSS now has 23 integrated Standard Operating Procedures (SOPs) in place. These efficiency improvements are particularly linked to Initiative 2 of Strategic Focus Area 1 of the Strategic Plan: Delivering Integrated Quality Services.

The implementation of the Paradigm 3 Electronic Document Management system also greatly advanced in 2019. With this software, only one integrated system is required by staff to view documents and records for the management of analytical non-conformances, equipment records, audits, work requests, reference documents, approved product/service provider lists, and change control forms. In 2019, complaint issues log and Externally Provided Products & Services Issues were made fully electronic, reflecting our continued push for efficiencies and integration throughout the service area. The approved product/service providers list was also introduced as an electronic addition to Paradigm 3.

In addition, risk assessments (Health and Safety) integrated approach and template was introduced for all MEFSS laboratories and is now effectively in use. The Integrated Risk Assessment template and guidelines are a follow-on from the implementation of a paperless electronic system for all Safety Data Sheets introduced Marine Institute-wide in 2017. The paperless system now allows all staff to log in anytime or place and view SDS sheets. All staff have access to all risk assessments on P3.

In 2019, new ISO 17025-2017 requirements were introduced that required all accredited labs to conform to the new standard's requirements by 2020. In this light, an ISO 17025 Transition Team represented by an integrated team of scientists from each of the programme delivery units within MEFSS was established and procedures were progressed such that MEFSS transitioned over fully to the new standard in April 2019, following a successful three days INAB audit, well ahead of the 2020 deadline. A risk register and improvement register have been introduced into the quality system to risk base all aspects of the quality system.

In addition to the actions and improvements made, Quality Inductions and presentations was updated for new MEFSS staff involved in the quality system. Also 'How to guides' were launched in December 2019 for Paradigm 3. These are helpful video guides that take you through Paradigm 3. Feedback has been extremely positive to date and MEFSS Quality would like to expand these guides to other uses in the labs in 2020.

The above improvements made by the Quality System throughout 2019, which will continue in 2020, are in line with the objective of the strategy for further integration of our services across the Marine Institute.

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

Information Services and Development

The information services and development team develops and manages the Information & Communications Technology (ICT) and data infrastructure across the Marine Institute to provide a robust operational platform for data and information services. The team also continues to develop new technical capabilities and support improvements in the Marine Institute's service delivery.

In 2019, the Institute began implementing the Strategic Plan's Data and IT Strategic Enabler, building on the progress made through the IT Strategy, the Data Strategy, and European Maritime and Fisheries Fund (EMFF) data programme which developed data governance and integration capabilities in support of the new Marine Spatial Planning (MSP) and Marine Strategy Framework Directive (MSFD) programmes.

As part of this work, the Data Management Quality Management Framework for the Marine Institute received accreditation from the International Oceanographic Data and Information Exchange of UNESCO's Intergovernmental Oceanographic Commission in February 2019. At the time, the Marine Institute was one of only 10 accredited centres globally. Support was also provided to the Department of Housing, Planning and Local Government (DHPLG) to produce maps for the consultation draft of the National Marine Planning Framework published in November 2019.

Online data services continue to be developed with up-to-date data being made available through a variety of online services such as **www.digitalocean.ie**, **http://data.marine.ie**, **http://smartbay.marine.ie** and **http://atlas.marine.ie**. The work also included an update to the Irish Spatial Data Exchange (**www.isde.ie**) to both refresh the online service and to allow continued integration with the public sector data.gov.ie portal and the developing INSPIRE Spatial Data Infrastructure.

These online services were visited over 76,000 times in 2019, with a significant uplift in views corresponding with major events, particularly storms such as Lorenzo in October. The Marine Institute data request service also processed over 180 manual data requests in 2019 for more customised queries.

Together, these services support access to important Irish marine data and information, supporting operational activities and an enhanced understanding of our marine.

Operational

The information services and development (IS&D) team provide operational programme support across Marine Institute services areas including for Fisheries Data Collection, the INFOMAR and Marine Ocean Energy programmes, the Marine Spatial Planning programme, as well as other marine environment management activities. In addition to technology development for the specific programmes the team serviced over 3,300 internal support requests covering ICT and data management needs, and providing in-house technical expertise and training.

Of note in 2019 were the commissioning of significant upgrades to the HABs and Biotoxin data processing services, supporting the efficient processing of related samples and enhanced online information access. The team also worked with the Fish Health Unit to upgrade back end management systems, with the Inshore Fisheries and UWTV (Underwater Television) teams to enhance fisheries data management systems, and with the Oceanographic Services team to support the upgraded data buoy network.

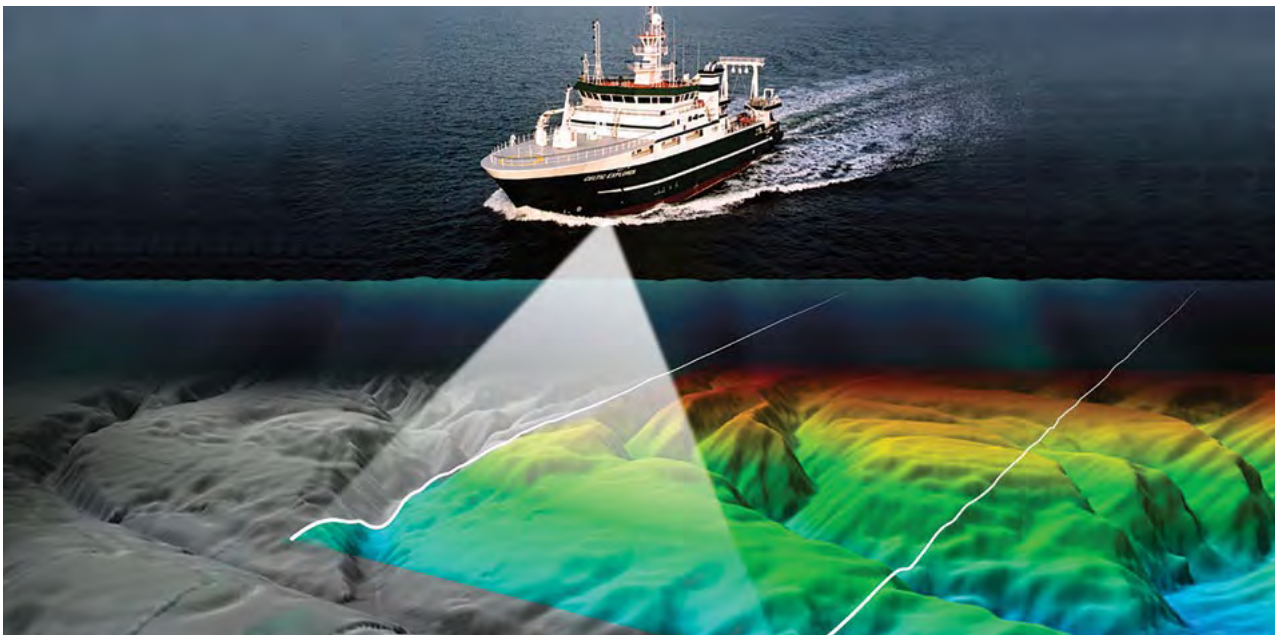
ICT operational updates in 2019 included upgrades to the Institute's telephony infrastructure, WiFi networks, plus server and cloud infrastructure. 2019 also saw good progress with regard to systems resilience and cyber-security with a number of important enhancements.

The team was also active in EU data-related research projects connected to the European Marine Observation and Data Network (EMODnet) and SeaDataCloud 2 EU data networks, in addition to continued work on the COMPASS INTERREG project working to coordinate and improve data management and service capabilities with partners in Northern Ireland and Scotland.

FISHERIES ECOSYSTEMS ADVISORY SERVICES (FEAS)

The FEAS data team worked on several Data and IT projects during 2019. Here are some of the significant projects and activities during the year:

- FEAS continued to implement the Marine Institute's Data Management Quality Management Framework (DM-QMF) - the Marine Institute was formally accredited by the IODE in February. The scope of the DM-QMF will be expanded to include Marine Institute Newport at the next submission date. Paradigm 3 document management system to support the DM-QMF was also implemented.
- Over 20 FEAS applications and their respective databases were supported and developed. Across all applications, 77 Support Calls were completed during 2019. Developments to support the new high definition Underwater TV survey system were completed. The groundfish survey team was supported as they finalised the design and testing of their new electronic measuring board system. New user interfaces and software was developed to meet FEAS' changing needs.
- FEAS continued to guide the development of the new ICES Regional Database & Estimation System (RDBES) – the Steering Committee meetings and a data population workshop in 2019 were chaired by the Marine Institute who also participated in 'Core Group' meetings and an estimation development workshop. The new RDBES will replace the existing regional database and InterCatch systems in 2022 and will have a significant impact on data quality for ICES assessments as well as supporting the relevant DCF Regional Coordination Groups.
- FEAS staff also chaired the DCF Regional Coordination Group intersessional sub-group looking at issues of data quality and confidentiality – as part of the multi-annual ToRs, this group has developed indicators to quantify member states' approaches to data quality, with a view to measuring improvements as they occur in the future.
- Phase 2 of the cross services European Maritime and Fisheries Fund (EMFF) Informatics project (with colleagues from FEAS and IS&D) was initiated – this project involves designing data tools, processes, and products to allow fisheries data to be more easily explored and better understood by stakeholders. This phase of the project involves collaborating with partners including Bord Iascaigh Mhara (BIM), Sea Fisheries Protection Authority (SFPA), and International Council for the Exploration of the Sea (ICES).
- All data calls including FDI (Fisheries Dependent Information), RDB (Regional Database), WGCEPH (Working Group on Cephalopod Fisheries and Life History), and contributed towards fulfilment of WGBYC (Working Group on Bycatch of Protected Species), WGCSE (Working Group on Celtic Seas Ecoregion), WGEF (Working Group on Elasmobranch Fishes), and DCF Economic data calls were fulfilled on time.




Evelyn Cusack
www.met.ie
Met
Éireann

STRATEGIC ENABLER **4**

ENGAGEMENT AND EDUCATION

ENGAGEMENT AND EDUCATION

Harnessing Our Ocean Wealth calls for a strengthening of our maritime identity, increased awareness of the value, opportunities and societal benefit of our oceans, as well as raising engagement with the ocean.

The Institute's strategic initiatives in engagement and education are particularly focused on increasing awareness and participation, communicating science and ocean knowledge and, encouraging a new generation of ocean professionals who will become leaders and champions for the marine environment.

Through government-led initiatives such as SeaFest, Ireland's national maritime festival, and other outreach and educational activities, the Marine Institute works in partnership with government departments, other agencies and local organisations to promote our ocean wealth and increase ocean literacy amongst our citizens.

COMMUNICATIONS

Education and engagement with all of our stakeholders was a focus for us in 2019 as we continue to implement our strategy with the ambition of increasing awareness, participation and strengthening our communications across all platforms.

The Marine Institute hosted and supported a number of events throughout the year including Our Ocean Wealth Summit and SeaFest 2019 - Ireland's national maritime festival – both of which were held in Cork this year. To mark World Oceans Day (8 June), the Marine Institute also supported and led the communications for the 'Go Atlantic Blue' initiative which saw more than 50 famous landmarks and buildings in Ireland light up blue to celebrate our connection with the Atlantic Ocean.

The Marine Institute also participated in the Mayo Science and Technology Festival and Galway Science and Technology Festival, with this year's theme being Climate Action, and attracting over 20,000 people. An open day in Newport Research Facility attracted over 300 members of the public and 150 primary school students to the facility (over two days) to learn about the research on wild salmon, climate and aquaculture.

In addition to participation on the European Marine Board, Government Communications Network and the Irish Ocean Literacy Network, Marine Institute Communications manages the Explorers Education Programme. An important programme in encouraging a new generation of ocean professionals, the Marine Institute Explorers Education Programme delivered its marine themed modules in 2019 to primary schools in Sligo, Donegal, Mayo, Galway, Clare, Kerry, Cork, Waterford, Dublin and Wicklow, reaching approximately 12,000 students.

'Our Ocean – Marine Legends, Fairy Tales and Folklore in Ireland' art and poetry exhibition produced by 300 primary school children around the country was displayed at SeaFest 2019 and a book of the same name was also presented to President Danny Faure of Seychelles, Minister Michael Creed TD and the Lord Mayor of Cork, Cllr John Sheehan, at SeaFest 2019.

The Marine Institute continues to develop and support Sea Science – The Wild Atlantic interactive exhibit at Galway City Museum, which attracted 220,000 visitors in 2019.

The Marine Institute also welcomed the launch of new online classroom resources for Irish Junior Cycle students which feature the documentary series, Ireland's Deep Atlantic. The resources include footage of the RV *Celtic Explorer* and the 'Real Map of Ireland' for Business Studies and Geography students.

The Communications team manages the Marine Institute's online channels to maximise the reach of our messages and target key audiences. Our online communications assets include a wide and ever expanding range of communications channels including our marine.ie website, intranet, and social media networks (Facebook, Twitter, YouTube, and LinkedIn). Our website (**www.marine.ie**) received a refresh in 2019 with the launch of a new, engaging home page.

The website continues to be a key information source, and 156 news stories were published throughout 2019, up from 136 in 2018 and 53 in 2014. That is a 194% growth in the number of annual news stories published in five years. The website continues to attract new visitors. In 2019, it received 169,478 unique visits, which is an increase of 4.5% in new visitors.

We continued to develop social media engagement on platforms such as Facebook, LinkedIn and Twitter with our content reaching over 50,000 people per week. The Scientists@Sea blog is an important communication tool for scientists to share their experience about the work they do on our research vessels. In 2019, the blog included 81 posts from 17 surveys.

In 2019, the Marine Institute also launched a new awareness campaign, 'Exploring Our Marine', to highlight the importance of our ocean and the work of the Marine Institute. The campaign covered a range of topics such as our Changing Climate, Fisheries Surveys, Ocean Economy and the RV *Celtic Explorer,* which were promoted in the local press, on the Marine Institute website and social media channels.

The Marine Institute complied fully with our policy in responding promptly to queries from Members of the Oireachtas.

POLICY, INNOVATION AND RESEARCH SUPPORT SERVICES (PIRS)

In 2019, PIRS continued to provide services to the Bureau of the Marine Coordination Group. This included supporting the annual Our Ocean Wealth Summit held in Cork as part of the SeaFest 2019 programme of events and the publication of the *Harnessing Our Ocean Wealth (HOOW) Review of Progress 2018*. Implementation of HOOW and integrated maritime policy in Ireland was also supported through hosting and maintaining a dedicated **ouroceanwealth.ie** website and social media platform.

King Carl XVI Gustaf and Queen Silvia of Sweden visiting the Marine Institute, Oranmore, Co Galway, as part of a three-day state visit in May 2019. Photo: Andrew Downes

IRISH MARITIME DEVELOPMENT OFFICE (IMDO)

Virtually all of the development targets set for the Irish maritime industry recognise the importance of education, training and skills development. The IMDO's remit includes an obligation to support education within the maritime sector and to heighten awareness by communicating effectively to national and international audiences that Ireland is open for maritime business and offers opportunities to companies and individuals to pursue their respective ambitions.

In pursuit of these objectives, the IMDO:

- Collaborates closely with the National Maritime College of Ireland (NMCI) and communicates the quality of its courses and facilities to current and prospective clients
- Administers the Irish Seafarers Education Assistance Scheme (ISEAS) programme which supports the training of cadets from the National Maritime College of Ireland. In 2019, some 81 students graduated from the college, who benefitted from the grant of €200,000 that was paid out under the ISEAS scheme. Irish graduates are in high demand internationally, due to having English as a first language and because of the quality of the education they receive in NMCI.
- Participates in Transition Year outreach events in the Marine Institute and the National Maritime College of Ireland, which drew attention to the diverse range of careers that can be pursued in the maritime industry and the career paths that have taken Irish mariners to the top of their professions. In 2019, the IMDO engaged with more than 800 transition year students, within the Marine Institute and at events in third level colleges.
- Continues to support education by funding the activities of the Institute of Chartered Shipbrokers, which trains the professionals who will drive progress in the maritime industry in the future.

OCEAN SCIENCE AND INFORMATION SERVICES (OSIS)

Marine operations (research vessels)

Once again, it was a busy year on board the Marine Institute's research vessels *Celtic Explorer, Celtic Voyager* and ROV *Holland I*. A comprehensive summary of the research vessels' activities are documented in Strategic Enabler 2 – Infrastructure but below are captured the key engagement and education activities undertaken during the year:

- Surveys and operations on research vessels were undertaken in conjunction with third level institutions including University of Limerick (UL), Ulster University, NUI Galway (NUIG), University College Cork (UCC), Galway-Mayo Institute of Technology (GMIT) and Maynooth University
- National Maritime College of Ireland (NMCI) student training and SMART Sea school student training, with students taking part from NUIG, and the Marine and Renewable Energy Ireland (MaREI) centre, NUI Cork
- The final student training survey of the spring season took place early-mid April, with John Boyd, head of the SMART sea school programme, carrying out a four day 'Science@Sea' programme with participants from a mix of careers/disciplines
- The RV *Celtic Explorer* docked in Cork city for SeaFest 2019 and was open to visitors over the three day event. More than 7,400 people toured the vessel and found out more about its key operations
- Five internationally renowned artists embarked onboard the RV *Celtic Explorer* as part of the Galway 2020/Marine Institute art-science collaboration, Aerial/Sparks

Ocean Energy & Infrastructures

Specific social media accounts were created across the Facebook (@SmartBaySite), Twitter (@SmartBaySite) and LinkedIn (**https://www.linkedin.com/showcase/smartbaysite/**) platforms to promote the SmartBay ocean energy test site and cabled observatory and to provide regular updates to the various research, industry, academic, and civil society stakeholders.

An Information Centre was established in Spiddal, Co. Galway, and a Community Engagement Officer was appointed to engage with the local schools and community groups in the vicinity of the SmartBay test site and cabled observatory.

The Irish Marine Data Buoy Observation Network (IMDBON)

Since 2001, IMDBON (formerly the Irish Weather Buoy Network) has been reporting hourly weather reports consisting of measurements of key near surface marine meteorological data: air temperature, humidity, atmospheric pressure, wind speed and direction and also oceanographic data including sea surface temperature, wave height, and wave period. The extreme western synoptic M6 location is a sentinel European monitoring site.

The budget subhead for the programme (operated via the Department of Agriculture, Food and the Marine, DAFM) saw a 2018 increase sustained in the core operations and maintenance programme budget for 2019. This is improving overall data delivery.

The significant SFI (Science Foundation Ireland) research infrastructure funding award in 2018 (EirOOS) is in the process of being disbursed, with a small amount of funds (10%) remaining in part to support activities in 2020 to complete the transfer to and deployment of new technologies. The funding provided an essential and urgent capital renewal programme for the network, but also includes additional data acquisition capacity for key climate variables, most notably carbon dioxide exchange across the air-sea boundary. The integration of these capabilities into the platforms will be an active workplan through 2020 and 2021.

The Irish National Tide Gauge Network

Operated by the Marine Institute on a 'best endeavours' basis, the Irish National Tide Gauge Network (INTGN) provides monitoring of tide level around the Irish coast. The increased level of monitoring during 2017 and 2018 means that greater resolution of the tidal harmonic is now possible with tidal predictions from more locations are available on **www.irishtides.ie/predict**.

As sea level relative to land level change is a key ECV (Essential Climate Variable) with regards to climate adaptation and coastal resilience, interest in this area is building, with a need identified to establish an advanced capacity. Capital funds for hardware and installation was provided in 2019 under the SFI 'EirOOS program to progress two global sea level observing stations (GLOSS).

In terms of the Marine Institute network, 2019 saw progress in three main areas:

i. Extensive land level surveying was undertaken at Union Hall Harbour, Howth Harbour and Galway Port. These surveys will allow land level to be tracked year on year to relate the tide level to changing land level.
ii. High accuracy GPS surveys were undertaken at a range of locations for which historical data exist. These data are feeding into a study led by NUI Maynooth into sea level rise led by Prof. Gerard McCarthy.
iii. In 2019, progress was made with wide ranging preparatory activities for the installation of the two global sea level observing stations (GLOSS) in Howth Harbour and Union Hall, with significant progress planned in 2021.

The long-term, ultra-high precision temperature data being collected at Ballycotton (east Cork) and the Portmore Pier (Malin Head) are now well established. These data build on decades of monitoring (at Malin Head) and continue to feed background climatological data into central archives of temperature, the fundamental climate change indicator.

GENERAL ADMINISTRATION

AUDIT RISK COMMITTEE

Membership

During the year ended 31st December 2019, the Audit and Risk Committee (ARC) comprised the following non-executive members of the Board: Patricia Barker (Chairperson), Dermot Clohessy, Donal Kelly and David Owens.

Meetings

Ten meetings were held during 2019 and member attendance was as follows:

	Patricia Barker	Dermot Clohessy	Donal Kelly	David Owens	Executive in attendance**
29th Jan	√	√	√	√	HB, CB
26th Feb	√	√	√	√	HB, CB, SC
25th Mar*	√	√			HB, CB, SC
30th Apr	√	√	√	√	HB, SC, CK
28th May	√	√	√	√	HB, SC, CK, CJ
25th Jun	√	√	√	√	
1st Oct	√	√		√	HB, PO, SC,CK
22nd Oct*	√	√			PO, SC
4th Nov	√	√		√	HB, PO, SC, EO'G
3rd Dec	√	√	√	√	HB, PO, SC

*The meetings of 25th March and 22nd October were pre- and post-audit planning meetings respectively with the external auditor.

** HB Ms. Helen Boles (ARC Secretary)
CB Ms. Caroline Bocquel
SC Mr. Seán Connolly
PO Ms. Patricia Orme
CK Mr. Cormac Kennedy
EO'G Mr. Eoin O'Grady
CJ Ms. Catherine Johnson

The Role of the Audit and Risk Committee (ARC)

The role of the ARC is to oversee and advise the Board and the Chief Executive Officer on matters relating to:

- Financial, operating and governance risks, including overall risk management
- Effectiveness of the internal controls and risk management
- Effectiveness of internal audit function
- Communication with the Comptroller and Auditor General (C&AG)
- Matters raised by the Internal Auditor and the C&AG
- The adequacy of governance procedures, and
- Value for money issues

While audit and risk committees in general have a duty to appoint and monitor the work of, and receive reports from, the External Auditor, the Marine Institute is audited by the Comptroller and Auditor General (C&AG). The ARC does not, therefore, have a role in appointing the external auditor.

However, one of the main duties of the ARC in exercising oversight of the relationship with the External Auditor includes meeting with the Comptroller and Auditor General in advance of the commencement of the audit (audit plan was discussed and assurances required by C&AG from the Board were appropriately provided) and again following completion of the audit. There were no material matters of concern arising from the audit. The management letter had not been received by the ARC by the close of 2019, but will be dealt with in the 2020 work programme.

The Committee also monitored the integrity of the financial statements prepared by the Institute. Following the external audit, the ARC reviewed the final financial statements before presentation to the Board to ensure compliance with best accounting practice. Changes in accounting policy relating to Fishing Rights, Depreciation and recording of Fixed Assets were discussed and recommended to the Board.

Areas identified for focus during 2019

In addition to completing the work related to the roles outlined above, the ARC focused on the following areas:

- **New vessel procurement**
  During the course of the year, the ARC closely monitored the expenditure element of the project to acquire the new research vessel. This included

reviewing the budget and spending on the procurement of the design and build teams. It also approved an Internal Audit control of the process and compliance with agreed budgets and approved plan.

- **External membership of ARC**
  During the year, the Committee considered the benefit of an external member of the ARC to augment the competency mix on the Committee. It was agreed that, in accordance, with best Corporate Governance, a policy should be discussed, agreed and approved by the Board for such appointment(s). Research was conducted on a framework for such a policy and was drawn up during the year. This policy will be presented to the Board in 2020 and an appointment will proceed therefrom.

- **Internal Control – Assurance from Internal Audit**
  The ARC's review of the effectiveness of Internal Audit (IA) during 2019 concluded that there was a satisfactory output during the year with good assurance for the Board on the systems of control and management of risk and governance. It was noted that due to the additional work required of IA arising from the new vessel procurement and to the changeover of Director of Corporate Affairs, a number of planned audits were deferred. On balance, however, the service provided by the IA team represented good value for money.

- **Internal Audits conducted during 2019, and reviewed by the ARC:**
  - New vessel procurement
  - Vessel usage efficiency
  - Systems of internal financial control
  - Contracts review
  - System of internal controls, Code of Practice review
  - Lookback on 2018 recommendations

  The reports from each of these audits were discussed with the Internal Auditor, with no material issues arising from them. Where there were recommendations for enhancement of practice, management had agreed to all relevant suggestions. In general, the opinion of the Internal Auditor was that the internal controls were effective and sufficient.

- **GDPR**
  Although the level of the ARC's concern surrounding GDPR was significantly reduced during 2019, due to the implementation and close management of the Marine Institute's policies and procedures, the ARC continued to exercise vigilance in this new area.

- During the year, the ARC met with members of the management team in order to receive briefings and have an opportunity to have all queries and suggestions discussed in relation to the following areas: Risk Management, Health and Safety, Procurement, Cyber Security and Data Protection, New Vessel Procurement.
- Additionally, the ARC sought specific reports from the Director of Corporate Affairs to assure the Committee on the following areas: Prompt Payments, Electronic Contract Management Systems, State Agency Claims, Capital Expenditure, Tax Compliance, Expenditure under Science Foundation Ireland (SFI) Funding, and Fraud, Corruption and Bribery.
- The ARC considered and offered recommendations on the following new or amended policies which were drafted, discussed and approved during 2019: Policy on Transitioning, Fixed Asset Capitalisation Policy, Depreciation Policy, Policy on Fishing Rights and other intangible assets, Procurement Policy, Stakeholder Engagement, and Ethics Policy.
- The Chairperson of the ARC met with the Chairman of the Board on a number of occasions during the year to discuss issues relating to the work of the ARC and ways in which the ARC could assist the Board in the conduct of its work.
- The ARC contributed to the framework for the selection of the CEO and the Director of Corporate Services. The ARC was represented on the selection boards for both of these posts.

Protected Disclosure

There were no Protected Disclosures during the year.

Terms of Reference

Terms of reference of the Audit and Risk Committee have been approved by the Board and are reviewed on an annual basis and amended as appropriate.

Conflicts of Interest

At each of its meetings, the ARC considers the possibility of conflicts of interest arising in relation to its agenda and such conflicts are dealt with in accordance with the Board's policy.

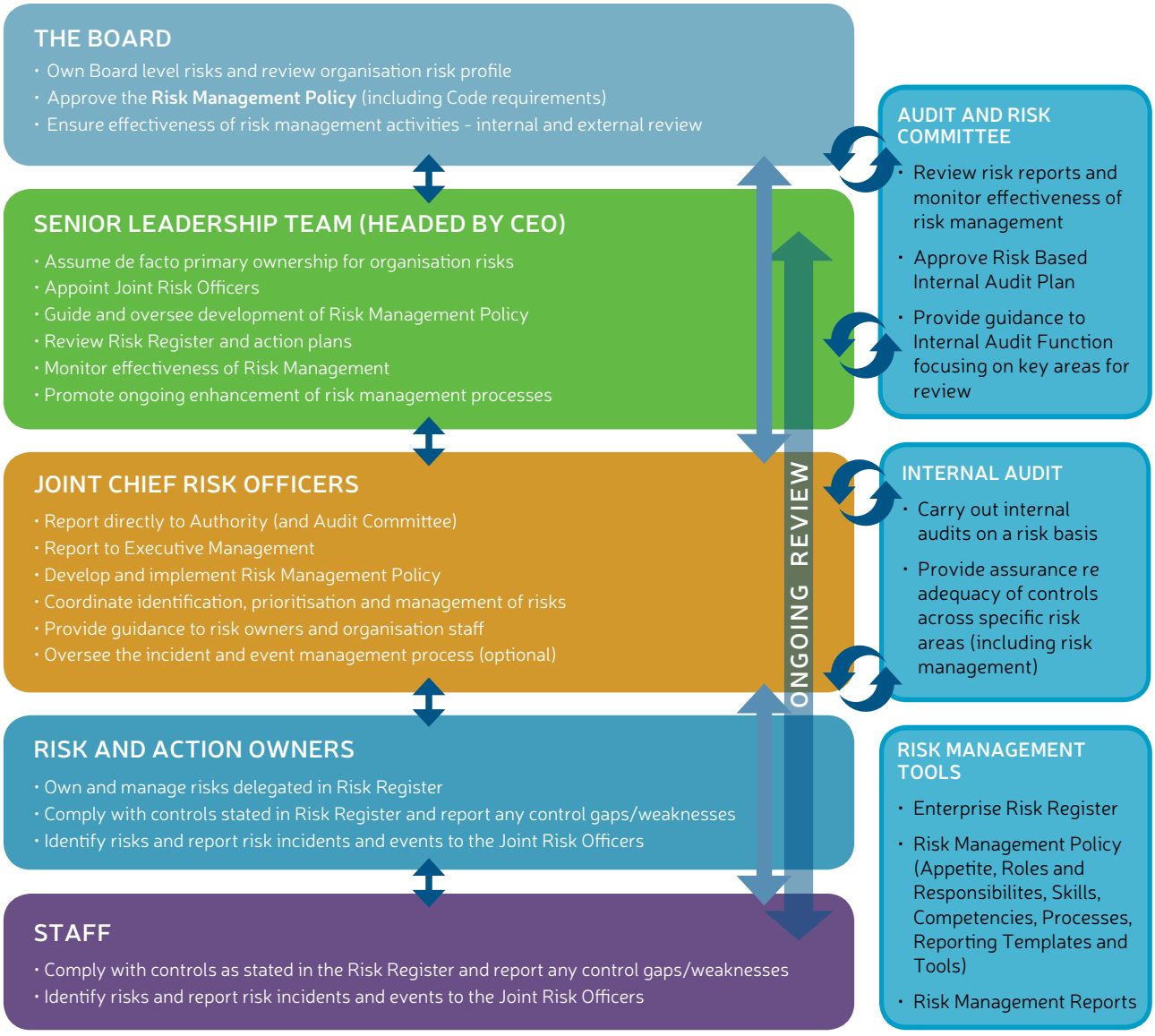
Having considered all relationships between the Marine Institute and the internal audit firm, the ARC does not consider that these relationships impair the auditor's judgement or independence.

RISK MANAGEMENT REPORT

The Board of the Marine Institute has established and maintains a robust risk management framework that supports the ongoing management of risk in accordance with the established risk appetite and corporate strategy. The risk framework addresses all the requirements of the Code of Practice for the Governance of State Bodies (2016) and is a practical process for the formal management of organisational risks.

The risk policy, which is reviewed annually by the Board, sets out the organisation's risk management objectives; the organisation's risk appetite; and the risk management framework which details the roles and responsibilities of staff and Board members, and the process for identifying, categorising and escalating risk.

Marine Institute Risk Management Framework



RISK REGISTER

A Risk Register is in place which identifies the key risks facing the Marine Institute and details the controls and actions needed to mitigate against those risks and assigns responsibility for the operation of mitigating controls to specific risk owners. The Risk Register is reviewed and updated by the Joint Risk Officers quarterly, and reported to both the Audit and Risk Committee and the Board.

The Marine Institute confirms that it has carried out an assessment of the organisation's risks and the following principal risks were identified:

Risk	Mitigations
Maintaining the trust and confidence of the Department of Agriculture, Food and the Marine (DAFM), other Government Departments and State Agencies, clients, key stakeholders, local communities, and the general public.	Implementation of the Marine Institute's Strategy 2018-2022 Building Ocean Knowledge. Delivering Ocean Services; Implementation and reporting on an Oversight and Performance Delivery Agreement with DAFM; Service Level Agreements with State Agencies
Risk of failure or loss of significant infrastructure including vessels, facilities and equipment deployed at sea.	Implementation of maintenance and safety policies and procedures, adhering to ISM codes for the vessels; A Health, Safety, Environment, & Quality plan is in place. In the event of a total loss the high value items are covered by insurance; Training for seafarers including sea survival training; Business Contingency Plans are in place to access alternate research vessels and laboratories
Adequate security controls and procedures in place to protect against cyber-attacks and loss of functionality and protection of data.	Implementation of ICT data and security policies and procedures; Investment in training for staff and continuous updating of security defences; Implementation of IT disaster recovery plans for the Marine Institute as part of overall business continuity planning

LIAISON

The programme of the Marine Institute covers a wide range of activities that require close liaison and cooperation with many individuals and organisations. These include the Department of Agriculture, Food and the Marine; the Department of Finance; the Department of Housing, Planning and Local Government; the Department of Transport, Tourism and Sport as well as other governmental departments and State agencies, private enterprises and the higher education sector. The Institute acknowledges the continued support and cooperation of all concerned.

HEALTH AND SAFETY

The Institute continues to implement appropriate measures to protect the safety and health of all employees and visitors to its premises.

ETHICS AND PUBLIC OFFICE ACT

All persons holding a designated position within the Marine Institute complied with the requirements of the Public Office Commission in accordance with Sections 18 and 20 of the Ethics in Public Office Act, 1995.

EMPLOYMENT EQUALITY

The Marine Institute is committed to a policy of equal opportunity and adopts a proactive approach to equality. The Institute operates a number of schemes that provide staff with options in relation to meeting their career and personal needs such as job sharing, study leave and educational programmes.

CODE OF PRACTICE (REPORTING)

The Marine Institute adheres to the Code of Practice for Governance of State Bodies. The Institute can confirm that Directors and employees have adopted and are trained on:

- Formal code of conduct on conflict of interest and customer charter
- Properly constituted audit committees
- Procurement procedures
- Sensitive issues

ENERGY EFFICIENCY REPORTING BY PUBLIC SECTOR BODIES (S.I. 542 OF 2009)

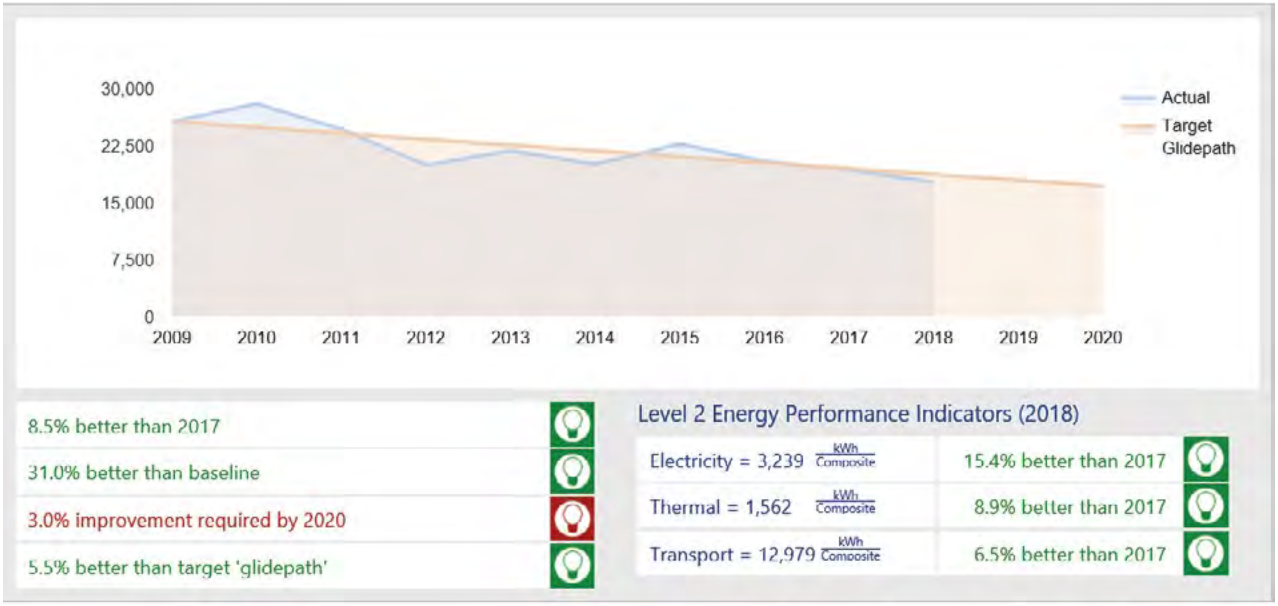
The energy consumed by the Institute remains divided into two main users: 70% by the research vessels *Celtic Explorer* and *Celtic Voyager* and 30% by buildings. The Institute achieved an overall reduction of 31% in 2019, based on 2018 consumption figures with a target of 33% reduction by 2020. We are performing well in this area and the target glide path indicates that we are due to achieve the 33% reduction by the 2020 deadline.

The Get Greener Energy and Sustainability teams were further enhanced by the introduction of a team in Newport concentrating on combined energy and sustainable objectives. The team has, for example, implemented the Pollinator Plan, built a bug hotel with engagement from the local community, undertaken bioblitzes and introduced compost bins throughout the facility. These teams are multi-disciplinary, made up of members from the Scientific, Facilities, IT, and Administrative areas throughout the organisation.

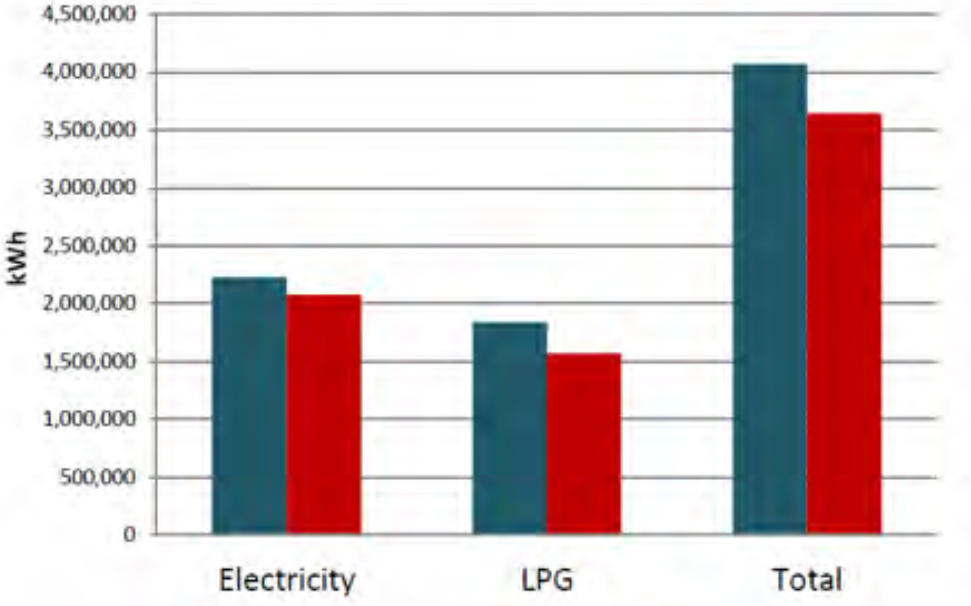
The Get Greener teams have also:

- Continued the 'Switch off' campaign on Fridays
- Held Energy Awareness Days in Oranmore and Newport
- Further reduced fume hood operational hours in conjunction with laboratory users
- Undertaken the annual review of the Energy Strategy and Action Plan
- Completed an energy efficiency audit of the Building Management System in Oranmore
- Implemented a 'no single use plastics' policy for events and meetings
- Set up a Research Vessel Energy Committee to review energy performance
- Undertaken two "out of hours" audits in Oranmore, Newport and Dublin
- Held two biodiversity community days in Newport
- Implemented a new Resource Efficiency Action Plan

The bar chart opposite shows the 10.5% savings made in the Institute's Oranmore building from January to December 2018 and January to December to 2019. The Oranmore location has made a 31% saving since joining Optimising Power@Work in 2016.



Annualised energy usage



Benchmark Year
Previous 12 months

Description	Electricity	LPG	TOTAL
Jan-Dec 2018	2,231,368	1,842,356	4,073,723
Jan-Dec 2019	2,075,489	1,569,156	3,644,644
% Difference	-7.0%	-14.8%	**-10.5%**

In 2019, the Marine Institute consumed:

- 2,417,648 kWh of electricity
- 14,953 litres of kerosene
- 265,486 litres of LPG (purchased by volume)
- 11,051 litres of road diesel
- 179,211 litres of marine gasoil for Marine Institute funded research surveys

UPDATE OF SCÉIM GAEILGE 2019

The Marine Institute, through Grúpa Gaeilge, is reviewing the current Scéim with a view to updating for the 2020-2022 period.

Grúpa Gaeilge was established to prepare the Marine Institute's Irish Language Scheme/Scéim Foras na Mara under Section 11 of the Official Languages Act 2003. The second period of the scheme was overseen by the Grúpa Gaeilge from 2015 to 2019 and the third phase is soon to commence for the period 2020 to 2022. This builds on the extensive efforts to implement the requirements under the Act that were brought about under the first period following identification of areas for enhancement of Irish language services by the Institute.

Following the satisfactory review of the Irish Language Commissioners in 2017, Grúpa Gaeilge continued to implement the recommendations of the Commissioners during 2019 by updating Institute web pages and continuing with arrangements to celebrate Seachtain na Gaeilge in the Marine Institute.

Events in 2019 included organisation of Irish language courses and an Irish morning in the canteens of the Marine Institute locations around the country with an Irish language crossword puzzle competition. The Marine Institute Sustainability Team joined forces with Grúpa Gaeilge to 'Go Green for Concern' by asking staff to bring in 'green' cakes to help raise funds for people and communities directly affected by climate change. There were also a series of translations on the Marine Institute intranet of many marine nautical terms and the updating of the Marine Institute's Irish language handbook for staff as well as other web-based activities.

The second period of the Irish language scheme maintained the Marine Institute's commitment to continually assess the level of demand for services through Irish, and to ensure that the Institute continues to meet this demand in a planned, coherent and accessible way. Under the third scheme which is being prepared by Grúpa Gaeilge for 2020-2022, the Marine Institute will continue to gauge the level of demand for its services in the Irish language by carrying out regular audits and review the level of queries and requests for services through Irish in a given period, documenting and promoting awareness among staff and clients as to which services the Institute should provide in Irish.

APPENDIX 1

MARINE RESEARCH PROGRAMME 2014 – 2020

SHIP-TIME PROGRAMME AWARDS 2019

Research Theme	Project Type	Project Reference	Project Title	Grantee/ Lead	Total Grant-Aid
Ocean Literacy and Education	Dedicated Training Programme	CV19002	Conservation Behaviour Monitoring GMIT	Galway-Mayo Institute of Technology	€68,000
Ocean Literacy and Education	Dedicated Training Programme	CV19004, CV19005, CV19009	National Maritime College of Ireland Training	National Maritime College of Ireland	€0 **Note 1**
Ocean Literacy and Education	Dedicated Training Programme	CV19006	SMART Socio- Economic Research Unit (SEMRU) NUI Galway Training	Galway-Mayo Institute of Technology	€8,500
Ocean Literacy and Education	Dedicated Training Programme	CV19007	SMART UCC MaREI Ocean Energy Training	Galway-Mayo Institute of Technology	€8,500
Ocean Literacy and Education	Dedicated Training Programme	CV19008	Science at Sea Multidisciplinary Marine Science Training	Galway-Mayo Institute of Technology	€34,000
Ocean Literacy and Education	Dedicated Training Programme	CV19010	Undergraduate Shipboard Training	Galway-Mayo Institute of Technology	€42,500
Ocean Literacy and Education	Dedicated Training Programme	CV19024	NUIG Post-Graduate Training	NUI Galway	€34,000
Ocean Literacy and Education	Dedicated Training Programme	CV19025	Multidisciplinary Survey Planning – A Peer Assisted Learning exercise led by postgraduates	Galway-Mayo Institute of Technology	€68,000
Ocean Literacy and Education	Dedicated Training Programme	CV19028	SMART NUI Galway Multidisciplinary Offshore Operations in Marine Science	Galway-Mayo Institute of Technology	€51,000
Ocean Literacy and Education	Dedicated Training Programme	CV19029	UCC MSc Marine Biology Training	University College Cork	€17,000

Research Theme	Project Type	Project Reference	Project Title	Grantee/ Lead	Total Grant-Aid
Ocean Literacy and Education	Dedicated Training Programme	CV19030	SMART NUI Maynooth MSc Climate Change Training	Galway-Mayo Institute of Technology	€17,000
Ocean Literacy and Education	Dedicated Training Programme	CV19031	SMART UCC Multidisciplinary Offshore Operations in Marine Science	Galway-Mayo Institute of Technology	€34,000
Ocean Literacy and Education	Dedicated Training Programme	CV19032	SMART UCC Postgraduate Offshore Environmental Geology Training	Galway-Mayo Institute of Technology	€51,000
Technologies	Integrated Research Survey	CE19001	MMRRC Research and MRE-ROV Missions	University of Limerick	€133,000
Ocean Observation and Seabed Mapping	Integrated Research Survey	CE19007	Backscatter and Biodiversity on Shelf Sea Habitats (BaBioSSH)	Ulster University	€390,000
Ocean Observation and Seabed Mapping	Integrated Research Survey	CE19008 & CE19014	MOnitoring CHAnge in Submarine CANyon Coral Habitats (MoCha_ SCan)	University College Cork	€468,000
Pollution and Litter	Integrated Research Survey	CV19003	IMP.act.sea I – Assessment of microplastic hotspots in Galway Bay	Galway-Mayo Institute of Technology	€42,500
Subsea Resources	Integrated Research Survey	CV19011	Quantifying Irish Marine Placer Resources II (QuIMPeR II)	University College Cork	€93,500
Biodiversity, Ecosystems and Food-webs	Integrated Research Survey	CV19016	Ocean Sampling Day 2019	NUI Galway	€8,500
Biodiversity, Ecosystems and Food-webs	Integrated Research Survey	CV19018	DINO19 - Origins and bloom dynamics of populations of the harmful dinoflagellate Dinophysis on the continental shelf around Ireland	NUI Galway	€59,500
Biodiversity, Ecosystems and Food-webs	Integrated Research Survey	CV19020	Top Marine Predators on the 100m contour	Galway-Mayo Institute of Technology	€76,500
Renewable Energy	Integrated Research Survey	CV19023 & CV19026	Derisking Offshore Wind Energy Development Potential in Irish Waters (DOWindy)	University College Cork	€153,000
Engineering	Integrated Research Survey	CV19027	Geohazard Investigation in the Irish Sea using Seismic and Seabed Mapping Techniques (GIST)	University College Dublin	€119,000
Bioresources: Wild Resources	Policy Support Survey	CE19003	Mackerel Egg Survey	Marine Institute	€159,600 **Note 2**

Research Theme	Project Type	Project Reference	Project Title	Grantee/ Lead	Total Grant-Aid
Bioresources: Wild Resources	Policy Support Survey	CE19006 & CE19004	Irish Anglerfish and Megrim Survey	Marine Institute	€266,000 **Note 2**
Climate Change	Policy Support Survey	CE19009	Ocean Climate Section: South Rockall Trough	Marine Institute	€237,600
Bioresources: Wild Resources	Policy Support Survey	CE19010	WESPAS Survey (Boarfish, Herring and Horse mackerel Stocks)	Marine Institute	€159,600 **Note 2**
Pollution and Litter	Policy Support Survey	CV19001	Winter Environmental Survey of Irish Coastal Waters 2019 (North about)	Marine Institute	€110,500
Bioresources: Aquaculture	Policy Support Survey	CV19021	Biological Oceanography of Harmful Algal Blooms (HABS) in Irish Waters	Marine Institute	€93,000
TOTAL					**€3,003,300**

Notes:

1. NMCI familiarisation training (four x 1 day) provided in dock, and costs were covered via other existing activities.
2. This represents the Marine Institute contribution of 40% (with 60% funded under EMFF - European Maritime and Fisheries Fund).

APPENDIX 2

MARINE RESEARCH PROGRAMME 2014 – 2020

FUNDED RESEARCH PROJECTS 2019

Research Theme	Project Type	Project Reference	Project Title	Grantee/ Lead	Total Grant-Aid
Bioresources: Wild Resources	Post-Doctoral Fellowship	PDOC/19/01/01	Impacts of Climate Change on Commercial Fish Stocks in Irish Waters	Galway-Mayo Institute of Technology	€335,244 **Note A**
Bioresources: High Value Products	Post-Doctoral Fellowship	PDOC/19/02/01	Progressing Marine Biodiscovery in Ireland	NUI Galway	€499,707
Pollution and Litter	Post-Doctoral Fellowship	PDOC/19/03/01	Monitoring the presence, abundance and fate of microplastics and their associated chemicals in an Irish deep water SAC's (MoP_up)	University College Cork	€284,397
Information and Spatial Technologies, Analytics and Modelling	Post-Doctoral Fellowship	PDOC/19/04/02	Improvement of Marine Institute operational modelling system and observation network of Irish marine waters using state-of-the-art model with data assimilation, model parametrization and machine learning techniques	NUI Galway	€492,806
Climate Change	Post-Doctoral Fellowship	PDOC/19/05/02	ACCAI: Decoding Arctic Climate Change: From Archive to Insight	NUI Galway	€298,346
Transport and Logistics	Post-Doctoral Fellowship	PDOC/19/06/01	Modelling Ireland's Maritime Transport Industry (MIMTI)	NUI Galway	€366,756
Tourism and Leisure	Post-Doctoral Fellowship	PDOC/19/07/01	Usage of Irish Seas and Coastal Ecosystems for Tourism Development (UISCE Tourism)	NUI Galway	€375,631
Ocean Observation and Seabed Mapping	Post-Doctoral Fellowship	PDOC/19/08/03	Novel Mapping of the Shallow Water INFOMAR Dataset: Towards Ireland's First Shallow Water Atlas (NOMANS_TIF)	University College Cork	€349,109
Climate Change	EPA Research Call 2019 (Managed by EPA)	2019-CCRP-MS.63	High-Resolution Coupled Atmosphere-Ocean-Wave Regional Climate Projections for Ireland	NUI Galway	€43,749 **Note B**

Research Theme	Project Type	Project Reference	Project Title	Grantee/ Lead	Total Grant-Aid
Transport and Logistics	EPA Research Call 2019 (Managed by EPA)	2019-SE-MS-15	Sustainable and Holistic management of Irish Ports (SHIP)	Queens University Belfast	€121,352 **Note C**
Pollution and Litter	Transnational Project	PBA/PL/20/01	ANDROMEDA	University College Cork	€75,000 **Note D**
Pollution and Litter	Transnational Project	PBA/PL/20/02	microplastiX	Galway-Mayo Institute of Technology	€75,000 **Note D**
Bioresources: High Value Products	Transnational Project	PBA/BIO/20/01	MINERVA	NUI Galway (Project Co-ordinator), University College Cork and CyberColloids Ltd	€240,000 **Note E**
Bioresources: High Value Products	Transnational Project	PBA/BIO/20/02	SuReMetS	University College Cork, University of Limerick and Bio-marine Ingredients Ireland Ltd	€230,000 **Note E**
Bioresources: Aquaculture	Transnational Project	PBA/BIO/20/03	ImprovAFish	NUI Galway	€110,000 **Note E**
Bioresources: Aquaculture	Transnational Project	PBA/BIO/20/04	InEVal	Galway-Mayo Institute of Technology, Marine Institute and Údarás na Gaeltachta	€210,000 **Note E**
Bioresources: Aquaculture	Transnational Project	PBA/BIO/20/05	AquaTech4Feed	Bantry Marine Research Station Ltd and Teagasc	€210,000 **Note E**
Advanced Technologies	Transnational Project	PBA/AT/20/01	NEMO	Dublin City University	€150,000 **Note F**
Climate Change	Transnational Project	PBA/CC/20/01	ROADMAP	NUI Maynooth	€199,887 **Note G**
Climate Change	Transnational Project	PBA/CC/20/02	CE2COAST	NUI Galway and Marine Institute	€400,000 **Note G**
Various	Networking and Travel Grants	NT/19/01 to NT/19/147	Hosting/Attending Marine Conferences, Workshops and Events	Various (116 awards granted in 2019)	€108,428
Renewable Energy	National Infrastructure Access Programme	NIAP/18/002	Wave parameter estimation from oscillating water column pressure signal - Phase 2 Electronic optimisation of the WASP	Dundalk Institute of Technology	€25,649
Climate Change	National Infrastructure Access Programme	NIAP/18/003	A Small Waterplane Area Twin Hulled (SWATH) Tide Buoy with Real-time Kinematic positioning for Accurate (cm level) Tide Gauge Calibration	Sligo Institute of Technology	€22,520

Research Theme	Project Type	Project Reference	Project Title	Grantee/ Lead	Total Grant-Aid
Biodiversity, Ecosystems & Food-webs	National Infrastructure Access Programme	NIAP/18/004	Environmental DNA/ RNA metabarcoding for monitoring marine biodiversity in Galway Bay, with particular attention to marine Invasive Alien Species	Galway-Mayo Institute of Technology	€24,949
Information & Spatial Technologies, Analytics and Modelling	National Infrastructure Access Programme	NIAP/18/005	LoRaC2.4 (geo-location and navigation system, using Low Power Wide Area technology)	Danalto Ltd	€27,964
Renewable Energy	National Infrastructure Access Programme	NIAP/18/007	Wave Resource Characterisation at the Galway Bay Marine and Renewable Energy Test Site	NUI Galway	€27,121
Ocean Observation and Seabed Mapping	National Infrastructure Access Programme	NIAP/18/009	Demystifying the Ocean through Underwater Video Analysis: marine life activity detection, classification and indexing for the SmartBay ocean observation platform	Dublin City University	€28,819
Biodiversity, Ecosystems & Food-webs	National Infrastructure Access Programme	NIAP/18/010	Can introduced marine infrastructure enhance the conservation of vulnerable species?	Queen's University Belfast and Inland Fisheries Ireland	€24,808
TOTAL					**€5,357,242**

Notes:

A. Funded by Fisheries Ecosystems Advisory Services, Marine Institute.

B. This represents the Marine Institute contribution to the project (25%), which is also funded with the Environmental Protection Agency, Met Éireann and the Office of Public Works.

C. This represents the Marine Institute contribution to the project (50%), which is jointly funded with the Environmental Protection Agency.

D. This represents the Marine Institute contribution to the project (50%), which is jointly funded with the Department of Housing, Planning and Local Government (DHPLG). Two projects awarded with Irish partners under the 2018 JPI Oceans Call entitled "Sources, distribution and impact of microplastics in the marine environment."

E. Five projects awarded with Irish partners under the 2018 Call ERA-NET Cofund on Blue Bioeconomy (BlueBio) – Unlocking the Potential of Aquatic Bioresources." Total grant-aid awarded is €1,859,657 with €1m funding contribution from the Marine Institute, €0.5m from Science Foundation Ireland and €0.36m from the European Commission.

F. One project awarded with an Irish partner under the 2018 MarTERA ERA-NET Cofund call for transnational research and innovation projects on maritime and marine technologies. The Marine Institute is the sole national funder for this call.

G. Two projects awarded with Irish partners under the 2019 JPI Climate JPI Oceans 2019 Joint Call "Oceans and climate, using observations and Earth system models". The Marine Institute is the sole national funder for this call.

APPENDIX 3

H2020 PROJECTS

PROJECT TITLE:

FLOTANT - Innovative, low cost, low weight and safe floating wind technology optimised for deep water wind sites

Instrument: Research and Innovation Action

Irish Partner: TECHNOLOGY FROM IDEAS

Value to TFI: €342,259

Project Abstract:

Many elements of an offshore wind farm become more expensive as depth increases: mooring, anchoring and dynamic cables are the most obvious. However, deep water areas also pose additional challenges for installation and Operations & Maintenance (O&M) strategies. FLOTANT project aims to develop an innovative and integrated Floating Offshore Wind solution, optimised for deep waters (100-600m) and to sustain a 10+MW wind turbine generator, composed by: a mooring and anchoring system using high performance polymers and based on Active Heave Compensation to minimise excursions, a hybrid concrete-plastic floater and a power export system with long self-life and low-weight dynamic cables. The project includes enhanced O&M strategies, sensoring, monitoring and the evaluation of the techno-economic, environmental, social and socio-economic impacts.

The prototypes of the novel mooring, anchoring and dynamic cable components, and a scaled model of the hybrid offshore wind floating platform will be tested and validated within the scope of the project. Three relevant environments have been selected to perform the tests: MARIN basin for global performance under controlled conditions; the Dynamic Marine Component Test facility (DMaC-UNEXE) for large scale prototypes tests; and PLOCAN Marine Test Site, for the characterisation of novel materials under real seawater conditions.

An expected 60% reduction in CAPEX and 55% in the OPEX by 2030 will be motivated by FLOTANT novel developments including additional sectorial reductions due to external technology improvements. Overall FLOTANT solution, will allow an optimisation of Levelised Cost of Electricity (LCOE) reaching values in the range of 85-95 €/MWh by 2030.

PROJECT TITLE:

OceanSET - Support to the Realisation of the Ocean Energy Implementation Plan of the SET-Plan

Instrument: Coordination and Support Action

Irish Partner: SEAI

Value to SEAI: €331,000

Project Abstract:

The SET Implementation Plan for Ocean Energy (IP) was adopted by the SET-Plan Steering Committee on the 21st of March 2018. The IP was prepared by a Temporary Working Group (TWG), with representatives from the European Commission, Member States and other stakeholders. For the execution of the IP, the TWG has evolved to assume the role of the Implementation Working Group (IWG).

Support for the Ocean Energy sector to date has focused on the development of research and roadmaps which have set out the aspirations of wave and tidal sector. The principle of the IP is to transform those aspirations into operational actions. The actions listed within the IP are primarily based upon the Ocean Energy Strategic Roadmap, which has been agreed by the European Commission, Member States, Regions, stakeholders and the wider ocean energy sector.

The ambition of the IP is to outline a structured approach that will enable wave and tidal technologies to follow a credible development path, with the ultimate destination of a commercially viable products and industry. The target timescale presented in the IP is 2025 for tidal technologies and 2030 for wave technologies.

OceanSET will assist the IWG to continue their work to deliver on the targets set in the IP. In particular, OceanSET will focus on assessing the progress of the ocean energy sector and will monitor the National and EU funded projects in delivering successful supports. Relevant data will be collected annually and will be used to inform Member States and European Commission on progress of the sector, it will also be used to review what works and what doesn't and to assess how to maximise the benefit of the funding streams provided across the Member States, Regions and the European Commission.

The partners on this project include representatives from Ireland (SEAI), UK (WES, University of Edinburgh), France (FEM), Portugal (DGEG), Spain (EVE, PLOCAN), Italy (ENEA) and from the industry (OEE). The Sustainable Energy Authority of Ireland (SEAI) will be lead partner on the project.

PROJECT TITLE:

NEMMO - Next Evolution in Materials and Models for Ocean energy

Instrument: Research and Innovation Action

Irish Partner: Dublin City University (DCU)

Value to DCU: €525,515

Project Abstract:

Making tidal energy more affordable

Harnessing power from flowing water is one of the oldest forms of energy generation. However, further technology advancements are needed to make this renewable energy source competitive with traditional energy sources relying on fossil fuels. The EU-funded NEMMO project aims to drive down costs by designing larger, lighter and more durable composite turbine blades. Researchers are working on ways to improve the hydrodynamic performance and active flow control of the turbine blade. They are also testing new composites and coatings that should increase resistance to fatigue, impact, cavitation erosion and biofouling. The ultimate aim is to reduce the levelised cost of energy for a 2-MW tidal turbine by 70%, bringing it down to EUR 0.15/kWh.

Objective

NEMMO will design, model and test downscaled prototypes of larger, lighter and more durable composite blades for >2MW floating tidal turbines to reduce LCoE of tidal energy to €0.15/kWh, meeting 2025 SET-Plan targets and making it competitive to competing fossil fuel sources. Novel blade designs with enhanced hydrodynamic performance due to the implementation of the different solutions, active flow control, materials and surfaces will be tested. Also, new nano-enhanced composites with properties that increase fatigue-, impact-, cavitation- and bio-fouling resistance of novel blade designs to prevent failures will be made. The project will then model, design and test the lifespan and resistance of the new composites for tidal turbine blades.

This will involve:

- accurate modelling of harsh hydrodynamic and environmental stresses for the development of testing and validation procedures
- a new test rig for the evaluation of fatigue and cavitation on test probes and downscaled prototypes
- a testing procedure including bio-fouling and marine environments evaluation in four different real scenarios
- development of numerical models for the prediction of lifespan and mechanical properties as function of the materials properties, hydrodynamic loads, time and water composition
- Novel tidal generator blades designs integrating active control flow, advanced surfaces and new nano-enhanced composites. The collective result of these innovations is 70% reduction in LCoE for tidal energy due to; (i) 50% CapEx reduction (lower material consumption and 25% lower cost of new composites), (ii) 2% lower FCR (increased understanding of failure and fatigue mechanisms and more durable composites with 66% higher lifespan), (iii) 40% reduction in Operations & Maintenance (O&M) (reduced cavitation wear, bio-fouling and aging) and, (iv) 20% increase in AEP (enhanced hydrodynamic performance and higher inlet flow speeds for tidal turbine).

PROJECT TITLE:

HIGHWAVE – Breaking of Highly Energetic Waves

Instrument: ERC Advanced Grant

Coordinator: University College Dublin (UCD)

Value to UCD: € 2,499,946

Project Abstract:

HIGHWAVE is an interdisciplinary project at the frontiers of coastal/ocean engineering, earth system science, statistics and fluid mechanics that will explore fundamental open questions in wave breaking. Why do waves break, how do they dissipate energy and why is this important? A central element of the work builds on recent international developments in the field of wave breaking and wave run-up led by the Principal Investigator that have provided the first universal criterion for predicting the onset of breaking of water waves in uniform water depths from deep to intermediate. This work has also shown that the run-up of nonlinear waves impinging on a vertical wall can exceed up to 12 times the far-field amplitude of the incoming waves.

These results have now opened up the possibility for more accurate operational wave models. They have practical and economic benefits in determining structural loads on ships and coastal/offshore infrastructure, evaluating seabed response to extreme waves, and optimising operational strategies for maritime and marine renewable energy enterprises. This is a tremendous advance comparable to the introduction of wave prediction during World War II, and the Principal Investigator aims to be at the forefront of this research effort to take research in wave breaking into fundamentally new directions.

The objectives of the project are: (i) to develop an innovative approach to include accurate wave breaking physics into coupled sea state and ocean weather forecasting models; (ii) to obtain improved criteria for the design of ships and coastal/offshore infrastructure; (iii) to quantify erosion by powerful breaking waves, and (iv) to develop new concepts in wave measurement with improved characterisation of wave breaking using real-time instrumentation. This highly interdisciplinary project will involve an ambitious and unconventional combination of computational simulation/theory, laboratory experiments, and field measurements of sea waves, closely informed by application needs.

PROJECT TITLE:

SafePASS – Next generation of life Saving appliances and systems for saFE and swift evacuation operations on high capacity PASSenger ships in extreme scenarios and conditions

Instrument: Research and Innovation Action

Irish Partner: Trinity College Dublin (TCD)

Value to TCD: €536,250

Project Abstract:

Evacuating a large passenger ship is a safety-critical and strictly time-bound task and a complex decision-making process based on the evolving situation and the information available. Timely evacuation requires fast and accurate evaluation of ship's condition and estimation of remaining evacuation time. The assumption that all passengers will be able to comprehend and follow instructions or even that the crew will be able to communicate verbally during a crisis is very optimistic. In response, a system that will provide clear instructions and guide passengers safely on how to react in an emergency situation without reliance on any passenger skills or experience is of paramount importance for any large passenger ship.

SafePASS will radically redefine the evacuation processes, evacuation systems/equipment and international regulations for passenger ships in all environments, hazards and weather conditions, independently of the demographic factor, by developing an integrated system that will collectively monitor, process and inform during emergencies both crew and passengers of the optimal evacuation routes, coupled with advanced, intuitive and easy to use Life-Saving Appliances (LSA), resulting to a significant reduction of the total time required for ship evacuation and increased safety. SafePASS is an integrated solution that provides passengers tailored evacuation assistance, assists the crew by enhancing their situational awareness and ability to handle de-skilled equipment, while incorporating fail-safe processes for the evacuation procedure.

SafePASS prototypes will be validated in real environment, on a cruise ship and in Life-Saving Appliances (LSA) manufacturers testbeds and towing tanks. The consortium, consisting of 15 partners, amongst which academic institutions, classification societies, innovative SMEs, shipyard, LSA manufacturers and a cruise operator, safeguards both the high impact and implementation of the project results, through the preparation of a set of recommendations for IMO submission.

PROJECT TITLE:

CONPARA – Control parametric resonance of wave energy conversion systems

Instrument: MSCA-IF - Individual Fellowships

Coordinator: NUIM

Value to TCD: €196,591

Project Abstract:

To date, no marine system, let alone wave energy device, has attempted to exploit parametric resonance as an assistive phenomenon. A number of wave energy researchers have observed the phenomenon and sought to dampen it, but the concept of harnessing the power transferred from (typically) heave to (typically) pitch/roll has not been considered. This fellowship aims to control the parametric resonance of Wave Energy Converter (WEC) dynamics to improve energy conversion efficiency, based on a 1/20 scale prototype.

The research objectives (ROs) are: RO1: Identify a high-fidelity and computation-effective model to represent the WEC parametric resonance with Computation Fluid Dynamics (CFD) verification in OpenFOAM (open source) and parametric analysis in MATLAB. RO2: Develop

advanced nonlinear control strategies and corresponding PTO mechanism for actuation, to improve WEC efficiency making use of its multi-DoF motion and parametric resonance. RO3: Conduct tank testing to verify the modelling of parametric resonance (RO1), and model-based control design and implementation (RO2), based on a self-assembled 1/20 scale prototype.

Successful achievement of this fellowship will lead to timely and useful contribution to the wave energy and relevant communities, including: (i) an hydrodynamic model describing WEC parametric resonance with real time computation capacity, (ii) advancing the understanding in WEC parametric resonance, (iii) a 1/20 scale WEC prototype, and (iv) implementable control and Power Take Off (PTO) systems for multi-DoF WEC systems. In the long term, the successful achievement of this project will improve the technology readiness level (TRL) of wave energy from 5 to 7 for commercial application.

PROJECT TITLE:

MEESO – Ecologically and economically sustainable mesopelagic fisheries

Instrument: Research and Innovation Action
Irish Partners: Marine Institute, Bord Iascaigh Mhara (BIM), Teagasc
Value to Marine Institute: €379,540
Value to Teagasc: €102,844
Value to BIM: €108,000

Project Abstract:

Sustainable mesopelagic fisheries

The mesopelagic zone, at depths between 200 and 1,000 metres below the ocean's surface, could contain a total fish biomass that is 100 times the annual catch of all existing fisheries. The EU-funded MEESO project will quantify the spatio-temporal distributions of biomass, production and ecosystem role of mesopelagic resources. It will assess options to sustainably exploit them.

Mesopelagic organisms are one of the largest unexploited resource left in the world's oceans. MEESO will develop new tools and technologies for abundance estimation, such as submersible acoustics and fine meshed trawls, as well as assessment and management roadmaps. MEESO will explore new technologies for commercial fishing and processing and map contaminant and nutrient contents to explore the basis for a viable and sustainable fishery. Its aim will be to find a balance between exploitation, sustainability and viability of the mesopelagic resources.

Objective

The overall goal of MEESO is to quantify the spatio-temporal distributions of biomass, production and ecosystem role of mesopelagic resources and to assess options to sustainably manage and govern their exploitation. To reach this goal, MEESO will create new knowledge and data on the mesopelagic community, its biodiversity, drivers of its biomass, its role in carbon sequestration, its role in the oceanic ecosystem and its interactions with the epipelagic community which includes several important commercial fish stocks.

Besides applying state of the art experimental and quantitative methods, MEESO will develop and implement new acoustic and trawling technologies necessary for the knowledge and data generation in relation to this largely unknown and remote part of marine ecosystems. MEESO includes a significant amount of in-kind financing for technology development and scientific surveys. MEESO will apply the new knowledge and data to determine the potential of the mesopelagic biomass to be sustainably exploited for products included in the human food chain.

For the first time combining leading experts in science, engineering, fisheries and governance, MEESO will develop commercial fishing and processing technologies and mapping of contaminant and nutrient contents to explore the basis for a viable fishery and creation of jobs. Mesopelagic organisms represent one of the largest unexploited resource left in the world's oceans, with a recent biomass estimate at 10 billion metric tons. The new tools and technologies, as well as assessment and management roadmaps, developed in MEESO will establish the trade-offs between exploitation, sustainability and viability of the resource, and identify options for its governance.

PROJECT TITLE:

SO-CHIC – Ecologically and economically sustainable mesopelagic fisheries

Instrument: Research and Innovation Action

Irish Partner: NUI Galway (NUIG)

Value to NUIG: €243,670

Project Abstract:

The Southern Ocean regulates the global climate by controlling heat and carbon exchanges between the atmosphere and the ocean. It is responsible for about 60-90% of the excess heat (i.e. associated with anthropogenic climate change) absorbed by the World Oceans each year, and is also recognised to largely control decadal scale variability of Earth carbon budget, with key implications for decision makers and regular global stocktake agreed as part of the Paris agreement. Despite such pivotal climate importance, its representation in global climate model represents one of the main weaknesses of climate simulation and projection because too little is known about the underlying processes.

Limitations come both from the lack of observations in this extreme environment and its inherent sensitivity to intermittent small-scale processes that are not captured in current Earth system models. The overall objective of SO-CHIC is to understand and quantify variability of heat and carbon budgets in the Southern Ocean through an investigation of the key processes controlling exchanges between the atmosphere, ocean and sea ice using a combination of observational and modelling approaches. SO-CHIC considers the Atlantic sector of the Southern Ocean as a natural laboratory both because of its worldwide importance in water-mass formation and because of the strong European presence in this sector already established at national levels, which allow to best leverage existing expertise, infrastructure, and observation network, around one single coordinated overall objective.

SO-CHIC also takes the opportunity of the recent re-appearance of the Atlantic Sector Weddell Polynya to unveil its dynamics and global impact on heat and carbon cycles. A combination of dedicated observation, existing decades-long time-series, and state-of-the-art modelling will be used to address specific objectives on key processes, as well as their impact and feedback on the large-scale atmosphere-ocean system.

PROJECT TITLE:

iAtlantic – Ecologically and economically sustainable mesopelagic fisheries

Instrument: Research and Innovation Action

Irish Partner: University College Cork (UCC)

Value to UCC: €140,000

Project Abstract:

Measuring the impact of climate change on the Atlantic

iAtlantic assesses health of deep and open-ocean Atlantic ecosystems. It scales and standardises measurements from different disciplines so ecosystem status can be assessed against multiple stressors and global change. It will predict where and when synergistic effects of global change and multiple stressors occur, and what implications these will have for society, economy and ocean health. iAtlantic focuses on 12 key areas of the ocean, using innovative approaches to upscale observations to address basin scale issues. Over 30 expeditions will study ecosystems most at risk of change. iAtlantic also builds human and technical capacities by creating iAtlantic Fellows through a capacity building programme including hands-on work at sea, technology transfer, analytical techniques and data interpretation training and a mentoring programme.

Objective

iAtlantic will take an interdisciplinary scientific approach to unifying stakeholder efforts to better inform sustainable management and enhance human and observational capacity throughout the Atlantic. The integration of ecosystem data with major circulation pathways connecting the North and South linked with climatic data and forecasts provides a systematic approach to jointly assess and tackle policy challenges. Ocean physics and ecosystem connectivity will enable high-resolution oceanographic hindcasts and forecasts of future circulation together with ground-truthing genomic data. Advances in eDNA genomics, machine learning and autonomous underwater robotics will be combined with existing data to provide step-changes in predictive habitat mapping approaches to expand species and biodiversity observations from local to basin-scales.

Ecological timeseries, including innovative palaeoceanographic and genomic reconstructions, will provide an unprecedented view of the impacts of climate change on Atlantic ecosystems. Assessment of the impact of multiple stressors will identify key drivers of ecosystem change and tipping points. New data will come from 12

carefully selected regions in the deep sea and open ocean that are of international conservation significance and of interest to Blue Economy and Blue Growth sectors. Innovative and efficient data handling and data publishing approaches will establish a better integrated Atlantic Ocean observation data community. Capacity and cooperation between science, industry and policymakers bordering the Atlantic will be boosted by joint multi-disciplinary research cruises, enhanced South Atlantic monitoring arrays, scientific training events, iAtlantic Fellowships and industry focussed workshops. Results will be used to stimulate dialogue with stakeholders and critically assess current ocean governance frameworks generating increased capacity for Marine Spatial Planning and enabling Blue Growth scenarios to be rapidly evaluated.

PROJECT TITLE:

SAFEMODE – Strengthening synergies between Aviation and maritime in the area of human Factors towards achieving more Efficient and resilient MODE of transportation

Instrument: Research and Innovation Action

Irish Partner: Ryanair

Value to Ryanair: €110,625

Project Abstract:

Currently, both maritime and aviation sectors are lacking a systematic approach to collect and assess Human Factors information in normal and emergency conditions. There is also a lack of agreed methodology to assess human-related risks with the aim of influencing design and operation of aircraft and ships. Therefore, the research question being addressed in this project is "How to fully capture human elements and their interaction with the other system elements to enhance safety in maritime and aviation operations?"

It is important to address Human Factors aspects in relation to risk-based design of system and operations in a measurable manner by taking the variation in human behaviour over time and the non-flexibility of machines into consideration.

The main aim of SAFEMODE project is to develop a novel HUman Risk Informed Design (HURID) framework in order to identify, collect and assess Human Factors data to inform risk-based design of systems and operation. These aims have not been achieved previously at a desirable level due to the unavailability of systematically collected data and lack of cooperation between different transport modes.

The focus will be to reduce risks for safety critical situations, (e.g. mid-air collisions, grounding, evacuation, runway excursions etc.) through the enhancement of human performance. This will be achieved through investigation of past accidents, incidents, near-misses, reports, data from everyday operations, including previously unknown uncertainties such as increasing levels of automation and increased number of drones in transportation.

This information will be incorporated the HURID framework and tools and into SHIELD, the open data repository and the living database, that will be maintained and continuously updated.

PROJECT TITLE:

PALAEMON – A holistic passenger ship evacuation and rescue ecosystem

Instrument: Research and Innovation Action

Irish Partner: Konnekt-able Technologies

Value to Konnekt-able Technologies: €500,000

Project Abstract:

New technology for the evacuation of vessels

Recent maritime catastrophes remind us how important effective evacuation readiness is for the safety of passengers and crew. These measures can also prove ineffective as human error and lack of orientation always impact performance during extreme, stressful situations. The EU-funded PALAEMON project aims to engage innovative technologies in a new intelligent, sophisticated ecosystem of mass evacuation vessels (MEVs). It will provide real-time data about the situation on a damaged or sinking vessel, monitor the localisation of persons on board, detect potential dangers and provide guidance about the best evacuation route. The ITC system equips both the vessel and the MEV so as to warrant a continuous monitoring during all the phases of the operation. The system will include a VDES, the new IMO standard for data exchange that will help to minimise maritime accidents and disasters.

Objective

PALAEMON proposes the development and evaluation of a sophisticated mass centralised evacuation system, based on a radical re-thinking of Mass Evacuation

Vessels (MEVs) combined with an intelligent ecosystem of critical components providing real-time access to and representation of data to establish appropriate evacuation strategies for optimising the operational planning of the evacuation process on damaged or flooded vessels.

The intelligent ecosystem of PALAEMON incorporates innovative technologies for sensing, people monitoring and counting and localisation services as well as real-time data during accident time. These will be integrated into an independent, smart situation-awareness and guidance system for sustaining an active evacuation route for large crowds, making emergency response in EU passenger ships more efficient. Continuous monitoring and permanent control will enhance the capacity to detect, prevent and mitigate any issue and potential harm arising from physical and/or man-made accidents and disasters. The proposed ecosystem will include the new IMO standard for data exchange-VDES.

Since maritime disasters in recent years are a stark reminder of the imperative need for timely and effective evacuation of large passenger ships during emergency the aim of this project is to maximise the effectiveness of passenger evacuation, during an emergency and/or a serious incident, from large Cruise and RoPax ships by combining the expertise of stakeholders from the field of cruise ship manufacturing, large cruise ship operators, classification societies, sensor and technology organisations, with a multidisciplinary group of innovators (incl. innovative start-ups, consolidated SMEs in the smart ICT domain, experts in the ship evacuation domain from research institutes, international networks in maritime and key industry drivers.

MEVs prototypes will be validated in controlled environment and the smart evacuation ecosystem will be demonstrated in two use cases.

PROJECT TITLE:

TRIATLAS – Tropical and South Atlantic climate-based marine ecosystem predictions for sustainable management

Instrument: Research and Innovation Action

Irish Partner: NUI Galway (NUIG)

Value NUIG: €101,000

Project Abstract:

Climate-based prognostics for the future of the tropics

Human activities such as intense fishing and coastal development are altering the Atlantic marine ecosystems around the South and Tropical Atlantic. The EU-funded TRIATLAS project aims to study the current situation of the Atlantic Ocean's marine ecosystem and predict future changes. A range of African, European, and South American institutions specialised in climate change, oceanography and social sciences, as well as local stakeholders will be engaged in the project. TRIATLAS will also work closely with relevant European Commission services. The project will observe the impact of pollution and climate change on the marine ecosystem to present the first prognosis for the next 40 years for the whole Atlantic. This will aid in sustainable management of human activities.

Objective

Sustainable management of human activities affecting Atlantic marine ecosystems is critical to maintain its health and to support the blue economy of the bordering countries. TRIATLAS will contribute to this by delivering knowledge of the current state and future changes of the Atlantic marine ecosystems. We achieve this through a basin-wide approach integrating research from the North and South, that closes critical knowledge gaps in the Tropical and South Atlantic which impede an understanding of the entire basin. We bring together an interdisciplinary team of marine ecologists, physical oceanographers, climate researchers, and social scientists from 34 different institutions in Europe, Africa, and South America, together with multisectoral and regional stakeholders.

We will enhance knowledge of the marine ecosystems in key areas of the Atlantic using existing and pivotal new (physical, biological, societal) observations. Earth system, ecological, and socio-economic models and observations will be used to assess the cumulative impacts of (climatic, pollution, and fishing) pressures driving fluctuations in the marine ecosystem, and the potential for tipping point behaviour and regime shifts. We will develop the first predictions of the marine-ecosystem for the next 40 years for the whole Atlantic, by combining state-of-the-art climate prediction and ecosystem models, with Shared Socioeconomic Pathways, and by conducting socio-economic vulnerability assessments services, with stakeholder engagement. TRIATLAS will enhance capacity in marine ecosystems, oceanography, and climate research in countries bordering the South and Tropical Atlantic Ocean. There will be close cooperation and alignment with relevant European Commission services and the South-South Framework for Scientific and Technical Cooperation, as well as other relevant initiatives in the field. We will contribute to upscale cooperation around the Atlantic.

PROJECT TITLE:

AquaVitae – New species, processes and products contributing to increased production and improved sustainability in emerging low trophic, and existing low and high trophic aquaculture value chains in the Atlantic

Instrument: Research and Innovation Action

Irish Partners: Galway-Mayo Institute of Technology (GMIT), Cartron Point Shellfish (CPS)

Value GMIT: €305,380

Value to CPS: €62,000

Project Abstract:

Sustainable and innovative aquaculture across the Atlantic Ocean

The AquaVitae project is a consortium of 36 partners from Europe and countries bordering the Atlantic Ocean. They are working towards sustainable aquaculture production and the development of new low trophic species in aquaculture value chains, including macroalgae, Integrated Multi-Trophic Aquaculture (IMTA), shellfish, echinoderms and finfish. Research activities will cover the whole aquaculture value chain, from analysing market potential of new products to the policy framework. Possible impacts on the environment will be monitored, including the development of new sensors. AquaVitae plans to set up an industry and research network with particular attention on social responsibility and community outreach. Expecting to influence industry and society long-term, the project's partners also plan to design good practice standards and provide training programs for specialists and the public, focusing on a circular economy and the zero-waste approach. See our project website at www.aquavitaeproject.eu.

Objective

The overall objective of AquaVitae is to increase aquaculture production in and around the Atlantic Ocean in a sustainable way by developing new and emerging low trophic species and by optimising production in existing aquaculture value chains. The value chains that AquaVitae will focus on include macroalgae production, integrated multi-trophic aquaculture, and production of new echinoderm species as well as existing shellfish and finfish species. A series of cross-cutting Work Packages (WPs) will include research on biosensors, Internet of Things (IoT), product characteristics, consumer attitudes, market potential, sustainability, environmental monitoring, risk assessment, analysis of value chains, profitability, and other socioeconomic aspects. AquaVitae will contribute to various policy dialogues and produce briefs on policy and governance issues. The AquaVitae consortium consists of 36 full partners from Europe and countries bordering the Atlantic Ocean, in addition to an Industry Reference group, a Policy Advice Group, and an External Advisory Group. AquaVitae supports extensive communication and outreach activities, employs a multi-actor approach to ensure stakeholder engagement in all phases of the project, and will set up a durable aquaculture industry and research network around the Atlantic Ocean. Industry partners are present in all case studies, and they have a special responsibility for exploitation and commercialisation of the project research results and outcomes. AquaVitae will have a lasting impact on society through the introduction of new species, and through the development of new processes and products based on a circular economy/zero waste approach with improved sustainability. AquaVitae will produce Good Practice standards, facilitate industry apprenticeship and student exchange, support extensive training programs for industry, academia, and the public, and contribute to the implementation of the EU-Brazil-South Africa Belém Statement.

PROJECT TITLE:

5G-HEART – 5G HEalth AquaculturE and Transport validation trials

Instrument: Research and Innovation Action

Irish Partners: Marine Institute, Redzinc

Value Marine Institute: €173,365

Value Redzinc: €792,278

Project Abstract:

Healthcare, transport and food verticals are hugely important in Europe, in terms of jobs, size (collectively surpassing €3Trillion) and export trade. Moreover, they are vital from a social perspective, for better patient outcomes, safer transportation and safer and more sustainable food production. 5G is important for these verticals, in terms of improvements for utility, efficient processes, safety among others.

5G-HEART (validation trials) will focus on these vital vertical use-cases of healthcare, transport and aquaculture. In the health area, 5G-HEART will validate pillcams for automatic detection in screening of colon cancer and vital-sign patches with advanced geo-localisation as well as 5G AR/VR paramedic services. In the transport area, 5G-HEART

will validate autonomous/assisted/remote driving and vehicle data services. Regarding food, focus will be on 5G-based transformation of aquaculture sector (worldwide importance for Norway, Greece, Ireland).

The infrastructure shared by the verticals, will host important innovations: slicing as a service; resource orchestration in access/core and cloud/edge segments with live user environments. Novel applications and devices (e.g. underwater drones, car components, healthcare devices) will be devised. Trials will run on sites of 5G-Vinni (Oslo), 5Genesis (Surrey), 5G-EVE (Athens), as well as Oulu and Groningen, which will be integrated to form a powerful and sustainable platform where slice concurrency will be validated at scale.

The consortium includes major vertical players, research/academic institutions and SMEs. Partners have proven know-how in 5G, vertical applications, standardisation, business modelling, prototyping, trials, demonstrations.

5G-HEART KPI validation ensures improved healthcare, public safety, farm management and business models in a 5G market, stimulating huge business opportunities within and beyond the project.

PROJECT TITLE:

CMMI-MaRITeC-X – Marine and Maritime Research, Innovation, Technology Centre of Excellence

Instrument: WIDESPREAD-01-2018-2019 - Teaming Phase 2, Coordination and Support Action

Irish Partners: Marine Institute, SmartBay Ireland

Value Marine Institute: €1,177,570

Value SmartBay: €810,003

Project Abstract:

With the economic recession behind it, the economy of Cyprus is expanding at a rate comparable to that of the global economy. Despite this welcoming trend, the investment landscape in research, technology development, and innovation (RTDI), a key factor in the economic competitiveness and sustainability of Cyprus — remains stagnant, with bottom-up initiatives towards a change remaining fragmented and underutilised. As a direct result, the innovation and entrepreneurial ecosystem of Cyprus remains at an embryonic stage, leaving Cyprus as a low-performing RTDI country within the European Union.

Innovation activities in SSP cannot proceed without a solid scientific and research and technology development foundation. Despite Cyprus hosting three state universities (and a number of private ones) with a wealth of excellent research and scientific expertise, this significant resource remains untapped and rarely exploited beyond the confines of academia. To reverse this ultimately detrimental relation between research and innovation, Cyprus is in dire need of an intermediary to help the country rise out of its RTDI slumber. This proposal seeks the European Union's support to establish in Cyprus a Centre of Excellence that fosters world-class research, technology development, and innovation activities. This will not be another academic entity but an institution developing practical solutions/products addressing the needs of the economy, and society, in Cyprus, the EU and the rest of the world in activities related to the marine and maritime sector.

The proposed project, Marine and Maritime Research, Innovation, Technology Centre of Excellence (MARiTeC-X), seeks to play a key role in the country's economic and social transformation through RTDI transformation, by setting up the Cyprus Marine and Maritime Institute (CMMI).

PROJECT TITLE:

MUSICA – Multiple-use-of Space for Island Clean Autonomy

Instrument: Innovation Action

Coordinator: University College Cork (UCC)

Irish Partners: ICoRSA, NeoDyne

Value UCC: €3,173,375

Value ICoRSA: €141,875

Value NeoDyne: €713,055

Project Abstract:

Combined RES systems to optimise space on small islands

MUSICA project has developed a replicable smart multi-usage of space (MUS) platform for the concurrent use of three types of renewable energy – wind, PV and wave – at small islands. This will also contribute to the advancement of a successfully tested multi-use platform (MUP) developed by a Greek state university and a private company. This will offer a one-stop decarbonising shop for the islands that includes on-site energy storage, modelling and forecasting, desalination, and so-called green services to support aquaculture. Small islands will now be able to take optimal

advantage of limited space and staff while MUSICA will provide a full suite of solutions for 'Blue Growth' that are not cost-prohibitive.

Objective

The overall Aim of MUSICA is to accelerate the roadmap to commercialisation of its Multi-Use Platform (MUP) and Multi-use of Space (MUS) combination for the small island market, and de-risk for future operators and investors, by validation to TRL7 and providing real plans to move to mass market commercialisation. The MUSICA solution will be a decarbonising one-stop shop for small islands, including their marine initiatives (Blue Growth) and ecosystems.

The overall Aim of MUSICA will be achieved by developing a replicable smart MUP. MUSICA will advance the existing FP7 funded MUP concept developed by the University of the Aegean (UoAeg) and EcoWindWater (EWW), currently at TRL5, to TRL7. The EWW MUP was successfully trialled in Heraclea in 2010 for 2 years, funded by FP7 of €2.8M.

MUSICA will provide a full suite of Blue Growth solutions for small island:

- Three forms of renewable energy (RE) (wind, PV and wave) (total 870kW), providing high RES penetration and competitively affordable electricity. Three forms of RE provide non-correlated supply.
- Innovative energy storage systems on the MUP, provide all required storage for power on the island and platform, as well as electrical output smoothening (compressed water/air storage and batteries).
- Smart energy system for the island, including: demand response, modelling and forecasting based on high flexibility services from distributed generation.
- Desalinated water made by desalination unit on the MUP powered by RES providing 1000m3 fresh water for a water stressed island.
- The MUP will provide "green" support services for island's aquaculture (pilot 200 tonnes production)

This project will demonstrate that the MUSICA MUP is a viable enabling infrastructure for multiple RES, desalination and BG aquaculture services for small islands, that can share the same space and work synergistically together, sharing supply chains. reducing operating and maintenance costs and solving increasing demand for space.

PROJECT TITLE:
FLOAWER – FLOAting Wind Energy netwoRk

Instrument: MSCA-ITN-ETN – Innovative Training Networks

Irish Partner: University College Cork (UCC)

Value UCC: €274,684

Project Abstract:

Towards ensuring smooth sailing for floating wind farms

Wind is a renewable source of energy that is both plentiful and free. Since the first windmill created in 1887 in Glasgow, wind-generated power uptake has been expanding and becoming more and more efficient. Since 90% of wind energy is produced inland, space is becoming scarce for new installations. Floating offshore wind (FOW) is a unique opportunity for Europe. The EU-funded FLOAWER project will train 13 early stage researchers (ESRs) to design better performing, economically viable floating wind turbines. The project's multidisciplinary approach will train and endow these ESRs with the requisite scientific, technical, and soft skills to become high-profile scientists and engineers, enhancing their career prospects while addressing offshore wind energy industry needs.

Objective

Wind power is one of the fastest-growing renewable energy technologies and is the second largest form of power generation capacity in Europe. However, 90% of the wind energy is currently produced inland and space is becoming scarce for new installations. Floating Offshore Wind (FOW) represents a unique opportunity for Europe, since deep (>60m) offshore areas represent 60-80% of the European offshore wind potential. However, the sector faces two main challenges: high costs and a gap of skilled human resources.

The FLOAting Wind Energy netwoRk (FLOAWER) will provide 13 Early Stage Researchers (ESR) with an interdisciplinary training with the aim to design better performing, economically viable floating wind turbines. As part of their research activity, ESRs will contribute to the development of cutting-edge numerical and experimental tools for the wind resource and the subsystem design (heave-plates, load effects on floaters, substructure) of vertical and horizontal axis wind turbines. Their work will contribute to define cost-effective floating wind turbine designs.

FLOAWER network uniquely gathers outstanding academics and FOW industrial leaders, covering the entire offshore wind industry value chain (i.e. farm developers, offshore subsystem suppliers -turbine, floater, mooring- and wind resource specialists). ESR will thus benefit from the multidisciplinary expertise of 25 major academic and industrial partners, and a unique panel of research infrastructures, from lab scale (wind tunnel, wave tanks, etc.) to full scale (pre-commercial floating wind turbines and farms).

FLOAWER multidisciplinary approach will endow the ESR with scientific, technical, and soft skills to train the new generation of high-profile scientists and engineers, provide them with enhanced career perspectives and address offshore wind energy industry needs. Altogether, FLOAWER will strengthen European wind energy industry leadership and competitiveness.

PROJECT TITLE:

SEALIVE – Strategies of circular Economy and Advanced bio-based solutions to keep our Lands and seas alIVE from plastics contamination

Instrument: Innovation Action

Irish Partner: Intrigo Ltd

Value Intrigo: €281,509

Project Abstract:

SEALIVE aims at demonstrating innovative circular strategies for bio-based plastics in land and sea applications. The project will be driven by economically and technically sustainable business models based on materials with advanced properties, design for circularity techniques and end-of-life solutions. It will establish a partnership of raw material providers, convertors, end users, recyclers, policy experts, certification organisations and NGOs to demonstrate solutions within a shared vision for circular plastic strategies. Solutions for reusable, recyclable and biodegradable bio-based plastics to prevent and significantly reduce marine pollution of all kinds will be demonstrated in four pilot territories: Cyprus, Ireland, France and Denmark (or Non-European site).

Innovative formulations based on PHAs, PLA and starch materials with advanced properties will be developed following recycling, biodegradability (marine and land) and composting standards. Design for circularity techniques (recyclable multi-layer single packaging materials, digital materials for traceability) and End-of-life solutions (high precision NIR-based mechanical recycling, controlled biodegradation/composting in natural and industrial conditions) will be upscaled at TRL6.

Solutions will be applied to 8 end-applications with high potential for pollution reduction of soils and water media: rigid food containers, flexible packaging, agricultural films, fish crates, fishing nets and aquaculture mesh bags. Pre-normative research will be carried out to improve current standards for biodegradation, composting and recycling with regards to eco-toxicity, safety and influence of plastic ageing. Policy recommendations at EU and global level will be provided in order to build a common framework enabling pollution reduction of land and sea via sustainable bio-based plastics solutions.

PROJECT TITLE:

EuroSea – Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans

Instrument: Innovation Action

Irish Partner: Marine Institute

Value Marine Institute: €433,744

Project Abstract:

Although the Ocean is a fundamental part of the global system providing a wealth of resources, there are fundamental gaps in ocean observing and forecasting systems, limiting our capacity in Europe to sustainably manage the ocean and its resources. Ocean observing is “big science” and cannot be solved by individual nations; it is necessary to ensure high-level integration for coordinated observations of the ocean that can be sustained in the long term. EuroSea brings together key European actors of ocean observation and forecasting with key end users of ocean observations, responding to the Future of the Seas and Oceans Flagship Initiative. Our vision is a truly interdisciplinary ocean observing system that delivers the essential ocean information needed for the wellbeing, blue growth and sustainable management of the ocean.

EuroSea will strengthen the European and Global Ocean Observing System (EOOS and GOOS) and support its partners. EuroSea will increase the technology readiness levels (TRL) of critical components of ocean observations systems and tools, and in particular the TRL of the integrated ocean observing system. EuroSea will improve: European and international coordination; design of the

observing system adapted to European needs; in situ observing networks; data delivery; integration of remote and in-situ data; and forecasting capability. EuroSea will work towards integrating individual observing elements to an integrated observing system, and will connect end-users with the operators of the observing system and information providers. EuroSea will demonstrate the utility of the European Ocean Observing System through three demonstration activities focused on operational services, ocean health and climate, where a dialogue between actors in the ocean observing system will guide the development of the services, including market replication and innovation supporting the development of the blue economy.

PROJECT TITLE:

LiftWEC – Development of a novel wave energy converter based on hydrodynamic lift forces

Instrument: Research & Innovation Action

Coordinator: Queen's University Belfast (QUB)

Irish Partners: NUI Maynooth (NUIM), University College Cork (UCC)

Value QUB: €TBC

Value NUIM: €340,935

Value UCC: €244,625

Project Abstract:

LiftWEC is a collaborative academic research project funded under the European Union's Horizon 2020 research and innovation programme. The LiftWEC project focuses on the development of a new type of wave energy converter which extracts ocean wave energy using lift forces generated on a rotating hydrofoil.

Although significant effort has been spent in the last 50 years in searching for a commercially-viable technology for extraction of energy from ocean waves, this objective remains unfulfilled. Although a vast number of different concepts have been proposed and investigated, 99% of these concepts have been based on interacting with the waves using either buoyancy or diffraction forces.

The LiftWEC concept is different because it is based on the exploitation of lift forces generated by wave-induced water velocities. By interacting with lift forces the LiftWEC concept has the advantage that the motion can be unidirectional. In addition, the lift-force can easily be reduced so that the concept can survive storms in the same way that modern wind turbines survive, by stopping turning.

PROJECT TITLE:

AquaticPollutants – Risks posed to human health and the environment by pollutants and pathogens present in water resources

Instrument: ERA-NET-Cofund

Irish Partner: Environmental Protection Agency (EPA)

Value EPA: €190,119

Project Abstract:

The AquaticPollutants proposal responds to the Horizon 2020 (H2020) Societal Challenge 5 SC 5 21-2019-2020: Risks posed to human health and the environment by pollutants and pathogens present in water resources. AquaticPollutants aims at pooling resources from the 32 participating national and regional research programme owners / managers of 26 countries to implement a joint call for proposals (with EU co-funding).

One of the most serious risks for freshwater and marine ecosystems and consequently human health derives from the occurrence of emerging pollutants and pathogens, especially antimicrobial resistant bacteria, in the environment. To face this challenge in a comprehensive way and to provide multidisciplinary solutions for a safe and clean aquatic ecosystems (freshwater, groundwater, marine) this ERA-NET Cofund is carried out as a collaboration between three Joint Programming Initiatives (JPIs): Water JPI "Water Challenges for a Changing World", JPI Oceans "Healthy and Productive Seas and Oceans" and JPI AMR "On Antimicrobial Resistance". The topic of the ERA-NET Cofund aims to deliver on priorities identified in the Research Agendas of the three JPIs.

The overall objective is to strengthen the European Research Area (ERA) in the field of clean and healthy aquatic ecosystems and to leverage untapped potential in the collaboration between the freshwater, marine and health research areas. Moreover, AquaticPollutants includes nine organisations from associated and third countries in an effort to reinforce and expand international cooperation. With new instruments in the Additional Activities the implementation of the co-funded call will be further supported and the cooperation of Water JPI, JPI Oceans and JPI AMR will be strengthened. It is envisaged to generate an increased visibility of the topic at European and international level and a stronger alignment of the three JPIs.

PROJECT TITLE:

FORCOAST – Earth Observation Services for Fishery, Bivalves Mariculture and Oyster-ground Restoration along European Coasts

Instrument: Innovation Action

Irish Partners: Marine Institute, Cuan Beo Environmental Company LBG

Value Marine Institute: €100,000

Value Cuan Beo: €100,000

Project Abstract:

The FORCOAST project addresses the topic "DT-SPACE-01-EO-2018-2020 COPERNICUS MARKET UPTAKE" which seeks to foster market development exploiting the value of Copernicus Earth Observation Products. FORCOAST aims to provide information services that offer high resolution water quality and met-ocean indicators in coastal and nearshore areas, to improve operation, planning and management of different marine activities in the sectors of wild fisheries, oystergrounds restoration, and bivalve mariculture. FORCOAST information products and services will be co-designed with stakeholders, thereby ensuring that these products and services are tailored to meet their needs.

FORCOAST is developing, testing and demonstrating, in operational mode, novel Copernicus-based downstream information services that will incorporate Copernicus Marine, Land and Climate Services Products, local monitoring data and advanced modelling in the service. The services will integrate Copernicus Earth Observation Products with local models and other diverse data sources (local, regional or global) with ICT (enhancing new frontiers opened by web, and use of cloud) across the different market segments. FORCOAST will provide consistent coastal data products, based on a standardised data processing scheme. FORCOAST is supporting the concept of developing an advanced platform and cloud computing for Copernicus-based downstream services utilising one of the DIAS systems. The availability and accessibility of data and derived products generated will stimulate their exploitation by a wide range of user communities in the targeted sectors. FORCOAST will provide those services in eight pilot service uptake sites covering five different regional waters (North Sea, Baltic Sea, Mediterranean Sea, Black Sea and the coastal Atlantic Ocean).

PROJECT TITLE:

ICHTHYS – OptImization of novel value CHains for fish and seafood by developing an integraTed sustainable approacH for improved qualitY, safety and waSte reduction

Instrument: MSCA RISE – Research and Innovation Staff Exchange

Irish Partners: Wild Atlantic Shellfish Ltd, Athlone Institute of Technology (AIT), Keywater Fisheries Ltd.

Value Wild Atlantic Shellfish: €115,000

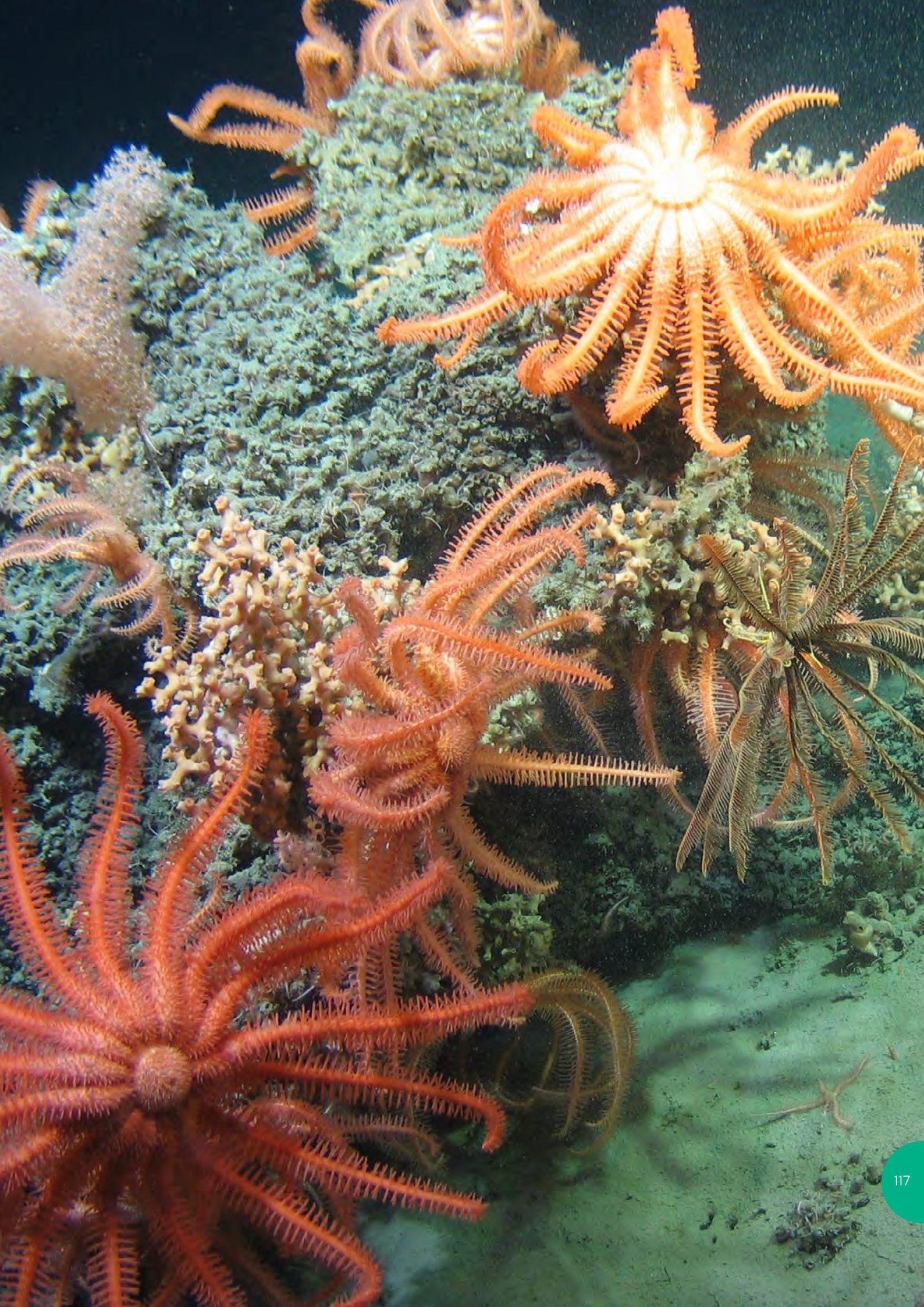
Value AIT: €147,200

Value Keywater Fisheries: €73,600

Project Abstract:

ICHTHYS (OptImization of novel value CHains for fish and seafood by developing an integraTed sustainable approacH for improved qualitY, safety and waSte reduction) will optimise novel value-chains for fish and seafood products for the EU and international markets. It will develop an integrated sustainable approach to improve quality and safety, while reducing product loss in the whole supply chain. ICHTHYS is intersectorial and focuses on two essential parts of the value chain, postharvest processing and packaging, integrating novel modern techniques and molecular biology tools in the evaluation of the quality and safety of fish and shellfish, including their allergenic capacity.

The proposal has 13 consortium members from six countries that have complementary expertise in food, aquaculture and postharvest processing. New nonthermal processing methods such as high pressure, pulsed electric fields and high-intensity pulsed light will be studied together with active and intelligent packaging and smart labels (Time Temperature Integrators) and biosensors for monitoring safety and shelf life enriched with novel data from ""omics"" analysis. The implementation of ICHTHYS will offer the industrial partners the opportunity to translate scientific research into well-defined knowledge-based end products and analytical tools. In addition, to the scientific objectives ICHTHYS will provide a platform for efficient dissemination and transfer of knowledge and technology through training and research with complementary measures to engage other stakeholders including citizens. Overall, ICHTHYS aspires to provide cross-cutting intersectorial and interdisciplinary knowledge exchange and training for academics and commercial partners to improve their employability and career prospects. The project will contribute to the knowledge-based economy and society and boost regional and European competitiveness and growth, food exports and job creation.



APPENDIX 4

MARINE INSTITUTE PUBLICATIONS

(Authors highlighted in bold indicate Marine Institute contributors)

SPECIAL REPORTS

Blachet A., Plets R., **Sacchetti F.**, Austenga A., Huntera A.J., & Hansena R.E. (2019) MBES data simulation: Assessment by direct comparison with a high-resolution multi-settings wreck survey. UACE Report.

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Irish Maritime Development Office (2019). IPORES 2018, A Review of Irish Ports Offshore Renewable Energy Services. Irish Maritime Development Office, Dublin, Ireland. http://hdl.handle.net/10793/1493

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O'Donohoe, P., Kane, F., Kelly, S., McDermott, T., Casserly, J., D'Arcy, J., Downes, J., McLoughlin, S. & **Jackson, D.** (2019). National Survey of Sea Lice (Lepeophtheirus salmonis Krøyer and Caligus elongatus Nordmann) on Fish Farms in Ireland – 2018. Irish Fisheries Bulletin No. 49. Marine Institute. http://hdl.handle.net/10793/1393

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Irish Maritime Development Office (2019). The Irish Maritime Transport Economist Volume 16. Irish Maritime Development Office, Dublin, Ireland. http://hdl.handle.net/10793/1491

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Marine Institute, Wageningen Marine Research, Institute of Marine Research Bergen, PINRO, Faroe Marine Research Institute, Marine Scotland Marine Laboratory, Johann Heinrich von Thünen-Institut, Danish Institute for Fisheries Research, and Spanish Institute of Oceanography (2019). International Blue Whiting Spawning Stock Survey (IBWSS) Spring 2019. Marine Institute, Galway. http://hdl.handle.net/10793/1395

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White, J., Aristegui, M., Blaszkowski, M., Fee, D., O'Connor, S., Power, J., Notaro, D., **O' Brien,** & **Doyle, J.**, (2019). The Labadie, Jones and Cockburn Banks Nephrops Grounds (FU20-21) 2019 UWTV Survey Report and catch scenarios for 2020. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/1430

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Depestele, J., Feekings, J., **Reid, D. G**., Cook, R., Gascuel, D., Girardin, R., ... & Savina-Rolland, M. (2019). The impact of fisheries discards on scavengers in the sea. In S. S. Uhlmann, C. Ulrich, & S. J. Kennelly (Eds.), The European Landing Obligation: Reducing Discards in Complex, Multi-Species and Multi-Jurisdictional Fisheries (pp. 129-162). Springer, Cham. https://doi.org/10.1007/978-3-030-03308-8_7

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Lorente, P., Sotillo, M. G., Amo-Baladrón, A., Aznar, R., Levier, B., Aouf, L., **Dabrowski, T.**, ... & Álvarez-Fanjul, E. (2019). The NARVAL Software Toolbox in Support of Ocean Models Skill Assessment at Regional and Coastal Scales. In J. M. F. Rodrigues, P. J. S. Cardoso, J. Monteiro, R. Lam, V. V. Krzhizhanovskaya, M. H. Lees, J. J. Dongarra, & P. M. A. Sloot (Eds.), *Computational Science – ICCS 2019* (Vol. 11539, pp. 315–328). Springer International Publishing. https://doi.org/10.1007/978-3-030-22747-0_25

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APPENDIX 5

SCIENTIFIC PAPERS AND PUBLICATIONS

(Authors highlighted in bold indicate Marine Institute contributors)

SCIENTIFIC PAPERS

Alves, R. N., Rambla-Alegre, M., Braga, A. C., Maulvault, A. L., Barbosa, V., Campàs, M., Reverté, ..., **Kilcoyne, J.**,... & Marques, A. (2019). Bioaccessibility of lipophilic and hydrophilic marine biotoxins in seafood: An in vitro digestion approach. *Food and Chemical Toxicology*, *129*, 153–161. **https://doi.org/10.1016/j.fct.2019.04.041**

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Birchill, A. J., Hartner, N. T., Kunde, K., **Siemering, B.**, Daniels, C., González-Santana, D., ... & Lohan, M. C. (2019). The eastern extent of seasonal iron limitation in the high latitude North Atlantic Ocean. *Scientific Reports*, *9*(1), 1435. **https://doi.org/10.1038/s41598-018-37436-3**

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APPENDIX 6

RESEARCH VESSEL PROGRAMME 2019

Research Vessel: *Celtic Explorer*
Start Date: 01/01/2019 End Date: 31/12/2019
No. of Surveys: 16

Survey Code	Survey Name	Start Date	End Date	Survey Days	No. of Scientists	Scientist Days
CE19001	MMRRC Research and MRE-ROV Missions 2019	04/01/2019	14/01/2019	11	8	88
CE19002	BSH Survey no.1	18/01/2019	30/01/2019	13	12	156
CE19003	Mackerel egg survey 2019	08/02/2019	28/02/2019	21	6	126
CE19004	Irish Anglerfish and Megrim Survey	01/03/2019	25/03/2019	25	10	250
CE19005	Blue whiting acoustic survey	26/03/2019	15/04/2019	21	6	126
CE19006	Irish Anglerfish and Megrim Survey	16/04/2019	25/04/2019	10	9	90
CE19007	Backscatter and Biodiversity on Shelf Sea Habitats (BaBioSSH)	28/04/2019	12/05/2019	15	9	135
CE19008	MOnitoring CHAnge in Submarine CANyon Coral Habitats {MoCha_SCan}	13/05/2019	23/05/2019	11	6	66
CE19009	Ocean Climate Section - extended S Rockall Trough section	24/05/2019	06/06/2019	14	13	182
CE19010	WESPAS	13/06/2019	24/07/2019	42	17	714
CE19014	MOnitoring CHAnge in Submarine CANyon Coral Habitats {MoCha_SCan}: leg2	25/07/2019	31/07/2019	7	11	77
CE19015	EMFF Offshore reef -SeaRover 3	01/08/2019	21/08/2019	21	9	189
CE19016	BSH Summer	26/08/2019	17/09/2019	23	10	230
CE19011	INFOMAR Seabed Mapping	21/09/2019	08/10/2019	18	4	72
CE19012	Celtic Herring Acoustic Survey	09/10/2019	29/10/2019	21	12	252
CE19013	IGFS 2019 Leg I_IV	30/10/2019	15/12/2019	47	15	705
				320		**3458**

Research Vessel: *Celtic Voyager*

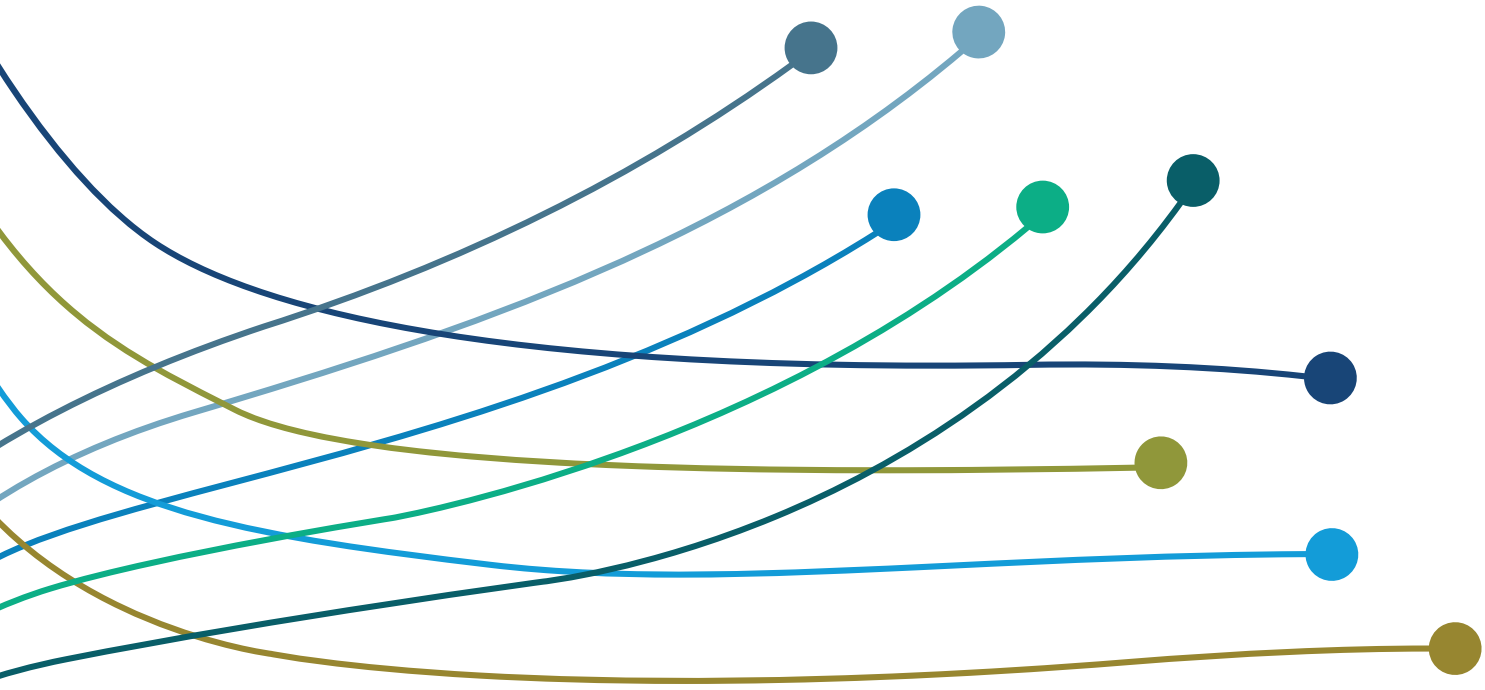
Start Date: 01/01/2019 End Date: 31/12/2019 No. of Surveys: 36

Survey Code	Survey Name
CV19001	Winter Environmental Survey 2019
CV19002	Conservation Behaviour Monitoring GMIT
CV19003	IMP.act.sea I - Assessment of microplastic hotspots in Galway Bay
CV19005	NMCI - Shipboard familiarisation and training
CV19006	SMART SEMRU M.Econ.Sci Training Survey 2019
CV19007	SMART UCC MaREI Ocean Energy 2019
CV19009	NMCI - Shipboard familiarisation and training
CV19010	Undergraduate Shipboard Training
CV19033	IMMErSE - Irish Marine Mammals Ecosystem-based SurvEy
CV19011	Quantifying Irish Marine Placer Resources II (QuIMPeR II)
CV19008	Science@Sea Multidisciplinary Marine Science Training 2019
CV19012	INFOMAR
CV19013	Langolf TV 2019
CV19014	INFOMAR
CV19015	Aran-Porcupine Nephrops UWTV
CV19016	Ocean Sampling Day
CV19017	Celtic Sea 1 Nephrops UWTV
CV19018	DINO19
CV19019	INFOMAR
CV19020	Marine top predators on the 100m contour
CV19021	The Biological Oceanography of Habs in Irish Waters
CV19022	Celtic Sea 2 Nephrops UWTV
CV19034	INFOMAR
CV19023	Derisking Offshore Wind Energy Development Potential in Irish Waters (DOWindy)
CV19024	NUIG Post-Graduate Training 2019
CV19039	Day grab trials
CV19025	Multidisciplinary Survey Planning â€“ A Peer Assisted Learning exercise led by postgraduates
CV19026	Derisking Offshore Wind Energy Development Potential in Irish Waters (DOWindy) Leg 2
CV19027	Geohazard Investigation in the Irish Sea using Seismic and Seabed Mapping Techniques (GIST)
CV19028	SMART NUIG Multidisciplinary Offshore Operations in Marine Science 2019
CV19029	UCC MSc Marine Biology 2019 (Annual Request)
CV19030	SMART NUI Maynooth MSc Climate Change Training Survey 2019
CV19031	SMART UCC BSc Multidisciplinary Offshore Operations in Marine Science 2019
CV19040	NUIG Post-Graduate Training 2019
CV19032	SMART UCC Postgraduate Offshore Environmental Geology 2019
CV19038	NW Herring Acoustic Trawl Survey 2019
Totals	

	Start Date	End Date	Survey Days	No. of Scientists	Scientist Days
	10/01/2019	22/01/2019	13	6	78
	25/01/2019	01/02/2019	8	3	24
	02/02/2019	06/02/2019	5	6	30
	18/02/2019	18/02/2019	1	2	2
	19/02/2019	19/02/2019	1	3	3
	20/02/2019	20/02/2019	1	4	4
	25/02/2019	25/02/2019	1	2	2
	01/03/2019	04/03/2019	4	4	16
	13/03/2019	19/03/2019	7	3	21
	22/03/2019	01/04/2019	11	4	44
	08/04/2019	11/04/2019	4	4	16
	12/04/2019	29/04/2019	18	5	90
	02/05/2019	15/05/2019	14	6	84
	18/05/2019	06/06/2019	20	5	100
	09/06/2019	20/06/2019	12	6	72
	21/06/2019	21/06/2019	1	4	4
	23/06/2019	03/07/2019	11	6	66
	05/07/2019	11/07/2019	7	4	28
	12/07/2019	30/07/2019	19	5	95
	31/07/2019	08/08/2019	9	6	54
	09/08/2019	18/08/2019	10	4	40
	20/08/2019	28/08/2019	9	5	45
	29/08/2019	14/09/2019	17	3	51
	16/09/2019	28/09/2019	13	6	78
	03/10/2019	06/10/2019	4	5	20
	07/10/2019	07/10/2019	1	2	2
	08/10/2019	15/10/2019	8	7	56
	16/10/2019	20/10/2019	5	6	30
	24/10/2019	06/11/2019	14	6	84
	08/11/2019	13/11/2019	6	4	24
	14/11/2019	15/11/2019	2	2	4
	16/11/2019	17/11/2019	2	4	8
	18/11/2019	21/11/2019	4	4	16
	22/11/2019	23/11/2019	2	3	6
	24/11/2019	27/11/2019	4	4	16
	01/12/2019	10/12/2019	10	5	50
			278		**1363**

Research Vessel: ROV *Holland 1*
Start Date: 01/01/2019 End Date: 31/12/2019
No. of Surveys: 4

Survey Code	Survey Name	Start Date	End Date	Survey Days	No. of Scientists	Scientist Days
CE19007	Backscatter and Biodiversity on Shelf Sea Habitats (BaBioSSH)	28/04/2019	12/05/2019	9	13	135
CE19008	Monitoring Change in Submarine Canyon Habitats (MoChaScan) leg 1	13/05/2019	23/05/2019	11	6	66
CE19014	Monitoring Change in Submarine Canyon Habitats (MoChaScan) leg 2	25/07/2019	31/07/2019	7	11	77
CE19015	EMFF Offshore Reef -SeaRover 3	01/08/2019	21/08/2019	21	9	189
Totals				**48**	**39**	**467**



APPENDIX 7

FOREIGN MARINE SCIENTIFIC RESEARCH ACTIVITIES IN IRISH WATERS IN 2019

FOREIGN VESSEL OBSERVER SCHEME 2019

35 foreign vessels conducted marine research surveys in Irish waters in 2019. The Northern Irish RV Corystes which has blanket approval to operate in Irish waters accounted for 6 of these surveys. Of the remaining surveys, 14 were UK vessels and the rest were French (1), Norwegian (2), Spanish (3), Dutch (4), German (3) and Belgian (2). The Marine Institute placed a total of 12 Irish observers, mostly recent marine science graduates, on foreign vessel surveys in 2019 with a total of 208 days at sea between them.

Scientist Days Ireland	Scientist Days Foreign
4355	**4375**

Country	Vessel Name	Survey Name /Code	Discipline	No. of Days in Irish waters	No. of Scientists	Scientist Days
UK	Cefas Endeavour *	Ground fish survey using commercially based survey standardised otter trawl	Fisheries	16	14	224
UK	Scotia	Bottom trawl survey targeting juvenile gadoid species	Fisheries	7	7	49
UK	Achilles	Agri-Food and Biosciences Institute Irish Sea Cod and round Fish Survey 2019-Fishery Science Partnership	Fisheries	25	2	50
UK	Cefas Endeavour *	Ground fish survey using 4m beam trawl	Fisheries	14	16	224
Netherlands	Tridens *	Blue Whiting Acoustic Survey	Fisheries	19	7	133
Spain	Miquel Oliver *	Blue Whiting Acoustic Survey	Fisheries	12	15	180
UK	MV Altaire	Mackerel Egg Survey 0119H	Fisheries	11	5	55
Germany	Walther Herwig III	Mackerel and Horse Mackerel Egg Survey	Fisheries	27	12	324
Norway	Kings Bay	Acoustic assessment of the blue whiting spawning stock. And Observations on hydrography	Fisheries	12	7	84
Spain	Ramon Margalef	Blue Whiting Acoustic Survey	Fisheries	10	15	150
UK	MV Altaire	Mackerel egg survey, to determine the spawning distribution of mackerel in the Atlantic	Fisheries	8	5	40
UK	MFV Genisis	Trawl survey to determine the abundance and distribution of anglerfish	Fisheries	6	4	24

Country	Vessel Name	Survey Name /Code	Discipline	No. of Days in Irish waters	No. of Scientists	Scientist Days
Norway	Fiskebas	Tagging and biological sampling of mackerel West of Scotland and Ireland	Fisheries	27	6	162
Netherlands	Tridens *	Mackerel and Horse Mackerel Egg Survey	Fisheries	6	8	48
UK	Scotia	Icthyoplankton survey sampling the water column for mackerel and horse mackerel eggs	Fisheries	17	7	119
Germany	Maria S Merian	Physical Oceanographic survey - to obtain continuous time series of the variability of the North Atlantic Current	Oceanographic	5	23	115
Belgium	BNS Belgica	Quality evaluation of an acoustic system and comparative studies with ground truthing on the French and UK reference areas for bathymetry and backscatter measurements	Geological/ Acoustic	5	15	75
Belgium	BNS Belgica *	The project DynaMOD will focus on the increase of bottom current intensity in the presence of a seabed with a complex topography such as cold-water coral mounds	Geology/ Geophysics	8	15	120
Netherlands	Tridens	Mackerel and Horse Mackerel Egg Survey	Fisheries	6	8	48
Netherlands	Pelagia *	The unknown role of submarine Canyons- Pathways or sinks for Organic Carbon	Oceanographic/ Marine Biology	15	14	210
UK	Altaire	Mackerel egg survey, to determine the spawning distribution of mackerel & horse mackerel in the Atlantic	Fisheries	18	6	108
UK	Scotia	Bottom trawl survey targeting juvenile gadoid species	Fisheries	8	9	72
UK	Cefas Endeavour *	Irish Sea and Bristol Channel Beam trawl survey	Fisheries	10	7	70
UK	RSS Discovery	Evaluating the status of cold-water corals in the Darwin Mound Special Area of Conservation (Class Project)	Oceanographic/ Geophysics	10	28	280
Spain	Vizconde de Eza *	Abundance estimations and distribution patterns of demersal-benthic species.	Fisheries	30	15	450
UK	Scotia	Deep water trawling survey	Fisheries	10	12	120
UK	Scotia *	Trawl survey and CTD Sampling	Fisheries	19	8	
Germany	Walther Herwig III *	Investigations on the occurrence of fish diseases and biological effects of contaminants, OSPAR/HELCOM monitoring	Biological	8	12	96
France	Thalassa *	EVHOE Survey	Fisheries	7	25	175
UK	Corystes	Ecosystems Health /Compass. To maintain an in situ monitoring programme in the Irish Sea and Liverpool Bay. To undertake MSFD water sampling across the Irish Sea Transect	Fisheries	57	20	570
Totals				**433**	**347**	**4375**

**Irish observers participated in these surveys.*

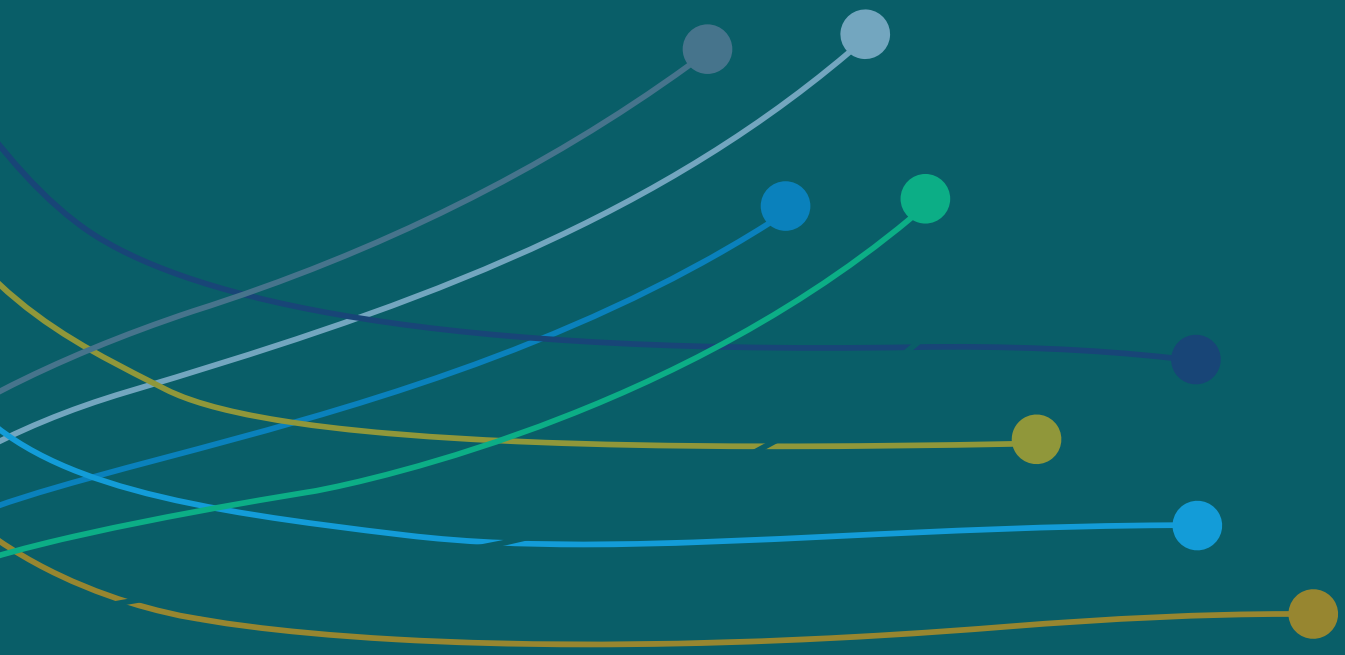
GLOSSARY OF ABBREVIATIONS

AMS	Advanced Mapping Services
AORA	Atlantic Ocean Research Alliance
ARC	Aquaculture Research Committee AND Audit Risk Committee
ARGO floats	Temperature/salinity profiling floats
ASP	Amnesic shellfish poisoning
BA	Bachelor of Arts
BIM	Bord Iascaigh Mhara (the Irish Sea Fisheries Board)
BSc	Bachelor of Science
CEFAS	Centre for Environment, Fisheries and Aquaculture (UK)
CEO	Chief Executive Officer
CTD	Conductivity, Temperature and Depth
DAFM	Department of Agriculture, Food and the Marine
DCCAE	Department of Communications, Climate Action and Environment
DCMAP	Data Collection Multiannual Programme
DCU	Dublin City University
DHPLG	Department of Housing, Planning and Local Government
DSP	Diarrhetic Shellfish Poisoning
DTTAS	Department of Transport, Tourism and Sport
EEZ	European Economic Zone
EI	Enterprise Ireland
EMFF	European Maritime and Fisheries Fund
EPA	Environmental Protection Agency
EU	European Union
EurOcean	European Centre for Information on Marine Science and Technology
FIRM	Food Industry Research Measure
FEAS	Fisheries Ecosystems and Advisory Services
FP7	Seventh Framework Programme
FSAI	Food Safety Authority of Ireland
FSS	Fisheries Science Services
GIS	Geographic Information System
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GMIT	Galway-Mayo Institute of Technology
GSI	Geological Survey of Ireland
HABS	Harmful Algal Blooms Service
HEI	Higher Education Institutions
HR	Human Resources
IBM	International Business Machines Corporation
ICES	International Council for the Exploration of the Sea
ICT	Information Communications Technology
IDA	Industrial Development Authority
IFREMER	Institut français de recherché pour l'exploration de la mer (French Research Institute for the Exploration of the Sea)
IFSRP	Irish Fisheries Research Science Partnership
IHO	International Hydrographic Organisation
IMDBON	Irish Marine Data Buoy Observation Network
IMDO	Irish Maritime Development Office

INFOMAR	Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
INTERREG	EU Inter-Regional Cooperation Programme
INTGN	Irish National Tide Gauge Network
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
MaREI	Research Centre for Marine and Renewable Energy Ireland
MEFSS	Marine Environment and Food Safety Services
MRFF	Marine Research Funders' Forum
MSc	Master of Science
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
MSY	Maximum Sustainable Yield
NASCO	North Atlantic Salmon Conservation Organisation
NDP	National Development Programme
NMCI	National Maritime College of Ireland, Cork
NMPF	National Marine Planning Framework
NOAA	National Oceanic and Atmospheric Administration
NPWS	National Parks and Wildlife Service
NUI Galway	National University of Ireland, Galway
NUI Maynooth	National University of Ireland, Maynooth
OAR	Open Access Repository
OIE	Office International des Epizooties (World Organisation for Animal Health)
OSIS	Ocean Science and Information Services
OSPAR	Oslo and Paris Convention (1992)
PhD	Doctor of Philosophy
PIRS	Policy, Innovation and Research Support Services
PSP	Paralytic Shellfish Poisoning
QUB	Queen's University Belfast
R&D	Research and Development
R&I	Research and Innovation
ROV	Remotely Operated Vehicle
RV	Research Vessel
SBIR	Small Business Innovation Research
SEAI	Sustainable Energy Authority of Ireland
SEMRU	Socio-Economic Marine Research Unit
SFI	Science Foundation Ireland
SFPA	Sea Fishers Protection Authority
SMEs	Small to Medium Sized Enterprises
UCC	University College Cork
UCD	University College Dublin
UK	United Kingdom
USA	United States of America
UU	University of Ulster
VIVALDI	Preventing and mitigating farmed bivalve diseases

FINANCIAL STATEMENTS

FOR THE YEAR ENDED 31 DECEMBER 2019



CONTENTS

ARD REACHTAIRE CUNTAS AGUS CISTE
COMPTROLLER AND AUDITOR GENERAL

Report for presentation to the Houses of the Oireachtas
Marine Institute

Opinion on the financial statements

I have audited the financial statements of the Marine Institute for the year ended 31 December 2019 as required under the provisions of section 12 of the Marine Institute Act 1991. The financial statements comprise

- the statement of income and expenditure and retained revenue reserves
- the statement of comprehensive income
- the statement of financial position
- the statement of cash flows and
- the related notes, including a summary of significant accounting policies.

In my opinion, the financial statements give a true and fair view of the assets, liabilities and financial position of the Marine Institute at 31 December 2019 and of its income and expenditure for 2019 in accordance with Financial Reporting Standard (FRS) 102 — *The Financial Reporting Standard applicable in the UK and the Republic of Ireland.*

Basis of opinion

I conducted my audit of the financial statements in accordance with the International Standards on Auditing (ISAs) as promulgated by the International Organisation of Supreme Audit Institutions. My responsibilities under those standards are described in the appendix to this report. I am independent of the Marine Institute and have fulfilled my other ethical responsibilities in accordance with the standards.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my opinion.

Report on information other than the financial statements, and on other matters

The Marine Institute has presented certain other information together with the financial statements. This comprises the annual report, the governance statement and Board members' report and the statement on internal control. My responsibilities to report in relation to such information, and on certain other matters upon which I report by exception, are described in the appendix to this report.

I have nothing to report in that regard.

Andrew Harkness
For and on behalf of the Comptroller and Auditor General
16 December 2020

Appendix to the report

Responsibilities of Board members

As detailed in the governance statement and Board members' report, the Board members are responsible for

- the preparation of financial statements in the form prescribed under section 12 of the Marine Institute Act 1991
- ensuring that the financial statements give a true and fair view in accordance with FRS 102 ensuring the regularity of transactions
- assessing whether the use of the going concern basis of accounting is appropriate ,and
- such internal control as they determine is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

Responsibilities of the Comptroller and Auditor General

I am required under section 12 of the Marine Institute Act 1991 to audit the financial statements of the Marine Institute and to report thereon to the Houses of the Oireachtas.

My objective in carrying out the audit is to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement due to fraud or error. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with the ISAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements .

As part of an audit in accordance with the ISAs, I exercise professional judgment and maintain professional scepticism throughout the audit. In doing so,

- I identify and assess the risks of material misstatement of the financial statements whether due to fraud or error; design and perform audit procedures responsive to those risks; and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- I obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the internal controls.
- I evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures .
- I conclude on the appropriateness of the use of the going concern basis of accounting and, based on the audit evidence obtained, on whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Marine Institute's ability to continue as a going concern. If I conclude that a material uncertainty exists I am required to draw attention in my report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify my opinion. My conclusions are based on the audit evidence obtained up to the date of my report. However, future events or conditions may cause the Marine Institute to cease to continue as a going concern.
- I evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

I communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that Iidentify during my audit.

Information other than the financial statements

My opinion on the financial statements does not cover the other information presented with those statements , and I do not express any form of assurance conclusion thereon.

In connection with my audit of the financial statements, I am required under the ISAs to read the other information presented and, in doing so, consider whether the other information is materially inconsistent with the financial statements or with knowledge obtained during the audit, or if it otherwise appears to be materially misstated. If, based on the work Ihave performed, I conclude that there is a material misstatement of this other information, I am required to report that fact.

Reporting on other matters

My audit is conducted by reference to the special considerations which attach to State bodies in relation to their management and operation. I report if I identify material matters relating to the manner in which public business has been conducted.

I seek to obtain evidence about the regularity of financial transactions in the course of audit. I report if I identify any material instance where public money has not been applied for the purposes intended or where transactions did not conform to the authorities governing them.

I also report by exception if, in my opinion,

- I have not received all the information and explanations I required for my audit, or
- the accounting records were not sufficient to permit the financial statements to be readily and properly audited, or
- the financial statements are not in agreement with the accounting records.

GOVERNANCE STATEMENT AND BOARD MEMBERS' REPORT

Governance

The Board of the Marine Institute was established under the Marine Institute Act, 1991. The functions of the Board are set out in section 3 of this Act. The Board is accountable to the Minister for Agriculture, Food and the Marine, is responsible for ensuring good governance, and performs this task by setting strategic objectives and targets and taking strategic decisions on all key business issues. The regular day-to-day management, control and direction of the Marine Institute are the responsibility of the Chief Executive Officer (CEO) and the senior management team. The CEO and the senior management team must follow the broad strategic direction set by the Board, and ensure that all Board members have a clear understanding of the key activities and decisions related to the entity, and of any significant risks likely to arise. The CEO acts as a direct liaison between the Board and management of the Marine Institute. In accordance with the Marine Institute Act, the Board discharges its duties as set out below.

Board Responsibilities

The work and responsibilities of the Board are set out in the *Board Standing Orders*, *The Schedule of Matters for Board Decision* and *The Roles of the Board*, *Chairman, Chief Executive* and Board Secretary, which also contain the matters specifically reserved for Board decision. Standing items considered by the Board include:

- Declaration of interests
- Reports from committees
- Financial statements and items of expenditure in excess of €50,000
- Implementation of strategy and
- Reserved matters.

The Board of the Marine Institute provides leadership and strategic direction for the organisation, defining the mission of the Institute and developing the policies required to achieve its goals. The Board sets performance targets and measures progress against these, closely monitoring budgets and financial performance. The Board leads the organisation in behaving ethically and in a manner that accords with the core values of the organisation.

Section 12 of the Marine Institute Act, 1991 requires the Board of the Marine Institute to keep, in such form as may be approved by the Minister for Agriculture, Food and the Marine with consent of the Minister for Public Expenditure and Reform, all proper and usual accounts of money received and expended by it.

In preparing these financial statements, the Board of the Marine Institute is required to:

- select suitable accounting policies and apply them consistently,
- make judgements and estimates that are reasonable and prudent,
- prepare the financial statements on the going concern basis unless it is intended to liquidate the organisation or to cease operations, or there is no realistic alternative but to do so, taking into account all available information about the future, which is at least, but not limited to twelve months from the date when the financial statements are authorised for issue and
- state whether applicable accounting standards have been followed, subject to any material departures disclosed and explained in the financial statements.

The Board is responsible for keeping adequate accounting records which disclose, with reasonable accuracy at any time, its financial position and enables it to ensure that the financial statements comply with Section 12 of the Marine Institute Act, 1991. The maintenance and integrity of the corporate and financial information on the Marine Institute's website is the responsibility of the Board.

The Board is responsible for approving the annual plan and budget. The Board is also responsible for safeguarding its assets and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

The Board considers that the financial statements of the Marine Institute give a true and fair view of the financial performance and the financial position of the Marine Institute for the year ended 31 December 2019 and as at 31 December 2019, respectively.

Board Structure

The Board consists of a Chairperson and eight ordinary members, all of whom are appointed by the Minister for Agriculture, Food and the Marine. The members of the Board were appointed for a period of five years and met ten times in 2019. The table below details the appointment period for current members:

Board Member	Role	Date Appointed/Reappointed (Term ended)
John Killeen	Chairperson	8th January 2019
Lorcán O'Cinneide	Ordinary Member	2nd December 2015 (Term ended 1st December 2020)
Dermot Clohessy	Ordinary Member	2nd December 2015 (Term ended 1st December 2020)
Alan Dobson	Ordinary Member	2nd December 2015 (Term ended 1st December 2020)
Owen Lewis	Ordinary Member	2nd December 2015 (Term ended 1st December 2020)
David Owens	Ordinary Member	6th February 2018
Berna Grist	Ordinary Member	6th February 2018
Patricia Barker	Ordinary Member	19th February 2018
Donal Kelly	Ordinary Member	15th April 2018

John Killeen's first term of office ended on 8 January 2019 and he was then reappointed for an additional five-year term by the Minister.

The Board has established two committees, as follows:

Audit and Risk Committee: comprises four Board members, all of whom are non-executive. The role of the Audit and Risk Committee (ARC) is to support the Board in relation to its responsibilities for issues of risk, control and governance and associated assurance. The ARC is independent from the financial management of the organisation. In particular, the Committee ensures that the internal control systems including audit activities are monitored actively and independently. The ARC reports to the Board after each meeting, and formally in writing annually.

The members of the Audit and Risk Committee are Patricia Barker (Chairman), David Owens, Dermot Clohessy and Donal Kelly. There were 10 meetings of the ARC in 2019.

In 2019, the Audit and Risk Committee conducted a self-evaluation of its performance and recommendations arising were implemented in full.

Board Strategy Committee: The initial role of the Board Strategy Committee was to guide the development of the Marine Institute Strategy 2018-2022. The Marine Institute's Board Strategy Committee was not active in 2019. It has been re-constituted in 2020 to assess progress at this mid-point of the period of the strategy. It comprises three Board members, all of whom are non-executive, being Lorcán O'Cinneide (Chairperson), Dermot Clohessy and Alan Dobson.

The Board establishes project specific advisory subgroups, as and when required. For 2019, the groups were as outlined below.

Vessel Oversight: This group comprises three Board members, all of whom are non-executive. The role of this group is to provide governance and oversight to the process for acquisition of the Marine Institute's new vessel, which is scheduled for delivery in 2022. The members of this sub-group are: Dr John Killeen (Chairperson), Lorcán O'Cinneide and Donal Kelly.

Department of Housing Planning and Local Government (DHPLG) Service Level Agreement (SLA) Oversight: The Marine Institute has entered into an SLA with the Department of Agriculture, Food and the Marine (DAFM) and DHPLG. This service Level agreement covers delivery of scientific services to DHPLG relating to the Water Framework Directive, the Marine Spatial Planning Directive, the Marine Strategy Framework Directive and the Oslo Paris Commission. This Group comprises two non –Executive Board members (Berna Grist and Owen Lewis). The role of this group is to provide support and governance oversight to the periodic review by the parties of the SLA progress and performance.

Communications Strategy development – The role of this group is to oversee the Marine Institute's communication strategy development. Its members are two non-executive Directors, being Owen Lewis and Alan Dobson.

Marine Technology and Ocean Energy Review – The role of this group is to oversee the Executive's review of the Marine Institute's role in supporting the Ocean Technology and Ocean Renewable Energy development objectives contained within the Marine Institute's strategy. Its members are two non-executive Directors, being Owen Lewis and Dermot Clohessy.

Schedule of Attendance, Fees and Expenses

A schedule of attendance at the Board and Audit and Risk Committee meetings for 2019 is set out below including the fees and expenses received by each member:

Name	Board	Audit and Risk Committee	Fees 2019 €	Expenses 2019 €
Number of Meetings	**10**	**10**		
John Killeen	10		11,970	
Patricia Barker	9	10	7,695	1,827
David Owens	10	8	7,695	1,172
Berna Grist	10		7,695	2,864
Lorcán O'Cinneide*	9		-	3,857
Donal Kelly	7	6	7,695	4,457
Dermot Clohessy	9	10	7,695	1,936
Alan Dobson*	9		7,695	3,708
Owen Lewis	10		7,695	1,089
Total			**65,835**	**20,910**

*** Mr Alan Dobson is employed by UCC and the fee is paid to UCC and not directly to him under the One Person One Salary (OPOS) principle. Mr. Lorcán O'Cinneide did not receive a board fee under the One Person One Salary (OPOS) principle in 2019.**

Disclosures Required by Code of Practice for the Governance of State Bodies (2016)

The Board is responsible for ensuring that the Marine Institute has complied with the requirements of the Code of Practice for the Governance of State Bodies ("the Code"), as published by the Department of Public Expenditure and Reform in August 2016. The following disclosures are required by the Code:

Consultancy Costs

Consultancy costs include the cost of external advice to management and exclude outsourced 'business-as-usual' functions.

	2019 €	2018 €
Legal	81,876	64,938
Financial and Governance	223,394	179,487
PR/Marketing	50,857	25,656
HR and Pension	9,446	14,329
Business Planning	13,288	15,785
Evaluators	69,954	64,187
Business Development	25,746	69,495
IT	25,817	28,597
Shipping Development	121,718	277,561
Other	119,533	55,965
Total	**741,629**	**796,000**

Legal Costs and Settlements

The Marine Institute had no legal costs or settlements in connection with dealings with third parties. This does not include expenditure incurred in relation to general legal advice received by the Marine Institute which is disclosed in Consultancy costs above.

Travel and Subsistence Expenditure

Travel and subsistence expenditure is categorised as follows:

		2019 €	2018 €
Domestic	Board	20,910	25,400
	Employees	760,154	680,861
International	Board	-	-
	Employees	796,888	551,817
Total		**1,577,952**	**1,258,078**

Hospitality Expenditure

The Statement of Income and Expenditure includes the following hospitality expenditure:

	2019 €	2018 €
Staff Hospitality	11,457	6,148
Client Hospitality	6,692	755
Total	**18,149**	**6,903**

Statement of Compliance

The Board has adopted the Code of Practice for the Governance of State Bodies (2016) and has put procedures in place to ensure compliance with the Code. The Marine Institute was in full compliance with the Code of Practice for the Governance of State Bodies at 31 December 2019.

On behalf of the Board

Dr John Killeen
Chairperson
8 December 2020

MARINE INSTITUTE STATEMENT ON INTERNAL CONTROL

Scope of Responsibility

On behalf of the Marine Institute, I acknowledge the Board's responsibility for ensuring that an effective system of internal control is maintained and operated. This responsibility takes account of the requirements of the Code of Practice for the Governance of State Bodies 2016.

Purpose of the System of Internal Control

The system of internal control is designed to manage risk to a tolerable level rather than to eliminate it. The system can therefore only provide reasonable and not absolute assurance that assets are safeguarded, transactions authorised and properly recorded and that material errors or irregularities are either prevented or detected in a timely way.

The system of internal control, which accords with guidance issued by the Department of Public Expenditure and Reform, has been in place in the Marine Institute for the year ended 31 December 2019 and up to the date of approval of the financial statements.

Key Control Procedures

The Board of the Marine Institute has established a strong and robust control environment in the Marine Institute through:

- Holding regular Board meetings where the agenda includes strategic issues such as corporate governance, financial management and corporate strategy
- The implementation of the Marine Institute Strategy
- Clearly defined management responsibilities, authority and accountability, delegation of appropriate functions and reviewing and approving all Marine Institute policies
- Approval of annual budgets, cash flow forecasting and capital programme expenditure with formal review of these at each Board meeting
- The work of the Audit and Risk Committee, which met ten times in 2019
- Five internal audits were conducted in 2019, with regular meetings between the Audit and Risk Committee and the Internal Auditors to discuss their work programme, the outcomes of their audits, their recommendations and a private meeting without members of the executive
- Consideration of any recommendations made by the External Auditor
- The operation of a risk management system with annual review of the risk policy and regular review of the risk register and report from the joint risk officers
- Robust systems of health and safety, with monthly reports to the Board
- Monitoring of compliance with legislation including Freedom of Information and Access to Environmental Information
- Implementation of a Protected Disclosures Policy, through which the Institute encourages anyone having in good faith suspicions of fraud, financial irregularity of other improper behaviour or practice; to report this in accordance with the procedures set out in the policy. There were no protected disclosures made in 2019.
- The systems of internal control as detailed in the Marine Institute Operating Control Framework which sets out each of the key controls in place within the Institute, together with the owner of each control. To further improve the quality of the report, each of the control owners has submitted an Assurance Statement for each set of controls in respect of 2019.

Statement on Internal Control

The Statement on Internal Control was reviewed by the Audit and Risk Committee on 25 February 2020.

Financial and Budgetary Management Systems

There is a comprehensive annual budgeting system with annual income, budget allocation process, cash flow forecasting and capital programme budgeting reviewed and approved by the Board at the start of each year, with formal review at each subsequent Board meeting. Policies and procedures are in place in relation to budgetary and financial matters, with all contracts with a value in excess of €50,000 coming to the Board for consideration and approval. There are regular reviews by the Executive of financial management reports and a Corporate Procurement Plan is in place.

Procedures for monitoring the effectiveness of the Internal Control System

The 2019 Internal Audit Plan was implemented in full with the following audits completed during the calendar year:

- Review of 2018 Internal Financial Controls
- Compliance with the Code of Practice for the Governance of State Bodies for 2018
- Review of vessel procurement process (two audits of two different stages of the process)
- Review of Contractors and vessel logs

Implementation plans to address internal audit recommendations are approved by the Audit & Risk Committee. Progress on the implementation of the agreed actions is reviewed annually and reported to the Audit & Risk Committee.

The Internal Audit Plan for 2019 reflected the risks identified in the Marine Institute's Risk Register, the management letter of the Office of the Comptroller and Auditor General, and general developments and issues in relation to Corporate Governance. The Internal Audit Plan for 2019-2021 was approved by the Audit & Risk Committee in December 2018 and by the Marine Institute Board in February 2019. This is a rolling plan which will be reviewed and updated in 2020 for current risk assessments, the results of audits and to consider the impact of general corporate governance developments.

Capacity to Handle Risk

The Marine Institute has an Audit and Risk Committee (ARC) comprising four Board members with a broad range of experience including financial and audit expertise, one of whom is the Chair.

The Marine Institute has also established an internal audit function, which is adequately resourced and conducts a programme of work agreed with the ARC and approved by the Board. The internal audit function is outsourced to a commercial firm. To ensure appropriate business continuity, two joint Risk Officers have been appointed.

The ARC oversees the implementation of the risk management policy, which sets out the Marine Institute's risk appetite, the risk management processes in place and details the roles and responsibilities of staff in relation to risk. The policy has been issued to all staff so as to ensure management are alert to emerging risks and so that each staff member is aware of their responsibility for mitigation of risk and operation of controls within their own area of work.

The financial implications of business risks have been considered through the formal business risk assessment process and in the preparation of the Marine Institute's Internal Audit Plans. A comprehensive set of Financial Procedures have been put in place to control the significant financial elements of the Marine Institute's business including authorisation limits for purchasing/expenditure.

Risk and Control Framework

The Marine Institute has implemented a risk management system which identifies and reports key risks and the management actions being taken to address and, to the extent possible, to mitigate those risks.

The Marine Institute's Risk Management Policy and Business Continuity Policy comply with the Code of Practice for the Governance of State Bodies 2016. The Marine Institute has appointed two Risk Officers. A risk register is in place which identifies the key risks facing the Marine Institute and these have been identified, evaluated and ranked according to their significance. The register is updated by the Executive on a quarterly basis and presented to the ARC. The outcome of these assessments is used to plan and allocate resources to ensure risks are mitigated against and managed to an acceptable level.

The risk register details the controls and actions needed to mitigate against risks and assigns responsibility for the operation of controls to specific staff. I confirm the following with regard to the control environment:

- Procedures for all key business processes have been documented
- Financial responsibilities have been assigned at management level with corresponding accountability
- There is an appropriate budgetary system with an annual budget which is kept under review by senior management
- There are systems aimed at ensuring the security of the information and communication technology systems
- There are systems in place to safeguard the assets, and
- Control procedures over grant funding to outside agencies ensure adequate control over approval of grants and monitoring and review of grantees to mitigate against the risk that grant funding might not be applied solely for the purpose intended.

Ongoing Monitoring and Review

Formal procedures have been established for monitoring control processes and control deficiencies are communicated to those responsible for taking corrective action and to management and the Board, where relevant, in a timely way. I confirm that the following ongoing monitoring systems are in place:

- Key risks and related controls have been identified and processes have been put in place to monitor the operation of those key controls and report any identified deficiencies
- Reporting arrangements have been established at all levels where responsibility for financial management has been assigned, and
- There are regular reviews by senior management of periodic and annual performance and financial reports which indicate performance against budgets/forecasts

Procurement

I confirm that the Marine Institute has procedures in place to ensure compliance with current procurement rules and guidelines. Except for the issues noted in the Internal Control paragraph below, the Institute was in compliance with these procedures during 2019.

Review of Effectiveness

I confirm that the Marine Institute has procedures in place to monitor the effectiveness of its risk management and control procedures. A review of the performance of the Board and the Audit and Risk Committee was undertaken through a self-appraisal exercise in late 2019. An external independent review of the Board and the Audit and Risk Committee also commenced in 2019. The Marine Institute's monitoring and review of the effectiveness of the system of internal financial control is informed by the work of the internal and external auditors, the Audit and Risk Committee, which oversees their work, and the senior management within the Marine Institute responsible for the development, and maintenance of the internal control framework.

Annual Review of the Effectiveness on Internal Control

I confirm that the Board conducted an annual review of the effectiveness of internal controls for 2019 and was approved by the Board on 25 February 2020. In undertaking this review, the Board considered the following:

- Risk management policies, systems and procedures
- Five internal audits which were completed in 2019
- Any internal audits completed in 2020 relating to the 2019 period
- Results of the external audit by the Comptroller and Auditor General
- The work of the Audit and Risk Committee

Internal Control Issues

There were no material losses, frauds or breaches in control in 2019.

The audit of the 2017 financial statements drew attention to weaknesses in control over fixed assets. Over 2018 and 2019, the Institute has worked to address the deficiencies noted. The final element of this work was to conduct a full stocktake of fixed assets during 2019. This is now complete and the statement of financial position reflects the outcome of this work, with a write down to the net book value of fixed assets during 2019 of €16,000 (Being cost of €7.991m net of accumulated depreciation of €7.975m).

The Marine Institute pays grants to various third parties (e.g. third level institutions, companies involved in marine research) under the Marine Research programme. In accordance with the provisions of Department of Public Expenditure and Reform (DPER) Circular 13/2014 (Management of and Accountability for Grants from Exchequer Funds) the Institute applied in February 2019, via the Department of Agriculture, Food and the Marine, for sanction from DPER to continue pre-funding these grants. At the date of approving the financial statements, the Institute had not received formal sanction. from DPER. However, it was confirmed (subsequently) that the sanction had been received from DPER by the Department of Agriculture Food and the Marine (parent Department, Marine Institute).

During 2019, orders of laboratory supplies were considered from a procurement perspective on a case by case basis, with three quotes or tenders being issued depending on the anticipated value of the specific order involved. In certain instances, cumulative purchases of multiple consumable types over time by different buyers from certain suppliers exceeded €25,000 and the total was not the subject of a tender. When this matter came to light in late 2019 during the 2018 audit, we reviewed this spend with a view to commencing the complex process of issuing an appropriate tender for these supplies, taking account of our scientific needs, quality and accreditation standards. We were subsequently advised that the Office of Government Procurement was introducing a new framework in 2020 for laboratory consumables. This framework commenced in April 2020 and have commenced utilisation of same. Implementation is being phased in across our service areas through 2020.

No other weaknesses in internal control were identified in 2019 that require disclosure in the financial statements.

On behalf of the Board

Dr John Killeen
Chairperson
8 December 2020

MARINE INSTITUTE
STATEMENT OF INCOME AND EXPENDITURE AND RETAINED REVENUE RESERVES

YEAR ENDED 31 DECEMBER 2019

	Note	2019 €'000	2018 €'000
Income			
Oireachtas Grants	2	35,496	32,430
Other State Grants	3	10,011	7,703
EU and Other Income	4	9,940	9,781
Net Deferred Funding For Retirement Benefits	19	4,067	4,296
		59,514	**54,210**
Expenditure			
Remuneration and Pension Costs	5	13,937	13,671
Retirement Benefit Costs	19	4,217	4,159
Vessel Operating Costs	6	8,144	8,136
Travelling Expenses	7	1,577	1,258
Grants and External Service Providers	8	16,211	15,503
Facilities Costs	9	2,015	1,872
IT, Telephone & Communications		1,496	1,717
Laboratory & Field Costs		1,338	1,296
Other Administration and Equipment Hire Costs	10	3,073	3,679
Depreciation	15	4,852	4,857
Total Expenditure		**56,860**	**56,148**
Transfer (to)/from Capital Account	14	(2,636)	1,942
Surplus for the year		**18**	**4**
Balance brought forward at 1 January		1,997	1,993
Balance carried forward at 31 December		**2,015**	**1,997**

The Statement of Cash flows and Notes 1 – 24 form part of these financial statements.

On Behalf of the Board

Dr John Killeen
Chairperson
8 December 2020

On Behalf of the Board

Prof Patricia Barker
Board Member
8 December 2020

MARINE INSTITUTE STATEMENT COMPREHENSIVE INCOME

YEAR ENDED 31 DECEMBER 2019

	Note	2019 €'000	2018 €'000
Surplus for the year		18	4
Revaluation of Assets	16	-	5,460
Experience Gains /(Losses) on Retirement Benefits Scheme Obligation	19	273	(1)
Changes in assumptions underlying the present value of the Retirement Benefit Obligation	19	(7,418)	767
Adjustment to Deferred Benefits Scheme Funding		7,145	(766)
Total Comprehensive Income for the year		**18**	**5,464**

The Statement of Cash flows and Notes 1 – 24 form part of these financial statements.

On Behalf of the Board

Dr John Killeen
Chairperson
8 December 2020

On Behalf of the Board

Prof Patricia Barker
Board Member
8 December 2020

MARINE INSTITUTE
STATEMENT OF FINANCIAL POSITION

AS AT 31 DECEMBER 2019

	Note	2019 €'000	2019 €'000	2018 €'000	2018 €'000
Property, Plant and Equipment	15		24,421		21,801
Current Assets					
Receivables	17	8,703		7,406	
Cash and cash equivalents		552		3,300	
		9,255		**10,706**	
Current Liabilities (amounts falling due within one year)					
Payables	18	7,240		8,709	
Net Current Assets			2,015		1,997
Total Assets Less Current Liabilities before Retirement Obligations			**26,436**		**23,798**
Deferred Retirement Benefit Obligations	19	(74,341)		(63,129)	
Deferred Retirement Benefit Funding	19	74,341		63,129	
Total Net Assets			**26,436**		**23,798**
Representing					
Capital Account	14	18,961		16,341	
Revaluation Reserve	16	5,460		5,460	
Retained Revenue Reserves		2,015		1,997	
			26,436		**23,798**

The Statement of Cash flows and Notes 1 – 24 form part of these financial statements.

On Behalf of the Board

Dr John Killeen
Chairperson
8 December 2020

On Behalf of the Board

Prof Patricia Barker
Board Member
8 December 2020

MARINE INSTITUTE STATEMENT OF CASH FLOWS

YEAR ENDED 31 DECEMBER 2019

	2019 €'000	2018 €'000
Net Cash flows from operating activities		
Surplus\(Deficit) for the financial year	18	4
Adjustments for:		
Depreciation of tangible Property, Plant and Equipment	4,852	4,857
Transfer to Capital Account	2,636	(1,942)
(Increase) Decrease in Receivables	(1,297)	(425)
Increase (Decrease)/ in Payables	(1,469)	3,584
Net cash flows from operating activities	**4,740**	**6,078**
Cash flows from investing activities		
Payments for tangible Property, Plant and Equipment	(7,488)	(2,915)
Net cash flows from investing activities	**(7,488)**	**(2,915)**
Net increase(decrease)/ in cash and cash equivalents	**(2,748)**	**3,163**
Cash and cash equivalents at beginning of financial year	3,300	137
Cash and cash equivalents at end of financial year	**552**	**3,300**

NOTES TO FINANCIAL STATEMENTS

YEAR ENDED 31 DECEMBER 2019

1. Accounting Policies

The basis of accounting and significant accounting policies adopted by the Marine Institute are set out below. They have all been applied consistently throughout the year. The Institute has analysed its expenditure based on the nature of the expense as opposed to a programme basis.

(a) General Information

The Marine Institute was established on 30 October 1992 under the provisions of the Marine Institute Act 1991. The Institute headquarters is located in Rinville, Oranmore, County Galway, H91 R673.

The Marine Institute's primary objectives as set out in section 4 of the Act are
"to undertake, to co-ordinate, to promote and to assist in marine research and development and to provide such services related to marine research and development, that in the opinion of the Institute will promote economic development and create employment and protect the marine environment".

The Marine Institute is a Public Benefit Entity (PBE).

(b) Statement of Compliance

The financial statements of The Marine Institute for the year ended 31 December 2019 have been prepared in accordance with FRS 102, the financial reporting standard applicable in the UK and Ireland issued by the Financial Reporting Council (FRC), as promulgated by Chartered Accountants Ireland.

(c) Currency

The financial statements have been presented in Euro (€) which is also the functional currency of the Institute. In instances where amounts have been rounded to the nearest thousand Euro, this is indicated by the symbol €'000.

(d) Basis of Preparation

The financial statements are prepared under the accruals method of accounting and under the historical cost convention, except that land and property is stated at fair value, in the form approved by the Minister for Food, Agriculture and the Marine with the concurrence of the Minister for Public Expenditure and Reform, in accordance with Section 12(1) of the Marine Institute Act 1991.

The financial statements are prepared using the going concern basis of accounting. There are no events between the reporting date and the date of approval of these financial statements for issue that require adjustment to the financial statements. The Board have considered the impact of COVID19, the future funding of the Institute and its strategic and operational planning and have concluded that there are no material uncertainties that may cast significant doubt about Institute's ability to continue to adopt the going concern basis of accounting for a period of at least twelve months from the date when the financial statements are authorised for issue.

The following accounting policies have been applied consistently in dealing with items which are considered material in relation to The Marine Institute's financial statements.

(e) Income

Income arising from Oireachtas Grants is recognised on a cash receipts basis, except for the Oireachtas income in relation to the European Maritime and Fisheries Fund (EMFF) expenditure. This is recognised on an accruals basis as the Oireachtas income for the direct related expenditure is funded in the year after occurrence of the expenditure.

Income received in relation to EU and other contract research projects is recognised on an accruals basis whereby the income is recognised in the accounting period in which the related expenditure is charged. Income received in advance is treated as deferred income and included within Payables in the Statement of Financial Position. Expenditure incurred where the related income has not been received is treated as accrued income and shown as a Receivable in the Statement of Financial Position.

(f) Property, Plant and Equipment and Depreciation

Plant and Equipment are stated at cost less accumulated depreciation.

Land and property is stated at valuation less accumulated depreciation. Land and properties were revalued in 2018 by independent professionally qualified valuers. Land and Buildings will be revalued every five years by a professionally qualified valuer.

Depreciation is provided on a straight line basis at rates estimated to reduce the assets to their realisable value by the end of their expected lives. The rates in use are as follows:

Buildings	**2%**
Building under Lease Contract	**4%**
Fixtures and Fittings	**25%**
Computers	**33%**
Research Vessel	**4%**
Research Vessel Equipment	**20 - 25%**
Motor Vehicles	**20%**

The carrying values of the Property, Plant and Equipment are reviewed for impairment when events or changes in circumstances indicate that the carrying value may not be recoverable. If there is objective evidence of impairment of the value of the asset, an impairment loss is recognised in the Statement of Income and Expenditure and Retained Revenue Reserves in the year.

(g) Intangible Assets

Intangible assets comprise fishing rights held by the Marine Institute to Lough Feeagh, Lough Furnace and Estuaries in Newport, County Mayo. These intangible assets are carried in the Statement of Financial Position at their cost of €nil as their fair value cannot be reliably determined by reference to an active market.

(h) Leased Assets

Rental expenditure under operating leases is recognised in the Statement of Income and Expenditure and Retained Revenue Reserves over the life of the lease. Expenditure is recognised on a straight-line basis over the lease period, except where there are rental increases linked to the expected rate of inflation, in which case these increases are recognised when incurred. Any lease incentives received are recognised over the life of the lease.

(i) Capital Account

The Institute recognises funding received for capital purposes under the Accruals Model specified in FRS102. The amount received is recognised in income on a systematic basis over the expected useful life of the asset.

(j) Foreign Currencies

Transactions denominated in a foreign currency are translated into the functional currency using the spot exchange rates at the date of the transactions. At the end of each financial year, foreign currency monetary items are translated to Euro using the closing rate. Non-monetary items measured at historical cost are translated using the exchange rate at the date of the transaction and non-monetary items measured at fair value are measured using the exchange rate when fair value was determined.

(k) Marine Research Programme

The Marine Institute enters into commitments in respect of contracts awarded for Marine Research Programme projects. Expenditure is charged in the financial statements as it is incurred. An initial payment is made on the signing of the project contract, an interim payment may be made subject to satisfactory performance under the contract and further payments are made on receipt and verification of claims in respect of work completed. Costs incurred by the Institute in the administration of Marine Research Programme projects are funded by the capital vote of the Marine Institute and charged to the financial statements as they are incurred.

(l) Employee Benefits - Short term benefits

Short term benefits such as holiday pay are recognised as an expense in the year in which the employee renders service, and benefits that are accrued at year-end are included in the payables figures in the Statement of Financial Position.

(m) Retirement Benefits

The Marine Institute operates its own defined benefit pension scheme, funded annually on a pay-as-you-go basis from monies provided by the Department of Agriculture, Food and the Marine and from contributions deducted from staff and members' salaries.

The Marine Institute also participates in the Single Public Service Pension Scheme ("Single Scheme"), which is a defined benefit scheme for pensionable public servants appointed on or after 1 January 2013. Single Scheme members' contributions are paid over to the Department of Public Expenditure and Reform (DPER).

Pension costs reflect pension benefits earned by employees, and are shown net of staff pension contributions which are remitted to the Department of Agriculture, Food and the Marine. An amount corresponding to the pension charge is recognised as income to the extent that it is recoverable, and offset by grants received in the year to discharge pension payments.

Actuarial gains or losses arising on scheme liabilities are reflected in the Statement of Comprehensive Income, and a corresponding adjustment is recognised in the amount recoverable from the Department of Agriculture, Food and the Marine.

The financial statements reflect, at fair value, the assets and liabilities arising from The Marine Institute's pension obligations and any related funding, and recognises the costs of providing pension benefits in the accounting periods in which they are earned by employees. Retirement benefit scheme liabilities are measured on an actuarial basis using the projected unit credit method. They are matched by a Deferred Retirement Benefit Funding asset as the pension liabilities are guaranteed by the State.

(n) Receivables

Receivables are recognised at fair value, less a provision for doubtful debts. The provision for doubtful debts is a specific provision, and is established when there is objective evidence that the Marine Institute will not be able to collect all amounts owed to it. All movements in the provision for doubtful debts are recognised in the Statement of Income and Expenditure and Retained Revenue Reserves.

(o) Contingencies

Contingent liabilities, arising as a result of past events, are not recognised when (i) it is not probable that there will be an outflow of resources or that the amount cannot be reliably measured at the reporting date or (ii) when the existence will be confirmed by the occurrence or non-occurrence of uncertain future events not wholly within the Institute's control. Contingent liabilities are disclosed in the financial statements unless the probability of an outflow of resources is remote.

Contingent assets are not recognised. Contingent assets are disclosed in the financial statements when an inflow of economic benefits is probable.

(p) Related Parties

Related party transactions have been disclosed in the notes to the financial statements in accordance with FRS 102. See note 21 for disclosure of the related party transactions during 2019.

(q) Critical Accounting Estimates and Judgements

The preparation of the financial statements requires management to make judgements, estimates and assumptions that affect the amounts reported for assets and liabilities as at the reporting date and the amounts reported for revenues and expenses during the year. However, the nature of estimation means that actual outcomes could differ from those estimates. The following judgements have had the most significant effect on amounts recognised in the financial statements.

Impairment of Property, Plant and Equipment
Assets that are subject to amortisation are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognised for the amount by which the asset's carrying amount exceeds its recoverable amount. The recoverable amount is the higher of an asset's fair value less cost to sell and value in use. For the purpose of assessing impairment, assets are grouped at the lowest levels for which there are separately identifiable cash flows (cash generating units). Non-financial assets that suffered impairment are reviewed for possible reversal of the impairment at each reporting date.

Depreciation and Residual Values
The Board has reviewed the asset lives and associated residual values of all fixed asset classes and in particular, the useful economic life and residual values of fixtures and fittings and have concluded that asset lives and residual values are appropriate.

Retirement Benefit Obligation
The assumptions underlying the actuarial valuations for which the amounts recognised in the financial statements are determined (including discount rates, rates of increase in future compensation levels, mortality rates and healthcare cost trend rates) are updated annually based on current economic conditions and for any relevant changes to the terms and conditions of the pension and post-retirement plans.

The assumptions can be affected by:

i. the discount rate, changes in the rate of return on high-quality corporate bonds
ii. future compensation levels, future labour market conditions
iii. Health care cost trend rates and the rate of medical cost inflation.

2. Oireachtas Grants from the Department of Agriculture, Food and the Marine

	2019 €'000	2019 €'000	2018 €'000	2018 €'000
Current Purposes				
Marine Institute - Vote 30,Subhead A.7	18,519		18,057	
EMFF Income (Note 17)	5,503		4,894	
Less Superannuation contributions repayable	(526)		(521)	
		23,496		22,430
Capital purposes				
Marine Research Programme Vote 30, Subhead A.7 (Note 12)	12,000		10,000	
		12,000		10,000
		35,496		**32,430**

Since 2014, the EMFF Income has been accounted for on an accruals basis as the direct related expenditure is funded in the year after occurrence. The EMFF is the EU's maritime and fisheries policies fund which is co-funded by the EU and the Department of Agriculture, Food and the Marine and supports Ireland's operational programme. By agreement with the Department of Agriculture, Food and the Marine, employee pension contributions are refunded directly to the Department and are shown as a reduction in grant levels. Single scheme pension contributions are remitted to the Department of Public Expenditure and Reform.

3. Other State Grants

	2019 €'000	2019 €'000	2018 €'000	2018 €'000
National Seabed Survey – Department of Communications, Energy and Natural Resources Vote 29, Subhead D.7	2,000		2,000	
BIM – EMFF Funded	359		486	
Water Framework Directive funded by EPA	1,246		1,168	
FIRM projects funded by Department of Agriculture, Food and the Marine Vote	127		181	
Wave Energy Test Sites Funded by SEAI	1,135		988	
EMFF projects funded by Department of Agriculture, Food and the Marine Vote	3,403		2,880	
SFI Infrastructure Award	1,741		-	
TOTAL		**10,011**		**7,703**

4. EU and Other Income

	2019 €'000	2019 €'000	2018 €'000	2018 €'000
EU Contract Research		**7,270**		**6,663**
Other Income				
Research Vessel Charterage	1,100		1,719	
Sundry and Other Contract Income	1,570		1,399	
		2,670		**3,118**
TOTAL		**9,940**		**9,781**

5. Remuneration and Pension Costs

Aggregate Employee Benefits	2019 €'000	2018 €'000
Staff Short term benefits	12,205	11,930
*Pension Contribution	477	492
Board Fees	66	70
Movement in Holiday Pay Accrual	(23)	26
Employers Contribution to Social Welfare	1,212	1,153
	13,937	**13,671**

Total salary costs include an accumulated accrual of €0.327m (2018: €0.350m) in respect of accumulated staff annual leave entitlements.

Pension related deductions of €0.389m (2018 €0.400m) were made from salaries and were remitted to the Department of Agriculture, Food and the Marine. Single pension related deductions of €0.138m (2018 €0.121m) were made from salaries and were remitted to the Department of Public Expenditure and Reform.

*Pension contribution (20% of Gross Pay) is to cover the deferred cost to the Exchequer of future pension entitlements for employees on contract research and other externally funded posts. This amount was refunded to the Department of Agriculture, Food and the Marine.

Chief Executive Officer Salary and Expenses	2019 €'000	2018 €'000
Basic Pay	149	144
	149	**144**

The total expenses for business purposes for the CEO for 2019 was €33,789 (2018: €33,178), which includes foreign travel expenses of €12,773. The amounts paid to the CEO for reimbursement of expenses in 2019 was €17,077 (2018 €19,568).

Staff Short term Benefits	2019 €'000	2018 €'000
Basic Pay	11,668	11,380
Overtime	-	-
Allowances	537	550
	12,205	**11,930**

The average number of employees by location at year end is as follows:

Employees	2019 No.	2018 No.
Rinville Galway	189	193
Newport	18	17
Dublin	8	8
Ports	13	16
EU Based	2	3
	230	237
The whole time equivalents at each year end	**221.08**	**227.10**

Key Management and Personnel	2019 €'000	2018 €'000
Salary	764	792
	764	**792**

Key Management personnel in the Marine Institute include the members of the Board and the members of the Senior Leadership Team of the Marine Institute, including the Chief Executive Officer (CEO). The total value of employee benefits for key personnel is set out above. No payments in respect of termination payments, allowances and health insurance were made. This does not include the value of retirement benefits earned in the period. The Senior Leadership Team including the CEO are members of the Marine Institute Staff Superannuation Scheme 1998 or the Single Public Service Pension scheme and their entitlements in that regard do not extend beyond the terms of the model public service pension scheme.

The total expenses paid to key executive management in 2019 was €77,983 (2018: €72,871).

Employee Short-Term Benefits Breakdown

Employees' short-term benefits in excess of €60,000 are categorised into the following bands:

Wages and Salaries breakdown of Employees	2019 No's	2018 No's
€60,000 - €69,999	38	36
€70,000 - €79,999	21	25
€80,000 - €89,999	13	12
€90,000 - €99,999	2	4
€100,000 - €109,999	3	2
€110,000 - €119,999	1	1
€120,000 - €129,999	1	0
€130,000 - €139,999	0	0
€140,000- €149,999	0	1

Note: For the purposes of this disclosure, short-term employee benefits in relation to services rendered during the reporting period include salary, overtime allowances and other payments made on behalf of the employee, but exclude employer's PRSI and accrued holiday pay.

6. Vessel Operating Costs

	2019 €'000	2018 €'000
Payroll and Associated Costs	4,429	4,261
Fuel	1,044	1,111
Insurance	251	237
Victualling	189	187
Management Fee	262	265
Port Fees and Safety	88	80
Leases	164	140
Engineering and Maintenance Costs	1,083	1,071
Operating and Administration Costs	634	784
	8,144	**8,136**

The vessel operating costs exclude the cost of vessel equipment and refits, which are capitalised per note 15, as they meet the criteria for recognition as property, plant and equipment. The vessels are owned by the Marine Institute and the operations of the vessels are subcontracted to a third party vessel management company.

7. Travelling Expenses

Travel & Subsistence	2019 €'000	2018 €'000
Domestic	781	706
Foreign	796	552
	1,577	**1,258**

An element of these expenses relate to funded projects, where the cost incurred will be reimbursed to the Marine Institute.

8. Grants and External Service Providers

	2019 €'000	2018 €'000
Marine Research Programme Grants and support costs (Note 12)	4,162	4,417
Seafarer Training & Education	154	170
Contractors, External Service Providers, Professional Fees and Other Research Funding*	11,510	10,474
Sample Analysis	385	442
	16,211	**15,503**

*This includes project payments to partners where the Marine Institute is the lead partner in EU funded projects, payments relating to EMFF funded projects and payments to other contract providers for samples, scientific surveys, operations support, external survey contractors and other items required in order for the Marine Institute to fulfil its statutory mandate

9. Facilities Costs

	2019 €'000	2018 €'000
Maintenance	1,056	1,075
Light & Heat	384	401
Replacements	320	171
Other	255	225
	2,015	**1,872**

10. Other Administration and Equipment Hire Costs

	2019 €'000	2018 €'000
Rent, Rates & Other Property Costs	237	237
Journal Subscriptions, Memberships and Library Costs	215	203
Training	191	190
Stationery & Consumables	142	124
Publications, Promotional Materials and Design	415	401
Insurance	117	134
Audit fee	22	20
Hire of Equipment & Vessels	633	1,085
Sundry Equipment	77	134
Other Admin Costs	1,024	1,151
	3,073	**3,679**

The provisions of the European Communities (Late Payment in Commercial Transactions) Regulations 2012 (S.I. No. 580 of 2012) apply to the Marine Institute. Interest and compensation paid during 2019 was €1,628 (2018: €139).

11. Taxation

The Marine Institute is specifically exempted from taxation under the provisions of Section 32 and Schedule 2 of the Finance Act 1994. Accordingly, no taxation charge has been included in the financial statements.

12. Marine Research Programme Payments – Capital Exchequer Funded

This is a memorandum note the function of which is to show the application of the €12m capital funding received in 2019 (2018 : €10m) as it is expended in support of the *National Marine Research & Innovation Strategy 2017-2021.*

The National Marine Research & Innovation Strategy 2017-2021 was published in June 2017, and identified 15 research themes under the three goals of *Harnessing Our Ocean Wealth*,. This strategy will set the research priorities for the next number of years.

	2019 €'000	2018 €'000
Oireachtas Income (Note 2)	12,000	10,000
Other income	45	563
Total Income on Marine Research	**12,045**	**10,563**
Expenditure on Marine Research Programme projects		
Access to Shiptime Award	3,003	2,641
Marine Research Programme Grants (Note 8)	4,162	4,417
Marine Research Policy Support and Administration Payments	792	1,947
Capital, IT and Oceanographic Equipment	654	1,362
Vessel Equipment and Refit	434	196
Acquisition of New Vessel – initial payments	3,000	-
Total Expenditure on Marine Research	**12,045**	**10,563**

Access to Shiptime Award. Access to the Institute's research vessels is provided to Researchers, including to Higher Education Institutions for research and education purposes, after an annual competitive call "Shiptime Award". The €3,003,000 is the value of this "in kind" award to the successful applicants, who are not charged a monetary usage fee. The €3,003,000 is the estimated operating cost of the vessels, while in use by such applicants. This sum is part of the total vessel operations costs included in the income and expenditure account.

Marine Research Programme Grants: This includes payments linked to the *National Marine Research & Innovation Strategy 2017-2021* for awards in strategically important areas of marine research. Research projects awarded are subject to contracts which specify that an initial payment will be made on signature of the contract; an interim payment(s) may be made subject to satisfactory performance with a final payment made on receipt of and verification of claims. These payments are included in "Grants and External Service Providers" in the Income and Expenditure account

Marine Research Policy Support and Administration Payments: This includes the administration, auditor and evaluation costs of the Marine Research Programme. It also includes policy support to International research organisations. It also includes the cost of education and outreach programmes including Seafest and Our Ocean Wealth Summit. These payments are included in various captions the Income and Expenditure account.

Capital, IT and Oceanographic Equipment: This includes capital equipment purchases and costs related to the fit out of 3 Park Place. These costs, to the extent that they meet the definition of an asset under FRS102, are capitalised in the statement of financial position.

Vessel Equipment and Refit: This includes payments for vessel equipment and vessel refit funded from our capital vote. These costs, to the extent that they meet the definition of an asset under FRS102, are capitalised in the statement of financial position.

Acquisition of New Vessel: Included in contractual amounts committed during 2019 is €25m committed to the build of a new research vessel. Associated payments of €3m were made in 2019, reducing commitments at 31 December 2019. These payments have been included in fixed assets (note 15). The remaining commitment as at 31 December 2019 of €22m will be paid in stage payments between 2020 and 2022 at which point the new research vessel will be commissioned.

Expenditure is charged in the financial statements as it is incurred in accordance with the Marine Research Programme accounting policy. At 31 December 2019 payments in the amount of €370,805 (2018: €199,975) were outstanding and are included within payables.

13. Marine Research Programme Future Capital Commitments

A total of 296 projects have been supported under the Marine Research Programme 2014-2020 with 96 of these projects still ongoing at the end of 2019. Contractual commitments at 31 December 2019, which have not yet been charged to the financial statements, were €39.7m, analysed as follows:

		Total €'000
Commitments as at 1 January 2019		**16,408**
New Commitments 2019		
Marine Research Programme Grants	5,493	
Acquisition of New Vessel	25,000	30,493
Paid in 2019		(7,117)
Commitments as at 31 December 2019		**39,784**

14. Capital Account

	2019 €'000	2019 €'000	2018 €'000	2018 €'000
Balance at 1 January		16,341		18,228
Transfer (to) /from Statement of Income and Expenditure				
Income allocated for Capital funding	7,488		2,915	
Depreciation charge for the year	(4,852)		(4,857)	
		2,636		(1,942)
Impact of disposals of property, plant and equipment		(16)		55
Balance at 31 December		**18,961**		**16,341**

The balance of the Capital Account (€18.961m) and the Revaluation Reserve (€5.46m) agrees to the Net Book Value of Property, Plant and Equipment (€24.421m)

15. Property, Plant and Equipment

	Land & Buildings €'000	Research Vessels €'000	Vessel Under Construction €'000	Vessel Equipment €'000	Equipment/ Fixtures & Fittings €'000	Computers €'000	Motor Vehicles €'000	TOTAL €'000
Cost or Valuation								
Balance at 1 January 2019	9,258	34,978	0	6,602	25,296	7,846	448	84,428
Additions	437	455	3,000	811	1,983	782	20	7,488
Disposals	-	(3,611)	0	(436)	(1,797)	(2,111)	(36)	(7,991)
Balance at 31 December 2019	9,695	31,822	3,000	6,977	25,482	6,517	432	83,925
Depreciation								
Balance at 1 January 2019	1,452	25,116	0	6,149	22,737	6,860	313	62,627
Charge for the financial year	195	1,718	0	446	1,441	995	57	4,852
Disposal	-	(3,611)	0	(436)	(1,784)	(2,108)	(36)	(7,975)
Balance at 31 December 2019	1,647	23,223	0	6,159	22,394	5,747	334	59,504
Net Book Value								
At 31 December 2019	**8,048**	**8,599**	**3,000**	**818**	**3,088**	**770**	**98**	**24,421**
At 31 December 2018	**7,806**	**9,862**	**0**	**453**	**2,559**	**986**	**135**	**21,801**

The Marine Institute's headquarters are at Rinville, Oranmore, County Galway. This building, which is owned by the OPW, is provided rent-free. The Institute owns land and buildings in Newport, Co Mayo and in Parkmore, Galway. All the land, and buildings owned by the Marine Institute were revalued by independent professional qualified valuers during 2018.

The Institute undertook a full stocktake of all fixed assets on the fixed asset register during 2019. The statement of financial position reflects the outcome of this work, with a write down to the net book value of fixed assets during 2019 of €16,000 (Being cost of €7.991m net of accumulated depreciation of €7.975m). This relates to assets, which were mainly fully depreciated, and which were obsolete, scrapped, disposed of or where their existence could not be verified at 31 December 2019.

The other various premises used by the Institute in Dublin and at the port locations around Ireland are held under either operating leases or rental agreements as set out in Note 20.

Depreciation was not recognised during 2019 in relation to €1.1m of Property, Plant and Equipment and €3.0m on the research vessel under construction. While these items meet the definition of an asset, they were not in use at 31 December 2019, and therefore had not commenced their useful lives for depreciation purposes. In accordance with the Institute's policy, depreciation will commence, with a full year's depreciation, in the year in which the asset comes into use.

16. Revaluation Reserve

	2019 €'000	2019 €'000	2018 €'000	2018 €'000
Balance at 1 January		5,460		0
Revaluation			5,460	
Balance at 31 December		**5,460**		**5,460**

The basis of the valuation of land, property was changed in 2018 from cost to revaluation and the amount of €5.460m is the resultant increase in value, which has been included in the revaluation reserve.

17. Receivables

	2019 €'000	2018 €'000
Trade Receivables	142	191
Contract Income	2,214	1,621
EMFF Accrued Income (Note 2)	5,503	4,894
Prepayments	844	700
	8,703	**7,406**

All receivables are due within one year. Trade receivables are shown net of impairment in respect of doubtful debts.

18. Payables

	2019 €'000	2018 €'000
Amounts falling due within one year		
Trade Payables	2,898	3,596
Deferred Income	3,120	4,033
Marine Research Programme Accrual (Note 12)	370	199
Accruals	177	138
Payroll and Revenue Accruals	348	393
Holiday Pay Accrual (Note 5)	327	350
	7,240	**8,709**

Included in trade payables above are the following amounts due to the Revenue Commissioners:

	2019 €'000	2018 €'000
Professional Service Withholding Tax	319	229
PAYE/PRSI/USC	362	393
VAT	395	185
Relevant Contract Tax	-	5
	1,076	**812**

19. Superannuation Scheme and Spouse & Children's Contributory Retirement Benefits Scheme

(a) General Description of the Scheme

The Marine Institute is a statutory State agency, established under section 3(1) of the Marine Institute Act, 1991 (No. 2 of 1991). Section 9(1) of the Act provides that the Institute shall make schemes for the granting of superannuation benefits to and in respect of staff members, subject to Ministerial approval. Two such approved schemes – the Marine Institute Staff Superannuation Scheme 1998 and the Marine Institute Spouses' and Children's Contributory Pension Scheme 1998 are being operated by the Institute. The former scheme provides retirement benefits (lump sum and pension) to staff members and death gratuity benefits in respect of death in service. The latter scheme provides pension benefits for the surviving spouses and dependent children of deceased members. Normal retirement age is a member's 65th birthday. Both schemes are defined benefit superannuation schemes. Staff Superannuation contributions are paid to the Department of Agriculture, Food and the Marine.

The Single Public Service Pension Scheme (Single Scheme) is the defined benefit pension scheme for pensionable public servants appointed for the first time on or after 1 January 2013 in accordance with the Public Service Pension (Single Scheme and Other Provisions) Act 2012. The scheme provides for a pension and retirement lump sum based on career-average pensionable remuneration, and spouses and children's pensions. The minimum pension age is 66 years (rising in line with State pension age changes). It includes an actuarially reduced early retirement facility from age 55. Pensions in payment increase in line with the consumer price index.

For the purposes of reporting in accordance with FRS102, the Institute has been advised by a qualified actuary who has prepared a full valuation in order to assess the liabilities of the superannuation schemes at 31 December 2019.

The principal actuarial assumptions, per annum, are as follows:

	2019	2018	2017
Inflation rate increase	1.80%	1.95%	1.95%
Salary rate increase	2.80%	2.95%	2.95%
Pension rate increase	2.30%	2.45%	2.45%
Scheme liabilities discount rate	1.90%	1.90%	2.00%

As pension, increases under the Marine Institute schemes are based on salary increases rather than on price increases, a price inflation assumption is not necessary for the purposes of this valuation. However, since FRS 102 requires reference to an assumed rate of inflation, the above rate would be appropriate for this purpose.

The average remaining future life expectancy according to the mortality tables used to determine pension liabilities, is as follows:

	2019	2018
Male aged 65	21.5	21.4
Female aged 65	24.0	23.9

On the basis of these and other assumptions and applying the projected unit method prescribed in FRS 102, the deferred funding asset and retirement benefits liability are as follows:

	2019	2018
Total accrued retirement benefits liability	€74.3m	€63.1m

(b) Analysis of the Total Pension Costs charged to Expenditure

	2019 €'000	2018 €'000
Current Service Cost	3,550	3,493
Interest on pension scheme liabilities	1,194	1,188
Employee Contributions	(527)	(522)
	4,217	**4,159**

(c) Analysis of the amount recognised in the Statement of Comprehensive Income

	2018 €'000	2017 €'000
Experience gains/(Losses)	273	(1)
Changes in assumptions underlying the present value of scheme	(7,418)	767
Actuarial gain and (loss) recognised in the Statement of Comprehensive Income	**(7,145)**	**766**

(d) Net Deferred Funding for Pensions Recognised in the year

	2019 €'000	2018 €'000
Current Service and Interest Cost	4,744	4,681
Less benefits paid in the year	(677)	(385)
	4,067	**4,296**

The Marine Institute recognises amounts owing from the State as an asset corresponding to the unfunded deferred liability for pensions on the basis of the set of assumptions described above and a number of past events. These events include the statutory basis for the establishment of the superannuation scheme and the policy and practice in relation to funding public service pensions, including contributions from employees and the annual estimates process. In common with the generality of public service superannuation schemes, no separate fund is maintained, or assets held, to finance the payment of pensions and gratuities.

In line with the custom and practice as adopted by the Department of Agriculture, Food and the Marine to date, the Marine Institute has no evidence that this funding policy will not continue to meet such sums in accordance with current practice. The deferred funding asset for pensions as at 31 December 2019 amounted to €74.3million (2018: €63.1million). The quantification of the liability is based on the financial assumptions set out in this note. The assumptions used, which are based on professional actuarial advice, are advised to the Department of Agriculture, Food and the Marine but are not formally agreed with the Department.

(e) Analysis of movement in net pension liability during the year

	2019 €'000	2018 €'000	2017 €'000	2016 €'000	2015 €'000	2014 €'000
Liability at the beginning of the year	63,129	59,599	51,870	40,050	30,200	28,200
Current Service Cost	3,550	3,493	3,181	2,299	1,772	1,800
Interest on Scheme Liabilities	1,194	1,188	1,013	1,017	1,652	1,500
Actuarial Gains/(Losses) recognised in the Statement of Comprehensive Income	7,145	(766)	3,893	8,850	6,772	(816)
Benefits paid in the year	(677)	(385)	(358)	(346)	(346)	(484)
Liability at the end of the year	**74,341**	**63,129**	**59,599**	**51,870**	**40,050**	**30,200**

(f) History of Defined Benefit Obligations

	2019 €'000	2018 €'000	2017 €'000	2016 €'000	2015 €'000
Deficit benefit obligations	74,341	63,129	59,599	51,870	40,050
Experience Gains/(Losses) on Scheme Liabilities	273	(1)	(3,754)	1,251	1,694
Percentage of Scheme Liabilities	0%	0%	6.3%	2.4%	4.2%
Assumption Gains/(Losses) on Scheme Liabilities	(7,418)	767	(139)	(10,101)	(8,466)
Percentage of Scheme Liabilities	9.97%	1.21%	0.2%	19.4%	21.1%

The cumulative actuarial loss recognised in the Statement of Comprehensive Income amounts to €18,914,000.

20. Operating Lease commitments

The Marine Institute occupies leased and rented premises at the following locations:

- **Lease 1:** 3 Park Place, Dublin 2, commenced in June 2019 for a period of 25 years and is due to terminate on 31 October 2044.
- **Lease 2:** Parkmore Office Park, Galway, commenced in 1999 for a period of 25 years with five yearly rent reviews.
- **Lease 3**: Red Sail Warehouse, Galway Harbour, commenced in 2013 for a period of 11 years with a rent review in 2018.
- **Lease 4:** Industrial Land, Galway Harbour, commenced in 2014 for a period of 5 years with the option to extend to August 2024.
- **Lease 5:** Industrial Land, Galway Technology Park, commenced in 1988 for a period of 999 years, with five yearly rent reviews.
- **Lease 6:** Foreshore lease in Spiddal, granted for 35 years with effect from 15 December 2017.
- **Rental Agreements:** The Institute has a number of rental agreements relating to piers, labs and sheds, all of which are renewable on an annual basis.

The total future minimum lease payments under non-cancellable operating leases, all of which relate to Land & Buildings, are as follows:

Relating to leases:	2019 €'000	2018 €'000
Payable within 1 year	282	270
Payable between 2 and 5 years	994	612
Payable thereafter	2,476	117
	3,752	**999**

Operating lease payments recognised as an expense in 2019 amounted to €350,557 (2018: €308,750).

21. Related Party Transactions

Smartbay Ireland CLG, was established to implement the Programme for Research in Third-Level Institutions (PRTLI) Smartbay project to develop a Marine Research, Test and Demonstration Platform consisting of a communications and sensing infrastructure deployed in Galway Bay. The company was established as a company limited by guarantee by PRTLI project partners Dublin City University (DCU) and National University of Galway in Feb 2012.

The Head of Corporate Services of the Institute was Secretary of Smartbay Ireland CLG at 31 December 2018. As at 31 December 2019, a member of the Institute's Senior Leadership Team is on the Board of Directors of Smartbay Ireland CLG.

During 2019, the Institute was charged €449,874 by Smartbay Ireland CLG (2018: €322,467). This expenditure is included within research expenditure in Note 8 to these financial statements and is in respect of a contract to provide operational support in respect of the development of the Ocean Energy Test Site in Galway and the Atlantic Test Site at Belmullet. The balance payable to Smartbay Ireland CLG at 31 December 2019 was €nil (2018: €nil).

Smartbay Ireland CLG is constituted as a company limited by guarantee, registered with the Irish companies registration office. The Marine Institute is not a member of SmartBay Ireland CLG and consequently, the Institute does not have voting rights at a members meeting (including AGM or EGM). The Board of Directors of the Marine Institute is entirely separate and independent of the Board of Directors of SmartBay Ireland CLG. The Board considered the definition of control in FRS102, being the power to govern the financial and operating policies of an entity so as to obtain benefits from its activities. We also considered the FRS102 concept of significant influence. Having considered these provisions relative to the membership and Governance structure of Smartbay Ireland CLG, the Board is satisfied that SmartBay Ireland CLG is not a subsidiary or associate of the Marine Institute.

22. Register of interests

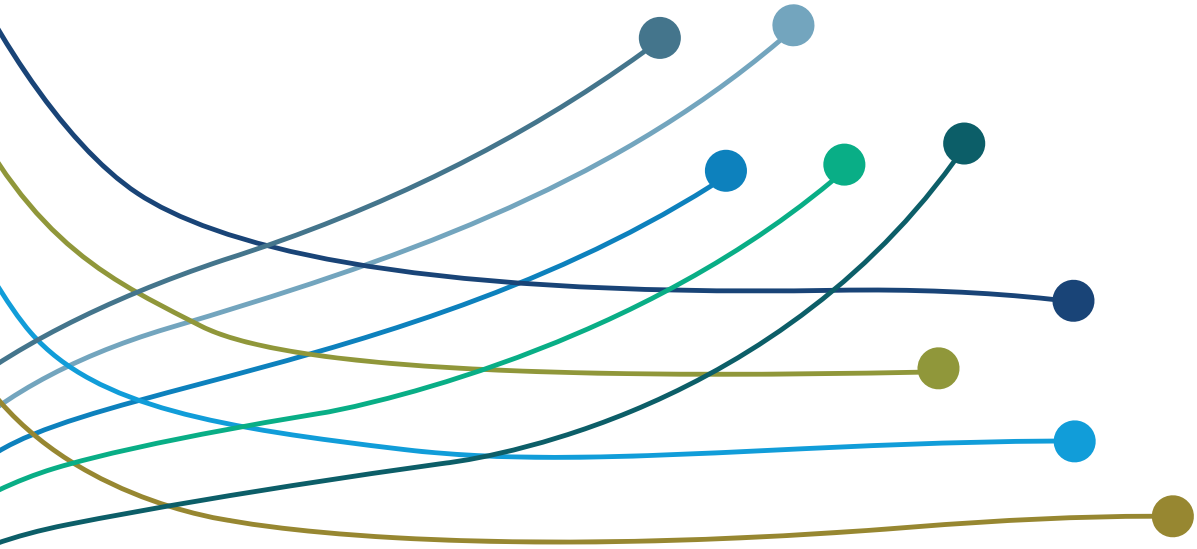
The Institute has adopted procedures in accordance with the guidelines issued by the Department of Public Expenditure and Reform in relation to the disclosure of interests by the Board and the Institute has adhered to these procedures. There were no transactions in the year in relation to the Institute's activities in which members of the Board had a beneficial interest.

23. Events after the end of the financial year

The Board is not aware of any events occurring after 31 December 2019 which affect these financial statements. The Board recognises that the COVID 19 pandemic is a significant event which has occurred since the reporting date. The Board is taking the situation seriously and is monitoring the situation in conjunction with management, on an ongoing basis.

24. Board Approval

The financial statements were approved by the Board on 8 December 2020.



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