



ANNUAL REPORT 2022

Begin



Vision

To enable a transition to a zero carbon, resource efficient and sustainable society

Mission

To generate new research knowledge for the understanding and protection of our natural environment, and develop technologies, tools, services and policy knowledge to facilitate a transformation to a zero carbon, resource efficient, and sustainable society

THE ENVIRONMENTAL RESEARCH INSTITUTE IS COMMITTED TO THE FOLLOWING FIVE CORE PRINCIPLES

Research excellence

Interdisciplinary collaboration

Research with impact – Environmental, Societal & Economic

High quality postgraduate and postdoctoral education and training

Diversity and Equality

Photography credits:

Tomas Tyner, Claire Keogh and Marcin Lewandowski

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Message from ERI Director (Outgoing)

It has been a great pleasure to have the role of ERI Director since 2014. Since that time the Institute, its constituent centres, research base and community has expanded significantly to truly be a university-wide institute, with a strong national and international focus, reputation and reach. We now have over 500 affiliated researchers, with 83 academics from 20 disciplines across four Colleges, involved in 316 live research projects and generating an academic output of 386 publications this year alone.

The impact of the research that our community carries out is considerable - from ERI research informing national policy in the areas of food, energy and soil, to local partnerships such as with Cork City Council which have resulted in Cork's first Clean Air Zone. Our contribution to the international and national discourse on so many topics that have profound societal relevance is evident when ERI researchers are in attendance at COP27 or are providing expert testimony to the Citizens Assembly on Biodiversity Loss.

Recent engagement from the Arts and Humanities has added a very welcome dimension to the ERI's thematic reach. The establishment of the UCC Eco-Humanities Research Group has provided a space for reflection and contemplation on the climate crisis, from which we can draw solace from the wealth of perspectives that speak to us on emotional and philosophical levels.

In 2022, we had the pleasure of renaming our Lee Road Building in honour of Cork's first female botanist, Ellen Hutchins. Ellen Hutchins discovered at least twenty species that were new to science or new to Ireland, and made a significant contribution to the understanding of non-flowering plants, especially seaweeds. Her spirit of inquisitiveness and love for her natural environment inspires us all. While the symbolism of this honour is important, it is equally crucial that our work aspires to continue Ellen's legacy.

The University's commitment to sustainability has never been so strong and we can all take considerable pride in the fact, that we are a leading university in sustainability, in large part, due to the ERI. The significant capacity which the ERI has built in the area of sustainability will be leveraged within the ambitious programme of UCC Futures in 2022 which identifies sustainability as one of the ten strategic areas for the university and will allow us to further integrate and build on our significant capacity to ensure UCC maintains and builds on its international reputation in this area.

I would like to extend a warm welcome to our new ERI Academics - you are joining the Institute as it moves to a new exciting phase with the appointment of Prof. Brian O'Gallachoir as Director and Associate Vice President for

Sustainability. Brian has played a considerable role for many years in the Institute as co-Director of MaREI with Prof. Jerry Murphy and as Vice Director of the Institute. I wish Brian every success and firmly believe that there are great things ahead!

In my role as Head of College, Science, Engineering and Food Science, I look forward to working with the institute team, to ensure the success and growth of the institute in the coming years. I will continue as a PI in the Institute and I hope I can play my part, in contributing to the outputs of the institute!

PROFESSOR SARAH CULLOTY

Outgoing Director,
Environmental Research Institute



Message from ERI Director (Incoming)

It is with great pride that I become the new Director of UCC's Environmental Research Institute, taking up the reins from Prof. Sarah Culloty, who set a high bar and is a hard act to follow. As I reflect on the past 23 years since the ERI was established, I believe this 2022 Annual Report provides a wonderful confirmation of how far we have come.

The ERI is now home to over 500 researchers in many disciplines from right across the university. These researchers are undertaking

excellent research that is achieving significant societal impact and advancing many areas related to climate action, healthy environments and the circular economy. During 2022, the ERI secured over €20 million in additional funding, while also participating in over 300 research projects with a collective value of nearly €100 million.

The ERI demonstrated significant scientific excellence in 2022, as evidenced by the 386 publications, the awards and prizes received

from Science Foundation Ireland, Sustainable Energy Authority of Ireland and many others, and the rankings amongst the top engineering and technology scientists in Ireland. This excellence was further acknowledged through peer recognition in appointments including Royal Irish Academy Committees and advisory roles on the IUCN World Commission on Environmental Law.

Translating research results into societal impact by ERI researchers was also very evident in 2022. This comprised multiple policy impacts including the Oireachtas adopting Ireland's first carbon budgets in 2022, new guidance for integrating climate adaptation into Irish Emergency Planning and the design and implementation of Ireland's first Children's and Young Persons' Citizens Assembly on biodiversity loss.

ERI researchers also continued to use their research to support new economic activity in sustainability, including delivering new post-graduate programmes to develop capacity to drive the industry and business response to sustainability challenges, launching the first decision support tool for wind farm owners to decide between decommissioning, extension or repowering as end-of-life approaches, a new precision genetic engineering capabilities that can make improvements in plants such as disease resistance and drought tolerance, and new ways to reduce our dependence on transition metals such as iron, nickel and copper in the pharmaceutical sector.

A handwritten signature in blue ink that reads "Brian Ó Gallachóir".

PROFESSOR BRIAN Ó GALLACHÓIR
Incoming Director,
Environmental Research Institute

ERI Management



1. **PROFESSOR SARAH CULLOTY** ERI Director (Outgoing), Head of College of SEFS
2. **PROFESSOR BRIAN Ó GALLACHÓIR** ERI Director (Incoming), Director of the SFI MaREI Centre, Associate Vice-President of Sustainability.
3. **PROFESSOR JERRY MURPHY** Director of the SFI MaREI Centre, Vice-Director of the ERI
4. **DR PAUL BOLGER** ERI Manager
5. **DR GILLIAN BRUTON** SFI MaREI Centre Manager
6. **DR JIMMY MURPHY** LIR NOTF Manager

ERI Academic Advisory Board 2022

PROF SARAH CULLOTY (CHAIR)
Outgoing Director of ERI (Head of SEFS)

PROF BRIAN Ó GALLACHÓIR
Incoming Director of ERI
(School of Engineering and Architecture)

PROF JERRY MURPHY
Deputy Director of ERI
(School of Engineering and Architecture)

DR PAUL BOLGER
Manager of the ERI

PROF EDMOND BYRNE
School of Engineering and Architecture

DR FIONA CAWKWELL
School of the Human Environment

PROF ELEANOR DOYLE
Cork University Business School

DR NIALL DUNPHY
School of Engineering and Architecture

DR CLODAGH HARRIS
School of Society, Politics and Ethics

PROF JUSTIN HOLMES
School of Chemistry

PROF MARCEL JANSEN
School of BEES

DR MARIA KIRrane
Head of Sustainability and Climate Action Office

PROF MARY MCCARTHY
Cork University Business School

PROF OWEN MCINTYRE
School of Law

DR PAT MEERE
School of BEES

DR JOHN MORRISSEY
School of Microbiology

DR GER MULLALLY
School of Society, Politics and Ethics

DR STEPHEN ONAKUSE
Cork University Business School

DR ÉILIS O'REILLY
School of Public Health

DR TOM REED
School of BEES

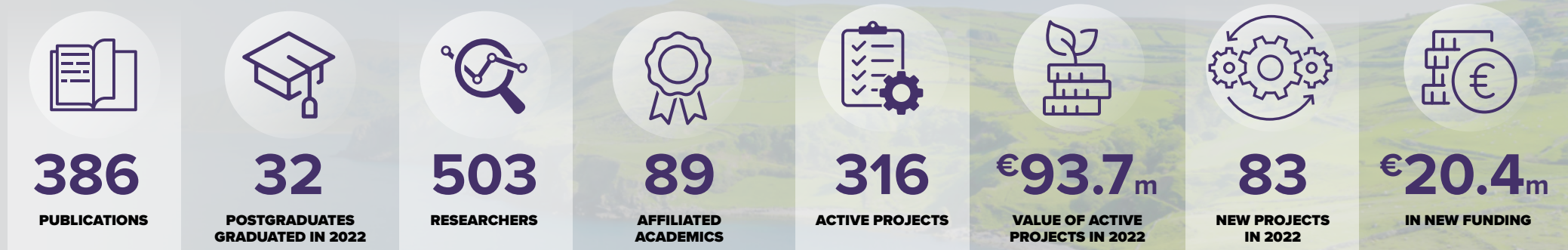
DR ÁINE RYALL
School of Law

DR MARIA DE SOUSA GALLAGHER
School of Engineering and Architecture

PROF JOHN WENGER
School of Chemistry

PROF ASTRID WINGLER
School of BEES

Snapshot of ERI in Numbers for 2022



Funding Source

€473,712

INDUSTRY/
PHILANTHROPIC/
OTHER



€13.0M
EXCHEQUER



1 | Sustainable Futures Project

LAUNCH OF SUSTAINABLE FUTURES - €3.9M PROJECT TO DRIVE THE SUSTAINABILITY TRANSFORMATION IN ENTERPRISES IN IRELAND



Professor Sarah Culloty, ERI Director and Head of College of Science, Engineering and Food Science; Dr Orla Flynn, President, ATU; Kevin Marshall, Head of Education, Microsoft Ireland; Professor John O'Halloran, President, UCC; Dr Marguerite Nyhan, Associate Professor, Environmental Engineering & Future Sustainability, UCC; Professor Brian Donnellan, VP for Research and Innovation, Maynooth University. Credit: Gerard McCarthy Photography.

Sustainable Futures, led by Academic Director Dr Marguerite Nyhan, launched a landmark new nationally-coordinated initiative which brings together higher education and multiple industry and enterprise partners to drive climate action and environmental sustainability in enterprise in Ireland. Sustainable Futures is led by UCC in partnership with Maynooth University and Atlantic Technological University and it was awarded €3,913,440 under the Higher Education Authority's Human Capital Initiative to co-develop educational programmes focused on sustainability, decarbonisation, circular economy and business leadership. It has recently been awarded a further €1,427,000 for additional programmes.

As part of this initiative, the new Sustainable Futures Lab in the Iris Ashley Cummins Building and the Sustainable Futures Hub in the ERI Ellen Hutchins Building were launched. These are new collaborative spaces for co-innovating solutions for a sustainable, net zero and nature positive future.

A range of new postgraduate programmes, including a flagship Masters in Sustainability in Enterprise and the Higher Diploma in Sustainability & Climate Action for Enterprise, have been developed, aimed at university graduates from all disciplines, industry staff, and current and aspiring leaders looking to develop their capacity to drive the industry and business response to sustainability challenges. New executive education and continuing professional development courses have also been developed, aimed at professionals across all sectors who wish to enhance their skills to deliver on all aspects of sustainability within enterprise.

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The Government's Climate Action Plan proposes major national carbon emissions reduction targets. As such, there has never been a more urgent time to create leaders in environmental sustainability in industry, enterprise, business, and broader society who will drive the transition to a net zero future. This can't be solved by any one discipline and as such, we have brought together engineering, science, business, management and sociology. Sustainable Futures aims to help leaders to take action on climate change and sustainability by applying academic rigour to real-world problems

Academic Director Dr Marguerite Nyhan, Senior Lecturer in Environmental Engineering & Future Sustainability in UCC's School of Engineering & Architecture and the ERI.

UCC'S DR MARGUERITE NYHAN AND SUSTAINABLE FUTURES COLLABORATE WITH MICROSOFT ON SUSTAINABILITY TRANSFORMATION RESEARCH

Led by Dr Marguerite Nyhan, UCC Sustainable Futures and Microsoft launched their research report entitled The Sustainability Transformation: Assessing the Readiness of Irish Businesses at the Microsoft Envision event in November 2022. Microsoft

commissioned Dr Marguerite Nyhan to lead this research and report on how prepared Irish businesses are for the zero-carbon transition. Dr Nyhan also gave a keynote speech at Microsoft's Envision Conference at the Convention Centre in Dublin.



Anne Sheehan, General Manager, Microsoft Ireland and Dr. Marguerite Nyhan, Associate Professor in Future Sustainability & Environmental Engineering and ERI Academic, University College Cork are pictured at Microsoft Envision launching the insights of UCC Sustainable Futures report, commissioned by Microsoft Ireland, which reveals that Irish businesses are largely underprepared for a net zero transition. Photo credit: Leon Farrell / Photocall Ireland

PARTNERSHIP WITH CORK LOCAL ENTERPRISE OFFICE FOR TRAINING

In 2022, the Sustainable Futures Team also partnered with the Local Enterprise Office (LEO) of South and North West Cork to deliver a short series of workshops to help small and micro enterprises understand environmental sustainability and how it relates to business. The 'Breakfast Series for Sustainability' was run as a series of masterclasses in which participants learned how business can play a part in the transition to a sustainable society. From understanding the fundamental concepts of sustainability to managing resources within operations and communicating

sustainability efforts, this series provided direction and advice for implementing sustainability in a business context.

Sustainability experts from the ERI including Dr Marguerite Nyhan (Sustainable Futures Academic Director and Senior Lecturer in Future Sustainability in Environmental Engineering) and Dr Paul Bolger (ERI Manager) brought insights from cutting-edge research to help participants identify practical and achievable actions that can help sustainable businesses.

FINDINGS

The report found that businesses are extremely under prepared for the sustainability and net zero transition.



1 in 5

Irish businesses have not started their sustainability journey and have no set commitments or targets for any critical sustainability issues.



CONCERNINGLY

3 in 5

businesses do not have a dedicated sustainability strategy in place.



35%

reported they were "not at all aware" of the Corporate Sustainability Reporting Directive.



4 in 5

businesses believe digital technologies are important in accelerating their sustainability transition.

“

It's clear from UCC's report that Irish businesses underestimate the scale of ambition and action that is required to transition to a net zero future. The lack of progress is concerning given Government's overarching climate action commitments for 2030 and beyond. In order for national targets to be met, every organisation must play its part and take action by making sustainability a business imperative and a leadership priority.

Anne Sheehan, General Manager, Microsoft Ireland

“

Climate change is one of our world's most pressing challenges, and this decade will be extremely important in terms of setting us on a path to a sustainable and net zero future. It is absolutely certain that businesses will play an extremely important role in the sustainability transformation and their actions will be vitally important in our global and national efforts to rapidly reduce emissions and mitigate climate change.

Academic Director Dr Marguerite Nyhan, Senior Lecturer in Environmental Engineering & Future Sustainability in UCC's School of Engineering & Architecture and the ERI.

2 | UCC at COP27

UCC PRESIDENT'S COP27 DELEGATION

As the only Irish university with official observer status at the United Nations COP27 conference, UCC sent a delegation of 11 researchers and students to the annual global summit in Sharm El-Sheikh, Egypt in November 2022. The UCC President's COP27 delegation was led by Prof Hannah Daly and was organised by a working group within the President's office and the ERI. The delegation included postgraduate students and academic

experts in carbon emissions and budgets, transport, societal change, sustainable cities, air and water pollution and energy efficiency. The UCC delegation were highly visible on national media throughout the COP27 conference with numerous appearances on TV, radio, newsprint and social media.



Members of UCC's COP27 delegation (L-R): Natasha Sutton, UCCSU Environmental and Sustainability Officer; Rajas Shinde, ERI PhD student ; Nathan Gray, ERI PhD Student; Dr Marguerite Nyhan, Associate Professor in Environmental Engineering & Future Sustainability; Dr Aisling Finucane, Lecturer in Economics and Finance; Prof Hannah Daly, Professor in Sustainable Energy & Energy Systems Modelling; Dr Jacqueline Lyons, Project Manager on Smart Protein; Dearbhla Richardson, International Development student, Dr Ben Gearey, lecturer in Archaeology.

“
Against a backdrop of worsening impacts of climate change at home and across the world, it's impossible to overstate the importance of this climate summit. While countries have made strong commitments to decarbonisation, that ambition is being realised only at a snail's pace relative to what is necessary. This will be the COP of implementation: governments, businesses and civil society must come together to collaborate on the millions of individual actions essential to drive emissions down rapidly.

Prof Hannah Daly, Professor in Sustainable Energy and Energy Systems Modelling at UCC (MaREI, ERI)

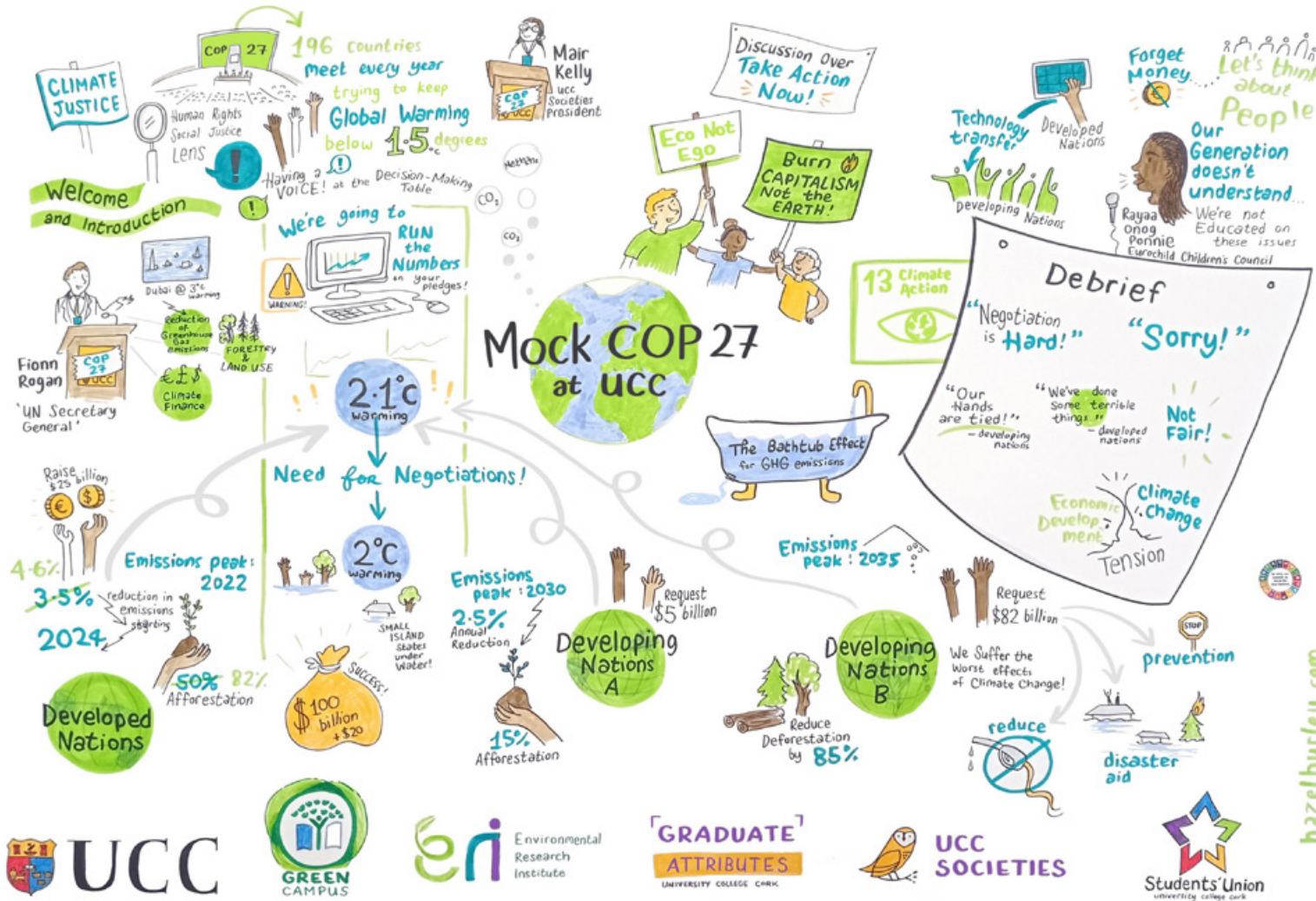
“
Personally, COP27 is not just special because it's a representation for Africa - it's held in my home country. Joining the Irish delegation under UCC's flag as an Egyptian is live evidence that different perspectives are encouraged to engage in the conversation, and even shape it. I hope to see an implementation COP, where countries share clear roadmaps and strategies about meeting climate targets relative to their contribution to carbon emissions.

Delegate and Egyptian citizen Omar Ibrahim (School of Engineering and Architecture, MaREI, ERI)

MOCK COP27

To coincide with the official conference, the UCC Student Recruitment Office, with the collaboration of the ERI, the Office of Sustainability and Climate Action, Student Societies and UCC's Students' Union, organised a Mock COP27 as part of the UCC Open Day 2022. The event was hosted by Dr Fionn Rogan (ERI, MaREI) and was designed to increase awareness of what would be discussed at COP27 in

Egypt. The 70 secondary school student attendees from all over Ireland adopted negotiating positions for different country groupings and had the opportunity to experience the dynamics of negotiating an international agreement on climate change. Students were surprised at how difficult it was to reach agreements on the difficult topic of carbon emission targets!



THE RIGHT TO A HEALTHY ENVIRONMENT FOR OUR YOUTH

The right to a healthy environment is being increasingly recognised at international level, thanks to youth climate activists and advocates who have been key to progressing action against climate change. Coinciding with COP27, Dr Aoife Daly (School of Law, Centre for Law and the Environment and the ERI) convened an online event at which children and youth reflected on the significance of the right to a healthy environment for children and youth, particularly from the perspective of the UN Convention on the rights of the child and contributed to the decision-making process around the UN Climate Change Convention. Speakers at this event included law students and academics, climate justice advocates and the Director of the Global Network on Human Rights and the Environment.

GOVERNING DISASTER RISK IN A CHANGING CLIMATE - LESSONS FROM AOTEAROA NEW ZEALAND AND IRELAND

The Centre for Criminal Justice and Human Rights (CCJHR) led by Dr Dug Cubie (ERI, School of Law, Centre for Law and the Environment) also held a lunchtime seminar on the topic of disaster risk to coincide with COP27. Chaired by Dr Marie Aronsson-Storrier (ERI, School of Law, Centre for Law and the Environment), presenters Dr Cubie and Holly Faulkner (University of Canterbury, New Zealand) examined how the legal and policy frameworks of two countries, Aotearoa New Zealand and Ireland, are preparing for and responding to the changing hazard profile and disaster risks resulting from climate change.

3 | Celebrating Ellen Hutchins



Prof Astrid Wingler, Head of Plant Science in UCC, Dr Paul Bolger, ERI Manager, Madeline Hutchins, Ellen's great-great-grandniece and member of the organising committee of the Ellen Hutchins Festival, Prof Sarah Culloty, ERI Director and Head of SEFS in UCC, UCC President John O'Halloran, and Dr Avril Hutch, UCC Director of Equality, Diversity and Inclusion

In September 2022, the Environmental Research Institute's Lee Road Building was renamed in honour of the pioneering botanist and Cork woman, Ellen Hutchins. Widely recognised as Ireland's first female botanist, Ellen Hutchins overcame a series of challenges in her personal life to identify several previously unknown species of plants, in and around her native Bantry Bay.

Between 1805 and 1813, in Ballylickey on the shores of Bantry Bay, Ellen Hutchins applied herself to the study of a particularly difficult branch of botany - the non-flowering plants - seaweeds, lichens, mosses and liverworts. She also produced a list of all the plants she could find in her neighbourhood, which amounted to over one thousand. This would be the first proper account of West Cork's flora. In those eight years,

aged 20 to 27, Ellen Hutchins found at least 20 species that were new to science or new to Ireland, and made a significant contribution to the understanding of non-flowering plants, especially seaweeds. She also produced hundreds of exquisitely detailed watercolour drawings of seaweeds. Ellen's achievements are all the more impressive when we consider that she suffered from periods of ill-health throughout her life and had extensive caring responsibilities at home, having returned to Bantry from school in Dublin to care for her ailing mother and a disabled brother.

Ellen herself died young, just before her 30th birthday. Her legacy includes ten plants which have been named after her, such as the moss *Ulota hutchinsiae* (Hutchins' Pincushion), in recognition of the



Carrie O'Flynn, historical re-enactor, dressed as Ellen might have been in clothes of the early 1800s. Credit: Ellen Hutchins Festival

importance of her botanical studies. Paying tribute following her death, Ellen's botanist friend Dawson Turner wrote that: "*Botany had lost a votary as indefatigable as she was acute, and as successful as she was indefatigable.*" Now Ellen Hutchins' indefatigable spirit will be immortalised in the naming of UCC's ERI building on the Lee Road. The official naming ceremony included contributions from a number of speakers including Madeline Hutchins, Ellen's great-great grandniece and an organiser of the Ellen Hutchins Festival and poet Laura McKenna who read a poem specially commissioned for the event.

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This is a very special day for the UCC Environmental Research Institute. By sharing in the legacy of women like Ellen Hutchins we hope we can encourage generations of UCC students to find inspiration in Ellen's remarkable story and be motivated to follow in her ambitious footsteps. This is the second building to be named after a female trailblazer here at UCC, with the Iris Ashley Cummins Civil Engineering Building named in February of this year. We have also celebrated four other female pioneers - Prof Mary Ryan, Dr Dora Allman, Dr Lucy Smith and Prof Aine Hyland - who now have prominent rooms named after them on campus. We are delighted that Ellen Hutchins will today join their ranks and we know she will also empower and inspire our UCC community.

Professor Sarah Culloty,
Outgoing ERI Director and Head
of SEFS

“

I am immensely proud that UCC has chosen to name its Environmental Research Institute building after my great-great-grand-aunt, Ellen Hutchins. The challenges she faced in overcoming illness and balancing caring responsibilities with her own interest in botany, span the centuries and are just as relevant today as they were at the time. I hope that UCC students and staff will be encouraged by Ellen's life and her love of nature, and strive to protect our environment for future generations.

Madeline Hutchins,
Ellen's great-great grandniece and
an organiser of the Ellen Hutchins Festival

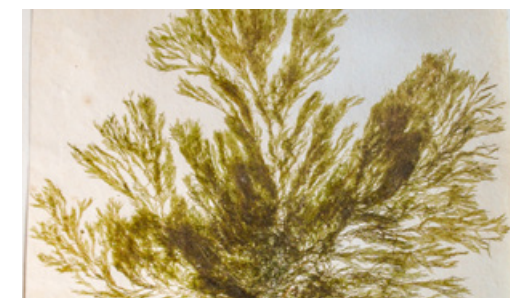
THE ELLEN HUTCHINS LIBRARY AND READING ROOMS

The renaming event also coincided with the unveiling of the Ellen Hutchins Library and Reading Room on the first floor of the ERI Ellen Hutchins building, where the story of Ellen Hutchins is told through her letters and artefacts from her life and work, including original drawings and coverage of her plant finds in botanical books. Visiting the room, you can view the display case containing items related to Ellen's letter writing including a pewter ink well from the early 1800s, a wooden handled seal, sealing wax, goose feather quills, four letters from Ellen to her brothers and laid paper with text from her letters.

There is also a bookcase and shelves contain a number of pressed modern seaweed specimens, framed silhouettes representing Ellen Hutchins and Dawson Turner and a number of books on the themes of botanical illustration, bryophytes and seaweeds of Ireland, Ellen's biography, and guides to the nature and ecology of Bantry Bay. The Ellen Hutchins archives cabinet contains several letters, books, and a single drawing by Ellen. These materials are all from the Hutchins Family Collection and are kindly on loan to the ERI from the Ellen Hutchins Festival.



Images are reproduced by kind permission of the Ellen Hutchins Festival, the Hutchins Family Collection, the C.V. Starr Virtual Herbarium of the New York Botanical Garden, the Natural History Museum of London, the National Parks and Wildlife Service, the Master and Fellows of the Trinity College of Cambridge, the Herbarium in the Botany Dept of Trinity College Dublin, the UCC Library, and the Board of Trustees of the Royal Botanical Gardens in Kew.



4 | ERI Research Highlights 2022

4.1 CLIMATE ACTION

Climate change is one of the greatest threats facing humanity. The transition to a zero carbon and climate resilient society as committed to in the 2015 Paris Agreement is now underway. The ERI Climate Action challenge is focused on understanding, responding, adapting, and living with climate change.



POLICY IMPACT: OUTLINING A VISION FOR THE BEEF SECTOR

The Irish agriculture sector as a whole was directly responsible for 37.5% of the national Green House Gas (GHG) emissions in 2021, and the sectoral target for agriculture is to reduce greenhouse gas emissions by 25% (or an estimated 5.75 Mt CO₂ equivalent) by 2030. The Food Vision Beef and Sheep Group was established, along with the Food Vision Dairy Group, to chart a path for the sector to meet this challenging target. Chaired by Prof Thia Hennessy (Head of CUBS, Head of the Department of Food Business and Development, Chair of Agri-Food Economics at Cork University Business School, and ERI Academic), the Group includes representatives from farm organisations, the meat processing industry, academia, relevant State, and other agencies, as well as the Department of Agriculture, Food and the Marine.

In November 2022, the Group presented its final report to the Minister for Agriculture, Food and the Marine, Charlie McConalogue T.D. The objective of the report was to identify measures which can reduce emissions from the beef sector while also protecting the viability of the more than 80,000 farm families engaged in beef production in Ireland. The report sets out 21 recommendations whose impact can be counted directly in the national agriculture emissions inventory, as well as indirectly by enabling actions which support and enable the adoption of the direct measures. When combined with the report from the Food Vision Dairy Group, this report from the Beef Group proposes measures that can potentially deliver 4.28Mt of CO₂ equivalent without a reduction in animal numbers.

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I want to thank the Food Vision Beef and Sheep Group, and its Chair Professor Thia Hennessy, for the intense effort that went into this report, which details direct and enabling measures needed to reduce greenhouse gas emissions from the beef sector. Putting the beef sector on an even more sustainable footing is a key priority of mine and I believe we can build a more resilient sector for this and the coming generations of beef and sheep farmers. It is key that first we have a pathway to reducing emissions and know what measures can contribute to that.

Charlie McConalogue T.D.
Minister for Agriculture,
Food and the Marine,



CLIMATE CHANGE AND CIVILIZATION COLLAPSE

Shifts in climate – both large and small – are at least partly responsible for the rise and fall of many ancient civilizations. From the drought-related collapse of the Maya in 900AD to the dust storms and prolonged winters which contributed to the fall of ancient Mesopotamian cities over 4,000 years ago, scientists have observed that civilisations which failed to adapt to changing patterns of weather were victims of their inflexibility. In today's globalised and technologically interconnected society, the concept of civilisational collapse due to anthropogenic climate change may seem far-fetched, but perhaps this is because our definition of what would constitute such a collapse needs to be revised. A new project involving Dr Kian Mintz-Woo (ERI, Dept of Philosophy) will assess the risk of civilization collapse due to anthropogenic climate change and explore the resulting conceptual, epistemological, and ethical issues.

The project, Climate Change and Civilization Collapse, led by Dr Daniel Steel in the University of British Columbia will begin by clarifying what the collapse of modern-day civilisation would really look like. Dr Kian Mintz-Woo proposes that a society collapses when

it reaches a point where justice can no longer be implemented. Dr Mintz-Woo and colleagues will also examine possible emission and adaptation scenarios that may make climate collapse more or less likely, and finally, will consider the ethical implications of the risk of climate collapse. The most apparent being to provide support for a precautionary approach, on the basis that avoiding catastrophe has complete priority over non-catastrophic considerations.

“

The importance of this project is to understand whether high estimates of warming, e.g., four degrees Celsius, should be thought of as reasonable proxies where state capacity is undermined. Given that state capacity is important for both individuals pursuing their plans and for coordinating policy for social benefit, these would be incredibly dangerous outcomes. If so, precautionary thinking might support avoiding them at almost any cost. We examine and try to develop this precautionary argument.

Dr Kian Mintz-Woo



INTEGRATING CLIMATE ADAPTATION AND EMERGENCY PLANNING IN IRELAND

In Ireland, there is a portfolio of policies, plans, and strategies that address the consequences of climate change and emergency planning. However, emergency management and climate change adaptation are currently two discrete and separate systems for governance, management and coordination at the national level. Climate change adaptation focuses on the probable chronic long-term impacts likely to occur across multiple sectors. In contrast, emergency planning and disaster risk reduction primarily aims to address acute short-term impacts. The challenge is to balance the immediate risks of extreme weather and climate events with planning for how these threats will evolve and alter future vulnerabilities of communities and/or environments.

Published in 2022, the EPA Research Report: *Enhancing Integration of Disaster Risk and Climate Change Adaptation into Irish Emergency Planning*

authored by ERI researchers Dr Dug Cubie (School of Law, Centre for Law and Environment) and Dr Martin Le Tissier (MaREL) with humanitarian consultant Peter Medway, aimed to identify ways to enhance and reconcile integration of knowledge, policies and practices between climate change adaptation and disaster risk reduction/management. The research identified a roadmap to facilitate the objective of preparing for and responding to the climate crisis, and to more readily achieve integration of climate change adaptation and disaster risk reduction into Irish emergency planning. This roadmap will assist government, key stakeholders and sectors most likely to be affected by the existing and increasing risks of climate change to achieve greater coherence and integration between the emergency management and climate adaptation frameworks in Ireland.



TRANSLATING RESEARCH INTO IRISH CLIMATE POLICY

The Energy Policy and Modelling Group (EPMG) is Ireland’s scientific leader in energy systems modelling with detailed modelling tools developed over 20 years. To date, EPMG researchers have provided energy modelling for landmark Irish climate policy including Ireland’s first low carbon roadmap in 2013, Ireland’s Energy White Paper in 2015, the first Climate Action Plan in 2019, and Ireland’s first carbon budgets in 2022.

The climate policy impact that ERI has achieved in the past year provides a striking testament to how effectively EPMG-lead Prof Brian Ó Gallachóir has fostered a strong collective motivation, not only to achieve scientific excellence, but also to successfully translate research results into useable policy insights. The most significant recent impact is the Oireachtas adoption in May 2022 of carbon budgets. One of the most important factors underpinning the proposed carbon budgets is the obligation under the Climate Act to achieve a 51% reduction in greenhouse gas emissions by 2030 relative to 2018

levels. Prof Ó Gallachóir and Prof Hannah Daly were invited members of the Carbon Budgets Committee established by the Climate Change Advisory Council in 2021 to assist them in quantifying Ireland’s carbon budgets. The Council submitted proposed carbon budgets and asked Prof Ó Gallachóir to lead a sub-group to present these to the Joint Oireachtas Committee on Climate Action in 2022, which were approved by the Government and adopted by the Oireachtas.

Modelling conducted by the Energy Policy and Modelling Group (EPMG) also underpinned a Department of Transport report on the role of biofuels in meeting national and EU targets - *A Review of Requirements and Constraints on Biofuels in Ireland Arising from RED II and National Targets*. This comprehensive study report concerned the future demand and supply of biofuels under ambitious climate action plan targets, and clearly illustrates the required amount of biofuel and related feedstock supply and production needed by 2030.



DEVELOPING A LONG-TERM DECARBONISATION PATHWAY FOR IRELAND

In April 2022, the Energy Policy and Modelling Group (EPMG) was requested to undertake energy systems modelling analysis to inform the development of Sectoral Emissions Ceilings as part of the Government’s carbon budgeting programme. This work took place under phase I of the CAPACITY (Climate Action Pathways & Absorptive Capacity) project, part of the Department of the Environment, Climate and Communications- funded Climate Action Modelling Group (CAMG). The next phase of the CAPACITY project will be supported by €3.5m in funding which has been awarded to the EPMG by the Department of Environment, Climate and Communications in 2022 to provide energy modelling analysis over the next five years. Under the funding agreement Government Departments will be able to directly access UCC’s expertise, in a bid to ensure future decisions on Ireland’s energy and climate policy are evidence-based.



CAPACITY project co-PIs Prof Hannah Daly, Prof Brian Ó Gallachóir and Dr Fionn Rogan

“

I am delighted that UCC has been selected as one of our CAMG partners. Ireland’s climate ambition and emission reduction commitments are challenging but attainable. To find the most effective and feasible pathways to meet our goals will require robust and up to date modelling and analysis. The work undertaken by UCC, as part of the CAMG, will be essential to inform policy.

Eamon Ryan
Minister for the Environment,
Climate and Communications

“

As Ireland’s climate commitments require a rapid transition to a sustainable, zero-carbon energy system, it’s never been as important that the policy system is supported with a rigorous evidence base. The energy systems models we develop under this project will provide timely, transparent analysis to the State at this crucial time.

Prof Hannah Daly
Project co-PI

“

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Dr Fionn Rogan
Project co-PI

“

The tools, ideas and analysis we have developed in UCC over the past decade allow us to be proactive rather than reactive when it comes to future energy planning and never has this been more necessary now as Ireland faces twin challenges of a climate and energy crisis.

Dr Paul Deane
Project co-PI

CLIMATE CHANGE ADAPTATION FOR IRELAND'S CRITICAL INFRASTRUCTURE

Ireland's water and wastewater treatment systems form a vital component of the country's critical infrastructure network, but are vulnerable to extreme weather events. The latest report by the Intergovernmental Panel on Climate Change (IPCC), which states that the warming of the climate system is unequivocal, predicts that future changes in climate may lead to increased risk to such critical infrastructure. Given the considerable costs and long service life associated with wastewater infrastructure, it is vital that we develop an understanding of the potential future risks our wastewater system may face, with a view to developing effective adaptation strategies.

Next Generation Energy Systems (NexSys) is a unique large-scale project funded by the SFI Strategic Partnership Programme with Irish industry, seeking to address fundamental questions in this space across the five strands of Energy Systems, Water, Transport, Offshore Wind, and Cities and Communities. A key consideration in this project will be the impact of climate change on our water system. The UCC research activities will be led by Dr Paraic Ryan (ERI, School of Engineering and Architecture) and primarily centred around the water strand but will also address the cross-cutting themes of Society, Climate and Finance. To date Dr Ryan's group has been exploring the development of sustainable concretes for water and transport infrastructure and the vulnerability of critical infrastructure to climate change effects and cascading failures. Now the group will use innovative risk-based methods to examine the potential impacts of climate change on water and wastewater infrastructure, as well as examining cascading climate change effects from, and to, other critical infrastructure sectors.



INFORMING END-OF-LIFE DECISIONS FOR WIND FARMS

At the end of the life of a windfarm, a decision must be made whether the farm should be decommissioned, have its life extended or be repowered by replacing with new turbines. By analysing the value of wind farms as they age, the IRC-funded Wind Value project led by Dr Peter Deeney (ERI, MaREI, CPPU) and Dr Paul Leahy (ERI, School of Engineering and Architecture) aims to develop two decision support tools, one commercial and one for the community. The first decision support tool is for wind farm owners to decide between decommissioning, extension or repowering as end-of-life approaches. The second decision support tool is for local communities who may wish to invest in their local wind farm at a reasonable cost. Local people bring a unique leverage regarding local authority decisions about locally produced renewable energy. In this way, the researchers based in the ERI, the School of Engineering and Architecture and CUBS will examine the possible ways in which citizens can invest in existing windfarms as they approach end-of-life by using equity crowdfunding and other investment methods and examine the risk profile of such investments.

The first Wind Value conference on end-of-life issues for onshore wind farms was held in the ERI Ellen Hutchins Building in May 2022. Attendees from academia, industry, governmental agencies and regulatory bodies from Ireland UK, mainland Europe, North America and South America, heard from speakers from Georgia Tech, UCC, Wind Energy Ireland, MTU and the University of Leeds. The conference used the context of the circular economy to link the research of the Re-Wind Network, which looked at methods to re-purpose used wind turbine blades, to the new Wind Value project which examines the value of wind farms, particularly as they approach end-of-life.

“ *The End-of-Life Issues for Onshore Wind Farms Conference has raised the profile of ERI as a centre for renewable energy research. The conference brought together an international team of experts in circular economy and wind energy to help the participants make decisions about the future of wind farms.* ”

Prof Sarah Culloty
Outgoing ERI Director



EXPLORING THE EFFECTS OF CLIMATE STRESS ON IRISH GRASSLANDS

Irish grasslands can roughly be divided into intensively used, frequently reseeded 'improved' grasslands and 'semi-natural' grasslands which are typically under extensive agricultural use but harbour greater biodiversity. Biodiversity is not only reflected in the number of species but also in the diversity of plant traits. Launched in 2022, the StableGrass project led by Prof Astrid Wingler, Dr Samuel Hayes (both of ERI, School of BEES), Dr Fiona Cawkwell (ERI, MaREI, Dept of Geography) and colleagues in Galway addresses the important question of how plant diversity in semi-natural grasslands affects below-ground carbon storage and yield in response to climate-related stress.

Over the next three years the project funded by the Department of Agriculture, Food and the Marine will determine plant diversity (species and traits) in semi-natural grasslands in Ireland and conduct carbon audits to relate soil carbon profiles to plant diversity. Using high-resolution satellite and drone imagery, the researchers intend to classify grasslands and determine their biodiversity and yield through remote sensing. By working directly with farmers, the results will feed back to improve farm management and inform policy on the priorities for the management of semi-natural grassland habitats, with the aim of protecting biodiversity while increasing carbon storage and yield stability in a future climate.



SUPPORTING IRELAND'S SHIFT FROM SOLID FUEL USE

Emissions of fine particulate matter (PM2.5), attributable to the burning of solid fuels, such as coal, peat and wood, are a particular cause of poor air quality in urban areas, but the complexity of the residential solid fuel sector hampers the task of developing effective policy solutions to support the continued transition away from the use of solid fuels for residential home heating. EPA-

funded research carried out by Dr John Eakins, Dr Bernadette Power, Dr Gordon Sirr (all of ERI, CUBS) and Dr Niall Dunphy (ERI, CPPU) has now provided a deeper understanding of the sector using existing data on solid fuel use and has provided new data on supplementary solid fuel use which can help to strengthen the understanding and management of air quality in Ireland.



FINDINGS & POLICY RECOMMENDATIONS

- Residential solid fuel use is a significant contributor to air pollution and greenhouse gas emissions in Ireland, with significant health impacts on vulnerable populations.
- The heterogeneity of solid fuel users in relation to household characteristics and levels of use has not previously been the subject of research study.
- The report calls for a phased transition towards cleaner fuels, including renewable energy sources and low-carbon alternatives such as natural gas, with a focus on promoting energy efficiency and reducing fuel poverty, and increased public awareness and engagement on the issue.
- This report highlighted the significance of the non-traded market, particularly for certain solid fuels, such as peat and wood, and for households in rural areas.
- Recommends a periodic survey of a nationally representative sample of households to capture trends in this sector and household solid fuel use in general which would complement the top-down methods used by the SEAI in its energy balance statistics.

CORK COUNTY COUNCIL AND UCC COLLABORATE ON COASTAL EROSION PROJECT

Cork County Council and ERI/MaREI, have agreed a pioneering partnership that will see the entire coast of Cork assessed and mapped for coastal erosion. The three-and-a-half-year project will see UCC researchers conduct a detailed review of the 1199km Cork coast to assess areas that are vulnerable to coastal erosion. The projects outputs will inform the future planning of coastal management along the Cork coastline and the development of coastal management activity in the future. The research project team will liaise with the Office of Public Works, the Climate Action Regional Office, the Geological Survey of Ireland and other lead agencies to build on existing studies and collaborate with related projects currently underway.



“ *This project shows that Local Authorities are becoming very proactive in terms of managing coastal erosion and addressing future challenges due to climate change. There is a long tradition of coastal research in UCC so we very much welcome the initiative taken by Cork County Council to support this project. Its outcomes will provide a quantification of the magnitudes of erosion and a means to prioritise work to the most vulnerable locations. We hope that the approaches adopted can be rolled out nationwide and so provide more uniformity in how Ireland manages its coastline.*

Dr Jimmy Murphy
School of Engineering and Architecture
MaREI and ERI

USING NOVEL TECHNOLOGIES TO HELP OUR FORESTS ADAPT TO CLIMATE CHANGE

It is crucial to make forest ecosystems more resistant to face the challenges presented by climate change, through resilience strengthening and close-to-nature forestry. However, implementing such approaches and monitoring their progress requires accurate knowledge about forest ecosystems that rely on forest *in situ* data at high spatial and temporal resolution.

Novel, terrestrial-based technologies will play an important part and such technologies have experienced a fast development in recent years. The forests can now be observed and monitored in a very high spatial and temporal resolution that was not possible even a few years ago. Researchers and practitioners are facing a unique opportunity to deepen the understanding of forest ecosystems and to change the forestry to adapt to the climate, environment and industrial changes. Various research groups across EU and beyond are testing such technologies or developing processing algorithms for precision forestry and forest ecology. But further cooperation is urgently required and Dr Markus Eichhorn (ERI, School of BEES) is currently leading on communication and dissemination in a COST Action which aims to promote such collaboration.

3DForEcotech (Three-dimensional Forest Ecosystem Monitoring and Better Understanding by Terrestrial-based Technologies) will establish a strong network of scientists, stakeholders and sensor manufacturers to synchronise the knowledge, to develop general protocols and algorithms for forest ecosystem state survey and forest functioning, and to make these

novel technologies available to a broad audience. Specifically, 3DForEcoTech will develop protocols for data acquisition, processing, fusion for forest inventory and ecological applications, and will establish open-data and open-source algorithm databases.



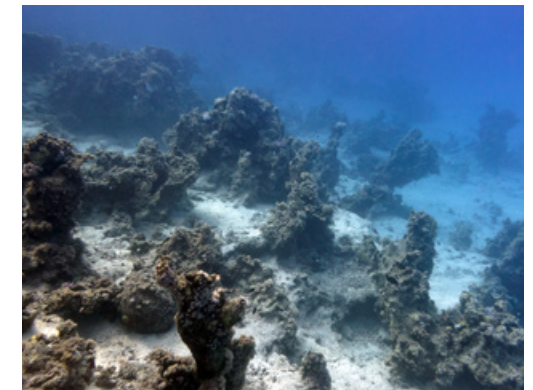
UNCOVERING THE HIDDEN FORCE GOVERNING THE SURVIVAL OF DEEP-SEA LIFE

Our ocean biodiversity is dependent on the strong circulation system of our oceans. Water near the ocean surface moves towards the poles, where it becomes cold and dense. When the dense water sinks, it brings oxygen with it from the atmosphere to the ocean floor. This oxygen is vital for the survival of deep-sea creatures. Similarly, nutrients from sunken organic matter are delivered back to the surface, providing plankton with the sustenance to grow and support the wonderful biodiversity of our oceans. However, this was not always the case throughout the Earth's history, and research from Dr Andrew Keane (ERI, School of Mathematical Sciences) published in *Nature* in 2022, has found that this circulation can suddenly disappear with the gradual shifting of the continents.

Decades of modelling and analysis show that if precipitation in certain parts of the Atlantic Ocean pass a certain threshold, or if atmospheric CO₂ passes a critical level, then the ocean would quickly find itself in a state of reduced circulation. This new study uses a complex computer model of the Earth with a 3D representation of the ocean dynamics and reconstructed continental configurations from across the past 540 million years. The simulations of this model show that even small adjustments to the positions of the continents can 'tip' us into a completely different distribution of oxygen in the deep ocean.

“ *The Earth's climate system is so complex that it is possible for a seemingly tiny change to result in a relatively sudden and often drastic response. The critical threshold that is overcome by this tiny change is often referred to as a climate 'tipping point'. It's clear from many recent studies that a tipping of the modern Atlantic Ocean circulation would change life as we know it in western European countries because our climate would become drastically colder. Some of these studies even suggest that we are approaching a tipping point. Our study highlights the threat to ocean biodiversity, especially to creatures of the deeper and darker parts of the ocean*

Dr Andrew Keane



4.2 HEALTHY ENVIRONMENT

Our economic prosperity and well-being are underpinned by the quality of our environment and natural capital. The ERI Healthy Environment challenge is focused on protecting our natural ecosystems and providing a healthy environment for humans, animals and plants to live in.



UCC REPORT WILL GUIDE FUTURE DEVELOPMENT OF POLICY FOR SOILS IN IRELAND

The publication of the EU Roadmap New Soil Strategy and the commitment in Ireland's Programme for Government 2020 to put a new national soil policy in place emphasise the immediate need to support the development of policy for soil research and protection in Ireland. This can be achieved through the synthesis of our current knowledge of Irish soils and of how soils are affected by human activities and climate change. Authored by Prof Maria McNamara, Hannah Binner, Eric Hynes and Luisa Andrade (all ERI, School of BEES), a 2022 EPA study aimed to generate an accessible evidence base to support this development and to enable Ireland to meet its commitments to both national and EU soil strategies. The study reviewed Irish soil research from 2013 to the present, encompassing government reports and academic

papers on soil quality, health, damage, management, remediation, biodiversity and climate change, and on soils in urban, agricultural and other settings.

Amongst the other findings of the report, the authors highlighted major knowledge gaps with current research biased towards counties with permanent soil research facilities and soils in agricultural settings, and soils in other settings, notably urban and mining settings, underrepresented. The study recommended that future government policy should prioritise supporting soil research, in particular research on human impacts on soil in non-agricultural settings and soil characteristics that are understudied.

DR MARGUERITE NYHAN WINS SFI FRONTIERS FOR THE FUTURE RESEARCH FUNDING TO ADVANCE THE SCIENCE OF SUSTAINABLE CITIES

Dr Marguerite Nyhan, Senior Lecturer/Associate Professor in Future Sustainability & Environmental Engineering, won Science-Foundation Ireland Frontiers for the Future funding worth €611,117 for her project entitled "Environmental Intelligence - Modelling Complex Human-Environment Interactions for Maximising Environmental Health in Urban Areas". The "Environmental Intelligence" frontier research project will significantly advance the science of sustainable, healthy and liveable cities of the future. This ground-breaking research will harness sensors, largescale Information Communications Technologies (ICT) datasets, artificial intelligence and machine learning to understand urban dynamics, air pollution and greenspace in unprecedented accuracy and scale in a number of cities in Ireland and the United States. Importantly, Dr Nyhan will examine associations between human exposures, behaviour change and health outcomes with a view towards informing the planning and design of cities as well as urban environmental health policies.

Directed by Dr Marguerite Nyhan, the Future Sustainability Research Group investigates and develops intelligent solutions for sustainable, net zero, healthy, liveable and equitable cities of the future. The group employs state-of-the-art technologies and methodologies from a number of disciplines including engineering, computer science, urban planning, public health and sociology to achieve its vision. The Future Sustainability Research

Group sits within the Sustainable Futures Lab, the School of Engineering & Architecture, the Environmental Research Institute and the MaREI Centre at UCC.

In March 2022, Dr Nyhan gave a TEDx entitled 'A Perspective for a Shared Sustainable Future' at UCC. Dr Nyhan spoke about her perspective for a shared sustainable, net zero and nature-positive future and highlighted her leadership of Sustainable Futures and her research.



IMPACT OF THE LIVE PROJECT ECO- MUSEUM

What is an Eco-Museum?

Eco-museums originated in France in the 1970's as a new idea of holistic interpretation of natural and cultural heritage, as opposed to the traditional focus on specific items and objects by conventional museums. There is no blueprint for an Eco- Museum, only a shared value of celebrating a sense of place based on local participation with the aim of growing the economy whilst enhancing the welfare and development of local communities.

The LIVE Eco- Museum

Funded by the European Regional Development Fund (Ireland Wales Cooperation Programme) LIVE (Llŷn, Iveragh Eco- Museum) is a partnership located on both sides of the Irish Sea. LIVE is using the Eco- Museum model of co-operative marketing to create a powerful suite of digital and non-digital resources for eco and educational tourism. LIVE aims to enable coastal communities in Llŷn (Wales) and Iveragh (Kerry) to promote their natural and cultural assets, creating opportunities for sustainable tourism and moving away from 'extractive' tourism. It is coordinated in Iveragh by Prof Pat Meere and Dr Fidelma Butler and managed by Lucy Taylor and Orla Breslin (all from School of BEES and the ERI).

What impacts has the LIVE project had so far?

Policy:

LIVE is currently informing the new tourism strategy for Kerry County Council and the new multi-agency action plan that will be overseen by a taskforce established for the Iveragh Peninsula in south Kerry to tackle the issues of rural depopulation in the south Kerry Gaeltacht. The work of LIVE is also feeding into a new local economic development plan for Valentia Island.

Scientific:

Citizen Science has been a significant component of the LIVE project with findings presented at European scientific conferences and resulting áin datasets for the National Biodiversity Data

Centre. These datasets have been used to update the knowledge of distribution of species of bees, butterflies and birds of conservation concern in south Kerry.

Environmental-sustainability-ecological impact:

In collaboration with Met Eireann and the Office of Public Works, local groups are now establishing natural meadows and low nutrient grasslands using revised mowing regimes rather than introducing seed.

Societal:

- Cahersiveen tidy towns, the Ballinskelligs Environmental Action Group, and newly formed Green Glens group are all local community organisations that have been supported by the work of LIVE who have provided tailored information to these groups and advised them on the best actions to take for conserving biodiversity in their areas.
- Many of the public events held by LIVE have the intention of increasing community engagement with the local natural heritage. Examples include whale and bird watching and guided walks along local walking trails to highlight the overlooked local biodiversity.
- Citizen science initiatives included a chough count where members of the public received training and participated. In addition, a campaign to involve people in monitoring seasonal change in their local native trees engaged members of the public in training to identify tree species and resulted in weekly recordings being submitted for 3 months.



NOVEL METHOD FOR STUDYING PLANT STRESS RESPONSES IN A CHANGING CLIMATE

Plants live in highly dynamic surroundings and need to cope with constant environmental challenges. In order to do so, they have developed quick reactions to stress that allow them to gain time while mounting a major response. This first line of defence includes the stomata - leaf epidermal pores in charge of regulating water loss and photosynthesis. Stomatal movements are controlled by plant stress hormones which induce fast closure of the stomata upon perception of stress conditions thus preventing loss of water. This is an area of research becoming ever more crucial in a changing climate but the two main approaches to determine changes in stomata require either specialised equipment or damage to the plant tissues.

Dr Rossana Henriques (ERI, School of BEES) and colleagues have devised a novel method by obtaining leaf imprints which is quick, simple and does not disrupt the plant tissues. The protocol describes an inexpensive method to prepare high-quality impressions of *Arabidopsis thaliana* seedling leaves from long-lasting silicone-based casts, allowing

detailed imaging of the stomatal pores. This method can be used to test leaf epidermal cell size/number and stomata number, size and aperture in crop species in the field, capturing a precise moment in the plants stress response *in vivo*. Importantly, these imprints can be generated at different stages of leaf development in distinct species. It is anticipated that this versatile protocol would have the potential to easily assess markers for drought responses in many different types of plants and have broad applications in plant research.



SIMPLIFYING AN UNSUSTAINABLE FOOD SYSTEM

It is widely recognised that the current food systems in Europe are unsustainable and unjust, causing harm to health, the environment, and public sector health and care services. Large multinational corporations perpetuate the "Lose-Lose-Lose-Win" food system where corporations win at the expense of the environment, health and the public sector. However, a transition to "Win-Win-Win-Win" food systems is challenging due to the heterogeneity, complexity, and unpredictable nature of food systems. Heuristics (simple rules of thumb) are a type of solution that can provide the flexibility needed to account for different contexts, preferences and needs. Within food systems, food democracy could be a heuristic solution that can form the basis for driving transition processes while also ensuring that these transition processes are fair, equitable, sustainable and constructive.

The Horizon Europe project, FEAST, in which Dr Janas Harrington (School of Public Health, ERI) is a key partner proposes to use multilevel governance approaches to create constructive food democracy. The consortium envisages that this will inform just processes that can be used to design and implement

policies, in line with food democracy, while being able to accommodate the shifting demands of complex food systems. The ultimate goal is to enact food democracy as a heuristic solution to overcome the current imbalances and injustices while facilitating transitions to "Win-Win-Win-Win" food systems across Europe that makes it easy for every European to eat a health and sustainable diet that is good for their health, good for the environment, reduce demand on public sector services, and bring benefits for businesses.



CITIZEN SCIENCE PROJECT ENGAGES LOCAL COMMUNITIES ON FRESHWATER QUALITY

Streams and rivers are amongst the most endangered ecosystems in the world and water quality is an important measure for maintaining ecosystem function. Despite several decades of the EU Nitrates and Water Framework Directives, nutrient-rich organic matter of both agricultural and municipal origin continues to pollute many waterways in Ireland, most of which are not routinely monitored in terms of water quality. This lack of data hampers efforts to improve water quality. Citizen science projects have been identified by the EU as a growing field of practice that is likely to yield significant outcomes for water quality and data capture.

An exciting new citizen science method developed in UCC and supported by both the EPA and the Local Authority Waters Programme (LAWPRO) allows anyone to determine the quality of their local rivers or streams by looking at the types of creatures which are living in it. Created by Dr Simon Harrison (pictured) of the ERI and School of BEES, the Citizen Science Stream Index looks at the types of water bugs that are found at the bottom of our rivers. The Index is based on the presence or absence of six key aquatic invertebrates. Three pollution-sensitive invertebrates ('good guys') – the Stonefly, the Flattened Mayfly and the Green Caddisfly - are commonly found in clean streams, while three pollution-tolerant invertebrates ('bad guys') – snails, leeches and the Waterlouse - are commonly found in polluted streams. The scheme

has been trialled with the support of locally led catchment projects and are currently being rolled out across LEADER areas via bespoke water training programmes developed by LAWPRO and the Rural Development Companies. The National Biodiversity Data Centre are also currently developing the online repository into which the gathered data will feed.



Credit: Noreen Byrne

RESEARCHERS IDENTIFY MOST DANGEROUS TIMES FOR HARES AT DUBLIN AIRPORT

The number of wildlife-aircraft collisions with mammals are increasing by up to 68% annually in some countries and have caused damage that has cost in excess of \$103 million in the United States alone over a 30-year period. When we think of these wildlife-aircraft collision, we usually think of bird strikes, but ground-dwelling animals are also prone to fatalities due to aircrafts.

An IRC-funded study authored by Dr Samantha Ball, Dr Anthony Caravaggi, and Dr Fidelma Butler (School of BEES, ERI) used motion-activated camera traps to collect activity data on the hare population inhabiting

the airfield at Dublin Airport. They then used this data to identify when aircraft collisions with hares were most likely to occur - generally around sunrise and in the hours approaching midnight. This was closely associated with the times of day when hares were most active at the airfield but when aircraft movements were relatively low. Recommendations from the authors included focusing strike prevention efforts- such as scaring tactics and runway patrols- directly onto the hare population themselves as opposed to facing the near-impossible task of altering aircraft activity, to reduce hare strike events.



“*This work has allowed us to identify periods throughout the day, and year, when strike risk with hares may be higher, indicating when strike prevention efforts can be increased to deter hares from the active runway. The research can also be applied to other airfields, as although we focus here on the Irish hare at Dublin Airport, this method can be used to identify periods of increased strike risk with ground-dwelling species of concern worldwide, such as deer and large carnivore species.*”

Dr Samantha Ball, lead author

WILDFIRES MAY HAVE SPARKED ECOSYSTEM COLLAPSE DURING EARTH’S WORST MASS EXTINCTION

In recent times wildfires have caused shocking mass animal die-offs in several regions around the world. During the same period our warming global climate has led to prolonged droughts and increased wildfires in typically wet habitats, such as the peat forests of Indonesia and the vast Pantanal wetlands of South America. These major ‘carbon sinks’—regions of natural capture of carbon from the atmosphere—are crucial in our fight against climate change. Research published in 2022 by Dr Chris Mays (ERI, School of BEES) and colleagues in the Swedish Museum of Natural History has shown that wildfires may have been a key contributor to the total collapse of land ecosystems during the Earth’s worst mass extinction event over 250 million years ago.

The research team examined the end-Permian mass extinction that eliminated almost every species on Earth, with entire ecosystems collapsing, and discovered a sharp spike in wildfire activity from this most devastating of mass extinctions. Promoted by rapid greenhouse gas emissions from volcanoes, extreme warming and drying led to wildfires across vast regions that were previously permanently wet. Instead of capturing carbon from the atmosphere, these wetlands became major sources of atmospheric carbon, enhancing the sharp warming trend.

“*The potential for wildfires as a direct extinction driver during hyperthermal events, rather than a symptom of climatic changes deserves further examination. Unlike the species that suffered the mass extinctions of the past, we have the opportunity to prevent the burning of the world’s carbon sinks and help avoid the worst effects of modern warming.*”

Dr Chris Mays



SUPPORTING UK CONSERVATION LAW ENFORCEMENT

Understanding the distribution of species is crucial for the effective planning and implementation of conservation protocols. There is a growing demand for predictive distribution models for marine species due to the continuing threats faced by marine biodiversity such as pollution, invasive species, fisheries bycatch and climate change. Species distribution models (SDMs) can provide important insight into the species' habitat preferences and highlight potential anthropogenic threats. Evidence-based SDMs inform organisations with a conservation remit such as Natural England, a non-departmental public body in the UK sponsored by the Department for Environment, Food and Rural Affairs which is responsible for enforcing laws that protect wildlife and the natural environment.

In 2022, Dr Darren Wilkinson and Prof John Quinn (ERI, School of BEES) were commissioned to do a review for Natural England which summarises the environmental predictor variables regularly used in distribution models for marine megafauna species around the UK. It highlights a wide range of variables that can be targeted in future modelling studies of marine megafauna species, based on the extent of their successful use to date, and gives an indication of which variables should be considered for which marine taxa (turtles, cetaceans, sharks, seabirds etc).

RESEARCH FOCUSES ON THREATS TO MARINE SEABIRDS

On Little Saltee, a small island off the south-east coast of Ireland, researchers from the UCC Marine Ecology Group (ERI, School of BEES, MaREI) attached tiny trackers to the feathers of Manx shearwaters. The aim of the study, published in Proceedings of the Royal Society B, was to understand how underwater visibility affects seabirds' ability to forage for fish and other prey. It is the first study to examine the impact of ocean clarity (which is becoming compromised by climate change) on seabirds' diving abilities. The study found that the birds dove deeper when sunlight could penetrate further underwater, suggesting that visibility is key to their ability to dive for food. As the planet warms and the ocean becomes cloudier this finding is important because it means that seabirds will have to overcome this challenge.

In a separate study, Marine Ecology Group researchers also collected feathers from Manx shearwaters, a seabird species thought to be at-risk from oil pollution. The researchers examined the feathers to see how quickly water would pass through after exposure to increasing concentrations of oil. Feathers were also assessed under high-powered microscopes to examine structural changes after contamination. This study found that even very thin oil sheens, were enough to have a significant effect on feather structure and impacted waterproofing. Seabirds exposed to oil are more likely to become waterlogged, cold, and less buoyant.

“

The chemical and physical properties of the planet's oceans are changing at an unnatural rate, bringing about challenges for marine life. One consequence of climate change is that large areas of our oceans are becoming cloudier.

Jamie Darby, lead author.

“

Chronic small-scale oil pollution is commonly overlooked in the marine environment, though it has been shown to have serious implications for the fitness and survival of seabirds. This study examined one species, but the results can be extended to other species that rely on waterproofing to stay healthy when at sea for long periods.

Emma Murphy, lead author.



CAN INNOVATIVE GENE EDITING TECHNOLOGY PROVIDE FOOD SECURITY IN THE FACE OF CLIMATE CHANGE?

The world faces enormous challenges in producing sustainable food for its growing population, given the escalating pressures of climate change and biodiversity loss. The EU's farm to fork strategy is the cornerstone of its Green Deal with the objective to contribute to a more sustainable food production system by reducing, among other things, dependency on pesticides by 50%. The strategy refers to the possibility of using genomic engineering to increase sustainability, but there is still intransigence regarding GMO adoption in the EU.

In March of 2022, researchers from UCC School of BEES and the ERI, led by Dr Barbara Doyle-Prestwich, addressed the Oireachtas Joint Committee on Agriculture Food and the Marine, as well as officials from Dept of Environment, Climate and Communications and representatives from Teagasc. The main focus was on the use of innovative technology (in particular CRISPR gene editing) as this topic is due out for additional consultation across Europe in the next few months.

“

These techniques offer precision genetic engineering capabilities that can introduce discrete changes in a plant's DNA in order to make improvements such as disease resistance and drought tolerance, as well as many others. If we are to realise the Government's ambitions in terms of the Green Deal and the farm to fork strategy, then it cannot be business as usual. The diseases that farmers are faced with are not going to disappear overnight. We really need CRISPR technology and, therefore, we need to invest in research in Ireland to make sure we are ready to go.

Dr Barbara Doyle-Prestwich



CITIZENS ASSEMBLY ON BIODIVERSITY LOSS

The Citizens' Assembly on Biodiversity Loss was a unique initiative taken by the Irish government as a response to the global decline of biodiversity. The Assembly was tasked with making recommendations on how Ireland could better protect and enhance its natural environment. To inform these recommendations, the Assembly heard from experts in the fields of ecology, environmental science, and policy. Amongst the experts who guided the Assembly's decisions in 2022 were several ERI Academics.

In October, Prof Áine Ryall (Centre for Law & the Environment, ERI) delivered an invited contribution to the Assembly. Prof Ryall's presentation considered environmental rights and rights of nature. It included an analysis of the right to a healthy environment, the role of the procedural environmental rights guaranteed under the Aarhus Convention and the implications of the decision of the Supreme Court in 'Climate Case Ireland' for environmental constitutionalism.

Dr Paul Holloway (Dept of Geography, ERI) was amongst the panel of 'Voices from the Community' who presented to the Assembly. Dr Holloway spoke about his work of mapping and modelling the urban biodiversity in Cork city, outlining the extent of the green and blue spaces and their capacity to support wildlife. In addition, Dr Clodagh Harris (Dept of Government & Politics, ERI) was a member of the Expert Advisory Group. Dr Harris' role was to advise on the Assembly's deliberative processes. Dr Harris and ERI Colleagues Dr Aoife Daly and Aoife Deane were also members of a research team which designed and implemented Ireland's first Children's and Young Persons' Citizens Assembly on biodiversity loss (CYPABL). At the end of the process, the Citizens' Assembly presented a report to the Irish government, which contained 17 recommendations on how to address biodiversity loss in the country.

WASTEWATER – A KEY TO TRACKING COVID-19 AT A WHOLE-COMMUNITY LEVEL

Dr Niall O’Leary (School of Microbiology, ERI) has been exploring the possibility of testing local wastewater and environmental sewage for the presence of the COVID-19 virus as a way to monitor prevalence in communities. The SARS-CoV-2 virus that causes COVID-19 can be present in the guts and faeces of infected people at high levels before they have noticeable symptoms of the disease. Currently it is estimated that 1 in 6 adults who are infected with the COVID-19 virus can have mild or no symptoms and yet pass the virus on to others. Such individuals may not be referred for diagnostic testing and their infection/transmission can go undetected. However, there is evidence that the virus can be present in the faeces of infected individuals from an early stage, whether or not they go on to develop COVID-19 symptoms. Testing sewage also offers a way to screen communities rather than individuals, widening the testing net.

Dr O’Leary’s wastewater surveillance work has been a crucial component of the UniCoV project - a multi-site, randomised controlled clinical study led by NUIG, in partnership with TCD, UCD and UCC which explored the feasibility and acceptability of self-reporting, self-testing and surveillance systems to assist with the safe and sustainable re-opening of Higher Education Institutes’ campuses, and society more broadly. Molecular tracking of SARS-CoV-2 in automated wastewater sampling stations from UCC campus sites (and other universities) allowed researchers to monitor virus levels among the staff and student community.



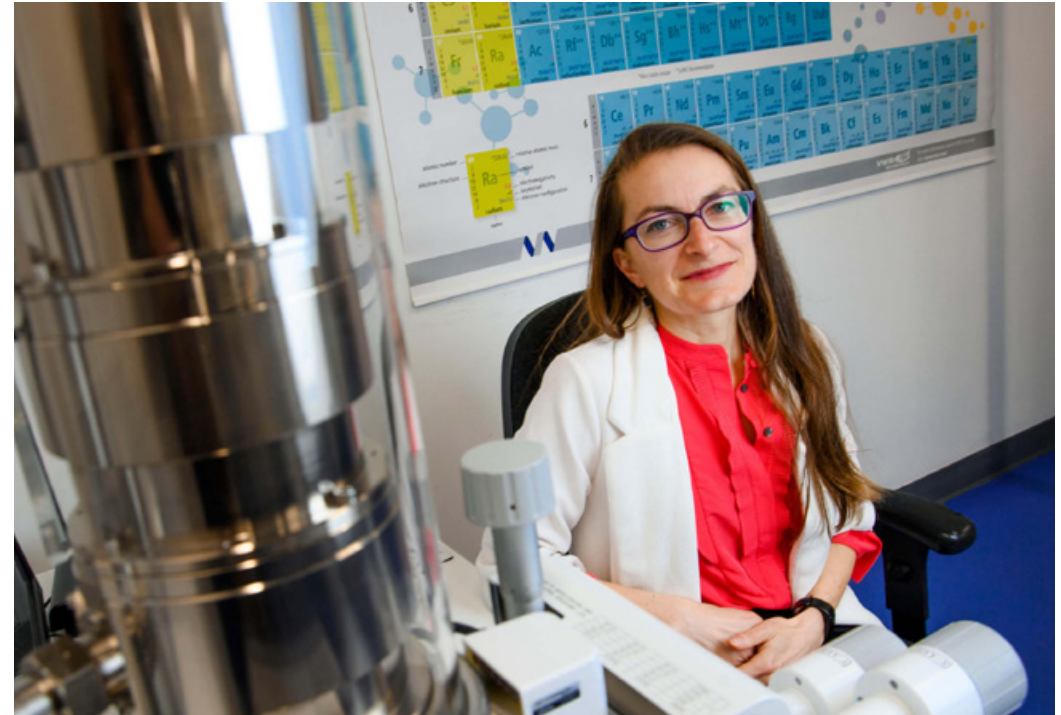
Dr Niall O’Leary with Dr John MacSharry from the School of Medicine, a co-PI in the UniCov project, at one of the automated wastewater sampling stations in UCC

UCC PALAEOLOGY RESEARCH GROUP HOSTS PREMIER INTERNATIONAL MEETING

The Palaeontological Association was founded in 1957 and has become one of the world’s leading learned societies in this field, with its Annual Meeting being the centrepiece of the Association’s calendar. Prof Maria McNamara’s research group (School of BEES, ERI) hosted this major international conference in 2022, with Prof McNamara herself as lead organiser (pictured). The conference welcomed nearly 200 delegates to Cork, including seven invited speakers, and the ERI was delighted to sponsor the *RIA Discourse Lecture on Mammal Biodiversity and Climate Change* from Prof Larisa DeSantis of Vanderbilt University.

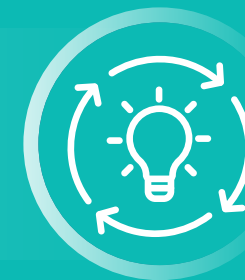
It was an extremely busy year for Prof McNamara’s group which also led an international study to discover remarkable new evidence that pterosaurs, the flying relatives of dinosaurs, were able to control the colour of their feathers using melanin pigments. The study, published in *Nature* in 2022, was led by palaeontologists Dr Aude Cincotta and Prof McNamara. The work was based on analyses of a new 115 million year old fossilized headcrest of the pterosaur *Tupandactylus imperator* from north-eastern Brazil. The team then studied the feathers with high-powered electron microscopes and found preserved melanosomes – granules of the pigment melanin. Unexpectedly, the study shows that the melanosomes in different feather types have different shapes.

2022 also saw Prof McNamara being awarded an SFI *Frontiers for the Future* grant to investigate how, and why, melanin evolved in vertebrates, by better understanding the biology of melanin in modern-day vertebrates and how this is impacted by aspects of the fossilization process. Another high profile 2022 study led by Daniel Falk, postgraduate student in Prof McNamara’s research group, shed light on a long-standing mystery of why hundreds of fossil frogs died in an ancient swamp 45 million years ago. By studying the bones of the fossil frogs, the team was able to conclude that the deaths occurred in mating congregations during the short explosive breeding season.



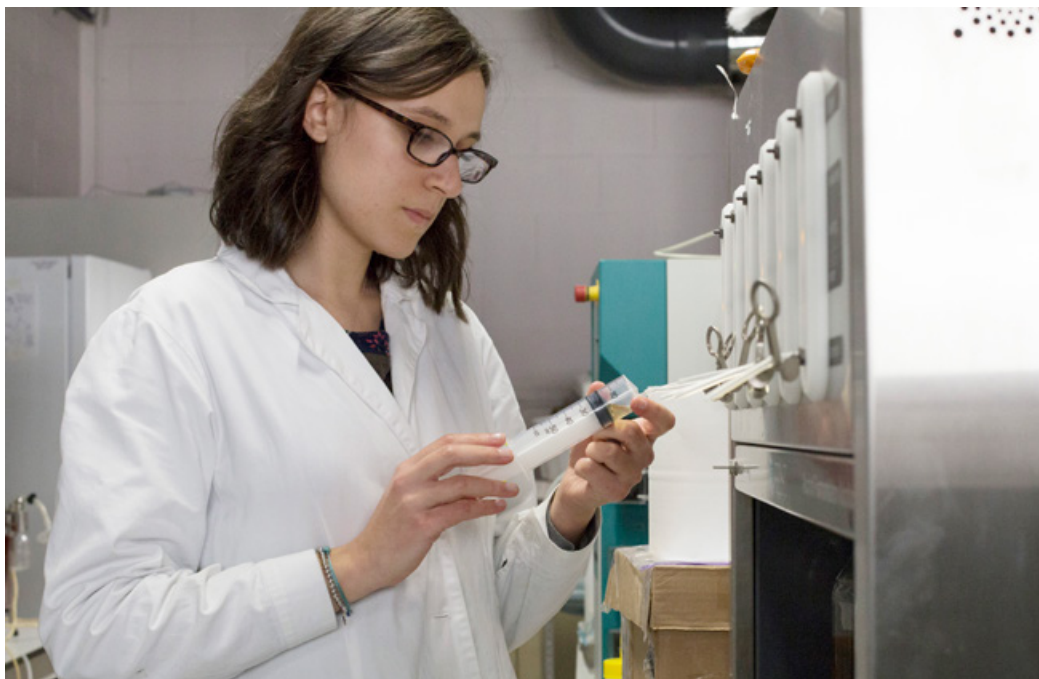
4.3 CIRCULAR ECONOMY

A shift from a “take-make-consume” to a closed-loop economy where resources are kept in use for as long as possible is now an imperative for society and economy. The ERI Circular Economy challenge is focused on producing food and goods in a closed-loop approach with minimal or no waste.



ACCELERATING THE TRANSITION TO A SUSTAINABLE BIOECONOMY THROUGH MICROBIAL FERMENTATION

In a circular economy, the biotechnology sector can play a vital role in developing innovative solutions to sustainability challenges such as scarcity of resources, finite capacity of land, mitigation of waste and growing demand for energy. In 2022, SFI awarded €1.8million to Prof John Morrissey of the ERI, SUSFERM, and School of Microbiology, for the establishment of a facility for rapid development of microbial bioprocesses for applications in the food and bioeconomy sectors. The MICROFERM (Microbial Fermentation Facility for scale-up of sustainable food and industrial fermentations with real-time process monitoring) facility comprises four fermentation platforms at a micro-scale to enable simultaneous screening and testing of large numbers of strain and process variables. This will accelerate the design of large-scale microbial processes for the bio-based sector. MICROFERM is embedded in the larger SUSFERM Fermentation Science and Bioprocess Engineering Centre, which is an interdisciplinary centre leading the development of microbial solutions for the transition to a sustainable bioeconomy.



DRIVING A SUSTAINABLE SHIFT IN PHARMACEUTICAL PROCESSES

Rare and expensive precious metals are used extensively as essential catalysts in the pharmaceutical industry. Transition metals make excellent catalysts as they can both donate and accept electrons easily from other molecules, but issues such as growing costs, coupled with toxicity, environmental and geopolitical concerns, mean that we need to look at new ways to reduce our dependence on transition metals such as iron, nickel and copper. The SOS Earth (Sustainable Organic Synthesis) using Earth Abundant Metals in Critical Pharmaceutical Processes project, funded by SFI Future Frontiers Programme, will involve using earth abundant metals as catalysts in important organic transformations instead. Led by Dr Gerard McGlacken (ERI, ABCRF, School of Chemistry) in collaboration with the University of York the project will also involve input from the pharmaceutical industry through GSK, reflecting the project's aim of driving a broad step-change in the use of earth abundant metals in a number of pharmaceutically relevant transformations. The project is also aligned with the SFI Research Centre for Pharmaceuticals (SSPC) - a world-leading hub of Irish research expertise developing innovative technologies to address key challenges facing the pharmaceutical and biopharmaceutical industry.

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The pharmaceutical industry has become very reliant on precious metals as catalysts. This SFI funded project will help obviate our dependence. The problem is that the mining of many precious metals is unsustainable. It is noteworthy that Russia is a major supplier of palladium and platinum for example, so in addition to the environmental concerns of extensive mining, there are also geopolitical issues. Earth-Abundant Metals provide a much more sustainable source. We will develop important chemical processes that utilise Earth-Abundant Metals.

Dr Gerard McGlacken



THE ROLE OF IRISH SMES IN THE TRANSITION TO A CIRCULAR ECONOMY

The transition to a more circular economy is a key national priority, and Irish small and medium-sized enterprises (SMEs) are well-positioned to play an important role in this transition. SMEs are generally more flexible and agile than larger companies which allows SMEs to experiment with new circular business models and develop innovative solutions. In addition, SMEs often have strong local networks and relationships with customers, suppliers, and other stakeholders which allows them to develop closed-loop systems by collaborating with other local businesses to reduce waste and increase resource efficiency.

In 2022, researchers Dr Bernadette Power, Dr Geraldine Ryan, Dr John Eakins and Dr Gordon Sirr (all of CUBS, ERI) were awarded EPA funding to assess Irish SMEs' current engagement in circular economy practices and trends in their engagement over time. The project will

also assess the barriers and opportunities for SMEs in making the transition. A key idea underpinning the project is that the barriers and opportunities for engaging in circular economy practices are likely to differ across SME sectors. Therefore, SMEs' engagement in circular economy practices, and the barriers and opportunities for such practices, will be examined on a sectoral basis. Another key consideration is that the transition will require the support of SMEs' suppliers and customers, so the willingness of customers to pay for or switch to buying SMEs' circular economy product or service instead of the traditional offering, will also be examined. It is anticipated that this project will inform policy decisions regarding funding instruments and supports directed at SMEs promoting resilience and growth in the Irish business community.



HOW CAN WE ADDRESS HOUSEHOLD FOOD WASTE IN THE BIOECONOMY?

Food waste creates a burden for waste management systems, worsens food insecurity and is a major contributor to the climate change crisis. Yet, the sheer scale of the food waste challenge has not been fully quantified.

The IRC-funded FORWARD project will contribute to the development of a waste-to-value bioeconomy by assessing, quantifying, and developing a roadmap for converting household food waste to bio-based products using circular bioeconomy approach. A collaboration between TU Dublin Faculty of Business and Prof Marcel Jansen (ERI, School of BEES), FORWARD will first quantify food waste generated by Irish households and conduct simulation modelling to identify spatiotemporal, occupational, compositional, and demographic clusters of food waste

generation. Based on this new knowledge, a roadmap for converting household food waste into sustainable biobased products using the cascading approach of a biorefinery will be developed. Finally, by conducting the sustainability assessment of the generated food waste and its conversion into value-added-products, researchers will develop an Environmental-Economic Footprint Index and a Project Development Assistance Tool. These resources will allow accurate estimation of GHG emissions, water, and land use, together with individual- and household-scale economic losses per kg of food waste generated. These outputs will inform evidence-based policy, in parallel with demonstrating the feasibility of household food waste as a sustainable feedstock and source of sustainable revenue.



COULD DIRECT AIR CAPTURE BE KEY TO IRELAND'S LOW-CARBON TRANSITION?

Although the world is making progress towards a low carbon transition through the use of renewable energies, the pace of the change is uncertain because of factors such as geopolitical influence, extraction of materials, access to innovative technologies, and fluctuating energy demands. International agencies such as the IPCC and IEA have called for the implementation of Carbon Dioxide Removals (CDR) such as Direct Air Capture (DAC) at an industrial scale as a mid-term program to reduce emissions.

The Republic of Ireland is one of the largest pollutants per capita, and in 2019, its emissions reached 13Mt of CO₂ per person. As a country we are developing our wind capacity in order to mitigate these emissions, and the geographical advantage of the island could allow us to meet most of our energy demand by wind. Yet, the problem of energy storage remains

an obstacle. This means that if there is no wind, fossil gas will take its place in the lower electricity generation periods,

A 2022 study published in *Energy Reports* by Dr Elena Tsalaporta (ERI, School of Engineering and Architecture) and Daniel Casaban addressed the importance of developing DAC in Ireland, suggesting that Ireland could position itself as a role model in this regard for other European countries. The geological conditions have the great capacity to reduce the concentration of CO₂ in the atmosphere, and in the meantime, the production of e-fuels could take advantage of the excess of renewable energy. Overall the authors conclude that there are numerous gaps to fill only with renewables and ignoring alternatives such as DAC can be counterproductive. They recommend that future studies should focus on the viability of implementing DAC in the Republic of Ireland.



PIONEERING SUSTAINABLE SOLUTIONS FOR END-OF-LIFE RENEWABLES IN IRELAND

Wind turbines are normally designed for 20 years lifetime, so in Ireland there will be 500 turbines reaching the end of their life by 2025, and 1000 by 2030. There are generally three options for wind turbines at end-of-life: life extension, decommissioning and repowering, but the decision as to which route a particular turbine should take is not always clear. WindLEDeRR is SEAI-funded project which is developing a comprehensive decision-making tool for end-of-life wind turbines in Ireland. Led by UCD with UCC partner Dr Paul Leahy (ERI, MaREI, School of Engineering and Architecture), this project is also developing a new protocol for repurposing decommissioned blades for specific purposes. The results will form the most authoritative evidence base around the topic for Ireland and will become an international benchmark.

Currently, the team are developing a holistic structural dynamic model of wind turbines using a multi-

body approach which accounts for the aeroelastic behaviour of the wind turbines employing Irish meteorological conditions. Aeroelasticity concerns the interaction between aerodynamics, dynamics, and elasticity. This interaction can have a significant effect on the turbine lifetime, so WindLEDeRR aims to develop cutting-edge structural health monitoring techniques for lifetime extension. Novel approaches are also being developed for anomaly detection and fatigue assessment of the tower structure through smart advanced identification methods. In addition, a new methodology will be developed for predicting remaining fatigue life and residual strength of wind turbines' blades periodically until their end-of-life. Lifecycle assessment of foundations will be also developed. Furthermore, WindLEDeRR considers the energetic, environmental, social and economic factors affecting sustainable decommissioning of end-of-life wind turbines.

THE LEAF-INSPIRED TECHNOLOGY PAVING THE WAY FOR CLEAN AND EFFICIENT HYDROGEN ENERGY

It is difficult to overstate the extent to which cheap, efficient green hydrogen energy could help address the climate crisis, and also mitigate energy and resource scarcity, as well as ecosystem damage. A new system being developed in UCC is proposing to provide such a solution by developing a novel hydrogen-based system. FreeHydroCells, a multi-partner European consortium, coordinated by researchers in Tyndall National Institute, the ERI and the School of Chemistry including Prof Justin Holmes, Prof Colm O'Dwyer and Dr Ievgen Nedrygailov has received nearly €3.75m in Horizon Europe research funding for three years of exploratory activity based on a novel photoelectrochemical system design. The research team are proposing a low-cost solar-to-chemical energy conversion system designed using sustainable materials which would be entirely ecologically friendly, circular, and readily up-scaled for European-led global commercialisation.

The inspiration for the novel concept driving FreeHydroCells comes from the combined need to absorb as much solar energy as possible in a material system while at the same time making sure the clean solar energy can be used productively by humans with minimal loss, in this case to make hydrogen fuel. This idea has functional similarity to a leaf during photosynthesis, since it also absorbs solar energy and water to produce organic growth for plant life, while releasing some of the oxygen as a benign gas by-product. The system will be submerged in water and be comprised of thin film semiconducting material on a flexible and transparent substrate film. This has the aim of self-driving photoelectrochemical water splitting reactions by efficiently converting solar energy to chemical energy that would then be held in the bonds of molecular hydrogen as fuel.



ADOPTING A CIRCULAR ECONOMY APPROACH TO SUSTAINABLE SEAFOOD FOR HEALTHY AGING

It is projected that by around 2040, the 65+ age group will make up 24% - 45% of the population in the Atlantic Area regions. Malnutrition is a prevalent issue in this demographic due to changes in eating habits, food choices, and difficulties in meal preparation and intake. Seafood products are an essential source of nutrients for healthy ageing however sustainable use of marine resources presents challenges.

project's Ready-to-Eat seafood product) designed and developed by researchers at UCC led by Prof Maria De Sousa Gallagher (ERI, School of Engineering and Architecture, Tyndall). The coatings were shown to be a successful eco-food packaging strategy and could be one step towards improving sustainability of food packaging.

Concluding in 2022, the SEAFOODAGE project aimed to develop new and innovative seafood products that cater to the changing consumer demands in the European market, while also being sustainable and environmentally friendly. Over the course of the project, various new seafood products were developed from underutilized fish species. The SEAFOODAGE final conference showcased an edible coating (for the

The project also focused on improving the sustainability of seafood production by developing new technologies and techniques for aquaculture, such as integrated multitrophic aquaculture systems. The project has received positive feedback from consumers, retailers, and the seafood industry for its innovative and sustainable approach to seafood production.

MULTI-FUNCTIONAL CATALYSTS FOR PLASTIC RECYCLING

Ireland's recycling rate for plastic packaging waste in 2022 was just 29%, meaning that our plastic recycling performance will need to improve significantly to meet EU recycling targets of 50% by 2025 and 55% by 2030. Dr Gillian Collins (ERI, School of Chemistry, SFI AMBER Centre) has developed multifunctional catalysts for chemical recycling of the plastic polyethylene terephthalate (PET) and the bioplastic polylactic acid (PLA). Bioplastics such as PLA are increasingly used as a packaging material and PLA also becomes a contaminant in PET waste streams, so catalysts that can chemically recycle both plastics are very attractive. The catalyst converts PLA into commodity chemicals that can be used as green solvents, and the PET into its monomer that can make new plastic. The use of bioplastics is on the rise but many, such as PLA, only degrade effectively under industrial composting conditions and their disintegration in the environment leads to problematic microplastics. Chemical recycling provides a valuable end-of-life option for these materials. The chemistry of bioplastics is less well understood compared to established petrochemical plastics such as PET, so Dr Collins and PhD student Rachel Breen (pictured) are currently collaborating with the University of Barcelona who are modelling the interactions between the catalysts and the plastic to design better materials for chemical recycling.



PhD student Rachel Breen



CREATING HEALTHIER AND MORE SUSTAINABLE FOOD FROM THE SEA

Food production from aquatic systems such as capture fisheries and aquaculture has been suffering from a lack of diversity in both the species being used and the products being produced. In addition, the considerable environmental impact of the industry is prompting a restructuring of production processes and value chains to achieve more balanced, sustainable, and efficient food production from aquatic systems.

The NOVAFOODIES project will demonstrate innovative functional food production systems based on a sustainable value chain of marine and freshwater raw materials for conscientious European consumers. Launched in May 2022, the NOVAFOODIES project brings together a pan-European network of 26 leading academic and private sector partners to address these challenges. Funded under the Horizon Europe *Farm to Fork* strategy the goal of NOVAFOODIES is to provide consumers with new functional products of marine and freshwater origin using more sustainable, circular production processes, and without compromising sectoral competitiveness. Focussing on lower trophic species, UCC partner Dr Linda O'Higgins (ERI) will develop low-cost approaches to microalgae biomass production, optimising cultivation protocols for Ireland's temperate climate, and providing a pilot-scale facility to demonstrate production of a sustainable new biomass supply and nutrient-rich food ingredients.

MAXIMISING THE POTENTIAL FOR SEAWEED BIOREFINERY IN IRELAND

The application of biomass-based fuels and chemicals in the energy transition can not only mitigate greenhouse gas emissions from fossil fuel but also capture CO₂ in the atmosphere via photosynthesis during biomass growth. Seaweed offers several advantages over terrestrial plants, including high photosynthetic efficiency, high biomass productivity, worldwide cultivation feasibility, lack of competition for land and freshwater with food crops, and potential for value-added chemicals and biofuels production. Seaweed biorefinery has been extensively studied, utilizing technologies such as anaerobic digestion, pyrolysis, and hydrothermal carbonization (HTC). HTC is a thermochemical process that involves heating biomass in the presence of water under high pressure and temperature (typically above 180°C and 20 bar). This process can convert a variety of biomass feedstocks into a solid carbon-rich material called hydrochar or biochar. A 2022 study from authors in the Circular Economy, Energy, and Environmental Systems (CEES) group led by Prof Jerry Murphy, demonstrated how microwave-assisted HTC at lower temperatures (160 - 200 °C) can efficiently valorise brown seaweed *L. digitata* (common kelp) into multiple products, including hydrochar, as well as process liquor containing monomers and polymers of sugars, proteins, organic acids, alcohols, phenols, and soluble minerals. The microwave-assisted process offers several advantages over conventional heating, including faster and more uniform heating and lower energy costs. The research highlights the importance of optimizing operating conditions to selectively achieve high energy production, high product quality, and high economic value.



5 | Research Centres Section

5.1 MAREI, THE SFI RESEARCH CENTRE FOR ENERGY, CLIMATE AND THE MARINE

MaREI is coordinated by the ERI and is Ireland's SFI Centre for energy, climate and marine research, development and innovation working across 12 Irish academic institutions and collaborating with over 50 industry partners. The Centre is led by Co-Directors Prof Brian Ó Gallachóir and Prof Jerry Murphy. The Centre Manager is Dr Gillian Bruton.



SUPPORTING THE EU MISSION TO RESTORE OUR OCEANS AND WATERS

During 2022, researchers in the MaREI Centre secured over €5M in funding from Horizon Europe; within these projects MaREI are working with partners from industry, policy and citizen groups to tackle challenges linked to climate change, energy transition and environmental protection. To address some of Europe's greatest challenges the European Commission has developed a series of "Missions" – a new way to bring concrete solutions through impact generated by research and innovation within Horizon Europe. While all of MaREI's EU projects directly or indirectly contribute to EU Missions, MaREI was a key partner in four successful applications that are specifically focused on supporting the Mission: *Restore Our Ocean and Waters*:



Visit by high-level EU delegation to Lir NOTF / MaREI during Horizon Europe project event. (L-R) Ian Power, Operations Co-Ordinator, Lir-NOTF; Elisabetta Balzi, Head of Unit, Healthy Oceans and Seas, DG RTD (Research and Innovation); Genevieve Pons, Vice President of Europe in the Jacques Delors Cabinet; Pascal Lamy, Chair, Mission Board; Cathal O'Mahony, EU Grant Manager, MaREI Centre; Kestutis Sadauskas, Deputy Director, DG MARE & Mission Manager; John Bell, Director of Healthy Planet & Deputy Mission Manager

- **PREP4BLUE** (Preparing the Research and Innovation Core for Mission Ocean, Seas and Waters) will deliver a series of tools, guidelines, methodologies and recommendations tested through pilots which will cumulatively support the objectives of Mission Oceans. MaREI as partner will lead the work package on empowering and engaging citizens with a view to increasing their involvement in Mission related activities.
- **BlueMissionAA** (Building a Coordination Hub to Support the Mission Implementation in the Atlantic and Arctic Basin) is tasked with putting in place supporting and monitoring measures to ensure effective delivery of Mission Oceans. MaREI brings expert knowledge of marine science-policy interfaces, marine governance, integrated approaches to marine planning and management, and engaged research / participatory approaches.
- **A-AAGORA** (Blueprint for Atlantic-Arctic Agora on Cross-Sectoral Cooperation for Restoration of Marine and Coastal Ecosystems and Increased Climate Resilience Through Transformative Innovation) focuses on the co-development of implementable Nature Based Solutions to boost resilience to climate change and mitigating its impacts in coastal areas. MaREI co-lead one of the three demonstration pilots within the project which will focus on multi-actor approaches to restoration of coastal habitats and systems.
- **Danube4All** (Restoration of the Danube River Basin Waters for Ecosystems and People from Mountains to the Coast) has the overall objective of developing a comprehensive Restoration Action Plan for the Danube River basin in an unprecedented co-creation process with all stakeholders. Researchers in MaREI are involved in tasks linked to science communication and demonstration and upscaling of restoration approaches.

ADVANCING ENGAGED RESEARCH

Engaged research describes a wide range of rigorous research approaches and methodologies that share a common interest in collaborative engagement with the community and aims to improve, understand or investigate an issue of public interest or concern, including societal challenges. Engaged research is advanced with community partners rather than for or about them, where 'community' refers to a range of public research stakeholders, including public or professional service and product users, policy makers, members of the public, civil and civic society organisations and other actors. MaREI are pioneering engaged research in a number of projects. Approaches include participatory and deliberative processes, action research and co-production working alongside practitioners and community partners, and a responsible research and innovation.

Steps for Public Engagement with Energy Infrastructure

- This SFI and EirGrid-funded project entails an impartial analysis of EirGrid's evolving public engagement processes, based on a mapping of actors, and a framework to codify different elements of existing strategies. This approach offers guidance and suggestions throughout the consultation and engagement process lifecycle, seeking to improve both engagement processes and outcomes. Target audiences include communities impacted by energy infrastructure developments, CSOs, relevant public bodies and industries, and policy makers and regulators. In 2022, a publication on good practice guidelines for undertaking community engagement in Irish public bodies was developed into a practice and policy brief. Based on the work to date the, the Institute for Civil Engineers (UK) have invited the project to join their 'knowledge network' associated with engagement strategies for engineering projects related to infrastructure.

Dingle Peninsula 2030

- ERI and MaREI researchers have demonstrated outstanding leadership in the multi-award winning, multi-stakeholder Dingle Peninsula 2030 partnership project. The project was initiated when Prof Brian Ó Gallachóir secured funding from ESB Networks and SFI, enabling him to establish a transdisciplinary research team (Dr Clare Watson, Dr Evan Boyle and Dr Connor McGookin, with significant contributions also from Prof Ed Byrne, Dr Gerard Mullally and Aoife Deane) to harness the rich community spirit on the Dingle Peninsula to advance this groundbreaking engaged research. Importantly, this research team works in a deeply embedded way in the local community, co-producing solutions with the community to address critical energy and climate challenges, while also building societal resilience and capacity. In

this way, the team advances not only multi- but also transdisciplinary methods, building a new understanding of the technical and societal elements of sustainability transitions, as well as highlighting the role of multi-stakeholder collaborations. Key research outputs in the past year include 12 journal papers (3 co-authored with local partners), 12 learning briefs alongside extensive outreach via RTÉ, IUA and RIA programmes and events. Additional funding from Creative Ireland Climate Action Fund has facilitated the creative project - *Corca Dhuibhne Inbhuanaithe – A Creative Imagining* which will combine practical and creative approaches, to create an understanding in the wider community about the challenges that farmers face, thus creating a more supportive environment in which farmers can diversify.

PREP4BLUE Citizen Engagement

- PREP4BLUE, a new Horizon Europe project which started in June 2022, has the ambitious aim to restore the health of our ocean, seas and waters by protecting and restoring marine and freshwater ecosystems and biodiversity, preventing and eliminating pollution, and making the Blue Economy sustainable, carbon neutral and circular by 2030. Key to this aim is promoting an ocean-literate European citizenry and MaREI are leading a work package on supporting citizen engagement by building capacity using participatory approaches in research and innovation stakeholders, advocacy groups, policy makers, and citizens including organisations that represent indigenous communities, promote the participation of women in marine science, and disadvantaged/minority groups. The team will use survey data to design bespoke training and learning resources to help alleviate the specific challenges that each group faces in engaging with ocean literacy.



ROOFTOP SOLAR PANEL RESEARCH SPARKS GLOBAL INTEREST

With countries racing to end their reliance on the fossil fuels that cause climate change, researchers in MaREI Siddharth Joshi, Dr Paul Holloway (also Dept of Geography), Prof Brian Ó Gallachóir and Dr James Glynn (also of the Center on Global Energy Policy, Columbia University) conducted research which demonstrated that if every available rooftop was equipped with solar panels, they could generate enough electricity to power the world. The report published in *Nature Communications* was the first high-resolution global assessment of rooftop solar photovoltaics (PV) potential. It showed how rooftop solar can best be deployed to help nations decarbonise and decentralise their power grids and will have important implications for sustainable development and climate change mitigations efforts. Publication of the report led to both international and national media coverage such as Forbes, World Economic Forum, The Conversation and Irish Times. The study also led to a report authored by Siddharth Joshi and Dr Paul Deane and published in collaboration with the Irish Solar Energy Association, which found a quarter of all the electricity needed by Irish households could be produced by putting solar panels on domestic rooftops.



SETTING EUROPEAN MARINE MANAGEMENT ON A COURSE TO REVERSE BIODIVERSITY DECLINE

Effective marine environmental management and biodiversity protection are fundamental to achieving the transformation to a modern, resource-efficient, and competitive low-carbon sustainable ocean economy. A new, Horizon Europe funded research project called MarineSABRES aims to address the continued and accelerated biodiversity loss caused by the intensification of human activities on land and at sea. The project coordinated by Dr Emma Verling of MaREI will bring together an international consortium of 22 partners across 11 countries.

Running for four years, MarineSABRES aims to enable stakeholders from government and policy, coastal and marine management, scientists, and the public to make informed decisions that balance human and ecosystem needs. MarineSABRES will attempt to weave the diverse perspectives of these stakeholder groups to co-design a simple Socio-Ecological System (SES) framework to strengthen interventions and measures for the protection and conservation of coastal and marine areas and improve the uptake of ecosystem-based management.



COLLABORATIVE ACTIONS FOR EFFECTIVE MARINE POLLUTION MANAGEMENT

Marine contamination (including pollution) occurs as a direct result of human activities on both land and in the marine environment, and requires urgent attention as healthy and clean seas provide numerous ecosystem services (food, oxygen production, climate regulation), which are critical for our survival and wellbeing. Given the complex and interconnected nature of marine pollution, the integration of sustainability-focused agendas and circular economy principles and practices is essential for the development of effective actions that can address its impacts. The implementation of processes and measures to reduce marine pollution will have consequences for numerous economic sectors (e.g., agriculture, fisheries, food and beverage industry, waste management, packaging industry, tourism, offshore energy) at multiple scales (local, national, regional and international), framing marine pollution as a considerable global socio-economic

challenge that requires active collaboration from multiple stakeholders, across a range of geographic areas.

Source to Seas – Zero Pollution 2030 (SOS-ZEROPOL2030) is a Horizon Europe project coordinated by Dr Kathrin Kopke which aims to co-design, co-produce, and co-deliver a stakeholder-led European Seas zero-pollution framework that provides practical guidance from source to sea addressing shortcomings in marine pollution management and governance. This holistic approach is based on best practice, puts emphasis on human behaviour, socioeconomics and governance; and is underpinned in knowledge about and understanding of current barriers to effective and efficient prevention, reduction, mitigation and monitoring of marine pollution in European Seas.

IDENTIFYING SOLUTIONS FOR SEAL-FISHERY CONFLICT

Interactions between seals and the fishing industry occur globally, with depredation – the full or part removal of fish from nets by seals, leading to significant conflict. Fishermen suffer economic losses due to loss of catch, gear damage and time spent disentangling damaged fish/by-caught seals, while ecological impacts can include seal mortality (by-catch and/or authorised or illegal killing), alongside changes in animal behaviour (e.g., seals may become reliant on artificial food sources). In recent years, conflicts have escalated significantly; hence, an effective and pragmatic solution to the problem is urgently needed. The Horizon Europe funded SEAFICS project coordinated by Dr Mark Jessop (MaREI, ERI, School of BEES) will address this challenge, using an area across South-West Ireland as a case study for seal-fishery conflict. SEAFICS will combine stakeholder engagement, emerging technologies and advanced statistical analyses to assess interactions between seals and fisheries and minimise conflicts through the development of effective mitigation. The project's findings will be used to respond to pressing socio-economic and conservation issues both across Europe and globally.



5.2 CLEANER PRODUCTION PROMOTION UNIT (CPPU)

CPPU conducts engaged research focused on the theme of society, sustainability and energy, with a particular emphasis on people’s relationship with energy and the energy system. The unit is led by Dr Niall Dunphy (School of Engineering and Architecture, and ERI).



EMPOWERING COMMUNITIES THROUGH THE ENERGY TRANSITION

The ACCEPT H2020 project brings together citizens, local businesses and organisations to produce and consume locally generated, renewable energy in four distinct energy communities. Within this project, CPPU leads the community engagement programme, which is developing a digital toolbox that offers energy communities a suite of innovative digital services to reduce the dependency on fossil fuels and save energy in the users’ households without compromising their quality of life. Applying a living

lab approach to its community engagement work, the CPPU team led by Dr Breffní Lennon and Dr Niall Dunphy has already catalogued the community dynamics and stakeholder needs in the four pilot sites in Greece, the Netherlands, Spain and Switzerland. This iterative, engaged learning approach has enabled co-development with communities of best-practice models for building sustainable energy governance structures and business models involving over 3,000 people and 750 residences.



“THE ECOLOGICAL NEIGHBOURHOOD”
Culemborg, Netherlands

The Eva Lanxmeer Community is a sustainable urban demonstration site and community in Culemborg. The focus within this pilot site will be to combine changes in individual behaviour to realise advantages on district level.

“THE URBAN COMMUNITY”
Murcia, Spain

The selected residences in Murcia range from 10-story block of flats to detached buildings. Fifteen buildings will be utilized as a platform for the validation of the ACCEPT solution.

“THE RESIDENTIAL SUBURB”
Capriasca, Switzerland

The Swiss pilot site consists of 2 district areas. The first is a residential suburb with 100 residents spread across 11 buildings, a public swimming pool and district heating, while second is a five-story nursing home with 30 residents.

“THE SMART VILLAGE”
Aspra Spitia, Greece

Aspra Spitia is a large modern settlement, which keeps improving its infrastructures while offering high standards of living to its residents. The installation of Internet of Things devices in the area will enable efficiency related services.



REIMAGINING CITIZENS WITHIN THE ENERGY SYSTEM

Building on their previous work in the area, CPPU researchers led by Dr Niall Dunphy are leading the (re)conceptualisation of the idea of energy citizenship. This work within the ENCLUDE H2020 project looks to characterise the many individual and collective expressions of citizenship within the energy domain. The CPPU team have adopted a mixed-methods approach, applying a range of research techniques to capture, analyse and interpret the nature of the ‘energy citizen’ and to better understand the impact they are having (and could have) on the energy transition. The first report from this work outlines the existing

and emerging ideas of citizenship in the energy system and analyses how current modes of (citizen) participation are forwarded. This work is feeding into the development of an energy citizenship typology that acknowledges the privileges that shape the type of relationships particular individuals and groups might have with energy. It also opens up a discussion on the types of energy citizenship experienced by those at the margins of decision making in the energy domain, in an effort to understand the multiple, and sometimes overlapping, expressions of citizenship around energy.

COMBATTING ENERGY VULNERABILITY

With energy prices increasing, there has never been a greater need for an initiative like the EnergyMeasures project led by CPPU. Through this project the team are providing tailored measures to energy vulnerable households across seven European countries: Belgium, Bulgaria, Ireland, Netherlands, North Macedonia, Poland, and the UK. An interesting development to emerge from this work has been the book *Living with Energy Poverty: Perspectives from the Global North and South*, which the group is

currently producing with Routledge. Bringing together scholars from the Global South and the Global North, this collected work examines the lived experiences of energy poverty at the household level and explores the links between energy poverty and sustainability, outlining actions to achieve SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy for all. Publication is expected late in 2023 and will contribute to the growing discourse on energy poverty and its impact on the energy transition.



VALUING THE SOCIAL SCIENCES AND HUMANITIES PERSPECTIVE ON CLIMATE CHANGE

CPPU researchers are at the centre of the new COST action SHiFT (Social sciences and humanities for transformation and climate resilience), which launched in September 2022. SHiFT has two overarching aims, namely (i) to foster more creative, future-oriented, and tangible solutions for connecting and mobilising social sciences and humanities research to address the challenge of accelerating change in an inclusive and responsible manner; and (ii) to deepen our understanding of practices involved

in ‘doing transformation’ and to promote a shift in thinking with regards to the role of transdisciplinary social sciences and humanities research in these emerging and evolving spaces. This exciting new action was realised to a large extent through the work of Dr Alex Revez (MaREI, CPPU, ERI), Dr Niall Dunphy (CPPU, ERI), and Dr Evan Boyle (MaREI, ERI) who serve as the Action Vice Chair, Science Communication Coordinator and Working Group leader respectively.



5.3 CENTRE FOR LAW AND THE ENVIRONMENT

The Centre for Law and the Environment is a centre of excellence for research, teaching and policy work relating to environmental law, policy, regulation and governance. Based in the School of Law, the Centre supports and promotes a wide range of research activity in Environmental, Marine, Climate, Energy and Natural Resources Law. Although the Centre is rooted firmly in the discipline of Law, it is engaged in significant interdisciplinary research collaborations and extensive advocacy and outreach activity. The Centre is led by its Co-Directors Professor Owen McIntyre and Professor Áine Ryall.



LAW AND THE ENVIRONMENT CONFERENCE 2022

The 18th annual *Law and the Environment Conference* was held at UCC on 5 May 2022. Convened by Prof Owen McIntyre, the conference addressed the theme *Environmental Rights: From Discourse to Legal Action*. The conference attracted a very high level of interest, with close to 200 attendees drawn from across legal practice, academia, government, civil society and industry enjoying over 30 expert presentations arranged over 11 specialist sessions. As always, the conference provided a unique forum for presenting the latest developments and cutting-edge research, and for an inter-sectoral and interdisciplinary exchange of views on all aspects of environmental law, policy, regulation and governance. Once again, a selection of papers presented at the 2022 conference was submitted for publication in a special issue of *Environmental Liability: Law, Policy and Practice* which was published in early 2023.



L-R: Dr Orla Kelleher, Maynooth University; Dr Aoife Daly, UCC; Prof Owen McIntyre, UCC (Conference Convenor), Prof Salmi Abdesselam, Ajman University, United Arab Emirates

CHILDREN AND YOUNG PEOPLE'S ASSEMBLY ON BIODIVERSITY LOSS

Dr Aoife Daly was a member of the team leading the Children and Young People's Assembly on Biodiversity Loss. Designed with children and young people, this initiative aimed to explore, discuss and create calls to action on how to protect and restore biodiversity in Ireland.



ENVIRONMENTAL LAW ENFORCEMENT: EMERGING CHALLENGES 2022

Centre members participated in the annual Environmental Law Enforcement: Emerging Challenges conference organised by the Environmental Protection Agency (EPA) and the Irish Centre for European Law (ICEL) on 30 November 2022. Following a competitive selection process, PhD candidate Julián Suárez was selected to present his research on 'Recognising "Rights of Nature" in Ireland'. Prof Áine Ryall contributed an invited paper on 'Standards for Effective Access to Justice in Intersecting Legal Systems'.

POSTGRADUATE RESEARCH SYMPOSIUM IN ENVIRONMENTAL LAW 2022

In conjunction with the annual *Law and the Environment Conference*, the 12th annual *Postgraduate Research Symposium in Environmental Law* was held at the School of Law UCC on 4 May 2022. Following an open call for applications, the 2022 symposium provided an important opportunity for postgraduate research students from Ireland, the United Kingdom and Turkey to present aspects of their doctoral research.

RESEARCH HIGHLIGHTS 2022

The Centre delivers a wide range of high-impact, frontier research activity. In 2022, Centre PIs continued to publish their work in important edited collections with leading international publishers and in prestigious national and international peer reviewed journals including the *Human Rights Law Review*, *Environmental Policy and Law*, *Chinese Journal of Environmental Law*, *Environmental Liability: Law Policy and Practice* and the *Irish Planning and Environmental Law Journal*.

Centre PI Dr Aoife Daly and Prof Laura Lundy co-authored the *Synthesis Report on Children's Rights and Climate Justice* published by the *European Network of Ombudspersons for Children* (October 2022). In August 2022, the EPA published research conducted by Peter Medway, Dr Dug Cubie (Centre PI) and Dr Martin Le Tissier on *Enhancing Integration of Disaster Risk and Climate Change Adaptation into Irish Emergency Planning*. In Autumn 2022, Professor Áine Ryall was awarded a Visiting Research Fellowship at the European University Institute, Florence.

In September 2022, PhD candidates Alison Hardiman and Rhoda Jennings presented aspects of their research at the *9th European Environmental Law Forum Annual Conference* hosted by the University Rovira Virgili in Tarragona.

COLLABORATION AND PEER ESTEEM ACTIVITY

Centre PIs are called on regularly to provide expert input to law and policy developments at the highest level. During 2022, Prof Owen McIntyre was invited by the IUCN World Commission on Environmental Law to lead a special research / advisory project on *State Responsibility and Related Liability in International Water Law* and to contribute to the IUCN Task Force on Plastic Pollution, leading the development of the IUCN Briefing on *Treaty Regime Interaction* for the Intergovernmental Negotiating Committee (INC) for the proposed global Treaty on Plastic Pollution (UNEP). Prof McIntyre was reappointed to the Expert Advisory Body of Evaluators established by the Research, Development and Innovation Council of the Czech Republic and as an External Reviewer. Dr Dug Cubie was appointed to the Ethical, Political, Legal and Philosophical Studies Committee of the Royal Irish Academy.

Dr Aoife Daly co-authored the *White Paper on the Right of the Child to a Safe, Clean, Healthy and Sustainable Environment* (2022) submitted to the UN Committee on the Rights of the Child and also hosted an online seminar on the theme *Children / Youth and the Right to a Healthy Environment* on 11 November 2022.

During 2022 the Centre was delighted to host visiting scholars Professor Salmi Abdesselam, Ajman University, United Arab Emirates and Ms Esra Ata Dagistanli, Akdeniz University, Turkey.

RESEARCH FUNDING

Prof Owen McIntyre was the recipient of an IRC *New Foundations* award for the project *Doubling Global Hydropower Capacity by 2050: What about the Transboundary Dimension?* Dr Sahara Nankan secured an IRC Government of Ireland Postdoctoral Fellowship (2022-2024): *Mechanisms and Dynamics of Gender-Responsive Participation in Sustainable Access to Water, Sanitation and Hygiene ('WASH') Services: Developments in Selected Critical Jurisdictions*. Dr Nankan is undertaking her postdoctoral research at the Centre, mentored by Prof McIntyre.



INTEGRATION OF RESEARCH AND TEACHING

Research-informed teaching, at both undergraduate and postgraduate levels, is a fundamental element the Centre's activity. The Centre offers its flagship LLM Environmental and Natural Resources Law programme, as well as specialist undergraduate modules in environmental law.

Postgraduate modules include an Environmental Law Clinic module which provides students with the opportunity to advise real-world clients on ongoing legal projects and problems. The Centre's Co-Directors contribute annually to the University Wide Module on Sustainability.

CITIZENS' ASSEMBLY ON BIODIVERSITY LOSS

The Citizens' Assembly on Biodiversity Loss is tasked with examining how the State can improve its response to the issue of biodiversity loss and to bring forward proposals in that regard. On 16 October 2022, Prof Áine Ryall delivered an invited contribution to the Citizens' Assembly on the theme Environmental Rights and Rights of Nature.



Citizens' Assembly on Biodiversity Loss

5.4 THE CENTRE FOR RESEARCH INTO ATMOSPHERIC CHEMISTRY (CRAC)

CRAC is a leading national centre for atmospheric chemistry research carrying out laboratory, field and modelling studies to support clean air quality. The Centre is based in the School of Chemistry and the ERI. The CRAC Centre Director is Prof John Wenger.



COVID-19 RISK MITIGATION

Meat plants have proven to be vulnerable flashpoints for COVID-19 in Ireland and internationally and the transmission dynamics of SARS-CoV2 within plants are incompletely understood with multiple occupational and environmental factors are likely to be involved. Completed in 2022, the SFI-funded UPCOM project proposed to improve infection prevention and control methods in such environments, by developing precision methods for understanding transmission and environmental stability of the virus and developing mitigation measures. This multidisciplinary and multi-partner project was led by the School of Veterinary Science in UCD with UCC partners in CRAC and the Department of Pathology.

CRAC researchers Dr Mehael Fennelly, Dr Stig Hellebust, Prof John Wenger, and Prof John Sodeau investigated the patterns of bio-aerosol formation and accumulation and determine concentrations of respirable particles in the size range emitted by human speech, breathing and coughing/sneezing throughout working shifts. Air changes per hour were correlated with environmental conditions such as air temperature, humidity and carbon dioxide content. The measurements, reported in *Frontiers in Public Health* will be used by the Department of Health to mitigate risks in food production facilities by informing objective assessment of air quality interventions such as filtration and UV treatment of re-circulated air, changing occupancy levels, and altering ventilation rates.



IMPACT OF AGRICULTURAL EMISSIONS ON RURAL AND URBAN AIR QUALITY

The EPA has identified five key air pollutants which impact air quality, health and the environment - ammonia, non-methane volatile organic compounds, sulphur dioxide, nitrogen oxides and fine particulate matter (PM_{2.5}). To comply with the 2030 National Emissions Reduction Commitment, Ireland is obliged to reduce ammonia emissions by 1% per year until 2029 and 5% annually thereafter, and to reduce PM_{2.5} by 18% per year until 2029 and 41% annually thereafter. However, Ireland has already exceeded the emissions ceiling for ammonia in 2016 and 2017. Ammonia emissions are driven by emissions from manure and fertiliser use in the agriculture sector, and Ireland can achieve compliance with the 2030 emissions reduction commitment for ammonia through full implementation of planned ammonia reduction measures, such as Low Emissions Slurry Spreading and use of inhibited urea fertiliser products.

A reduction in ammonia would also lead to reduction in ambient PM_{2.5} levels.

Launched in 2022, the EPA-funded IMAGE project aims to quantify and understand the impact of agricultural emissions on air quality. Project partners Technical University of Dublin, DCU and CRAC will be deploying aerosol monitoring and sampling equipment in rural areas influenced by agricultural emissions of particulate matter and ammonia - in dense poultry and swine farming regions - to determine the effect of ammonia on the formation of PM_{2.5} and its influence on rural and urban air quality. The resulting data on the bioaerosol contribution and the composition and source of particulate matter will inform the development of an Irish particulate matter and ammonia source apportionment model.



IMPROVING ACCESS TO AIR QUALITY MONITORING IN LOW-INCOME COMMUNITIES

Nitrogen dioxide (NO₂) is a priority air pollutant that is emitted in ambient air when petrol or diesel is burned in internal combustion engines. Breathing air with a high concentration of NO₂ can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms, hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO₂ may contribute to the development of asthma and potentially increase susceptibility to respiratory infections.

Low-cost NO₂ sensors are increasingly being used for community air quality monitoring. However, data

collected by low-cost sensors contain significant noise, and their accuracy is poor. A key motivation of the SFI-funded LOCOMOSHUN project, led by Dr Dean Venables in CRAC is to develop reliable sensors that could be used to expand the regulatory monitoring network to small towns in advanced economies and to cities in low-income countries. The project will develop a novel spectroscopic sensor for measuring NO₂ which will combine high accuracy with affordability. The sensors will be demonstrated in a vehicle emissions study and in an innovative citizen science study in which pupils study air quality around their schools.



ENVIRONMENTAL IMPACT – IMPROVING CORK'S AIR QUALITY



CRAC researchers were key local partners in the EPA's 2022 citizen science project *Clean Air Together Cork*, which aimed to develop a spatial map of NO₂ around Cork city. CRAC researchers set up over 30 NO₂ sensor tubes in and around UCC sites, promoted the project on social media, and contributed to the launch event and media. The Clean Air Partnership in Cork — Dr Dean Venables (CRAC, ERI), Dr Marica Cassarino (Applied Psychology, ERI), Denise Cahill (Cork Healthy Cities), and Kevin Ryan (Cork City Council) as well as Cork Chamber of Commerce and Cork Business Association also coordinated, publicised and launched a Clean Air Zone in the centre of Cork city - the first such designation in an Irish city.

The Clean Air Zone in Cork is an area restricted to vehicular traffic and will have fewer sources of air pollution as a result. Cork's Clean Air Zone includes Oliver Plunkett Street and adjacent streets. As part of the Clean Air Zone activity programme, five air monitors were placed on the east and west end of Oliver Plunkett Street, on Grand Parade, St Patrick's

St and South Mall at the start of June. These will measure nitrogen oxides (NO_x), ozone and particulate matter over time. NO_x is a specific measure of pollution attributable to petrol or diesel engines. The Clean Air Zone is a continuation of Cork City Council's innovative air quality programme in collaboration with CRAC, which includes developing Ireland's first Local Authority Air Quality Strategy and rolling out an extensive district scale, air monitoring sensor network across the city.

ERI researchers in CRAC and the School of Applied Psychology collaborated with Cork City Council to complete two preliminary studies on attitudes towards air quality among households and schools in Cork in 2022. The results suggest that there is some level of concern about air quality in Cork, however, there seems to be limited awareness of the sources of air pollutants and therefore additional guidance and education is required around behavioural solutions that can be easily implemented at individual, household, or school level.

David Joyce, Director of Services, Cork City Council; Dr Dean Venables, CRAC; Margaret Kelly, Cork Chamber of Commerce; Lord Mayor of Cork, Cllr Colm Kelleher; Helen Murphy, Cork Business Association; Kevin O'Brien, artist; Debbie Aribasoye, MTU Bishopstown student, and Dr Marica Cassarino, School of Applied Psychology and the ERI

“

If we want to achieve low emissions and a healthy environment, it is crucial that we raise people's awareness of the importance of good air quality and that we engage with the public to enable positive behavioural change. Cork's Clean Air Zone will stimulate our community to think about the solutions needed to promote air quality for the health of people and the environment.

Author of the study, Dr Marica Cassarino (ERI, School of Applied Psychology)

“

Cork's Clean Air Zone is a major milestone for the city. Air pollution is often worst near roads because vehicles are a major source of particles and nitrogen oxides. Pedestrianising this area will result in cleaner air and less traffic noise

Dr Dean Venables

5.5 UN ENVIRONMENT PROGRAMME GEMS/WATER CAPACITY DEVELOPMENT CENTRE

The United Nations Environment Programme (UNEP) GEMS/Water Capacity Development Centre (CDC) provides global capacity development in water quality monitoring and assessment working on a programme of activities to support the Sustainable Development Goals (SDGs), specifically SDG 6 – Clean Water and Sanitation. The Centre is, based in the Environmental Research Institute, is part of the School of Biological, Earth, and Environmental Sciences (BEES) and is led by its Director, Dr Tim Sullivan.



50 YEARS OF GEMS/WATER: PROGRAMME HISTORY

2022 marked 50 years since the 1972 UN Conference on the Human Environment in Stockholm, where the UNEP and the World Health Organisation (WHO) were commissioned to launch a global health-related water quality monitoring programme as part of UNEP's Global Environment Monitoring System (GEMS). Concurrently, a global programme to assess river fluxes of nutrients and toxic substances to the oceans was launched. The interagency UNEP/WHO/ UNESCO/WMO programme on water quality monitoring, known as GEMS/Water, was formally founded in December 1977. Now in its third phase, the programme focuses on maintenance and expansion of the global water quality database (GEMStat), located at the International Centre for Water Resources and Global Change (ICWRGC), Germany, and on capacity development to support water quality monitoring in developing countries, centred at the ERI in UCC. In previous phases, the focus was on establishing a global network and preparing water quality

assessments. A global network of over 100 national agencies, international bodies and water institutes have now been established as GEMS/Water partners, providing water quality data to GEMStat and referring recipients for GEMS/Water training and education programmes.

In 2022, to mark the role of the UNEP in encouraging and supporting global water quality, a group of GEMS/Water colleagues including Dr Debbie Chapman, produced a brochure reflecting on the mission, activities and achievements of GEMS/Water during its 50 years history. The document summarises reports and studies published at an international level by institutions and scientists in participating countries. It also looks ahead to some of the challenges for global water quality monitoring and the strategies and activities needed to help achieve good ambient water quality as the programme continues to evolve.



RECOMMENDATIONS TO BRING CITIZEN SCIENCE INTO MAINSTREAM EUROPEAN POLICY

Citizen science, through its potential to bridge science, society and policy, is in a unique position to play a role helping our governments and administrations to make sensible policies in relation to societal challenges. The ACTION (Participatory science toolkit against pollution) project was a three-year programme dedicated to transforming the way citizen science is conducted today: from a mostly scientist-led process to a more participatory, inclusive, citizen-led one, which acknowledges the diversity of the citizen science landscape and of the challenges citizen science teams have to meet as their projects evolve. It was implemented by ten research and third-sector organisations, universities, institutes and SMEs including Dr Debbie Chapman of UN GEMS/Water CDC, working together with 16 on-the-ground citizen science pilots tackling major forms of pollution.

Dr Chapman contributed to the development of the final report on recommendations to mainstream citizen science in policy and a white paper of science innovation through citizen science. Dr Chapman also gave a presentation on the benefits of citizen science

for water resources management in the context of the SDGs to the Water-ForCE (Water Scenarios for Copernicus Exploitation) workshop on citizen science. The Water-ForCE project aims to improve the Copernicus Earth Observation water-related services by using inputs from experts and the wider community to build a roadmap by the end of 2023. At the workshop, citizen science was discussed as a potential solution for ground truth water data validation of satellite products. As Dr Chapman outlined, some of the main challenges in developing a global methodology for freshwater quality monitoring is that it must be feasible for all nations worldwide and add minimal monitoring burden for countries while resulting in meaningful and comparable data. In this context, it can be beneficial to involve citizen scientists.

The World Water Quality Alliance (WWQA) has since set up a dedicated workstream to promote the generation and use of citizen science in water quality policy making.

REGIONAL ENGAGEMENT IN THE SOUTHWEST PACIFIC

The GEMS/Water 2022 Summer School workshop ‘Biological and chemical monitoring of freshwater resources; Regional engagement in the Southwest Pacific’ was organised in partnership with the GEMS/Water CDC in the ERI, the Water Authority of Fiji, the Global Programme Coordination Unit of the UNEP and the local UN Development Programme (UNDP) teams. Dr Michelle McKeown (School of BEES, ERI) led the workshop and fieldtrips in Fiji. The training featured a series of remote and local lectures delivered by water quality experts including Dr Simon Harrison (School of BEES, ERI) who introduced attendees to the Citizen Science Stream Index; roundtable discussions, as well as local field trips covering

water quality, biological monitoring techniques and citizen science engagement. Field exercises included the physical and chemical monitoring of streams, in tandem with collecting, identifying, and recording macroinvertebrates for the biological assessment of water quality. Because live organisms integrate variable exposure to pollution over time and space, they reflect the health of freshwater systems and can function as indicators of contamination, pollution, and climate change. Biological sampling can also provide opportunities for social engagement by including local citizens in water quality monitoring of their local area.



Workshop participants at the field site in Colo-i-suva collecting macroinvertebrate samples. Photo credit: Michelle McKeown.



2022 - YEAR OF GROUNDWATER: A CASE STUDY OF CHALLENGES FROM THE FIELD

Groundwater is a major water-supply source, while also sustaining aquatic ecosystems and maintaining baseflow in rivers and being a critical storage element for climate-change adaptation. Despite this, groundwater is out of sight, out of mind for most people. To raise awareness of the role that groundwater has in a variety of societal and environmental issues: from wetlands to food production, from sanitation to climate change, the UN named 2022 as the

International year of Groundwater. GEMS/Water currently hosts data on groundwater with increasing cooperation with experts from the WWQA's Friends of Groundwater (FoG). On this theme, we are featuring the work of MSc Freshwater Quality graduate Megan Cox and her ongoing research on the pollution of vital karst aquifers in Barbados – groundwater ecosystems which provide essential drinking water sources.

MSC STUDENT IN FRESHWATER QUALITY MONITORING AND ASSESSMENT PROJECT FEATURE:

Megan Cox, MSc. Caribbean Institute for Meteorology and Hydrology, Barbados.

Through its global scoping exercise and bilateral discussions with the water and education sectors worldwide, GEMS/Water CDC identified a need for a flexible, advanced course for individuals involved in water quality management. The MSc in Freshwater Quality Monitoring and Assessment builds on the existing Postgraduate Diploma and addresses these needs by enabling the development of expertise in countries around the world through part-time, online learning.

Barbados is one of the highest-ranking nations globally regarding water scarcity. Due to the geology of the island, many streams in Barbados only carry water occasionally and the population is almost totally dependent on groundwater from limestone aquifers. These aquifers are at risk of contamination from pollutants due to the presence of sinkholes and caves that provide a direct path for runoff.

“*The national water quality monitoring program in Barbados takes samples at pumping stations and springs; however, it was considered more meaningful to study water quality issues via observational boreholes. So as part of my MSc, I developed a project to investigate nitrate changes from three boreholes within the same groundwater catchment in Barbados.*”

Megan Cox

However, while sampling at one of the boreholes, the pump became entangled with roots that had broken through the borehole's casing. In the days that followed, the La Soufrière volcano on a neighbouring island, St Vincent, entered into an effusive phase after many years of relative inactivity, making it impossible to return to the site due to the heavy volcanic ash plume passing over Barbados, which made it difficult to breathe and operate outdoors. Several attempts were made to recover the pump in the weeks that followed, but all were unsuccessful.

“*Several lessons were learnt. The road to success is always filled with uncertainty and obstacles yet we press on to further our understanding of the environment in which we live. The investigation will recommence in June 2022. Despite difficulties, the monitoring project will continue.*”

Megan Cox



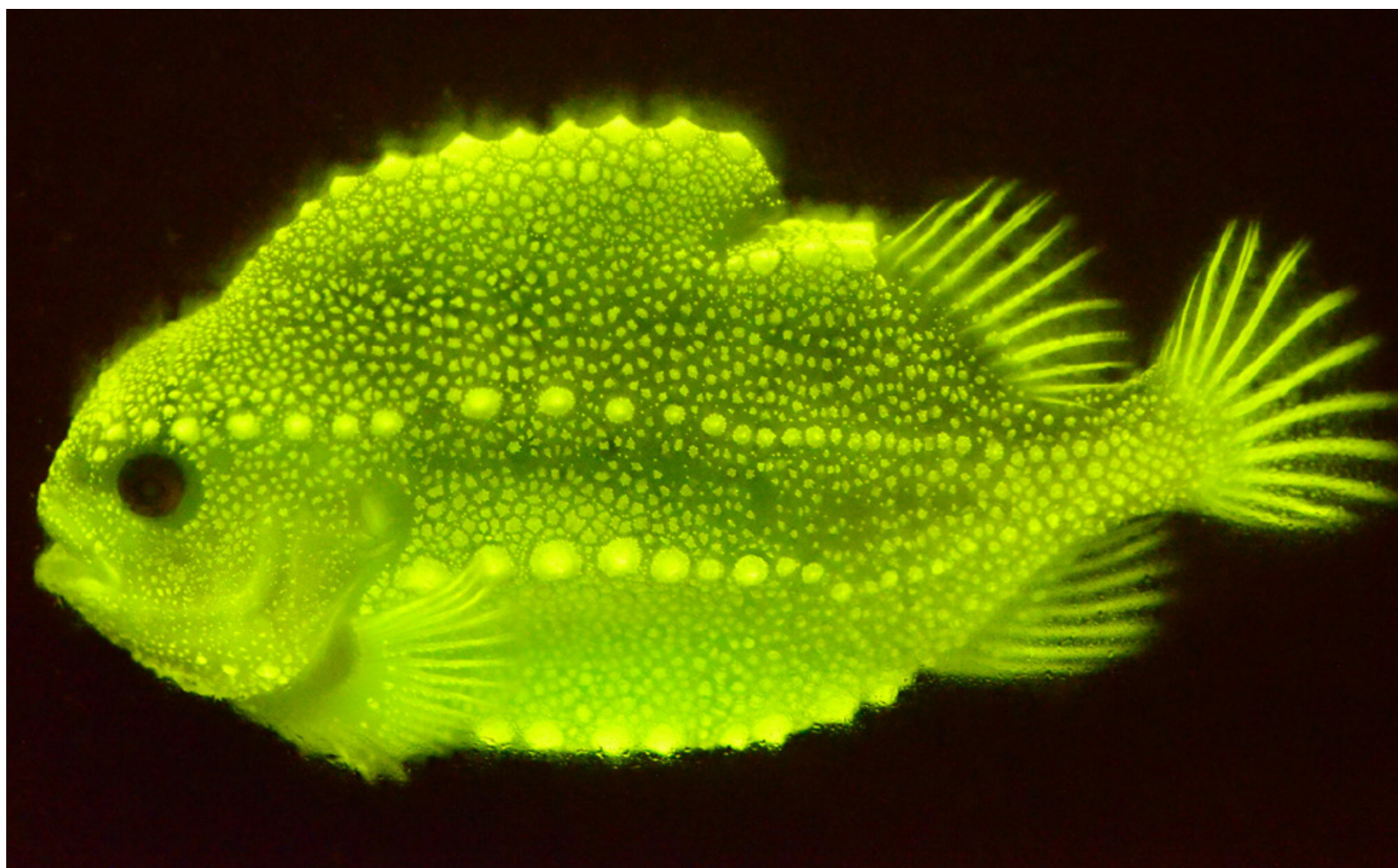
5.6 AQUACULTURE AND FISHERIES DEVELOPMENT CENTRE (AFDC)

The AFDC is a centre of excellence for aquaculture and fisheries research focusing on fisheries and fish population genetics, health of aquaculture species, and marine mammal research based in the School of BEES and affiliated to the ERI. The Centre is led by its Director, Prof Sarah Culloty.



HUMBLE LUMPFISH REVEALS SECRET BIOLUMINESCENCE IN STUNNING DISCOVERY

Scientists have discovered that the lumpfish, a small round fish found in cold waters around the world, glows under ultraviolet light, revealing a secret bioluminescence previously unknown to science. Researchers Thomas Juhasz-Dora and Dr Tom Doyle (AFDC, School of BEES, ERI) have found that the lumpfish's skin glows bright blue-green under ultraviolet light, which is invisible to the human eye. This is the first time that bioluminescence has been observed in the lumpfish, and the team were surprised to find that the glowing effect was not caused by bacteria or other microorganisms on the fish's skin, as is the case with many other bioluminescent animals. Instead, they discovered that the lumpfish's skin contains a unique combination of proteins that emit light when exposed to ultraviolet radiation. The researchers believe that the lumpfish's bioluminescence may serve a variety of purposes, such as communication, camouflage, or attracting prey. They also note that the discovery could have implications for medical research, as the proteins responsible for the glowing effect could potentially be used in bioluminescent imaging techniques. The discovery of bioluminescence in the lumpfish adds to our understanding of the diversity and complexity of life in the ocean and highlights the importance of continued exploration and research in this field.



INNOVATING TO SUSTAIN OUR NATIVE BIVALVE AQUACULTURE INDUSTRY

The bivalve aquaculture sector is a mainstay in the country's socioeconomic growth but annual variation in offspring recruitment and seed/spat supply is a major industry bottleneck globally. Understanding reasons for suboptimal recruitment, along with improving hatchery larvae production technologies, will support the sustainability of this low trophic industry, as well as futureproofing it in a changing marine environment. The Marine Institute-funded SusAqua project (advancing Irish Bivalve Biomass Production by Promoting Seed Abundance and more Disease Resilient Stocks), led by Prof Sarah Culloty, Dr Sharon Lynch and Dr Catherine Collins (all AFDC, School of BEES, ERI) will investigate both

abiotic and biotic factors, including predicted future environmental conditions, influencing reproductive output and biomass production in both oysters *Ostrea edulis* and mussels *Mytilus* species. The potential for seaweed biocompounds and selenium to promote fecundity will be investigated along with the use of antimicrobial photodynamic therapies for pathogen control in hatcheries that impact all life stages during the production cycle. Biodegradable equipment will be tested alongside traditional plastic structures to assess their efficacy in bivalve larvae settlement. Project outputs will support a green sustainable aquaculture industry nationally and beyond.



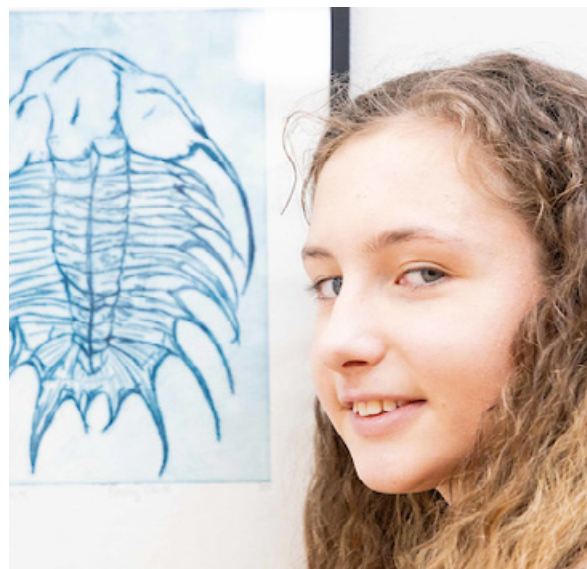
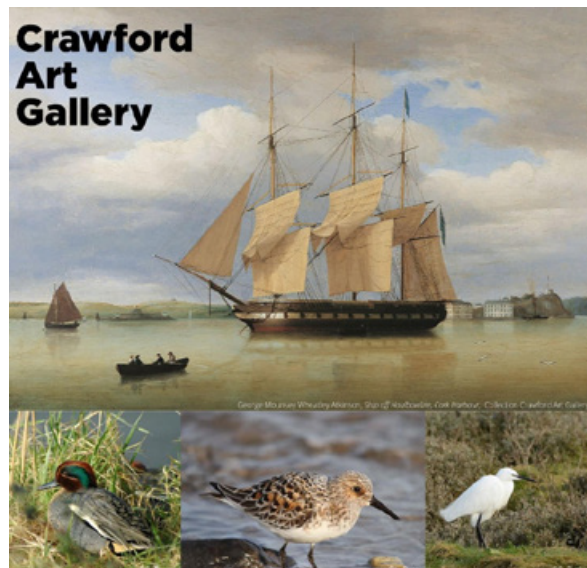
ADVANCING SUSTAINABLE BIVALVE PRODUCTION THROUGH GENETICS AND HEALTH MANAGEMENT

Bivalves provide consumers with a rich source of dietary protein and high value essential nutrients such as omega-3 fatty acids and iodine; in addition the environmental footprint of bivalve production is low. However, the technological development of the European bivalve production sectors lies far behind other aquaculture sectors. The ERANET and Marine Institute co-funded BIVALVI project (Advancing European bivalve production systems) with a consortium including Dr Sharon Lynch (AFDC, School of BEES, ERI) aims to advance bivalve production in Europe in a sustainable way by combining genetics and reproductive technologies with improved health and production management.

BIVALVI focuses on blue mussel, Manila clams and Pacific oysters - the bivalve species with the highest production in Europe. By combining technology and social sciences, the project will enhance the impact and acceptability of bivalve production, through

characterising the health, reproduction status and immune functions of diploid and triploid bivalve stocks; advancing breeding programmes and mapping disease resistance genes; and supporting sustainable quality stocks through stakeholder and ecosystems services studies. An important added value of BIVALVI is the close co-operation between R&D and the bivalve industries in Ireland, Italy and Norway. The multidisciplinary qualifications of the R&D partners, including UCC, are complementary, showing the importance of European cooperation for the developments in BIVALVI.

6 Outreach and Public Engagement



COLLABORATION WITH THE CREATIVE ARTS

The climate and biodiversity crises can appear to be complex and abstract issues to the general public. It can be challenging to communicate the urgency of their real-world impact. In recent years the ERI has been increasingly exploring the role that the arts can play in facilitating communication, reaching new audiences and creating impact. The creative arts

have the power to engage emotions and personal experiences, helping people to connect with the issue on a more visceral level, building empathy and creating a sense of urgency, but also showcasing innovative solutions, highlighting the resilience of communities, and inspiring collective action.

- **The Parklife Exhibition** was a collaborative project curated by the Glucksman curatorial team and the ERI and supported by the Arts Council. *Parklife* featured the work of 12 Irish artists who consider the biodiversity of the world around us, looking at how different forms of life thrive in the urban realm as well as in more remote environments. The exhibition also presented ten different ERI research projects which are investigating various aspects of flora and fauna biodiversity, including ECHOES, NatureWatch, Observe II, the Woodcock project, JellyJet, PhenoClimate and Cockles.
- **Ireland's Fossil Heritage** (led by Prof Maria McNamara of the ERI and School of BEES) also collaborated with the Glucksman Gallery to host their very first fossil art exhibition in June. The exhibition celebrated the artwork of Irish schoolchildren – and fossils - in two exciting new collections, *Fossil Freak*, in collaboration with Cork-based artists Susie Walsh and Leah Murphy, and *Irish Fossils Alive*. The winning artworks include pencil sketches, chalk sketches, paintings, prints and mixed media.
- **A jellyfish-inspired garden** could be seen on display in Blarney Castle & Gardens in August. The concept was developed jointly by Dr Tom Doyle (of the School of BEES and the ERI), award winning botanical artist Shevaun Doherty and head gardener and designer at Blarney Castle and Gardens, Adam Whitbourn, and funded by the SFI

Discover Program. The aim of the garden was to 'take jellyfish out of the sea' and place them in a very different environment so that the viewer sees them in a different and more positive light rather than simply fear them.

- **The Port of Cork Collection:** Cork Harbour is home to a great diversity of wildfowl, shorebirds, seabirds, raptors and many other species. The Crawford Art Gallery recognised that their *The Port of Cork* Collection of paintings shows birds only from a distance, so as part of the Life Long Learning Festival, the Gallery invited Prof John Quinn (School of BEES, ERI) to shed light on the remarkable lives that many of these species' lead, focusing on where they come from, how they get here, and what they do when they arrive.
- **The KinShip Project** is a public artwork, developing a variety of socially engaged cultural initiatives at Tramore Valley Park, that began in 2022 with the overall aim to develop a sense of connection between the people of Cork and the ecology and heritage of the park. Local partners formed a working group that includes the ERI, with the project being coordinated by Cork City Council and artist partnership LennonTaylor. Funded by the Creative Climate Action Fund, it has manifested as a year-long creative programme of citizen-led skills and knowledge-based exchanges, artist's placements, a KinShip EcoLab construction commission, and a focused series of creative interventions in the park.



PERSPECTIVES FROM THE HUMANITIES

The Eco-Humanities Research Group, spanning the ERI and the Future Humanities Institute, College of Arts, Celtic Studies and Social Sciences, aims to bring the perspectives of the humanities to bear on the multiple interlocking ecological and existential crises of our time. Formed in 2020, the group includes scholars from across and beyond the humanities disciplines whose work is concerned with climate and biodiversity crisis and with their far-reaching implications for values, ideologies, identities, and symbolic systems. Together, they explore how work in the humanities can help individuals and communities, including communities of researchers in the natural and social sciences, to navigate the growing conceptual, emotional, ethical and other demands of contemporary ecological and environmental crises.

Co-convenors Dr Crystal Addey (ERI, Dept of Classics), Dr Jenny Butler (Study of Religions Dept), Dr Laurence Davis (ERI, Dept of Government and Politics) and Dr Maureen O'Connor (Dept of English), together with previous co-convenor Prof Cairtriona Ní Dhúill (now at the University of Salzburg and an International Affiliate of the Group), have spent 2022 carefully curating the group's public lecture series. Prof Alexander Hampton (University of Toronto) delivered a lecture on the aesthetics of nature and realist ontology, Dr

Thomas Hylland Ericksen (University of Oslo) spoke about the homogenizing effects of globalisation on biological and cultural diversity, and Prof Freya Matthews (La Trobe University) presented research on indigenous approaches to walking the land and the decolonisation of nature. In January 2022, the Group hosted an online workshop on diverse notions of distributive agency, onto-epistemology and the 'more-than-human' which was attended by more than 200 people from across four continents. The Group also organised seminars on topics such as Dark Ecology, Energy Futures as portrayed in Contemporary Irish fiction, the field of Energy-Poetry, the importance of climate change in civilisation collapse and climate ethics, Eco-Cosmology and Contemporary Paganism, and ancient Greek philosophy and its relevance to contemporary environmental crises.



Dr Eoin Lettice, Ms Emma Hutchinson and Dr Barbara Doyle Prestwich, Irish Tree Explorers Network team members. Photo by Tomas Tyner, UCC

FOSTERING INCLUSION IN STEM

The ERI is increasingly broadening our outreach and public participation both geographically and amongst less represented voices. In 2022, the SFI Discover Programme was instrumental in supporting this effort

by awarding a joint €451,000 to fund four projects led by ERI coordinators which aim to improve diversity and inclusion in STEM.

- **Irish Tree Explorers Network (ITEN) :** Based on the Tree Explorers project, which involved the development of tree tours around UCC's campus along with workshops, public talks, educational materials, a self-guided map and a series of videos, the ITEN has received funding to take what has been learned from the project's success in Cork and bring it to a national audience. Led by Dr Eoin Lettice, Dr Barbara Doyle Prestwich (both ERI, School of BEES) and Prof Claire Connolly (School of English), in partnership with Coillte, the Office of Public Works (OPW) and the Tree Council of Ireland, ITEN will engage even more people with the importance of trees, nature, and the environment through important tree collections.

- **Fossils for our Future—Ireland's Palaeontology Participation Programme:** led by Dr Chris Mays (ERI, School of BES) is a citizen science fossil preparation programme. Through sustained, practical engagement with real fossils from past extinction events, the programme will establish a deep appreciation of science among Irish populations not generally or widely engaged with STEM such as the active retired community.

- **Teaching Resources for Youth-informed Biodiversity Education (TRYBE):** led by Aoife Deane (MaREI, ERI) will co-design and pilot a set of educational resources based on the recommendations of the Children and Young People's Assembly on Biodiversity Loss held last year. The resources will then be refined and disseminated to schools, clubs, and community groups to support environmental awareness and local action. On completion of the project, researchers will share learnings on the co-design process to inform future work in this space.

- **Circular Tales - engaging with the past to inspire the future,** led by Dr Cliona O'Carroll, James Furey (Cork Folklore Project and Department of Folklore and Ethnology, School of Irish Learning) and Dr Paul Bolger (ERI) is a collaboration with the Cork Traveller Women's Network which will explore the theme of the circular economy through collecting and sharing stories and memories of reuse, recycling and thrift, and through performance and song relating to the topic.

TELL ME MORE ABOUT ...

HOW TECHNOLOGY CAN HELP US TO ENGAGE WITH NATURE

There is increasing evidence to show that green spaces provide mental-health benefits, greater wellbeing, and lower levels of depression, stress, and anxiety. However, we don't all have equal access to such spaces, so researchers in the ERI, Dept of Geography and School of Applied Psychology have developed a major new Citizen Science project to support immersion in nature, even when access to traditional green spaces may be limited. The NatureWatch project links nature and technology to support the wellbeing of older adults. The team is led by Dr Paul Holloway (Dept of Geography, ERI) and funded by the SFI Discover Programme, and have been developing training materials and exercises for people who are interested in exploring nature, photography, technology, and wellbeing. The training developed within this project supports individuals to identify different bird and plant species, with photos and recordings being uploaded to the project website. Noting where species are found, and when they are recorded can support scientific research aimed at supporting biodiversity. For example, the project has had participants using cameras and recorders to note the date and time of migrating species, which can identify whether such species are arriving earlier due to climate change, potentially leading to mismatches in the emergence of their natural food sources.

THE SCIENTIFIC HISTORY AND NATURAL HERITAGE OF WEST CORK

Designated as Ireland's first Marine Nature Reserve in 1981, Lough Hyne in Co. Cork has attracted scientists from around the globe. In August 2022, over 200 people attended the annual Heritage Week Touch Tanks event on the North Shore of the Lough Hyne Marine Nature Reserve near Skibbereen. This highly popular event run by the Lough Hyne Research Team, from the ERI, MaREI and School of BEES in association with the Skibbereen Heritage Centre, was led by Prof Rob McAllen along with Dr Mark Jessopp, Luke Harman, Hannah Brownlow and Prof Ruth Ramsay. A selection of starfish, crabs, urchins and sea squirts amongst other common marine animals collected from Lough Hyne were on display. The ERI was also delighted to support the Ellen Hutchins Festival's Wild Child Day as part of National Heritage Week. Wildlife in the Woods with the Rangers took place in Glengarriff Woods Nature Reserve. This was followed by Nature Art with plant materials led by artists Sonia Caldwell and Shia Tremayne. This allowed children to make their own nature journals and use them to explore and document nature.

IRELAND'S PREHISTORIC WORLD

Ireland's Fossil Heritage is a science engagement project funded by the SFI and led by Prof Maria McNamara (School of BEES, ERI) which aims to increase awareness of, and interest in, Irish fossils by offering a diverse range of free resources to the public, including school workshops, a travelling exhibition, science and art collaborations and lots of interactive web content for all ages and backgrounds. 2022 was an especially busy year for the project team featuring appearances at Cork Science Festival, National Ploughing Championships, Cork Carnival of Science, as well as hosting over 700 attendees at the Family Fossil Expo in July. The team also toured schools all over Ireland offering free interactive fossil workshops delivered in person by scientists, which allowed students to interact with real fossils, 3D printed materials and real laboratory equipment using UV light and X-rays. Artwork played a significant role in the project's outreach activities with the National Fossil Photo Contest and the National Fossil Art Contest, while the Fossil Freaks Art Workshops was rolled out in Cork schools in conjunction with local artists to introduce the idea of the palaeo-artist who uses a combination of fossil evidence, evolution and imagination to reconstruct prehistory.

HOW SCIENCE CAN CREATE A WORLD OF 'INFINITE POSSIBILITIES'

Science Week 2022 was based on the theme of 'Infinite Possibilities' which explored the role of science in delivering solutions that support our future opportunities and challenges. Each year, Cork Science Festival is an opportunity to highlight the richness of ERI research - the range of topics that our researchers are interested in, and the impact and relevance of research in the real world. The Family Day event allowed the ERI and MaREI to showcase a wide range of interactive experiments and demos with experts from the WindValue, RADICAL and ECHOES projects on hand to answer questions about renewable energy, air quality and migratory birds respectively. The MaREI Centre also led a programme of events taking place over the entire week of the festival, including a takeover of the Ireland Environmentalists' twitter account to give an overview of MaREI research in plankton; participation in the Science Week Podcast on 'Dingle Peninsula 2030: How one Irish rural area is leading the way in community climate solutions'; and the 'Meet our Researchers' and 'Research focus' social media campaigns.

HOW CLIMATE CHANGE IS AFFECTING BIRDLIFE IN IRELAND

ECHOES (Effect of climate change on bird habitats around the Irish Sea) seeks to address how climate change will impact coastal bird habitats of the Irish Sea, and what effect this could have on our society, economy, and shared ecosystems. The project has a strong outreach component with the aim of raising awareness amongst farmers, landowners and members of the public about the importance of maintaining the habitats of the Eurasian Curlew and the Grey Fronted Goose in particular. The team, led in UCC by Dr Paul Holloway, Dr Fiona Cawkwell, Luke Lambert (of the ERI, MaREI, Dept of Geography and School of BEES) and Dr Aoife Corcoran (ERI) engaged with a diverse range of audiences in 2022, including Sea Scouts in Wicklow and Cork, farmers at the National Ploughing Championships, local authorities at Wexford County Hall, birdwatchers in Wexford Naturalists' Field Club and NGOs such as Cork Nature Network who collaborated with the team to host a Walk 'n' Talk along the Blackrock Estuary.

HOW STAKEHOLDER OUTREACH CAN OPEN UP NEW RESEARCH OPPORTUNITIES

Sustained two-way communication between end users of research and the researchers themselves provides vital practical insight and opportunities to test research in real life scenarios. Two projects led by Prof Marcel Jansen (School of BEES, ERI) are encouraging open discussion with their stakeholders in a variety of ways. The SFI-funded UV-SINTEC project is exploring the influence of UV wavelengths on plant responses, which could lead to more sustainable production of crops of high nutritional quality. In 2022, the team created a video which highlighted the huge commercial potential of the project, and called out to stakeholders such as commercial growers, as well as electronic companies who produce LEDs, to connect with the project, with the objective of taking the proof of concept to the next stage of technology readiness. Meanwhile, the Brainwaves project (funded by the European Regional Development Fund through the Ireland Wales Cooperation Programme) is using duckweed to implement an innovative circular economy approach to remediating wastewater. The team has been leading an extremely active stakeholder communication campaign, featuring on RTE TV and radio, meeting An Taoiseach at Cork Carnival of Science, discussing collaboration with the Welsh Rural Affairs Minister and producing a video for World Water Day 2022. All of which garnered much industry interest in the project and provided opportunities to the team to trial their systems at farms and agri-industries.

7 Awards & Recognitions

ERI ACADEMICS APPOINTED TO ROYAL IRISH ACADEMY COMMITTEES

Congratulations to our ERI academics who were appointed to a number of Royal Irish Academy expert committees in 2022:

- Dr Fidelma Butler, School of BEES and the ERI - Climate Change and Environmental Sciences Committee
- Dr Ger McGlacken, School of Chemistry and the ERI - Physical, Chemical and Mathematical Sciences Committee
- Dr Jean O'Dwyer, School of BEES and the ERI - Climate Change and Environmental Sciences Committee
- Dr Marguerite Nyhan, School of Engineering and Architecture, ERI and MaREI - Engineering and Computer Science Committee
- Dr Paul Holloway, ERI and Dept of Geography - Geoscience & Geographical Sciences Committee
- Dr Dug Cubie, School of Law and the ERI - Ethical, Political, Legal & Philosophical Studies Committee

ERI ACADEMICS LISTED IN THE TOP 10 ENGINEERING & TECHNOLOGY SCIENTISTS IN IRELAND

Congratulations to ERI and MaREI researchers Prof Gregorio Iglesias, Dr Gordon Lightbody, Prof Jerry Murphy and Prof Brian Ó Gallachóir on being named in the Top Engineering and Technology Scientists in Ireland by *research.com*, one of the major websites for engineering and technology research offering credible data on scientific contributions.



UCC RESEARCH AWARDS

Congratulations to ERI researchers who had their contributions to innovation and knowledge enhancement recognised at the UCC Research Awards:

- Prof Justin Holmes, School of Chemistry and the ERI - Researcher of the Year.
- Dr Paul Deane, MaREI and the ERI - Research Communicator of the Year
- The Marine Ecology Group, School of BEES, MaREI and the ERI - Best Research Team of the Year
- The Dingle Peninsula project team, School of Engineering and Architecture, MaREI and the ERI - Engaged Research of the Year
- Dr Gerard McGlacken, School of Chemistry and the ERI - Research Collaboration of the Year.
- The Imagining 2050 project team, School of Engineering and Architecture, Dept of Government and Politics, Dept of Sociology and Criminology, CPPU, MaREI and the ERI - President's Award for Research Impacting the Sustainable Development Goals

UCC NAMED SUSTAINABILITY INSTITUTION OF THE YEAR AT GREEN GOWN AWARDS

Congratulations to our colleagues in UCC Green Campus on being awarded the top prize of Sustainability Institution of the Year at the 2022 Green Gown Awards of UK & Ireland.

UCC ACADEMIC APPOINTED TO THE CARBON BUDGETS WORKING GROUP

Congratulations to Dr Kian Mintz-Woo (ERI, Dept of Philosophy) on being appointed by the EPA to the Carbon Budgets Working Group of the Climate Change Advisory Council. Dr Mintz-Woo will contribute to the carbon budgets methodology for the coming five-year carbon budgets, by bringing in a climate justice and just transitions perspective.

MULTI-AWARD-WINNING DINGLE PENINSULA 2030 TEAM

Congratulations to MaREI's transdisciplinary research group behind the Dingle Peninsula 2030 project Prof Brian Ó Gallachóir, Dr Connor McGookin, Dr Clare Watson, Dr Evan Boyle and Aoife Deane, on winning several awards in 2022, including SFI Engaged Research of the Year Award, Climate Action Award at the IPB National Pride of Place Awards, UCC Engaged Research of the Year award, and SEAL Inspirational Energy Community 2022.

ERI APPOINTEE TO BOARD OF THE IRISH FULBRIGHT COMMISSION

Congratulations to Prof Sarah Culloty, outgoing ERI Director and Head of the College of Science, Engineering and Food Science who has been appointed to the Board of the Irish Fulbright Commission for a two-year term.

AWARDS FOR ERI DELEGATION AT ENVIRON 2022

Congratulations to PhD student Irene O'Callaghan (School of BEES, School of Chemistry and the ERI) who was named ESAI Postgraduate Researcher of the Year at Environ 2022, and to PhD student Anna O'Regan (MaREI, School of Engineering and Architecture, ERI) who won the Best Waste and Resource Management Presentation.

OFFSHORE RENEWABLE ENERGY GROUP RECEIVES SUSTAINABLE ENERGY AWARD

Congratulations to the Offshore Renewable Energy Group, led by Prof Gregorio Iglesias (School of Engineering and Architecture, MaREI and the ERI) who were winners of the Excellence in Energy Research and Innovation category at the SEAI Energy Awards 2022.

APPOINTMENT TO EUROPEAN ENVIRONMENT AGENCY FORESIGHT BOARD

Congratulations to the ERI Manager, Dr Paul Bolger, who was selected to join the European Environment Agency EIONET Foresight Board to develop knowledge, skills and methodological expertise on futures' analysis and foresight studies to support policy-making and governance of sustainability transitions at European level.

UCC PALAEOLOGY GROUP RECOGNISED AT CONFERENCE AWARDS

Congratulations to the members of the UCC Palaeontology Group led by Prof Maria McNamara (School of BEES, ERI) who received prizes at the Annual Meeting of the Society for Vertebrate Palaeontology and Comparative Anatomy (SVPCA), including award for best talk for Zixiao Yang; runner-up for best talk awarded to Valentina Rossi; runner-up for best poster awarded to Tiffany Slater. Congratulations also to PhD student Hannah Binner who received an honourable mention for her research poster at the iCrag 2022 symposium.

INTERNATIONAL APPOINTMENTS FOR CENTRE FOR LAW AND THE ENVIRONMENT DIRECTOR

Congratulations to Prof Owen McIntyre (ERI, School of Law, Centre for Law and the Environment) who was invited by IUCN World Commission on Environmental Law to lead a special research / advisory project on *State Responsibility and Related Liability in International Water Law*; and re-appointed to the Expert Advisory Body of Evaluators established by the Research, Development and Innovation Council of the Czech Republic and as an External Reviewer.

UCC TEACHING AWARDS

Dr Ger Mullally (Dept of Sociology and Criminology, and the ERI) - President's Award for Teaching Excellence for the University Wide Module on Sustainability.



8 | Meet Our New Academics



DR FERGAL O'CONNOR

(Cork University Business School and the ERI)

Dr Fergal O'Connor is a Lecturer in Financial Economics in Cork University Business School (CUBS). His research focuses on the financial economics of precious metals, particularly the London Market.

"I am interested in the operation and efficiency of Emissions Trading Systems globally, especially whether systems in different regions integrate efficiently with one another. I am also interested in gathering long run price data on commodities and metals markets in order to understand how these markets functioned in the past in order to better plan for the future."



DR TRACEY SKILLINGTON

(Department of Sociology & Criminology and the ERI)

Dr Tracey Skillington is Director of the BA (Sociology) and Chair of the Undergraduate Committee in the Department of Sociology & Criminology.

"My core interest is the justice dimensions of climate change and how they are played out between peoples, generations, world regions, various socio-economic groupings, communities, etc. I am interested in how justice reasoning continues to evolve in response to various deepening climate related problems and forces a new dialogue on our commitments to the democratic society."



DR CHRIS MAYS

(School of BEES and the ERI)

Dr Chris Mays is a Lecturer in Palaeontology in the School of Biological, Earth and Environmental Sciences. His research has focused on mass extinctions, and the responses of polar plants and animals to past greenhouse events.

"I study fossil plants to gauge the health of past environments during extreme warming events. Through studying the most extreme climates of Earth's past, and their links to mass extinction, my research aims to inform present global environmental changes and their projected impact on land biomes."



DR ARCHISHMAN BOSE

(School of Engineering and Architecture, MaREI and the ERI)

Dr Archishman Bose is the Eli Lilly Lecturer in Process and Chemical Engineering in the School of Engineering and Architecture. He is also a Principal Investigator in the Circular Economy, Energy, and Environmental Systems (CEEES) Research Group. His research interests include BioEnergy Systems, Energy Systems Modelling, Energy Planning, and Smart Cities.

"Currently, I have interdisciplinary and transdisciplinary research interests which include decarbonisation of industrial processes including the application of Green Chemistry techniques."



DR JAMES RICHARDSON

(School of BEES and the ERI)

Dr James Richardson is a Lecturer in the School of Biological, Earth and Environmental Sciences. He joined the ERI and the UCC School of BEES from the Universidad del Rosario in Columbia where he led the Natural History of Tropical Plants Research Group. Dr Richardson's research areas include Botany, Evolutionary Biology and Taxonomy.

"My main interest is to understand how global geological and climatic change affects plant diversity."



DR MARIE ARONSSON-STORRIER

(School of Law, Centre for Law and the Environment, and the ERI)

Dr Marie Aronsson-Storrier is a Lecturer in the School of Law and a member of the Centre for Criminal Justice and Human Rights.

"My research explores the role of international law in creating and addressing disaster risk, including questions around root causes of risk, the Anthropocene, epistemologies of international law, and the inclusion of marginalised groups and persons in law- and decision-making processes."



DR AARON LIM

(Department of Geography and the ERI)

Dr Aaron Lim is a lecturer in Coastal Geomorphology in the Department of Geography.

"I am interested in the development of novel seabed mapping methodologies (AUV, ROV, coupled sonars, photogrammetry and machine learning to understand seabed process and monitor change over time; environmentally friendly and cost-effective marine geophysical and hydrographic survey design for offshore renewable energy projects and the development of virtual reality teaching tools in marine and coastal settings."



DR FRANK CROWLEY

(Cork University Business School and the ERI)

Dr Frank Crowley is a lecturer in Economics and Co-Director of Spatial and Regional Economics Research Centre in Cork University Business School (CUBS). He specializes in the fields of sustainable business and innovation, sustainable regional and urban planning, and regional science. Dr Crowley's current research focuses on examining sustainable land use and urban development, commuting, remote working, innovation in offshore renewable energy, and sustainable practices and innovation in family businesses.

9 | ERI in the Media 2022

EMPLOYERS HAPPY, BUT MEDICS CONCERNED AT EASED CONSTRAINTS

Prof John Wenger, The Irish Examiner, 23rd Jan 2022.



'NEGLECTED': WHY IRELAND IS THE WORST COUNTRY IN THE EU AT USING RENEWABLES TO MAKE HEAT ENERGY

Dr Fionn Rogan, The Journal.ie, 6th Jan 2022.



UCC EXPERT WARNS IRELAND NEEDS TO UP RENEWABLE ENERGY SUPPLY

Dr Paul Leahy, The Echo, 8th March 2022.



HOW IRELAND IS FREEWHEELING INTO A POSSIBLE ENERGY CRISIS

Dr Paul Deane, The Sunday Times, 13th March 2022.



CURLEW ECHOES

Dr Fiona Cawkwell, Mooney Goes Wild, RTE Radio One, 13th May 2022



HOW TO CARE ABOUT CLIMATE CHANGE (AND WHY)

Dr Clare Watson, Irish Independent Science Week podcast, 15th Nov 2022



CONGRATULATIONS TO DR PAUL DEANE WHO WROTE RTE BRAINSTORM'S MOST READ ARTICLE LAST YEAR.

Dr Dean's article *What happens in Ireland if Russia turns off the gas supply?* recorded 346,760 reads last year, easily making it Brainstorm's top read in 2022.



SEEDLINGS WITH HISTORIC ROOTS IN HIROSHIMA GROWING IN CORK

Dr Eoin Lettice, RTE, 5th July 2022.



WILDFIRES MAY HAVE SPARKED ECOSYSTEM COLLAPSE DURING EARTH'S WORST MASS EXTINCTIONS

Dr Chris Mays, The Irish Times, 10th July 2022.



THE GREEN SCENE SERIES

Prof Brian Ó Gallachóir on the Pat Kenny Show, Newstalk, 17th Sept 2022.



CAN OCEAN SHIPPING GO GREEN?

Prof Wim Naude in The American Prospect, 22nd Sept 2022.



BUSINESSES YET TO GRASP THE SCALE OF SUSTAINABILITY CHALLENGE, ACCORDING TO NEW UCC REPORT

Dr Marguerite Nyhan, Irish Independent, 10th Nov 2022



COP27

Omar Ibrahim, Today FM, 30th Nov 2022.



JANUARY

MARCH

MAY

JULY

SEPTEMBER

NOVEMBER

FEBRUARY

APRIL

JUNE

AUGUST

OCTOBER

DECEMBER

PUSH AND PULL OF GENETIC DRIVE AND ENVIRONMENTAL SWAY

Prof John Quinn, The Irish Times, 4th Feb 2022.



INCREASE IN SIGHTINGS OF GIANT SUNFISH IN IRISH WATERS AS OCEAN TEMPERATURES RISE

Dr Tom Doyle, The Irish Examiner, 10th Feb 2022.



IN OUR TIME: FEATHERED DINOSAURS

Prof Maria McNamara, BBC Radio 4, 21st April 2022.



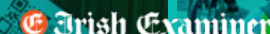
BREASTFEEDING CAN BE GOOD FOR PUBLIC HEALTH—AND THE PLANET TOO

Dr Kian Mintz-Woo & Dr Aoife Long, RTE Brainstorm, 23rd April 2022



AVOID, SHIFT, IMPROVE: HOW TO LOWER YOUR CARBON FOOTPRINT BY CYCLING

Vera O'Riordan, The Irish Examiner, 24th June 2022



UCC SEEKS VOLUNTEERS IN CORK FOR A STUDY ON THE LONG-TERM IMPACTS OF COVID-19

Dr Paul Holloway, Cork Beo, 30th June 2022



'I WAS, LIKE, WOW': AN IRISH SCIENTIST ON HIS GLOW-FISH DISCOVERY

Dr Thomas Juhasz-Dora, New York Times, 3rd August 2022.



HUNDREDS OF ANCIENT FROGS DIED IN THIS SWAMP MATING DEATH TRAP, RESEARCHERS SAY

Daniel Falk, NPR, August 10th 2022.



THE ISLAND

Prof Andy Wheeler and Prof Maria McNamara, RTE One, 7th Oct 2022.



CLIMATE CHANGE DEBATE BEING POISONED BY AGRICULTURE'S MANUFACTURED DOUBT AND DIVISION.

Prof Hannah Daly, Irish Times, 20th Oct 2022.



PUFFINS LOSE ABILITY TO FLY FOR UP TO TWO MONTHS EACH YEAR, EXPOSING THEM TO WINTER STORMS

Jamie Darby, Irish Examiner, 22nd Dec 2022.



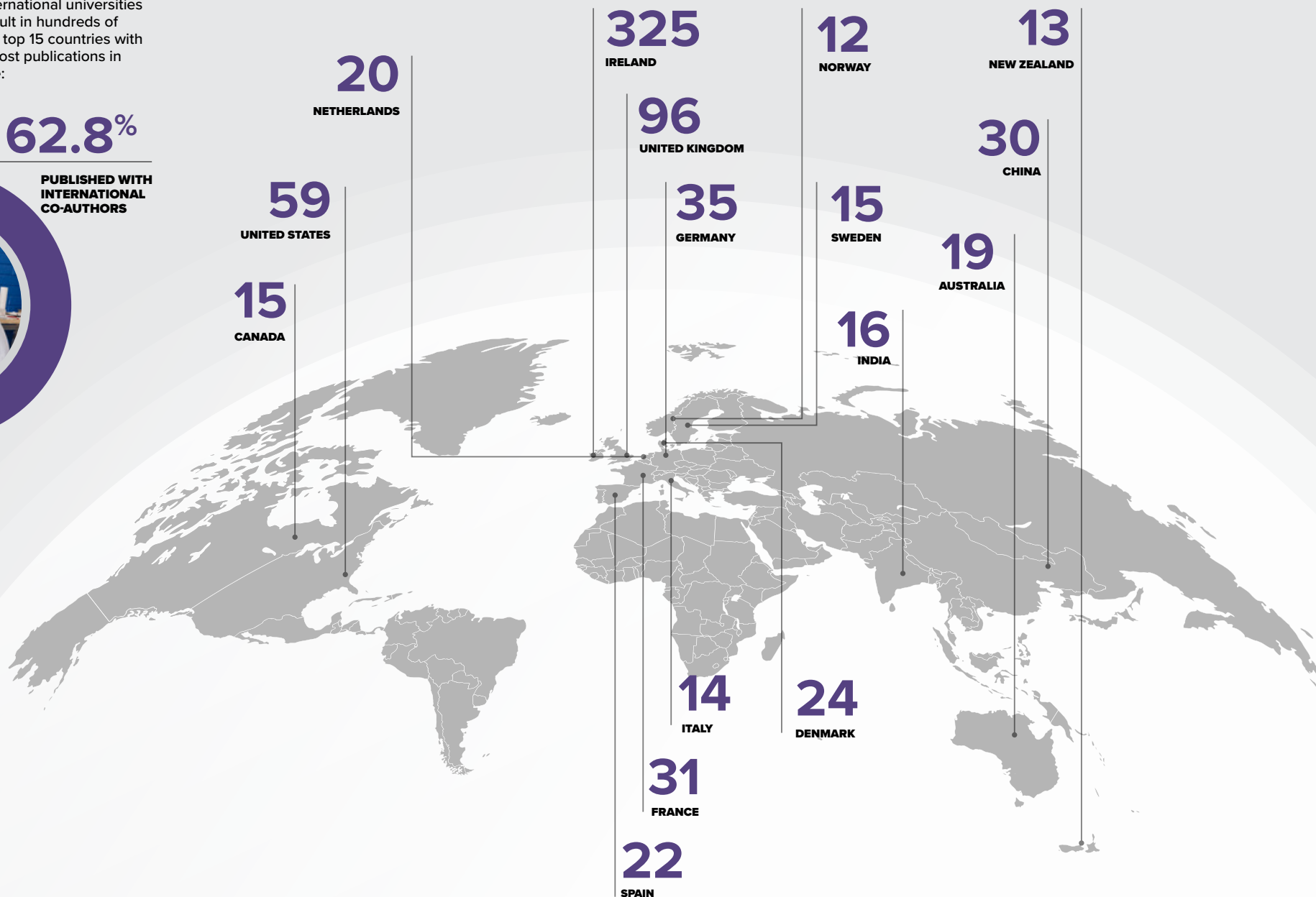
CIRCULAR ECONOMY

Prof Marcel Jansen and Dr Niall O'Leary, 10 Things to Know About, RTE One, 12 Dec 2022.



10 | ERI Around the World in 2022

The ERI has collaborative partnerships with over 500 national and international universities and companies, which result in hundreds of publications annually. The top 15 countries with which we produced the most publications in 2022 are highlighted here:



11 | ERI 2022 PhD and Research Masters Awards

| POSTGRADUATE | | QUALIFICATION | SUPERVISOR(S) |
|----------------|--------------------|-------------------------------|---|
| Albuxech Marti | Sara | PhD (Science) | Professor Sarah Culloty, Dr Sharon Lynch |
| Al Mahdi | Hussain | PhD (Engineering) | Dr Alan Morrison, Dr Paul Leahy |
| Benchikh | Hocine Amine | PhD (Science) | Professor Emer Rogan |
| Bernardi | Luca | MSc | Dr Peter Deeney |
| Bradfield | Tracy Rebecca | PhD (Commerce) | Professor Thia Hennessy, Dr Robert Butler |
| Brennan | Mary | PhD (Commerce) | Professor Thia Hennessy, Dr Emma Dillon |
| Cadogan | Eimer Marie | Doctor of Clinical Psychology | Dr Annalisa Setti, Dr Mike Murphy |
| Coleman | James Elliot Peter | MSc | Dr Mark Jessop |
| Donzella | Lorena | PhD (Microbial Biotechnology) | Dr John Morrissey |
| Heffernan | Eimear Patricia | PhD (Science) | Dr Stig Hellebust, Professor John Wenger |
| Hickey | Aobha Barbara | PhD (Science) | Dr Gerard McGlacken |
| Hynes | Eric James | Master of Research (Science) | Dr Eoin Lettice, Dr Barbara Doyle Prestwich |
| Kelly | Joseph | PhD (Engineering) | Dr Paul Leahy, Dr Alan Morrison |
| Kett | Gary | PhD (Science) | Professor Sarah Culloty, Dr Sharon Lynch, Professor Marcel Jansen |
| Looney | Caitlin Rita | PhD (Science) | Professor Astrid Wingler, Dr Michael Egan |
| Mac Uidhir | Tomas | PhD (Engineering) | Professor Brian Ó Gallachóir, Dr Fionn Rogan |
| Martinez Diaz | Abel | PhD (Engineering) | Dr Paul Leahy, Professor Gregorio Iglesias |
| McCarthy | Alan Michael | PhD (Science) | Professor John O'Halloran, Dr Fidelma Butler |
| McGookin | Connor John | PhD (Engineering) | Professor Brian Ó Gallachóir, Professor Ed Byrne, Professor William Marnane |
| McSorley | Brendan Eugene | MSc | Dr Simon Harrison, Dr Tim Sullivan, Dr Fidelma Butler |
| Montini | Noemi | PhD (Science) | Dr John Morrissey |

| POSTGRADUATE | | QUALIFICATION | SUPERVISOR(S) |
|--------------|--------------------|-----------------------------------|---|
| Murphy | Aisling Mary | Master of Research (Arts) | Dr Kieran Hickey, Dr Karen Taylor |
| Nuyts | Siegmund | PhD (Engineering) | Dr James, Murphy, Dr Kieran Hickey, Professor William Marnane |
| O'Keefe | Laurie | PhD (Law) | Professor Owen McIntyre |
| O'Mullane | Colm Cornelius | MSc (Commerce) | Dr Derek Butler, Dr Robert Butler, Dr John Eakins |
| O'Reilly | Luke Gerard Ronnie | PhD (Science) | Professor Andy Wheeler, Dr Aaron Lim |
| Pereras | Gerard | PhD (Science) | Dr Davide Tiana, Professor Justin Holmes |
| Ross | Megan | PhD (Food Science and Technology) | Professor Alan Kelly, Dr Shane Crowley, Dr Alan Morrison |
| Scarrott | Rory Gordon | PhD (Science) | Dr Fiona Cawkwell, Dr Mark Jessopp, Dr Caroline Cusack (Marine Institute) |
| Slater | Tiffany | PhD (Science) | Professor Maria McNamara |
| Ugwah | Anulika Justina | PhD (Science) | Dr Eric Moore, Dr Martin O'Sullivan, Dr Brian O'Donnell |
| Wilson | Hazel | PhD (Science) | Dr Markus Eichhorn |

Spring 2020

A poem by Dr Fionn Rogan

The bird song was louder that year,
more cats crossed the road safely,
fewer pigeons were verbally abused,
more dogs were walked twice a day.
The rivers were cleaner;
the horses and cows that drank
had their thirst quenched quicker.
The trees that cleaned the air
had less diesel fumes to dispel;
more lilac blossom fragrance lingered.
Daffodil day was cancelled. Spring powered ahead.
Fewer nests were made with plastic,
more fledglings were overheard.
The cherry blossoms simply blossomed;
fewer leaves were flattened where they fell.
The bees noticed no difference:
each load of pollen was collected,
buttercup, snowdrop, bluebell.
Phenomena such as rush hour ceased to be.
The school run ran no more.
Taxi ranks were empty.
Urban foxes were perplexed
at the spoils of city in retreat.

- Dr Fionn Rogan

Fionn is a Senior Research Fellow at the ERI and MaREI. His research interests include energy systems modelling to inform climate policy, energy innovation, societal transitions, and transdisciplinary research.

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“For me, poetry is the original transdisciplinary activity. It engages the head, heart, hands and senses. As a researcher I try to see things differently and to see what is often overlooked - reading and writing poetry helps me cultivate both these practices. As the emotions of environmental issues - e.g. anxiety at climate breakdown and biodiversity loss - become more widespread, I believe poetry has a powerful role to play by helping us to express our deep feeling and thus become empowered.”

12 | ERI 2022 Peer-Reviewed Publications

1. Abdallah, G.K., Masurel, E., Naudé, W.A. and Eijdenberg, E.L. (2022) *Unboxing Entrepreneurial Motivations in Tanzania: Business-related and Personal-related Factors*, Journal of African Business, 23 (1) 60-78.
2. Agnew, S., Kopke, K., Power, O.-P., Troya, M.D.C. and Dozier, A. (2022) *Transdisciplinary Research: Can Citizen Science Support Effective Decision-Making for Coastal Infrastructure Management?*, Frontiers in Marine Science, 9, 809284.
3. Ahern, M., O'Sullivan, D.T.J. and Bruton, K. (2022) *Development of a Framework to Aid the Transition from Reactive to Proactive Maintenance Approaches to Enable Energy Reduction*, Applied Sciences 12(13), 6704.
4. Al Khalaf, S., Bodunde, E., Maher, G.M., O'Reilly, É.J., McCarthy, F.P., O'Shaughnessy, M.M., O'Neill, S.M. and Khashan, A.S. (2022) *Chronic kidney disease and adverse pregnancy outcomes: a systematic review and meta-analysis*, American Journal of Obstetrics and Gynecology, 226 (5) 656-670, e32.
5. Al Khalaf, S., Khashan, A.S., Chappell, L.C., O'Reilly, É.J. and McCarthy, F.P. (2022) *Role of Antihypertensive Treatment and Blood Pressure Control in the Occurrence of Adverse Pregnancy Outcomes: A Population-Based Study of Linked Electronic Health Records*, Hypertension, 79 (7) 1548-1558.
6. Alatawi, H., Hogan, A., Albalawi, I., O'Sullivan-Carroll, E., Alsefri, S., Wang, Y. and Moore, E. (2022) *Rapid determination of NSAIDs by capillary and microchip electrophoresis with capacitively coupled contactless conductivity detection in wastewater*, Electrophoresis, 43 (20) 1944-1952.
7. Alatawi, H., Hogan, A., Albalawi, I., O'Sullivan-Carroll, E., Wang, Y. and Moore, E. (2022) *Fast determination of paracetamol and its hydrolytic degradation product p-aminophenol by capillary and microchip electrophoresis with contactless conductivity detection*, Electrophoresis, 43 (45145) 857-864.
8. Albalawi, I., Alatawi, H., Alsefri, S. and Moore, E. (2022) *Electrochemical Synthesis of Reduced Graphene Oxide/Gold Nanoparticles in a Single Step for Carbaryl Detection in Water*, Sensors, 22 (14) 5251.
9. Allington, L., Cannone, C., Pappis, I., Cervantes Barron, K., Usher, W., Pye, S., Brown, E., Howells, M., Zachau Walker, M., Ahsan, A., Charbonnier, F., Halloran, C., Hirmer, S., Cronin, J., Taliotis, C., Sundin, C., Sridharan, V., Ramos, E., Brinkerink, M., Deane, P., Gritsevskiy, A., Moura, G., Rouget, A., Wogan, D., Barcelona, E., Niet, T., Rogner, H., Bock, F., Quirós-Tortós, J., Angulo-Paniagua, J., Krishnamurthy, S., Harrison, J. and To, L.S. (2022) *Selected 'Starter kit' energy system modelling data for selected countries in Africa, East Asia, and South America (#CCG, 2021)*, Data in Brief, 42, 108021.
10. Alvarez, E.G., Carslaw, N., Dusanter, S., Edwards, P., Gábor Mihucz, V., Heard, D., Kleffmann, J., Nehr, S., Schoemacker, C. and Venables, D. (2022) *Techniques for measuring indoor radicals and radical precursors*, Applied Spectroscopy Reviews, 57 (7) 580-624.
11. Álvarez, M., Ramos, V., Carballo, R., López, I., Fouz, D.M. and Iglesias, G. (2022) *Application of Marine Spatial Planning tools for tidal stream farm micro-siting*, Ocean and Coastal Management, 220, 106063.
12. Analakkattillam, S., Langsi, V.K., Hanrahan, J.P. and Moore, E. (2022) *Analytical method validation for assay determination of cannabidiol and tetrahydrocannabinol in hemp oil infused products by RP-HPLC*, Scientific Reports, 12 (1) 12453.
13. Andrade, L., Boudou, M., Hynds, P., Chique, C., Weatherill, J. and O'Dwyer, J. (2022) *Spatiotemporal dynamics of Escherichia coli presence and magnitude across a national groundwater monitoring network, Republic of Ireland, 2011–2020*, Science of the Total Environment, 840, 156311.
14. Andrady, A.L., Barnes, P.W., Bornman, J.F., Gouin, T., Madronich, S., White, C.C., Zepp, R.G. and Jansen, M.A.K. (2022) *Oxidation and fragmentation of plastics in a changing environment; from UV-radiation to biological degradation*, Science of the Total Environment, 851, 158022.
15. Appah, J.K.M., Killeen, O., Lim, A., O'Riordan, R., O'Reilly, L. and Wheeler, A.J. (2022) *Accumulation of marine litter in cold-water coral habitats: A comparative study of two Irish Special Areas of Conservation, NE Atlantic*, Marine Pollution Bulletin, 180, 113764.
16. Appah, J.K.M., Lynch, S.A., Lim, A., O'Riordan, R., O'Reilly, L., de Oliveira, L. and Wheeler, A.J. (2022) *A health survey of the reef forming scleractinian cold-water corals Lophelia pertusa and Madrepora oculata in a remote submarine canyon on the European continental margin, NE Atlantic*, Journal of Invertebrate Pathology, 192, 107782.
17. Aronsson-Storrier, M. (2022) *Keep the curtains drawn! Event, process and disaster in international law*. In: Aronsson-Storrier M. and Dahlberg R. (Editors) *Defining Disaster: Disciplines and Domains*, Edward Elgar Publishing, Cheltenham, UK, pp. 45-57.
18. Aronsson-Storrier, M. and Dahlberg, R. (2022) *On disaster: Disciplines, domains and definitions*. In: Aronsson-Storrier M. and Dahlberg R. (Editors) *Defining Disaster: Disciplines and Domains*, Edward Elgar Publishing, Cheltenham, UK, pp. 1-8.
19. Aronsson-Storrier, M. and Dahlberg, R. (2022) *Preface*. In: Aronsson-Storrier M. and Dahlberg R. (Editors) *Defining Disaster: Disciplines and Domains*, Edward Elgar Publishing, Cheltenham, UK, p. xv.
20. Aronsson-Storrier, M. and Dahlberg, R. (Editors) (2022) *Defining Disaster: Disciplines and Domains*, Edward Elgar Publishing, Cheltenham, UK, 264 pp.
21. Aryanpur, V., Balyk, O., Daly, H., Ó Gallachóir, B. and Glynn, J. (2022) *Decarbonisation of passenger light-duty vehicles using spatially resolved TIMES-Ireland Model*, Applied Energy, 316, 119078.
22. Aryanpur, V., Fattahi, M., Mamipour, S., Ghahremani, M., Ó Gallachóir, B., Bazilian, M.D. and Glynn, J. (2022) *How energy subsidy reform can drive the Iranian power sector towards a low-carbon future*, Energy Policy, 169, 113190.
23. Aryanpur, V., Ghahremani, M., Mamipour, S., Fattahi, M., Ó Gallachóir, B., Bazilian, M.D. and Glynn, J. (2022) *Ex-post analysis of energy subsidy removal through integrated energy systems modelling*, Renewable and Sustainable Energy Reviews, 158, 112116.
24. Assan, D., Kuebutornye, F.K.A., Hlordzi, V., Chen, H., Mraz, J., Mustapha, U.F. and Abarike, E.D. (2022) *Effects of probiotics on digestive enzymes of fish (finfish and shellfish): status and prospects: a mini review*, Comparative Biochemistry and Physiology. Part B, Biochemistry and Molecular Biology, 257, 110653.
25. Assis, O.S., Zaffarana, C.B., Orts, D., Puigdomenech, C., Ruiz González, V., Gallastegui, G., Hauser, N., Kiseeva, E.S., Molina, J.F. and Pernich, S. (2022) *Emplacement conditions and exhumation of the Varvarco Tonalite and associated plutons from the Cordillera del Viento, Southern Central Andes*, Geological Magazine, 159 (5) 645-672.
26. Badmus, U.O., Aç, A., Klem, K., Urban, O. and Jansen, M.A.K. (2022) *A meta-analysis of the effects of UV radiation on the plant carotenoid pool*, Plant Physiology and Biochemistry, 183, 36-45.
27. Badmus, U.O., Crestani, G., Cunningham, N., Havaux, M., Urban, O. and Jansen, M.A.K. (2022) *UV Radiation Induces Specific Changes in the Carotenoid Profile of Arabidopsis thaliana*, Biomolecules, 12 (12) 1879.
28. Badmus, U.O., Crestani, G., O'Connell, R.D., Cunningham, N. and Jansen, M.A.K. (2022) *UV-B induced accumulation of tocopherol in Arabidopsis thaliana is not dependent on individual UV photoreceptors*, Plant Stress, 5, 100105.
29. Balbaied, T. and Moore, E. (2022) *Real-Time Impedance Monitoring of Alkaline Phosphatase (ALP) Release by Microelectrode Arrays*, Analytical Letters, 55 (8) 1318-1330.
30. Balyk, O., Glynn, J., Aryanpur, V., Gaur, A., McGuire, J., Smith, A., Yue, X. and Daly, H. (2022) *TIM: Modelling pathways to meet Ireland's long-term energy system challenges with the TIMES-Ireland Model (v1.0)*, Geoscientific Model Development, 15 (12) 4991-5019.
31. Bank, L. C., Gentry, T. R., Al-Haddad, T., Alshannaq, A., Zhang, Z., Bermek, M., Henao, Y., McDonald, A., Li, S., Poff, A., Respert, J., Woodham, C., Nagle, A., Leahy, P., Ruane, K., Huynh, A., Soutsos, M., McKinley, J., Delaney, E. and Graham, C. (2022) *Case studies of repurposing FRP wind blades for second-life new infrastructure*. In Zingoni, A. (Editor) *Current Perspectives and New Directions in Mechanics, Modelling and Design of Structural Systems - Proceedings of the 8th International Conference on Structural Engineering, Mechanics and Computation (SEMC 2022, Cape Town, South Africa, 5-7 September 2022)*, CRC Press/Balkema, London, pp. 1441-1446.
32. Bao, X., Wang, Z., Fu, D., Shi, C., Iglesias, G., Cui, H. and Sun, Z. (2022) *Machine learning methods for damage detection of thermoplastic composite pipes under noise conditions*, Ocean Engineering, 248, 110817.

33. Barnes, P.W., Robson, T.M., Neale, P.J., Williamson, C.E., Zepp, R.G., Madronich, S., Wilson, S.R., Andrady, A.L., Heikkilä, A.M., Bernhard, G.H., Bais, A.F., Neale, R.E., Bornman, J.F., Jansen, M.A.K., Klekociuk, A.R., Martínez-Abaigar, J., Robinson, S.A., Wang, Q.-W., Banaszak, A.T., Häder, D.-P., Hylander, S., Rose, K.C., Wängberg, S.-Å., Foereid, B., Hou, W.-C., Ossola, R., Paul, N.D., Ukpebor, J.E., Andersen, M.P.S., Longstreth, J., Schikowski, T., Solomon, K.R., Sulzberger, B., Bruckman, L.S., Pandey, K.K., White, C.C., Zhu, L., Zhu, M., Aucamp, P.J., Liley, J.B., McKenzie, R.L., Berwick, M., Byrne, S.N., Hollestein, L.M., Lucas, R.M., Olsen, C.M., Rhodes, L.E., Yazar, S. and Young, A.R. (2022) *Environmental effects of stratospheric ozone depletion, UV radiation, and interactions with climate change: UNEP Environmental Effects Assessment Panel, Update 2021*, Photochemical and Photobiological Sciences, 21 (3) 275-301.
34. Basurrah, A.A., Di Blasi, Z., Lambert, L., Murphy, M., Warren, M.A., Setti, A., Al-Haj Baddar, M. and Shrestha, T. (2022) *The effects of positive psychology interventions in Arab countries: A systematic review*, Applied Psychology: Health and Well-Being, online.
35. Bell, J.J., Micaroni, V. and Strano, F. (2022) *Global status, impacts, and management of rocky temperate mesophotic ecosystems*, Conservation Biology, online, e13945.
36. Bell, J.J., Micaroni, V., Harris, B., Strano, F., Broadribb, M. and Rogers, A. (2022) *Regime shifts on tropical coral reef ecosystems: Future trajectories to animal-dominated states in response to anthropogenic stressors*, Emerging Topics in Life Sciences, 6 (1) 95-106.
37. Bell, S., Boyle, E., Canton, J., Khan, Z., Quinn, R., Rollason, E., Tully, K., Ward, S. and Xavier, P. (2022) *Establishing a statement of principles for community engagement with civil engineering*, Proceedings of the Institution of Civil Engineers: Civil Engineering, 175 (3) 133-140.
38. Belvasi, N., Conan, B., Schliffke, B., Perret, L., Desmond, C., Murphy, J. and Aubrun, S. (2022) *Far-Wake Meandering of a Wind Turbine Model with Imposed Motions: An Experimental S-PIV Analysis*, Energies, 15 (20) 7757.
39. Belvasi, N., Judge, F., Murphy, J. and Desmond, C. (2022) *Analysis of Floating Offshore Wind Platform Hydrodynamics Using Underwater SPIV: A Review*, Energies, 15 (13) 4641.
40. Ben Massoud, M., Kharbech, O., Mahjoubi, Y., Chaoui, A. and Winkler, A. (2022) *Effect of Exogenous Treatment with Nitric Oxide (NO) on Redox Homeostasis in Barley Seedlings (Hordeum vulgare L.) Under Copper Stress*, Journal of Soil Science and Plant Nutrition, 22 (2) 1604-1617.
41. Bennison, A., Giménez, J., Quinn, J.L., Green, J.A. and Jessopp, M. (2022) *A bioenergetics approach to understanding sex differences in the foraging behaviour of a sexually monomorphic species*, Royal Society Open Science, 9 (1) 210520.
42. Bergillos, R.J., Rodriguez-Delgado, C., Medina, L., Fernandez-Ruiz, J., Rodriguez-Ortiz, J.M. and Iglesias, G. (2022) *A combined approach to cliff characterization: Cliff Stability index*, Marine Geology, 444, 106706.
43. Bertacchi, S., Jayaprakash, P., Morrissey, J.P. and Branduardi, P. (2022) *Interdependence between lignocellulosic biomasses, enzymatic hydrolysis and yeast cell factories in biorefineries*, Microbial Biotechnology, 15 (3) 985-995.
44. Binner, H., Kamali, N., Harding, M. and Sullivan, T. (2022) *Characteristics of wastewater originating from dental practices using predominantly mercury-free dental materials*, Science of the Total Environment, 814, 152632.
45. Binner, H., Sullivan, T., Jansen, M.A.K., McNamara, M.E., 2022. *Metals in urban soils of Europe: A systematic review*. Science of the Total Environment, 854, 158734
46. Booth, C.G., Brannan, N., Dunlop, R., Friedlander, A., Isojunno, S., Miller, P., Quick, N., Southall, B. and Pirotta, E. (2022) *A sampling, exposure and receptor framework for identifying factors that modulate behavioural responses to disturbance in cetaceans*, Journal of Animal Ecology, 91 (10) 1948-1960.
47. Bose, A., O'Shea, R., Lin, R., Long, A., Rajendran, K., Wall, D., De, S. and Murphy, J.D. (2022) *The marginal abatement cost of co-producing biomethane, food and biofertiliser in a circular economy system*, Renewable and Sustainable Energy Reviews, 169, 112946.
48. Bose, A., O'Shea, R., Lin, R., Long, A., Rajendran, K., Wall, D., De, S. and Murphy, J.D. (2022) *Optimisation and performance prediction of photosynthetic biogas upgrading using a bubble column*, Chemical Engineering Journal, 437, 134988.
49. Bose, A., O'Shea, R., Lin, R., Long, A., Rajendran, K., Wall, D., De, S. and Murphy, J.D. (2022) *Evaluation of a biomethane, food and biofertiliser polygeneration system in a circular economy system*, Renewable and Sustainable Energy Reviews, 170, 112960.
50. Boyle, E., Galvin, M., Revez, A., Deane, A., Ó Gallachóir, B. and Mullally, G. (2022) *Flexibility & structure: Community engagement on climate action & large infrastructure delivery*, Energy Policy, 167, 113050.
51. Boyle, E., Ó Gallachóir, B. and Mullally, G. (2022) *Participatory network mapping of an emergent social network for a regional transition to a low-carbon and just society on the Dingle Peninsula*, Local Environment, 27 (12) 1431-1445.
52. Brennan, M., Hennessy, T., Dillon, E. and Meredith, D. (2022) *Putting social into agricultural sustainability: Integrating assessments of quality of life and wellbeing into farm sustainability indicators*, Sociologia Ruralis, online, 1-32.
53. Brennan, M., Hennessy, T., Meredith, D. and Dillon, E. (2022) *Weather, Workload and Money: Determining and Evaluating Sources of Stress for Farmers in Ireland*, Journal of Agromedicine, 27 (2) 132-142.
54. Brinkerink, M., Zakeri, B., Huppmann, D., Glynn, J., Ó Gallachóir, B. and Deane, P. (2022) *Assessing global climate change mitigation scenarios from a power system perspective using a novel multi-model framework*, Environmental Modelling and Software, 150, 105336.
55. Burke, R., Sherwood, O.L., Clune, S., Carroll, R., McCabe, P.F., Kane, A. and Kacprzyk, J. (2022) *Botanical boom: A new opportunity to promote the public appreciation of botany*, Plants People Planet, 4 (4) 326-334.
56. Burslem, A., Isojunno, S., Pirotta, E. and Miller, P.J.O. (2022) *Modelling the impact of condition-dependent responses and lipid-store availability on the consequences of disturbance in a cetacean*, Conservation Physiology, 10 (1) coac069.
57. Byrne, E., Keohane, K., Revez, A., Boyle, E., McGookin, C., Dunphy, N., O'Neill, C., Harris, C., Hughes, I., Sage, C., Barry, J., Ó Gallachóir, B. and Mullally, G. (2022) *Engineering with Social Sciences and Humanities; Necessary Partnerships in Facing Contemporary (Un) Sustainability Challenges?*, Philosophy of Engineering and Technology, 42, 375-393.
58. Byrne, E.P. and Mullally, G. (2022) *Educating engineers to embrace complexity and context*, Proceedings of the Institution of Civil Engineers: Engineering Sustainability, 167 (6) 241-248.
59. Cabral, D., Fonseca, S.C., Moura, A.P., Oliveira, J.C. and Cunha, L.M. (2022) *Conceptualization of Rice with Low Glycaemic Index: Perspectives from the Major European Consumers*, Foods, 11 (14) 2172.
60. Canwat, V. and Onakuse, S. (2022) *Organic agriculture: A fountain of alternative innovations for social, economic, and environmental challenges of conventional agriculture in a developing country context*, Cleaner and Circular Bioeconomy, 3, 100025.
61. Canwat, V. and Onakuse, S. (2022) *Table banking plus certified organic agriculture: an integrated microfinance approach to sustainable livelihoods*, Journal of Development Effectiveness, online.
62. Carmody, P.R. and Murphy, J.T. (2022) *Chinese neoglobalization in East Africa: logics, couplings and impacts*, Space and Polity, 26 (1) 20-43.
63. Carr, C.M., de Oliveira, B.F.R., Jackson, S.A., Laport, M.S., Clarke, D.J. and Dobson, A.D.W. (2022) *Identification of BgP, a Cutinase-Like Polyesterase From a Deep-Sea Sponge-Derived Actinobacterium*, Frontiers in Microbiology, 13, 888343.
64. Carter, M.I.D., Boehme, L., Cronin, M.A., Duck, C.D., Grecian, W.J., Hastie, G.D., Jessopp, M., Matthiopoulos, J., McConnell, B.J., Miller, D.L., Morris, C.D., Moss, S.E.W., Thompson, D., Thompson, P.M. and Russell, D.J.F. (2022) *Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management*, Frontiers in Marine Science, 9, 875869.
65. Casaban, D. and Tsalaporta, E. (2022) *Direct air capture of CO2 in the Republic of Ireland. Is it necessary?*, Energy Reports, 8, 10449-10463.
66. Casaban, D., Ritchie, S. and Tsalaporta, E. (2022) *The impact of Direct Air Capture during the last two decades: A bibliometric analysis of the scientific research, part I*, Sustainable Chemistry for Climate Action, 1, 100009.
67. Casey, É., Holmes, J.D. and Collins, G. (2022) *PdAu Nanosheets for Visible-Light-Driven Suzuki Cross-Coupling Reactions*, ACS Applied Nano Materials, 5 (11) 16196-16206.
68. Cassarino, M., Cronin, Ú., Robinson, K., Quinn, R., Boland, F., Ward, M.E., McNamara, R., O'Connor, M., McCarthy, G., Ryan, D. and Galvin, R. (2022) *Development and delivery of an allied health team intervention for older adults in the emergency department: A process evaluation*, PLoS ONE, 17 (45051) e0269117.
69. Cele, L.P., Hennessy, T. and Thorne, F. (2022) *Evaluating farm and export competitiveness of the Irish dairy industry: post-quota analysis*, Competitiveness Review, 32 (7) 1-20.
70. Cele, L.P., Hennessy, T. and Thorne, F. (2022) *Regional technical efficiency rankings and their determinants in the Irish dairy industry: A stochastic meta-frontier analysis*, Agribusiness, online, 1-17.

71. Chapman, D.V. and Sullivan, T. (2022) *The role of water quality monitoring in the sustainable use of ambient waters*, *One Earth*, 5 (2) 132-137.
72. Chaudhary, E., Dey, S., Ghosh, S., Sharma, S., Singh, N., Agarwal, S., Tibrewal, K., Venkataraman, C., Kurpad, A.V., Cohen, A.J., Wang, S. and Jain, S. (2022) *Reducing the burden of anaemia in Indian women of reproductive age with clean-air targets*, *Nature Sustainability*, 5 (11) 939-946.
73. Cheung, G., Chai, Y., Troya, M.I. and Luo, H. (2022) *Predictive factors of nonfatal self-harm among community-dwelling older adults assessed for support services*, *International Psychogeriatrics*, 34 (9) 813-826.
74. Chitteth Ramachandran, R., Desmond, C., Judge, F., Serraris, J.-J. and Murphy, J. (2022) *Floating wind turbines: marine operations challenges and opportunities*, *Wind Energy Science*, 7 (2) 903-924.
75. Cincotta, A., Nicolai, M., Campos, H.B.N., McNamara, M., D'Alba, L., Shawkey, M.D., Kischlat, E.-E., Yans, J., Carleer, R., Escuillie, F. and Godefroit, P. (2022) *Pterosaur melanosomes support signalling functions for early feathers*, *Nature*, 604 (7907) 684-688.
76. Clancy, R., Bruton, K., O'Sullivan, D. and Cloonan, A.J. (2022) *The HyDAPI framework: a versatile tool integrating Lean Six Sigma and digitalisation for improved quality management in Industry 4.0*, *International Journal of Lean Six Sigma*, online.
77. Clancy, R., Bruton, K., O'Sullivan, D. and Keogh, D. (2022) *Industry 4.0 driven statistical analysis of investment casting process demonstrates the value of digitalisation*, *Procedia Computer Science*, 200, 284-297.
78. Clements, T., Atterby, J., Cleary, T., Dearden, R.P. and Rossi, V. (2022) *The perception of palaeontology in commercial off-the-shelf video games and an assessment of their potential as educational tools*, *Geoscience Communication*, 5 (3) 289-306.
79. Collins, C. and O'Riordan, R. (2022) *Data triangulation confirms learning in the zoo environment*, *Environmental Education Research*, 28 (2) 295-317.
80. Coomes, J.R., Davidson, G.L., Reichert, M.S., Kulahci, I.G., Troisi, C.A. and Quinn, J.L. (2022) *Inhibitory control, exploration behaviour and manipulated ecological context are associated with foraging flexibility in the great tit*, *Journal of Animal Ecology*, 91 (2) 320-333.
81. Coral-Medina, A., Fenton, D.A., Varela, J., Baranov, P.V., Camarasa, C. and Morrissey, J.P. (2022) *The evolution and role of the periplasmic asparaginase Asp3 in yeast*, *FEMS yeast research*, 22 (1) .
82. Cosgrave, M., Moore, E. and Storey-Cosgrave, A. (2022) *Narrative Games in BioAnalytic Forensics*, *Proceedings of the European Conference on Games-based Learning*, 2022-October, 172-179.
83. Costello, K.E., Lynch, S.A., McAllen, R., O'Riordan, R.M. and Culloty, S.C. (2022) *Assessing the potential for invasive species introductions and secondary spread using vessel movements in maritime ports*, *Marine Pollution Bulletin*, 177, 113496.
84. Coughlan, N.E., Armstrong, F., Baker-Arney, C., Crane, K., Cuthbert, R.N., Jansen, M.A.K., Kregting, L., Vong, G.Y.W. and Dick, J.T.A. (2022) *Retention of viability by fragmented invasive *Crassula helmsii*, *Elodea canadensis* and *Lagarosiphon major**, *River Research and Applications*, 38 (8) 1356-1361.
85. Coughlan, N.E., Dickey, J.W.E., Dick, J.T.A., Médoc, V., McCard, M., Lacroix, G., Fiorini, S., Millot, A. and Cuthbert, R.N. (2022) *When worlds collide: Invader-driven benthic habitat complexity alters predatory impacts of invasive and native predatory fishes*, *Science of the Total Environment*, 843, 156876.
86. Coughlan, N.E., O'Shea, W., Cuthbert, R.N., Kelly, T.C., Mitham, N. and Nicholson, J. (2022) *The fox in the box: Acoustic deterrent and simulated predator disturbance to reduce problematic bird accumulations*, *Wildlife Research*, online.
87. Coughlan, N.E., Walsh, É., Ahern, R., Burnell, G., O'Mahoney, R., Kuehnhold, H. and Jansen, M.A.K. (2022) *Flow Rate and Water Depth Alters Biomass Production and Phytoremediation Capacity of *Lemna minor**, *Plants*, 11 (16) 2170.
88. Coughlan, N.E., Walsh, É., Bolger, P., Burnell, G., O'Leary, N., O'Mahoney, M., Paolacci, S., Wall, D. and Jansen, M.A.K. (2022) *Duckweed bioreactors: Challenges and opportunities for large-scale indoor cultivation of *Lemnaceae**, *Journal of Cleaner Production*, 336, 130285.
89. Crane, K., Cuthbert, R.N., Coughlan, N.E., Kregting, L., Reid, N., Ricciardi, A., Macisaac, H.J. and Dick, J.T.A. (2022) *No time to dye: dye-induced light differences mediate growth rates among invasive macrophytes*, *Management of Biological Invasions*, 13 (2) 288-302.
90. Crane, K., Kregting, L., Coughlan, N.E., Cuthbert, R.N., Ricciardi, A., MacIsaac, H.J., Dick, J.T.A. and Reid, N. (2022) *Abiotic and biotic correlates of the occurrence, extent and cover of invasive aquatic *Elodea nuttallii**, *Freshwater Biology*, 67 (9) 1559-1570.
91. Creane, S., Coughlan, M., O'Shea, M. and Murphy, J. (2022) *Development and Dynamics of Sediment Waves in a Complex Morphological and Tidal Dominant System: Southern Irish Sea*, *Geosciences (Switzerland)*, 12 (12) 431.
92. Cullinane, M., Judge, F., O'Shea, M., Thandayutham, K. and Murphy, J. (2022) *Subsea superconductors: The future of offshore renewable energy transmission?*, *Renewable and Sustainable Energy Reviews*, 156, 111943.
93. Dalla Pria, C., Cawkwell, F., Newton, S., and Holloway, P. (2022) *City Living: Nest-Site Selection Preferences in Urban Herring Gulls, *Larus argentatus**, *Geographies*, 2 (2) 161-172.
94. Daly, A. (2022) *Climate Competence: Youth Climate Activism and Its Impact on International Human Rights Law*, *Human Rights Law Review*, 22 (2) ngac011.
95. Daly, A., Stern, R.T. and Leviner, P. (2022) *UN Convention on the Rights of the Child, Article 2 and Discrimination on the Basis of Childhood*, *Nordic Journal of International Law*, 91 (3) 419-452.
96. Darby, J., Clairbaux, M., Bennison, A., Quinn, J.L. and Jessopp, M.J. (2022) *Underwater visibility constrains the foraging behaviour of a diving pelagic seabird*, *Proceedings of the Royal Society B: Biological Sciences*, 289 (1978) 20220862.
97. Darby, J.H., Harris, M.P., Wanless, S., Quinn, J.L., Bråthen, V.S., Fayet, A.L., Clairbaux, M., Hart, T., Guilford, T., Freeman, R. and Jessopp, M.J. (2022) *A new biologging approach reveals unique flightless molt strategies of Atlantic puffins*, *Ecology and Evolution*, 12 (12) e95719.
98. Davidson, G.L., Reichert, M.S., Coomes, J.R., Kulahci, I.G., de la Hera, I. and Quinn, J.L. (2022) *Inhibitory control performance is repeatable over time and across contexts in a wild bird population*, *Animal Behaviour*, 187, 305-318.
99. Davitt, F., Rahme, K., Raha, S., Garvey, S., Roldan-Gutierrez, M., Singha, A., Chang, S.L.Y., Biswas, S. and Holmes, J.D. (2022) *Solution phase growth and analysis of super-thin zigzag tin selenide nanoribbons*, *Nanotechnology*, 33 (13) 135601.
100. de Eyto, E., Kelly, S., Rogan, G., French, A., Cooney, J., Murphy, M., Nixon, P., Hughes, P., Sweeney, D., McGinnity, P., Dillane, M. and Poole, R. (2022) *Decadal Trends in the Migration Phenology of *Diadromous Fishes Native to the Burrishoole Catchment, Ireland**, *Frontiers in Ecology and Evolution*, 10, 915854.
101. de la Hera, I. and Reichert, M.S. (2022) *No Indication of Background Color Matching in a Population of the Brown-Green Polymorphic Admirable Grasshopper (*Syrbula admirabilis*)*, *Journal of Insect Behavior*, 35 (4) 114-126.
102. de la Hera, I., Reichert, M.S., Davidson, G.L. and Quinn, J.L. (2022) *A longitudinal analysis of the growth rate and mass of tail feathers in a great tit population: ontogeny, genetic effects and relationship between both traits*, *Journal of Avian Biology*, 2022 (5) e02894.
103. De Noia, M., Poole, R., Kaufmann, J., Waters, C., Adams, C., McGinnity, P. and Llewellyn, M. (2022) *Towards an in situ non-lethal rapid test to accurately detect the presence of the nematode parasite, *Anguillicoloides crassus*, in European eel, *Anguilla anguilla**, *Parasitology*, 149 (5) 605-611.
104. de Oliveira, L.M.C., Lim, A., Conti, L.A. and Wheeler, A.J. (2022) *High-resolution 3D mapping of cold-water coral reefs using machine learning*, *Frontiers in Environmental Science*, 10, 1044706.
105. de Oliveira, L.M.C., Oliveira, P.A.D., Lim, A., Wheeler, A.J. and Conti, L.A. (2022) *Developing Mobile Applications with Augmented Reality and 3D Photogrammetry for Visualisation of Cold-Water Coral Reefs and Deep-Water Habitats*, *Geosciences (Switzerland)*, 12 (10) 356.
106. Deng, C., Lin, R., Kang, X., Wu, B., David, W. and Murphy, J.D. (2022) *Improvement in biohydrogen and volatile fatty acid production from seaweed through addition of conductive carbon materials depends on the properties of the conductive materials*, *Energy*, 239, 122188.
107. Deng, C., Lin, R., Kang, X., Wu, B., Ning, X., Wall, D. and Murphy, J.D. (2022) *Co-production of hydrochar, levulinic acid and value-added chemicals by microwave-assisted hydrothermal carbonization of seaweed*, *Chemical Engineering Journal*, 441, 135915.
108. Deng, S., Li, X., Morrison, A., Chen, M., Deng, H., Teng, C., Liu, H., Xu, R., Cheng, Y. and Yuan, L. (2022) *Design and Analysis of a Photon Counting System Using Covered Single-Photon Avalanche Photodiode*, *IEEE Transactions on Instrumentation and Measurement*, 71, 7002409.
109. Díez, A.R., Duque, P. and Henriques, R. (2022) *Assessing Abscisic Acid-Mediated Changes in Stomatal Aperture Through High-Quality Leaf Impressions*, *Methods in Molecular Biology*, 2494, 217-227.

110. Dillane, E., Hayden, R., O'Hanlon, A., Butler, F. and Harrison, S. (2022) *The first recorded occurrence of the Asian hornet (Vespa velutina) in Ireland, genetic evidence for a continued single invasion across Europe*, Journal of Hymenoptera Research, 93, 131-138.
111. Dixneuf, S., Ruth, A.A., Häselser, R., Brauers, T., Rohrer, F. and Dorn, H.-P. (2022) *Detection of nitrous acid in the atmospheric simulation chamber SAPHIR using open-path incoherent broadband cavity-enhanced absorption spectroscopy and extractive long-path absorption photometry*, Atmospheric Measurement Techniques, 15 (4) 945-964.
112. Djojoseparto, S.K., Kamphuis, C.B.M., Harrington, J.M., Løvhaug, A.L., Roos, G., Sawyer, A.D.M., Stronks, K., Terragni, L., Torheim, L.E., Vandevijvere, S., Poelman, M.P. and van Lenthe, F.J. (2022) *How theory can help to understand the potential impact of food environment policies on socioeconomic inequalities in diet: an application of Bourdieu's capital theory and the scarcity theory*, European journal of public health, 32 (4) iv66-iv70.
113. Djojoseparto, S.K., Kamphuis, C.B.M., Vandevijvere, S., Murrin, C., Stanley, I., Romaniuk, P., Harrington, J.M. and Poelman, M.P. (2022) *Strength of EU-level food environment policies and priority recommendations to create healthy food environments*, European Journal of Public Health, 32 (3) 504-511.
114. Dokur, E., Erdogan, N., Salari, M.E., Karakuzu, C. and Murphy, J. (2022) *Offshore wind speed short-term forecasting based on a hybrid method: Swarm decomposition and meta-extreme learning machine*, Energy, 248, 123595.
115. Domenzain, I., Sánchez, B., Anton, M., Kerkhoven, E.J., Millán-Oropeza, A., Henry, C., Siewers, V., Morrissey, J.P., Sonnenschein, N. and Nielsen, J. (2022) *Reconstruction of a catalogue of genome-scale metabolic models with enzymatic constraints using GECKO 2.0*, Nature Communications, 13 (1) 3766.
116. Donkor, E., Onakuse, S., Bogue, J. and de los Rios Carmenado, I. (2022) *Income inequality and distribution patterns in the cassava value chain in the Oyo State, Nigeria: a gender perspective*, British Food Journal, 124 (13) 254-273.
117. Donkor, K.O., Gottumukkala, L.D., Lin, R. and Murphy, J.D. (2022) *A perspective on the combination of alkali pre-treatment with bioaugmentation to improve biogas production from lignocellulose biomass*, Bioresource Technology, 351, 126950.
118. Dunphy, N.P. and Lennon, B. (2022) *Whose transition? A Review of Citizen Participation in the Energy System*. In: Araujo, K. (Editor), The Handbook of Energy Transitions, Routledge, London, Chapter 26.
119. Dyar, O.J., Haglund, B.J.A., Melder, C., Skillington, T., Kristenson, M. and Sarkadi, A. (2022) *Rainbows over the world's public health: determinants of health models in the past, present, and future*, Scandinavian Journal of Public Health, 50 (7) 1047-1058.
120. Eakins, J., Sirr, G., and Power, B (2022). *An Examination of the Extent and Characteristics of the Non-Traded Residential Solid Fuel Market in Ireland*. 3rd International Conference on Energy Research & Social Science. Manchester. June 2022.
121. Egerton, S., Donoso, F., Fitzgerald, P., Gite, S., Fouhy, F., Whooley, J., Dinan, T.G., Cryan, J.F., Culloty, S.C., Ross, R.P. and Stanton, C. (2022) *Investigating the potential of fish oil as a nutraceutical in an animal model of early life stress*, Nutritional Neuroscience, 25 (2) 356-378.
122. Erdogan, N., Kucuksari, S. and Murphy, J. (2022) *A multi-objective optimization model for EVSE deployment at workplaces with smart charging strategies and scheduling policies*, Energy, 254, 124161.
123. Ewlad-Ahmed, A.M., Morris, M., Holmes, J., Belton, D.J., Patwardhan, S.V. and Gibson, L.T. (2022) *Green Nanosilicas for Monoaromatic Hydrocarbons Removal from Air*, Silicon, 14 (4) 1447-1454.
124. Falk, D., Wings, O. and McNamara, M.E. (2022) *The skeletal taphonomy of anurans from the Eocene Geiseltal Konservat-Lagerstätte, Germany: insights into the controls on fossil anuran preservation*, Papers in Palaeontology, 8 (4) e1453.
125. Fawsitt, F., Dockray, S. and Setti, A. (2022) *Regulatory focus and perceptions of ageing: exploring the connections*, Aging and Mental Health, 26 (7) 1451-1459.
126. Fennelly, M., Gallagher, C., Harding, M., Hellebust, S., Wenger, J., O'Sullivan, N., O'Connor, D. and Prentice, M. (2022) *Real-time Monitoring of Aerosol Generating Dental Procedures*, Journal of Dentistry, 120, 104092.
127. Fenton, D.A., Kiniry, S.J., Yordanova, M.M., Baranov, P.V. and Morrissey, J.P. (2022) *Development of a ribosome profiling protocol to study translation in Kluyveromyces marxianus*, FEMS Yeast Research, 22 (1) foac024.
128. Fielding, C.R., Frank, T.D., Savatic, K., Mays, C., McLoughlin, S., Vajda, V. and Nicoll, R.S. (2022) *Environmental change in the late Permian of Queensland, NE Australia: The warmup to the end-Permian Extinction*, Palaeogeography, Palaeoclimatology, Palaeoecology, 594, 110936.
129. Fitzgerald, M., Lynch, S.A. and Jessopp, M. (2022) *Breeding stage impacts on chronic stress and physiological condition in northern gannets (Morus bassanus)*, Comparative Biochemistry and Physiology -Part A : Molecular and Integrative Physiology, 274, 111305.
130. Flannery, C., Dennehy, R., Riordan, F., Cronin, F., Moriarty, E., Turvey, S., O'Connor, K., Barry, P., Jonsson, A., Duggan, E., O'Sullivan, L., O'Reilly, E., Sinnott, S.-J. and McHugh, S. (2022) *Enhancing referral processes within an integrated fall prevention pathway for older people: A mixed-methods study*, BMJ Open, 12 (8) e056182.
131. Fletcher, P.A., Worthen, D.L., Mcsweeney-Feld, M.H., Gibson, A., Seblova, D., Pagán, L., Troya, M.I., Fang, M.L., Owusu, B., Lane, C., Wada, M., Harrell, E.R. and Viana, A. (2022) *Rural Older Adults in Disasters: A Study of Recovery from Hurricane Michael*, Disaster Medicine and Public Health Preparedness, 16 (6) 2602-2606.
132. Foulds, C., Royston, S., Berker, T., Nakopoulou, E., Bharucha, Z.P., Robison, R., Abram, S., Ančić, B., Arapostathis, S., Badescu, G., Bull, R., Cohen, J., Dunlop, T., Dunphy, N., Dupont, C., Fischer, C., Gram-Hanssen, K., Grandclément, C., Heiskanen, E., Labanca, N., Jeliakzova, M., Jörgens, H., Keller, M., Kern, F., Lombardi, P., Mourik, R., Ornetzeder, M., Pearson, P.J.G., Rohrer, H., Sahakian, M., Sari, R., Standal, K. and Živčić, L. (2022) *An agenda for future Social Sciences and Humanities research on energy efficiency: 100 priority research questions*, Humanities and Social Sciences Communications, 9 (1) 223.
133. Fouz, D.M., Carballo, R., López, I. and Iglesias, G. (2022) *A holistic methodology for hydrokinetic energy site selection*, Applied Energy, 317, 119155.
134. Fouz, D.M., Carballo, R., López, I. and Iglesias, G. (2022) *Tidal stream energy potential in the Shannon Estuary*, Renewable Energy, 185, 61-74.
135. Furnes, H., Dilek, Y. and Kiseeva, E.S. (2022) *Chalcophile element (Cu, Zn, Pb) and Ga distribution patterns in ancient and modern oceanic crust and their sources: Petrogenetic modelling and a global synthesis*, Gondwana Research, 109, 394-415.
136. Garcia, A., Biswas, S., McNulty, D., Roy, A., Raha, S., Trabesinger, S., Nicolosi, V., Singha, A. and Holmes, J.D. (2022) *One-Step Grown Carbonaceous Germanium Nanowires and Their Application as Highly Efficient Lithium-Ion Battery Anodes*, ACS Applied Energy Materials, 5 (2) 1922-1932.
137. Garcia-Gil, A., Biswas, S., McNulty, D., Roy, A., Ryan, K.M., Nicolosi, V. and Holmes, J.D. (2022) *High Aspect-ratio Germanium-Tin Alloy Nanowires: Potential as Highly Efficient Li-Ion Battery Anodes*, Advanced Materials Interfaces, 9 (29) 2201170.
138. Garcia-Gil, A., Biswas, S., Roy, A., Saladukh, D., Raha, S., Blon, T., Conroy, M., Nicolosi, V., Singha, A., Lacroix, L.-M. and Holmes, J.D. (2022) *Growth and analysis of the tetragonal (ST12) germanium nanowires*, Nanoscale, 14 (5) 2030-2040.
139. Gargari, N.S., Panahi, R., Akbari, H. and Ng, A.K.Y. (2022) *Long-Term Traffic Forecast Using Neural Network and Seasonal Autoregressive Integrated Moving Average: Case of a Container Port*, Transportation Research Record, 2676 (8) 236-252.
140. Garvey, S., Serino, A., Maccioni, M.B., Holmes, J.D., Nolan, M., Draeger, N., Gurer, E. and Long, B. (2022) *Towards Ge-based electronic devices: Increased longevity of alkanethiol-passivated Ge(100) in low humidity environments*, Thin Solid Films, 759, 139466.
141. Gaur, A.S., Fitiwi, D.Z., Lynch, M. and Longoria, G. (2022) *Implications of heating sector electrification on the Irish power system in view of the Climate Action Plan*, Energy Policy, 168, 113136.
142. Gerstner, R.M., Narváez, F., Leske, S., Troya, M.I., Analuisa-Aguilar, P., Spittal, M.J. and Gunnell, D. (2022) *Police-reported suicides during the first 16 months of the COVID-19 pandemic in Ecuador: A time-series analysis of trends and risk factors until June 2021*, The Lancet Regional Health - Americas, 14, 100324.
143. Gray, N., O'Shea, R., Smyth, B., Lens, P.N.L. and Murphy, J.D. (2022) *What is the energy balance of electrofuels produced through power-to-fuel integration with biogas facilities?*, Renewable and Sustainable Energy Reviews, 155, 111886.
144. Gray, N., O'Shea, R., Wall, D., Smyth, B., Lens, P.N.L. and Murphy, J.D. (2022) *Batteries, fuel cells, or engines? A probabilistic economic and environmental assessment of electricity and electrofuels for heavy goods vehicles*, Advances in Applied Energy, 8, 100110.
145. Gries, T. and Naudé, W. (2022) *Modelling artificial intelligence in economics*, Journal for Labour Market Research, 56 (1) 12.
146. Gueydon, S., Lyden, E., Judge, F., O'Shea, M. and Murphy, J. (2022) *Looking for a simplified approach for the propagation of systematic uncertainty in the motion response of a floater*, Journal of Physics: Conference Series, 2362 (1) 12015.
147. Günther, B., Jourdain, E., Rubincam, L., Karoliussen, R., Cox, S.L. and Arnaud Haond, S. (2022) *Feces DNA analyses track the rehabilitation of a free-ranging beluga whale*, Scientific Reports, 12 (1) 6412.

148. Gwanyanya, A., Godsmark, C.N. and Kelly-Laubscher, R. (2022) *Ethanolamine: A Potential Promoiety with Additional Effects on the Brain, CNS and Neurological Disorders - Drug Targets*, 21 (2) 108-117.
149. Gyurchev, N.Y., Coral-Medina, Á., Weening, S.M., Almayouf, S., Kuijpers, N.G.A., Nevoigt, E. and Louis, E.J. (2022) *Beyond Saccharomyces pastorianus for modern lager brews: Exploring non-cerevisiae Saccharomyces hybrids with heterotic maltotriose consumption and novel aroma profile*, *Frontiers in Microbiology*, 13, 1025132.
150. Hadfield, J.D. and Reed, T.E. (2022) *Directional selection and the evolution of breeding date in birds, revisited: Hard selection and the evolution of plasticity*, *Evolution Letters*, 6 (2) 178-188.
151. Hand, B.P., Erdogan, N., Murray, D., Cronin, P., Doran, J. and Murphy, J. (2022) *Experimental testing on the influence of shaft rotary lip seal misalignment for a marine hydro-kinetic turbine*, *Sustainable Energy Technologies and Assessments*, 50, 101874.
152. Hardiman, A. (2022) *Seeking to Deliver Renewable Energy Infrastructure within an Incomplete and Vague' Legal Framework*, *Carbon and Climate Law Review*, 16 (3) 192-204.
153. Harding, L., Gallagher, A., Jackson, A., Bortoluzzi, J., Dolton, H.R., Shea, B., Harman, L., Edwards, D. and Payne, N. (2022) *Capture heats up sharks*, *Conservation Physiology*, 10 (1) coac065.
154. Harmon O'Driscoll, J., Siggins, A., Healy, M.G., McGinley, J., Mellander, P.-E., Morrison, L. and Ryan, P.C. (2022) *A risk ranking of pesticides in Irish drinking water considering chronic health effects*, *Science of The Total Environment*, 829, 154532.
155. Hashim H., Clifford E., and Ryan, P.C. (2022) *False alarm moderation for performance monitoring in industrial water distribution systems*, *Advanced Engineering Informatics*, 52, 101592.
156. Hayes, S., Lim, M., Whalen, D., Mann, P.J., Fraser, P., Penlington, R. and Martin, J. (2022) *The Role of Massive Ice and Exposed Headwall Properties on Retrogressive Thaw Slump Activity*, *Journal of Geophysical Research: Earth Surface*, 127 (11) e2022JF006602.
157. Helbig, M., Živković, T., Alekseychik, P., Aurela, M., El-Madany, T.S., Euskirchen, E.S., Flanagan, L.B., Griffis, T.J., Hanson, P.J., Hattakka, J., Helfter, C., Hirano, T., Humphreys, E.R., Kiely, G., Kolka, R.K., Laurila, T., Leahy, P.G., Lohila, A., Mammarella, I., Nilsson, M.B., Panov, A., Parmentier, F.J.W., Peichl, M., Rinne, J., Roman, D.T., Sonnentag, O., Tuittila, E.-S., Ueyama, M., Vesala, T., Vestin, P., Weldon, S., Weslien, P. and Zaehle, S. (2022) *Warming response of peatland CO₂ sink is sensitive to seasonality in warming trends*, *Nature Climate Change*, 12 (8) 743-749.
158. Henchion, M., McCarthy, M., Zimmermann, J. and Troy, D.J. (2022) *International comparisons, domestic influences and where to next? The case of Irish meat consumption*, *Meat Science*, 193, 108921.
159. Henriques, R., Calderan-Rodrigues, M.J., Luis Crespo, J., Baena-González, E. and Caldana, C. (2022) *Growing of the TOR world*, *Journal of Experimental Botany* 73(20), 6987-6992.
160. Hickey, A., Merz, J., Al Mamari, H.H., Friedrich, A., Marder, T.B. and McGlacken, G.P. (2022) *Iridium-Catalyzed Borylation of 6-Fluoroquinolines: Access to 6-Fluoroquinolones*, *Journal of Organic Chemistry*, 87 (15) 9977-9987.
161. Hill, M. and Duffy, A. (2022) *A Digital Support Platform for Community Energy: One-Stop-Shop Architecture, Development and Evaluation*, *Energies*, 15 (13) 4763.
162. Hin, R.C., Hibbert, K.E.J., Chen, S., Willbold, M., Andersen, M.B., Kiseeva, E.S., Wood, B.J., Niu, Y., Sims, K.W.W. and Elliott, T. (2022) *The influence of crustal recycling on the molybdenum isotope composition of the Earth's mantle*, *Earth and Planetary Science Letters*, 595, 117760.
163. Hirst, R.J., Cassarino, M., Kenny, R.A., Newell, F.N. and Setti, A. (2022) *Urban and rural environments differentially shape multisensory perception in ageing*, *Aging, Neuropsychology, and Cognition*, 29 (2) 197-212.
164. Hlrdzi, V., Tan, B., Dong, X., Zhang, S., Zhu, L., Zhang, L., Hu, X. and Chi, S. (2022) *Enzymatic Chicken Pulp Promotes Appetite, Digestive Enzyme Activity, and Growth in Litopenaeus vannamei*, *Metabolites*, 12 (8) 698.
165. Hlrdzi, V., Wang, J., Kuebutornye, F.K.A., Yang, X., Tan, B., Li, T., Cui, Z., Lv, S., Lao, T. and Shuyan, C. (2022) *Hydrolysed fish protein powder is better at the growth performance, hepatopancreas and intestinal development of Pacific white shrimp (Litopenaeus vannamei)*, *Aquaculture Reports*, 23, 101025.
166. Hlrdzi, V., Wang, J., Li, T., Cui, Z., Tan, B., Liu, H., Yang, Q., Dong, X., Zhang, S. and Chi, S. (2022) *Effects of Lower Fishmeal With Hydrolyzed Fish Protein Powder on the Growth Performance and Intestinal Development of Juvenile Pearl Gentian Groupers (Epinephelus fuscoguttatus and Epinephelus lanceolatus)*, *Frontiers in Marine Science*, 9, 830398.
167. Hoang, P.H., Ozkan, G., Badr, P.R., Papari, B., Edrington, C.S., Zehir, M.A., Hayes, B., Mehigan, L., Kez, D.A. and Foley, A.M. (2022) *A Dual Distributed Optimal Energy Management Method for Distribution Grids With Electric Vehicles*, *IEEE Transactions on Intelligent Transportation Systems*, 23 (8) 13666-13677.
168. Hoare, C., Aghamolaei, R., Lynch, M., Gaur, A. and O'Donnell, J. (2022) *A linked data approach to multi-scale energy modelling*, *Advanced Engineering Informatics*, 54, 101719.
169. Hong, X., Garud, S.S., Thaore, V.B., Karimi, I.A., Farooq, S., Wang, X., Usadi, A.K., Chapman, B.R. and Johnson, R.A. (2022) *Hydrogen Economy Assessment & Resource Tool (HEART): A python-based tool for ASEAN H2 roadmap study*, *International Journal of Hydrogen Energy*, 47 (52) 21897-21907.
170. Huang, S., Venables, D.S. and Lawrence, S.E. (2022) *Pharmaceutical Salts of Piroxicam and Meloxicam with Organic Counterions*, *Crystal Growth and Design*, 22 (11) 6504-6520.
171. Ibrahim, O.S., Singlitico, A., Proskovics, R., McDonagh, S., Desmond, C. and Murphy, J.D. (2022) *Dedicated large-scale floating offshore wind to hydrogen: Assessing design variables in proposed typologies*, *Renewable and Sustainable Energy Reviews*, 160, 112310.
172. ICES (2022): *Working Group on Bycatch of Protected Species (WGBYC)*, *ICES Scientific Reports*, 4, 91, 265 pp.
173. Iorio-Merlo, V., Graham, I.M., Hewitt, R.C., Aarts, G., Pirotta, E., Hastie, G.D. and Thompson, P.M. (2022) *Prey encounters and spatial memory influence use of foraging patches in a marine central place forager*, *Proceedings of the Royal Society B: Biological Sciences*, 289 (1970) 20212261.
174. Iosilevskii, G., Kong, J.D., Meyer, C.G., Watanabe, Y.Y., Papastamatiou, Y.P., Royer, M.A., Nakamura, I., Sato, K., Doyle, T.K., Harman, L., Houghton, J.D.R., Barnett, A., Semmens, J.M., Maoiléidigh, N.O., Drumm, A., O'Neill, R., Coffey, D.M. and Payne, N.L. (2022) *A general swimming response in exhausted obligate swimming fish*, *Royal Society Open Science*, 9 (9) 211869.
175. Jackson, S.A., Duan, M., Zhang, P., Ihua, M.W., Stengel, D.B., Duan, D. and Dobson, A.D.W. (2022) *Isolation, identification, and biochemical characterization of a novel bifunctional phosphomannomutase/phosphoglucomutase from the metagenome of the brown alga Laminaria digitata*, *Frontiers in Microbiology*, 13, 1000634.
176. Jackson-Blake, L.A., Clayer, F., De Eyto, E., French, A.S., Frías, M.D., Mercado-Bettín, D., Moore, T., Puértolas, L., Poole, R., Rinke, K., Shikhani, M., Van Der Linden, L. and Marcé, R. (2022) *Opportunities for seasonal forecasting to support water management outside the tropics*, *Hydrology and Earth System Sciences*, 26 (5) 1389-1406.
177. Jackson-Bué, M., Brito, A.C., Cabral, S., Carss, D.N., Carvalho, F., Chainho, P., Ciutat, A., Couñago, Sanchez, E., de Montaudouin, X., Fernández Otero, R.M., Incera Filgueira, M., Fitch, A., Garbutt, A., Goedknecht, M.A., Lynch, S.A., Mahony, K.E., Maire, O., Malham, S.K., Orvain, F., Rocroy, M., van der Schatte Olivier, A. and Jones, L. (2022) *Inter-country differences in the cultural ecosystem services provided by cockles*, *People and Nature*, 4 (1) 71-87.
178. Jani, A., Exner, A., Braun, R., Braun, B., Torri, L., Verhoeven, S., Murante, A.M., Van Devijvere, S., Harrington, J., Ochoa, A., Marchiori, G.D.L., Defranceschi, P., Bunker, A., Bärnighausen, T., Sanz Sanz, E., Napoléone, C., Verger, E.O., Schader, C., Röcklov, J., Stegeman, I., Tonello, S., Pederson, R., Kristensen, N.H., Smits, T., Wascher, D., Voshol, P., Kaptejns, A., Nesrallah, S., Kjørven, O., DeClerck, F., Biella, C., Gjorgjioska, M.A., Tomicic, A., Ferreira Oliveira, A.T., Bracco, S., Estevens, S., Rossi, L., Laister, G., Róžalska, A., Jankuloski, B., Hurbin, C., Jannic, M., Steel, F., Manbaliu, E., De Jager, K., Sfetos, A., Konstantopoulou, M., Kapetanakis, P.-A., Hickersberger, M., Chiffard, E. and Woolhead, C. (2022) *Transitions to food democracy through multilevel governance*, *Frontiers in Sustainable Food Systems*, 6, 1039127.
179. Jansen, M.A.K., Alexander, A.Č., Klem, K. and Urban, O. (2022) *A meta-analysis of the interactive effects of UV and drought on plants*, *Plant Cell and Environment*, 45 (1) 41-54.
180. Jennings, R. (2022) *Probing the scientific evidence base of the Plant Protection Regulation*, *Environmental Law Review*, 24 (3) 191-200.
181. Jones-Todd, C.M., Pirotta, E., Durban, J.W., Claridge, D.E., Baird, R.W., Falcone, E.A., Schorr, G.S., Watwood, S. and Thomas, L. (2022) *Discrete-space continuous-time models of marine mammal exposure to Navy sonar*, *Ecological Applications*, 32 (1) e02475.

182. Joshi, P., Dey, S., Ghosh, S., Jain, S. and Sharma, S.K. (2022) *Association between Acute Exposure to PM_{2.5} Chemical Species and Mortality in Megacity Delhi, India*, Environmental Science and Technology, 56 (11) 7275-7287.
183. Kandrot, S., Hayes, S. and Holloway, P. (2022) *Applications of Uncrewed Aerial Vehicles (UAV) Technology to Support Integrated Coastal Zone Management and the UN Sustainable Development Goals at the Coast*, Estuaries and Coasts 45, 1230–1249.
184. Kane, A., Ayllón, D., O'Sullivan, R.J., McGinnity, P. and Reed, T.E. (2022) *Escalating the conflict? Intersex genetic correlations influence adaptation to environmental change in facultatively migratory populations*, Evolutionary Applications, 15 (5) 773-789.
185. Kane, A., Monadjem, A., Aschenborn, H.K.O., Bildstein, K., Botha, A., Bracebridge, C., Buechley, E.R., Buij, R., Davies, J.P., Diekmann, M., Downs, C.T., Farwig, N., Galligan, T., Kaltenecker, G., Kelly, C., Kemp, R., Kolberg, H., MacKenzie, M.L., Mendelsohn, J., Mgumba, M., Nathan, R., Nicholas, A., Ogada, D., Pfeiffer, M.B., Phipps, W.L., Pretorius, M.D., Rösner, S., Schabo, D.G., Shatumbu, G.L., Spiegel, O., Thompson, L.J., Venter, J.A., Virani, M., Wolter, K. and Kendall, C.J. (2022) *Understanding continent-wide variation in vulture ranging behavior to assess feasibility of Vulture Safe Zones in Africa: Challenges and possibilities*, Biological Conservation, 268, 109516.
186. Kang, X., Lin, R., Wu, B., Li, L., Deng, C., Rajendran, K., Sun, Y., O'Shea, R. and Murphy, J.D. (2022) *Towards green whiskey production: Anaerobic digestion of distillery by-products and the effects of pretreatment*, Journal of Cleaner Production, 357, 131844.
187. Kang, X., Xu, C., Lin, R., Song, B., Wall, D. and Murphy, J.D. (2022) *Feedstock pretreatment for enhanced anaerobic digestion of lignocellulosic residues for bioenergy production*. In: Pandey, A., Wah Tong, Y., Zhang, L., Zhang, J. (Editors) Biomass, Biofuels, Biochemicals: Microbial Fermentation of Biowastes, Elsevier, pp. 253-282.
188. Kazlauskaitė, R., Cheaib, B., Humble, J., Heys, C., Ijaz, U.Z., Connelly, S., Sloan, W.T., Russell, J., Martínez-Rubio, L., Sweetman, J., Kitts, A., McGinnity, P., Lyons, P. and Llewellyn, M.S. (2022) *Deploying an In Vitro Gut Model to Assay the Impact of the Mannan-Oligosaccharide Prebiotic Bio-Mos on the Atlantic Salmon (Salmo salar) Gut Microbiome*, Microbiology Spectrum, 10 (3) .
189. Kearney, P.M., Spillane, M., Humphries, R., Gannon, A., Stamenic, D., Bhuachalla, C.N., Hoevel, P., Arensman, E., O'Riordain, M., Troya, M.I., Khashan, A.S., O'Reilly, E., Buckley, C., O'Connor, L. and Perry, I.J. (2022) *Compliance with local travel restrictions and face masks during first phase of COVID-19 pandemic in Ireland: a national survey*, Journal of Public Health, fdac017.
190. Kempf, J., Breen, P., Rogan, E. and Reid, D.G. (2022) *Trends in the abundance of Celtic Sea demersal fish: Identifying the relative importance of fishing and environmental drivers*, Frontiers in Marine Science, 9, 978654.
191. Keogh, N., Corr, D., O'Shea, R. and Monaghan, R.F.D. (2022) *The gas grid as a vector for regional decarbonisation - a techno economic case study for biomethane injection and natural gas heavy goods vehicles*, Applied Energy, 323, 119590.
192. Kerr, C., Kelleher, M., Coughlan, S., Crowley, B., O'Reilly, E.J. and Bergin, C. (2022) *Changing demographics and immunity to vaccine preventable diseases in people with HIV in Ireland*, BMC Infectious Diseases, 22(1), 582.
193. Kett, G.F., Culloty, S.C., Jansen, M.A.K. and Lynch, S.A. (2022) *Development of a sensitive polymerase chain reaction (PCR) and digoxigenin (DIG)-labeled in situ hybridization (ISH) for the detection of Vibrio bacteria in the Pacific oyster Crassostrea gigas*, Aquaculture Reports, 22, 100961.
194. Kett, G.F., Jansen, M.A.K., Culloty, S.C. and Lynch, S.A. (2022) *The impact of UV-B radiation on pacific oyster Crassostrea gigas health and pathogen Vibrio aestuarianus development*, Journal of Experimental Marine Biology and Ecology, 555, 151783.
195. Khalid, O., Hao, G., Desmond, C., Macdonald, H., McAuliffe, F.D., Dooly, G. and Hu, W. (2022) *Applications of robotics in floating offshore wind farm operations and maintenance: Literature review and trends*, Wind Energy, 25 (11) 1880-1899.
196. Khan, M.M.H., Ullah, A., Siddiquee, S.M.S., Alam, M.S., Biswas, K. and Ali, R.B. (2022) *Power compensation and Voltage flicker control of Solar-wind hybrid microgrid with optimized D-STATCOM using a control Technique 2022 International Conference on Innovations in Science, Engineering and Technology (ICISSET)*, Chittagong, Bangladesh, 1-6.
197. Khojasteh, D., Chen, S., Felder, S., Glamore, W., Hashemi, M.R. and Iglesias, G. (2022) *Sea level rise changes estuarine tidal stream energy*, Energy, 239, 122428.
198. Khojasteh, D., Lewis, M., Tavakoli, S., Farzadkhoo, M., Felder, S., Iglesias, G. and Glamore, W. (2022) *Sea level rise will change estuarine tidal energy: A review*, Renewable and Sustainable Energy Reviews, 156, 111855.
199. Kinane, O., Butler, F., O'Driscoll, K. (2022) *Freedom to Move: Free Lactation Pens Improve Sow Welfare*, Animals, 12, 1762.
200. Kiseeva, E.S., Korolev, N., Koemets, I., Zedgenizov, D.A., Unitt, R., McCammon, C., Aslandukova, A., Khandarkhaeva, S., Fedotenko, T., Glazyrin, K., Bessas, D., Aprilis, G., Chumakov, A.I., Kagi, H. and Dubrovinsky, L. (2022) *Subduction-related oxidation of the sublithospheric mantle evidenced by ferroprecipitate and magnesiowüstite diamond inclusions*, Nature Communications, 13 (1) 7517.
201. Klem, K., Oravec, M., Holub, P., Šimor, J., Findurová, H., Surá, K., Veselá, B., Hodaňová, P., Jansen, M.A.K. and Urban, O. (2022) *Interactive effects of nitrogen, UV and PAR on barley morphology and biochemistry are associated with the leaf C:N balance*, Plant Physiology and Biochemistry, 172, 111-124.
202. Kourtchev, I., Hellebust, S., Heffernan, E., Wenger, J., Towers, S., Diapoulis, E. and Eleftheriadis, K. (2022) *A new on-line SPE LC-HRMS method for the analysis of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in PM_{2.5} and its application for screening atmospheric particulates from Dublin and Enniscorthy, Ireland*, Science of the Total Environment, 835, 155496.
203. Krishnan, K., Garde, B., Bennison, A., Cole, N.C., Cole, E.-L., Darby, J., Elliott, K.H., Fell, A., Gómez-Laich, A., De Grissac, S., Jessopp, M., Lempidakis, E., Mizutani, Y., Prudor, A., Quetting, M., Quintana, F., Robotka, H., Roulin, A., Ryan, P.G., Schalcher, K., Schoombie, S., Tatayah, V., Tremblay, F., Weimerskirch, H., Whelan, S., Wikelski, M., Yoda, K., Hedenström, A. and Shepard, E.L.C. (2022) *The role of wingbeat frequency and amplitude in flight power*, Journal of the Royal Society Interface, 19 (193) 20220168.
204. Leahy, P.G. and Sovacool, B.K. (2022) *Decarbonize pedagogy – apply sustainable development goals*, Nature, 608 (7922) 266.
205. Lee, N., Setti, A. and Cassarino, M. (2022) *Gratitude as a predictor of pro-environmental behaviour? A survey investigation considering the role of environmental values and nature connectedness*, Journal of Ecopsychology, 2(2), 1-12.
206. Lee, P.L.M., Sherman, C.D.H., Rollins, L.A., Wapstra, E. and Phillips, K.P. (2022) *Do female amphibians and reptiles have greater reproductive output if they have more mates?*, Behavioral Ecology and Sociobiology, 76 (7) 96.
207. Lennon, B. and Dunphy, N.P. (2022) *Energy and citizenship in a time of transition and socio-technical change*. In: Baikady, R., Sajid, S.M., Nadesan, V., Przeperski, J., Islam, M.R. and Jianguo, G. (Editors) The Palgrave Handbook of Global Social Change, Palgrave Macmillan.
208. Lennon, B., Dunphy, N. P., Velasco-Herrejón, P. and Quinlivan, L. (2022) *Shifting the Power Balance: community-led resistance and the shaping of local understandings of place*. In: Getzinger, G., Jahrbacher, M. and Häller, F. (Editors) Conference Proceedings of the 20th STS Conference Graz: Critical Issues in Science, Technology and Society Studies, Verlag der Technischen Universität Graz, pp. 194–213.
209. Lima, A.P., Hernandez, H.M., Giannoumis, J., O'Suilleabhain, D., O'Reilly, A., Heward, M., Presse, P., Santana, M., Falcon, J.G. and Silva, E. (2022) *ProtoAtlantic: Innovation in the Marine Environment in the Atlantic Area Region*, Oceans Conference Record (IEEE) 2022, 1-5.
210. Loughrey, J. and Hennessy, T. (2022) *A Microsimulation Model for the Land Rental Market in Irish Farming*, International Journal of Microsimulation, 15 (2) 77-101.
211. Løvhaug, A.L., Granheim, S.I., Djojoseparto, S.K., Harrington, J.M., Kamphuis, C.B.M., Poelman, M.P., Roos, G., Sawyer, A., Stronks, K., Torheim, L.E., Twohig, C., Vandevijvere, S., van Lenthe, F.J. and Terragni, L. (2022) *The potential of food environment policies to reduce socioeconomic inequalities in diets and to improve healthy diets among lower socioeconomic groups: an umbrella review*, BMC Public Health, 22 (1) 433.
212. Luck, C., Jessopp, M., Cronin, M. and Rogan, E. (2022) *Using population viability analysis to examine the potential long-term impact of fisheries bycatch on protected species*, Journal for Nature Conservation, 67, 126157.
213. Lyashevskaya, O., Brophy, D., Wing, S., Johns, D.G., Haberlin, D. and Doyle, T.K. (2022) *Evidence of a range expansion in sunfish from 47 years of coastal sightings*, Marine Biology, 169 (2) 20.
214. Lyden, E., Judge, F., Gueydon, S., O'Shea, M. and Murphy, J. (2022) *An experimental investigation into the most prominent sources of uncertainty in wave tank testing of floating offshore wind turbines*, Journal of Physics: Conference Series, 2362 (1) 12023.
215. Lynch, S.A., Rowley, A., Longshaw, M., Malham, S.K. and Culloty, S.C. (2022) *Diseases of Molluscs*. In: Rowley, Andrew F., Christopher J. Coates, and Miranda W. Whitten (Editors), Invertebrate Pathology, Oxford University Press, Oxford, pp. 171-216.

216. Mac Mahon, J. (2022) *Water purity and sustainable water treatment systems for developing countries*. In: Letcher, T.M. (Editor) *Water and Climate Change: Sustainable Development, Environmental and Policy Issues*, Elsevier, pp. 115-144.
217. Mac Uidhir, T., Ó Gallachóir, B., Curtis J. and Rogan, F. (2022) *Achieving the unprecedented: Modelling diffusion pathways for ambitious climate policy targets*, *Energy and Climate Change* 3, 100073.
218. Mackey, K., McHugh, M. and McGlacken, G.P. (2022) *Some people and personalities of organic chemistry: A teaching hook for mid-level university students*, *Chemistry Teacher International*, 4 (4) 327-338.
219. Mahony, K.E., Egerton, S., Lynch, S.A., Blanchet, H., Goedknegt, M.A., Groves, E., Savoye, N., de Montaudouin, X., Malham, S.K. and Culloty, S.C. (2022) *Drivers of growth in a keystone fished species along the European Atlantic coast: The common cockle *Cerastoderma edule**, *Journal of Sea Research*, 179, 102148.
220. Mahony, K.E., Lynch, S.A., de Montaudouin, X. and Culloty, S.C. (2022) *Extrinsic and intrinsic drivers of parasite prevalence and parasite species richness in a marine bivalve*, *PLoS ONE*, 17 (45178) e0274474.
221. Maloney, E.M., Corcoran, P., Costello, D.J. and O'Reilly, É.J. (2022) *Association between social deprivation and incidence of first seizures and epilepsy: A prospective population-based cohort*, *Epilepsia*, 63 (8) 2108-2119.
222. Marcato, M., Kenny, J., O'Riordan, R., O'Mahony, C., O'Flynn, B. and Galvin, P. (2022) *Assistance dog selection and performance assessment methods using behavioural and physiological tools and devices*, *Applied Animal Behaviour Science*, 254, 105691.
223. Martinez, A. and Iglesias, G. (2022) *Climate change impacts on wind energy resources in North America based on the CMIP6 projections*, *Science of the Total Environment*, 806, 150580.
224. Martinez, A. and Iglesias, G. (2022) *Mapping of the levelised cost of energy for floating offshore wind in the European Atlantic*, *Renewable and Sustainable Energy Reviews*, 154, 111889.
225. Martinez, A. and Iglesias, G. (2022) *Site selection of floating offshore wind through the levelised cost of energy: A case study in Ireland*, *Energy Conversion and Management*, 266, 115802.
226. Mateos-Cárdenas, A. (2022) *Fate of petroleum-based and plant-based teabags exposed to environmental soil conditions for one year*, *Frontiers in Bioengineering and Biotechnology*, 10, 966685.
227. Mateos-Cárdenas, A., Jansen, A.R.J., O'Halloran, J., van Pelt, F.N. and Jansen, M.A.K. (2022) *Microplastics in the freshwater environment*. In: Mehner, T. and Tockner, K., *Encyclopedia of Inland Waters* 2nd edition, vol. [4], Elsevier, Oxford, pp. 260-271.
228. Mateos-Cárdenas, A., Moroney, A.V.D.G., van Pelt, F.N.A.M., O'Halloran, J. and Jansen, M.A.K. (2022) *Trophic transfer of microplastics in a model freshwater microcosm; lack of a consumer avoidance response*, *Food Webs*, 31, e00228.
229. Mays, C. and McLoughlin, S. (2022) *End-Permian burnout: the role of Permian-Triassic wildfires in extinction, carbon cycling, and environmental change in Eastern Gondwana*, *Palaiois*, 37 (6) 292-317.
230. McAllen, R., Bell, J., Davenport, J., Little, C., Micaroni, V., Nunn, J., Strano, F. and Trowbridge, C.D. (2022) *Lough Hyne: Europe's First Statutory Marine Reserve—A Biodiversity Hotspot*, *Imperiled: The Encyclopedia of Conservation: Volume 1-3*, 44986, 866-880.
231. McGinley, J., Harmon O'Driscoll, J., Healy, M.G., Ryan, P.C., Mellander, P.E., Morrison, L., Callery, O. and Siggins, A. (2022) *An assessment of potential pesticide transmission, considering the combined impact of soil texture and pesticide properties: A meta-analysis*, *Soil Use and Management*, 38 (2) 1162-1171.
232. McGinley, J., Healy, M.G., Ryan, P.C., Mellander, P.-E., Morrison, L., O'Driscoll, J.H. and Siggins, A. (2022) *Batch adsorption of herbicides from aqueous solution onto diverse reusable materials and granulated activated carbon*, *Journal of Environmental Management*, 323, 116102.
233. McGookin, C., Mac Uidhir, T., Ó Gallachóir, B. and Byrne, E. (2022) *Doing things differently: Bridging community concerns and energy system modelling with a transdisciplinary approach in rural Ireland*, *Energy Research and Social Science*, 89, 102658.
234. McGookin, C., Ó Gallachóir, B. and Byrne, E. (2022) *Systematically reviewing the use of participatory methods in energy system modelling and planning literature*, *MethodsX*, 9, 101862.
235. McGuinness, M., Brownlow, H., McAllen, R., Harman, L., Haberlin, D. and Doyle, T.K. (2022) *Abundance and seasonality of phoronid larvae in coastal temperate waters: More abundant than previously thought?*, *Aquatic Ecology*, 56 (4) 1315-1321.
236. McHuron, E.A., Adamczak, S., Arnould, J.P.Y., Ashe, E., Booth, C., Don Bowen, W., Christiansen, F., Chudzinska, M., Costa, D.P., Fahlman, A., Farmer, N.A., Fortune, S.M.E., Gallagher, C.A., Keen, K.A., Madsen, P.T., McMahon, C.R., Nabe-Nielsen, J., Noren, D.P., Noren, S.R., Pirota, E., Rosen, D.A.S., Speakman, C.N., Villegas-Amtmann, S. and Williams, R. (2022) *Key questions in marine mammal bioenergetics*, *Conservation Physiology*, 10 (1) coac055.
237. McIntyre, O. (2022) *Convergence in International Environmental and Natural Resources Law*, *Environmental Policy and Law*, 52 (45019) 237-251.
238. McIntyre, O. (2022) *Convergence in International Environmental and Natural Resources Law*. In: Desai, B.H. (Editor) *Envisioning Our Environmental Future: Stockholm+50 and Beyond*, IOS Press, 2022, pp. 78-93.
239. McIntyre, O. (2022) *Embedding 'Solidarity' in International Water Law: Framing 'Equity' in Transboundary Water Governance*. In: den Heijer, M. and van der Wilt, H. (Editors) *Netherlands Yearbook of International Law 2020*, Netherlands Yearbook of International Law, vol 51, T.M.C. Asser Press, The Hague, pp. 227-256.
240. McIntyre, O. (2022) *International Water Law's Role in Addressing the Problem of Marine Plastic Pollution: A Vital Piece in a Complex Puzzle!*, *Chinese Journal of Environmental Law*, 6 (2) 218-252.
241. McIntyre, O. (2022) *The Role of "Convergence" in Clarifying the Boundaries of International Law on Transboundary Aquifers*. In: Sánchez, R. (Editor) *Transboundary Aquifers: Challenges and the Way Forward*, UNESCO, Paris, pp. 187-195.
242. McLoughlin, S. and Mays, C. (2022) *Synchrotron X-ray imaging reveals the three-dimensional architecture of beetle borings (*Dekosichnus meniscatus*) in Middle-Late Jurassic araucarian conifer wood from Argentina*, *Review of Palaeobotany and Palynology*, 297, 104568.
243. McSweeney, D., Delaby, L., O'Brien, B., Ferard, A., Byrne, N., McDonagh, J., Ivanov, S. and Coughlan, N.E. (2022) *Dynamic algorithmic conversion of compressed sward height to dry matter yield by a rising plate meter*, *Computers and Electronics in Agriculture*, 196, 106919.
244. Mehigan, L., Ó Gallachóir, B. and Deane, P. (2022) *Batteries and interconnection: Competing or complementary roles in the decarbonisation of the European power system?*, *Renewable Energy*, 196, 1229-1240.
245. Mehigan, L., Zehir, M.A., Cuenca, J.J., Sengor, I., Geaney, C. and Hayes, B.P. (2022) *Synergies Between Low Carbon Technologies in a Large-Scale MV/LV Distribution System*, *IEEE Access*, 10, 88655-88666.
246. Micaroni, V., Strano, F., Crocetta, F., Di Franco, D., Piraino, S., Gravili, C., Rindi, F., Bertolino, M., Costa, G., Langeneck, J., Bo, M., Betti, F., Froggia, C., Giangrande, A., Tiralongo, F., Nicoletti, L., Medagli, P., Arzeni, S. and Boero, F. (2022) *Project "Biodiversity MARE Tricase": A Species Inventory of the Coastal Area of Southeastern Salento (Ionian Sea, Italy)*, *Diversity*, 14 (11) 904.
247. Micaroni, V., Strano, F., McAllen, R., Woods, L., Turner, J., Harman, L. and Bell, J.J. (2022) *Adaptive strategies of sponges to deoxygenated oceans*, *Global Change Biology*, 28 (6) 1972-1989.
248. Millar, S.R., Harrington, J.M., Perry, I.J. and Phillips, C.M. (2022) *Associations between a protective lifestyle behaviour score and biomarkers of chronic low-grade inflammation: a cross-sectional analysis in middle-to-older aged adults*, *International Journal of Obesity*, 46 (3) 476-485.
249. Millar, S.R., Navarro, P., Harrington, J.M., Perry, I.J. and Phillips, C.M. (2022) *Associations between the Nutrient Profiling System Underlying the Nutri-Score Nutrition Label and Biomarkers of Chronic Low-Grade Inflammation: A Cross-Sectional Analysis of a Middle-to Older-Aged Population*, *Nutrients*, 14 (15) 3122.
250. Millar, S.R., Navarro, P., Harrington, J.M., Shivappa, N., Hébert, J.R., Perry, I.J. and Phillips, C.M. (2022) *Dietary score associations with markers of chronic low-grade inflammation: a cross-sectional comparative analysis of a middle- to older-aged population*, *European Journal of Nutrition*, 61 (7) 3377-3390.
251. Mintz-Woo, K. (2022) *Carbon pricing ethics*, *Philosophy Compass*, 17 (1) e12803.
252. Mintz-Woo, K. (2022) *Fossil Fuels*. In: Hale, B., Light, A., & Lawhon, L. (Editors) *The Routledge Companion to Environmental Ethics* (1st ed.), Routledge, New York, pp. 317-326.
253. Mintz-Woo, K. (2022) *Teaching & learning guide for: Carbon pricing ethics*, *Philosophy Compass*, 17 (2) e12816.
254. Mintz-Woo, K. (2022) *The Need-Efficiency Tradeoff for negative emissions technologies*, *PLOS Climate*, 1(8), e0000060.

255. Moghadam, T.T., Ochoa Morales, C.E., Lopez Zambrano, M., Bruton, K., O'Sullivan, D.T.J. (2022) *The indoor air quality, ventilation and energy nexus in the COVID-19 context*, CLIMA 2022: the 14th REHVA HVAC World Congress, Rotterdam, The Netherlands, 22-25 May.
256. Montini, N., Doughty, T.W., Domenzain, I., Fenton, D.A., Baranov, P.V., Harrington, R., Nielsen, J., Siewers, V. and Morrissey, J.P. (2022) *Identification of a novel gene required for competitive growth at high temperature in the thermotolerant yeast Kluyveromyces marxianus*, Microbiology (United Kingdom), 168 (3) 1148.
257. Mooney, S., Boudou, M., O'Dwyer, J. and Hynds, P.D. (2022) *Behavioral pathways to private well risk mitigation: A structural equation modeling approach*, Risk Analysis.
258. Moradian, S., Akbari, M. and Iglesias, G. (2022) *Optimized hybrid ensemble technique for CMIP6 wind data projections under different climate-change scenarios*. Case study: United Kingdom, Science of the Total Environment, 826, 154124.
259. Moran, C., McCarthy, M., O'Neill, C., Hashem, S. and Moore, O. (2022) *Necessity Breeds Ingenuity: Exploring the Sustainable Food Practices of Members of a Community Supported Agriculture (CSA): An Abstract*. In: Allen, J., Jochims, B., Wu, S. (Editors) Celebrating the Past and Future of Marketing and Discovery with Social Impact, AMSAC-WC 2021, Developments in Marketing Science: Proceedings of the Academy of Marketing Science, Springer, Cham, pp. 593-594.
260. Morand-Ferron, J., Reichert, M.S. and Quinn, J.L. (2022) *Cognitive flexibility in the wild: Individual differences in reversal learning are explained primarily by proactive interference, not by sampling strategies, in two passerine bird species*, Learning and Behavior, 50 (1) 153-166.
261. Morris, L., Clancy, R., Hryshchenko, A., O'Sullivan, D. and Bruton, K. (2022) *Using Model Selection and Reduction to Develop an Empirical Model to Predict Energy Consumption of a CNC Machine*. In: Margaria, T. and Steffen, B. (Editors) Leveraging Applications of Formal Methods, Verification and Validation. Practice. ISoLA 2022. Lecture Notes in Computer Science, vol 13704. Springer, Cham, pp. 227–234.
262. Moynihan, E., Mackey, K., Blaskovich, M.A.T., Reen, F.J. and McGlacken, G. (2022) *N-Alkyl-2-Quinolonyprones Demonstrate Antimicrobial Activity against ESKAPE Pathogens Including Staphylococcus aureus*, ACS Medicinal Chemistry Letters, 13 (8) 1358-1362.
263. Msoffe, R., Hewitt, M., Masalu, J.P., Finda, M., Kavishe, D.R., Okumu, F.O., Mpolya, E.A., Kaindoa, E.W. and Killeen, G.F. (2022) *Participatory development of practical, affordable, insecticide-treated mosquito proofing for a range of housing designs in rural southern Tanzania*, Malaria Journal, 21 (1) 318.
264. Mughal, F., Troya, M.I., Dikomitis, L., Tierney, S., Corp, N., Evans, N., Townsend, E. and Chew-Graham, C.A. (2022) *The experiences and needs of supporting individuals of young people who self-harm: A systematic review and thematic synthesis*, eClinicalMedicine, 48, 101437.
265. Murphy, E., Jessopp, M. and Darby, J. (2022) *Light to intermediate oil sheens increase Manx shearwater feather permeability*, Royal Society Open Science, 9 (10) 220488.
266. Murphy, K.J., Griffin, L.L., Nolan, G., Haigh, A., Hochstrasser, T., Ciuti, S. and Kane, A. (2022) *Applied autoethnography: A method for reporting best practice in ecological and environmental research*, Journal of Applied Ecology, 59 (11) 2688-2697.
267. Mwakasungula, S., Rougeron, V., Arnathau, C., Boundenga, L., Miguel, E., Boissière, A., Jiolle, D., Durand, P., Msigwa, A., Mswata, S., Olotu, A., Sterkers, Y., Roche, B., Killeen, G., Cerqueira, F., Bitome-Essono, P.Y., Bretagnolle, F., Masanja, H., Paupy, C., Sumaye, R. and Prugnolle, F. (2022) *Using haematophagous fly blood meals to study the diversity of blood-borne pathogens infecting wild mammals*, Molecular Ecology Resources, 22 (8) 2915-2927.
268. Nagle, A.J., Mullally, G., Leahy, P.G. and Dunphy, N.P. (2022) *Life cycle assessment of the use of decommissioned wind blades in second life applications*, Journal of Environmental Management, 302, 113994.
269. Nair, I.M., Condon, E., Prestwich, B.D. and Mackrill, J.J. (2022) *Myo-D-inositol Trisphosphate Signalling in Oomycetes*, Microorganisms, 10 (11) 2157.
270. Nasti, R., Bassanini, I., Ferrandi, E.E., Linguardo, F., Bertuletti, S., Vanoni, M., Riva, S., Verotta, L. and Monti, D. (2022) *Stereoselective Biocatalyzed Reductions of Ginger Active Components Recovered from Industrial Wastes*, ChemBioChem, 23 (8) e202200105.
271. Naudé, W. and Nagler, P. (2022) *COVID-19 and the city: Did urbanized countries suffer more fatalities?*, Cities, 131, 103909.
272. Neimanis, A., Stavenow, J., Ågren, E.O., Wikström-Lassa, E. and Roos, A.M. (2022) *Causes of Death and Pathological Findings in Stranded Harbour Porpoises (Phocoena phocoena) from Swedish Waters*, Animals, 12 (3) 369.
273. Nguyen, P.H., Dinh, V.N., Trinh, H.A.N., Ngo, T.N., Truong, A.H. and Ha-Duong, M. (2022) *Options for Zonation and Grid Integration of Offshore Wind in Vietnam*, Lecture Notes in Civil Engineering, 208, 509-517.
274. Ní Dhúill, C. and Novak, J. (2022) *"A Way Out of the Prison of Gender": Interview with Novelist Patricia Duncker*. In: Novak, J. and Ní Dhúill, C. (Editors) *Imagining Gender in Biographical Fiction*. Palgrave Studies in Life Writing, Palgrave Macmillan, Cham, pp. 369-385.
275. Nolan, G., Kane, A. and Fernández-Bellón, D. (2022) *Natural history films generate more online interest in depicted species than in conservation messages*, People and Nature, 4 (3) 816-825.
276. Novak, J. and Ní Dhúill, C. (2022) *Imagining Gender in Biographical Fiction: Introduction*. In: Novak, J. and Ní Dhúill, C. (Editors) *Imagining Gender in Biographical Fiction*. Palgrave Studies in Life Writing, Palgrave Macmillan, Cham, pp. 1-45.
277. Nowbakht, P., O'Sullivan, L., Cawkwell, F., Wall, D.P. and Holloway, P. (2022) *A comparison of obfuscation methods used for privacy protection: Exploring the challenges of polygon data in agricultural research*, Transactions in GIS, 26 (2) 949-979.
278. Ó Céileachair, D., O'Shea, R., Murphy, J.D. and Wall, D.M. (2022) *The effect of seasonal biomass availability and energy demand on the operation of an on-farm biomethane plant*, Journal of Cleaner Production, 368, 133129.
279. O'Donnell, C.W., Salari, M.E. and Toal, D.J. (2022) *A study on directly interconnected offshore wind systems during wind gust conditions*, Energies, 15 (1) 168.
280. O'Leary, D., Doran, J. and Power, B. (2022) *Intensity of competition and firm innovative behavior*, Economics and Business Letters, 11 (2) 53-69.
281. O'Mahoney, R., Coughlan, N.E., Walsh, E. and Jansen, M.A.K. (2022) *Cultivation of Lemna Minor on Industry-Derived, Anaerobically Digested, Dairy Processing Wastewater*, Plants, 11 (22) 3027.
282. O'Riordan, V., Rogan, F., Ó Gallachóir, B. and Daly, H. (2022) *Impact of an emissions-based car tax policy on CO2 emissions and tax revenue from private cars in Ireland*, International Journal of Sustainable Transportation, online.
283. O'Sullivan-Carroll, E., Howlett, S., Pyne, C., Downing, P., Rafael, A., Lynch, M., Hogan, A.M. and Moore, E.J. (2022) *Determination of Pharmaceuticals in Surface and Wastewater by Capillary Electrophoresis (CE): A Minireview*, Analytical Letters, 55 (3) 495-504.
284. O'Callaghan, I., Fitzpatrick, D. and Sullivan, T. (2022) *Thiophilicity is a determinant of bioaccumulation in benthic fauna*, Environmental Pollution, 294, 118641.
285. Ochatt, S.J., Beruto, M.I., Chan, M.-T., Doyle Prestwich, B.M., Eimert, K., Lambardi, M. and Winkelmann, T. (2022) *Biotechnology of ornamental plants: when beauty joins science—preface from the editors*, Plant Cell, Tissue and Organ Culture, 149 (3) 497-502.
286. O'Dwyer, C. (2022) *(Invited) Material Porosity*, ECS Transactions, 109 (3) 37-59.
287. O'Hanlon, S. and O'Dwyer, C. (2022) *Electrodeposition onto Conductive Additive-Impregnated 3D Printed Polylactic Acid Electrodes*, Journal of the Electrochemical Society, 169 (8) 82514.
288. Okafor, C.C., Ibekwe, J.C., Nzekwe, C.A., Ajaero, C.C. and Ikeotuonye, C.M. (2022) *Estimating emissions from open-burning of uncollected municipal solid waste in Nigeria*, AIMS Environmental Science, 9 (2) 124-144.
289. O'Keefe, S., O'Sullivan, D. and Bruton, K. (2022) *Methodology for Carbon Emissions Neutrality in Industrial Manufacturing*, Chemical Engineering Transactions, 94, 43-48.
290. Oliveira, J.C., Ramos, A.V. and Sousa-Gallagher, M.J. (2022) *A Meta-study of the Permeance of Perforated Packaging Films to Oxygen and Carbon Dioxide*, Food Engineering Reviews, 14 (2) 328-352.
291. O'Neill, C., Hashem, S., Moran, C. and McCarthy, M. (2022) *Thou shalt not waste: Unpacking consumption of local food*, Sustainable Production and Consumption, 29, 851-861.
292. Onoufriou, A.B., Gaggiotti, O.E., Aguilar de Soto, N., McCarthy, M.L., Morin, P.A., Rosso, M., Dalebout, M., Davison, N., Baird, R.W., Baker, C.S., Berrow, S., Brownlow, A., Burns, D., Caurant, F., Claridge, D., Constantine, R., Demaret, F., Dreyer, S., Dúras, M., Durban, J.W., Frantzis, A., Freitas, L., Genty, G., Galov, A., Hansen, S.S., Kitchener, A.C., Martin, V., Mignucci-Giannoni, A.A., Montano, V., Moulins, A., Olavarria, C., Poole, M.M., Reyes Suárez, C., Rogan, E., Ryan, C., Schiavi, A., Tepsich, P., Urban, R.J., West, K., Olsen, M.T. and Carroll, E.L. (2022) *Biogeography in the deep: Hierarchical population genomic structure of two beaked whale species*, Global Ecology and Conservation, 40, e02308.

293. Oommen, A.A., Coughlan, N.E., Jansen, M.A. and Morrison, A.P. (2022) *Development and construction of an automated harvesting arm for the efficient cultivation of duckweed*. In: Ahearne, Eamonn, and Denis P. Dowling (Editors) Proceedings of the 38th International Manufacturing Conference (IMC38), University College Dublin, School of Mechanical and Materials Engineering, Dublin, pp. 198-206. <http://hdl.handle.net/10197/24274>
294. Orcesi, A., O'Connor, A., Bastidas-Arteaga, E., Stewart, M.G., Imam, B., Kreislova, K., Schoefs, F., Markogiannaki, O., Wu, T., Li, Y., Salman, A., Hawchar, L. and Ryan, P.C. (2022) *Investigating the Effects of Climate Change on Material Properties and Structural Performance*, Structural Engineering International, 32 (4) 577-588.
295. O'Regan, A.C., Byrne, R., Hellebust, S. and Nyhan, M.M. (2022) *Associations between Google Street View-derived urban greenspace metrics and air pollution measured using a distributed sensor network*, Sustainable Cities and Society, 87, 104221.
296. O'Reilly, L., Fentimen, R., Butschek, F., Titschack, J., Lim, A., Moore, N., O'Connor, O.J., Appah, J., Harris, K., Vennemann, T. and Wheeler, A.J. (2022) *Environmental forcing by submarine canyons: Evidence between two closely situated cold-water coral mounds (Porcupine Bank Canyon and Western Porcupine Bank, NE Atlantic)*, Marine Geology, 454, 106930.
297. O'Reilly, L., Lim, A., Titschack, J., Moore, N., O'Connor, O.J., Appah, J., Fentimen, R., Butschek, F., Harris, K., Vennemann, T. and Wheeler, A.J. (2022) *Using novel methods to track British and Irish Ice Sheet dynamics since the Late Pleistocene, along the west Porcupine Bank, NE Atlantic*, Quaternary Science Reviews, 284, 107463.
298. O'Riordan, V., Rogan, F., Mac Uidhir, T., Ó Gallachóir, B. and Daly, H. (2022) *Passenger transport demand, fuel consumption, and emissions data for the Irish Passenger Transport Emissions and Mobility (IPTeM) model*, Data in Brief, 42, 108154.
299. O'Riordan, V., Rogan, F., Ó Gallachóir, B., Mac Uidhir, T. and Daly, H. (2022) *How and why we travel – Mobility demand and emissions from passenger transport*, Transportation Research Part D: Transport and Environment, 104, 103195.
300. O'Shea, R., Lin, R., Wall, D.M. and Murphy, J.D. (2022) *A comparison of digestate management options at a large anaerobic digestion plant*, Journal of Environmental Management, 317, 115312.
301. O'Shea, R., Lin, R., Wall, D.M., Browne, J.D. and Murphy, J.D. (2022) *Assessing decarbonisation pathways in the food and beverage sector: A multi-criteria decision analysis approach*, Journal of Cleaner Production, 371, 133534.
302. Otter, A., Desmond, C., Flannery, B. and Murphy, J. (2022) *Combined current and wind simulation for floating offshore wind turbines*, Journal of Physics: Conference Series, 2362 (1) 12028.
303. Otter, A., Flannery, B., Murphy, J. and Desmond, C. (2022) *Current simulation with Software in the Loop for floating offshore wind turbines*, Journal of Physics: Conference Series, 2265 (4) 42028.
304. Otter, A., Murphy, J., Pakrashi, V., Robertson, A. and Desmond, C. (2022) *A review of modelling techniques for floating offshore wind turbines*, Wind Energy, 25 (5) 831-857.
305. Paolacci, S., Stejskal, V., Toner, D. and Jansen, M.A.K. (2022) *Integrated Multitrophic Aquaculture; Analysing Contributions of Different Biological Compartments to Nutrient Removal in a Duckweed-Based Water Remediation System*, Plants, 11 (22) 3103.
306. Paolacci, S., Stejskal, V., Toner, D. and Jansen, M.A.K. (2022) *Wastewater valorisation in an integrated multitrophic aquaculture system; assessing nutrient removal and biomass production by duckweed species*, Environmental Pollution, 302, 119059.
307. Penalba, M., Aizpurua, J.I., Martínez-Perurena, A. and Iglesias, G. (2022) *A data-driven long-term metocean data forecasting approach for the design of marine renewable energy systems*, Renewable and Sustainable Energy Reviews, 167, 112751.
308. Pereira, P., Fandos Esteruelas, N., Nakamura, M., Rio-Maior, H., Krofel, M., Di Blasio, A., Zoppi, S., Robetto, S., Llana, L., García, E., Oleaga, Á., López-Bao, J.V., Fayos Martínez, M., Stavenow, J., Ágren, E.O., Álvares, F. and Santos, N. (2022) *Hair cortisol concentration reflects the life cycle and management of grey wolves across four European populations*, Scientific Reports, 12 (1) 5697.
309. Pineda, E., Poelman, M.P., Aaspöllu, A., Bica, M., Bouzas, C., Carrano, E., De Miguel-Etayo, P., Djajoseparto, S., Blenkuš, M.G., Graca, P., Geffert, K., Hebestreit, A., Helldan, A., Henjum, S., Huseby, C.S., Gregório, M.J., Kamphuis, C., Laatikainen, T., Løvhaug, A.L., Leydon, C., Luszczynska, A., Mäki, P., Martínez, J.A., Raulio, S., Romaniuk, P., Roos, G., Salvador, C., Sassi, F., Silano, M., Sotlar, I., Specchia, M.L., de Arriaga, M.T., Terragni, L., Torheim, L.E., Tur, J.A., von Philipsborn, P., Harrington, J.M. and Vandevijvere, S. (2022) *Policy implementation and priorities to create healthy food environments using the Healthy Food Environment Policy Index (Food-EPI): A pooled level analysis across eleven European countries*, The Lancet Regional Health - Europe, 23, 100522.
310. Pirotta, E. (2022) *A review of bioenergetic modelling for marine mammal populations*, Conservation Physiology, 10 (1) coac036.
311. Pirotta, E., Booth, C.G., Calambokidis, J., Costa, D.P., Fahlbusch, J.A., Friedlaender, A.S., Goldbogen, J.A., Harwood, J., Hazen, E.L., New, L., Santora, J.A., Watwood, S.L., Wertman, C. and Southall, B.L. (2022) *From individual responses to population effects: Integrating a decade of multidisciplinary research on blue whales and sonar*, Animal Conservation, 25 (6) 796-810.
312. Pirotta, E., Thomas, L., Costa, D.P., Hall, A.J., Harris, C.M., Harwood, J., Kraus, S.D., Miller, P.J.O., Moore, M.J., Photopoulou, T., Rolland, R.M., Schwacke, L., Simmons, S.E., Southall, B.L. and Tyack, P.L. (2022) *Understanding the combined effects of multiple stressors: A new perspective on a longstanding challenge*, Science of the Total Environment, 821, 153322.
313. Pohl, A., Ridgwell, A., Stockey, R.G., Thomazo, C., Keane, A., Vennin, E. and Scotese, C.R. (2022) *Continental configuration controls ocean oxygenation during the Phanerozoic*, Nature, 608 (7923) 523-527.
314. Power, J., Power, B. and Ryan, G. (2022) *Determinants of equity financing: a demand-side analysis of Irish indigenous technology-based firms*, Irish Journal of Management, 41(1), 52-68.
315. Praena, J., van Veen, E., Henriques, R. and Benlloch, R. (2022) *Assessing Flowering Time Under Different Photoperiods*, Methods in Molecular Biology, 2494, 101-115.
316. Raha, S., Biswas, S., Doherty, J., Mondal, P.K., Holmes, J.D. and Singha, A. (2022) *Lattice dynamics of Ge_{1-x}Sn_x alloy nanowires*, Nanoscale, 14 (19) 7211-7219.
317. Rajkumar, A.S. and Morrissey, J.P. (2022) *Protocols for marker-free gene knock-out and knock-down in Kluyveromyces marxianus using CRISPR/Cas9*, FEMS Yeast Research, 22 (1) foab067.
318. Ralphs, K., Collins, G., Manyar, H., James, S.L. and Hardacre, C. (2022) *Selective Hydrogenation of Stearic Acid Using Mechanoelectrically Prepared Titania-Supported Pt and Pt-Re Bimetallic Catalysts*, ACS Sustainable Chemistry and Engineering, 10 (21) 6934-6941.
319. Ravindran, R., Donkor, K., Gottumukkala, L., Menon, A., Guneratnam, A.J., McMahan, H., Koopmans, S., Sanders, J.P.M. and Gaffey, J. (2022) *Biogas, Biomethane and Digestate Potential of By-Products from Green Biorefinery Systems*, Clean Technologies, 4 (1) 35-50.
320. Reen, F.J., Jump, O., McEvoy, G., McSharry, B.P., Morgan, J., Murphy, D., O'Leary, N., O'Mahony, B., Scallan, M., Walsh, C. and Supple, B. (2022) *Developing student codesigned immersive virtual reality simulations for teaching of challenging concepts in molecular and cellular biology*, FEMS Microbiology Letters, 369 (1) fnac051.
321. Reichert, M.S. and de la Hera, I. (2022) *Sensory biases in response to novel complex acoustic signals in male and female grey treefrogs, Hyla chrysoscelis*, Proceedings of the Royal Society B: Biological Sciences, 289 (1984) 20221306.
322. Reichert, M.S., Crane, J.M.S., Davidson, G.L., Dillane, E., KulaHCI, I.G., O'Neill, J., van Oers, K., Sexton, C. and Quinn, J.L. (2022) *No reproductive fitness benefits of dear enemy behaviour in a territorial songbird*, Behavioral Ecology and Sociobiology, 76 (7) 90.
323. Revez, A., Dunphy, N., Harris, C., Rogan, F., Byrne, E., McGookin, C., Bolger, P., Ó Gallachóir, B., Barry, J., Ellis, G., O'Dwyer, B., Boyle, E., Flood, S., Glynn, J. and Mullally, G. (2022) *Mapping emergent public engagement in societal transitions: a scoping review*, Energy, Sustainability and Society, 12 (1) 2.
324. Riedewald, F., Povey, I., O'Mahoney, M. and Sousa-Gallagher, M. (2022) *A multi-purpose pilot-scale molten metal & molten salt pyrolysis reactor*, MethodsX, 9, 101606.
325. Riedewald, F., Wilson, E., Patel, Y., Vogt, D., Povey, I., Barton, K., Lewis, L., Caris, T., Santos, S., O'Mahoney, M. and Sousa-Gallagher, M. (2022) *Recycling of aluminium laminated pouches and Tetra Pak cartons by molten metal pyrolysis – Pilot-scale experiments and economic analysis*, Waste Management, 138, 172-179.
326. Ritchie, S. and Tsalaporta, E. (2022) *Trends in carbon capture technologies: a bibliometric analysis*, Carbon Neutrality, 1 (1) 38.
327. Romaniuk, P., Kaczmarek, K., Brukała, K., Grochowska-Niedworok, E., Łobczowska, K., Banik, A., Luszczynska, A., Poelman, M., Harrington, J.M. and Vandevijvere, S. (2022) *The Healthy Food Environment Policy Index in Poland: Implementation Gaps and Actions for Improvement*, Foods, 11 (11) 1648.
328. Ross, M.M., Collins, A.M., McCarthy, M.B. and Kelly, A.L. (2022) *Overcoming barriers to consumer acceptance of 3D-printed foods in the food service sector*, Food Quality and Preference, 100, 104615.

329. Ross, M.M., Crowley, S.V. and Kelly, A.L. (2022) *Applications of micellar casein concentrate in 3D-printed food structures*, *Innovative Food Science and Emerging Technologies*, 82, 103182.
330. Rossi, V., Unitt, R., McNamara, M., Zorzini, R. and Carnevale, G. (2022) *Skin patterning and internal anatomy in a fossil moonfish from the Eocene Bolca Lagerstätte illuminate the ecology of ancient reef fish communities*, *Palaeontology*, 65 (3) e12600.
331. Ruane, K., Zhang, Z., Nagle, A., Huynh, A., Alshannaq, A., McDonald, A., Leahy, P., Soutsos, M., McKinley, J., Gentry, R. and Bank, L. (2022) *Material and Structural Characterization of a Wind Turbine Blade for Use as a Bridge Girder*, *Transportation Research Record*, 2676 (8) 354-362.
332. Runge T., Latacz-Lohmann U., Schaller L., Todorova K., Daugbjerg C., Termansen M., Liira J., Le Gloux F., Dupraz P., Leppanen J., Fogarasi J., Vigh E.Z., Bradfield T., Hennessy T., Targetti S., Viaggi D., Berzina I., Schulp C., Majewski E., Bouriaud L., Baciú G., Pecurul M., Prokofieva I. and Velazquez F.J.B. (2022) *Implementation of Eco-schemes in Fifteen European Union Member States [Mise en œuvre des éco-régimes dans quinze États membres de l'Union européenne] [Umsetzung der Eco-Schemes in fünfzehn Mitgliedstaaten der Europäischen Union]*, *EuroChoices*, 21 (2) 19-27.
333. Rusmanis, D., Yang, Y., Lin, R., Wall, D.M. and Murphy, J.D. (2022) *Operation of a circular economy, energy, environmental system at a wastewater treatment plant*, *Advances in Applied Energy*, 8, 100109.
334. Ryall, Á. (2022) *Standards for Effective Access to Justice in Intersecting Legal Systems*, *Irish Planning and Environmental Law Journal* 29 (2) 43-47.
335. Ryan, D. (2022) *The US Postcolonial e/Empire: The Case of the Missing Upper Case*. In: Alan P. Dobson, A.P. (1951-2022) and Marsh, S. (Editors) *Anglo-American Relations and the Transmission of Ideas: A Shared Political Tradition?*, Berghahn Books, New York, Oxford, pp. 179-214.
336. Saab, M.M., Murphy, M., Meehan, E., Dillon, C.B., O'Connell, S., Hegarty, J., Heffernan, S., Greaney, S., Kilty, C., Goodwin, J., Hartigan, I., O'Brien, M., Chambers, D., Twomey, U. and O'Donovan, A. (2022) *Suicide and Self-Harm Risk Assessment: A Systematic Review of Prospective Research*, *Archives of Suicide Research*, 26 (4) 1645-1665.
337. Saeid Atabaki, M., Mohammadi, M. and Aryanpur, V. (2022) *An integrated simulation-optimization modelling approach for sustainability assessment of electricity generation system*, *Sustainable Energy Technologies and Assessments*, 52, 102010.
338. Saikia, S.D., Ryan, P., Nuyts, S. and Clifford, E. (2022) *Precipitation, tidal and river level impacts on influent volumes of combined wastewater collection systems: A regional analysis*, *Results in Engineering*, 15, 100588.
339. Sánchez, M., Fouz, D.M., López, I., Carballo, R. and Iglesias, G. (2022) *Effects of Tidal Stream Energy Exploitation on Estuarine Circulation and Its Seasonal Variability*, *Journal of Marine Science and Engineering*, 10 (10) 1545.
340. Santamarina, P.E., Barreda, V.D., Iglesias, A., Varela, A.N. and Mays, C. (2022) *Comparison of mid-Cretaceous (Cenomanian–Turonian) high-latitude palynofloras from Patagonia and New Zealand: Richness, ecology, and provincialization*, *Palaeogeography, Palaeoclimatology, Palaeoecology*, 604, 111216.
341. Sarwar, A., McSweeney, C., Smith, M. and Moore, E. (2022) *Estimation of the Number of Scans Required per Hard-to-Clean Location and Establishing the Limit of Quantification of a Partial Least Squares Calibration Model When the FTIR Is Used for Pharmaceutical Cleaning Verification*, *Molecules*, 27 (14) 4569.
342. Sarwar, A., McSweeney, C., Timmermans, J. and Moore, E. (2022) *Identifying pharmaceutical manufacturing equipment's surface roughness and mitigating robustness concerns when using specular reflectance Fourier-transform infrared (FTIR) spectroscopy for rapid cleaning verification*, *Talanta Open*, 6, 100130.
343. Shenton, F.C., Addissie, A., Alabaster, G., Baziwe, D., Carrasco Tenezaca, M., Chinula, D., Jatta, E., Jawara, M., Jones, R., Knudsen, J., Krystosik, A.R., McCann, R., Murima, N., Mutuku, F., Nguela, R.L., Nieto Sanchez, C., Nix, E., Okumu, F., Ruel-Bergeron, S., Spitzen, J., Tusting, L.S., Wilson, A.L., Wood, H., Zahouli Bi Zahouli, J., Davies, M. and Lindsay, S.W. (2022) *Research agenda for preventing mosquito-transmitted diseases through improving the built environment in sub-Saharan Africa*, *Cities and Health*, 6 (1) 72-80.
344. Siddiquee, S.M.S., Agyeman, K.A., Bruton, K., Howard, B. and O'Sullivan, D.T.J. (2022) *A Data-driven Assessment Model for Demand Response Participation Benefit of Industries*, 2022 IEEE Texas Power and Energy Conference (TPEC), College Station, TX, USA, 1-6.
345. Siddiquee, S.M.S., Khan, M.M.H., Al-Ismaïl, F.S., Ullah, A., Alam, M.S. and Ahmed, H. (2022) *Blockchain applications in smart sustainable city context—A systematic mapping study*, *Energy Reports*, 8, 162-169.
346. Singh, R., Paritosh, K., Pareek, N. and Vivekanand, V. (2022) *Integrated system of anaerobic digestion and pyrolysis for valorization of agricultural and food waste towards circular bioeconomy: Review*, *Bioresource Technology*, 360, 127596.
347. Siroli, L., Giordani, B., Rossi, S., Gottardi, D., McMahon, H., Augustyniak, A., Menon, A., Vannini, L., Vitali, B., Patrignani, F. and Lanciotti, R. (2022) *Antioxidant and Functional Features of Pre-Fermented Ingredients Obtained by the Fermentation of Milling By-Products*, *Fermentation*, 8 (12) 722.
348. Smith, G., LeTissier, M., O'Hagan, A.M. and Farrell, E.J. (2022) *Policy Coherence for Climate Change Adaptation at the Land-Sea Interface in Ireland*, *Planning Practice and Research*, 37 (2) 173-188.
349. Spyreli, E., McGowan, L., Heery, E., Kelly, A., Croker, H., Lawlor, C., O'Neill, R., Kelleher, C., McCarthy, M., Wall, P. and Heinen, M. (2022) *Public beliefs about the consequences of living with obesity in the Republic of Ireland and Northern Ireland*, *BMC Public Health*, 22 (1) 1910.
350. Steel, D., DesRoches, C.T. and Mintz-Woo, K. (2022) *Climate change and the threat to civilization*, *Proceedings of the National Academy of Sciences of the United States of America*, 119 (42) e2210525119.
351. Stejskal, V., Paolacci, S., Toner, D. and Jansen, M.A.K. (2022) *A novel multitrophic concept for the cultivation of fish and duckweed: A technical note*, *Journal of Cleaner Production*, 366, 132881.
352. Ste-Marie, E., Grémillet, D., Fort, J., Patterson, A., Brisson-Curadeau, É., Clairbaux, M., Perret, S., Speakman, J.R. and Elliott, K.H. (2022) *Accelerating animal energetics: high dive costs in a small seabird disrupt the dynamic body acceleration-energy expenditure relationship*, *The Journal of experimental biology*, 225 (12) .
353. Strano, F., Micaroni, V., Davy, S.K., Woods, L. and Bell, J.J. (2022) *Near-future extreme temperatures affect physiology, morphology and recruitment of the temperate sponge *Crella incrustans**, *Science of the Total Environment*, 823, 153466.
354. Suhail, M.A., Shrivastava, S., Paritosh, K., Pareek, N., Kovalev, A.A., Kovalev, D.A., Litt, Y.V., Panchenko, V., Bolshev, V. and Vivekanand, V. (2022) *Advances in Applications of Cereal Crop Residues in Green Concrete Technology for Environmental Sustainability: A Review*, *Agriculture (Switzerland)*, 12 (8) 1266.
355. Sullivan, T. and O'Callaghan, I. (2022) *Understanding the Source, Behaviour, and Fate of Nanoplastics in Aquatic Environments* Lang, Y. (Editor) *Influence of Microplastics on Environmental and Human Health: Key Considerations and Future Perspectives* (1st ed.), CRC Press, Boca Raton, pp. 41-60.
356. Summers, G., Lim, A. and Wheeler, A.J. (2022) *A Characterisation of Benthic Currents from Seabed Bathymetry: An Object-Based Image Analysis of Cold-Water Coral Mounds*, *Remote Sensing*, 14 (19) 4731.
357. Sumner, R.C., Cassarino, M., Dockray, S., Setti, A. and Crone, D.M. (2022) *Moving towards a multidimensional dynamic approach to nature and health: A bioavailability perspective*, *People and Nature*, 4 (1) 44-52.
358. Sweeney, C.J., Hennessy, R., Jones, P.W., Lettice, E. and Sleeman, D.P. (2022) *Do badgers (*Meles meles*) affect the distribution of Elder (*Sambucus nigra*)?*, *Irish Naturalists' Journal* 39: 60-66.
359. Taheri, J., Moghadam, T.T., Taheri, S., Safari, M.K. and Eslami, F. (2022) *Assessment of passive design strategies in traditional houses of Sabzevar, Iran*, *Journal of Cultural Heritage Management and Sustainable Development*, 12 (4) 570-592.
360. Tan, Z., Fuchs, H., Hofzumahaus, A., Bloss, W.J., Bohn, B., Cho, C., Hohaus, T., Holland, F., Lakshminisha, C., Liu, L., Monks, P.S., Novelli, A., Niether, D., Rohrer, F., Tillmann, R., Valkenburg, T.S.E., Vardhan, V., Kiendler-Scharr, A., Wahner, A. and Sommariva, R. (2022) *Seasonal variation in nitryl chloride and its relation to gas-phase precursors during the JULIAC campaign in Germany*, *Atmospheric Chemistry and Physics*, 22 (19) 13137-13152.
361. Todd, N.R.E., Jessopp, M., Rogan, E. and Kavanagh, A.S. (2022) *Extracting foraging behavior from passive acoustic monitoring data to better understand harbor porpoise (*Phocoena phocoena*) foraging habitat use*, *Marine Mammal Science*, 38 (4) 1623-1642.
362. Tran, T.Q., Banning, A., Heinze, T. and Wohnlich, S. (2022) *Integration of self-organizing maps, statistical analysis, and hydrogeochemical modeling methods to identify spatio-seasonal variations in mine water quality*, *Journal of Geochemical Exploration*, 233, 106908.
363. Troya, M.D.C., Power, O.-P. and Kopke, K. (2022) *Is It All About the Data? How Extruded Polystyrene Escaped Single-Use Plastic Directive Market Restrictions*, *Frontiers in Marine Science*, 8, 817707.
364. Troya, M.I., Spittal, M.J., Pendrous, R., Crowley, G., Gorton, H.C., Russell, K., Byrne, S., Musgrove, R., Hannah-Swain, S., Kapur, N. and Knipe, D. (2022) *Suicide rates amongst individuals from ethnic minority backgrounds: A systematic review and meta-analysis*, *eClinicalMedicine*, 47, 101399.

365. Tyack, P.L., Thomas, L., Costa, D.P., Hall, A.J., Harris, C.M., Harwood, J., Kraus, S.D., Miller, P.J.O., Moore, M., Photopoulou, T., Pirotta, E., Rolland, R.M., Schwacke, L.H., Simmons, S.E. and Southall, B.L. (2022) *Managing the effects of multiple stressors on wildlife populations in their ecosystems: Developing a cumulative risk approach*, Proceedings of the Royal Society B: Biological Sciences, 289 (1987) 20222058.
366. Urrea-Castellanos, R., Caldana, C., Henriques, R. (2022) *Growing at the right time: interconnecting the TOR pathway with photoperiod and circadian regulation*. Journal of Experimental Botany, 73(20), 7006-7015.
367. Verswijveren, S.J.J.M., Powell, C., Chappel, S.E., Ridgers, N.D., Carson, B.P., Dowd, K.P., Perry, I.J., Kearney, P.M., Harrington, J.M. and Donnelly, A.E. (2022) *The Influence of Sitting, Standing, and Stepping Bouts on Cardiometabolic Health Markers in Older Adults*. Journal of Aging and Physical Activity, 30 (1) 114-122.
368. Vesanen, T., Shemeikka, J., Tsatsakis, K., O'Regan, B., Hryshchenko, A., O'Leidhin, E. and O'Sullivan, D. (2022) Digital Tools for HVAC-Design, Operation and Efficiency Management. In: Daniotti, B., Lupica Spagnolo, S., Pavan, A. and Bolognesi, C.M. (Editors) Innovative Tools and Methods Using BIM for an Efficient Renovation in Buildings, SpringerBriefs in Applied Sciences and Technology, Springer, Cham, Chapter 5, pp. 63-73.
369. Veselá, B., Holub, P., Urban, O., Surá, K., Hodaňová, P., Oravec, M., Divinová, R., Jansen, M.A.K. and Klem, K. (2022) *UV radiation and drought interact differently in grass and forb species of a mountain grassland*, Plant Science, 325, 111488.
370. Vingiani, G.M., Leone, S., De Luca, D., Borra, M., Dobson, A.D.W., Ianora, A., De Luca, P. and Lauritano, C. (2022) *First identification and characterization of detoxifying plastic-degrading DBP hydrolases in the marine diatom *Cylindrotheca closterium**, Science of the Total Environment, 812, 152535.
371. Vu Dinh, Q., Doan, Q.-V., Ngo-Duc, T., Nguyen Dinh, V. and Dinh Duc, N. (2022) *Offshore wind resource in the context of global climate change over a tropical area*, Applied Energy, 308, 118369.
372. Walsh, É., Cialis, E., Dillane, E. and Jansen, M.A.K. (2022) *Lemnaceae clones collected from a small geographic region display diverse traits relevant for the remediation of wastewater*, Environmental Technology and Innovation, 28, 102599.
373. Wang, M., Varma, R., Venables, D.S., Zhou, W. and Chen, J. (2022) *A Demonstration of Broadband Cavity-Enhanced Absorption Spectroscopy at Deep-Ultraviolet Wavelengths: Application to Sensitive Real-Time Detection of the Aromatic Pollutants Benzene, Toluene, and Xylene*, Analytical Chemistry, 94 (10) 4286-4293.
374. Weinstein, B.G., Garner, L., Saccomanno, V.R., Steinkraus, A., Ortega, A., Brush, K., Yenni, G., McKellar, A.E., Converse, R., Lippitt, C.D., Wegmann, A., Holmes, N.D., Edney, A.J., Hart, T., Jessopp, M.J., Clarke, R.H., Marchowski, D., Senyondo, H., Dotson, R., White, E.P., Frederick, P. and Ernest, S.K.M. (2022) *A general deep learning model for bird detection in high-resolution airborne imagery*, Ecological Applications, 32 (8) e2694.
375. Weyman, G., Butler, F. and McKeown, S. (2022) *Enhancing Our Understanding of Ladybirds in Ireland—A Case Study of the Use of Citizen Science*, Frontiers in Conservation Science, 3, 759113.
376. Wingler, A. and Henriques, R. (2022) *Sugars and the speed of life—Metabolic signals that determine plant growth, development and death*, Physiologia Plantarum, 174 (2) e13656.
377. Wo, D., Bi, G., Li, L., Kang, X., Kong, X., Jiang, E. and Xie, J. (2022) *Effects of Iron Oxides on the Anaerobic Codigestion Performances of the Pennisetum Hybrid and Kitchen Waste*, Journal of Environmental Engineering (United States), 148 (10) 4022062.
378. Wu, B., Lin, R., Ning, X., Kang, X., Deng, C., Dobson, A.D.W. and Murphy, J.D. (2022) *An assessment of how the properties of pyrochar and process thermodynamics impact pyrochar mediated microbial chain elongation in steering the production of medium-chain fatty acids towards n-caproate*, Bioresource Technology, 358, 127294.
379. Xue, X., Jin, S., An, F., Zhang, H., Fan, J., Eichhorn, M.P., Jin, C., Chen, B., Jiang, L. and Yun, T. (2022) *Shortwave Radiation Calculation for Forest Plots Using Airborne LiDAR Data and Computer Graphics*, Plant Phenomics, 2022, 9856739.
380. Yadav, M., Joshi, C., Paritosh, K., Thakur, J., Pareek, N., Masakapalli, S.K. and Vivekanand, V. (2022) *Reprint of Organic waste conversion through anaerobic digestion: A critical insight into the metabolic pathways and microbial interactions*, Metabolic Engineering, 71, 62-76.
381. Yadav, M., Joshi, C., Paritosh, K., Thakur, J., Pareek, N., Masakapalli, S.K. and Vivekanand, V. (2022) *Organic waste conversion through anaerobic digestion: A critical insight into the metabolic pathways and microbial interactions*, Metabolic Engineering, 69, 323-337.
382. Yang, Z., Benton, M.J., Hone, D.W.E., Xu, X., McNamara, M.E. and Jiang, B. (2022) *Allometric analysis sheds light on the systematics and ontogeny of anurognathid pterosaurs*, Journal of Vertebrate Paleontology, 41 (5) e2028796.
383. Yang, Z., Wang, M., Hou, Y., Liu, Y., Chandran, S., Varma, R., Lou, S. and Chen, J. (2022) *Intercomparison of Ambient Nitrous Acid Measurements in a Shanghai Urban Site*, Atmosphere, 13 (2) 329.
384. Zangana, K.H., Fernandez, A. and Holmes, J.D. (2022) *Simplified, fast, and efficient microwave assisted chemical recycling of poly (ethylene terephthalate) waste*, Materials Today Communications, 33, 104588.
385. Zhang, Y., Kang, X., Zhen, F., Wang, Z., Kong, X. and Sun, Y. (2022) *Assessment of enzyme addition strategies on the enhancement of lipid yield from microalgae*, Biochemical Engineering Journal, 177, 108198.
386. Zhou, J., Zhao, W., Zhang, Y., Fang, B., Cheng, F., Xu, X., Ni, S., Zhang, W., Ye, C., Chen, W. and Venables, D.S. (2022) *Amplitude-Modulated Cavity-Enhanced Absorption Spectroscopy with Phase-Sensitive Detection: A New Approach Applied to the Fast and Sensitive Detection of NO₂*, Analytical Chemistry, 94 (7) 3368-3375.



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