QUEEN'S UNIVERSITY BELFAST

MARINE LABORATORY

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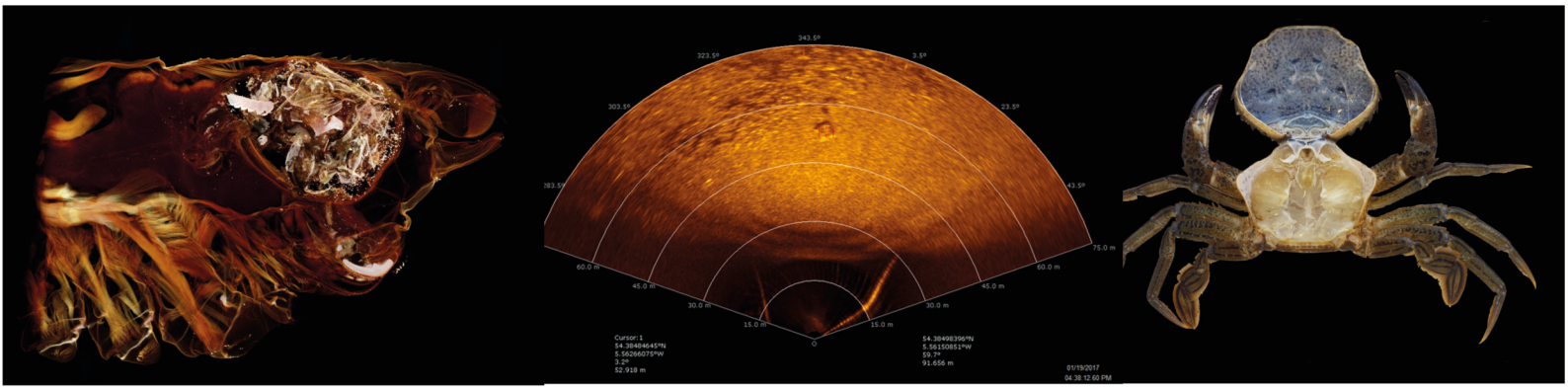
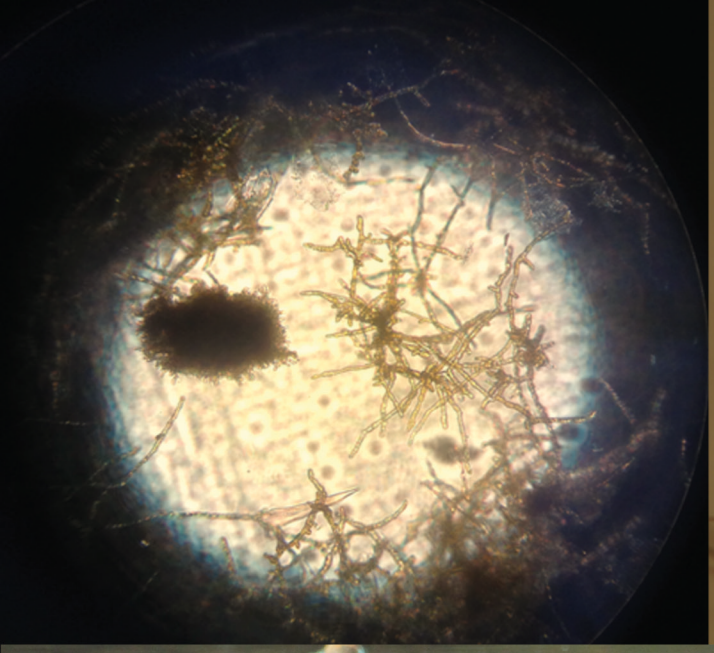
Review 2015 - 2017





Queen's University Marine Laboratory QML Review 2015-2017 Prepared by Prof. Jaimie Dick and Mr. Simon Exley, with contributions from QML staff and researchers. Photography credits: Neil Coughlan (*Corbicula* in sieve) , Dr. Ross Culloch (seal), Ruadri Cunningham and Gina Vong (Mosquito larvae head), Ross Cuthbert (Copepod with mosquito larvae), Ivan Ewart (QML boats), Emma Gorman (seaweed collecting, *Saccharina latissima* gametophytes), Dr. Lilian Lieber (Strangford Lough seascapes, sonar, ADCP), Dr. Karen Mooney-McAuley (*S. Latissima* longline), Simon Exley (Strangford Sunset).

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Introduction

Queen's Marine Laboratory (QML) Review 2015-2017

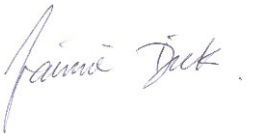
In 2015, Dr. Julia Sigwart introduced the QML 2014-15 Annual Review, in which we showcased the success of the 2010-14 QML Strategic Plan, listing our major funded research projects, individual research profiles of QML staff and students, plus details of conferences, outreach, meetings and visitors. We also detailed an impressive range of over 100 publications from QML in the period 2014-15 alone. The 2014-15 Annual Review has been used to report to QML Senior Management and to advertise our activities to prospective staff, students and visitors. In addition, the Annual Review was an opportunity to hand the Directorship to myself and strategise for the future of QML in uncertain times.

My overarching theme for the past two years has thus been diversification for QML, stemming from the realisation that QML has huge potential within and across scientific disciplines and sponsors. We are thus pleased to present the QML Review of 2015-17 as evidence of our successes in developing the potential and range of QML activities. QML now has significant footprints from three major Schools at QUB: the School of Biological Sciences (SBS), School of Natural and Built Environment (SNBE), and the School of Chemistry and Chemical Engineering (SCCE). This is reflected in several Principal Investigators such as myself, Dr. Julia Sigwart, Prof. Mark Emmerson, Dr. Alberto Longo and Dr. Karen Mooney (SBS), Dr. Louise Kregting (SNBE) and Dr. Pamela Walsh (SCCE). These projects are funded from diverse sources, such as Seafish, Irish EPA, EU, InvestNI, BBSRC and NERC. PhD studentships at QML are now also from a wide variey of sources, such as DAERA, DfE, EU, NIEA, IFI and RCUK.

Further, we have developed research projects in the marine, freshwater and terrestrial realms, recognising that global issues are common to all habitats and environments. Hence, for example, we have developed invasive species facilities to examine the interplay of climate change with alien species, such as lionfish, Asian clams and mosquitoes. We also continue with the themes of algal biofuels and products such as animal feed with joint SBS/SCCE projects. We also have world leading wave and tidal energy research facilities which incorporate the assessment of the environmental interactions of these new technologies. Funding streams are thus no longer only "marine" in nature and span basic and applied sciences. We also now publish in a wider array of journals, with several 3* and 4* REF papers already identified. In addition, this strategy has attracted more PhD, MSc and Honours students, and visitors and sponsors from around the world.

We also recognise that QML must engage more with undergraduate and graduate teaching, and hence we continue to host SBS Field Courses and student groups from elsewhere, such as TCD. We now use QML facilities for lecture delivery combined with one-day field excursions and research showcasing, such as with MSc programmes in Ecological Management and Conservation Biology, Policies and Strategies for Sustainable Development, and Marine Energy Courses. Placement students from SERC and Nuffield also join our teams.

I thus invite you to browse the following pages and note our diversity of research, teaching and community engagement, and warmly extend our welcome to you from the QML family.



Prof. Jaimie T.A. Dick
QML Director, March 2018

QML Key Infrastructure

Boats

Queen's University Marine Laboratory has two open sea boats, "Tonicella" (7m Rigid -Hulled Inflatable Boat) and "Cumella" (5.7m long fibreglass, clinker-hulled boat). Their purpose is to facilitate research and teaching activities within Strangford Lough, although they are also used further afield (via towing trailers). These boats are particularly adept to access a great many shallow and confined sites in Strangford Lough. In total, 178 passages have been made using the QML boats (since 2015) covering over 1400 nautical miles. The majority of boat passages were made to carry out potting surveys (43%), SCUBA diving surveys (11%), and plankton tows (9%).

Diving

QML has its own SCUBA diving facility on site. It is the only HSE-approved diving facility in QUB. It caters for sub-surface scientific research in Northern Ireland with the majority of the work occurring in Strangford Lough.

The facility has an excellent safety record and robust management system for SCUBA diving, which includes membership of the UK Scientific Diving Supervisory Committee. QUB also maintain good links with the National Facility for Scientific Diving (based at the Scottish Association for Marine Science) and UK conservation agencies such as the Marine Division (in Northern Ireland) and the Joint Nature Conservation Committee (in England). These provide unique research opportunities as well as access to training courses for trainee divers.

Since 2015, there have been twelve major diving projects. In this time QML has facilitated 122 person dives to sites throughout Northern Ireland, Scotland and Australia. Since 2015, there have been ten divers who have participated in underwater research at QML.

Seawater System

The life-blood of QML is the flow-through seawater system. The system allows long-term husbandry of live specimens for research. Seawater is pumped out of Strangford Lough into two holding tanks where the majority of the suspended sediments settle out of the water. Next it flows via two drainage valves into the QML pumphouse, where two pumps force the water through two sand filters. The filtered water leaves the pumphouse and enters general circulation around indoor and outdoor aquarium facilities in QML. The seawater system was established in the 1970s and upgraded in 2012. New air blowers were fitted in 2016.

Diving and Boating Training Centre

QML is also now an RYA approved training centre allowing students and staff to gain their MCA commercial endorsements. QML can also train people as European Advanced Scientific Divers, again qualifying students and staff to work in the scientific sector commercially.

Coastal Wave Basin

QML has a 18 x 16 m wave basin, with an operating depth up to 0.65 m. The wave tank is equipped with state of the art instrumentation, including a 24-paddle Edinburgh Design Ltd Wave Maker with active wave absorption. The electric paddles can produce regular and random waves with heights up to 0.55 m, wave angle variations from 0° to 45° and wave periods from 1 s to 3.5 s.

Video capture, motion tracking, load measurement along the 6-degrees-of-freedom and conductivity measurements using twin-wire wave gauges are additional instrumentations also available. The basin has an adjustable tank floor for tests at various depths.

Recent tests have included: Interaction of wave energy converter arrays; Effect of marine energy array on the coastline; Wave breakers, wave barriers, piers, harbours, piles, revetment slopes; Effects on navigation and berthing; Coastal flooding estimation.

QML Key Infrastructure

Research and Teaching Equipment and Capacity

QML has numerous amenities available to facilitate teaching and research. These include:

Amenities

- Teaching laboratory suitable for 60+ students, equipped with running seawater
- Molecular laboratory
- Macroalgal culture constant temperature room with incubation chamber
- Microalgal hatchery and 1000 litre bioreactor
- Microscopy and histology laboratory
- 18 x 16m wave basin with 24 paddle wave maker, video imaging and motion tracking equipment
- Large mesocosm facility with pumped air and seawater, electrical connection and space to accommodate over 100 replicates
- Purpose built and biosecure insectiary with humidity and temperature control
- Outdoor large scale seaweed growth research site in Strangford Lough
- Dark rooms for experimental set up
- Conference and seminar rooms
- Generally equipped multiple wet and dry laboratories
- Large tank arrays for animal and plant housing/experimental set up
- Office facilities for 30+ staff and students
- Communal meeting room
- Fully equiped workshop
- Library

Equipment

- Bran Leubbe Autoanalyser for nutrient analysis
- Histology suite with microtome with diamond cutting blade
- Graphics workstation supporting AMIRA 3D model rendering
- Dissecting and compound microscopes with digital camera attachment
- PCR and gel electrophoresis equipment
- 6 channel fibre optic oxygen probes
- Centrifuge and microcentrifuge
- Open and sealed shaker tables
- Environmental monitoring equipment
- Plankton tow nets
- Autoclave facility
- Water chillers/heaters and UV water sterilisers and water distillation unit
- Fume and Laminar flow cabinets
- Freeze drying capacity
- Muffle furnace
- Coulter counters for cell size analysis
- Freezer sample storage
- Soil/invertebrate sorting equipment (eg Tullgren Funnells, insect light traps)
- Glass aquaria, multiple volumes

Teaching Activities QML 2015-17

School of Natural and Built Environment Environmental Impact Assessment Module led by Prof. Hutchinson.
25–30 students each year come to Queen's Marine Laboratory where they are taken out on the Lough for a trip around SeaGen, then they are given a 2 hour lecture in the teaching lab on the Environmental Monitoring of SeaGen by Dr. Louise Kregting.

School of Natural and Built Environment Architecture course led by Prof. Morrow.
10-12 students spend a day at the laboratory discussing their Architecture projects designed to be located within the Lough and the environmental implications of their designs. Dr. Louise Kregting provides them with a history of Strangford Lough and why it is so important from both a physical and biological perspective, with reference to human land use changes and developments.

School of Natural and Built Environment Tidal Energy Course led by Dr. Kregting.
15–20 Students each year spend the day in the state-of-the-art wave tank facilities at QML as well as out on the Lough to get hands-on experience of how to measure currents and waves.

School of Biological Sciences Biodiversity Level 1, led by Dr. Mensink.
110-120 students in three batches spend 3 days at QML learning environmental issues with field and laboratory based exercises, data collection and analyses, problem solving and report writing. Prepares students for Level 2 field courses and Honours projects.

School of Biological Sciences Coastal and Oceanic Biology, Level 2, led by Dr. Houghton.
Field course in plankton sampling, boating, BRUV deployments, shore sampling, project design, data collection, analyses in R. Builds on Level 1 field course and prepares for Honours projects.

Policies and Strategies for Sustainable Development, MSc led by Dr. Stephens.
Students are introduced to topics in sustainable land use and fisheries, plus fieldsports and the economics of recreational hunting/shooting/fishing, plus structured debates on ethics/conservation/animal welfare. Boat trips and lough shore visits complement class activities, with discussions on PhD opportunities and the job market.

School of Biological Sciences Ecological Management and Conservation Biology, MSc. led by Dr. Reid.
The QML location is ideal for use in practical application of concepts and techniques from lectures, with field trips to view land-use types and conflicts, integration of conservation and management practices, fisheries and environmental monitoring/assessment.

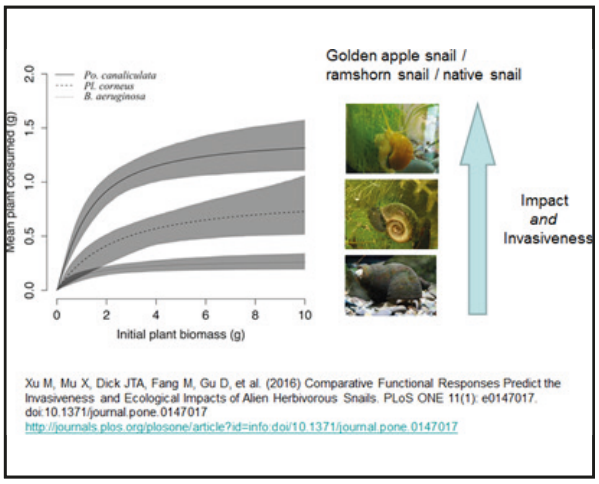
School of Biological Sciences Honours Project.
Around 8 students each year undertake field and laboratory based Honours Projects in the Marine, Freshwater and Terrestrial Environments, benefitting from the interdisciplinary projects at QML with exposure to ecologists, evolutionary biologists, behaviourists, engineers and chemists.

Predicting the Ecological Impacts of Invasive Species across the Globe in Changing Environments

Prof. Jaimie T.A. Dick (QML Director/Professor of Invasion Ecology)

Environmental Protection Agency, Seafish, Invest NI, British Council Newton Fund

School of Biological Sciences



Invasive species continue to disrupt ecosystems around the world, costing £Billions annually to the global economy and harm human, animal and plant health. We have developed new metrics, based on *per capita* consumption (the functional response; **see Figure**), that successfully predict which introduced species will have impact, and even the severity of that impact. We can also, for the first time, assess the impact potential of new and future invaders. **The Figure** shows that the impacts of the invasive golden apple snail were entirely predictable from our method.

KEY FINDINGS

Invasive species have their impacts through heightened "functional responses", which can be measured for any consumer of any taxonomic or trophic group. Thus, we have unified invasion ecology with a truly universal metric that can assess the impacts of any invader.

OUTPUTS

Paterson, R., Dick, J.T.A., Pritchard D., Ennis, M., Hatcher, M.J. & Dunn, A.M. (2015). Predicting invasive species impacts: a community module functional response approach reveals context dependencies. Journal of Animal Ecology, 84: 453-463.

Dick, J.T.A. et al. (2017). Invader Relative Impact Potential: a new metric to understand and predict the ecological impacts of existing, emerging and future invasive alien species. Journal of Applied Ecology,54:1259-1267(+Keynotes in S. Africa, Spain, USA, Canada, Argentina, Croatia)

COLLABORATORS

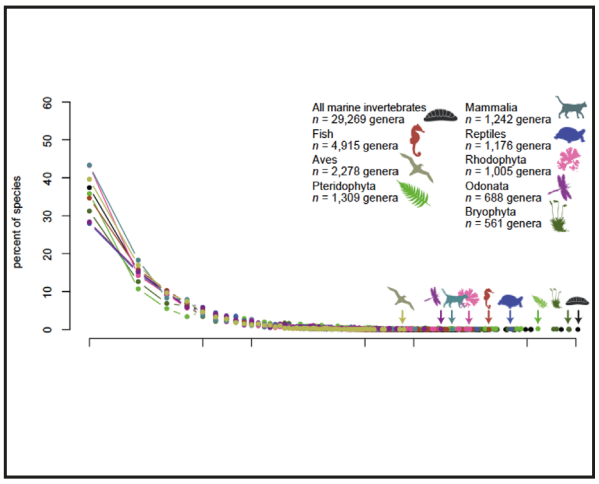
Profs T. Ricciardi & H. MacIsaac, McGill & Windsor, Canada; Prof. J. Jeschke, Leibniz, Germany; Profs D. Richardson & O. Weyl, CIB Stellenbosch, S. Africa; Prof. M. Thiel, Coquimbo, Chile; Dr. M. Xu, China; Prof. P. Banks, Australia; Profs D. Aldridge & WJ Sutherland, Cambridge, UK; Drs A. Dunn & M. Hatcher, Leeds, UK; Dr. H. Roy, NERC, UK.

Modelling Biodiversity Dynamics in Deep Time

Dr. Julia Sigwart (QML Assoc. Director/Senior Lecturer)

EU H2020 (Marie Skłodowska-Curie Actions), British Council, SeaFish

School of Biological Sciences



The focus of my sabbatical research project 'DeepTrees: Computational modelling of evolutionary dynamics in deep time', is to create better comparisons of patterns in living biodiversity and the fossil record. Evolution is chaotic. Adaptive features, which are relevant to each particular species, shape how they respond to environmental perturbations, now and in the fossil record. But with enough comparative data, we find surprising consensus in large-scale patterns across all animal groups. The work in my research group crosses genetics, morphology, anatomy, neurobiology, physiology, computational modelling, and experimental approaches, to understand the adaptations that drive species diversity. The theoretical foundation of these ideas will also be discussed in my forthcoming book, What Species Mean, which will be published by CRC/Taylor & Francis (USA).

KEY FINDINGS

The branching patterns of speciation are reflected in the size and scope of animal groupings, even though taxonomy pre-dates modern understanding of evolution.

OUTPUTS

Led training workshops in Malaysia on coastal conservation (2016) & mollusc biodiversity (2017).

Over 20 invited lectures and conference presentations in 7 countries (2015-2017).

Over 30 papers in journals such as Current Biology, BMC Evolutionary Biology, and Evolution.

Forthcoming book, What species mean, will be published in 2018.

COLLABORATORS

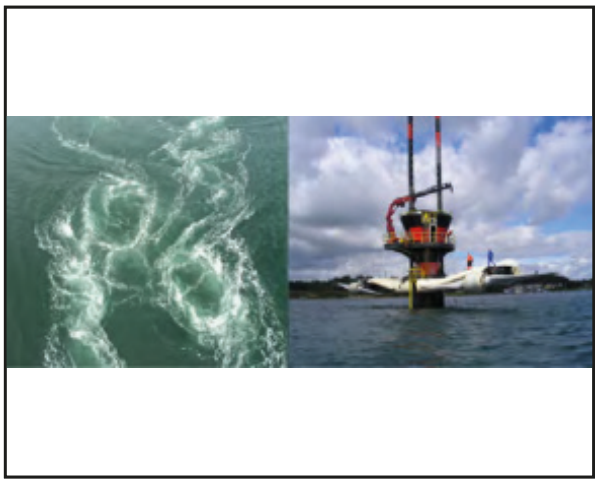
USA: University of California, Berkeley (Museum of Paleontology) UC Davis (Bodega Marine Lab); UC Santa Barbara; California Academy of Sciences; Lawrence Berkeley National Labs; Japan: JAMSTEC; Falkland Islands: South Atlantic Environmental Research Institute; Malaysia: Universiti Putra Malaysia, Universiti Sains Malaysia, Universiti Malaya.

Environmental Impacts of Marine Renewable Energy Farms

Dr. Bjoern Elsaesser (Lecturer)

EPSRC

School of Natural and Built Environment



The aim of this research is to demonstrate the ability to numerically model the change in ambient hydrodynamics resulting from the installation of wave and tidal device arrays and to couple the model output to associated ecological models, to allow prediction of associated changes in benthic habitats and dynamics, plankton growth and fish communities.

KEY FINDINGS

Coupled hydrodynamic ecological models can be successfully used as tools to simulate the changes in a range of biological processes, including biogeochemistry processes, large scale dispersal processes and changes to benthic communities. Results suggest that natural variation of biological processes are larger than from changes caused by hydrodynamics alone.

OUTPUTS

Schmitt, P. & Elsaesser, B. (2015). On the use of OpenFOAM to model Oscillating wave surge converters. Ocean Engineering, 108: 98-104.

Schmitt, P., Asmuth., H. & Elsaesser, B. (2016). Optimising power take-off of an oscillating wave surge converter using high fidelity numerical simulations. International Journal of Marine Energy, 16: 196-208.

COLLABORATORS

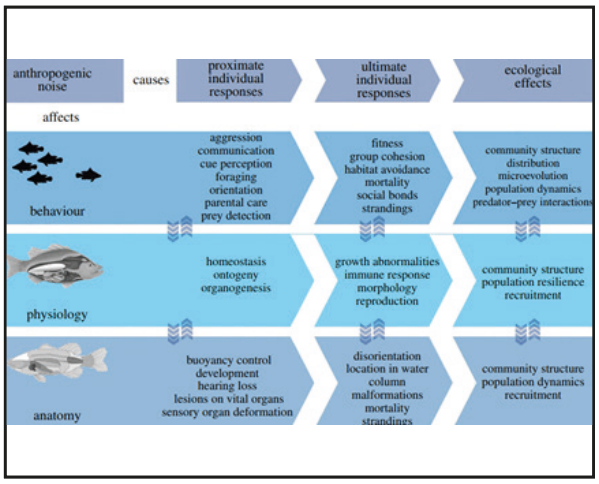
Dr. Louise Kregting, Dr. Pal Schmitt, Prof. Trevor Whittaker, Imperial College London, CEFAS.

Aquatic Noise Pollution

Dr. Hansjoerg Kunc (Lecturer in Animal Behaviour)

DAERA, AFBI

School of Biological Sciences



My research is strongly hypothesis driven and most of my current work deals with how animals cope with global change and why species differ in their susceptibility to environmental changes.

Figure. The effects of anthropogenic noise on individuals' anatomy, physiology, and/or behaviour. Changes in the acoustic environment through increasing noise levels can lead to immediate proximate responses, resulting in a variety of emergent responses, leading to large-scale ecological effects.

KEY FINDINGS

Anthropogenic noise affects both aquatic and terrestrial species. Not only species that use acoustic signals such as birds and cetaceans are affected by anthropogenic noise, but also species such as the Dublin bay prawn, hermit crabs and cuttle fish. Thus, increasing noise levels affect commercially important species.

OUTPUTS

Kunc HP, McLaughlin KE, Schmidt R (2016). Aquatic Noise Pollution: Implications for Individuals, Populations and Ecosystems. Proceedings of the Royal Society B 283: 20160839.

Walsh E, Arnott G, Kunc HP (2017). Noise affects resource assessment in an invertebrate. Biology Letters. 20170098.

COLLABORATORS

Dr. Gareth Arnott (QUB), Dr. Jon Houghton (QUB).

Pelagic Ecology

Dr. Jonathan D.R. Houghton (Lecturer in Marine Biology)

Fisheries Society of the British Isles, NERC, Irish Marine Institute, BECAS (Chile).

School of Biological Sciences

Dr. Houghton's group uses a range of techniques from satellite tracking through to stable isotopes to investigate the movement & trophic ecology of pelagic species (e.g. salmonids, sharks, sea turtles & gelatinous zooplankton). He serves as a panel member for NERC and provided advice to UK Government & the UN on climate change & migratory species. His interest in outreach culminated in the British Science Association Charles Lyell Award for Public Understanding of Environmental Science.

KEY FINDINGS

Ocean sunfishes emerge as a highly abundant migratory species, prone to extraordinary levels of bycatch; Avian predators reveal an unexpected trophic subsidy by feeding extensively on jellyfish; The distribution and physiology of tiger sharks is predictably governed by temperature; Basking shark physiological performance is akin to highly predatory white sharks.

OUTPUTS

Phillips et al. (2017). Applying species distribution modelling to a data poor, pelagic fish complex: The ocean sunfishes. Journal of Biogeography. I. DOI: 10.1111/jbi.13033.

Payne et al. (in press). Temperature systematically governs tiger shark activity, movement and occurrences throughout global coastlines. Global Change Biology.

Two Discovery Channel documentaries aired on ocean sunfish & basking sharks.

COLLABORATORS

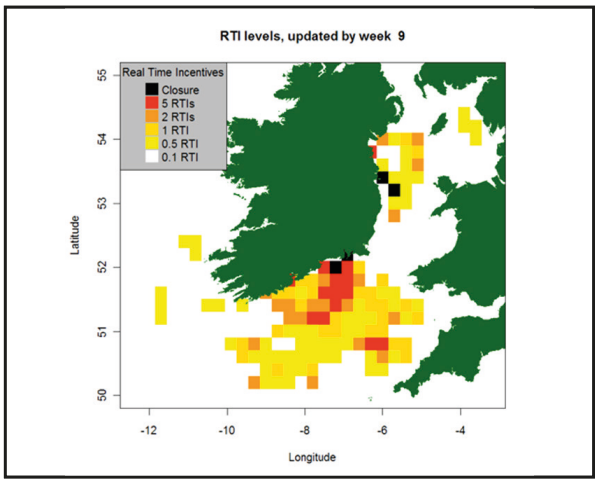
Dr. Yuuki Watanabe, National Institute of Polar Research, Japan; Dr. Pete Klimely, University of Calfornia Davis, USA; Drs Nicholas Payne & Lewis Halsey, University of Roehampton, UK; Macarena Parra, The Charles Darwin Foundation, Galapagos; Portofino Marine Protected Area Authority, Japan; Thierney Thys, National Geographic, USA; Inland Fisheries Ireland, ROI; Prof. Chris Harrod, University of Antofagasta, Chile.; Prof. John Davenport, University of Exeter; Dr. Tom Doyle, National University of Ireland, Galway.

The Scientific Underpinning for Sustainable Fisheries Management

Dr. Keith D Farnsworth (Lecturer)

DEL/SFI

School of Biological Sciences



Marine fisheries management now takes account of the whole ecosystem which produces what is harvested and additional ecosystem services. This approach is incorporated into law at EU and UK levels by the Marine Strategy Framework Directive and is informed by scientific understanding of marine ecosystems, fisheries behaviours and economics. This is based on complex ecological models and data from research surveys, fish landings reports and satellite information. Our work has contributed to better understanding marine biodiversity, its functioning and economic value and the way fish populations interact with one another.

KEY FINDINGS

Different fishery sectors can strongly influence one another's yield through ecological interactions among the fish species they target. Conversely, seals (often blamed for loss of yield) have no significant effect on trawl fishery yields (excludes inshore salmon fishing, which they can affect). Fishing has a strong effect on the size-structure of the marine community of the Celtic and North Seas and it is one that cannot recover in less than twenty years.

OUTPUTS

Farnsworth, K.D., Adenuga, A.H. & de Groot, R.S. (2015). The complexity of biodiversity: A biological perspective on economic valuation. Ecological Economics, 120: 350-354.

Effects of seal predation on a modelled marine fish community and consequences for a commercial fishery. JE Houle, F Castro, MA Cronin, KD Farnsworth, M Gosch, DG Reid. 2016.
Journal of Applied Ecology, 53 (1): 54-63.

COLLABORATORS

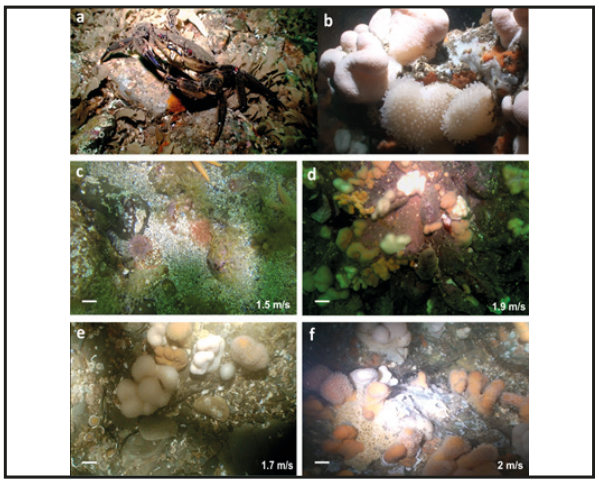
Marine Institute (Republic of Ireland); Danish Technical University; Thünen Institut, Germany; University College Cork; University of Wisconsin, USA; The International Council for the Exploration of the Seas (ICES); Queen Mary College, London; University of Cape Town, South Africa; Agri-Food and Biosciences Institute, N.I.

Waves, Currents and Turbulence in Nearshore Marine Environments

Dr. Louise Kreging (Lecturer, Queen's Fellow)

H2020, University of Tasmania

School of Natural and Built Environment



Hydrodynamics control and influence many key physical and biological factors in the marine environment including flux of dissolved nutrients to macroalgae, larval, spore and plastic transport, food availability and fertilization. My current research subjects include all these critical factors with various collaborators both within QUB and world-wide. The results provide valuable information to emerging industries such as marine renewables (wave and tide) as well as aquaculture (macroalgae and shellfish) in order to protect and ensure a sustainable future for our oceans.

KEY FINDINGS

To date there has been no evidence to suggest that marine renewables (wave or tide) have a detrimental effect on the marine environment. Strategic site selection for the re-introduction of shellfish can significantly accelerate their recovery and restoration. Many macroalgae growing in high wave and current put energy into strengthening the components of the blades rather than elongation.

OUTPUTS

Kregting L, Elsäßer B, Kennedy R, Smyth D, O'Carroll J, Savidge G. (2016). Do Changes in Current Flow as a Result of Arrays of Tidal Turbines Have an Effect on Benthic Communities? PLoS ONE 11(8): e0161279.

Kregting L, Blight A, Elsäßer B, Savidge G. (2016). The influence of water motion on the growth rate of the kelp Laminaria digitata. Journal of Experimental Marine Biology and Ecology, 478: 86-95.

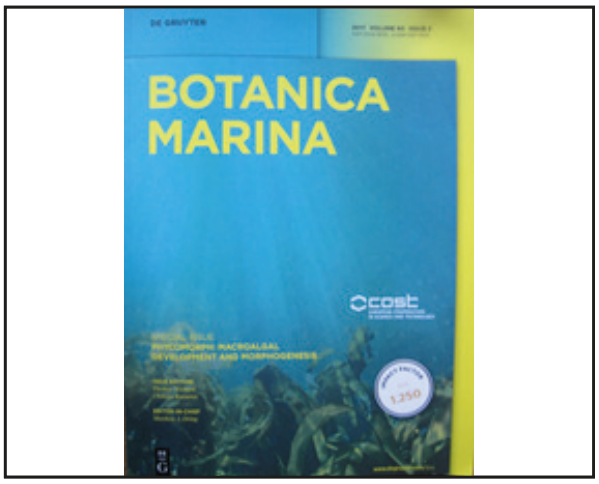
COLLABORATORS

Ass. Prof. Catriona Hurd (UTAS), Dr. Sue Molloy (Dalhousie University), Dr. Bjorn Elsäßer (DHI), Dr. Dannielle Senga Green (Anglia Ruskin University), Dr. Dave Smyth (Qatar University), Dr. Matt Pine (University of Victoria), Dr. Chris Hepburn (Otago University), Dr. Pal Schmitt (QUB), Dr. Lilian Lieber (QUB), Dr. Ross Culloch (QUB), Prof. Jaimie Dick (QUB), Prof. Paulo Prodhohl (QUB).

Seaweed Biology and Aquaculture

Prof. Matthew Dring (Emeritus)

School of Biological Sciences



Promotion of knowledge of seaweed biology, and especially their aquaculture and usage for foodstuffs, medicines, rare chemicals, bioremediation, bioenergy through support for ongoing research projects (e.g.Biogas), undertaking consultancy on algae, attending phycological conferences and acting as Editor-in-Chief of the international journal Botanica Marina (published by De Gruyter, Berlin).

KEY FINDINGS

Initiation and publication of two Special Issues of Botanica Marina in 2016: "Phycomorph: Macroalgal development and morphogenesis" and "Recent advances in marine mycology" Initiated a Special Issue of Botanica Marina on "Seagrass Research in Southeast Asia" to be published in 2018

OUTPUTS

"Seventeen years of seaweed aquaculture research at Queen's University" - SAMS, August 2015.

Attended 6th European Phycological Congress, London, August 2015.

Attended 12th International Seagrass Biology Workshop, North Wales, October 2016.

Attended 11th International Phycological Congress, Szczecin, Poland, August 2017.

COLLABORATORS

Karen Mooney (QUB), Louise Kregting (QUB), Philip Kerrison (SAMS), Craig Sanderson (Tasmania), Georg Pohnert, Thomas Wichard (Jena, Germany), Kirsten Heimann (Townsville, Australia), Ka-Lai Pang (Taiwan), Michel Poulin (Ottawa, Canada), Christos Katsaros (Athens, Greece), Siti Maryam Yaakub (Singapore).

Biodiversity and Ecosystem Functioning in Marine, Terrestrial and Freshwater Ecosystems

Prof. Mark Emmerson (Professor of Biodiversity and Director of Research)

NERC, Science Foundation Ireland and Department for Economy, DAERA

School of Biological Sciences

Prof. Emmerson's research focusses on the relationships between biodiversity, ecosystem functioning and the provision of ecosystem services across a range of different ecosystems. These include marine, freshwater and terrestrial systems with a unifying focus on multitrophic level relationships and the effects of system structure on stability. His work integrates empirical and theoretical approaches to the study of natural systems employing experiments and mathematical models to understand the complexity of nature.

KEY FINDINGS

Prof. Emmerson's work has focussed on the mechanisms underlying patterns in ecosystems, and has focussed on the fundamental nature of species interactions. Notably, his work has focussed on predator-prey interactions and the underlying mechanisms which drive the strength of interactions. This is important because his work has shown that the strength and arrangement of predator-prey interactions in a food web can determine the stability of an ecosystem.

OUTPUTS

Barrios-O'Neill, D., Kelly, R., Dick, J. T. A., Ricciardi, A., MacIsaac, Hugh J., Emmerson, M. C. (2017). On the context-dependent scaling of consumer feeding rates. Ecology Letters, 19: 668-678

Vye, S., Emmerson, M.C., Dick, J.T.A. & O'Connor, N.E. (2017). Cumulative effects of multiple stressors: An invasive oyster and nutrient enrichment reduce subsequent invasive barnacle recruitment. Journal of Experimental Marine Biology and Ecology, 486: 322–327.

COLLABORATORS

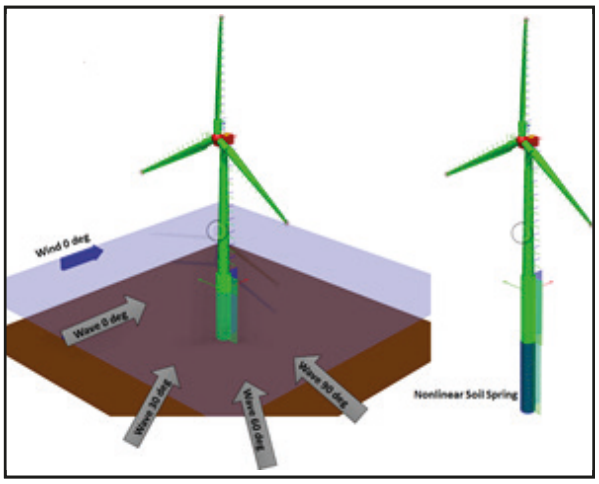
Prof. Paul Somerfield et al. Plymouth Marine Laboratory. Marine Ecosystem Research Programme (NERC funded). Dr. Jon Yearsley et al. University College Dublin. ResGRASS (SFI and DfE funded). Prof. Dave Paterson et al. University of St. Andrews. CBESS (NERC funded). Prof. Richard Bardgett et al. University of Manchester. Soil Security Programme (NERC funded).

Offshore Wind Turbine

Dr. Madjid Karimirad (Senior Lecturer)

EPSRC

School of Natural and Built Environment



Dr. Madjid Karimirad, recently joined Queen's University Belfast (QUB) as a senior lecturer in marine and coastal engineering. Prior to joining QUB, he was a Research Scientist in MARINTEK (Norwegian Marine Technology Research Institute) and SINTEF Ocean, Trondheim, Norway.

KEY FINDINGS

Sensitivity analyses were performed to investigate the importance of limited actuation of aerodynamic and generator loads for the responses of bottom-fixed turbines. In normal operational cases, the dynamic torque, and aerodynamic sway force and pitch moment were not significant for the selected motion and structural responses. The aerodynamic yaw moment was only important for the yaw/torsional responses, but the sensitivity was quite high (up to 80% changes in the dynamic responses).

OUTPUTS

Madjid Karimirad and Erin E. Bachynski, "Sensitivity Analysis of Limited Actuation for Real-time Hybrid Model Testing of 5MW Bottom-fixed Offshore Wind Turbine", DeepWind EERA Conference, February 2017, Trondheim, Norway, accepted for publication in Journal of Energy Procedia, Elsevier.

COLLABORATORS

Erin E. Bachynski, Norwegian University of Science and Technology, NTNU, Norway, Virgile Delhaye, SINTEF Ocean (Previously called MARINTEK), Trondheim, Norway, Nikolaos Lampropoulos, Laboratory for Wind Turbine Testing, CRES, Greece, Constantine Michailides, Liverpool John Moores University, United Kingdom.

Protecting our Coastal Resources

Dr. Nessa O'Connor, (Senior Lecturer)

BBSRC, NERC, DEFRA, Interreg, Royal Society

School of Biological Sciences

Dr. O'Connor is an ecologist with special interests in biodiversity-ecosystem functioning relationships, coastal ecology, aquaculture and habitat restoration. Her research includes the sustainable development of coastal resources (such as mussels, oysters and seaweed) and understanding the impacts of global change on the functioning and stability of marine ecosystems.

Figure. Examples of ocean sprawl - the proliferation of artificial structures in the sea.

KEY FINDINGS

Our research identified a mismatch between the theoretical problems addressed by scientists and information required by policy makers, thus, we have provided recommendations for theoreticians, empiricists and policymakers on how to better integrate the multidimensional nature of ecological stability into their research, policies and actions. Our recent findings have highlighted the potential for increased sustainable production of several benthic resources including seaweed & mussels.

OUTPUTS

Mrowicki, R.J., Maggs, C.A. & O'Connor, N.E. (2015). Consistent effects of consumer species loss across different habitats. Oikos, 124: 1555-1563.

Zwerschke, N., Kockmann, J., Ashton, E. C., Crowe, T. P., Roberts, D. & O'Connor, N. E. (in press). Co-occurrence of native *Ostrea edulis* and non-native *Crassostrea gigas* revealed by monitoring of intertidal oyster populations. Journal of the Marine Biological Association of the UK.

COLLABORATORS

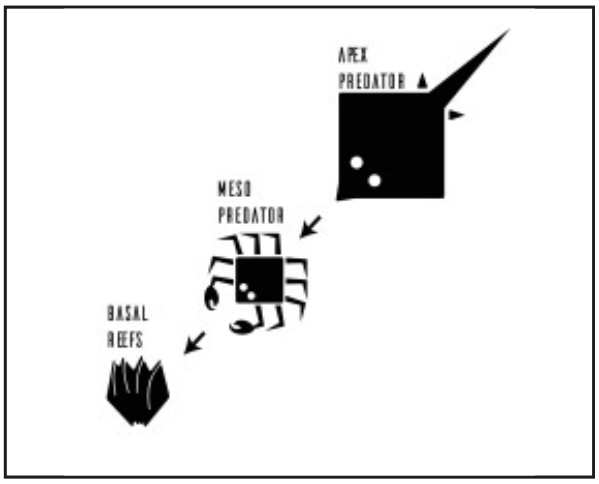
Ian Montgomery (QUB), Mark Emmerson (QUB), Jon Houghton (QUB), Karen Mooney (QUB), Billy Hunter (QUB), Justin Lathlean (QUB), Camilla Bertolini (QUB), Abby Gilson (QUB), Lydia White (QUB), Victoria McCreedy (QUB). Marine Ecosystems Research Programme, CBESS, SeaGas, Enalgae.

SkatePark/Marine Ecology, Taxonomy, Deep Sea Biology and Habitat Restoration

Dr. Patrick Collins (Lecturer in Marine Biology)

DAERA, EMFF, Irish Marine Institute

School of Biological Sciences



I am working on developing infrastructure at QML. My principle project is SkatePark, an ecosystem restoration project using Strangford Lough as a model site to demonstrate the efficacy of translocating critically endangered apex marine predators (flapper skate) to degraded systems in order to improve environmental status and restore ecosystem services. I am also working on deep-sea exploration, cybertaxonomy and scientific outreach.

KEY FINDINGS

Skates and other elasmobranchs can act as transient keystone species and may act, within the context of the Lough, as a mechanism to supress crab foraging on horse mussel spat and support the recovery of the biogenic reefs.

OUTPUTS

Barrios O'Neill D, Hunter R, Bertolini C, Collins PC. (2017) The transient keystone concept: temporary predator-induced cascades facilitate the establishment of basal species. Conservation Biology, 212: 191-195.

Carlsson J, Egan D, Collins PC, Farrell E, Igoe F, Carlsson J. (2017). A qPCR MGB probe based eDNA assay for European freshwater pearl mussel (*Margaritifera margaritifera L.*). Aquatic Conservation. DOI: 10.1002/aqc.2788

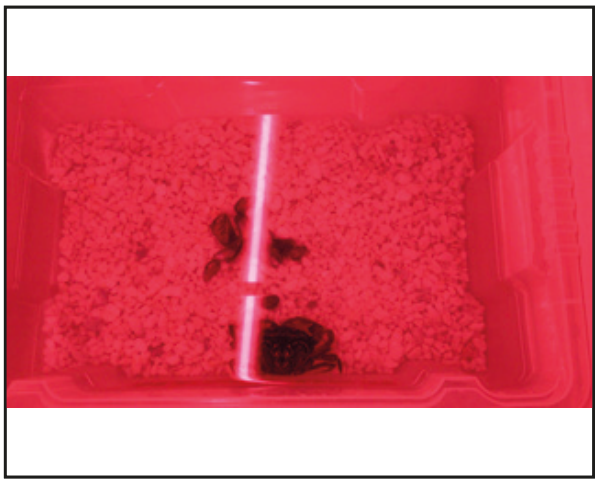
COLLABORATORS

University College Dublin: Jens Carlsson, Emmanuel Reynaud, Aggeliki Georgiopoulou Queens Unversity Belfast: Billy Hunter, Danny Barrios O' Neil, Paulo Prodohl, Jon Houghton Ulster Wildife Trust: Rebecca Hunter, National Unviersity of Ireland, Galway: Robert Kennedy Duke University: Cindy Van Dover, AFBI: Carrie McMinn, Mathieu Lundy, DAERA: Joe Breen Icelandic Institute of Marine Science: Stefan Aki Ragnarsson, Korean Institute of Ocean Science and Technology: Se-Jong Ju, Inland Fisheries Ireland: Willie Roche.

Understanding Population Dynamics and Intraspecific Competition through Behavioural Ecology

Dr. Paul Mensink (Lecturer Education)

School of Biological Sciences



My research explores how the size-structure of animal populations (i.e. the distribution of body sizes) shapes intraspecific and interspecific interactions by modifying the intensity of competition and dictating predator-prey relationships. I use a combination of field and experimental techniques to quantify the ecological consequences of spatial and temporal variation in the size-structure of marine populations while measuring how size-based interactions are modified by environmental conditions (e.g. habitat structure, food availability, parasitism). For harvested marine species in particular, understanding how the drastic truncation of their population size-structure influences individual fitness (survival & reproduction), alters population dynamics, and mediates interspecific relationships, will be critical in predicting how perturbations to single species may proliferate throughout ecosystems.

KEY FINDINGS

Current results suggest there is an interaction between prey distributions and the relative importance of exploratory or bold behaviour. These findings indicate that whilst foraging ability is influenced by personality, it is critical to also consider the environmental context.

OUTPUTS

Mensink, P.J. & Shima, J.S. (2015). Home-range size in juveniles of the temperate reef fish, the common triplefin (Forsterygion lapillum). Marine and Freshwater Research, DOI: 10.1071/MF14414.

Dick, J.T.A, Laverty, C., Lennon, J.J., Barrios O'Neill, D., Mensink, P.J., Robert Britton, J., Médoc, V., Boets, P., Alexander, M.E., Taylor, N.G. and Dunn, A.M., (2017). Invader Relative Impact Potential: a new metric to understand and predict the ecological impacts of existing, emerging and future invasive alien species. Journal of Applied Ecology, 54: 1259-1267

COLLABORATORS

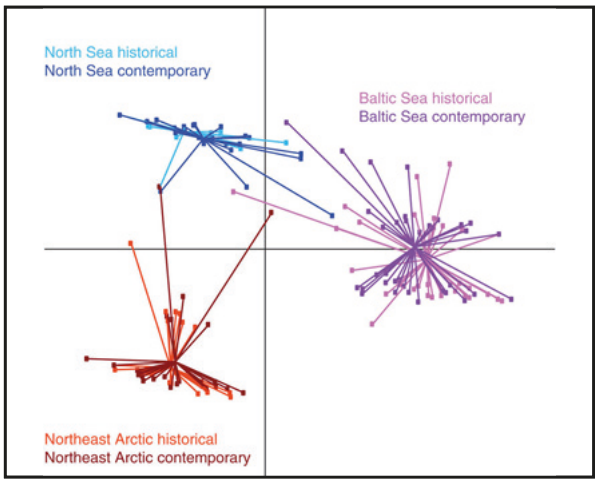
Prof. Jaimie Dick , Dr. Patrick Collins, Dr. Jon Houghton, Dr. Gareth Arnott.

Utilising Genetic Tools for Sustainability, Conservation and Food Authenticity

Dr. Sarah J Helyar

H2020, Norwegian Research Council, Industry

School of Biological Sciences



I am a molecular ecologist with wide research interests, but the core of those interests focus on how evolution, adaptation and the exploitation of commercial species impact on the sustainability, structure and diversity of marine ecosystems.

Figure: PCA plot based on individual genotypes from Northeast Arctic, North Sea and Baltic cod, illustrating both population differentiation and temporal stability of assignment (6, 4 and 10 years between samples, respectively) based on 8 selected SNPs (figure taken from Nature Communications 3:851).

KEY FINDINGS

Recent work has used genetic markers to identify the population that fish have originated from, to enable population level management, allowing us to distinguish cod and herring from geographically close, but genetically differentiated populations. We have also utilised the same techniques to trace aquaculture escapees, where the use of DNA profiling differentiating wild and farmed fish can help understand the scale of aquaculture escapees and assess their impact on natural populations.

OUTPUTS

Bekkevold D, Gross R, Arula T, Helyar SJ, Ojaveer H. (2016). Outlier Loci Detect Intraspecific Biodiversity amongst Spring and Autumn Spawning Herring across Local Scales PLoS ONE. 11(4): e0148499.

Bylemans J, Maes GE, Diopere E, Cariani A, Senn H, Taylor M, Helyar SJ, Tinti F, Ogden R, Volckaert FAM (2016) Evaluating genetic traceability methods for captive bred marine fish and their applications in fisheries management and wildlife forensics Aquaculture Environment Interactions 8: 131-145.

COLLABORATORS

Prof. Chris Elliot; Prof. Moira Dean. Prof. Gary Carvalho (Bangor University); Prof. Paul Shaw (Aberystwyth University); Paul Brereton (FERA); DTU-Aqu (Denmark); MRI (Norway); University of Bergen (Norway); University of Uppsala (Sweden).

SeaGas & MERP

Mr Brendan McNamara (Algae Research & Mesocosm Technician)

BBSRC, MERP

School of Biological Sciences

Assisting Dr. Alberto Longo, Dr. Karen Mooney and Dr. Liz Ashton to propagate and harvest 20 tonnes of *Saccharina latissima* (sugar kelp) to be used as Anaerobic Digestion feedstock for SeaGas project partners. Gathering data for environmental impact analysis of growing *S. latissima* on 2.1km of longlines. Outreach including seaweed talks at local schools, meeting local stakeholders, working with Ocean Veg Rathlin Island, presenting experience of cultivation to SeaGas partners in London and working with Royal IHC to investigate mechanisation of harvest. Assisting Prof. Mark Emmerson, Dr. Nessa O'Connor and Dr. Daniel Barrios-O'Neill to organise and run the mesocosm facility of 10 salt water fed tables to allow mass repetition of ecology experiments.

KEY FINDINGS

Possible to grow and harvest 20 tonnes of *Saccharina latissima* on 2.1km of longlines in Strangford in 8 months. The process of harvest can be mechanised and labour costs reduced. Mesocosm facility at QML can run successfully for an indefinite length of time to accommodate long term complex experimental design.

OUTPUTS

20 tonne *Saccharina latissima* harvest, UK largest cultivated seaweed harvest.

Benthic samples, water and chlorophyll samples, algal growth measurements.

Highly effective simple mechanised longline stripping device.

School visits and stakeholder meetings.

COLLABORATORS

CPI (The Centre for Process Innovation), The Crown Estate, Newcastle University, Cefas and SAMS

Providing Technical Support to QML Projects

Ms. Emma Gorman (Core Technician)

Core funding

School of Biological Sciences

Figure 1 : EnAlgae seaweed harvesting

As the general site technician for the Marine Lab, my role is varied. After working on projects growing microalgae, analysing benthic habitats in Strangford Lough and growing seaweed for biofuel, I use my background in marine work to aid our varied staff and students. This may involve boat and shore based fieldwork, diving, assisting in setting up experiments and providing training to staff and students.

The variety of work at the lab means it's never boring, and it's always exciting to see new projects come to fruition!

KEY FINDINGS

Growing seaweed on longlines in Strangford Lough as part of the EnAlgae (and now the Seagas project) has been very successful, and will hopefully lead to future funding in this field for QML.

OUTPUTS

QML Open Days in 2015, 2016 and 2017, inviting members of the public to view the laboratory.

Standard Operating Procedures in Macroalgae Cultivation for the EnAlgae Project.

"Panning for Green Gold" EnAlgae Promotional Video, Dec 2015.

Interview for 'Farming Today', BBC Radio 4, 10th Sept 2016.

COLLABORATORS

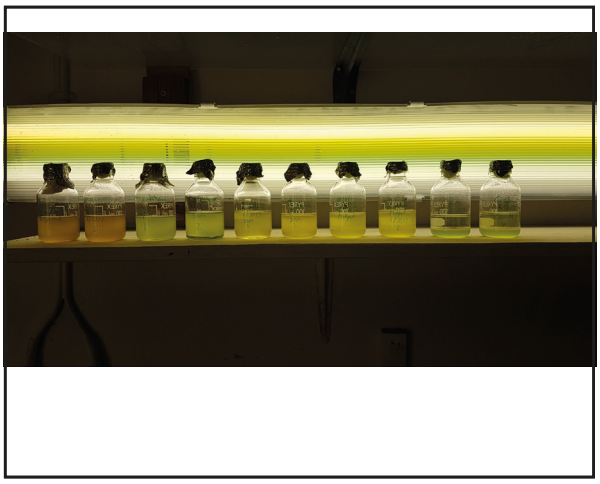
Prof. Jaimie Dick, Simon Exley, Brendan McNamara, Bernie Curran, Chris Preshaw, Gillian Riddell, Dr. Karen Mooney, Dr. Louise Kregting, Dr. Nessa O'Connor

Sustainable Oyster Fisheries and Development of Microalgae Cultures

Dr. Lawrence Eagling (Microalgae Technician)

CASE InvestNI, IBIS (PhD funding)

School of Chemistry and Chemical Engineering



My PhD research aimed to investigate the landings, distribution and sex ratio of native oyster fisheries in light of past and present management techniques to ensure a sustainable future for the fishery. Aside from bivalve fisheries, my research interests include using histological techniques to assess ageing structures and gonadal research within invertebrate populations and my current research focus is developing microalgae cultures and extraction techniques in colloberation with industry.

KEY FINDINGS

Native oyster populations that have been over exploited can recover, however this requires active conservation management and a significant amount of time to achieve. The proportion of male phase native oysters is positively correlated with water temperature. Populations with an unbalanced sex ratio can still produce significant numbers of brooding females.

OUTPUTS

Eagling et al. (2015). The incentives of a resource owner: Evidence from a private oyster fishery. Marine Policy, 58: 28-35.

Syvret, M., Woolmer, A. and Eagling, L., (2015). Ranching of the native oyster, *Ostrea edulis,* Restoration and Aquaculture Potential - Evaluation Report. For: The Mumbles Oyster Company.

COLLABORATORS

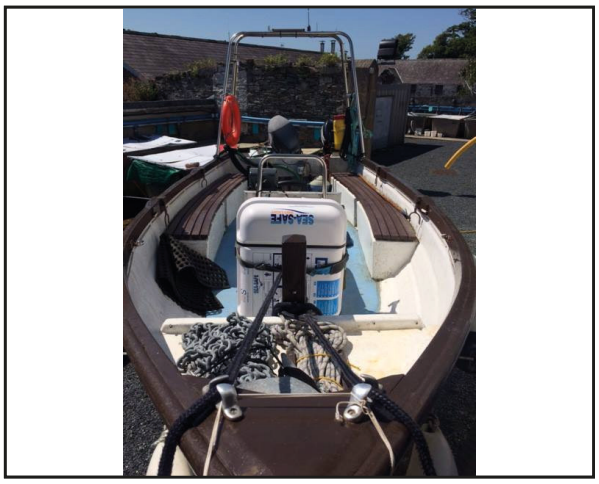
Dr. Dai Roberts (QUB), Dr. Julia Sigwart (QUB), Dr. Elizabeth Ashton (QUB), Dr. Antony Jensen (NOC, University of Southampton), Natasha Phillips (QUB), Dr. Josh Eagle (University of South Carolina), Prof. John Davenport (UCC), Tristan Hugh-Jones (The Loch Ryan Oyster Co.), Dr. Pamela Walsh (QUB), Dr. Carola Becker (QUB).

Providing Technical Support to QML Projects

Mr Simon Exley (Head Marine Technician)

NERC and Core funding

School of Biological Sciences



As the head marine technician for the Marine Lab, my role is varied. These roles include facilitating boating and diving for projects, in house training for staff and students, as well as ensuring that the legislation and health and safety responsibilities are complied with.

KEY FINDINGS

Academics need to be asked for things 6 months before they are needed.

Academics cannot fill in simple templates.

OUTPUTS

The marine lab has become a RYA training centre, allowing staff and students to gain their RYA Powerboat level 2 commercially endorsed.

We can also offer training and assessment of the European Scientific diver qualifications. This allows students and staff to work commercially in the scientific sector.

Formatting of the 2015-2017 review.

COLLABORATORS

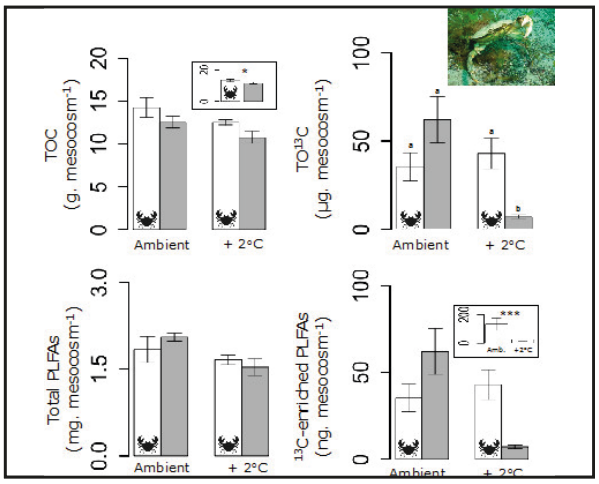
Emma Gorman (QUB), Paul Mayo (QUB), Jon Houghton (QUB), Joe Breen (DAERA), Clara Alvarez Alonso (DAERA), Bernard Picton (NMNI), Shelia Lyons (Ulster Wildlife), Royal Yachting Association, Scientific Diving Sub Committee.

Extinction, Ecosystem Structure and Carbon Cycling in Coastal Sediments

Dr. Billy Hunter (Research Fellow)

Leverhulme Trust Early Career Fellowship

School of Biological Sciences



Since coming ot QML in 2014, I have been studying how faunal species loss affects microbial activity, carbon sequestration and burial in coastal sediments. More broadly, my research cuts across a range of freshwater and marine ecosystems. This includes studies investigating the impacts of sediment erosion on microbial carbon and nitrogen cycling in alpine streams, and studies of how organic matter quality and oxygen availability affect the ecosystem processes in deep-sea sediments.

KEY FINDINGS

Over the past three years, I have used the mesocosm facilities at QML to conduct manipulative experiments that reveal that the impacts of faunal species loss are context dependent, and will be altered by changes in ambient temperature, faunal community structure and the traits of individual species.

OUTPUTS

Hunter, W.R., Ogle, N., O'Connor, N.E. (In Review). Warming affects the impact of a common predator upon carbon fixation and retention in coastal sediments. Global Change Biology.

Roche, K., Drummond, J., Boano F., Packman A., Battin T.J., Hunter, W.R. (in press). Benthic Biofilm Controls on Fine Particle Dynamics in Streams. Water Resources Research.

COLLABORATORS

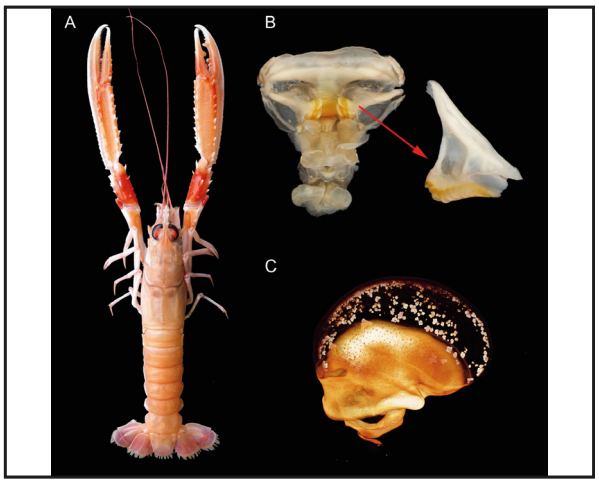
Dr. Nessa O'Connor (Trinity College Dublin, Ireland); Dr. Neil Ogle (Queen's University Stable Isotope Facility); Prof. Tom Battin (Stream Biofilm and Ecosystem Research Laboratory, Ecole Polytechnique Fédérale de Lausanne, Switzerland); Prof. Aaron Packman, Mr Kevin Roche (Civil and Environmental Engineering, Northwestern University, USA); Dr. Fulvio Boana (Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, Italy).

Enhancing the Sustainability and Market Share of Crustacean Fisheries

Dr. Carola Becker

Seafish, Kilkeel Seafoods

School of Biological Sciences



The goal of this project is to establish better-informed relationships between age, size and reproductive stages of commercially exploited crustaceans in different geographic regions to increase the sustainability and market share of crustacean fisheries in the UK.

Figure: (A) *Nephrops norvegicus* is commercially one of the most important species in the UK. Teeth in the stomach (B) and eyestalks (C) have been used to determine age of crustaceans.

KEY FINDINGS

We have tested the feasibility of a new aging method that uses cuticle bands in strongly calcified body parts of crustaceans from an anatomical perspective. Our results demonstrate that cuticle bands do not represent annual rings and are not retained through the moult as previously believed. We further studied reproductive cycles of *Nephrops norvegicus* and developed a staging scheme incorporating macroscopic and microscopic observations on female ovarian maturation stages.

OUTPUTS

Distribution of Annual Project Report to steering group members, research institutions, industry and stakeholders, February 2017.

Oral and poster presentation, The Crustacean Society Mid-Year Meeting, June 2017, Spain.

Organisation of a Workshop on current research on crabs and lobsters, July 2017, Portaferry.

COLLABORATORS

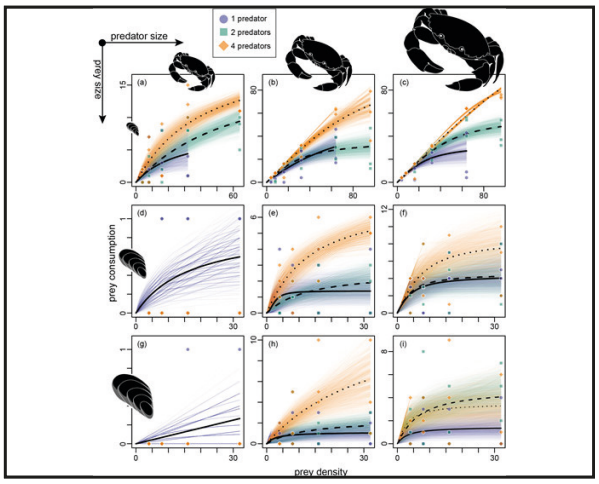
Agri-Food and Biosciences Institute (AFBI) Max Planck Institute of Colloids and Interfaces (MPI, Potsdam, Germany).

Context-Dependent Consumer-Resource Interactions in Benthic Systems

Dr. Daniel Barrios-O'Neill (Research Fellow)

NERC (Marine Ecosystems Research Programme)

School of Biological Sciences



Temperature and body size underpin metabolic rates which, very broadly, drive consumer feeding rates across the biosphere. My research is focussed on discovering whether other generalisations can be made beyond these primary metabolic factors. Does interference between predators scale predictably with size? Is fear generalisable? What are the systematic effects of habitat structure on feeding rates? Gathering data to answer these questions informs our understanding of basic ecology, and provides more realistic parameters for whole-ecosystem models that are used to forecast responses to global change.

KEY FINDINGS

There is a body-size basis to interference: larger predators experience greater *per captia* reductions in feeding rates when foraging in larger groups. Fear-driven trophic cascades initiated by apex predators can be transient with respect to environmental context. In benthic reef systems, strong top-down effects disappear in structurally complex habitats.

OUTPUTS

Barrios-O'Neill, D., K. Ruth, J. Dick, A. Ricciardi, H. MacIsaac, and M. Emmerson. (2016). On the context-dependent scaling of consumer feeding rates. Ecology Letters, 19: 668–678.

Barrios-O'Neill, Daniel, Bertolini, C., and P. C. Collins. (2017). Trophic cascades and the transient keystone concept. Biological Conservation, 212:191–195.

COLLABORATORS

Plymouth Marine Laboratory, Marine Vertebrate Group, University of Exeter, Skate Park (Ulster Wildlife, Queen's and DAERA).

From Anaerobic Digestate to Microalgal Animal Feeds in a Circular Economy Project

Dr. Daniel McDowell (Research Fellow)

InvestNI, Industry

School of Chemistry and Chemical Engineering

I am active in research concerning food security, the environment and the agri-food sector. I am currently researching the feasibility of producing microalgae in Northern Ireland which are fed on digestate waste, and their potential as a livestock food source. We are aiming to establish how the strain of microalgae and abiotic conditions they experience will affect the composition of the nutritional components within the algal cell. We are particularly interested in the fatty acid content of the algal cells, as this is an important nutrient for livestock.

Picture: Bioreactors using during training at Prof. Matt Julius, St. Cloud University MN, June 2017.

KEY FINDINGS

The research is still in the early stages and we are currently in the process of establishing bioreactors at QML to grow microalgae for our trials. We hope to have various strains of microalgae growing in the bioreactors within the coming months. After which we can start analysing their composition. Work thus far has focused on developing analytical techniques for the analysis of microalgae.

OUTPUTS

Once the bioreactors are up and running at QML we will be able to start assessing the composition of the microalgae. After which we will have data that we can show to the industry and the scientific community.

COLLABORATORS

Dr. Pamela Walsh (PI) Chemical Engineering, Dr. Katerina Theodoridou, Global Food Security, Dr. Gary Sheldrake, Chemistry, Prof. Jaimie Dick, Biological Science. Prof. Matt Julius - St. Cloud Univeristy MN. Thomas Chromie – AgriAD, David Surplus - B9 Energy, Laurance Coey, Harlequin Plastics.

Tidal Turbine Testing

Mr. Ian Benson

InvestNI, Schottel Hydro, ARR, Ocean Flow Energy, QED Naval, Joules Energy, SME

School of Natural and Built Environment

Laboratory and field investigation of tidal turbine rotor performance.

Laboratory work at CNR-INSEAN, Rome (one of the world's largest towing-test facilities).

Fieldwork at Strangford Narrows, Northern Ireland.

KEY FINDINGS

A new commercial rotor developed by Schottel Hydro was fully characterised at approximately ½ physical scale of the prototype. Previous work at Strangford with a rotor having blade profiles similar to wind energy machines was repeated and verified and accuracy of measurements improved. New turbine control system developed and tested, further fieldwork expected 2018.

OUTPUTS

European Wave and Tidal Energy Conference, Cork 2017.

'Science Uncovered', a large public-engagement event at Ulster Museum, Sept 2016. Exhibited instruments and turbine drivetrain to public.

Velocimetry instruments owned by QUB were calibrated and validated at the CNR-INSEAN facility. These are now being hired by the Danish National Hydraulics laboratory.

COLLABORATORS

CNR-INSEAN (Italian national government engineering hydraulics laboratory), Ocean Flow Energy (preparing an experimental turbine for deployment in Faro, Portugal).

Assessing Biotic Resistance to Invasive Fishes in South Africa

Dr. Josie South (Post-doc)

NRF/SAIAB South Africa

School of Biological Sciences

Invasive species are pervasive and damaging globally, with huge economic and social costs in South Africa due to native species displacement. I am using new metrics developed at QUB to measure the likely biotic resistance to invaders of current South African native fish communities. This will translate into fisheries policies on how best to manage fish communities and minimise invader impacts.

KEY FINDINGS

My work to date has shown that functional responses and "Relative Impact Potential" metrics developed at QUB/QML successfully predict the strength of interactions among invader and native species under climate change.

OUTPUTS

South, J. & Dick, J.T.A. (2017). Effects of acute and chronic temperature changes on the functional responses of the dogfish *Scyliorhinus canicula* (Linnaeus, 1758) towards amphipod prey *Echinogammarus marinus* (Leach, 1815). Environmental Biology of Fishes, 100: 1251-1263.

South, J., Dick, J.T.A., McCard, M., Barrios-O'Neill (2017). Predicting predatory impact of juvenile invasive lionfish (Pterois volitans) on a crustacean prey using functional response analysis: effects of temperature, habitat complexity and light regimes. Environmental Biology of Fishes, 100: 1155-1165.

COLLABORATORS

Profs J. Dick (QUB), O. Weyl (SAIAB) and R. Britton (Bournemouth).

SeaGas

Dr. Karen M. Mooney (Post-doc)

BBSRC and Innovate UK

School of Biological Sciences

My main research interests are in aquatic systems, the ecological interactions within and how they affect/are affected by human activities. My primary interest is in algae, being the basis of many aquatic systems and an integral part of their functioning. I am currently working on the SeaGas project, using kelp for energy production via Anaerobic Digestion. Specifically looking at optimising kelp cultivation and its associated environmental impact.

My main aim is to effectively and economically maximise the cultivation potential of kelp and other seaweeds in a sustainable manner. This can be done either alone or in conjunction with other aquaculture or renewable energy technologies, and to enhance the policy and community engagement processes around coastal and offshore development.

KEY FINDINGS

Lab production of algae can be increased 5x original output to produce over 20tonnes/7ha, with production on over 50% lines over our target of 10kg/m; seaweed for AD gives very good results and stable energy output but is currently too expensive for sole use in energy production, biorefinery approach is needed; there is high potential for cultivation in the UK, requires important genetic population considerations for regional siting of farms.

OUTPUTS

Schiener P. et al. (2016). The nutritional aspects of biorefined *Saccharina latissima*, *Ascophylum nodosum* and *Palmaria palmata*. Biomass Conversion and Biorefinery. DOI: 10.1007/s13399-016-0227-5

van der Molen J. et al. (in review). Modelling potential production and environmental effects of macroalgae farms in UK and Dutch coastal waters. Biogeosciences.

COLLABORATORS

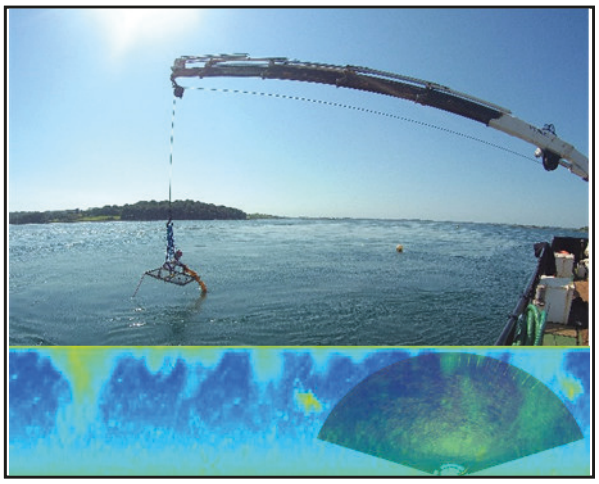
CPI, SAMS, Newcastle University, Aberystwyth University, NUI Galway, Trinity College Dublin, The Crown Estate, CEFAS.

Detailed Bio-Physical Interactions of Marine Fauna around a Subsea Tidal Kite

Dr. Lilian Lieber (Post-doc)

PowerKite (European Union's Horizon 2020)

School of Natural and Built Environment



Using high-resolution acoustic instruments (multibeam sonar, Acoustic Doppler current profilers; ADCPs), I am investigating the interactions between marine fauna (seals, fish, zooplankton) and fine-scale hydrodynamics in the vicinity of a novel tidal turbine, 'the kite', developed by Minesto. The research aims to further our understanding of the mechanisms underlying the distribution and behaviour of animals in tidal flow environments. Combining in-situ measurements with visual survey techniques will generate empirical data for collision risk modelling.

Figure: Deployment of a seabed frame equipped with a multibeam sonar at Minesto's site, located in the Narrows. Inset below shows a time-series of acoustic backscatter from an upward-facing ADCP along with the swath of an upward-facing multibeam sonar (for demonstration).

KEY FINDINGS

A recent study investigating pinniped dynamics in the Narrows using vessel-mounted ADCP transects has shown a spatiotemporal heterogeneity in their use of the tidal channel, strongly linked to the tidal cycle and fine-scale hydrodynamic features (turbulence, shear and low velocity back-eddies). Further, ADCP backscatter analysis can be used to cross-reference targets on the multibeam sonar (Kongsberg M3) during fine-scale acoustic monitoring.

OUTPUTS

Lieber L, Nilsen T, Zambrano C, Kregting L (2017). Optimising multiple multibeam sonars to assess marine life interactions with an underwater kite. Proceedings of the 12th European Wave and Tidal Energy Conference 27 Aug-01th Sept 2017, Cork, Ireland.

Schmitt P, Culloch R, Lieber L, Molander S, Hammar L, Kregting L (in review). A tool for simulating collision probabilities of animals with moving marine renewable energy devices. Plos One.

COLLABORATORS

Minesto (Developer of tidal energy devices, Sweden), Sverker Molander, Linus Hammar (Chalmers University, Sweden), Terje Nilsen (Kongsberg, Norway).

Understanding Extreme Nearshore Wave Events through studies of Coastal Boulder Transport

Dr. Louise O'Boyle (Post-doc)

US-Ireland Grant

School of Natural and Built Environment

In winter 2013-2014, storm waves on the west coast of Ireland dislocated and transported very large boulders with estimated masses 50-430 tonnes. These boulders were moved in some cases 10s of meters at elevations up to 16m above high water and 100m inland. The boulders themselves provide evidence for the forces exerted by storm waves at those locations.

KEY FINDINGS

This project investigates the magnitude of extreme-wave behaviour in the coastal zone. Through a combination of field measurements, numerical modelling, and physical wave-tank experiments we will generate an understanding of the relationship between coastal wave energy and onshore mass transport.

OUTPUTS

O'Boyle, L., et. al. (Accepted); Monitoring of sea level variations for studies of coastal boulder transport on the Aran Islands, Ireland. International Geoscience Programme (IGCP639) Sea Level Meeting, S. Africa

O'Boyle, L. et. al. (Accepted); Field measurement of nearshore wave conditions at the Aran Islands, Co. Galway – winter 2016/2017. European Conference for Applied Meteorology and Climatology, Dublin.

COLLABORATORS

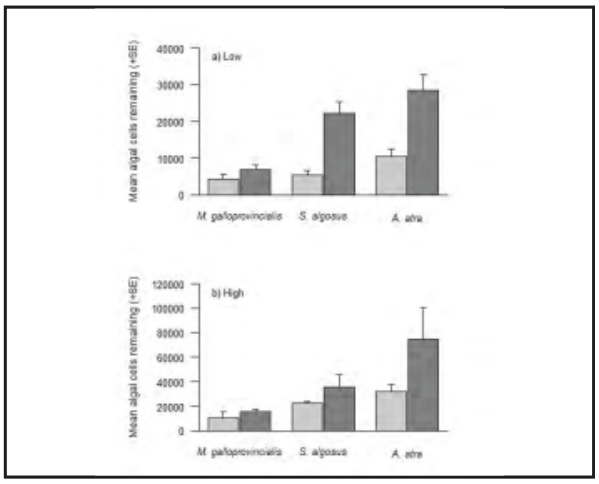
Prof. Trevor Whittaker, Dr. Louise Kregting, Dr. Paul Lamont-Kane.

Predicting the Impacts of Invasive Marine Mussels in South Africa

Dr. Mhairi E. Alexander (Post-doc)

Centre for Invasivion Biology, S. Africa

Stellenbosch University



In South Africa, the arrival of invasive mussel species has dramatically changed coastal communities. Using a comparative resource use approach, Mhairi has shown that the Mediterranean mussel, *Mytilus galloprovincialis*, with known field impacts, shows heightened resource use in comparison to the native species. Similar observations in the newly arrived invasive mussel, the South American *Semimytilus algosus*, are suggestive of further establishment of this species along as yet un-invaded regions of the coast.

Figure – resource use of invasive and native mussels in South Africa.

KEY FINDINGS

Resource use in filter-feeding mussels corroborates with abundance in the field and heightened resource use is a key characteristic that can help us understand and predict invasive species.

OUTPUTS

Alexander, M.E., Dick, J.T.A. & O'Connor, N.E. (2015). Predation in the marine intertidal amphipod *Echinogammarus marinus* Leach: implications of inter- and intra-individual variation. Journal of Experimental Marine Biology and Ecology, 462: 50-54.

Alexander, M.E., Adams, R., Dick, J.T..A & Robinson, T.B. (2015) Forecasting invasions: resource-use by mussels informs invasion patterns along the South African coast. Marine Biology, 162: 2493-2500.

COLLABORATORS

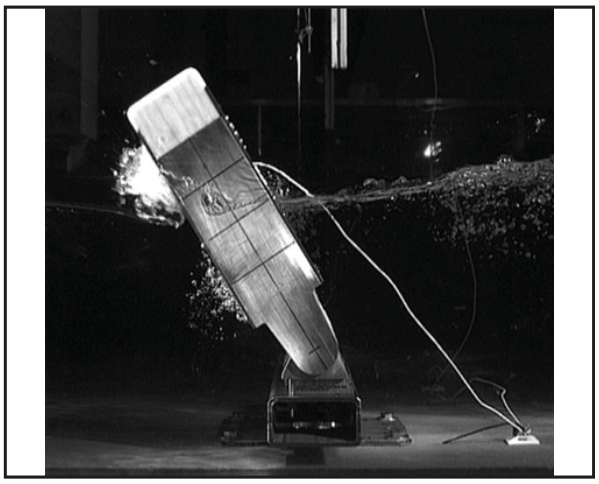
Prof. JTA Dick, QML/QUB; Dr. T Robinson, Stellenbosch, S. Africa; Dr. Olaf Weyl, SAIAB, S. Africa; Prof. J Vitule, Parana, Brazil; Prof. T Ricciardi, McGill, Canada; UK; Dr. Danny Barrios-O'Neill, QML/QUB, UK; Dr. A. Dunn & Dr. M. Hatcher, Leeds, UK.

Extreme Loading of Wave Energy Converters

Dr. Paul Lamont-Kane (Post-doc)

Engineering & Physical Sciences Research Council (EPSRC)

School of Natural and Built Environment



My research focuses on the development of marine renewable energy sources such and in particular the field of wave and tidal energy. My primary focus has been on developing an understanding of the loads experienced by Wave Energy Converters in extreme seas. The research has been conducted primarily using small-scale physical modelling in the QUB wave basin facilities located in both Belfast and at the Queen's Marine Laboratory in Portaferry. The image on the left shows the testing of an Oscillating Wave Surge Converter (OWSC) type device during its operation in extreme seas. The work has determined that the predominant extreme loading mechanism experienced by such a device is that of slamming where the prime mover itself is accelerated into an oncoming wave, as opposed to the impact of a wave upon the device as may have been expected.

KEY FINDINGS

Identification of slamming as predominant impulsive loading mechanism for OWSCs. Development of novel experimental techniques suitable for use in extreme load studies. Improved understanding of structural requirements of large OWSCs. Improved design recommendations for improved survivability.

OUTPUTS

McKinley, A., Lamont-Kane, P., Whittaker, T., & Elsaesser, B., (2016), Preliminary Development of a Pseudo-3D Testing Technique for the Prediction of Extreme Loads on an Oscillating Wave Surge Converter, Paper presented at 3rd Asian Wave and Tidal Energy Conference (AWTEC 3), Singapore.

Lamont-Kane, P., Folley, M. & Whittaker, T., (2017), Combined Performance and Loading Assessment of Pitching Flap-Type Wave Energy Converters, Paper Presented at 12th European Wave and Tidal Energy Conference (EWTEC 12), Cork, Ireland.

COLLABORATORS

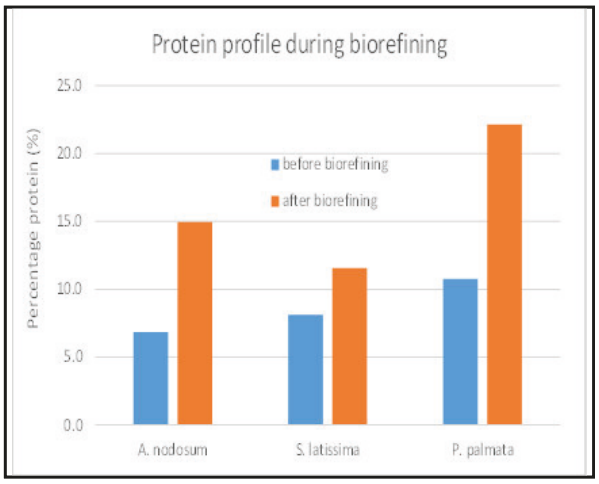
Dr. Louise O'Boyle, Alan McKinley, Dr. Louise Kregting, Dr. Bjoern Elsaesser.

EnAlgae Research Programme

Dr. Peter Schiener (Post-doc)

European Regional Development Funding via the INTERREG IVB NWE programme

School of Biological Sciences



Research focus: 1) Profiling of the chemical composition of cultivated kelp species during a growing season; 2) Assessment of the biomass for bioenergy production and biorefining.
Determination of the chemical composition of seaweeds will assess the changes of its chemical constituents during one growing season. This knowledge will help future seaweed growers in identifying best harvest times. Evaluation of the chemical profiles can also be used to identify potential components, such as carbohydrates, for biogas production and protein and polyphenol contents for biorefining.

KEY FINDINGS

Maximum carbohydrate contents in all kelp species was found in summer time, coinciding with low ash. Polyphenol content in *S. latissima* was around 20 fold higher compared to *L. digitata* with potential negative implications for biogas production using anaerobic digestion processes. Using enzymatic saccharification for carbohydrate removal has shown that protein contents in seaweed residue can be enhanced by 2-fold (see Figure 1), turning a waste product in a potential feed source.

OUTPUTS

Schiener, P., Zhao, S. & Theodoridou, K., Carey, M., Mooney-McAuley, K., Greenwell, C. (2017). The nutritional aspects of biorefined *Saccharina latissima, Ascophyllum nodosum* and *Palmaria palmata*. Biomass Conversion and Biorefinery, 2: 221-235.

COLLABORATORS

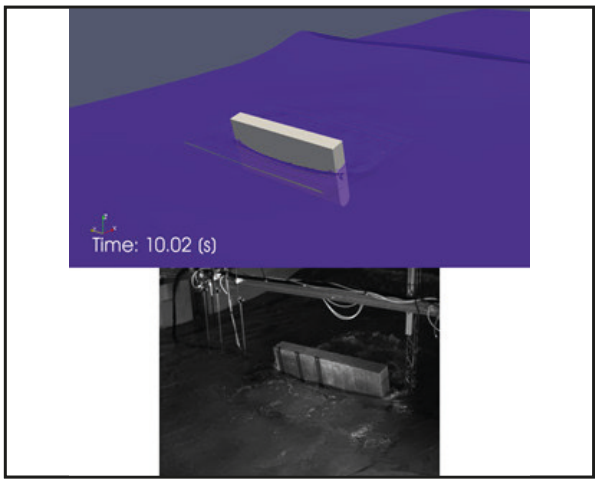
Prof. Dr. Andy Meharg and Dr. Katerina Theodoridou, Institute for Global Food Security, Dr. Sufen Zhao, Fisheries College, Guangdong Ocean University, Zhanjiang 524025, China. Prof. Chris Greenwell, Department of Earth Sciences, Durham University,

Development of a Numerical Wavetank

Dr. Pal Schmitt (Post-doc)

EU Horizon 2020 Powerkite Project

School of Natural and Built Environment



Numerical tools are becoming ever more important for all areas of marine and coastal engineering, providing easy access to variables of interest and offering flexibilty of application. The accurate simulation of waves and their interaction with fixed or moving bodies is still a challenge. We develop and apply fully viscous non-linear methods to simulate waves, with careful validation against experimental tank tests.

KEY FINDINGS

While the kite operates ideally when neutrally buoyant, some positive buoyancy is needed to surface it. Dynamic lift forces will decrease when approaching the surface and wave action will further complicate access to the kite.

OUTPUTS

Devolder, B., Schmitt, P., Rauwoens, P., Elsaesser, B., Troch, Peter. (2015). A Review of the Implicit Motion Solver Algorithm in OpenFOAM® to Simulate a Heaving Buoy. Paper presented at 18th Numerical Towing Tank Symposium (NuTTS'15), Cortona, Italy. 7 p.

Elsaesser, B., Torrens-Spence, H., Schmitt, P., Kregting, L. (2016). Comparison of Four Acoustic Doppler Current Profilers in a High Flow Tidal Environment. Proceedings of the 3rd AWTEC 2016 Asian Wave and Tidal Energy Conference (AWTEC 2016).

COLLABORATORS

Dr. Louise Kregting, Josh Davidson, Christian Windt, NUI Maynooth, Ireland, Johan Roenby, DHI, Denmark.

Ecology of Marine Mammals with Emphasis on Interactions with Anthropogenic Activities Including Marine Renewable Energy

Dr. Ross Culloch (Post-doc)

EU Horizon 2020 Powerkite Project

School of Natural and Built Environment

My research interests are broad, but generally lie within ecology, behaviour, and conservation and management. Currently, I am working towards developing our understanding of the ecology of harbour and grey seals within Strangford Lough. These data will be used to feed into a Collision Risk Model, assessing probabilities of seals colliding with Marine Renewable Energy devices, where collision risk is one of the key issues for regulators when consenting developments.

Photograph: A telemetry tagged, rehabilitated harbour seal being released. This was filmed for the BBC and is research in collaboration with Exploris Aquarium. Telemetry tagging was conducted under DEARA and DoH licenses.

KEY FINDINGS

Focus must be directed towards integrating species-specific and site-specific empirical data into collision risk models. In doing so, more accurate estimates of collision risk can be calculated, which will assist in moving the Marine Renewable Energy industry forward.

OUTPUTS

Invited expert at the transnational bottlenose dolphin conservation workshop, Dublin.

Poster presentation: “Integrating empirical data with probability distributions from a numerical 4-D model to assess marine mammal collision risk with a novel marine renewable energy device” presented at the European Cetacean Society 30th conference, Middelfart, Denmark.

Media coverage of telemetry tagged rehabilitated harbour seals being released, BBC1.

COLLABORATORS

Dr. Louise Kregting, Dr. Pal Schmitt, Dr. Lilian Lieber, Dr. Sarah Helyar and Dr. Jonathan Houghton (QUB); Ms. Victoria McCready (Exploris Aquarium); Dr. Sean Twiss (Durham University); Dr. Matt Pine (University of Victoria); Dr. Linus Hammar (Swedish Agency for Marine Water Management); Dr. Sverker Molander (Chalmers University). Dr. Nikolai Liebsch and Dr. Peter Kraft (Customized Animal Tracking Solutions).

Addressing the Gaps in Marine Ecosystem Science: The Role of Kelp in Coastal Food-webs

Ms. Abby Gilson (PhD Student)

DoE, Defra and NERC (Marine Ecosystems Research Programme)

School of Biological Sciences

The aim of my PhD is to examine the dynamics of macrophyte-derived detrital production in the Irish sea. My primary focus is to identify and characterise the pathways by which intertidal kelp-derived energy enters coastal food webs. Field surveys are being undertaken to quantify species-specific differences in detrital production and test for links to biotic and abiotic factors that may regulate this production. Field manipulations are being used to test empirically for the relative roles of microbes versus detritivores in the degradation process and species-specific differences in degradation rates of common kelp species. Experiments are underway testing for differences in the functioning between warm and cold-water kelp species in terms of secondary productivity and trophic transfer.

KEY FINDINGS

Differences in production and detrital production between species and seasons. Multiple factors controlling detrital production dynamics.

OUTPUTS

July, 2016- BES Aquatic Ecology Group (Poster).

COLLABORATORS

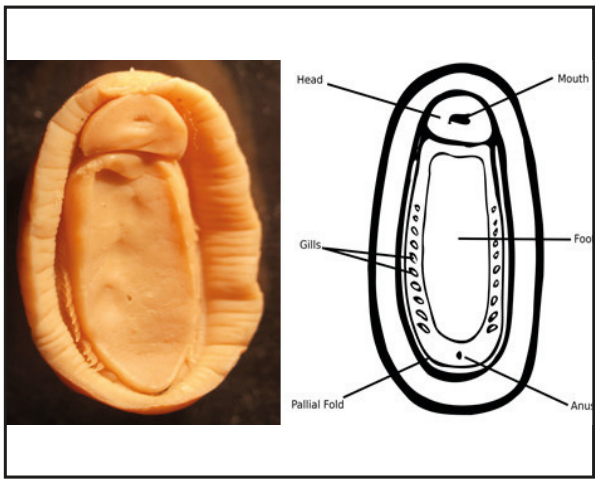
Nessa O'Connor, Trinity College Dublin; Dan Smale, Marine Biological Association; Mike Burrows, Scottish Association for Marine Science; Mark Emmerson, Queens University Belfast; MERP (Marine Ecosystem Research Programme) Consortium.

Multidisciplinary and Integrative Approach to Understanding the Influence of Taxonomic Surrogacy on Biodiversity.

Ms. Amy Garbett (PhD Student)

Department of Employment and Learning

School of Biological Sciences



My current research is examining the relationship between species of the genus *Tonicella*; Exploring morphological characteristics along with molecular genetics to determine taxonomic classification and evolutionary history of the species found across the Atlantic and Pacific Oceans. This includes DNA barcoding of individuals to better understand the relationship and divergence between species.

KEY FINDINGS

The research highlight some interesting connections between species globally, and also aids in the bigger question of "what is a genus?" The relative genetic distance among the Atlantic and Pacific species, and how this compares to other genera/subgenera within the Family can help understand the influence of taxonomic surrogacy on biodiversity.

OUTPUTS

Natural History Museum London (BBSRC funded) – short course on Intergrating molecules with taxonomy and systematics: and introductory molecular phylogenetics course for species identification and evolutionary analysis (May 2017).

COLLABORATORS

Saint Andrews University; conducting molecular analysis of chiton DNA; Bruno Dellangelo – putative new species research collaborator.

Disentangling Effects of Habitat Complexity in Soft-Sediment Mussel Reef Formation and Functioning

Ms. Camilla Bertolini (PhD Student)

NIEA/Queen's University Belfast

School of Biological Sciences

The overarching aim of my thesis is to assess the role of habitat complexity in a biogenic reef system, using mussel reefs as a model system, as a mechanism for the maintenance of the reef-forming species and associated functioning. With four experimental chapters I investigated: (1) the role of substratum and density for mussels aggregation behaviour, (2) the role of edge effects for reefs functioning, and ultimately the role of habitat spatial configuration, (3) mussels population sustainability and (4) the development of high associated species richness and diversity (picture of field experiment).

KEY FINDINGS

I identified the effect of mussel density on aggregative behaviour and a size-mediated effect of density on predation rate. Patch complexity increases with increasing mussel density. The effects of patch complexity in supporting a rich and diverse community of associated species demonstrated time-mediated or possibly transient effects of complexity on diversity. At larger scales, I found that some reef self-sustainability processes and ecosystem functioning are related to edge effects.

OUTPUTS

BES Aquatic Ecology SIG Annual Meeting, London, July 2016 - Poster presentation: "Assessing predation pressure on and off mussel beds using the 'squidpops'".

11th International Temperate reef symposium, Pisa, June 2016 Oral presentation: "Effects of habitat complexity on predation rates are size-dependent: implications for the design of artificial reefs for mussel restoration".

COLLABORATORS

Lough's Agency.

Predicting the Damaging Impacts of Invasive Species in Relevant Abiotic and Biotic Contexts

Mr Ciaran Laverty (PhD Student)

Department of Employment and Learning, Presidents Award, IT Sligo

School of Biological Sciences

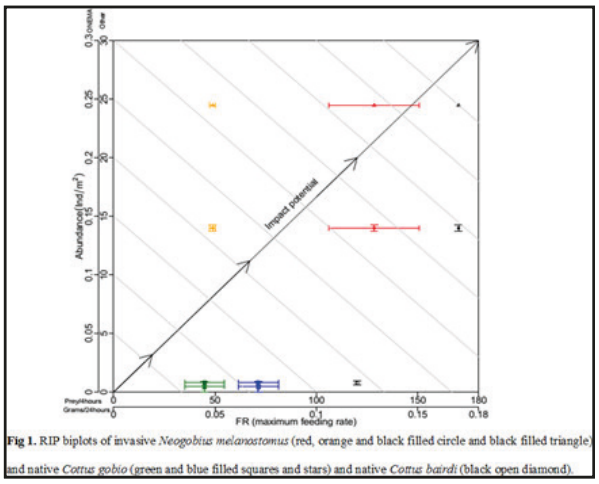


Fig 1. RIP biplots of invasive *Neogobius melanostomus* (red, orange and black filled circle and black filled triangle) and native *Cottus gobio* (green and blue filled squares and stars) and native *Cottus bairdi* (black open diamond).

Invasive species have detrimental impacts on ecosystems globally, contributing to reductions in the number and diversity of native species. In the UK alone, invaders are estimated to cost £1.7 billion annually. We have developed a new metric, based on *per capita* consumption and abundance (Relative Impact Potential; see Figure), that successfully predicts the identity of which species will cause damage and the magnitude of those impacts in an *a priori* manner.

Figure: This shows that the impacts of the Round Goby were entirely predictable from our RIP method.

KEY FINDINGS

Invasive species have their impacts through increased "functional responses" and often greater abundances, which can be measured for any consumer of any taxonomic or trophic group in various contexts. Thus, we can assess the impacts of invaders in many conditions.

OUTPUTS

Dick, J.T.A., Laverty, C et al. (2017). Invader Relative Impact Potential: a new metric to understand and predict the ecological impacts of existing, emerging and future invasive alien species. Journal of Applied Ecology, 54: 1259-1267

Laverty, C., Green, K., Dick J.T.A. et al. (2017) Assessing the ecological impacts of invasive species based on their functional responses and abundances. Biological Invasions, 19: 1653-1665.

COLLABORATORS

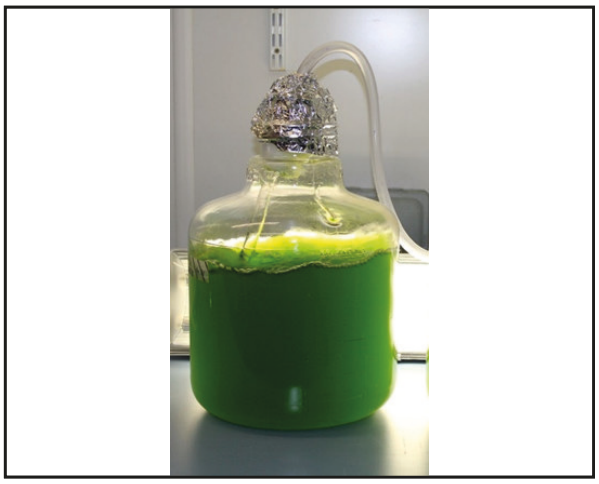
Profs T. Ricciardi & H. MacIsaac; Prof. Wolfgang; Profs D. Richardson & O. Weyl; Dr. M. Xu; Prof. P. Banks; Profs D. Aldridge; Drs A. Dunn & M. Hatcher; Dr. H. Roy; Dr. Frances Lucy; Dr. Joe Caffrey; Dr. Vincent Medoc.

Remediation of Agricultural Wastes to Grow Algal Biomass for Nutritional Supplements in Animal Feed.

Ms. Clare Mcguire (PhD Student)

DAERA, AgriAD

School of Chemistry and Chemical Engineering



This project is a study of the nutritional value of microalgae grown using an alternative biofertiliser, in this case anaerobic digestate. The algae being grown are known to contain substantial amounts of omega-3 fatty acids, sterols and carotenoids. These compounds, which can be extracted from the algae, have great value, both nutritional and commercial.

KEY FINDINGS

The extraction of valuable products, especially fatty acids, is being undertaken on different species of algae and an extensive profile of the fatty acid produced by each species. At the same time a long-term study is being conducted on the anaerobic digestate from AgriAD in order to get an in depth look at the contents for its future use as biofertilizer. Information such as trace elements and total nitrogen content is gathered on a monthly basis.

OUTPUTS

Draft Reports submitted and approved.

COLLABORATORS

Collaborators include AgriAD, QML, DAERA and Julius Group in St. Cloud University.

Trophic Impacts of Gelatinous Zooplankton on Fish Communities in the Irish Sea

Mr. Donal Griffin (PhD Student)

DAERA, NERC

School of Biological Sciences

Traditionally, gelatinous zooplankton have been labelled as stressors and indicators of poor ocean health, with much of the research focusing on the negative influences gelatinous zooplankton, since their characteristic to form large blooms. However, recently there is a changing perception among scientists as to the full range of impacts gelatinous zooplankton can have in our oceans. My research is based around obtaining a balanced view of the potentially negative as well as positive impacts gelatinous zooplankton can have, specifically on fish communities in the Irish Sea. The overall aim of this research is to feed ecosystem and fishery models with accurate and relevant information to better inform management and policy decision for a more sustainable future for the fishing industry.

KEY FINDINGS

The association of juvenile fish with gelatinous zooplankton for shelter and protection from predators is globally underestimated as a useful ecosystem service. Its potential impact on juvenile fish survivorship is not insignificant, considering 72% of the fish species documented as displaying this behaviour are of economically important either as commercial species or gamefish.

OUTPUTS

Baines, M., Reichelt, M. and Griffin, D., (2017). An autumn aggregation of fin (*Balaenoptera physalus*) and blue whales (*B. musculus*) in the Porcupine Seabight, southwest of Ireland. Deep Sea Research Part II: Topical Studies in Oceanography.

Cornelia et al. Ocean current connectivity propelling secondary spread of a marine invader across western Eurasia, (Submitted to Global Ecology & Biogeography).

COLLABORATORS

Dr. Jonathan Houghton, Prof. Mark Emmerson, Dr. Daniel Barrios-O'Neill (QUB), Dr. Steven Beggs (AFBI), Dr. Chris Harrod (UA, Chile), Dr. Isabella Capellini (UH, UK), Dr. Jason Newton (SUERC, Scotland), Dr. Ian Bull (University of Bristol), Dr. Christophe Eizaguirre (QML, UK).

Tidal Flow Characterisation

Ms. Hanna Torrens-Spence (PhD Student)

Department of Employment and Learning

School of Natural and Built Environment

This study investigates the temporal and spatial variability of tidally driven currents, focusing on the high frequency fluctuations of flow velocity. 'Turbulence' impacts a turbine's power performance and load conditions. Tidal flow field data of sufficient detail to allow turbulence characterisation are relatively scarce. This work involves the acquisition of field data in Strangford Narrows, a highly turbulent tidal channel. A variety of methodologies using a range of instrument platforms are employed to enable detailed characterisation of the flow conditions.

Figure: The barge platform used for a recent measurement campaign. N.B. The platform was commissioned for the TTT3 project.

KEY FINDINGS

Flow characteristics in Strangford Narrows vary significantly with tidal cycle and across the site. Results from different Acoustic Doppler Current Profilers, commonly used for flow measurement in the tidal environment, can also vary substantially. This should be considered when carrying out site comparison studies. Five beam ADCPs can provide improved turbulence characterisation when compared to 3 or 4 beam devices and results compare favourably to ADV outputs.

OUTPUTS

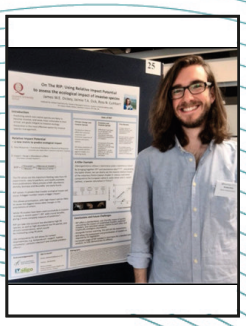
Comparison of Four Acoustic Doppler Current Profilers in a High Flow Tidal Environment, B. Elsaesser, H. Torrens-Spence, P. Schmitt and L. Kregting, Asian Wave and Tidal Energy Conference, Singapore, 2016.

Assessment of Flow Characteristics at Two Locations in an Energetic Tidal Channel, H. Torrens-Spence, P. Schmitt, C. Frost, I. Benson, P. Mackinnon and T. Whittaker, European Wave and Tidal Energy Conference, Cork, 2017.

COLLABORATORS

Dr. Pauline Makinnon; Dr. Trevor Whittaker; Dr. Louise Kregting; Dr. Pal Schmitt; Dr. Carwyn Frost; Mr. Ian Benson.

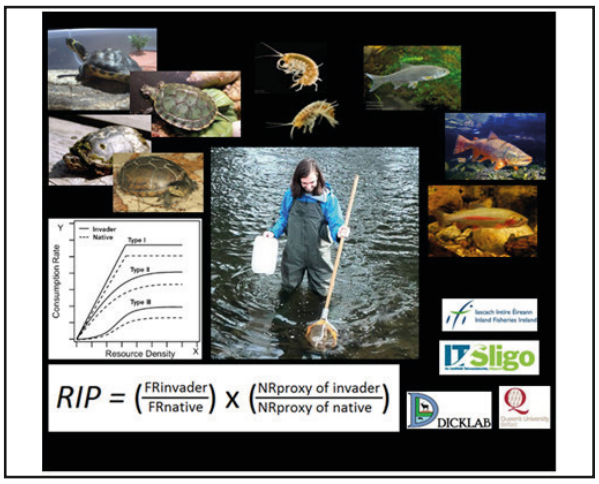
Using the Relative Impact Potential Metric (RIP) to Assess the Ecological Impact of Invasive Species



Mr James Dickey (PhD Student)

Inland Fisheries Ireland, IT Sligo

School of Biological Sciences



Predicting which non-native species are likely to become invasive, and areas most vulnerable to their arrival, are goals integral to invasion ecology. Invasive species management has proven difficult in the past, and prevention has been deemed the most effective option. However, for this to be effective, greater predictive powers and improved means of quantifying impact are required, especially for species with no history of invasion. RIP incorporates functional response, a metric that has been used with success for impact prediction, alongside proxies for numerical response, giving a more rounded means of predicting ecological impact.

KEY FINDINGS

The role played by the NI pet trade as a vector for invasive spread – surveys have so far demonstrated the selling of numerous species with invasion histories, and RIP studies have allowed the ranking of four species of commonly traded pet terrapin by impact. The impact of dace (*Leuciscus leuciscus*) and how it compares to brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). Using RIP as a tool to study the inter- and intraspecific competition between two gammarids in Northern Ireland.

OUTPUTS

Sigwart, J., Sumner-Rooney, L., Dickey, J. and Carey, N. (2016). The scaphopod foot is ventral: more evidence from the anatomy of *Rhabdus rectius* (Carpenter, 1864) (Dentaliida: Rhabdidae). Molluscan Research, 37: 79-87.

Environ 2017 Conference poster presentation: 'On The RIP: Using Relative impact potential to assess that ecological impact of invasive species' (April, 2017).

COLLABORATORS

Prof. Jaimie Dick; Prof. Joe Caffrey; Dr. Frances Lucy; Cathal Gallagher; Prof. Rob Britton; Dr. Elizabeta Briski; Prof. Olaf Weyl.

How Species Simultaneously Contribute to a Range of Different Ecosystem Stabilities Rather than Functions

Mr. Justin Judge (PhD Student)

Marine Ecosystem Research Program (MERP)

School of Biological Sciences

My project is focused on assessing how species simultaneously contribute to a range of different ecosystem stabilities rather than functions, where historical research has focused mostly on the latter. Specifically, my project will assess how species traits, e.g. body mass or linkage density, explain variation in their contribution to multiple forms of stability. It is hoped the findings of this project may be extrapolated along a defined latitudinal gradient (Iceland – Ireland – Portugal), where meiofaunal communities from these locations are being tested for similarities in their responses to changing ecosystem stability through experiencing the same perturbations.

KEY FINDINGS

Due to the magnitude of samples generated from the initial two mesocosm experiments (1728), analysis is still being carried out so no defining results have been obtained as of yet.

OUTPUTS

Icelandic newspaper article talking about my research.

COLLABORATORS

Prof. Jörundur Svavarsson, University of Iceland: Advisor and guide for field Icelandic field sites. Francisco Arenas, Porto University, Portugal. Advisor and guide for Portuguese field sites.

Assessing and Predicting the Threats of Invasive Species and Climate Change on the Sustainability of NI Sea Fisheries

Ms. Josie South (PhD Student)

DAERA

School of Biological Sciences

I work on understanding how changing environmental factors will affect the predator-prey interactions in the Irish Sea. I am looking to understand whether temperature differentially affects predator and prey species, and whether temperature change will increase or dampen predatory responses in a number of different species. This will help predict how population dynamics may change in the future under the context of warming oceans and inform management policies on fishing quotas and sustainability.

Figure: Lesser-spotted dogfish (*Scyliorhinus canicula*)

KEY FINDINGS

Temperature increase causes a higher maximum feeding rate in lesser-spotted dogfish (*Scyliorhinus canicula*). Dogfish acclimated to an increased temperature showed higher maximum feeding rates to prey that were acclimated as opposed to prey that were unacclimated to temperature. Temperature increase decreased attack rates in lesser-spotted dogfish and shanny fish.

OUTPUTS

South, J. & Dick, J.T.A. (2017). Effects of acute and chronic temperature changes on the functional responses of the dogfish Scyliorhinus canicula (Linnaeus, 1758) towards amphipod prey Echinogammarus marinus (Leach, 1815). Environmental Biology of Fishes, 100: 1251-1263.

South, J., Dick, J.T.A., McCard, M., Barrios-O'Neill, D. & Anton, A. (2017). Predicting predatory impact of juvenile invasive lionfish (Pterois volitans) on a crustacean prey using functional response analysis: effects of temperature, habitat complexity and light regimes. Environmental Biology of Fishes, 100: 1155-1165.

COLLABORATORS

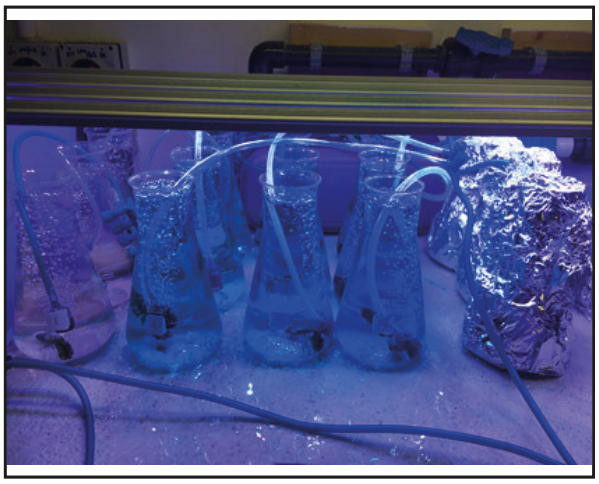
Prof. Jaimie Dick (QUB), Dr. Julia Sigwart (QUB), Dr. Daniel Barrios-O'Neill (QUB), Dr. Andrea Anton (KAUST).

Aquatic Alien Invasive Species: Distribution, Impact, Control and Prevention

Ms. Kate Crane (PhD Student)

Waterways Ireland, McGill University, University of Windsor

School of Biological Sciences



My research focusses on aquatic alien invasive species such as *Elodea nuttallii, Elodea canadensis* and *Dreissina polymorpha*. Investigations are being made to see whether zebra mussels mediate competitive interactions of *Elodea spp*.; if there is differential utilization of *Elodea spp*. as a resource for Limnephilid caddisflies; whether biosecurity measures can help control the spread of invasive macrophytes and if the distribution of *Elodea nuttallii* is related to environmental variables. Control strategies being investigated include the use of biodegradable dyes, dry ice and steam.

KEY FINDINGS

Understanding what is driving the growth and distribution of aquatic invasive species is key to enabling solutions to develop control strategies that can reduce their spread and competitive advantage.

OUTPUTS

Invasive Alien Species (IAS) Horizon Scanning Workshop; 19-20 April 2017; Institute of Technology, Sligo; workshop contributor.

Diffuse Pollution & Catchment Management Conference; 23-27 October 2016; Dublin City University; Dublin; paper and workshop contributor.

ISWG Conference, IT Sligo, 8-9 January 2015; presentation.

COLLABORATORS

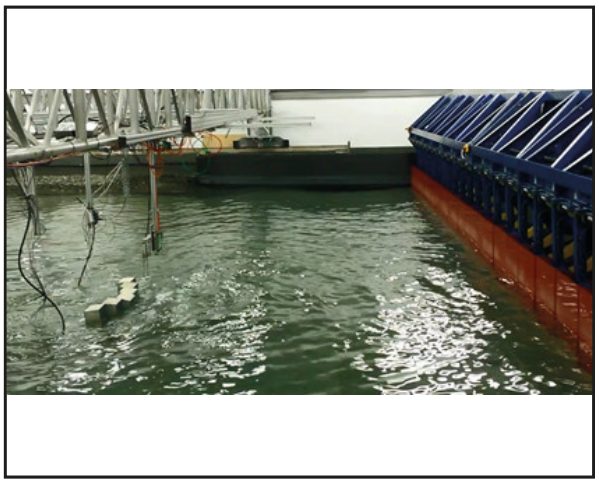
Prof. Jaimie Dick (QUB); Dr. Neil Reid (QUB); Dr. Louise Kregting (QUB); Prof. Anthony Ricciardi; Prof. Hugh McIsaac; Dr. Joe Caffrey (INVAS Biosecurity).

Assessment of Modular Flap-Type Wave Energy Converters

Mr. Laurie Wilkinson, (PhD Student)

Aquamarine Power, Energy Technologies Institute and the RCUK Energy Programme

School of Natural and Built Environment



My research is on the assessment of a modular flap-type wave energy converter. The power-capture and foundation loads were evaluated and compared to results associated with a rigid equivalent concept. The assessment was carried out using the QUB Portaferry Wave Tank.

Picture: 30th scale model being testing in the Portaferry Wave Tank.

KEY FINDINGS

The research found that the power-capture and foundation loads were similar to the rigid device in head-on waves; in off-angle waves, however, a small increase in power-capture and a reduction in twisting foundation loads were identified. Overall, the research showed that the modular concept was promising, with further advantages related to manufacturing and installation also possible to exploit.

OUTPUTS

Modelling of a Modular Flap-Type Wave Energy Converter, EWTEC conference, September 2015.

An assessment of a nearshore modular flap-type wave energy converter, EngD thesis, June 2017.

The power-capture of a nearshore, modular, flap-type wave energy converter in regular waves, Ocean Engineering journal, June 2017.

COLLABORATORS

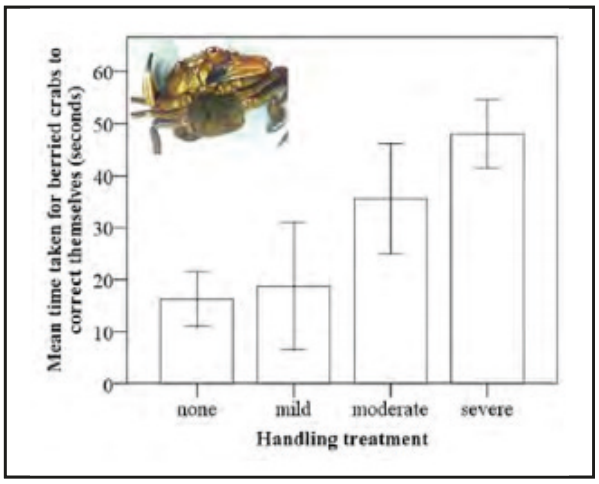
QUB Marine Research Group, Aquamarine Power Ltd, IDCORE supervisors.

Enhancing the Velvet Crab Fishery in Northern Ireland

Ms. Laura Hinchcliff (PhD Student)

Seafish

School of Biological Sciences



As the velvet crab fishery is a relatively recent development in the industry, little legislation exists to protect the species, and declines in catch have caused concern among local fishermen. Several ongoing research projects aim to enhance the fishery by providing baseline information about local populations, reduce mortality during capture, provide evidence-based recommendations with regards to the protection of berried females and assess methods to establish a stock enhancement scheme in Strangford Lough. Sampling has been carried out directly with fishermen, and steering group meetings are held 3 times a year to guide research and discuss results.

KEY FINDINGS

Population sampling has identified a size discrepancy between the two major fishery areas of Strangford Lough and the Irish Sea. These data may enhance the development of a stock enhancement scheme in Strangford Lough where crabs are larger. Welfare studies aim to provide recommendations to industry with regards to best practice during capture and handling by fishermen to reduce mortality and protect berried females.

OUTPUTS

107th Annual National Shellfisheries Association Conference (Monterey, USA).

12th Annual Marine Biological Association PG Conference (Belfast, N. Ireland).

Production of Seafish PhD Final Report with recommendations for industry.

COLLABORATORS

Prof. Jaimie Dick, Dr. Julia Sigwart (QUB) Dr. Lynn Gilmore (Seafish), Dick James (NIFPO), Dr. Carrie McMinn (AFBI), Institute for Global Food Security (QUB).

Noise Pollution as an Emerging Threat to Commercial Fisheries: A Case Study using the Norway Lobster.

Ms. Lorraine McLean (PhD Student)

DAERA, AFBI

School of Biological Sciences

I am investigating the effect of anthropogenic noise on the Dublin bay prawn *Nephrops norvegicus*. I am interested in how fitness related behaviours are influenced by changes in the acoustic environment. My approach uses a combination of tank based and *in situ* studies to develop our understanding of how this commercially important species is affected.

KEY FINDINGS

My key findings to date show that *Nephrops norvegicus* 'freeze' for a significantly longer time when subjected to anthropogenic noise than during a silent control treatment. This has implications for anti-predator responses, from both animal and human threats.

OUTPUTS

Poster presentation, SeaBASS Syracuse New York, July 2016.

Sigwart, J.D. and McLean, L. (2017) Contribution of Caulerpa spp. to Marine Mollusc Species Richness in the Megadiverse Philippines. Visaya, 4(6), 71-77.

Poster presentation, DAERA Postgraduate conference, Hillsborough, June 2017.

COLLABORATORS

Dr. Hansjoerg Kunc (QUB); Dr. Jonathan Houghton (QUB); Dr. Adam Mellor (AFBI); Dr. Paul Mensink (QUB).

Does Biodiversity Promote Ecosystem Recovery? Emprical Test of Resistance and Resilience in Coastal Systems

Ms. Lydia White (PhD student)

DfE NI, Trinity College Dublin

School of Biological Science

In light of predicted global change scenarios and biodiversity loss, it is increasingly important to understand how biodiversity-ecosystem functioning relationships vary under increasingly disturbed conditions. Predicted increases in warming, eutrophication events and sedimentation, alongside climate-driven range shifts of key consumer species, are likely to have substantial effects on coastal communities. I am examining experimentally the top-down effects of biodiversity (trophic complexity, grazer diversity, predator diversity) on the structure and stability of natural marine benthic communities exposed to various combinations of environmental stressors.

KEY FINDINGS

Analysis still on going, but preliminary results suggest that trophic complexity moderates the vulnerability of communities exposed to multiple stressors. Nutrient enrichment and warming modify indirect effects of predates on marine communities.

OUTPUTS

Poster Presentation at Aquatic Biodiversity and Ecosystems Conference, Liverpool, August 2015.

Poster Presentation at British Ecological Society Annual, Liverpool, December 2016.

Oral Presentation at Ecological Society of America Annual, Portland, USA August 2017.

COLLABORATORS

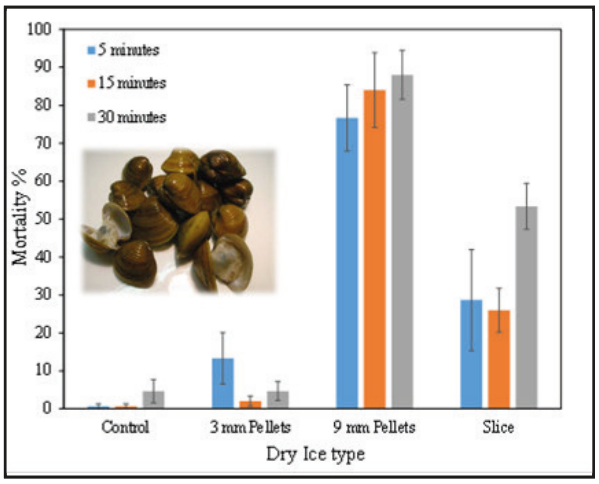
Dr. Nessa O'Connor (QUB and TCD), Dr. Ian Donohue (TCD).

Prevention, Control and Eradication of Invasive Asian Clam *Corbicula fluminea*

Mr. Neil Coughlan (PhD student)

Environmental Protection Agency: Cash for clams.

School of Biological Sciences



Asian clam *Corbicula fluminea* is a high impact freshwater invader that dominates macroinvertebrate communities and physically alters benthic habitats. Established populations are extremely difficult to remove or control. Here, however, we aim to develop novel control and eradication techniques. In particular, we utilise application of Dry Ice (-78°C) to induce clam mortality via thermal shock, across a varied range of clam population densities and habitat conditions.

Figure: Application of various dry ice formations (350 g) to groups of 30 individual adult clams (equivalent to a distribution of 1179 individuals per m^2) at a water depth of 10cm for 5, 15 and 30 minutes exposure time (n= 5).

KEY FINDINGS

Dry ice can induce 100% mortality of Asian clam within as little as 5 minutes of exposure. However, factors such as water column depth and clam population densities can reduce this success rate (e.g. Figure displayed). Accordingly, longer exposure times and greater quantities of dry ice may be required. Other methods of clam control, such as immersion within hot water (45°C), can also be effective biosecurity measure for spread mitigation.

OUTPUTS

Caffrey J., Dick J.T.A., Lucy F., … Coughlan N. (2016). First record of the Asian clam *Corbicula fluminea* (Müller, 1774) (Bivalvia, Cyrenidae) in Northern Ireland. BioInvasions Records, 5: 239–244.

Piria M., Dick J.T.A., Lucy F.E., Coughlan N.E., Davis E., Caffrey J.M. (2017), Tackling Invasive Alien Species in Europe II: Threats and Opportunities until 2020. Management of Biological Invasions, 8: 273-286.

COLLABORATORS

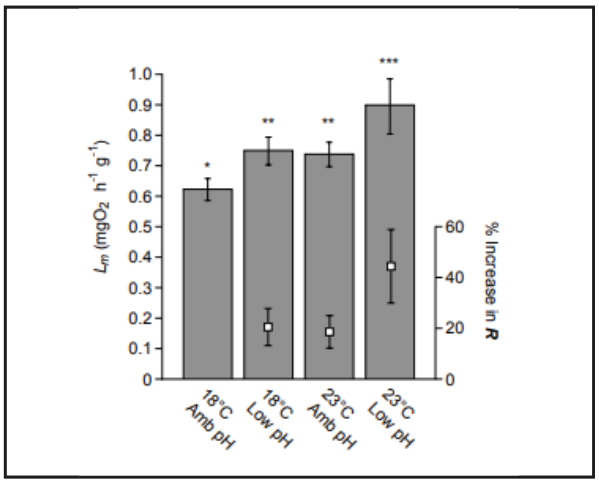
Prof. Jaimie Dick (QUB); Prof. Frances Lucy (Institute of Technology Sligo); Prof. Joe Caffrey (INVAS Biosecurity); Dr. Neil Reid (QUB); Ms Eithne Davis (Institute of Technology Sligo).

Metabolism and Body-size, and What do they Mean for Animals under Climate Change?

Mr. Nicholas Carey (PhD student)

Department of Employment and Learning

School of Biological Sciences



The fundamental relationship between body-size and metabolic rate has been studied for nearly a century, but remains to be definitively explained and new complexities are still emerging. Animal size and their metabolic rate determines how much energy they need, so changes to metabolism may affect large scale ecological relationships. How the metabolic rate of marine organisms responds to the dual challenges of ocean warming and ocean acidification remains uncertain, but one trait, their size, may affect how vulnerable they are.
(Figure: how the metabolic rate of an Australian sea urchin is affected by warming and ocean acidification.)

KEY FINDINGS

Body-size is a major variable that might affect species' responses to both ocean acidification and warming. Different responses to temperature by different sizes confirm predictions of recent fundamental physiological theory. However, not all species respond in the same way; juveniles and adults of echinoderms, for instance, appear to be equally responsive to both warming and ocean acidification.

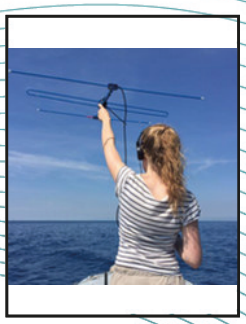
OUTPUTS

Carey, N., Dupont, S. & Sigwart, J.D. (2016). The sea hare *Aplysia punctata* (Mollusca: Gastropoda) can maintain shell calcification under extreme ocean acidification. Biological Bulletin, 231: 142–151.

COLLABORATORS

Dr. Julia Sigwart, QML/QUB; Prof. Jeffrey Richards, University of British Columbia; Prof. Maria Byrne, University of Sydney; Dr. Jeremy Goldbogen, Stanford University; Dr. Sam Dupont, University of Gothenburg; Dr. Lauren Sumner-Rooney, QML/QUB.

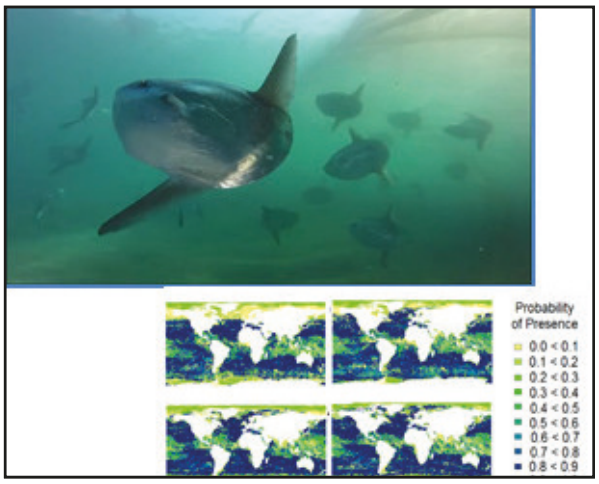
Extent and Drivers for Cryptic Benthivory in the Ocean Sunfish



Ms. Natasha Phillips (PhD Student)

The Fisheries Society of the British Isles

School of Biological Sciences



Ocean sunfish (the world's largest bony fish) were long thought of as rare, passive drifters of little ecological relevance. However, recent research has provided new evidence of extraordinary aggregations, long distance migrations and complex foraging. Using a combination of theoretical modelling, biochemical analysis and data logging, this project aims to explore the dietary and energetic drivers underpinning the high-density aggregations in the Mediterranean Sea. As unwanted sunfish bycatch is estimated to remove 100,000s of individuals each year, such data will be vital for sustainable fisheries management. The figure (left) shows the sunfish bycatch in a small Italian fishery (all released unharmed) and our recently published work on sunfish global distribution.

KEY FINDINGS

Large aggregations of ocean sunfish have been identified near Genoa, with up to 5000 individuals caught annually. Field work during 2015 and 2016 enabled collection of tissue samples for isotopic analysis, morphometric data for allometry of growth and energy use, alongside deployment of accelerometer data loggers. Mathematical modelling of sunfish sightings has provided the first global overview of the distribution of the *Mola* genus.

OUTPUTS

Phillips et al. (2016). Seeking the sun in deep, dark places: mesopelagic sightings of ocean sunfishes (Molidae) Journal of Fish Biology, 87: 1118-1126.

Phillips et al. (2017). Applying species distribution modelling to a data poor, pelagic fish complex: The ocean sunfishes Journal of Biogeography, DOI 10.1111/jbi.13033.

Presented research at the FSBI 2017 conference, awarded 2nd prize for student contribution.

COLLABORATORS

Drs J. Houghton & Dr. N. Reid; Prof. C. Harrod; Drs Y. Watanabe & N. Payne; Dr. I. Nakamura; Dr. T. Thys; Mr M. Howard; Dr. A. Gates; Ms V. Cappenera; Dr. L. Eagling; Dr. A. Ahuir-Baraja; Drs J. Alfaro Shigueto & J. Mangel.

Interplay of Hydrodynamics and Invasive Species in the Marine Environment

Mr. Patrick Joyce (PhD student)

Department for the Economy (DfE)

School of Biological Sciences / School of Natural and Built Environment

The Pacific oyster is one of the most globalised non-native species due to its large-scale introductions for aquaculture, yet its ecological impacts have not been widely studied. The coastal habitats in which this species occurs are changing due to anthropogenic influences such as coastal infrastructure which can modify the hydrodynamics in adjacent ecosystems. This project aims to identify how relationships between the Pacific oyster and native species (i.e. predator-prey relationships and competition with native filter feeders) are affected by different hydrodynamic scenarios.
Image Left: Juv. native mussel, *Mytilus edulis*. Right: Juv. non-native oyster, *Crassostrea gigas*.

KEY FINDINGS

Native mussel feeding IS more affected by changes in flow velocity compared to the Pacific Oyster. Pacific oyster feeding rates appeared lower than the native mussels, however, when they occur in high abundances then it is likely that Pacific oysters will filter more plankton from the surrounding water than native mussels.

OUTPUTS

Presentation at ASLO 2017 (Association for the Sciences of Limnology and Oceanography): “The influence of oscillatory flow velocity on the clearance rates of native and non-native bivalves”.

COLLABORATORS

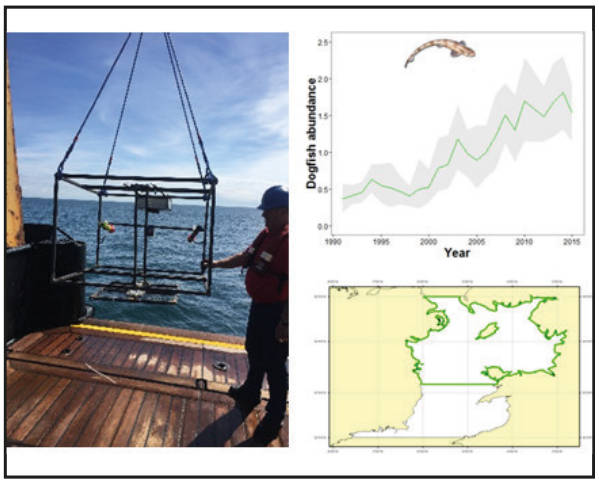
Prof. Jaimie Dick (QUB), Dr. Louise Kregting (QUB), Björn Elsäßer (Danish Hydraulic Institute), Dr. Antony Knights (Plymouth University), Dr. Colin Whittaker (Univeristy of Auckland), Dr. Keri Collins (Plymouth University).

Spatio-Temporal Variation of Dogfish (*Scyliorhinus canicula*) Abundance in a Highly Fished Area

Mr. Paul Mayo (PhD student)

Department of Agriculture, Environment and Rural Affairs (DAERA)

School of Biological Sciences



A recent change in EU legislation will end discarding at sea. This will mean there will be a drastic reduction in the amount of food made available for marine scavengers. My main research interests include investigating the indirect effects linked with changes in fishing practices in the Irish Sea and the fate of fisheries discards once they reach the seabed.

Figure: Baited remote underwater video (BRUV) being deployed in the Irish Sea to observe the fate of discards at the seabed and changes in dogfish biomass over the past 25 years indicate a dramatic increase in relative abundance.

KEY FINDINGS

Lesser-spotted dogfish have increased their abundance in the Irish Sea by over 300% in the past 25 years; however, there remains a weak negative relationship between dogfish abundance and prey species such as the Norway lobster (*Nephrops norvegicus*). This may be due to the presence of discards which, in part, subsidise the diet of marine scavengers. BRUV footage has shown a range of scavengers which utilise discards at the seabed, the most common being plaice (*Pleuronectes platessa*).

OUTPUTS

Oral presentation given at the 13th Annual Marine Biological Association conference.

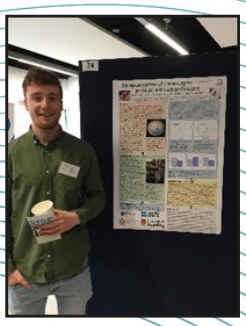
Outreach program with Loughs Agency to promote shark awareness and dismiss common myths.

Post presentation displayed at the annual AFBI Postgraduate Symposium.

COLLABORATORS

Dr. Jonathan Houghton (QUB), Dr. Paul Mensink (QUB), Simon Exley (QUB), Dr. Steven Beggs (AFBI), Mark McCaughan (DAERA fisheries), Aodhan Fitzgerald (MI), Rory Mullins (Irish Lights).

Biological Control of the Emerging UK Mosquito Problem



Mr. Ross Cuthbert (PhD student)

DfE studentship, British Council, South African Institute for Aquatic Biodiversity (SAIAB)

School of Biological Sciences

Climate change, urbanisation and changing domestic water storage practices are combining to drive greater proliferations of vectorially-important mosquitoes in the UK. This is causing increased nuisance biting and a higher risk of vector-borne disease transmission. We are seeking to optimise the biological control of mosquitoes using native natural enemies by examining their coupled functional and numerical responses, facilitating a holistic appraisal of biocontrol agent impact potential. Further, our experiments are integrative of environmental context-dependencies which modulate predator-prey interactions, increasing the empirical transparency of our results to policy makers.

KEY FINDINGS

Freshwater cyclopoid copepods exhibit great potential for the biological control of container-breeding mosquitoes, with a high *per capita* predatory impact combined with marked fecundity displayed. We have illustrated how future temperature projections will heighten the magnitude of their potential impact on mosquito populations

OUTPUTS

Participated in Invasive Alien Species (IAS) Horizon Scanning exercise for the island of Ireland, Institute of Technology, Sligo, April 2017.

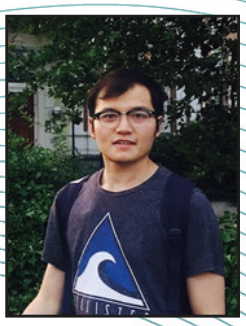
Poster presentation at Environ, Athlone Institute of Technology, April 2017.

Attended Irish Ecological Association (IEA) conference, Institute of Technology, Sligo, November 2016.

COLLABORATORS

Prof. Jaimie Dick (QUB), Dr. Neil Reid (QUB); Dr. Amanda Callaghan (University of Reading); Dr. Olaf Weyl (SAIAB).

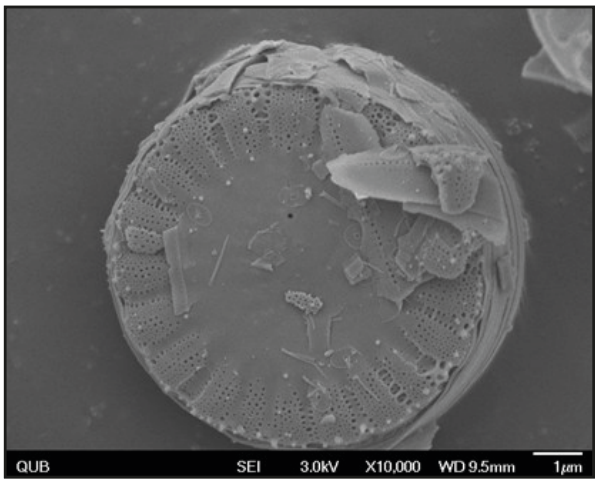
Investigating the Potential use of Marine Derived Biosilica for Bone Repair Strategies



Mr. Ri Han (PhD Student)

Beaufort Marine Biodiscovery, Self-funding

School of Chemistry & Chemical Engineering



My current study investigates the potential use of diatom as a biomaterial for bone repair. As a major group of algae, the frustule of diatom is composed of silica with a small amount of water. The unique nano-porous cell walls of diatoms can provide not only a source of Si4+ but also enhance material properties as components of a polymer composite. In this project, diatom was treated and transformed to pure marine derived biosilica, then incorporated with bioresorbable polymers to form new biomaterials used on 3D printed scaffolds in bone tissue engineering. The aims of this research include studying the role of released Si4+ from diatom for bone healing, and investigating the effects of diatom in biomaterials as well. SEM image of *Cyclotella meneghiniana* from Mississippi, USA.

KEY FINDINGS

Our treatment process can remove the organic matter (30 to 35 wt.%) from raw diatom effectively, resulting in a purity of 99.5% biosilica substrate. Inductively coupled plasma results demonstrated almost linear Si release kinetics up to 58ppm at 7 days in phosphate buffer solution (pH 7.4) media. The Young's modulus of polymer (PDLGA) - diatom (5 wt.%) filaments were significantly enhanced (3319±68 MPa) compared to the pure polymer (2907±126 MPa).

OUTPUTS

The Investigation of marine derived biosilica for bone repair strategies (Abstract & Presentation for UK Society for Biomaterials – 16th Annual Conference, June 2017).

Understanding the Release of Silicon Ions from Marine Diatoms for Therapeutic Application (Presentation & Poster in Marine Biodiscovery Research Meeting, June 2016).

COLLABORATORS

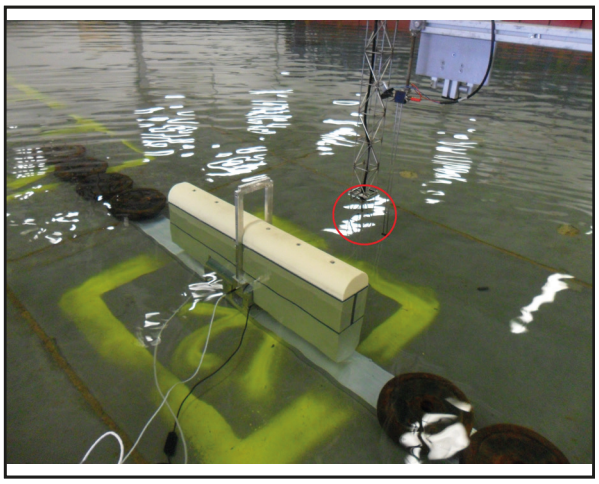
Dr. Pamela Walsh (QUB); Prof. Fraser Buchanan (QUB); Prof. Matt Julius (St. Cloud University MN).

A Numerical Tool to Predict the Near Shore Effect of an Array of Oscillating Wave Surge Converter (OWSC) Devices

Ms. Rachael McKee (PhD Student)

Engineering and Physical Sciences Research Centre (EPSRC)

School of Natural and Built Environment



This PhD project aims to demonstrate the use of numerical modelling to simulate the impact of an OWSC array on the surrounding wave field. Extensive physical experiments have been conducted in the Portaferry wave basin to produce sufficient calibration and validation data. The acquired data have been water particle velocity using an acoustic Doppler velocimeter, which is post processed to represent energy transfer. Energy transfer can be also simulated numerically in a Spectral Wave model, making it a transferable parameter. The figure shows a 40th scale OWSC model in the Portaferry wave basin with the velocimeter marked.

KEY FINDINGS

A novel method has been developed which will quantify the reflection present in a wave using water particle velocity measurements. A method to quantify energy transfer around an OWSC model using water particle velocity measurements. A method to realistically represent Wave Energy Converters in a Spectral Wave Model.

OUTPUTS

Conference paper published and presented at EWTEC (European Wave and Tidal Energy Conference) 2015.

Poster presented at ICOE (International Conference on Ocean Energy) 2016. Presented key aspects of this project to the Ports and Terminal Section of DHI (Danish Hydraulic Institute) at DHI's head office (Horsholm, Denmark) in March 2017.

COLLABORATORS

Marine Research Group, QUB; DHI (Danish Hydraulic Institute).

Hydrodynamic Influence on Kelp Productivity and Mechanical Properties

Ms. Rachel Millar (PhD Student)

Engineering and Physical Sciences Research Centre (EPSRC)

School of Natural and Built Environment

Water motion is an important parameter in controlling macroalgal morphology, community structure and physiological rates. Within Strangford Lough, a range of wave only and current only locations can be found which make it an ideal experimental field site for separating the influence that different types of water motion have on the physiological rates of macroalgae. Helping to further understand how kelp forests may be impacted by predicted changes in wave climate and increased storm frequency.

KEY FINDINGS

Research is ongoing; however, fieldwork results show that growth and erosion rates of *Laminaria digitata* differ between wave dominated and current dominated sites in Strangford Lough. This highlights the importance of further work into how different forms of water motion influence macroalgae productivity.

OUTPUTS

Conference presentation at: The Association for the Sciences of Limnology and Oceanography (ASLO) 2017.

COLLABORATORS

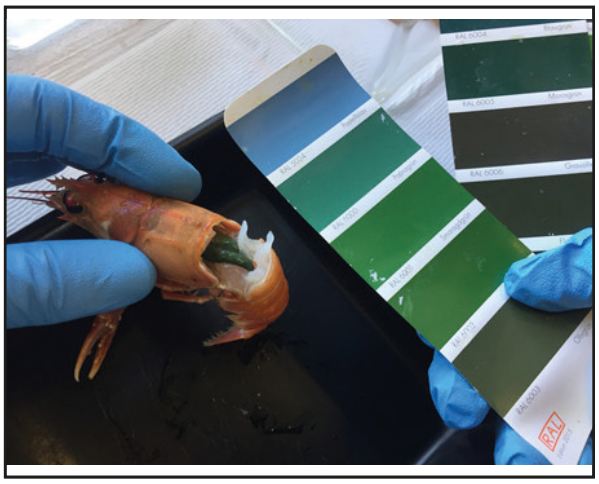
Dr. Louise Kregting (QUB); Dr. Jonathan Houghton(QUB); Dr. Bjoern Elsaesser (DHI).

The Reproductive Cycle of the *Nephrops norvegicus* and Implications for Fisheries Sustainability

Mr. Mánus Cunningham (Undergraduate Student)

Seafish, Kilkeel Whitby Seafoods

School of Biological Sciences



The aim of this project is to revise and improve the ovary staging scheme for *N. norvegicus* using macroscopic and microscopic observations. Our main focus is on the abundance and possible causes of ovary resorption in highly exploited populations.

Image: Staging ovaries of *N. norvegicus* from the Farne Deeps, North Sea.

KEY FINDINGS

Using histological methods, the maturation stages in ovaries were analysed. To test whether females with resorbing ovaries were inseminated, we also investigated female sperm storage organs for the presence of spermatophores. Our results showed that the females contained spermatophores, and therefore a lack of males in the population is not the cause of ovary resorption in *N. norvegicus*. Other factors, e.g. unsuitable environmental conditions, have to be considered.

OUTPUTS

Poster presentation at the QML open day on 15th July 2017.

COLLABORATORS

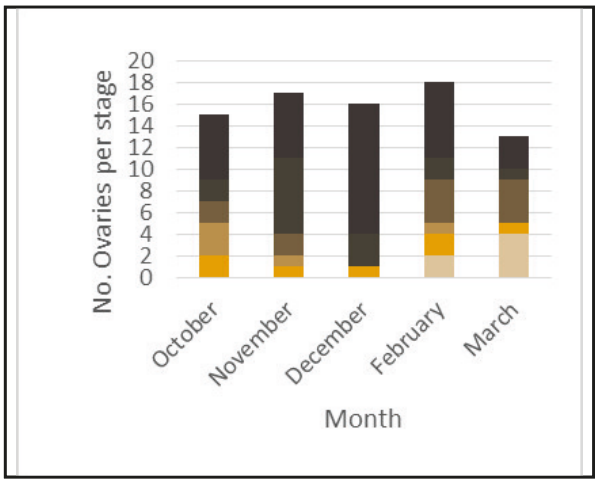
Dr. Carola Becker, Prof. Jaimie Dick.

The Reproductive Cycle of the Velvet Swimming Crab, *Necora puber*, in Strangford Lough

Ms. Victoria McEvoy (Undergraduate Student)

Seafish, Killkeel/Whitby Seafoods

School of Biological Sciences



Velvet swimming crabs, *Necora puber*, are becoming an increasingly important commercially fished species in Strangford Lough. Little information is available on the reproductive cycle of this population. This study aimed to fill this gap to improve future fisheries management. A population of *N. puber* was sampled monthly from October to March 2017, using 3 cm mesh creels at several sites around Kircubbin, Chapel Island and Ballyhenry.

Figure: Monthly distribution of ovary stages in samples (stages of ovary maturation: cream = immature, yellow = very early, light brown =early, brown = intermediate, dark brown = late).

KEY FINDINGS

The ovary maturation stages during the winter season were macroscopically staged using a standardized RAL colour palette. Samples for a microscopic study were preserved for each stage and incorporated into fidnings from external observations.

OUTPUTS

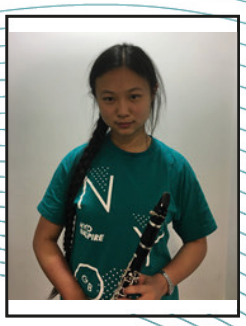
A poster on the outcomes of this project was presented on the Marine Laboratory Open Day in July 2017.

An oral presentation on the project was also given to Queen's University as part of my undergraduate Honours project.

COLLABORATORS

Dr. Carola Becker, Prof, Dr. Jaimie Dick, Dr, Lawrence Eagling, Emma Gorman.

Biocontrol of Native Mosquitoes using Cyclopoid Copepods



Ms. Gina Vong (Placement student)

Nuffield Foundation

Mosquito-transmitted diseases lead to millions of deaths every year. Climate change and transfer from Europe have led to an increase in mosquito populations (native and invasive) in the United Kingdom (UK). My project focuses on the potentials of cyclopoid copepods as a biocontrol agent for the regulation of British mosquito populations. Experiments tested the hunting capabilities of cyclopoid copepods; oviposition tendencies of *Culex* mosquitoes and larval behaviour in response to threat from copepods in order to assess the total predator effect of cyclopoid copepods on *Culex* mosquitoes.

KEY FINDINGS

Turbidity had no effect copepod hunting ability. Mosquitoes preferred to oviposit in containers without copepods. Larvae behaviour didn't differ with the treatment. Conclusion: results provide more evidence that cyclopoid copepods have high potential for use as a mosquito biocontrol agent.

OUTPUTS

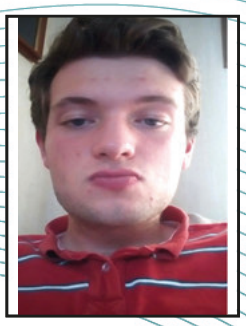
Nuffield Research Placement report -2017

CREST Gold Award report - 2017

COLLABORATORS

Ruadri Cunningham, Ross Cuthbert, Neil Coughlan, Kate Crane.

Methods to Induce Mortality in *Corbicula fluminea*



Mr. Ruadri Cunningham (Placement Student)

Nuffield Foundation

I was advised to apply for a research placement through Nuffield by my school, and this in turn lead me to QML. I applied for a placement to learn more about how scientific research is carried out and also for the CREST gold award which could help my UCAS application and also any future employment. I am very thankful for the opportunity that was granted to me by the staff and students at QML and I have learnt so much, as well as enjoying it. I helped many people during the five weeks I spent at QML, however, the bulk of my time was spent helping Neil Coughlan with a series of experiments designed to kill an invasive freshwater clam called *Corbicula fluminea* & this is what the report I did to get the CREST gold award is based on.

KEY FINDINGS

The experiments carried out included experiments with dry ice, bleach, Virasure® and Virkon® as well as salt and a steam cleaner. These treatments were designed to kill *C. fluminea* which could reduce its spread.

OUTPUTS

The output from my time at QML is a report of the experiments carried out, which was submitted to both Nuffield and CREST. The report was called "Methods to induce mortality in *Corbicula fluminea*" and contains details of the experiments carried out, as well as the wider effects *C. fluminea* could have if its spread is continued, which could be similar to the effects of other areas where *C. fluminea* is already widespread, showing why such research is required.

COLLABORATORS

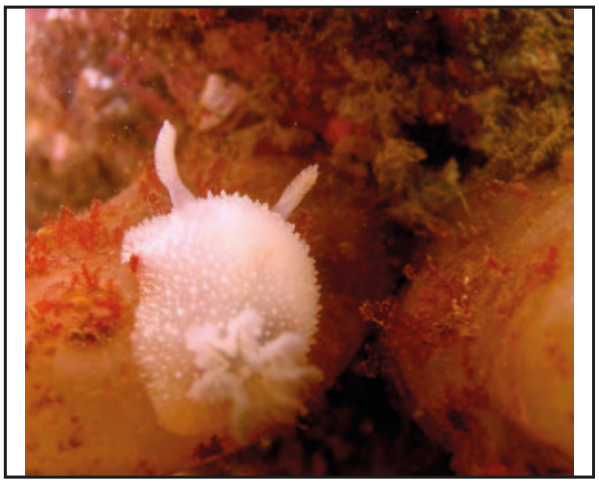
Ging Vong, Ross Cuthbert, Neil Coughlan, Kate Crane.

Nudibranch Diversity in Strangford Lough

Dr. Bernard Picton (Honorary research fellow)

School of Biological Sciences

National Museums Northern Ireland



For the last two years Bernard has hosted a scientific 'nudibranch safari' in Strangford Lough. This event brings together dive photographers from professional and hobby backgrounds who SCUBA dive to search for, and learn about, beautiful sea slugs. Fifteen participating divers from five European countries found more than 60 species of sea slugs, including at least two new records for Strangford Lough.

(photograph by PhD student and Safari co-organiser Lydia White)

KEY FINDINGS

There is a surprising diversity of beautiful and undiscovered species on our doorstep.

OUTPUTS

Outreach event: Irish Nudibranch Safari 2015, 15 international participants.

COLLABORATORS

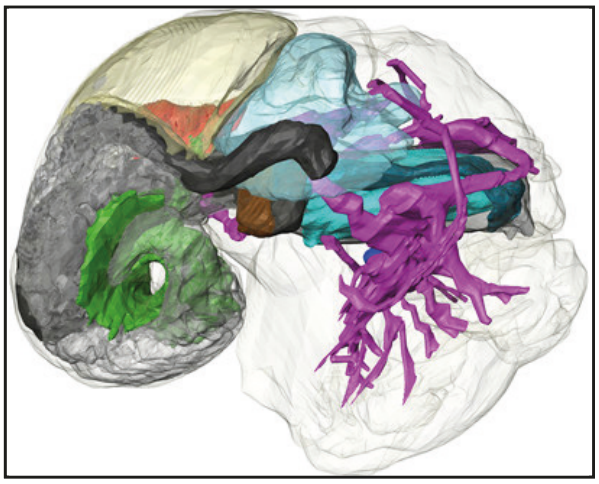
Simon Exley; Dr. Julia Sigwart, Dr. Christine Morrow, Lydia White (QML).

Evolution and Adaptation of Deep-sea Invertebrate Animals

Dr. Chong Chen (honorary research associate)

Japan Agency for Marine-Earth Science and Technology

School of Biological Sciences



I combine morphological (e.g., histology, dissection, microscopy) and molecular (e.g., phylogeny, population genetics, genomics) methodologies in an attempt to understand how and why animals have evolved to be the way they are today. One of my key interests is in exploring marine invertebrates evolved to adapt to 'extreme' environments, particularly deep-sea hydrothermal vents. Modification in the anatomy is a key yet often neglected part of adaptation, which I explore using technologies such as synchrotron radiation μCT and 3D reconstruction.

Figure: Reconstructed 3D anatomy of the holobiont vent snail *Gigantopelta.*

KEY FINDINGS

Our recent result demonstrated that two closely-related hydrothermal vent snails, *Gigantopelta* and the 'scaly-foot' *Chrysomallon*, convergently evolved the peculiar adaptation of housing endosymbiotic bacteria in their much enlarged oesophageal gland. Although superficially similar, a number of key anatomical differences between the two suggested two independent origins of a similar way of life, confirmed by a 5-gene phylogenetic reconstruction clearly showing that the two are not sister within the known members of family Peltospiridae.

OUTPUTS

Chen C, Uematsu K, Linse K, Sigwart JD (2017). By more ways than one: Rapid convergence in adaptations to hydrothermal vents shown by 3D anatomical reconstruction of *Gigantopelta* (Mollusca: Neomphalina). BMC Evolutionary Biology, 17: 62.

Zhang Y [Yanjie], Sun J, Chen C, Watanabe HK, Feng D, Zhang Y [Yu], Chiu JMY, Qian P-Y, Qiu J-W (2017) Adaptation & evolution of polynoid scale-worms (Annelida: Polynoidae) insights from transcriptome comparison among 2 deep-sea & a shallow-water species Scientific Reports, 7: 46205

COLLABORATORS

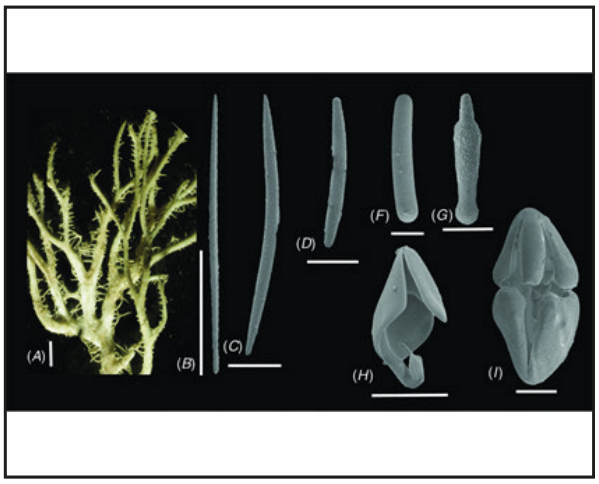
Dr. Julia Sigwart (QUB), Dr. Katrin Linse (BAS Cambridge), Dr. Takenori Sasaki (the University of Tokyo), Dr. Jin Sun & Prof. Pei-Yuan Qian (Hong Kong University of Science and Technology), Dr. Jian-Wen Qiu (Hong Kong Baptist University), Dr. Dilworth Y. Parkinson (Advanced Light Source, Berkeley), Dr. Hiromi Watanabe & Dr. Ken Takai (Japan Agency for Marine-Earth Science and Technology), Prof. Alex Rogers (Oxford University), Dr. Jonathan Copley (NOC Southampton).

Southern Ocean Sponges

Dr. Claire Goodwin

Leverhulme Trust

School of Biological Sciences



The Leverhulme funded project 'Southern Ocean Sponges' (October 2013- October 2016) investigated the biogeography and taxonomy of sponges from the Drake Passage and Antarctic Peninsula. It also examined the role of sponges in the silica cycle in this region.

Figure: *Asbestopluma* (Helophloeina) *keraia*, sp. nov.

KEY FINDINGS

Improved understanding of biodiversity of sponges in the Southern Ocean (Drake Passage Sea Mounts and Antarctic Peninsula). Descriptions of 11 species new to science. Knowledge of silica deposition within demosponges which will improve proxy used for determining historic seawater silica levels.

OUTPUTS

Goodwin, C, Berman, J, Janussen, D, Gocke, C & Hendry, K. (2015). Hexactinellida (Porifera) from the Drake Passage (Southern Ocean) with a description of three new species. Zootaxa, 4126: 207-220.

Goodwin, C.E., Berman, J. Downey, R., Hendry, K.R. (2017). Carnivorous sponges (Porifera: Demospongiae: Poecilosclerida: Cladorhizidae) from the Drake Passage (Southern Ocean) with a description of eight new species and a review of the family Cladorhizidae in the Southern Ocean. Invertebrate Systematics, 31(1): 37-64.

COLLABORATORS

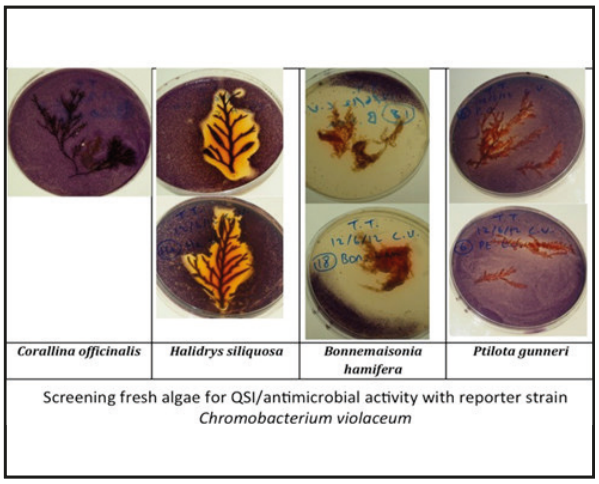
Katharine Hendry – University of Bristol, Jade Berman – Ulster Wildlife Trust, Dorte Janussen, Christian Göcke, Senkenberg Museum, Germany, Rachel Downey, Australian National University.

Systematics and Applications of Macroalgae

Prof. Christine A. Maggs (Visiting Professor)

National Development Plan Ireland, InvestNI, BBSRC/Innovate UK

School of Biological Sciences



With QUB colleagues and international collaborators, I am involved in a wide range of projects concerning aspects of the taxonomy, phylogeny, population genetics, genomics and exploitation of macroalgae, combining molecular and traditional approaches. We also explore the use of macroalgae in applications such as bioactives, bioengineering and anaerobic digestion.
Figure shows collaborative work between Pharmacy and Biological Sciences in QUB, which found that the brown seaweed *Halidrys siliquosa* is an excellent source of diverse bioactives.

KEY FINDINGS

Using chloroplast, mitochondrial and nuclear genomes and genes, we have resolved relationships among the main lineages of the largest red algal family Rhodomelaceae by constructing a comprehensive phylogeny with 52 newly sequenced chloroplast genomes and 48 mitochondrial genomes, with 266 rbcL, 125 18S and 143 cox1 sequences to include nearly half of all known species in the family (407 species in 89 genera). This has resulted in the description of many new genera & tribes.

OUTPUTS

Díaz-Tapia, P., Maggs, C.A., West, J.A. & Verbruggen, H. (2017). Analysis of chloroplast genomes and a supermatrix inform reclassification of the Rhodomelaceae (Rhodophyta). Journal of Phycology, DOI: 10.1111/jpy.12553.

Díaz-Tapia, P., McIvor, L., Freshwater, D.W., Verbruggen, H., Wynne, M.J. & Maggs, C.A. (2017). The genera *Melanothamnus* Bornet & Falkenberg and Vertebrata S.F. Gray constitute well-defined clades of the red algal tribe Polysiphonieae (Rhodomelaceae, Ceramiales). European Journal of Phycology, 52: 1-30.

COLLABORATORS

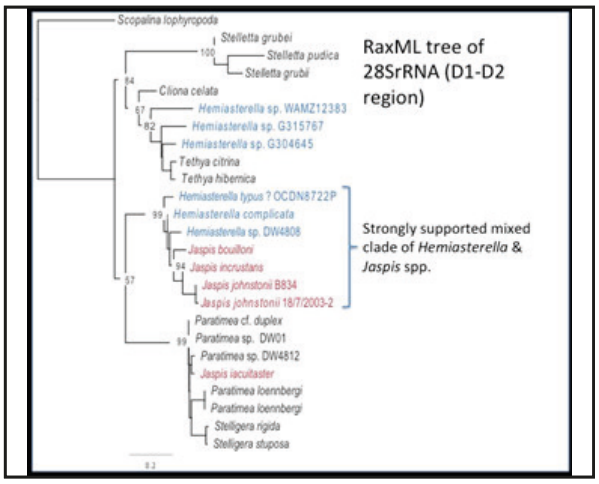
QUB: Prof. Brendan Gilmore, Pharmacy; Dr. Pamela Walsh, Chemistry and Chemical Engineering; Dr. Susan Clarke, Nursing; Dr. Alberto Longo, Biological Sciences. Dr. Pilar Díaz, University of A Coruña, Spain; Dr. Heroen Verbruggen, Melbourne University; Dr. Ruth Kelly and Dr. Jane Stout, Trinity College Dublin; Prof. Mark Johnson, NUI Galway.

Systematics, Ecology and Chemistry of Marine Demosponges

Dr. Christine Morrow (Visiting Researcher)

Irish Research Council, NUI Galway

School of Biological Sciences



My main areas of interest are the systematics, ecology and chemistry of marine demosponges. Currently I am working on the sytematics of sponges belonging to the genus *Jaspis* which are producers of bioactive compounds.

RaxML tree of 28S rRNA showing a strongly supported mixed clade of *Jaspis* and *Hemiasterella* species. A new oreder is necessary for this clade. *Jaspis* and *Hemiasterella* are both polyphyletic.

KEY FINDINGS

The main outcome of this research has been a proposal for a revised classification of Demospongiae. This proposal has now been implemented in the world Porifara Database and WorMs which are the main database sources for sponge classification and nomenclature. The proposal called for the abandonment of 5 orders, the resurrection or upgrading of 6 order names and the erection of 7 new orders.

OUTPUTS

Kelly M., Erpenbeck D., Morrow C.C., Van Soest R.W.M. (2015) First record of a living species of the genus *Janulum* (Class Demospongiae) in the Southern Hemisphere. Zootaxa 3980 (2): 255-266.

Perina D., Korolija M., Popović Hadžija M., Grbeša I., Belužić R., Imešek M, Morrow C.C., Posavec Marjanović M, Bakran-Petricioli T., Mikoč A., Ćetković H. (2015). Functional and Structural Characterization of FAU Gene/Protein from Marine Sponge *Suberites domuncula*. Marine Drugs 13(7):4179-96. doi: 10.3390/md13074179.

COLLABORATORS

Prof. Olivier Thomas, Marine biodiscovery Laboratory, NUI Galway; Prof. Grace McCormack, Zoology Department, NUI Galway; Dr. Paco Cardenas, University of Uppsala; Dr. Dennis Lavrov, University of Iowa; Dr. Jean Vacelet, University of Marseille; Dr. Jean Vacelet, University of Marseille; Dr. John Hooper, Queensland Museum.

Classification, Dispersal Biology and Evolution of Tropical Rain Forest Trees

Dr. Caroline M. Pannell

Self, QML

School of Biological Sciences

Classification, ecology, historical biogeography and evolution of tropical rain forest trees in SE Asia and Australasia. Field and herbarium work, collaborative research on molecular phylogenies and biomedical research. Evolution of plant-vertebrate disperser interactions that drive forest regeneration and, over millions of years, the evolution of biodiversity on opposite sides of Wallace's Line, one of the world's major faunal boundaries.

Image: Flightless Cassowary, *Casuarius casuarius*, feeding on fallen fruits of *Acronychia vestita* fruits from the lemon family (photo by C.M. Pannell).

KEY FINDINGS

By direct observation, photography and camera trapping in Far Northern Queensland in 2016, major switches of seed-dispersers within plant groups which occur on both sides of Wallace's Line were confirmed and the associated dispersal syndromes better understood. Preliminary work on an accounts of Aglaia (trees in the Mahogany family) for the Flora of Thailand and the Flora of Singapore was carried out in the Herbaria at Kew, Edinburgh and Trinity College Dublin.

OUTPUTS

C.M. Pannell, Melanie Grudinski, Alexandra N. Muellner-Riehl.
Wallace's Line and the Biogeography of *Aglaia* (Meliaceae). Poster at Systematics Association Biennial Meeting, Oxford 2015.

Nuraqilah Othman, Li Pan, Michele Mejin, Julian C. L. Voong, Hee-byung Chai, Caroline M. Pannell, A. Douglas Kinghorn, and Tiong C. Yeo Cyclopenta[b]benzofuran and Secodammarane Derivatives from the Stems of *Aglaia stellatopilosa*. Journal of Natural Products Vol. 79(4) Issue. 4 784-791. Publication Date (Web): March 14, 2016. DOI: 10.1021/acs.jnatprod.5b008

COLLABORATORS

Sarawak Biodiversity Centre, Malaysia. Dr. Stephen Harris, University of Oxford Herbaria, Department of Plant Sciences, Oxford. Dr. Wendy Cooper, Queensland, Australia. Prof. Darren Crayn and Lizzie Joyce, James Cook University, Cairns, Queensland, Australia. The Forest Herbarium Department of National Parks, Wildlife and Plant Conservation, Bangkok, Thailand. Singapore Botanic Garden. Royal Botanic Gardens Kew and Royal Botanic Gardens Edinburgh. National Botanic Gardens, Glasnevin, Ireland.

Environmental Stressors in Freshwaters

Dr. David William Kelly (Visiting Research Fellow)

Self, QML, DAHRRGA

School of Biological Sciences

Dr. Kelly is interested in invasion ecology, environmental stressors in freshwater, and fisheries ecology.

KEY FINDINGS

Main themes include the assessment of environmental impacts of large infrastructure projects on freshwaters and the provision of water resource management advice. Recent work has focused on the provision of advice to the farming community on land management for the protection of priority habitats and species (SPAs, SACs, ASSIs, RAMSAR, Annex species). Other current interests include river and lake surveys to identify the potential present of non-indigenous species.

OUTPUTS

Survey of fish hosts for the freshwater pearl mussel in 12 rivers (2017). Sub-contracted with Paul Johnston Associates & supported by Department of Arts, Heritage, Regional, Rural & Gaeltacht Affairs.

An Environmental Impact Assessment of a proposed industrial development at Knockmore Hill: Fisheries & Aquatic Ecological sensitivities in the Lissue Stream (2017). DWK Freshwater Consulting.

COLLABORATORS

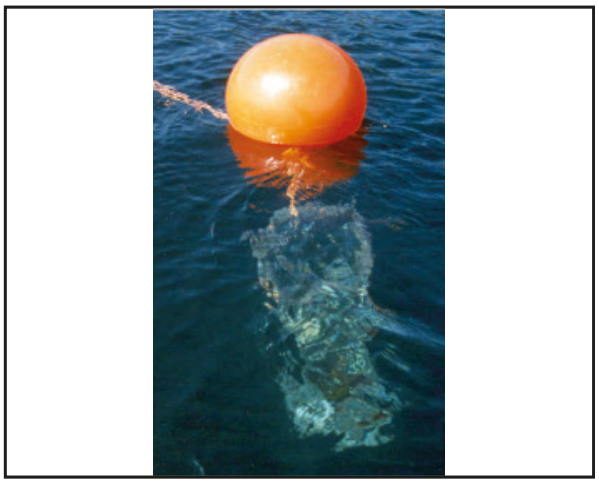
Prof. J.T.A. Dick – (QUB), Paul Johnston Associates Fisheries Consultants, ATEC NI, RPS group, AECOM.

Historical Context of the Strangford Lough Marine Conservation Zone

Dr. Daryl Anne Birkett (Honorary Research Fellow)

Self, QML

School of Biological Sciences



Daryl has undertaken research and monitoring to enable permitted development of local sites. As Honorary Secretary of the Upper Ards Historical Society, Daryl has considered the site context of the Strangford Lough area and this year wrote the first installment of the history of QML for the Marine Lab website.

KEY FINDINGS

Strangford Lough is a Special Area of Conservation and contains within it several Marine Nature Reserves and Sites of Special Scientific Interest.

OUTPUTS

Updates to QML website, organising Marine Lab annual Open Day and events for Portaferry Gala.

COLLABORATORS

Department of Environment NI, Upper Ards Historical Society, Jeanie Stenton-Dozey (NIWAS, New Zealand), National Trust UK.

Aquaculture of Seaweed and Shellfish

Dr. Liz Ashton (Research Fellow)

BBSRC, COST and PEPPUP Ltd

School of Biological Sciences

My research interests are in aquaculture, marine biodiversity, conservation and management. I continue to work with IBIS colleagues to complete manuscripts on *Ostrea edulis* biology, ecology and management. September 2016-May 2017, I managed SEAGAS production, growth, environmental monitoring and harvesting of 20 tonnes of *Saccharina* at the hatchery in the Marine Lab and at the marine long line site in Strangford Lough. Photo of harvesting seaweed using a barge and 3 new harvesting techniques. Currently working with the EU COST Action Oceans Past Platform on Shellfish Aquaculture.

KEY FINDINGS

One tonne of *Saccharina* can grow on 100 m longline in 6 months in Strangford Lough. Simple mechanical harvesting techniques can improve speed and efficiency of harvest. There are many threats to the future sustainability of *Ostrea edulis* but looking at historical references and case studies can aid with future management.

OUTPUTS

Bromley, C., McGonigle, C., Ashton, E.C. and Roberts, D. (2016). Bad moves: pros and cons of moving oysters, a case study of global translocation of *Ostrea edulis* L. (Mollusca: Bivalvia). Ocean and Coastal Management 122:103-115.

Bromley, C., McGonigle, C., Ashton, E.C. and Roberts, D., (2016). Restoring degraded European native oyster, *Ostrea edulis*, habitat: is there a case for harrowing? Hydrobiologia 768(1): 151-165.

COLLABORATORS

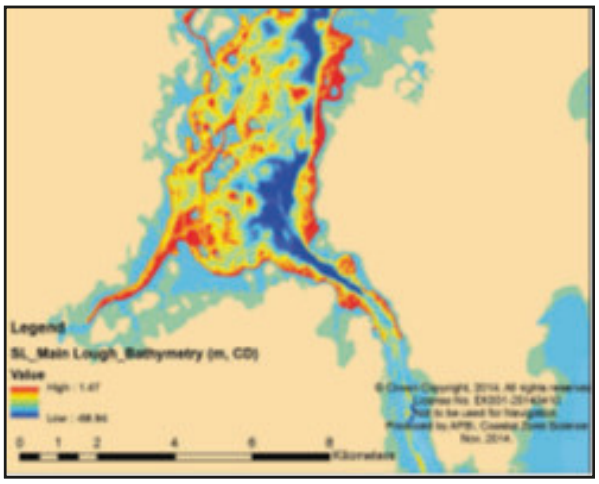
Alberto Longo, Nessa O'Connor, Brendan McNamara, Karen Mooney, Dai Roberts, Cass Bromley, Lawrence Eagling, Nadescha Zwerscke, CEFAS, CPI, IHC, Germany: Gesche Krause and Bernadette Pogoda. Croatia: Melita Peharda.

Seabed Habitat Mapping of Strangford Lough Marine Conservation Zone

Mr. Joe Breen (Visiting Research Fellow)

DAERA Marine and Fisheries Division

School of Biological Sciences



Strangford Lough, a highly protected marine area, has been the subject to significant research over recent years. The Lough holds many International and national designations which should ensure its protection and sustainability well into the future. Over recent years the Lough has seen significant impacts, both anthropogenic and natural resulting in massive shifts in the distribution and extent of key habitats such as *Modiolus* biogenic reefs and brittlestar beds. DAERA, QUB and AFBI collaborated in the monitoring and research which ultimately resulted in wide ranging sustainable fishery management measures. The focus of this project is to refine a high resolution seabed habitat map (originally produced by AFBI) which will supplement existing UK and EU seabed habitat maps layers as well as the Department's MapViewer.

KEY FINDINGS

To date, this project has revealed notable changes in the distribution and extent of marine habitats within Strangford Lough. These changes may be attributable to both anthropogenic and natural causes. Utilisation of further ground-truth data will enable the production of a hi-resolution, more precise and accurate seabed habitat model.

OUTPUTS

The deeper than 5m subtidal area of the lough has been fully mapped using a multibeam echosounder and habitats predicted based on existing video, diver and grab sample data from Ulster Museum, QUB, AFBI, NERC and Marine Division Datasets. These data may not reflect the more recent ecological changes, or sample at a spatial scale and distribution compatible with interpretation of acoustic remote sensing. DAERA and QUB have been resurveying using a small towed camera sledge and diving, the outputs will be used to refine the digital habitat map. https://www.afbini.gov.uk/publications/strangford-lough.

COLLABORATORS

Simon Exley, Jaimie Dick (QUB); Annika Clements, James Strong*, Matthew Service (AFBI); Clara Alvarez Alonso, Sally Stewart Moore, Liz Pothanikat, Nuala McQuaid, Stephanie Bennett (DAERA).
*NB. JS now based at IECS, University of Hull.

Evolution during the Quaternary period

Prof. Keith Bennett (Visiting Research Professor)

Self, QML

School of Biological Sciences

The last 2 million years (Quaternary period) have been a period of continually changing climate, oscillating between cold glacial stages and warm interglacial stages (such as the present, Holocene, stage). Classical evolutionary theory leads us to expect that environmental changes, such as climate, should lead to evolutionary change, including the splitting of lineages (formation of new species). However, both fossil and molecular data suggests that this has not been the case. My research interests lie in exploring how Quaternary environmental changes did affect the formation of new species and the course of evolution. The pattern of ancient sediment accumulation in lake basins is usually determined for the sole purpose of obtaining a chronology of the sequence. Graphical representations of lake basins show how they fill with sediment in order to make generalisations about sediment patterns which can be used to distinguish those that relate to an aspect of changing environment from those that relate solely to the shape of the basin itself.

KEY FINDINGS

Technical issues for extraction of ancient DNA from lake sediments discussed and clarified, generating guidelines for future work. The pattern of sediment accumulation in a lake basin has intrinsic value as an indicator of environmental change and potential utility in chronology construction, but only when interpreted in the context of basin shape.

OUTPUTS

Bennett, K. D. and Buck, C. E. (2016). Interpretation of lake sediment accumulation rates. The Holocene, 26:1092–1102.

Parducci, L., Bennett, K. D., Ficetola, G. F., Alsos, I. G., Suyama, Y., Wood, J. R., and Pedersen, M. W. (2017). Ancient plant DNA in lake sediments. New Phytologist, 214:924–942.

COLLABORATORS

Dr. Maarten Blaauw, School of Natural and Built Environment, QUB, UK, Prof. Caitlin Buck, School of Mathematics and Statistics, University of Sheffield, UK, Dr. Laura Parducci, Dept of Ecology and Genetics, Uppsala University, Sweden.

Fisheries Science and Ecological Modelling of Marine Ecosystems

Dr. Pia Schuchert (Honorary Research Fellow)

AFBI (Agriculture Food and Biosciences Institute)

School of Natural and Built Environment

I am using a range of modelling techniques and field data to understand behaviour of individuals and community structures in the marine environment. This includes community structure of (commercial) fish stocks, the behaviour of fishermen and individual fishes as well as impacts of hydrodynamics on the marine ecosystem.

Figure: Taking otoliths (ear-bones) of a cod to determine its age.

KEY FINDINGS

Large tidal energy arrays impact on phytoplankton dynamics in an idealized system; I am tracking analysing stock structure and assessment of cod in the Irish Sea- where are the older cod going? We have estimated scallop abundance in inshore Irish Sea regions.

OUTPUTS

Brickle, P., Schuchert, P.C., Arkhipkin, A.I., Reid, M.R., Randhawa, H.S. (2016). Otolith Trace Elemental Analyses of South American Austral Hake, *Merluccius australis* (Hutton, 1872) Indicates Complex Salinity Structuring on their Spawning/Larval Grounds. PLoS ONE 11(1): e0145479.

Schuchert, P.C., Kregting, L., Pritchard, D., Savidge, G. & Elsäßer, B. (2016). Using coupled hydrodynamic biogeochemical models to predict the effects of tidal turbine arrays on phytoplankton dynamics. Biogeosciences Discuss., doi:10.5194/bg-2016-232.

COLLABORATORS

Dr. Louise Kregting (QUB), QUB Department of Biology, Ulster University, Marine Institute (Ireland), CEFAS (England), Marine Scotland.

Major Project:
From Anaerobic Digestate to Microalgal Animal Feeds in a Circular Economy

Dr. Pamela Walsh, Dr. Daniel McDowell

CASE

School of Chemistry and Chemical Engineering

This project concerns food security, the environment and the agri-food sector, with multiple industry partners. We are currently researching the feasibility of producing microalgae in Northern Ireland, which are fed on digestate waste, and their potential as a livestock food source. We are aiming to establish how the strain of microalgae and abiotic conditions they experience will affect the composition of the nutritional components within the algal cell. We are particularly interested in the fatty acid content of the algal cells, as this is an important nutrient for livestock

KEY FINDINGS

The research is still in the early stages and we are currently in the process of establishing bioreactors at QML to grow microalgae for our trials. We hope to have various strains of microalgae growing in the bioreactors within the coming months. After which we can start analysing their composition. Work thus far has focused on developing analytical techniques for the analysis of microalgae.

OUTPUTS

Once the bioreactors are up and running at QML we will be able to start assessing the composition of the microalgae. After which we will have data that we can show to the industry and the scientific community.

COLLABORATORS

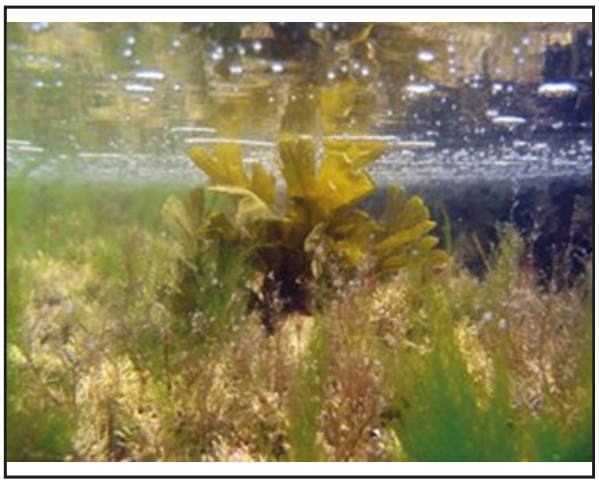
Academic Partners QUB: Dr. Pamela Walsh (PI) Chemical Engineering, Dr. Katerina Theodoridou, Global Food Security, Dr. Gary Sheldrake, Chemistry, Prof. Jaimie Dick, Biological Science. Microalgae Expert/External Collaborator: Prof. Matt Julius - St. Cloud Univeristy MN. Industrial Partners: Thomas Chromie – AgriAD, David Surplus - B9 Energy, Laurance Coey, Harlequin Plastics.

Major Project:
Marine Ecosystems Research Programme

Prof. Mark Emmerson, Dr. Dan Barrios-O'Neill

Natural Environment Research Council

School of Biological Sciences



The Marine Ecosystems Research Programme (MERP) is addressing key knowledge gaps in marine ecosystem research. By bringing together existing data and targeted new data, the programme scientists are integrating these data with current models and knowledge of ecosystem services within a common framework, in order to improve our understanding of the whole UK marine ecosystem.

KEY FINDINGS

The programme is developing a more accurate suite of marine ecosystem models and provides vital evidence, tools and advice to policymakers and environmental managers, including the development and implementation of the Marine Strategy Framework Directive, the Marine and Coastal Access Act, Marine (Scotland) Act, Common Fisheries Policy and the OSPAR Joint Assessment and Monitoring Programme.

OUTPUTS

Barrios-O'Neill, D., Bertolini, C., Collilns, P.C. (2017). Trophic cascades and the transient keystone concept. Biological Conservatio, 212: 191-195.

Barrios-O'Neill, D., Kelly, R., Dick, J. T. A., Ricciardi, A., MacIsaac, Hugh J., Emmerson, M. C. (2016) On the context-dependent scaling of consumer feeding rates. Ecology Letters, 19: 668-678.

COLLABORATORS

Plymouth Marine Laboratory, University of Sheffield, University of Strathclyde, University of Glasgow, CEFAS, Queen Mary University of London, Bangor University.

Major Project: Prevention, Control and Eradication of Invasive Alien Species

Prof. Jaimie Dick, Mr. Neil Coughlan

Environmental Protection Agency (EPA Ireland)

School of Biological Sciences

In response to new EU Regulations to tackle Invasive Alien Species (IAS), we have been funded by the Irish EPA to: (1) review the status of IAS in Ireland; (2) conduct a "horizon scan" for future invasions; (3) improve biosecurity in Ireland; (4) develop communication plans to better tackle IAS issues; and (5) develop eradication methods for two species (see Figure). The project is delivered through two PhD students and active involvement of the PIs at all levels, including field and laboratory surveys and experiments, workshops and public engagement.

KEY FINDINGS

We have thus far identified high risk new invaders (eg roe deer, signal crayfish and marine "pom-pom weed"); discovered Asian clams are susceptible to freezing with dry ice; and have trialled various herbicides and their efficacy throughout the year at controlling winter heliotrope.

OUTPUTS

Freshwater Invasives – Networking for Strategy II Conference, Zagreb, Croatia.

Workshop: Risk Management of Invasive Non-native Species in Europe, Belgium.

Piria, M,..Dick, J.T.A.,..Lucy, F.E.,..Coughlan, N.E., Davis, E. & Caffrey, J.M. (2017). Tackling invasive alien species in Europe II: threats and opportunities until 2020. Management of Biological Invasions, 8: 273-286.

COLLABORATORS

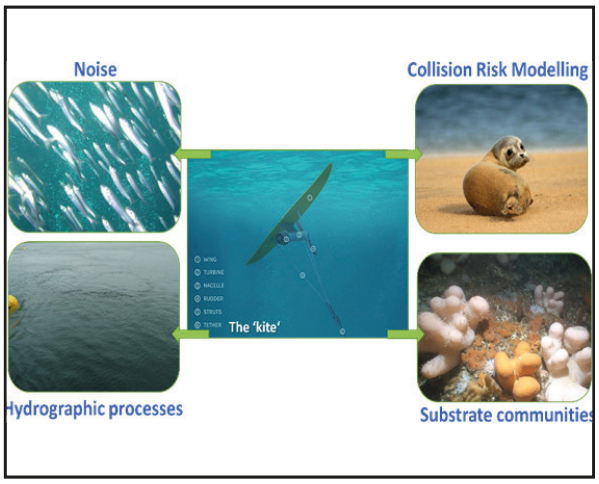
Prof. Frances Lucy (IT Sligo), Joe Caffery (IN-VAS Biosecurity), E Davies (IT Sligo), Gordon Copp, CEH, UK; Helen Roy, NERC, UK; Elena Tricarico, Italy, Emmanuelle Sarat, France; Marina Piria, Croatia; Quentin Groom, Belgium; Christine Maggs, JNCC, UK.

Major Project:
PowerKite Power Take-Off System for a Subsea Tidal Kite

Dr. Louise Kregting

Horizon 2020

School of Natural and Built Environment



The overall objective of the PowerKite project is to gather experience in open sea conditions to enhance the structural and power performance for a next generation tidal energy converter, known as the 'kite'. It is to ensure high survivability, reliability and performance, low environmental impacts and competitive cost of energy in the future commercial phases. Queen's main role in the project is assessing the environmental interactions of the kite, based at Queen's University Marine Laboratory field site in Portaferry, Strangford Lough.

KEY FINDINGS

Development of a collision risk model part 1 is complete; The masking footprint in regards to noise of the kite is small within the Strangford Narrows; Development of multibeam sonar system to understand the 4-D animal movement and interactions as well as the hydrodynamic features around the kite.

OUTPUTS

Lieber, L., Nilsen, T., Zambrano, C. & Kregting, L. (2017). Optimising multiple multibeam sonars to assess marine life interactions with an underwater kite. Proceedings of the 12th European Wave and Tidal Energy Conference 27 Aug-01th Sept 2017, Cork, Ireland.

Schmitt, P., Culloch, R., Lieber, L., Molander, S., Hammar, L. & Kregting, L. (2017). A tool for simulating collision probabilities of animals with marine renewable energy devices. PLoS One 12 (11): e0188780.

COLLABORATORS

Minesto, Chalmers University of Technology, SSPA Sweden, Applied Computing & Engineering Ltd, UW-Elast, Moorlink Solutions, ENGIE.

Major Project: Seagas

Dr. Alberto Longo, Dr. Karen M. Mooney

BBSRC and Innovate UK

School of Biological Sciences

The SeaGas project uses kelp for energy production via Anaerobic Digestion, specifically looking at optimising kelp cultivation and its associated environmental impact. The main aim is to effectively and economically maximise the cultivation potential of kelp and other seaweeds in a sustainable manner. This can be done either alone or in conjunction with other aquaculture or renewable energy technologies, and to enhance the policy and community engagement processes around coastal and offshore development.

Saccharina latissima ready for harvest.

KEY FINDINGS

Lab production of algae can be increased 5x original output to produce over 20tonnes/7ha, with production on over 50% lines over our target of 10kg/m; seaweed for AD gives very good results and stable energy output but is currently too expensive for sole use in energy production, biorefinery approach needed; there is high potential for cultivation in the UK, requires important genetic population considerations for regional siting of farms.

OUTPUTS

van der Molen J. et al. (2017). Modelling potential production and environmental effects of macroalgae farms in UK and Dutch coastal waters. Biogeosciences (under review).

Schiener P. et al. (2016). The nutritional aspects of biorefined *Saccharina latissima, Ascophylum nodosum* and *Palmaria palmata*. Biomass Conversion and Biorefinery. DOI: 10.1007/s13399-016-0227-5.

COLLABORATORS

QUB, CPI, SAMS, Newcastle University, Aberystwyth University, NUI Galway, Trinity College Dublin, The Crown Estate, CEFAS.

Major Project:
Tidal Turbine Testing, Phase 3

The TTT3 project is the third round of the international program for Testing Tidal Turbines. TTT3 builds upon the experience and results from deployment of two 1/10th scale horizontal axis tidal turbines. The ambitious TTT3 project will investigate the performance of a 1.5m diameter turbine in real tidal conditions at Strangford Narrows, Northern Ireland, and in idealised flow conditions at the large, calm water towing tank in CNR-INSEAN, Italy. Using industrially designed rotor machined from solid, the TTT3 project will gain further understanding into the performance effects of turbulence, wave-current interaction and off-axis flow conditions. Informing the industry of these critical issues in an independent manner.

KEY FINDINGS

Schottel Hydro SIT50 rotor designed scaled to 1.5m diameter; Successful field (July 2016) and laboratory (Nov 2016) campaigns; Performance comparison between TTT2 and TTT3; Independent validation of Schottel Hydro SIT50 rotor performance curve.

OUTPUTS

Frost, Carwyn, Ian Benson, Björn Elsäßer, Ralf Starzmann, and Trevor Whittaker. (2017). "Mitigating Uncertainty in Tidal Turbine Performance Characteristics from Experimental Testing." In European Wave & Tidal Energy Conference. Cork.

Torrens-Spence, H, P Schmitt, C Frost, I Benson, P Mackinnon, and T Whittaker. (2017). "Assessment of the Flow Characteristics at Two Locations in an Energetic Tidal Channel." In European Wave & Tidal Energy Conference. Cork.

COLLABORATORS

Applied Renewables Research Ltd, InvestNI, Joules, McLaughlin and Harvey, OceanFlow Energy, ORE Catapult, QED Naval Ltd, Schottel Hydro Ltd & Sustainable Marine Energy Ltd

QML Publications 2015-2017

In the period 2015-17, the QML team has published 200 papers in international journals, including ***Nature Communications, Scientific Reports, Ecology Letters, Journal of Applied Ecology, Biology Letters, Proceedings of the Royal Society B, Conservation Letters, Trends in Ecology and Evolution, Ecological Applications, Ecology, Evolution, Methods in Ecology and Evolution, Global Change Biology, and American Naturalist***

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National and international conferences and seminars:

In 2015-17, the QML team presented research at over 40 scientific conferences, seminars and workshops all over the UK and Ireland as well as further afield, many of them plenaries.

• German National Crustacean Conference, March 2017, Berlin, **Germany**

• Universiti Putra Malaysia Training Workshop on Intertidal Mollusc Taxonomy, May, 2017, Johor, **Malaysia**, Instructor (field teaching + 3 lectures)

• The Crustacean Society Mid-Year Meeting, June 2017, Barcelona, **Spain**

• Ecological Society of America Annual, Portland, **USA**, August 2017

• International Congress on Invertebrate Morphology, Moscow, **Russia**

• 3rd ICES/PICES early career researcher conference in Busan **S. Korea**

• Association for the Sciences of Limnology and Oceanography Conference, and Invasions Workshop, **Spain** (Keynotes)

• Functional Responses in Invasion Ecology Workshop, **South Africa** (Plenary)

• 19th International Conference on Aquatic Invasive Species, **Canada** (Keynote)

• Freshwater Invasives – Networking for Strategy II Conference, **Croatia**

• Marine and Freshwater Invasive Species Conference, **Argentina**

• 20th International Conference on Aquatic Invasive Species, **USA**

• Southern African Society of Aquatic Scientists Conference, **South Africa** (Keynote)

• Invited Departmental Seminar, Kiel, **Germany**

• Invasion Science Workshop, **Cambridge**

• 27th Irish Environmental Researchers Colloquium (Environ), **Ireland** (Plenary)

• Invasive Species in Ireland Horizon Scan Workshop, Sligo, **Ireland**

• Invited Departmental Seminar, University of Sydney, **Australia**

• Aquatic Invasive Alien Species in Southeast Asia Symposium, **Singapore** (Keynote)

• Invited Departmental Seminar, Glasgow University, **Scotland**

• Invited Departmental Seminar, SAMS, Oban, **Scotland**

• Risk Management of Invasive Non-native Species in Europe, Brussels, **Belgium**

• Invited “Invasions” Talk Dublin College University, Dublin, **Ireland**

• Invited “Invasions” Talk Dublin College University, Dublin, **Ireland**

• JpGU-AGU Joint Meeting, 2017, Chiba, **Japan**

• Ecological Society of America Annual, Portland, **USA**, August 2017

• World Congress of Malacology, 2016, Penang, **Malaysia**

• The Malacological Society of Japan Annual Meeting ,2016, Toho University (Narashino Campus), **Japan**.

• Underwater Noise: Background and Application, **Galway-Mayo** 2016

• 4th International Conference on the Effects of Noise on Aquatic Life, **Dublin** 2016

• 10th Flora Malesiana Symposium, Royal Botanic Gardens, **Edinburgh**, 2016

• Australasian Systematic Botany Society, Alice Springs, **Australia**, 2016

• British Ecological Society Annual Meeting, **Liverpool** 2016

• Systematics Association Biennial Conference, 2015, Oxford, **United Kingdom**.

• August 2015, Systematics Association Biennial Meeting, University of Oxford, **Oxford**

• Aquatic Biodiversity and Ecosystem Conference, **Liverpool**, August 2015

• 14th Deep-Sea Biology Symposium, September 2015, Aveiro, **Portugal**

• The 2nd InterRidge International Workshop, 2015, Incheon, **Republic of Korea**

• Mini Sunfish Symposium, **Tokyo**

• Cornish Wildlife Trust annual meeting, **Newquay**

• Marine Biological Association, **Belfast**

• Monterey Bay Aquarium seminar, **California**

• American Fisheries Society Conference, **Missouri**

• Fisheries Society of the British Isles Conference, **Exeter**

Meetings and workshops organised:

During the period 2015-2017, QML has hosted and organised many meeting and workshops.

• Invasions Workshop, Spain (+Keynote)

• Functional Responses in Invasion Ecology Workshop, South Africa (+Plenary)

• 19th International Conference on Aquatic Invasive Species, Canada (+Keynote)

• Freshwater Invasives – Networking for Strategy II Conference, Croatia

• 20th International Conference on Aquatic Invasive Species, USA

• Invasive Species in Ireland Horizon Scan Workshop, Sligo, Ireland

• Committee member and social events organiser for the Marine Biological Association student conference in Belfast, 2015, Natasha Phillips

• BESAG annual meeting and ECR workshop – Charles Darwin House, London, July 2015, Lydia White

• Organised a mini sunfish symposium in Tokyo, 2015, from raising funds to organising presentation sessions, reciprocal workshops and socials, Natasha Phillips

• SeaGas Project Workshop, 20 April, 2016

• BESAG annual meeting and ECR workshop – Charles Darwin House, London, July 2016, Lydia White

• BES Aquatic and Macroecology SIG joint event on macroecological approaches into the study of aquatic ecosystems – Charles Darwin House, London, 2016, Lydia White

• 4 November 2016: EIA module hosted by Dr. Louise Kregting

• 23-27, January 2017: Development Week QUB Undergraduates, Dr. Billy Hunter

• 5 May 2017, Ulster Wildlife Workshop, Sheila Lyons

• 23 June 2017, GIS Sandpit meeting, Dr. Louise Kregting

• 15 July 2017, "Showcase of current research on crabs and lobsters at QUB during the Open Day of the Marine Lab, Dr. Carola Becker and Lorraine McLean

• 29 July 2017, Cumbria Wildlife Trust workshop, Sheila Lyons

• Organisation of semi-annual Steering Group Meetings with representatives of Seafish, Kilkeel Seafoods, AFBI, NIFPO and Queen's University Belfast, Dr. Carola Becker

• ECR Treasurer for British Ecological Society – Aquatic Ecology Group, Lydia White

• BESAG annual meeting and ECR workshop – Charles Darwin House, London, September 2017 (still upcoming), Lydia White

Networking and outreach:

During 2015-2017, the QML team provided educational and outreach activities to all levels, from school children to professionals, scientists, Government and the media.

QML Annual Open Day to coincide with "Skiffie World" Week in July 2016

QML Annual Open Day to coincide with Portaferry Gala Week July 2017

Deep-sea Dream II "KAIDAN", September 2015. Talk event featuring the JAMSTEC-based novel "Umi Ni Furu" (by Kaeruko Akeno). Invited speaker with the author Kaeruko Akeno and Dr. Ken Takai (JAMSTEC)

Invited blog post: Making a skeleton out of iron: the 'scaly-foot gastropod', September 2015, Animal Bytes: Cambridge University Museum of Zoology Blog https://animalbytescambridge.wordpress.com/2015/09/21/making-a-skeleton-out-of-iron-the-scaly-foot-gastropod/

Maniac Manual ("ManiMani") Vol. 2: Shells. Main contributor. February 2016.

Occasional magazine published by Surplunear Co., Ltd. [In Japanese] http://www.manimani.online/vol02.html

20-21 April 2016, Dr. Karen Mooney-McAuley with 20 participants: Introduction to the SeaGas Project and Kelp for AD information. Evening and Networking event

JAMSTEC Yokosuka Headquarters Open Day: Public seminar, May 2016. Hosted by Department of Subsurface Geobiological Analysis and Research

Maniac Manual ("ManiMani") Vol. 3: Deep-sea. Co-contributor. June 2016, Occasional magazine published by Surplunear Co., Ltd. [In Japanese] http://www.manimani.online/vol03.html

Comic Market ("Comiket") 90, Exhibitor (with Surplunear Co., Ltd.)August 2016, Tokyo Big Sight

Ards and North Down Seafood Festival, Portavogie August 2016

Kanagawa Prefectural Museum of Natural History, February 2017, Yokosuka, Japan, Public lecture

Kannonzaki Nature Museum, March 2017, Yokosuka, Japan, Public lecture

Ulster Wildlife evening event "Marine Mammals of Northern Ireland, 9 March 2017

Committee member of the Belfast Naturalists' Field Club since April 2017, Dr. Pannell

Talk to Royal Society of Biologists, "Invasive Species: Local and Global Examples" Prof. J. Dick JAMSTEC Yokosuka Headquarters Open Day, Public seminar, May 2017. Hosted by Department of Subsurface Geobiological Analysis and Research

Japan Science Museum, July 2017, Tokyo, Japan, Public lecture

Adult Education: Committee member and tutor on the Ashmolean Natural History Society of Oxfordshire's Adult Education Programme, which provides training in using keys for identification of British and Irish plants, Dr. Caroline Pannell

European Commission – Science for Environment Policy

European Commission – DG Environment News Alert Service, http://ec.europa.eu/environment/integration/research/newsalert/newsalert.htm

Plenary speaker at the Cornish Wildlife Trust annual meeting, Newquay, Natasha Phillips

Research blog with hits from >6,660 visitors from 124 countries, Natasha Phillips

Twitter following of > 820 people, Natasha Phillips

STEMNET Ambassador with W5 and Sentinus

Career Scientist with Young Enterprise NI

Outreach experience includes: QUB Marine Lab Open Days, Eco-Schools, Titanic Belfast Maritime Festival, Titanic Belfast Career Video profile, Seacourt Print Workshop, Wildlife Trust events and Strangford Lough Maritime Festival, school talks across NI

Feature article in New Scientist;

Member of QUB Research Centre for Sustainable Energy, Dr. Karen Mooney

Member English Speaking Union Lindemann Committee, Dr. Karen Mooney

Member British Phycological Society, British Ecological Society, Dr. Karen Mooney

Reviewer for Marine Ecology Progress Series, Aquaculture, Algal Research, Environmental Science and Pollution Research, Dr. Karen Mooney

Member MHLS Faculty Postdoctoral Committee, Dr. Karen Mooney

Currently completing Introduction to Associate Fellowship of the Higher Education Academy (HEA) Course, Dr. Karen Mooney

Teach Environmental Sustainability on MSc course: Foundations for Sustainable Development (ii): Policies and Strategies for Sustainable Development, Dr. Mooney

Guest lectures on kelp aquaculture, Dr. Karen Mooney

"Capturing our Coast" Training Day at QML 19 August 2017 Ulster Wildlife

Crustacean Fisheries Workshop July 2017

Contributed to a workshop on PhD applications and CVs at British Ecological Society, 2016 Undergraduate Ecological Careers Conference, Lydia White

Visitors:

In 2015-2017, QML welcomed visitors from around the world from many institutions and Universities. These included both individual visitors and field courses/training sessions.

20 August 2015, Prof. Todd Oakley, Prof. of Law, University of South Carolina School of Law Columbia, USA

17 September 2015, Dr. Philip Boyd, Institute of Marine and Antarctic Studies Australia

8 October 2015, Madelyn Wood's ,Jacksville University, FL, USA

8 October 2015, Matt Julius, Blue Ocean Nuta Science USA

8 October 2015, Dr. Pam Walsh, Chemical Engineering QUB

8 October 2015, Tim Mackie, DOE and 2 visiting Master students from Florida

8 – 14 October 2015, Danni Green,Warwick University

15 October 2015, James Dingley, Honorary Queen's Gibson Institute QUB (Conflict & Terrorism)

15 October 2015, Will Leschen, Institute of Aquaculture, University of Stirling, Scotland

30 October 2015, Dr. Pam Walsh, Peter Robinson and Fraser Buchanan, Chemical Engineering QUB

2 November 2015, Judith Stephens and 20 students (Master class), Gibson Institute for Land, Food & Environment, QUB

2 November 2015, Chris McGonigle and 10 students from School of Geography & Environmental Sciences/University of Ulster

4 November 2015, Damian McFerran, Natural Museums, NI

4 November 2025, Prof. George Hutchinson plus 33 students, Institute of Global Food Security, MBC, QUB

18 November 2015, Simon Mills, MINESCO

26 November 2015, Dr. Chris McGonigle and student Cynthia Sassenroth, UU, Coleraine

26 November 2015, Seamus Kane, Retired Queen's lecturer

8 December 2015, Ivan McAteer and visiting group of students MINESTO

17 December 2015, Rebeka Schmits

25 January 2016, Mhairi Alexander, UWS

3 February 2016, Ivan McAteer and visiting group, MINESTO AD

15 February 2016, Mrs Paula Bennison and daughter Holly GCSE student, Saintfield, Co Down

10 March 2016, Dr. Ann McMahon, Business Alliance Manager Agri-food & Nutrition Sciences, QUB

15 March 2016, Dr. Pamela Walsh and student Clare, Chemical Engineer QUB

25 April 2016, Tom and Ruth Maxwell to visit Prof. Jaimie Dick

29 April 2016, Cheryl Niblock and group of students, South Eastern and Educational College, Bangor Campus

8 May 2016, David Aldridge, Cambridge University

11 & 12 May 2016, "Powerkite" Meeting with 20 participants organised by Dr. Louise Kregting/ Engineering Department

24 May 2016, Dr. Alex Weir and 8 field course students, Department of Environmental & Forest Biology, SUNY-ESF, Syracuse, New York 13210

27 May 2016, Rhian Taylor, Bangor University

1 August 2016, Dr. Hartmut Riechter, and family past QML student from Germany accompanied by Mrs Cherry Boaden wife of deceased Director of QML, Dr. Pat Boaden

8 August 2016, Sverber Molander, Chalmers University of Technology

9 August 2016 Gerard Hughs, SENTINUS

10 August 2016, Alex M Smith, Plymouth University

19 August, 2016, Aidan Burton, Newcastle University

10 September, 2016, BBC Farming Programme

12 September, Prof. Ikuo Yamamoto, Graduate School of Engineering, Nagasaki University, Japan

15 September 2016, Marie-Louise Cairns and Nikki Kernoghan, Research Development Officers, QUB Research and Enterprise

11 October 2016, Prof. Karimirad, MARINTEK

26 October 2016, Dr. Judith Stephens and 20 students (Postgraduate Degree Convenor, MBC, Gibson Institute for Land, Food and Environment, QUB

5-7 February 2017, MINESTO group meeting, MINESTO

10 May 2017, Alex M Smith, Plymouth University

19 May 2017, Daniel Raligues, NOIG Marine Institute

Representatives of Seafish from Wales, Scotland, England; Managers of Kilkeel Seafoods to collaborate with Dr. Carola Becker

Prof. Dalal, India

10 July 2017, Prof. Olaf Weyl, South African Institute for Aquatic Biodiversity. Workshop and collaboration with Prof. Jaimie Dick

Prof. John Davenport from UCC, 2017 – dissection of an ocean sunfish - three publications due to be submitted from this work

Dr. Adam Mellor (AFBI)

The following list consists of field courses and one day courses held at QML:

28-30 September 2015, Prof. Jim Wilson, Trinity College, Dublin

19 & 20 October 2015, Dr. Ed Adams, Belfast Met field course

1 & 2 December 2015, Dr. Ed Adams, Belfast Met field course

29 February 2016, Dr. Ed Adams, Belfast Met field course

2 June 2016, Sheila Lyons, Ulster Wildlife Teaching Workshop

14 & 15 September 2016, QUB Marine Zoology field course

27-30 September 2016, Prof. Jim Wilson, Trinity College, Dublin

19-20 October 2016, Dr. Ed Adams, Belfast Met field course

7 November 2016, Dr. Ed Adams, Belfast Met field course

5 December 2016, Dr. Ed Adams, Belfast Met field course

20 March 2016, Dr. Ed Adams, Belfast Met field course

7-15 April 2017, QUB Marine Ecology field course

23-28 April 2017, QUB Marine Ecology field course

4 May 2017, SERC – visit and educational tour of QML, Linda Little

5 May 2017, SERC – visit and educational tour of QML, Cheryl Niblock

26-28 September 2017, Prof. Jim Wilson, Trinity College, Dublin

Funding:

We are grateful to the many and diverse funding agencies, national and international bodies, sponsors and others who have contributed to funding our research over 2015-17.

AFBI (Agri-Food and Biosciences Institute)

AgriAD

ANHSO Education Group

ARR

BBSRC (Biotechnology and Biological Sciences Research Council)

Beaufort Marine Biodiscovery

BECAS (Chile)

BES (British Ecological Society)

British Council

CAISN (Canadian Aquatic Invasive Species Network)

CIB (Centre of Excellence for Invasion Biology)

CNR-INSEAN (Italian national government engineering hydraulics laboratory)

DAERA (Department of Agriculture, Environment and Rural Affairs)

DfE (Department for the Economy)

EPA (Irish Environmental Protection Agency)

EPSRC (Engineering and Physical Sciences Research Council)

European Commission (Horizon 2020)

EU Interreg IVB

European Regional Development Fund

EU COST action programme

Fisheries Society of the British Isles

IFI (Inland Fisheries Ireland)

Invest NI

Iraqi Government

Irish Research Council

IT Sligo

Japan Agency for Marine-Earth Science and Technology

Joules Energy

Kilkeel Seafoods

Laurence Berkeley National Laboratory

Leverhulme Trust

Marine Biological Association, UK

Marie Curie COFUND

Marie Skłodowska-Curie Actions

Marine Institute, Galway

McGill University

National Development Plan Ireland

NERC (Natural Environment Research Council)

NIEA (Northern Ireland Environment Agency)

Norwegian Research Council

NRF (South Africa)

NSERC (Natural Sciences and Engineering Research Council of Canada)

NUI Galway

Ocean Flow Energy

QED Naval

Royal Society

SAIAB (South African Institute for Aquatic Biodiversity)

Schottel Hydro

SEAFISH (The authority on seafood)

SFI (Science Foundation Ireland)

The Alice McCosh Trust

In Memoriam

QML lost a great friend in 2017 with the passing of Dr. Dai Roberts.

Dai was instrumental in making the Marine Lab the facility that it is today, championing research into marine aquaculture. He worked at Queen's for some 42 years from 1972 proving extremely gifted as an academic in teaching and research, but will be especially remembered as someone who treated his students and colleagues with great thoughtfulness, kindness and humanity.

Dai engaged across the full range of academic activities - teaching, research and administration - as well as involvement in the wider biological community through the institute of Biology, becoming a Fellow of the Royal Society of Biology. Dai received the President's Medal for exceptional contribution to his subject – an award for those individuals who have supported the Royal Society of Biology in an exceptional way, going above and beyond the normal volunteer role and having a significant impact on the organisation and the sector as a whole. His many interests included malacology and conchology, particularly the bivalves and Dai became a long-serving member of the Council of the Malacological Society, serving as Honorary Treasurer for many years.

Dai was considered one of the leading experts on echinoderms of Southern Australia and Indonesia through his involvement with Operation Wallacea. He had a particular interest in deep sea species and was one of the first to examine the tentacle structure and particle size using electron microscopy. His research interests with Queen's varied from the ecology and conservation of the freshwater pearl mussel through to the restoration and re-establishment of the horse mussel.

Dai's interest in non-fin fish aquaculture at the Queen's University Marine Laboratory at Portaferry secured an INTEREG funding award from 1990 through to 2007 which resulted in the Centre for Marine and Aquaculture Research (C-MAR). The work undertaken at C-MAR was extensive and involved studies as diverse as the culture of Abalone through to the restoration of the native oyster. C-MAR focused on fundamental science and applied research as development drivers of employment in isolated communities and indeed numerous growers and fishermen benefitted as a result.
Dai was a great colleague and friend throughout his tenure at Queen's and will be remembered with affection by many staff and students. We will miss him terribly.