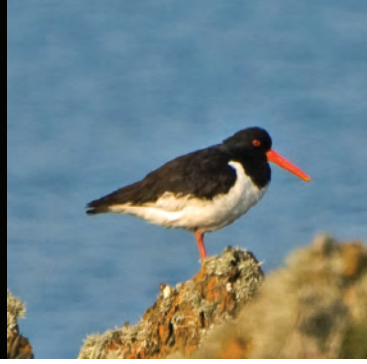

Queen's University
Marine Laboratory

www.qub.ac.uk/qml

Annual Review 2014-15

Queen's University Marine Laboratory, Annual Review 2014-15.

Prepared September 2015 by Dr Julia D. Sigwart with contributions from QML staff and researchers. Revised edition for web publication www.qub.ac.uk/qml

Cover photo credits: *Tonicella*, *Ostrea*: Julia Sigwart, oystercatcher: Alain Le Garsmeur, QML: Ivan Ewart, *Necora*: Paul Mensink, kelp forest: Henk van Rein, waves: Alain Le Garsmeur.

Queen's University Marine Laboratory Annual Review 2014-15

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The Queen's University Marine Laboratory (QML) is an inter-disciplinary research centre and part of the research infrastructure of Queen's University Belfast. As a core facility of the University we serve all scholars who can productively use our resources to further knowledge about the marine environment, in its broadest possible interpretation. The resident academic staff based in QML span three schools in two different faculties, the School of Biological Sciences, the School of Planning, Architecture, and Civil Engineering, and the School of Geography, Archaeology, and Palaeoecology. The visitors from within Queen's University, the broader community, and indeed around the world, come from disciplines as broad as sociology, law, art and print-making, social and environmental activism, as well as science and engineering. The QML community based in Portaferry provides a meeting place that supports inter-disciplinary discussion and collaboration. The facilities are active and occupied year-round by resident researchers and support staff.

Over the last five years, QML has seen significant growth and investment. The activities under my leadership have followed a five-year Strategic Plan implemented from 2010-2014. At the successful conclusion of that Strategic Plan, we have exceeded all of the set the income and growth targets. Now in the new period after implementing our Strategic Plan, this is the first opportunity to encapsulate a single year and to highlight some of the many accomplishments of the team. Much of this document focusses on the people who contribute to the success of QML, from established academics to undergraduate researchers.

During the 2014-15 year we hosted a number of scientific and other visitors from around the world, including Japan, China, USA, and many European countries, who contribute to our research or who come to learn more about our work. We also hosted an official visit from the Rt Hon Andrew Robathan, MP, the UK Minister of State for Northern Ireland.

Queen's University Marine Laboratory plays a particularly important role as a member of our local community in Portaferry, and we are grateful to the local people for their support. Each summer we host an 'Open Day' with public activities, and in summer 2015 there were two events timed to coincide with the Strangford Maritime Festival and the Portaferry Gala. There were also a host of other incredibly successful public outreach activities, many organized by the FP7-funded project EnAlgae.

The oceans remain the greatest frontier on earth. They provide our food, our energy, and our inspiration. We are proud to contribute our efforts as stewards of the marine environment and to promote its importance to the scientific community and in society beyond the science.

In the next year, Prof Jaimie Dick will take over as Laboratory Director for QML. He brings a wealth of experience as the former Director of Research for the QUB Ecology, Evolution, Behaviour and Environmental Economics research cluster and former Director of Quercus, the Conservation and Biodiversity Centre funded by NIEA. As his own expertise spans the marine, freshwater, and also terrestrial realms, I look forward to his leading a continuing expansion of QML activities into many further fields.

Dr Julia D Sigwart
QML Laboratory Director

QML Strategic Plan 2010-2014

Located on Strangford Lough at Portaferry, 50 km from Belfast, QML is a specialist facility for marine sciences providing infrastructure for biological research and a platform for interdisciplinary work (e.g. marine renewable energy, coastal defences) led by the School of Biological Sciences (SBS) in space shared with the School of Planning, Architecture and Civil Engineering (SPACE) and also the School of Geography, Archaeology and Palaeoecology (GAP).

QML is the only UK marine station that is truly interdisciplinary, hosting research units from both Biology and Engineering in the same centre, which facilitates fluid collaboration and inputs and outputs that take advantage of this unique facility.

Success of the Marine Laboratory, Portaferry

QML is a specialist research centre that provides a crucial advantage in bidding for external research funding. The research infrastructure includes high-quality seawater aquarium facilities, microscopy laboratory, constant temperature facilities, boats, HSE-approved SCUBA scientific diving, weather station, and the SPACE wave basin facility. QML also controls several seabed licenses in Strangford Lough for interdisciplinary experimental testing relevant to biology and engineering. QML research is a mixture of applied (coastal engineering, fisheries, aquaculture) and blue-skies (evolutionary biology, discovery-led) science.

As a research centre there is also a teaching remit, focused on intensive residential field courses. Approximately 200 students per year (in years 1-3 of various Biological Sciences programmes) take field courses and field trips based at QML, as part of modules in multiple degree programmes. Undergraduate Honours students on various programmes (including both SBS and SPACE) undertake research projects at QML. We also host external field courses, such as Trinity College Dublin.

QML is used by a community of ~60 researchers. On-site occupancy is 35 FTE, 20 on-site full time, with many other part-time users based in Belfast, and industry partners as honorary research associates.

- The last five years have seen strong and sustained growth after the appointment of a new Director (Julia Sigwart).
- QML functions as a **multidisciplinary research centre**, uniting researchers from across Faculties, with resident researchers from three schools: SBS, SPACE, and GAP.
- The facilities are **occupied year round** by a diverse workforce.
- QML researchers publish papers of 3* and 4* quality, in journals such as *Nature*, *Science*, *Journal of the Royal Society Interface.*
- Over the last 4.5 years, QML has attracted over **£6 million in grant income to SBS** (plus over £3.5 million to SPACE): over £1.4 million per year, for projects that would not be possible without QML.

Management

Dr Julia Sigwart (academic appointment with responsibility for QML) oversees infrastructure and facilities as Laboratory Director, reporting to the School Management Board and Head of School, Biological Sciences. A bilateral advisory committee representing SPACE and SBS is convened for *ad hoc* consultation on matters of strategy.

Dr Sigwart initiated an extensive multilateral review of the Portaferry facilities in autumn 2009. The purpose of developing the Strategic Plan was to define the goals and expectations for the laboratory as a research and teaching unit over a five-year period. The Strategic Plan was approved at Faculty level through its inclusion in the SBS 2009-10 Academic Plan.

The success of leadership and management structures in QML is clear from performance during the implementation of the 2010-2014 five-year plan. The implementation of the QML Strategic Plan has improved the use of office and laboratory space, optimizing efficiency and staff communication. New remotely accessible booking systems and clear costings for key infrastructure (e.g. boats) have improved transparency and therefore usage. Implementation of the strategic plan has increased the user base for QML facilities from approximately 10 to a total community of over 60 regular users.

Some notable visitors to the facilities in this period include:

- Minister for Environment, Alex Attwood MLA
- Minister of State for Northern Ireland, Rt. Hon. Andrew Robathan
- HRH the Prince of Wales
- Patsy McGlone MLA, chair of the ETI committee
- In recognition of her work in QML, Julia Sigwart was nominated by DOE to attend the 2014 annual Garden Party at Hillsborough, hosted that year by the Queen.
- TV features, most recently BBC TV's Countryfile but also on Channel 4 News, Northern Ireland's UTV, Ireland's RTE, National Geographic, Discovery, German TV and Chinese World TV
- Annual QUB Alumni Weekends organized with Norma Sinte to run alongside Strangford Lough Maritime Festival (recorded footfall c. 1,800 annual attendees in 2013 and 2014)
- QML Facebook page has 640 followers; posts reaching up to 47,000 people

Investment arising from the 2010-2015 strategy

The targets of the 2010-2014 Strategic Plan have been met and exceeded (Table 1). Dr Sigwart requested a complete condition report for the buildings in 2009, which ultimately resulted in extensive investment by the Queen's University Estates directorate, including: an entirely new roof and roofspace insulation, new cabling for high speed internet, further funding for upgraded internet pipeline linking Portaferry to Belfast, all new windows in the Grade II listed main building, a substantial change in traffic flow and space allocation in the building, upgrading office space, consolidating redundant rooms, extensive redecorating, external repainting of the main building in line with Estates strategy for heritage buildings, new external signage in line with QUB branding, new energy efficiency strategy, and overhaul of all fire safety and security measures. A new project to resolve drainage issues is currently underway.

Future plans for Queen's University Marine Laboratory

Dr Sigwart will be on extended sabbatical in University of California, Berkeley from Autumn 2015 – Summer 2018 (funded by a European Commission H2020 Marie Curie Global Fellowship). Prof. Jaimie Dick, will take over as Director of QML, assisted by the existing support staff in QML and a new temporary lecturer (Dr Patrick Collins) who has been appointed and will be based full time in QML.

Table 1. Specific targets included in the 2010-2014 Strategic Plan, and how we met them:

Targets	Accomplished
The number of PhD students based in QML will increase from 1.5 FTE (in 2009) to 8 students by 2012 and 12 students by 2015.	Yes. Current PhD population 14 (12 FTE)
Attract grants to build the research capacity of recently appointed staff, from - BBSRC; EPSRC; NERC - DARD - EU (e.g. Northern Periphery); InterReg; FP7	Yes. Funding secured from all these sources. Income over 2010-2014 at over £1.4 million per year to SBS
Recruit independent research fellows, e.g. Leverhulme	Yes.Two independent fellows, 2014: Leverhulme Fellow, William Hunter 2015: QUB University Fellow Louise Kregting
An 'open house' event for local residents to tour the facility will be held in 2010.	Yes. Annually 2010-2015, footfall increasing to over 1,200 attendees annually in 2013, 2014, and 2015
Temporary public exhibitions showcasing QML research	Yes. 2011-2014, exhibits in Exploris, Portaferry Tourist Information Centre, Portaferry Credit Union, Titanic Belfast.
Focussed mini-conferences	Yes. 2012-2014 mini conference and workshops on shellfish, seaweed, and marine energy.
New audiences may include, e.g. dive groups such as Sea Search and NIEA.	Yes. New participants attending Professional Continuing Development courses (2013-2015), Nudibranch Safari 2014, 2015.
Increase publication rate above current 6 papers per year (5-year average 2005-2009)	Yes. 2012-2015 c. 20 papers per year, increasing to **over 100 papers** in 2014-15
Internal communication improvements	Yes. Internal mailing list and Facebook page set up 2011 – now >**640 'likes'** and quantified reach over **47,000 people**. QML research centre website set up (2009) and Youtube Channel established (2013).
Improvements and renovations to the fabric of the historic main building.	New roof (2014). All new windows, reglazed and rebuilt original wooden sash windows (2013). New dive store (2013). New lab facilities. New seawater pumps (2012).
New state of the art microscopy and histology laboratory facilities	Yes.
New large-scale constant temperature facility for algae.	Yes.
New marine mesocosms facility for experimental ecology	Yes.

QML Key Infrastructure

Boats

Queen's University Marine Laboratory has two open sea boats, "*Bubbles*" (7 m Rigid-Hulled Inflatable Boat) and "*Cumella*" (5.7 m 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, 235 passages have been made using the QML boats under the present boat-management (since 2011). The majority of boat passages were made to carry out plankton tows (27.2 %), potting surveys (11.1 %), bird count surveys (10.6 %) and SCUBA diving surveys (9.8 %).

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.

Following a complete restructuring of SCUBA diving in the University in 2011, the QML has supported twelve major diving projects. In this time the QML has facilitated 226 person dives to 37 sites throughout Northern Ireland. Since 2011, there have been sixteen divers who have participated in underwater research at QML.

Seawater System

The life-blood of the 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. In 2012 the seawater pumphouse was refitted to improve performance including installation of two new pumps and remodelled pipework to reduce friction. Further renovations are planned in the near future. New air blowers are expected in late 2015, and the architecture of flow around the whole site will be redesigned to improve delivery for research.

Major Funded Research Projects

At present we are proud to host multiple major large-scale multi-institutional projects funded by UK Research Council and the European Commission.

MARINET - *Marine Renewables Infrastructure Network for emerging Energy Technologies*
http://www.fp7-marinet.eu/

A network of research centres and organizations, including QML, working together to accelerate the development of marine renewable energy technologies - wave, tidal & offshore-wind. The programme is co-financed by the **European Commission** specifically to enhance integration and utilisation of research infrastructures and expertise. MARINET offers periods of free-of-charge access to world-class R&D facilities & expertise and conducts joint activities in parallel to standardise testing, improve testing capabilities and enhance training & networking.

EnAlgae - *Energetic Algae*
http://www.enalgae.eu

EnAlgae brings together 19 partners and 14 observers across seven EU Member States, funded by the **INTERREG IVB Northwest Europe Programme**. It aims to reduce CO_2 emissions and dependency on unsustainable energy sources. The project is developing sustainable technologies for algal biomass production, bioenergy and greenhouse gas (GHG) mitigation, taking them from pilot facilities through to market-place products and services. The team at QML has been evaluating offshore cultivation methods that will allow sustainable kelp biomass production. Our cultivation sites are in and around Strangford Lough, a protected conservation area, so a particular focus of its work is the development of cultivation processes that can be used in areas of high human activity. We have collected biological, ecological, and socio-economic data to assess the suitability of various seaweed strains for large-scale cultivation.

IBIS - *Integrated Aquatic Resources Management between Ireland, Northern Ireland and Scotland*
http://www.loughs-agency.org/ibis

A partnership between the Loughs Agency, Queen's University Belfast, and the University of Glasgow, supported by the **EU's INTERREG IVA** Programme. It has created an £8 million cross-border project to help protect aquatic resources across Northern Ireland, the Border Region of Ireland and Western Scotland. IBIS delivered 70 person-years of applied research in doctoral and masters projects, 16 Continuing Professional Development courses and 12 Knowledge Transfer workshops, many hosted in QML—leaving a legacy of expertise in sustainable aquatic resources management in the three jurisdictions.

MERP - *Marine Ecosystems Research Programme*
http://www.marine-ecosystems.org.uk

The **Natural Environment Research Council** (NERC) UK funded a consortium of 12 UK universities including Queen's University, to address key knowledge gaps in marine ecosystem research. By bringing together existing data and targeted new data, the programme scientists will integrate 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. One key infrastructure to delivery of MERP's objectives is the large-scale **Marine Mesocosm** facilitiy in QML, unique in Europe.

QML Research Profiles

The following pages encompass brief research profiles of QML users. These profiles are organized alphabetically in groups by role within QML

*12 **academic staff** and independent fellows*

Dr Julia Sigwart (QML Director), Prof. Keith Bennett, Prof. Jaimie Dick, Prof. Matthew Dring, Dr Bjoern Elsaesser, Prof. Mark Emmerson, Dr Keith Farnsworth, Dr Jonathan Houghton, Dr William Ross Hunter, Dr Louise Kregting, Dr Paul Mensink, Dr Nessa O'Connor

*2 research **support staff***

Dr Henk van Rein, Emma Gorman

*13 **visiting researchers**, including sabbatical visitors in 2014-15 and long-term collaborators from outside institutions around the world*

Dr Mhairi E. Alexander, Dr Andrea Anton, Dr Daryl Anne Birkett, Dr John Bothwell, Dr Nicholas Carey, Dr Chong Chen, Dr Nicholas Fleming, Dr Claire Goodwin, Dr Heather Hunt, Alan McKinley, Tim Morrissey, Bernard Picton, Dr Sufen Zhao

*9 **postdoctoral researchers** whose research is based in QML*

Dr Liz Ashton, Dr Daniel Barrios-O'Neill, Dr Nathan R. Geraldi, Dr Penny Jeffcoate, Dr Paul Lamont-Kane, Dr Karen Mooney-McAuley, Dr Peter Schiener, Dr Pal Schmitt, Dr Pia Schuchert,

*18 current **PhD students** whose research is based in QML*

Lydia Luise Bach, Camilla Bertolini, Dr Cass Bromley (completed 2015), Dr Julia Calderwood (completed 2015), David Crooks, Lawrence Eagling, Amy Garbett, Donal Griffin, Carina Gsottbauer, Laura Hinchliff, Emmett Johnston, Clare McMorrow, Natasha Phillips, Josie South, Lauren Sumner-Rooney (completed 2015), Lydia White, Nagore Zaldua-Mendizabal, Nadescha Zwerschke

*2 examples of **undergraduate projects** in QML in 2014-15*

Dawn Diamond, James Dickey

Evolution and re-invention: 500 million years of molluscs

Dr Julia Sigwart (QML Director & Senior Lecturer)

School of Biological Sciences

Molluscs are the most diverse marine animals, spanning giant squid to tiny worms, edible shellfish and a host of bizarre creatures adapted to specialist marine environments (shown left). Understanding how these disparate forms arose from the same common ancestor is one of the grand challenges of modern evolutionary biology. Julia's research has developed new tools to understand the evolutionary adaptations of marine animals to a changing world, including genetics, high resolution morphological descriptions, neuro-anatomy, physiology, and computational modelling of long term dynamics.

KEY FINDINGS

Important features have been re-invented multiple times in molluscan evolution: sense organs, and shells, may be advanced adaptations not primitive features.

OUTPUTS

- D.R. Lindberg & J.D. Sigwart. 2015. What is the molluscan osphradium? A reconsideration of homology. Zoologischer Anzeiger. 256: 14–21.
- C. Chen, ...J.D. Sigwart. 2015. How the mollusc got its scales: convergent evolution of the molluscan scleritome. Biological Journal of the Linnean Society 114: 949–954.
- L.H. Sumner-Rooney,...J.D. Sigwart. in press. A neurophylogeny approach provides new insight to the evolution of Scaphopoda. Evolution & Development.
- Deep-sea Biology Symposium, Aveiro, Portugal; Systematics Association, Oxford, UK

COLLABORATORS

Prof. David Lindberg (University of California, Berkeley), PD Dr Michael Schroedl (Munich), Dr Matthew Parkes (National Museum of Ireland), Dr Mark Sutton (Imperial College London), Dr Paddy Orr (UCD Dublin), Chong Chen (JAMSTEC, Japan), Lauren Sumner-Rooney (QML), Amy Garbett (QML)

Interpretation of lake sediment accumulation rates

Professor Keith Bennett

School of Geography, Archaeology & Palaeoecology

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

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

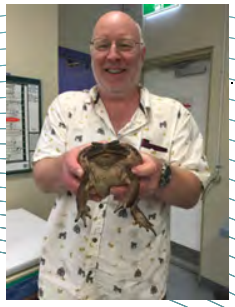
Environmental Change Research Cluster Seminar (School of Geography, Archaeology & Palaeoecology, 2015)

Bennett, K.D. & Buck, C.E. (2015) Interpretation of lake sediment accumulation rates. The Holocene, revised MS submitted.

COLLABORATORS

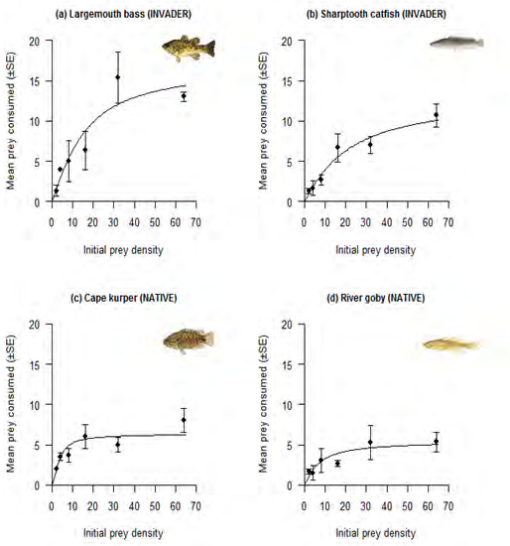
Professor Caitlin Buck, School of Mathematics and Statistics, University of Sheffield

Predicting invasive species and their impacts in a changing world



Jaimie T.A. Dick (Professor of Invasion Ecology)

School of Biological Sciences



Invasive alien species are threatening biodiversity and ecosystem services globally; a priority is thus to develop methods to predict their impacts. Further, such methods must be predictive under changing biotic and abiotic conditions. In a series of meetings, workshops and conferences, plus an award from The University of Sydney, Jaimie presented his 'comparative functional response' (FR) methodology to global audiences, showing that the most damaging invasive species are indeed predictable from their FRs.

Figure - damaging invasive fish in S. Africa have higher FRs than analogous native fish.

KEY FINDINGS

Across a range of taxonomic groups, habitats and environmental contexts, damaging invasive species have higher functional responses than natives, and this can help us understand and predict the ecological and economic threats from existing, emerging and future invasive species

OUTPUTS

NEOBIOTA Conference, Turkey, Nov 2014; IT Sligo Workshop, Jan 2015; Belgian Govt talk, Feb 2015; ASLO conference, Spain, Feb 2015; Darwin University, Australia, invited talk, March 2015; International Research Collaboration Award, University of Sydney, April 2015; IBIS invasive species workshop, May 2015; Centre for Invasion Biology workshop, S. Africa, Oct 2015.

Alexander, M.E., Dick, J.T.A., Weyl, O.L.F., Robinson, T.B. & Richardson, D.M. (2014). Existing and emerging high impact invasive species are characterized by higher functional responses than natives. Biology Letters, 10: 20130946.

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; Prof D. Aldridge, Cambridge, UK; Drs A. Dunn & M. Hatcher, Leeds, UK; Dr H. Roy, NERC, UK.

Seaweed biology & aquaculture

Professor (Emeritus) Matthew Dring

School of Biological Sciences

Promotion of knowledge of seaweed biology, and especially their aquaculture and usage for foodstuffs, medicines, rare chemicals, bioremediation, bioenergy, etc. through support for ongoing research projects (e.g. EnAlgae), 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

Seaweeds are valuable!

OUTPUTS

Attended 4th Nordic Seaweed Conference, Grenaa, Denmark, Sept. 2014
Attended Bord Iascaigh Mhara (BIM) conference "Farmed Irish Seaweed: An Ocean Wonder Food?", Limerick, November 2014
"Seventeen years of seaweed aquaculture research at Queen's University" - invited seminar at SAMS, Oban, August 2015
Attended 6th European Phycological Congress, London, August 2015

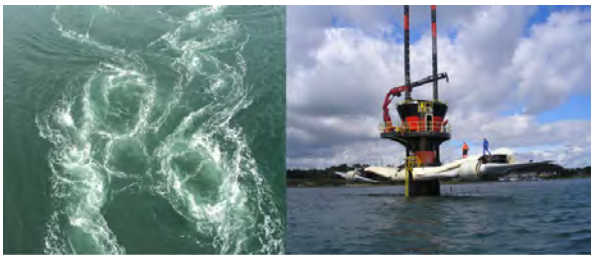
COLLABORATORS

QUB - Dr Karen Mooney, Dr Louise Kregting

Environmental impacts of marine renewable energy farms

Dr. Bjoern Elsaesser (Senior Lecturer)

School of Planning, Architecture and Civil Engineering



The aim of this project 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.

This is an EPSRC funded project led by QUB and in collaboration with Cefas and Imperial College London, finishing May 2016.

KEY FINDINGS

That 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

-QUB organised a session at the EGU 2015 on Environmental Impacts of Marine Energy Devices in Vienna (April 13th – 17th). The LINC project contributed two posters and one oral paper.

-Five papers have been submitted to the EWTEC 2015 conference.

COLLABORATORS

Dr. Julian Metcalfe (Cefas), Dr. Johan van der Molen Cefas), Dr. Axel Rossberg (Cefas), Dr. Matthew Piggott (ICL), Dr. Peter Allison (ICL), Dr. Stephan Kramer (ICL), Dr. Jon Hill (University of York), Dr. Pia Schuchert (QUB), Dr. Pal Schmitt (QUB), Dr. Louise Kregting (QUB).

Marine ecosystem research

Mark Emmerson (Professor of Biodiversity)

School of Biological Sciences

Mark's research uses the large-scale Marine Mesocosm Facility at QML, which provides a platform for the exploration of impacts of environmental change on marine ecosystems. The facility has revealed the impacts of multiple stressors, such as invasive species, warming and nutrients, on ecological community and food web structure. Current research focuses on studying the impacts of fishing activities on food web structure and associated ecosystem services in the Irish sea.

KEY FINDINGS

Effects of species richness on ecosystem function, in this case flux of nutrients, are less variable with increasing invertebrate species richness. Declines in species richness alone may thus not be the single most important factor in determining invasion success, and loss of functional biodiversity may be more important.

OUTPUTS

McElroy, DJ....Emmerson, ME (2015) Size-balanced community reorganization in response to nutrients and warming. Global Change Biology. DOI: 10.1111/gcb.13019

Plank, MJ...Emmerson, ME...(2015) Constructing Random Matrices to Represent Real Ecosystems. The American Naturalist, 185: 680-692.

Invited plenary speaker at British Ecological Society Aquatic Group meeting.

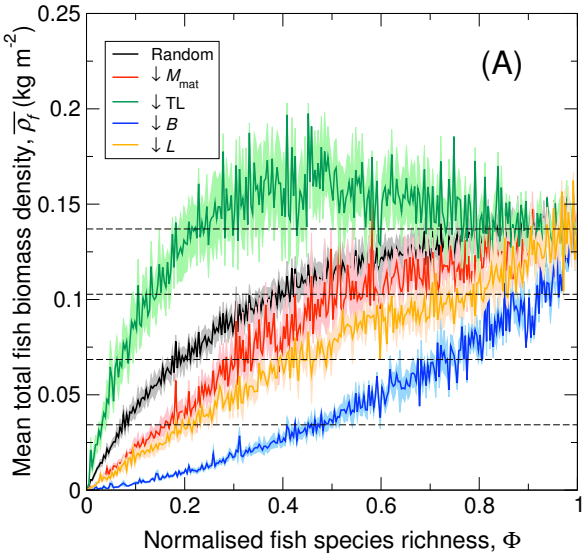
COLLABORATORS

Emmerson hosted Dr. David McElroy, University of Sydney; Dr. Eoin O'Gorman, Imperial College London; Dr. Florian Schneider, Univeristy of Montpellier to work on collaborative projects within the QML mesocosm facility.

Developing an ecosystem approach to fisheries management

Dr Keith D. Farnsworth (Lecturer)

School of Biological Sciences



The graph at left shows the predicted decline in total fish production as biodiversity is lost (moving towards the left). If higher predators are lost first (which is more likely due to fishing pressure), then system damage is masked by prey release, but eventually the system crashes (green line).

KEY FINDINGS

Much of fisheries management as practiced in North Western Europe under the EU Common Fisheries Policy is unlikely to meet the standards for sustainability being set by the EU Marine Strategy Framework Directive.

OUTPUTS

- JE Houle, F De Castro, MA Cronin, KD Farnsworth, M Gosch & DG Reid. Effects of seal predation on a modelled marine fish community and consequences for a commercial fishery. 2015. J. Applied Ecology. In press.
- T Fung, KD Farnsworth, DG Reid, AG Ross. 2015. Impact of biodiversity loss on production in complex marine food webs mitigated by prey-release. Nature Communications. 6.

COLLABORATORS

Marine Institute (Republic of Ireland): Prof David Reid; Danish Technical University: Prof K.H. Andersen, Dr Anna Rindorf; Thünen Institute (Germany) Dr Sarah Kraak; University College Cork: Dr Michelle Cronin; ICES (International) Dr Mark Dickey-Collas; CEFAS (England): Dr Axel Rossberg. We collaborate with members of 30 other institutions around Europe through ICES and EU Framework projects.

Pelagic ecology research group

Dr Jonathan D.R. Houghton (Lecturer)

School of Biological Sciences

Jon's research group at Queen's University Belfast focuses on gelatinous zooplankton and their interaction with commercial fish stocks through to the use of satellite transmitters and data loggers to investigate the spatial and behavioural ecology of marine predators (fishes, seabirds, cephalopods and sea turtles). International collaboration is central to these efforts with ongoing research in Japan, the Mediterranean, Spain, USA, Australia and Ecuador.

KEY FINDINGS

(1) Stable isotope analysis has revealed dietary complexity in jellyfish communities, helping us to understand their interaction with commercial fish stocks. (2) Recent advances in telemetry and data logging are providing vital insights into the physiological, behavioural and movement ecology of endanged marine predators on a global scale.

OUTPUTS

Fleming, N.E….Houghton, JDR (2014) Scyphozoan jellyfish provide short-term reproductive habitat for hyperiid amphipods in a temperate near-shore environment. Marine Ecology Progress Series 510 : 229-240.

Key outputs include: eight peer-reviewed publications and two documentary pieces for Discovery Channel

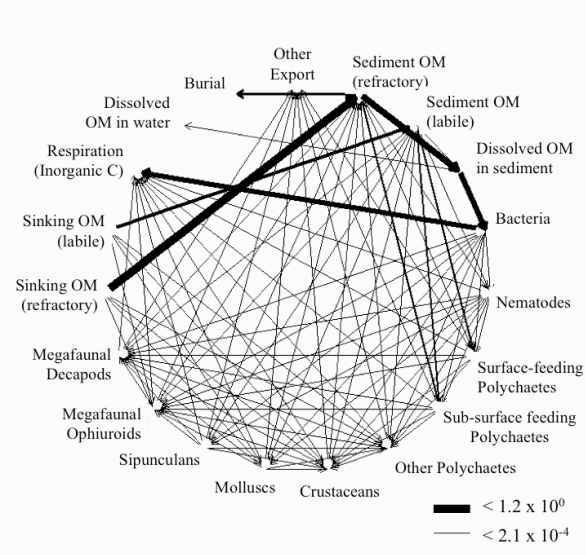
COLLABORATORS

Dr N. Reid (QUB), Prof. C. Harrod (University of Antofagasta), Drs Y. Watanabe & N. Payne (National Institute of Polar Research, Tokyo), Dr I. Nakamura (The University of Tokyo), Dr T. Thys (National Geographic), Mr M. Howard (Monterrey Bay Aquarium), Dr A. Gates (National Oceanography Centre, Southampton), Ms V. Cappenera (Portofino Marine Protected Area Authority, Italy), Dr Lewis Halsey, University of Roehampton, Drs S Beggs & A Mellor (AFBI).

Extinction, ecosystem structure and carbon cycling in coastal sediments

Dr William Ross Hunter (Leverhulme Fellow)

School of Biological Sciences



Coastal and shallow seas cover 7 % of the global seafloor but account for 50 % of seafloor carbon recycling. Coastal ecosystems are sensitive to human-induced pressure from fisheries and pollution that lead to localised extinctions of specific organisms. These extinctions disproportionately affect larger animals at higher trophic levels (predators and scavengers). This has cascading impacts upon ecosystem-scale carbon cycling pathways. The research here tests how selective removal of predators and scavengers affects ecosystem structure and functioning, changing nutrient fluxes and carbon cycling pathways in coastal sediments.

KEY FINDINGS

Within coastal sediments predators and scavengers play an important role regulate the transfer of carbon from the algal community up through the food web. They also act as bioturbators, facilitating the transfer of detritus deep into the sediment. Predator removal will restrict bottom-up nutrient transfer in coastal sediments.

OUTPUTS

Hunter, W.R.; Battin, T.J. (Submitted) Microbial metabolism mediates interactions between dissolve organic matter and clay minerals in streamwater. Scientific Reports.

Hunter, W.R.; Niederdorfer, R.; Gernard, A.; Veuger, B.; Prommer, J.; Mooshammer, M.; Wanek, W.; Battin, T. (In Review) Metabolism of mineral-sorbed organic molecules depends upon microbial lifestyles in freshwater ecosystems. Environmental Science and Technology.

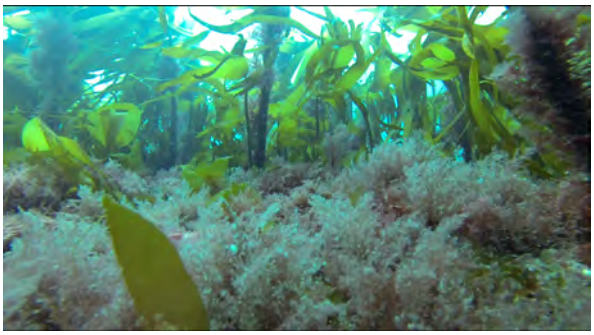
COLLABORATORS

Dr Nessa O'Connor; Prof Mark Emmerson (QUB); Prof Tom Battin (École Polytechnique Fédérale de Lausanne, Switzerland); Dr Fulvio Boano (Polytecnico di Torino, Italy); Mr Kevin Roche & Prof Aaron Packman (Northwestern University, USA); Dr Jennifer Drummond (Centre d'Estudis Avancats de Blanes, Spain).

Environmental impacts of marine renewable energy

Dr. Louise Kregting (QUB Fellow)

School of Planning, Architecture and Civil Engineering



Louise's research is using recent developments in high resolution hydrodynamic modelling to assist in answering how marine renewable energy developments may affect the marine environment. However this area of research has obvious application on a more general basis for coastal zone management by allowing the prediction of possible changes in a wide range of marine fauna and flora arising from changes such as coastal engineering, pollution, and the changes occurring due to climate change.

KEY FINDINGS

Coupled hydrodynamic ecological models are valuable tools for predicting many coastal processes such as determining the distribution, connectivity and genetic structure of marine organisms.

OUTPUTS

Organised special session at EGU (Vienna April 2015) entitled Environmental Impacts of Marine Renewables.

Brennan, G., Kregting, L. et al. (2014). Understanding macroalgal dispersal in a complex hydrodynamic environment: a combined population genetic and physical modelling approach. Journal of the Royal Society, Interface 11 : 20140197

COLLABORATORS

Cefas, Imperial College London, University of Otago, University of Tasmania, Australia, University of York, Heriot Watt University, National Institute of Water and Atmosphere, University of Hamburg, University of Hawaii, Down East Institute Maine.

Cryptic interference in size-structured populations

Dr Paul Mensink (Lecturer, Education)

School of Biological Sciences

Intraspecific competition can lead to density dependent demographic rates via reductions in per capita prey consumption. The consequences of direct confrontation with competitors during foraging can be severe (e.g. wounds, death, etc); therefore, individual foragers typically modify their foraging patterns to avoid other competitors. However, the alteration of optimal foraging patterns in response to competitor density also has associated costs, including measureable effects on per capita consumption of resources. My research attempts to measure how these costs vary in response to population size-structure.

KEY FINDINGS

Research is ongoing; however, this research will have important consequences for our understanding of population dynamics in species where size-structure is altered (e.g., commercially fished species).

OUTPUTS

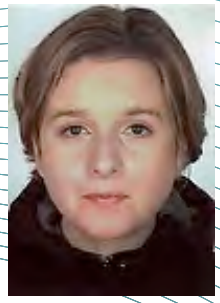
Mensink, PJ et al. (2014). Reproductive success of parasitized males in a marine reef fish. Marine Biology 161: 2689-2696

Experiments still in progress...

COLLABORATORS

Dr Daniel Barios-O'Neil
Prof. Jaimie Dick
Josie South (PhD student)

Impacts of global change on biodiversity and ecosystem functioning



Dr Nessa O'Connor (Lecturer)

School of Biological Sciences

Impacts of human activity on ecosystems rarely occur in isolation, yet we understand very little about their combined effects on the diversity of communities and how this relates to ecosystem functioning (e.g. primary production) and services (e.g. food production, clean water). Detailed experimental tests are required to identify and quantify cumulative impacts in order to predict how ecosystems will function under changing environmental conditions. Nessa's research examines the effects of species loss, ocean warming and nutrient enrichment on coastal ecosystems and their related services (e.g. food production).

KEY FINDINGS

Our findings highlight the need to include key physical drivers, such as nutrient availability, explicitly into biodiversity–ecosystem functioning models in order to move towards a predictive framework that incorporates the effects of both environmental heterogeneity and anthropogenic stressors.

OUTPUTS

- O'Connor, NE, et al. (2015). Nutrient availability regulates the functional consequences of species loss. Journal of Ecology 103: 862-870.
- Vye, SR... & O'Connor, NE (2015). Stressor intensity determines antagonistic interactions between species invasion and multiple stressor effects on ecosystem functioning. Oikos 124: 105-112.
- Mrowicki, R.J & O'Connor, NE (2015). Wave action modifies the effects of consumer diversity and warming on algal assemblages. Ecology 96: 1020-1029.

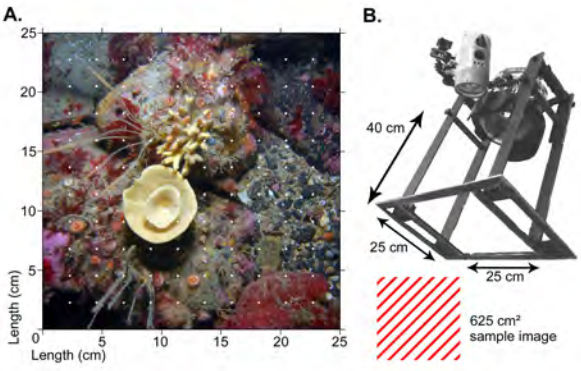
COLLABORATORS

Prof Heather Hunt (University of New Brunswick), Dr Dannielle Green (Trinity College Dublin), Dr Matthew Bracken (UC Irvine), Prof Phil Archambault (University of Quebec), Prof Emmett Duffy (Smithsonian Institution), Lydia White, Nadescha Zwerschke, Victoria McCready, Camilla Bertolini, Julia Calderwood, Cass Bromley.

Benthic community monitoring studies

Dr. Henk van Rein (QML research technician)

School of Biological Sciences



The image to left illustrates a technique we have developed for benthic community monitoring studies
A. High resolution photoquadrat sample image (25 x 25 cm) of benthic community collected at 25 m depth.
B. Photoquadrat sampling apparatus used to rapidly collect images of benthos. Key benefits include uniform image dimensions, no image parallax, consistency of image collection and ease of operation.

KEY FINDINGS

Photoquadrat-based monitoring methods proved to collect quantitative benthic data from sensitive habitats and communities with high levels of consistency, accuracy, efficiency and ease of sampling.

OUTPUTS

Collaborative reports published by the Joint Nature Conservation Committee (JNCC):
1.Moore, J.J., Bunker, F., van Rein, H. & Jones, J. 2015. Methodological trials: Recording subtidal epibiota in situ and in photographs, Portrush, August 2013 and Sound of Mull August 2014. JNCC Report, No. 561.
2. M.T. Burrows, D. Smale, N. O'Connor, H. Van Rein & P. Moore. 2014. Developing Indicators of Good Environmental Status for UK Kelp Habitats. JNCC Report No. 525, SAMS/MBA/QUB/UAber for JNCC, JNCC Peterborough.

COLLABORATORS

Emma Verling - JNCC; Hayley Hitchen - JNCC; Jon Moore - Coastal Assessment, Liaison & Monitoring Ltd.; Francis Bunker - MarineSeen; Jen Jones - Skomer Marine Nature Reserve; Michael Burrows - Scottish Association of Marine Science; Dan Smale - Marine Biological Association; Pippa Moore - Aberystwyth University; Nessa O'Connor - QUB

EnAlgae Public Outreach

Emma Gorman (QML algal technican)

School of Biological Sciences

The EnAlgae project have been spreading the message of the possibilities of using seaweed as a future source of renewable energy. Public outreach is a key part of this Interreg IVB funded project, and provides great opportunity to engage with the general public in Northern Ireland and gauge public opinion. The EnAlgae team have taken a seaweed roadshow to schools and events across Northern Ireland, hosted stakeholder workshops at QML, and have had a wide range of local and national media coverage including interviews with BBC, ITV and New Scientist.

KEY FINDINGS

By attending and sponsoring local events such as The Strangford Lough Maritime Festival, visiting schools, and opening the doors at QML on Open Days, in addition to conducting a public survey we have found there has been an overwhelmingly positive response from the general public to the EnAlgae project and its aims, and this work will continue with a new 3 year grant to continue to grow seaweed for bioenergy at QML.

OUTPUTS

Stakeholder Survey conducted by Dr. Felicity Greenwell, Willow Research
Sponsorship of The Strangford Lough Maritime Festival 2013 - 2015
Conferences presented at:
Nordic Seaweed Conference: Faroe Islands 7th May (Dr Karen Mooney and Dr Peter Schiener)
European Seaweed: Production and Marketability 13-14th May 2015, Oban (Emma Gorman)
Flanders Maritime Cluster IMTA Meeting: Belgium 2nd July (Dr Karen Mooney)
Public outreach events with NI Ecoschools, Titanic Belfast, and QML Open Day

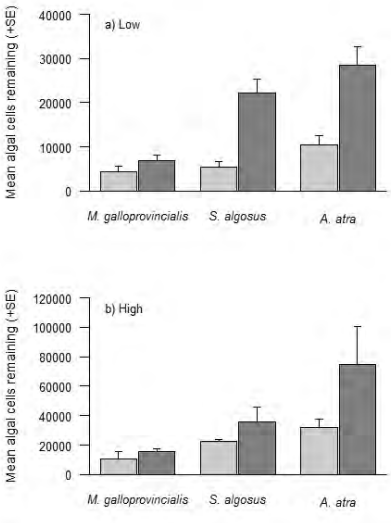
COLLABORATORS

- Dr Karen Mooney (QML EnAlgae project manager)
- The EnAlgae network of pilot sites and observers www.enalgae.eu
- Dr Felicity Greenwell, Prof. Matthew Dring, Prof. Christine Maggs, Dr Julia Sigwart

Predicting the impacts of invasive marine mussels in South Africa

Dr Mhairi E. Alexander

Department of Botany and Zoology, 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

2nd World Conference on Marine Biodiversity, Institute of Oceanology Chinese Academy of Sciences, Qingdao, China. Oral presentation “Predicting and explaining impacts of invasive mussels in South Africa”; Functional Response Workshop, CIB, S. Africa, 2015.

Alexander ME, Adams R, Dick JTA, Robinson TB (2015) Forecasting invasions: resource-use by mussels informs invasion patterns along the South African coast. Marine Biology (in review)

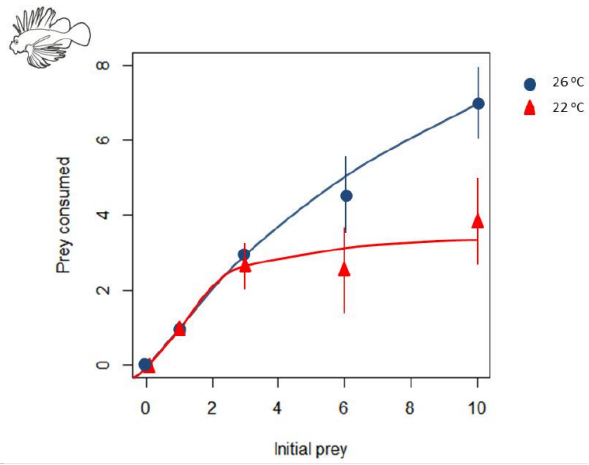
COLLABORATORS

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; Drs A. Dunn & M. Hatcher, Leeds, UK.

Predicting of the impacts of invasive predators under global warming

Dr Andrea Anton (honorary research associate)

School of Biological Sciences



The introduction of exotic predators around the world has resulted in staggering economic and ecological losses. Lionfish (Pterois volitans), a predator from the Pacific Ocean, has spread rapidly throughout the Western Atlantic and was recently sighted in the Mediterranean. By consuming native invertebrates and fish, invasive lionfish threaten species diversity and commercial fisheries. This study aims to quantify the effects that temperature could have on the impacts that this novel predator exerts on prey populations using functional responses.

KEY FINDINGS

Invasive lionfish consumption rate of prey increases with temperature.

OUTPUTS

- A Anton, MS Simpson, I Vu (2014) Environmental and Biotic Correlates to Lionfish Invasion Success in Bahamian Coral Reefs. PLoS ONE. 9(9): e106229

- New tropical aquarium facilities in place at QML.

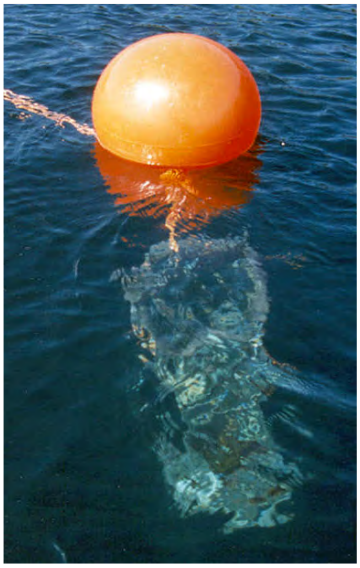
COLLABORATORS

Prof. Jaimie Dick (QML)

Historical context of the Strangford Lough Marine Conservation Zone

Dr Daryl Anne Birkett (honorary research fellow)

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

Seaweed bioenergy

Dr John Bothwell (honorary research fellow)

Durham University

Working with Dr Karen Mooney and Emma Gorman at QML, my group aims to improve seaweed by selectively breeding commercially important strains of green and brown seaweeds. To do this, we use next generation sequencing methods to identify the markers associated with favourable traits and then look at the environmental and economic bottlenecks involved in seaweed biomass cultivation.

KEY FINDINGS

Developing seaweed biomass as a sustainable source of biofuels and feedstocks.

Reddin, CJ…Bothwell, JH & Harrod, C (2015). Coastal Upwelling Drives Intertidal Assemblage Structure and Trophic Ecology. PLOS ONE: 10 e0130789.

OUTPUTS

Talks at SEB in Prague July 2015, Potsdam 'Plants and People' Sep 2015, Porto 'Phycomorph' Sep 2015

NERC AB-SIG grant awarded to develop commerical potential of our work.

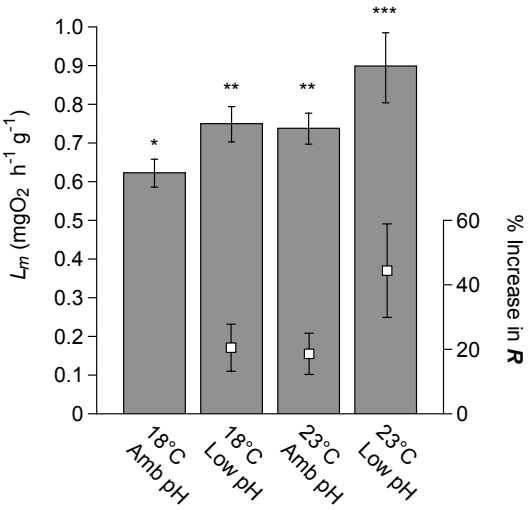
COLLABORATORS

Karen Mooney and Emma Gorman, QML.
Katherine Steele, Bangor.
CRK Reddy, CSMCRI Bhavnagar India.
Arvind Lali, CEB Mumbai, India.

Metabolism and body-size, and what they mean for animals under climate change

Dr. Nicholas Carey (honorary research associate)

Hopkins Marine Station, Stanford University, USA



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. & Sigwart, J. D. 2014. Size matters: responses to ocean acidification and temperature may be modulated by body size. Biology Letters 10(8).
Carey, N., Harianto, J., & Byrne, M. 2015. Urchins in a high CO2 world: partitioned effects of body-size, ocean warming and acidification on metabolic rate. Journal of Experimental Biology. In Review.
2nd Southern Ocean Acidification Workshop, Hobart, Tasmania, Sep 2014. Oral Presentation. "Changes to metabolic scaling under warming and ocean acidification in sea urchins".

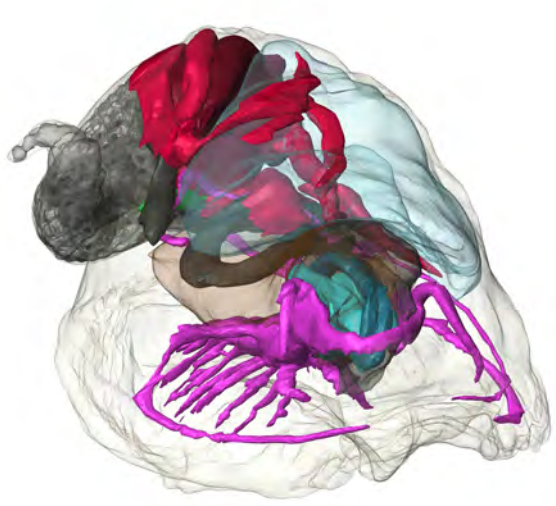
COLLABORATORS

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.

Anatomy of the vent-endemic 'scaly-foot gastropod' from the Indian Ocean

Dr Chong Chen (honorary research associate)

Japan Agency for Marine-Earth Science and Technology



The 'scaly-foot gastropod' (Chrysomallon squamiferum Chen et al., 2015), from Indian Ocean hydrothermal vents (> 2500 m deep), is a unique snail with numerous dermal sclerites covered in iron sulfide. To understand the autecology of this species, a 3D tomographic reconstruction of its internal anatomy was undertaken. This revealed numerous novel anatomical adaptations to resolve energetic needs in the extreme deep-sea hydrothermal vent environment, including a gigantic heart to supply its endosymbiotic bacteria with resources such as oxygen and sulfide. Furthermore, its sclerites were found to differ from similar structures in other molluscs.

KEY FINDINGS

As a result of adaptive evolution, the 'scaly-foot gastropod' has basically become a carrying vessel for its endosymbiotic bacteria. This study exemplifies how detailed investigations of anatomy can significantly enhance the understanding of an organism's autecology.

OUTPUTS

- Chen C .... Sigwart J (2015). The heart of a dragon: 3D anatomical reconstruction of the ‘scaly-foot gastropod’ (Mollusca: Gastropoda: Neomphalina) reveals its extraordinary circulatory system. Frontiers in Zoology, 12:13; doi:10.1186/ s12983-015-0105-1.
- Chen C .... Sigwart J (2015). How the mollusc got its scales: convergent evolution of the molluscan scleritome. Biological Journal of the Linnean Society, 114: 949-954.
- International Conference on Biodiversity, Ecology and Conservation of Marine Ecosystems, Hong Kong (Best Oral Presentation Award); Deep-sea Biology Symposium, Aveiro, Portugal

COLLABORATORS

Dr Julia Sigwart (QUB), Dr Katrin Linse (BAS Cambridge), Prof Alex Rogers (Oxford University), Dr Jonathan Copley (NOC Southampton), Dr Hiromi Watanabe & Dr Ken Takai (Japan Agency for Marine-Earth Science and Technology)

The trophic ecology of jellyfish

Dr Nicholas Fleming (honorary research associate)

School of Biological Sciences

Primarily driven by the exclusion of jellyfish from many fisheries and ecosystem models Nick's research sought to build a better picture of the trophic role of scyphozoan jellyfish (shown left) in the marine environment. Using stable isotope analysis (13C & 15N) Nick has challenged the conjecture that jellyfish occupy a single trophic level within the pelagic food web, established the nature of the interaction between the parasitic amphipod Hyperia galba and jellyfish within Strangford Lough, discovered an allometric shift in trophic level for some jellyfish species, similar to those found in fish and quantified the trophic niche overlap between fish and jellyfish communities.

KEY FINDINGS

Care should be taken when incorporating jellyfish (or gelatinous zooplankton) as a single functional group into fisheries and ecosystem models. Jellyfish play a more complex role in our marine ecosystems than previously thought - Not all jellyfish are equal!

OUTPUTS

Fleming, N.E.C., Houghton, J.D.R., Newton, J., Harrod, C. (2015). Not all jellyfish are equal: isotopic evidence for inter- and intraspecific variation in jellyfish trophic ecology. PeerJ. DOI: 10.7717/peerj.1110

Fleming, N.E.C., Harrod, C, Griffin D.C., Newton, J., Houghton, J.D.R. (2014). Scyphozoan jellyfish provide short-term reproductive habitat for hyperiid amphipods in a temperate near-shore environment. Marine Ecology Progress Series. 510, 229–240. DOI: 10.3354/meps10896

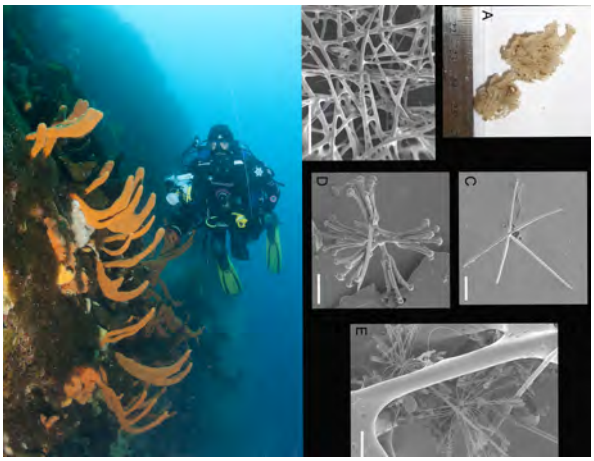
COLLABORATORS

Professor Chris Harrod (University of Antofagasta), Dr Jason Newton (NERC LSMSF, SUERC)

Southern Ocean Sponges: the link between biogeography and geochemistry.

Dr Claire Goodwin (honorary research fellow)

National Museums Northern Ireland



This is a multidisciplinary study into the impacts of physical and chemical processes on Southern Ocean sponges. We are providing taxonomic descriptions specimens collected in poorly studied areas of the Southern Ocean, assessing the biogeographical variation in sponge assemblages, and the role of the environment in sponge distribution. Geochemical analysis will study the silicon isotope variation in sponge skeletons between different individuals and taxonomic groupings, to improve our understanding of how silicon uptake is influenced by ocean chemistry and how sponges can be used as geochemical archives.

KEY FINDINGS

Sponge silica skeletons can be used as geochemical archives to help us understand the silicon cycle in the Southern Ocean and contribute to our understanding of current and past climatic change.

OUTPUTS

KR Hendry, GEA Swann, MJ Leng, HJ Sloane, C Goodwin, J Berman and M Maldonado (2015). Silica stable isotopes and silification in a carnivorous sponge Asbestopluma sp. Biogeosciences 12: 3489-3498; C Goodwin, J Jones, K Neely & P Brickle (2014) Sponge biodiversity of Beauchêne and the Sea Lion Islands and south-east East Falkland, Falkland Islands, with a description of nine new species. Journal of the Marine Biological Association of the UK. http://dx.doi.org/10.1017/S0025315414001775.

COLLABORATORS

Dr Katherine Hendry, University of Bristol; Dr Jade Berman, Ulster Wildlife Trust; Dr Dorte Janussen, Dr Christian Göcke and Rachel Downey, Senckenberg Museum; Shallow Marine Surveys Group, Falkland Islands; South Atlantic Environmental Research Institute; Dr Paul Dayton and Shannon Jarrell, UC San Diego.

Impacts of climate-driven range shifts of intertidal invertebrates

Dr. Heather Hunt (sabbatical researcher)

University of New Brunswick, Canada

The topshell Phorcus lineatus is a southern snail species whose range is expanding northward in the U.K. due to climate change. At QML, I conducted an experiment in the mesocosm to examine the effects of warming (+2 C temperature) and wave action on the impact of P. lineatus and other grazing gastropods on algal assemblages. I also surveyed field sites in Northern Ireland and the Republic of Ireland to determine biogeographic changes in the last 10 years. P. lineatus is now found up the entire eastern side of Strangford Lough but its distribution is relatively stable in other areas of Ireland.

KEY FINDINGS

The distribution of the topshell Phorcus lineatus has continued to shift in the last 10 years, expanding up the eastern side of Strangford Lough

OUTPUTS

QUB School of Biological Sciences special seminar, summer 2015

Sabbatical research visit, funded by Fredrik and Catherine Eaton Visitorship Award for exchanges between the University of New Brunswick and Queen's University Belfast.

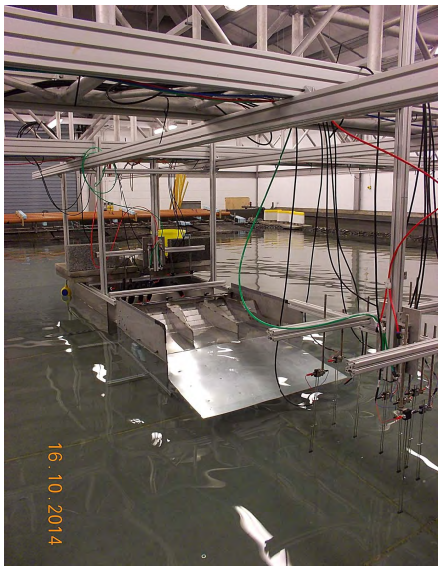
COLLABORATORS

Dr. Nessa O'Connor, QUB
Dr. Nova Mieszkowska, Mar. Biol. Assoc. of the UK

MARINET Access - CyanWave

Mr. Tim Morrissey & Mr. Alan McKinley

Cyan Technologies Ltd.



MARINET is an EC-funded network of research centers and organisations that are working together to accelerate the development of marine renewable energy. MARINET offers periods of free-of-charge access to test facilities at a range of world-class research centers.
Cyan Technologies Ltd. successfully secured a 7 week MARINET access period to test their CyanWave device in the Portaferry Wave Basin. The CyanWave device is an overtopping wave energy converter. The testing period was used to assess and optimise the performance of the device.

KEY FINDINGS

The drop-off in overtopping efficiency with increasing wave approach angle is within accepted levels while further structural design improvements to capture oblique wave energy better can also be incorporated for the next design model.
The measured hydraulic efficiency of the CyanWave model is consistent with long-term wave-to-wire efficiency goals of 30% or more overall.

OUTPUTS

MARINET Infrastructure Access Reports
Seminar on Cyan Technologies findings and future plans (David Keir Building, QUB -October 2015)

COLLABORATORS

MARINET (Marine Renewables Infrastructure Network for emerging Energy Technologies)
Bjoern Elsaesser (QUB)

Nudibranch diversity in Strangford Lough

Bernard Picton (honorary research fellow)

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

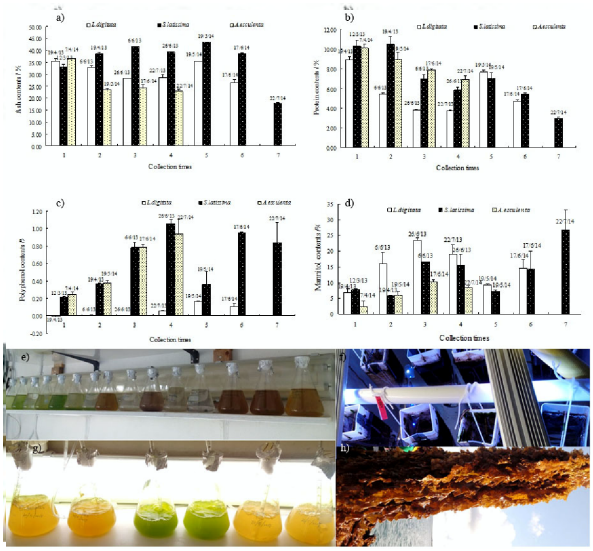
COLLABORATORS

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

Seaweed cultivation and chemical characterisations of seaweeds

Dr. Sufen Zhao (sabbatical researcher)

Fisheries College, Guangdong Ocean University, China



Several kinds of marine microalgae and macroalgae have been studied at QML. Fourteen kinds of marine microalgae including green and brown ones are stocked, and some of them are cultivated in the Marine Lab. Three kinds (more than ten strains) of macroalgae are also cultivated in the lab and at sea. They are Laminaria digitata, Saccharina latissima and Alaria esculenta. Using gravimetrical, chromotgraphic and spectrophotometrical methods have been used to analyse seasonal seaweed samples to determine protein, carbohydrate, ash and polyphenol levels for growth in 2013 and 2014.

KEY FINDINGS

Microalgae and macroalgae are cultivated successfully in the marine lab. The seasonal changes of L. digitata, S. latissima and A. esculenta chemical composition profile were identified: the highest yields of mannitol coincided with the lowest yields in ash, protein and polyphenol, which can be used to predict best harvest times of these seaweeds and identify suitable approaches for biorefining.

OUTPUTS

Sabbatical research training visit from Guangdong Ocean University, China: December 2014 to October 2015.

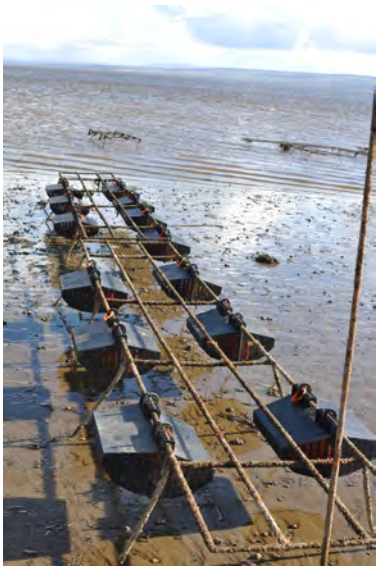
COLLABORATORS

Supervisors: Dr. Julia Sigwart (QUB)
Other collaborations: Dr. Karen Mooney, Dr Peter Schiener, Emma Gorman

Oyster aquaculture and fisheries

Dr Liz Ashton (postdoctoral researcher)

School of Biological Sciences



ORTACs (floating boxes in foreground) are a new technology for growing oysters and have had some success compared to common trestles and bags (in background) in growing the native European flat oyster Ostrea edulis in Jersey. A pilot study was carried out in Lough Foyle to compare the growth and mortality of O. edulis and Crassostrea gigas between the common trestle and bag with the new Ortac technology.

KEY FINDINGS

There is very good growth and further potential for growing oyster seed for 6 months in the Ortacs.

OUTPUTS

Guist, G., Developing Best Practices for Pacific oyster (Crassistrea gigas) Producers. MPhil, QUB.

Guist, S., Ashton, E.C., Roberts, D., 2015. The influence of temperature, salinity and husbandry practices on survival of cultured Pacific oysters, Crassostrea gigas, in Lough Foyle. In review

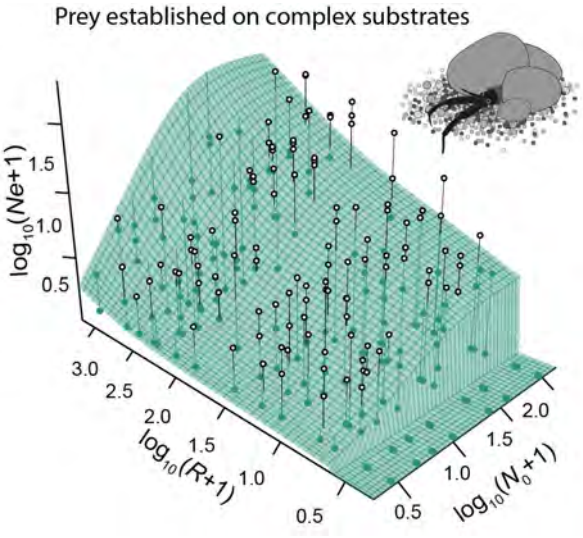
COLLABORATORS

Ciaran McGonigle, Loughs Agency
Martin Flanigan, Aquaculture Initiative
Willie Lynch, Foylemore Oysters
Don Saville, Native Island Shellfish Ltd

Marine ecosystems research programme

Dr Daniel Barrios-O'Neill (postdoctoral researcher)

School of Biological Sciences



This research focuses on resolving consumer-resource interactions in aquatic systems, using a combinations of simulation modeling and laboratory or field manipulations to inform my work. Daniel is particularly interested in how biotic and environmental factors modulate the body size scaling of interactions, and subsequently alter the outcomes of predator-prey population dynamics. The data generated at QML feeds in to the wider MERP project: the goal is to continuously improve the parameterisation of models capable of making predictions about how whole ecosystems will respond to change.

KEY FINDINGS

The size scaling of consumer feeding rates is dynamically variable in space and time, and coupled to key drivers such as habitat complexity.
MERP overview marine-ecosystems.org.uk

OUTPUTS

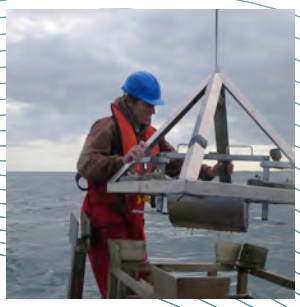
Barrios-O'Neill, D., Dick, J. T. A., Emmerson, M. C., Ricciardi, A., & MacIsaac, H. J. (2014). Predator-free space, functional responses and biological invasions. Functional Ecology, 29, 377–384.

Barrios-O'Neill, D., Dick, J. T. A., Emmerson, M. C., Ricciardi, A., MacIsaac, H. J., Alexander, M. E., & Bovy, H. C. (2014). Fortune favours the bold: a higher predator reduces the impact of a native but not an invasive intermediate predator. The Journal of Animal Ecology, 83, 693–701.

COLLABORATORS

Tony Ricciardi (McGill University, Canada), Hugh MacIsaac (University of Windsor, Canada) & Mhairi Alexander (CIB, South Africa)

Modiolus restoration research



Dr Nathan R. Geraldi (postdoctoral researcher)

School of Biological Sciences

The Modiolus restoration research group has multiple goals. The goals include mapping the extent of Modiolus modiolus reefs in and around Strangford Lough, monitoring these reefs, and conducting studies to test the feasibility of different restoration techniques.

KEY FINDINGS

Modiolus reefs within Strangford Lough do not seem to be recovering and relatively healthy reefs have been identified along the Outer Ards Peninsula.

OUTPUTS

Geraldi, N.R., M. Emmerson, N. O'Connor, , J. Sigwart, E. Boston, C. Bertolini and D. Roberts (2014) Restoration and long-term monitoring of Modiolus modiolus in Strangford Lough: Final Report 2015. Report prepared by the Natural Heritage Research Partnership (NHRP) between Quercus, Queen's University Belfast and the Northern Ireland Environment Agency (NIEA) for the Research and Development Series No. 13/XX.

Modiolus researchers meeting, Queens University Marine Lab, January 2015 (34 attended)

COLLABORATORS

Mark Emmerson, Nesso O'Connor, Julia Sigwart, Emma Boston, Camilla Bertolini and Dai Roberts

Funded by the Department of Environment, NI

Triple T

Dr Penny Jeffcoate (postdoctoral researcher)

School of Planning, Architecture and Civil Engineering

The TTT project involved the testing of medium-scale tidal turbines in three conditions: ideal towing tank tests, steady flow field tests and tidal turbulent flow in Strangford Lough. The 1.5m diameter devices are the first to be tested at the same scale in all three environments. They allow the assessment of the impact of flow condition on performance whilst decoupling the effects of scale.

KEY FINDINGS

Power performance is affected by turbulent tidal flow, and the amount and nature of this turbulence must be characterised minutely.

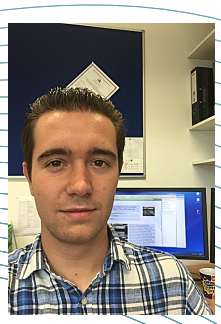
OUTPUTS

• Jeffcoate, P., Salvatore, F., Boake, C. & Elsaesser, B. (2015). Effects of submergence on tidal turbine performance. EWTEC 2015
• Jeffcoate, P., Whittaker, T. & Elsaesser, B. (under review). Field tests of multiple 1/10th scale tidal turbine devices in steady flows. Journal of Renewable Energy
• Jeffcoate, P., Elsaesser, B., Whittaker, T. & Boake, C. (2014). Testing Tidal Turbines – Part 1: Steady Towing Tests vs. Moored Tidal Tests. ASRANet International Conference on Offshore Renewable Energy.

COLLABORATORS

Dr Bjoern Elsaesser, Dr Pal Scmitt, Dr Louise Kregting, Hanna Torrens-Spence QUB; Cuan Boake, ARR; Dr Ralf Starzmann, SCHOTTEL Hydro; Dr Nick Wells, Joules Energy Efficiency; Adam Holland, McLaughlin and Harvey; Graeme Mackie, Oceanflow Energy; Francesco Salvatore, CNR-INSEAN; Sam McCloskey, CASE

Hydrodynamic testing of a ship-type array of oscillating water columns



Dr Paul Lamont-Kane (postdoctoral researcher)

School of Planning, Architecture and Civil Engineering

As part of the Marinet program, Paul was responsible for assisting testing novel energy converters in the QUB wide wave tank facility: the KNSWING and WaveTube devices. The objective of the KNSWING work was to carry out performance and survival experiments with the attenuator using simplified generic mooring systems of different stiffness at a water depth of 50 meters full scale. The tests provide evidence of the hydrodynamic performance, hull motions and mooring loads in performance and extreme conditions. In particular, waves were generated to model North Sea performance and extreme wave conditions.

KEY FINDINGS

Data have now been obtained in relation to both the hydrodynamic performance and survivability criterion of the proposed device. Preliminary analysis shows sea-worthiness of the concept and so design will be continued utilizing further, more detailed and comprehensive small scale testing.

OUTPUTS

A theoretical and Experimental Study of an Oscillating Water Column Attenuator, BA-project, Morten Ankjær Simonsen and Frederik Pors Jacobsen, June 2013, report DTU Mechanical Engineering
A report – paper for the SDWED project.
Ref. No.: IJOME-D-15-00011R1, Title: MARINET Experiment KNSWING testing an I-Beam OWC Attenuator

COLLABORATORS

Queen's University Belfast
KN Ocean Energy Science & Development
Danish Technological University

Energetic Algae

Dr. Karen Mooney-McAuley (postdoctoral researcher)

School of Biological Sciences

EnAlgae was a four-year strategic initiative of the INTERREG IVB North West Europe programme. It brings together 19 partners and 14 observers across 7 EU Member States with the aim of developing sustainable technologies for algal biomass production. The project aims to reduce reliance on fossil fuels in NW Europe by developing algal bioenergy technology pilot facilities across the region and by facilitating the emerging marketplace and policy development. The QUB research group's focus is on improving macroalgal cultivation methods, developing a semi-commercial scale pilot system and growing outreach and stakeholder engagement practices.

KEY FINDINGS

The cultivation of kelp is commercially viable in Northern Ireland, with excellent growth over the three deployment seasons and potential for several crops per season; this opens the way for new ventures for existing fishing and aquaculture industries, with overwhemingly positive public support, ongoing deployment and harvesting optimisation and establishment of a unique kelp culture stock at QML.

OUTPUTS

Anaerobic Digestion & Stakeholder Engagement workshops; Seaweed Industry workshop; Seacourt Print Workshop collaboration and school visit. Interactive EnAlgae exhibit for Into the Deep Festival, Strangford Lough Maritime Festival, Gala Week, NI Science Festival, 20th Anniversary Eco-Schools event.

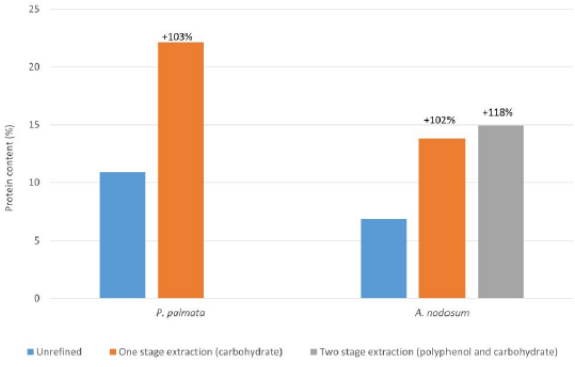
COLLABORATORS

QUB: Dr. Nessa O'Connor, Dr. Peter Schiener, Dr. Louise Kregting, Dr. Bjoern Elsaesser, Dr. Julia Sigwart, Dr. Jim Provan, Prof. Martin Atkins, Mr. Vincent Farrelly, Prof. Chris Maggs (now Bournemouth Uni)
Durham Uni: Dr. John Bothwell, Dr. Chris Greenwell. NUIG: Dr. Maeve Edwards, Dr. Benoit Quegiugneur. CEVA: Dr. Jennifer Champenois, Dr. Pierre Ewes

EnAlgae: Biorefinery and biofuel approaches using seaweed biomass

Dr Peter Schiener (postdoctoral researcher)

School of Biological Sciences



Seaweed biomass is being investigated as a novel resource suitable for biorefinery and biofuel approaches. Enzymatic saccharification is applied as a selective tool to remove the carbohydrate content of seaweeds, which can be converted to biofuels. The nutritional aspects of the seaweed residue after enzymatic treatment is being investigated as a novel animal feed supplement. Research has shown that the protein and lipid content of this residue can be enriched two-fold using enzymes. Removal of high-value polyphenols before enzymatic saccharification has also shown not to affect protein and lipid contents, allowing multiple extraction processes.

KEY FINDINGS

Multiple selective extraction processes are possible and all have shown to enhance the nutritional aspects of seaweed residue enabling the design of a process for the extraction of carbohydrates for biofuel production, extraction of a high-value product such as polyphenols and application of the residue as an animal feed supplement.

OUTPUTS

1) Oral presentation at the 4th Nordic Seaweed Conference in Grenaa, Denmark in 2014
2) Oral presentation at the Seaweed Symposium on the Faroe Islands in 2015
3) Organisation of an EnAlgae workshop on Biogas from Seaweed at QML in 2015
4) Outreach activities such as EcoSchool visit and NI Science Festival in 2015

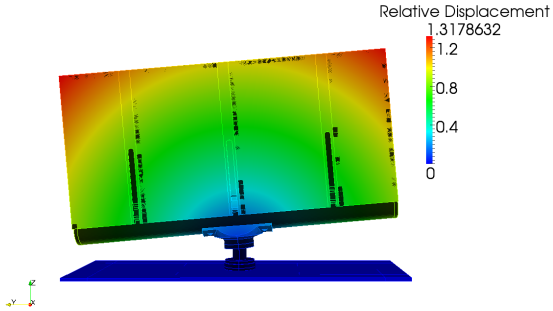
COLLABORATORS

Dr. Katerina Theodoridou and Prof. Andrew Meharg, Institute for Global Food Security, QUB
Dr. Hilary Redden and Dr. Chris Greenwell, University Durham

Numerical tools for Oscillating Wave Surge Converters

Dr. Pal Schmitt (postdoctoral researcher)

School of Planning, Architecture and Civil Engineering



Oscillating Wave Surge Converters (OWSC) are devices built to generate electricity from ocean waves. They consist of a bottom hinged buoyant flap, that is driven by wave action to move back and forth.
We develop and apply state of the art numerical tools to simulate for example the fluid flow and motion of the flap in operation. Another tool developed, allowed the simulation of vibration modes, efficiently taking into account the effect of the water on the vibration structure.
These tools complement and are validated against the experimental investigations undertaken in the QUB tank test facilities.

KEY FINDINGS

OWSC require custom made numerical tool for efficient design optimisation
RANS CFD, Finite element structural tools coupled with boundary element codes allow to investigate effects with high degree of accuracy

OUTPUTS

Asmuth, H, Schmitt, P, Henry, A & Elsaesser, B 2014, 'Determination of Non-linear Damping Coefficients of bottom-hinged Oscillating Wave Surge Converters Using Numerical Free Decay Tests' Paper presented at Renew 2014, Lisbon, Portugal, 24/11/2014 - 26/11/2014, .

Devolder, B, Schmitt, P, Rauwoens, P, Elsaesser, B & Troch, P 2015, 'A Review of the Implicit Motion Solver Algorithm in OpenFOAM® to Simulate a Heaving Buoy' Paper presented at 18th Numerical Towing Tank Symposium, Cortona, Italy, 28/09/2015 - 30/09/2015

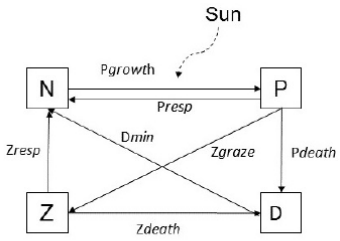
COLLABORATORS

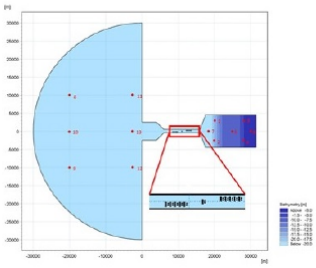
TU Hamburg-Harburg, Aquamarine Power Ltd.

Simulating ecological changes caused by marine renewable energy device arrays

Dr Pia Schuchert (postdoctoral researcher)

School of Architecture, Planning and Civil Engineering





There is widespread concern regarding the environmental impacts of marine renewable energy devices. Ecological impacts of tidal turbine arrays are difficult to quantify as operative arrays do not exist to date.
We used coupled hydrodynamic and bio-geochemical NPZD (Nutrient-Phytoplankton- Zooplankton- Detritus) models to numerically explore possible impacts and regional effects (up to 30 km) of an array of 55 tidal turbines on primary production. The aim was to establish whether impacts could be detected and the applicability of the modelling approach to the task.

KEY FINDINGS

Variation in dynamics of phytoplankton and nitrogen are larger among natural annual and spatial variations than impacts of an extreme set-up of 55 tidal turbines. Numerical models are a valuable tool in exploring possible impacts of large scale marine renewable energy devices.

OUTPUTS

EGU Conference, Vienna, Austria. Poster presentation "Simulating Ecological Changes caused by arrays of Marine Renewable Energy Devices."

COLLABORATORS

Dr Björn Elsäßer, QML/QUB; Dr L. Kregting, QML/QUB; Dr J. v. d. Molen, CEFAS; Dr J. Metcalf, CEFAS; Dr D. Pritchard, New Zealand; Prof S. Rushton, Newcastle, UK

Scaling food webs and biodiversity in intertidal coastal areas around the UK

Lydia Luise Bach (PhD student)

School of Biological Sciences

Lydia is working on the relationship between biodiversity, ecosystem function and services, as well as understanding the role spatial scale (a proxy for biodiversity) on topological food web properties. To do this, Lydia's research focuses on characterizing food webs in intertidal coastal areas around the UK at different spatial and temporal scales. Gaining a greater understanding of the properties of food webs in relation to spatial scale and environnmental context may reveal fundamental principles underlying stability and complexity of ecosystems.

KEY FINDINGS

Fundamental food web properties vary across spatial scales and enviromental gradients, characterised by changes in complexity and diversity. Moreover, δ13C & δ15N stable isotopes, proxies of carbon source & trophic status, indicate that the trophic status of marine invertebrates varies with enviromental context and spatial scale.

OUTPUTS

-Food(webs) for thought: what can we learn about food webs from Facebook? Soapbox Science promoting female researchers, Kelvingrove Museum, Glasgow, June 2015.
-Variation in δ13C and δ15N isotopes across space and time, Coastal Ecology Workshop, St Malo, October 2014.
-Spatial variation in food webs in intertidal areas in the UK, Invited talk organized by Prof Ross Coleman, The University of Sydney

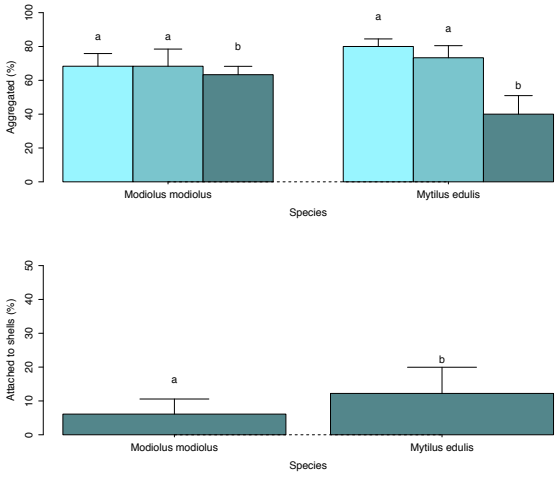
COLLABORATORS

Supervisors: Prof Mark Emmerson, Dr Nessa O'Connor

Developing methods for the restoration of biogenic reefs

Camilla Bertolini (PhD student)

School of Biological Sciences



The first part of this research identified and characterised differences in aggregation behaviour between the common blue mussel, Mytilus edulis, and the endangered mussel, Modiolus modiolus, using mesocosm experiments. These findings are essential to understand the functional ecology of common and rare species, which underpin important biogenic habitat formation and their associated biodiversity.

KEY FINDINGS

Understanding species functional ecology and biology is key for successful ecological restoration

OUTPUTS

Oral presentation at Modiolus meeting in Jan 2015
Oral presentation at MBA postgraduate conference May 2015

Planned:
Oral presentation at the Aquatic Biodiversity and Ecosystems in Liverpool (September 2015)
Manuscript submission to Functional Ecology

COLLABORATORS

Primary supervisor: Dr Nessa O'Connor
Secondary: Dr Nate Geraldi, Prof. Ian Montgomery

Environmental and commercial sustainable management of native oysters

Dr Cass Bromley (PhD student, 2012-2015)

School of Biological Sciences

This project was carried out in Lough Foyle, one of the last remaining wild native oyster (Ostrea edulis) fisheries in Europe. Populations of oysters have severely declined over the past 150 years owing to overexploitation, disease, pollution and sporadic, unpredictable recruitment. Native oysters are increasingly subject to conservation legislation. The research adopted an holistic approach to addressing key concerns influencing sustainability of populations. Field experiments and surveys were carried out to investigate reproductive cycles, fecundity, and habitat and stock enhancement.

KEY FINDINGS

It is unlikely that exploitation can be sustainable without establishing broodstock areas or using spatting ponds and hatcheries to produce additional stock.
Harrowing (habitat remediation) had no significant effect on oyster larvae settlement.
Increasing oyster population density had positive effects on oyster growth, reproduction and associated biodiversity.

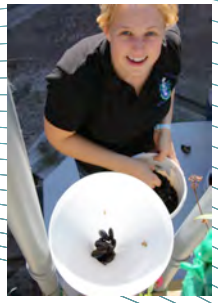
OUTPUTS

2015 IBIS Project "70 Years of Research" & Final Stakeholder Workshop, Newry
2014 Eurocean 2014, Rome
2014 Porcupine Marine Natural History Society Conference, Galway
2014 Queen's University Belfast, Second-year PhD Symposium
2014 Department of the Environment/ Loughs Agency Marine Protected Areas
2014 BIM/ IFA Aquaculture workshop, Dungarvan, Co. Waterford

COLLABORATORS

Dr. Dai Roberts, Dr. Julia Sigwart, Dr. Nessa O'Connor - Queen's University Belfast
Dr. Sarah Culloty, Dr. Sharon Lynch - University College Cork
Ciaran McGonigle - Loughs Agency
Dr. Terence O'Carroll and Dr. Patricia Daly - Bord Iascaigh Mara (BIM)

Improving yield of blue mussels in benthic cultivation



Dr Julia Calderwood (PhD student, 2012-2015)

School of Biological Sciences

Benthic cultivation of mussels is practiced throughout Europe and involves transporting small ‘seed’ mussels from offshore beds where there is competition for food and space, to inshore sheltered waters with a good supply of food, where they are grown on to a marketable size. The ongrowing of mussels is often inefficient resulting in poor harvest to seed ratios. Poor returns result in increased pressure on natural seed beds. There is a need to reduce such pressures in the wild by minimising losses in the industry and improving yields and this research has addressed these issues.

KEY FINDINGS

Transportation stress and predation have been identified as key sources of losses within the benthic mussel cultivation industry and predator removal techniques have been investigated to determine the best ways to reduce the impacts of crabs and starfish on mussel beds.

OUTPUTS

MARES conference, Portugal, November 2014 (Poster Presentation).
Benthic Ecology Meeting, Quebec, March 2015 (Oral Presentation).
MBA Postgraduate Conference, Belfast, May 2015 (Oral Presentation).

Calderwood, J., O’Connor, N.E., Roberts, D., 2015. The effects of transportation stress and barnacle fouling on predation rates of starfish (Asterias rubens) on mussels (Mytilus edulis). Aquaculture. 444, 108-103. doi:10.1016/j.aquaculture.2015.02.038

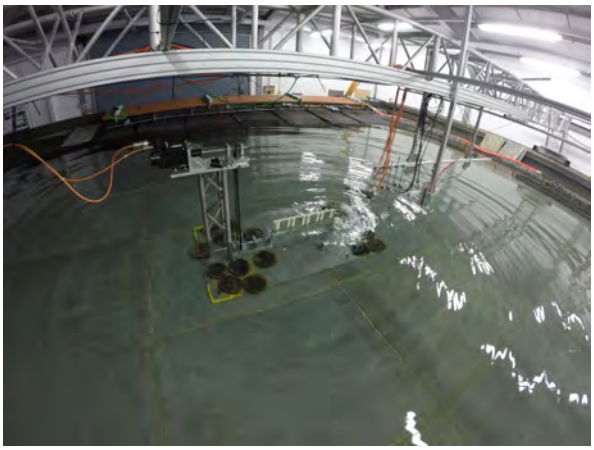
COLLABORATORS

Supervisors: Dr Dai Roberts (QUB), Dr Nessa O'Connor (QUB), Dr Julia Sigwart (QUB)

Developing the understanding of Oscillating Wave Surge Converters

David Crooks (PhD student)

School of Planning, Architecture and Civil Engineering



This picture shows an Oscillating Wave Surge Converter (OWSC) positioned in the QML wave tank. The photograph was taken during a test in which the OWSC was forced to pitch back and forth in water. This test has enabled the characterisation of the "hydrodynamic" resisting force that water applies to OWSCs as they oscillate through different amplitudes of motion and over a range of frequencies. Further tests performed in the QML wave tank involved measuring the excitation torque experienced by a fixed OWSC in waves and investigating the influence of different levels.

KEY FINDINGS

The amplitude and phase of OWSC excitation torque is effected by pitch angle.
Linear approximations of "hydrodynamic" torque have been shown to be inadequate in describing fully the torque that resists the motion of an OWSC when it is forced to oscillate rapidly or through large amplitudes of motion.
OWSCs can be tuned through the application of an external restoring torque.

OUTPUTS

Conference paper (Experimental validation of numerically generated wave excitation torque on an OWSC)
PhD Thesis (Developing the understanding of the Oscillating Wave Surge Converter through the testing of equation of motion terms)

COLLABORATORS

Prof. Trevor Whittaker, Dr. Bjoern Elsaesser & Dr. Matt Folley

Developing best practice for native oyster production in a small regional fishery

Lawrence Eagling (PhD Student)

School of Biological Sciences

Native oyster populations have been in decline since the late 19th century, with few remaining viable fisheries left in the U.K. One such fishery is located in Loch Ryan, Scotland, which through good management practice has been restored to historical landing levels. Ongoing investigations are monitoring the landings, distribution and sex ratio of the fishery, whilst considering past management techniques and what can be implemented to ensure the future of the fishery. This has been achieved through monthly sampling over the past 3 years, histological analysis of 480 samples and extensive research of the family held fishery records in Loch Ryan.

KEY FINDINGS

Populations that have been exploited due to overfishing can recover, however this requires well carried out management plans and a significant amount of time to achieve. It is important to have a long time series of data to be able to monitor how management strategies adapt to shape fisheries production and population size over a time scale of many decades.

OUTPUTS

Conferences presented at:
16th International Conference on Shellfish Restoration (Charleston, South Carolina)

Eagling, L.E., Ashton. A.C. and Eagle, J., 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

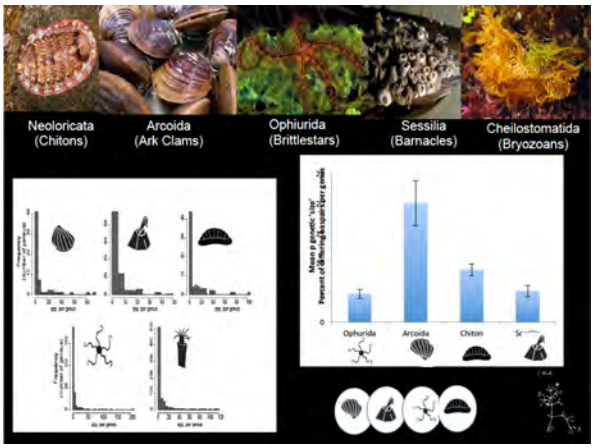
Supervisors: Dr. Dai Roberts, Dr. Elizabeth Ashton and Dr. Julia Sigwart

Other collaborations with: Dr Josh Eagle (University of South Carolina, School of Law), Martin Syvret (Aquafish Solutions Limited), Dr Andy Woolmer (Salacia Marine), Dr Matthew Service (AFBI) and Dr Annika Clements (AFBI)

The influence of taxonomy on biodiversity

Amy Garbett (PhD student)

School of Biological Sciences



The over-arching aim of this PhD is to address a seemingly simple question: “how big is a genus?”. This will be approached using an integrative taxonomical framework to assess genus level biodiversity in hard-shelled marine invertebrates, including morphological, geographical and molecular data.

KEY FINDINGS

Does the way taxonomy influences biodiversity masks the true amount of living and extinct biodiversity on earth?

OUTPUTS

The Linnaean Society of London special meeting 'Radiation and Extinction: Investigating Clade Dynamics in Deep Time' – contributed poster
The Malacological Society of London 'Molluscan Forum' 2014 – contributed poster
Systematics Association 'Young Systematics Forum' – contributed poster
12th Marine Biological Association postgraduate conference (QUB) – contributed talk
QUB 1st year PhD seminar – contributed talk
Systematics Association biennial, Oxford – contributed poster

COLLABORATORS

Supervisors:
Dr. Julia Sigwart (QML)
Prof. Keith Bennett (QML / QUB GAP)
Dr. Bernard Picton (National Museums Northern Ireland)

Trophic impacts of gelatinous zooplankton on fish in the Irish Sea

Donal Griffin (PhD student)

School of Biological Sciences

Large jellyfish blooms found within NI waters can have positive and negative effects on commercially important fish stocks.Jellyfish can feed on the eggs and larvae of sympatric fishes, yet provide shelter and food for juvenile fishes such as cod and whiting. Quantifying such interactions over broad temporal and spatial scales is challenging but through close collaboration with AFBI, it has been possible to amass >10 years of fish and jellyfish by-catch data. Using techniques such as stable isotope analysis and geospatial statistics we aim to showcase the Irish Sea as a text-book case study that has international relevance to ecologists and fisheries managers alike.

KEY FINDINGS

Exploratory meta-analysis has revealed that gadoids (i.e. cod, haddock, whiting) are the species most closely associated with jellyfish during development.

Size spectral models have revealed that jellyfish communities are structured as a largely self-contained food web that overlaps in part (but not exclusively) with commercial fishes.

OUTPUTS

Attended International Council for the Exploration of the Sea (ICES) conference in September 2014.

Fleming, N.E.C., Harrod, C., Griffin, D.C., Newton, J. and Houghton, J.D.R. 2014. Scyphozoan jellyfish provide short-term reproductive habitat for hyperiid amphipods in a temperate near-shore environment. Marine Ecology Progress Series 510, pp. 229–240.

COLLABORATORS

Dr. Jonathan Houghton (primary supervisor, QUB)
Prof. Mark Emmerson (secondary supervisor, QUB)
Dr. Steven Beggs (tertiary supervisor, AFBI)
Dr. Chris Harrod (collaborator, University of Antofagasta, Chile)
Dr. Isabella D'Amra (Stazione Zoologica, Anton Dohrn, Italy)

Effects of climate change on commercially harvested shellfish

Carina M. Gsottbauer (PhD student)

School of Biological Sciences

Near-future climate change will include an increase in seawater temperatures (ocean warming) and a decrease in ocean pH (ocean acidification). Commercially fished shellfish species will react differently to these changed climatic conditions. Therefore, predictions are needed to guide future fisheries towards species that can adapt or even thrive in this changing environment.
Species of shellfish such as the Common whelk (photo) were exposed to near-future sea-water conditions and growth, metabolic rate, and feeding rate were measured.

KEY FINDINGS

Near-future climate change will affect commercially harvested species in different ways with temperature being the dominant driver in post-larval shellfish.

OUTPUTS

Talk given at IBIS stakeholder meeting in Glasgow
Talk given at "One planet, one ocean" conference in Barcelona
Talk given at IBIS Conference: 70 Years of Applied Science Supporting Marine and Fresh Water Management in Newry
Harvey BP, Al-Janabi B, Broszeit S, Cioffi R, Kumar A, Aranguren-Gassis M, Bailey A, Green L, Gsottbauer CM, Hall EF, Lechler M, Mancuso FP, Pereira CO, Ricevuto E, Schram JB, Stapp LS, Stenberg S, Rosa LTS. Evolution of Marine Organisms under Climate Change at Different Levels of Biological Organisation. Water. 2014; 6(11):3545-3574.

COLLABORATORS

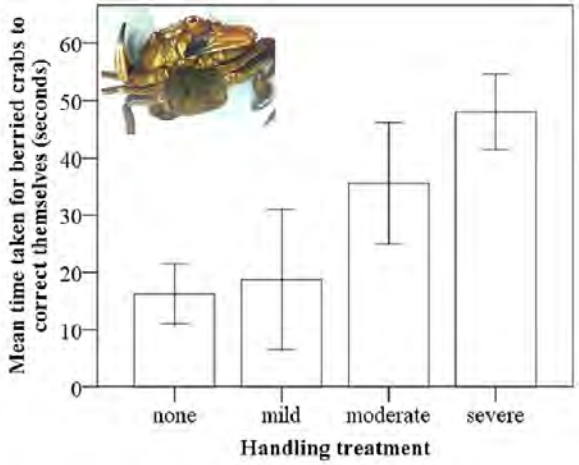
Supervisors: Mark Emmerson, Dai Roberts, Paulo Prodohl

Collaborators at Exeter University: Rod Wilson, Ceri Lewis, Rob Ellis

Population and welfare studies of the velvet crab fishery in Northern Ireland

Laura Hinchliff (PhD student)

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: Strangford Lough and the Irish Sea. This 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

Conferences presented at:
- 107th Annual National Shellfisheries Association Conference (Monterey, USA)
- 12th Annual Marine Biological Association PG Conference (Belfast, N. Ireland)

Production of Seafish PhD report with recommendations for industry.

COLLABORATORS

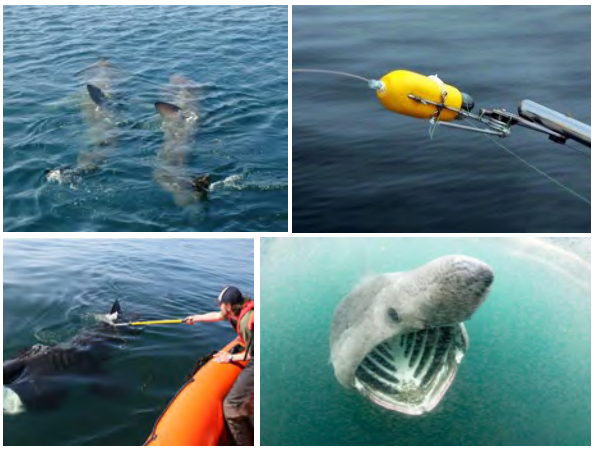
Supervisors: Prof. Jaimie Dick, Dr. Julia Sigwart (QUB)

Other collaborations with: Dr. Lynn Gilmore (Seafish), Dick James (NIFPO), Dr. Carrie McMinn (AFBI), Institute for Global Food Security (QUB)

Basking Shark spatial ecology in the Northeast Atlantic

Emmett Johnston (PhD student)

School of Biological Sciences



The lack of robust population estimates and distribution patterns for basking sharks in any body of water world-wide has been identified as the single most limiting factor in the conservation and management of the species. This PhD is focused on refining population census protocols for the basking shark through consideration of spatial and temporal patterns of distribution coupled with foraging behaviour within Irish coastal seas and across the open ocean. To achieve this goal we are using state-of-the-art HD cameras, accelerometers and satellite transmitters placing QUB at the forefront of international research efforts.

KEY FINDINGS

(1) The deployment of HD-camera/accelerometer loggers has revealed how sharks modify their behaviour to maximise the energetic returns from foraging. (2) Time-depth recorders are revealing how much time sharks spend at the surface helping refine population estimates. (3) Satellite tracking has shown basking sharks moving from Ireland to Africa.

OUTPUTS

Lieber et al. (in review). Basking without borders: Global gene flow in the basking shark despite first evidence of inter-annual site-fidelity in the Northeast Atlantic. 'Molecular Ecology' Submitted May 2015.
Conference presentation: Cape Race to Malin Head, The Basking Shark, A shared Resource. The Laurentic Conference, Letterkeny Institute of Technology, May 2015

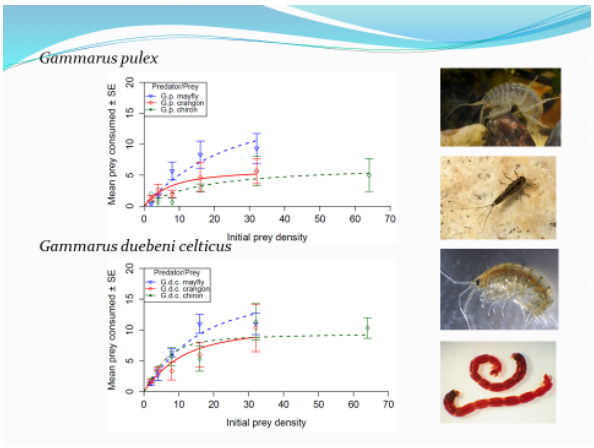
COLLABORATORS

Dr Jonathan Houghton (QUB) PhD Supervisor
Dr Pete Klimley, University of California Davis, USA
Dr Lewis Halsey, University of Roehampton, UK
Irish Basking Shark Study Group

Understanding and predicting the impacts of invasive species

Clare McMorrow (PhD student)

School of Biological Sciences



The use of novel comparative functional response (FR) experiments has had great success in highlighting that invasive species which have had the most damaging effects in the field are those which show the greatest magnitude of population destabilising type II FRs in the laboratory. A similar comparative approach was applied to switching experiments to investigate whether or not invasive species have a different propensity to switch than natives, and consider the effects this may have on prey populations, using freshwater amphipods Gammarus pulex and Gammarus duebeni celticus as study predators.

KEY FINDINGS

The invasive status of the prey is just as important as that of the predator: Crangonyx pseudogracilis, as an invasive prey species, appeared to benefit from the presence of a native prey, Baetis rhodani, which both predator species selected preferentially.

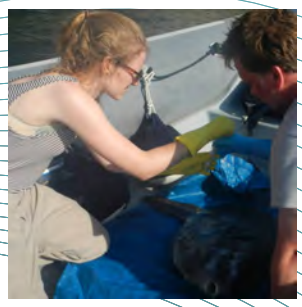
OUTPUTS

QUB first-year PhD student symposium

COLLABORATORS

Supervisors: Prof. Jamie Dick and Dr. Jack Lennon (QUB)

Extent and drivers for cryptic benthivory in the 'pelagic' ocean sunfish



Natasha Phillips (PhD student)

School of Biological Sciences

Ocean sunfish (the world's largest bony fish) were long thought of as rare, passive drifters of little ecological relevance. This perception has been replaced in recent years with evidence of extraordinary aggregations, long distance migration and complex foraging behaviour spanning shelf seas to the deep open ocean. Using a combination of biochemical and data logging techniques this project explores the dietary and energetic drivers underpinning the formation of high-density sunfish aggregations in the Mediterranean Sea. As markets for ocean sunfish continue to emerge, such data will be vital for sustainable fisheries management.

KEY FINDINGS

(1) Large aggregations of ocean sunfish have been identified near Genoa, Italy with up to 5000 individuals caught annually. Successful field trials during 2015 revealed that the site is ideal study site, with large scale deployments planned for 2016. (2) Observational data from deep remotely operated vehicles (ROV's; operated by the oil and gas industries) has provided evidence of deep-water (500m+) foraging in ocean sunfish, on a global scale.

OUTPUTS

Paper: Phillips et al. (in press) 'Seeking the sun in deep, dark places: mesopelagic sightings of ocean sunfishes (Molidae)' Journal of Fish Biology.
Conferences:
May, 2015: The Ocean Sunfish Symposium, National Institute of Polar Biology, Tokyo. Funding for this event made available to QUB via a DAIWA Foundation/ Royal Society Award.
June, 2015: The Marine Biological Association Conference, Belfast. Committee member & oral presentation.

COLLABORATORS

Dr J. Houghton (QUB), Dr N. Reid (QUB), Prof. C. Harrod (University of Antofagasta), Drs Y. Watanabe & N. Payne (National Institute of Polar Research, Tokyo), Dr I. Nakamura (The University of Tokyo), Dr T. Thys (National Geographic Researcher), Mr M. Howard (Monterrey Bay Aquarium), Dr A. Gates (National Oceanography Centre, Southampton), Ms V. Cappenera (Portofino Marine Protected Area Authority, Italy).

Predicting the interactions between climate change and invasive species

Josie South (PhD Student)

School of Biological Sciences

Quantifying and predicting the strength of predator prey interactions is essential for efficient management of fisheries. Climate change and invasive species are two drivers that may affect interaction strengths between valuable native fishery species. Using diet analysis and environmental surveys combined with complementary laboratory experiments it is possible to get baseline interaction data to use with novel statistical techniques to produce multi-species functional response curves. Furthermore, experiments are used to investigate specific climate change effects on interactions. This information can then be relayed to policy makers.

KEY FINDINGS

Cod and lesser spotted dogfish have a significant dietary overlap but exploit different substrate areas. Both species have a considerable predatory impact on the commercially valuable Nephrops fishery.

OUTPUTS

DARD postgraduate symposium
QUB 1st year PhD students symposium

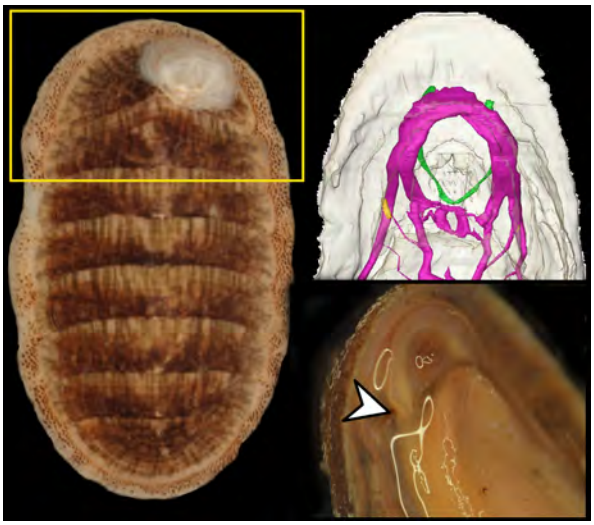
COLLABORATORS

Supervisors - Jaimie Dick (QML) and Julia Sigwart (QML)
Agri-Food Bioscience Institute

Sensory systems in marine invertebrates: structure, function and evolution

Dr Lauren Sumner-Rooney (PhD student, 2012-2015)

School of Biological Sciences



Marine environments are highly variable sensory landscapes: light, chemical cues, bioelectricity, magnetism and vibrations can all influence behaviour, ecology and physiology. Lauren's research explores the sensory and nervous systems of some of the most mysterious and diverse benthic marine animals, including chitons, scaphopods and brittle stars. Using a suite of cross-disciplinary techniques such as electron microscopy, tomographic reconstruction, behaviour, immunolabelling, phylogenetics and electrophysiology we can examine the interactions between sensation and evolution.

KEY FINDINGS

The discovery and description of the Schwabe organ, a paired pigment patch found throughout the chiton order Lepidopleurida (see image above). The Schwabe organ mediates negative phototaxis and appears to share developmental origins with the larval eye. Further work on the evolutionary loss of eyes in deep-sea vetigastropods demonstrated astonishing variability in the morphological trajectory to blindness in dark environments, even among closely related species.

OUTPUTS

- Sumner-Rooney et al. In Press. A neurophylogenetic approach provides new insight to the evolution of Scaphopoda. Evolution and Development.
- Sumner-Rooney and Sigwart. In Press. Is the Schwabe organ a larval eye? Anatomical and behavioural studies of a novel sense organ in Leptochiton asellus (Mollusca, Polyplacophora) indicate links to larval photoreceptors. PLoS One.

ICIM, Berlin (Sept 2014), CEMS, Cambridge (Sept 2014), MBA PGC, Belfast (May 2015).

COLLABORATORS

Dr Julia Sigwart, Dr Gerry Brennan, Dr Chris Johnson (QUB); Dr Michael Schrödl (ZSM, Munich); Dr Suzanne Williams (NHM, London); Dr Esther Ullrich-Lüter (MfN, Berlin); Dr Euan Brown (HWU Edinburgh); Dr Shaun Cain (EOU, La Grande); Dr Bill Wcislo, Dr Rachel Collin (STRI, Panamá).

Does biodiversity promote recovery?

Lydia White (PhD student)

School of Biological Sciences

In light of predicted global change scenarios and biodiversity loss, it is increasingly important to understand how biodiversity-ecosystem functioning (BEF) relationships vary under increasingly disturbed conditions. This empirical project focuses on ecosystem resilience (rates of recovery following disturbance), a key component of ecosystem stability that has been overlooked in the race to identify BEF relationships. Using intertidal rocky shore communities as a model system, our research will test the relationship between biodiversity and stability, as measured by resistance and resilience.

KEY FINDINGS

Currently undertaking empirical tests of resilience in coastal systems

OUTPUTS

Oral Presentation at MBA Postgraduate Conference, Belfast, May 2015
Poster Presentation at BES Aquatic Annual Meeting, London, July 2015
Poster Presentation at Aquatic Biodiversity and Ecosytems Conference, Liverpool, August 2015

COLLABORATORS

Supervisors: Nessa O'Connor (QUB), Ian Donohue (Trinity College Dublin), Mark Emmerson (QUB)

Gelatinous zooplankton & commercial risheries in the Bay of Biscay

Nagore Zaldua-Mendizabal (PhD student)

AZTI Tecnalia & QUB School of Biological Sciences

Recent work at Queen's University Belfast has suggested that dietary overlap between gelatinous zooplankton and commercial fishes may be most apparent for planktivorous species such as anchovies, sardines, herring and mackerel. A team comprising AZTI Tecnalia (Basque Country, Spain), QUB, the National University of Ireland Galway and the University of Antofagata (Chile) is testing this hypothesis on an international scale in one of Europe's most productive fishing grounds; the Bay of Biscay. To achieve this goal we are combining community ecology, stable isotope analysis and hydrographic modelling.

KEY FINDINGS

The Bay of Biscay contains an incredibly diverse array of gelatinous species ranging from large scyphozoan jellyfish weighing 10kg+, through to colonial salps, Portuguese Man-O-War and microscopic hydromedusae. These communities display a marked consistency in space and time from year to year. Isotopic analysis to date has revealed the existence of a partially self contained 'jelly-web' with minimal trophic overlap with adult fishes.

OUTPUTS

This project constitutes a 4-year PhD thesis that is due for completion in early 2016.

Publications to date:

Ferrer et al. (2015) Operational protocol for the sighting and tracking of Portuguese man-of-war in the southeastern Bay of Biscay: observations and modeling. Continental Shelf Research.

COLLABORATORS

Dr Jon Houghton (QUB)
Drs Unai Cotano and Javier Franco, AZTI-Tecnalia (Basque Country) Spain.
Dr Thomas Doyle, National University of Ireland Galway
Dr Chris Harrod, University of Antofagasta, Chile

Ecological impacts of the spread of non-native oysters

Nadescha Zwerschke (PhD student)

School of Biological Sciences

Non-native species can be a threat to local diversity and ecosystem functioning, by displacing native species and altering ecosystem processes. In Europe the escape of the Pacific oyster Crassostrea gigas from aquaculture and the establishment of extensive feral populations, have caused concern. Previous predictions didn't envisage that the European oyster O. edulis and C. gigas would occupy the same habitat, however, this was contradicted by recent surveys. Concern about possible effects of C. gigas on the recovery of native O. edulis resulted in the investigation of interspecific competition between both oyster species.

KEY FINDINGS

O. edulis and C. gigas are functionally similar in terms of nutrient cycling and facilitation of biodiversity, however, co-occurence of both species has an effect on growth rate and isotopic niche position.

OUTPUTS

• Competition between native and non-native oysters and implications for the recovery of native oyster beds. Knowledge Transfer Workshop, Newry, Ireland (13th -14th May 2015). Oral and poster presentation
• Competition between native and non-native oysters and implications for the recovery of native oyster beds. Mares Conference, Olhão, Portugal (17th-21st November 2014). Oral presentation
• Species range shifts alter nutrient cycling: functional redundancy between an invasive and a native species. 3rd World Conference on Marine Biodiversity, Quindao, China (12th-16th October 2014). Oral presentation

COLLABORATORS

Dr Chris Harrod - Universidad de Antofagasta

Nudibranch diversity in the Western Indian Ocean

Dawn Diamond (undergraduate student)

School of Biological Sciences

Dawn completed a research project to describe a new-to-science nudibranch (commonly known as sea slugs). The aim of this exercise was build a 3D digital reconstruction of internal anatomy to look at taxonomically relevant features to identify the genus of the animal. The species was from the Western Indian Ocean off the cost of Mozambique and eastern South Africa. The Western Indian Ocean is a relatively poorly researched region, despite its exceptionally high biodiversity. It is therefore important to describe new species to fully understand the regions actual biodiversity.

KEY FINDINGS

The new species was identified as Sakuraeolis in the family Facelinidae, clade Aeolidoidea based on the structure of the reproductive system. This is a common species along eastern South Africa and southern Mozambique.

OUTPUTS

Undergraduate PhD dissertation 2015: 'Description of a new aeolid nudibranch (Gastropoda: Nudibranchia) from Mozambique using computer-based 3-dimensional reconstruction software'

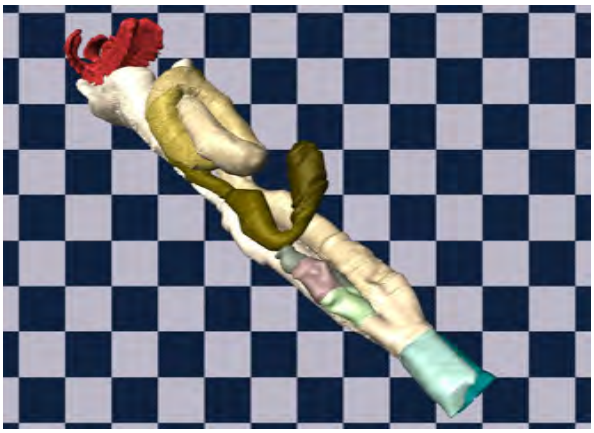
COLLABORATORS

Field work carried out with Yara Tibirica from Zavora marine labs, Mozambique. All other data collection carried out through Queens marine labs. Supervised by Dr. Julia Sigwart.

Anatomical modelling of a scaphopod

James Dickey (undergraduate student)

School of Biological Sciences



Using specimen slides from Zoologische Staatssammlung München (Germany), my task was to import photographs of the slides into 3D tomographic modeling software Amira. By highlighting and grouping the different anatomical parts, we were able to produce three dimensional images of the animal's internal anatomy, as shown, furthering understanding of scaphopod digestive and neural make up. Further work involved the preparation of Amira models from slides of Nautilus, Paroctopus and Argonauta sent from the Smithsonian Institution, to enable neuroanatomical comparison.

KEY FINDINGS

The discovery of the scaphopod stomach, and confirmation of dorsal and ventral alignment due to the positioning of the dorsoventral muscles.

OUTPUTS

- summer internship July-August 2015
- anatomical results being prepared for submission for publication to Journal of Morphology

COLLABORATORS

Dr Julia Sigwart & Dr Lauren Sumner-Rooney (QML), Zoologische Staatssammlung München, Smithsonian Institution

This academic year demonstrated the continuing strength of inter-disciplinary activity in the Marine Laboratory, Portaferry.

In the 2014-15 academic year we supported funded projects from 40 different funding agencies, spanning large and small projects from local research grants to major multinational research projects. Our students secured small grants to support travel and research funding at home and abroad.

QML research was represented at more than 40 conferences in over 14 countries in Europe, North America, Asia, and Australia.

We welcomed scientific and public visitors from many countries and our outreach activities reached over 40,000 people through in-person events at schools and within QML, and through social media including Facebook and Twitter.

Our researchers produced 108 publications many in top journals such as *Science*, *Nature Communications*, and *Biology Letters*.

Funding

We are grateful to the many funding agencies, national and international bodies, that have contributed to funding our research in 2014/15.

European Union & Research Councils UK
European Commission FP7 INTERREG IVA Cross-border Co-operation
European Commission FP7 INTERREG IVB Northwest Europe
European Commission FP7 network initiative
European Commission SYNTHESYS Integrated Activities
European Commission H2020 Marie Skłodowska-Curie actions
NERC Summer of Science
BBSRC / Innovate UK Biotechnology grant
NERC Biodiversity & Ecosystem Service Sustainability Consortium CBESS
NERC Marine Ecosystems Research Programme

Government
Department of the Environment (DOE) NI
Department of Agriculture and Rural Development (DARD) NI
Department of Employment and Learning (DEL) NI
InvestNI Research Grant
SeaFish industry authority

Scholarly Societies & Foundations
Leverhulme Trust
The Daiwa Foundation (Royal Society) Japan-UK interchange grant.
American Embassy to the UK
British Ecological Society
Marine Institute
Marine Biological Association
Unitas Malacologica
American Microscopical Society
Conchological Society of Great Britain and Ireland
Systematics Association
Fisheries Society of the British Isles
Society of Experimental Biology
The Alice McCosh Trust

QUB Endowments
Emily Sarah Montgomery Travel Scholarship (QUB)
Sir Thomas Dixon Travel Scholarship (QUB)
Student-Led Initiative Grant (QUB)
Soulby Research Fund (QUB)
Hugh Wisnom Scholarship (QUB)

International Institutions
Smithsonian Tropical Research Institute
Dublin City University, Smart Bay NIAP Award
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
University of Sydney "International Research Collaboration Award"
Technological Centre Foundation “Iñaki Goenaga”
Waterways Ireland
Inland Fisheries Ireland
Windsor/McGill University

National and international conferences and seminars

In 2014-15, the QML team presented our research at ***more than 40 scientific conferences****, in the UK and Ireland as well as* ***Australia****,* ***Belgium, Canada, China, Denmark, France, Japan, the Netherlands, Portugal, Spain, Turkey,*** *and the* ***USA.***

- European Wave and Tidal Energy Conference, Nantes, **France**
- Renewable UK and Turbulence in Marine Environments Workshop, Edinburgh, UK
- ASRANet International Conference on Offshore Renewable Energy, Glasgow, UK
- Bord Iascaigh Mhara (BIM) conference "Farmed Irish Seaweed: An Ocean Wonder Food?" Limerick, Ireland
- 6th European Phycological Congress, London, UK
- 5th Nordic Seaweed Conference, **Faroe Islands**
- European Seaweed: Production and Marketability, Oban, UK
- Flanders Maritime Cluster Integrated Multi-trophic Aquaculture Meeting, **Belgium**
- International Council for the Exploration of the Sea, Annual Science Conference 2014, La Coruña, **Spain**
- ICES Benthic Ecology Working Group Meeting, Corsica, **Spain** [Chair]
- ISOBAY 14: XIV International Symposium on Oceanography of the Bay of Biscay, Bordeaux, **France**
- Turning the tide on mangrove loss, Zoological Society London, UK [Invited Chair]
- Shellfish Association of Great Britain annual conference, Fishmongers Hall, London, UK
- BIM/IFA Aquaculture Oyster workshop, Dungarven, Ireland
- Invited to attend Euroshell, Hilton Hotel, Rotterdam, The **Netherlands**
- Mares Conference on Marine Ecosystems Health and Conservation, Olhão, **Portugal**
- 3rd World Conference on Marine Biodiversity, Quindao, **China [Best Student Presentation]**
- Association of Scottish Shellfish Growers Conference, Oban, UK
- Marine Biological Association Postgraduate Conference, Scarborough, UK
- 14th Deep Sea Biology Symposium, Aveiro, Portugal
- 7th Congress of the European Malacological Societies, Cambridge, UK **[Best Student Presentation]**
- 1st International Conference on Biodiversity, Ecology and Conservation of Marine Ecosystems (BECoME 2015), **Hong Kong [Winner: Best Oral Presentation]**
- Systematics Association biennial meeting, Oxford, UK
- Irish Geology Researchers Meeting, Belfast, UK
- Agri-Food and Biosciences Institute (AFBI) postgraduate conference (June 2015).
- EnAlgae Pilot Symposium, Kortrijk, **Belgium**
- Benthic Ecology Meeting, Quebec, **Canada**
- British Ecological Society Aquatic Annual Meeting, London, UK
- Aquatic Biodiversity and Ecosystems, Liverpool, UK
- 16th International Conference on Shellfish Restoration, Charleston, South Carolina, **USA**.

- Nortek User Symposium, Texel, **Netherlands**
- The Linnaean Society of London special meeting “Radiation and Extinction: Investigating Clade Dynamics in Deep Time”, London, UK
- The Malacological Society of London “Molluscan Forum 2014”, London, UK
- The Wildlife Trust Seaquest conference, UK [invited speaker]
- NEOBIOTA Conference, **Turkey**
- Invasives Workshop, Sligo, Ireland [invited talk]
- Invasives Forum, **Belgium** [invited talk]
- Association for the Sciences of Limnology and Oceanography, annual meeting, Granada, **Spain** [Plenary talk]
- “Seventeen years of seaweed aquaculture research at Queen’s University” Scottinsh Association for Marine Science, Oban, UK
- Hong Kong University of Science and Technology, Invited talk, invitation from Prof Pei-Yuan Qian University of **Hong Kong**
- Invited talk, invitation from Prof Kenneth Leung JAMSTEC International Workshop for Large-scale Research Cruises, **Japan**
- NOC Association 5th annual meeting, London, UK
- Marine Biology Appreciation lecture delivered to Trinity College Dublin, Ireland
- Mussel Producers’ Meeting, Bantry Bay, Ireland
- Darwin University, **Australia**
- University of Sydney, **Australia**

Networking and outreach

In 2014/15 the QML team provided educational and outreach activities to all levels from school children to professionals.

- **QML Annual Open Day**, during Strangford Maritime Festival, [**1,200 attended]**
- *EnAlgae* Stakeholder Survey conducted by Dr. Felicity Greenwell, Willow Research
- Sponsorship of The Strangford Lough Maritime Festival 2015
- Public outreach events with NI Ecoschools,
- Public outreach via Titanic Belfast
- MED-JELLYRISK Summer Course in Barcelona
- Invited to attend discussion on Co-location of marine windfarm operations with shellfish restoration and shellfish aquaculture, Fishmongers Hall, May 21, 2014.
- Marine Conservation Zone workshop, Lough Neagh Discovery Centre
- co-organised the Belfast chapter of Bright Club: re-launched during the 2015 NI Science Festival, also part of the Belfast Comedy Festival
- obtained funding from the American Embassy in Dublin to bring world renowned marine biologist Prof. Peter Klimley (University of California, Davis) to deliver a series of lectures around the universities of Ireland including Queen's University Belfast
- **Finalist**, Famelab science communication competition, Northern Ireland
- QUBio blog entries ("A shark swims into an electromagnetic field and asks what's the charge…", The sky's the limit: in defence of blue-skies research, Unexpected item: news from the plastic bagging area, Underway, South Goes North, A picture says a thousand words, Fairness at the end of the line – tails of success from Indonesia, Do ask silly questions, A love letter to the rocky shore, The Infinite Monkey Cage, Underestimating Outreach, Changing perceptions: The 'cold' fish with a warm heart…, Just a Technician?)
- 2nd annual Nudibranch Safari, Strangford Lough
- Two documentary pieces for Discovery Channel
- Invited member, ICES Benthic Ecology Working Group

Meetings and workshops organised

In 2014/15 the QML team organised conferences hosted within the Marine Laboratory, and via international conferences. The post-graduate marine students organised the national Marine Biological Association Postgraduate Conference, the first conference ever held in the new QUB Graduate School.

- Organised session at the EGU 2015 on Environmental Impacts of Marine Energy Devices, Vienna, Austria
- The Ocean Sunfish Symposium, National Institute of Polar Biology, Tokyo, Japan
- IBIS CPD on Oyster Nursery and Hatchery Techniques delivered by and at SAMS and Ardtoe Fish Farms, Scotland.
- IBIS CPD on Identifying Marine Invertebrates delivered by Brendan O'Conner and Eddie McCormack, AQUAFACT, Queen's University Marine Laboratory, N Ireland.
- Organiser and participant in IBIS Knowledge Transfer (KT) WS on Native oyster regeneration, Redcastle Hotel, Moville, N Ireland.
- IBIS Grand Finale Knowledge Transfer Workshop "70 years of research", Newry, N Ireland
- Marine Biological Association Postgraduate Conference, Queen's University Belfast
- *Modiolus* Researchers Meeting, two day national workshop focussed on restoration of endangered *Modiolus* mussels in Strangford Lough, Queen's University Marine Laboratory, N Ireland.

Visitors

In 2014-15 we welcomed visitors from around the world from many institutions:

Göteberg Nat History Museum, Sweden; Aquatilis/ University Sweden; Imperial College, London; E. ON Technologies; University of Oxford; National Museums Northern Ireland; Fyne Pioneer; JNCC UK; University of Essex; University of Liverpool; Vanderbilt University, USA; visitors from Derry, Carryduff, Dundrum, Ards Area, Belfast; Minister of State for Northern Ireland; University of Ulster; Aix Marseille University, France; LPS; AGRIAD; CASE; Invest NI; FAST TECH; CASE; Trinity College Dublin; Old Dept Primary Industry, Australia; Seafish Industry Authority; Cambridge University; Australia; Wallace High School; Belfast High School; NI Assembly; Seacourt Paint Workshop; Peking University; Bermuda Natural History Museum; Environmental Research Institute; National Oceanography Centre, Southampton; Institute of Marine Sciences; Marine Biological Association UK ; Plymouth University; Marine Biological Association ; NUI Galway; Uppsala University, Sweden; University of California, Santa Barbara, USA

The majority of our visitors are visiting researchers. We also hosted visits from **Mr Patsy McGlone MLA** from the Northern Ireland Assembly, and 12 visiting artists in an inspiration session that resulted in an art exhibition at **Seacourt Print Workshop,** Bangor.

In particular we were honored to host an official visit from the **Rt. Hon. Andrew Robathan, MP**, **Minister of State for Northern Ireland.**

Publications

In 2014/15 the QML team have published more than 100 articles in international peer-reviewed journals, including ***Science****,* ***Nature Communications,*** *and* ***Biology Letters.***

1. Alexander ME, Dick JTA, O'Connor NE. (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.
2. Alexander ME, Dick JTA, Weyl OLF, Robinson TB, Richardson DM. (2014). Existing and emerging high impact invasive species are characterized by higher functional responses than natives. **Biology Letters**, 10: 20130946.
3. Alexander ME, Kaiser H, Weyl OLF, Dick JTA. (2015). Habitat simplification increases the impact of a freshwater invasive fish. **Environmental Biology of Fishes**, 98: 477-486.
4. Andren E, Klimaschewski A, Bennett KD, Hammarlund D. (2015). Holocene climate and environmental change in north-eastern Kamchatka (Russian Far East), inferred from a multi-proxy study of lake sediments. **Global and Planetary Change**.
5. Barrios-O'Neill D, Dick JTA, Emmerson MC, Ricciardi A, MacIsaac HJ. (2015). Predator-free space, functional responses and invasions. **Functional Ecology**, 29: 377-384.
6. Barrios-O'Neill D, Dick JTA, Emmerson MC, Ricciardi A, MacIsaac HJ, Alexander ME, Bovy HC. (2014). Fortune favours the bold: a higher predator reduces the impact of a native but not an invasive intermediate predator. **Journal of Animal Ecology**, 83: 693-701.
7. Barrios-O'Neill D, Dick JTA, Ricciardi A, MacIsaac HJ, Emmerson MC. (2014). Deep impact: in situ functional responses reveal context-dependent interactions between vertically migrating invasive and native mesopredators and shared prey. **Freshwater Biology**, 59: 2194-2203.
8. Battarbee RW, Lamb H, Bennett K, ... et al. (2015). John Birks: Pioneer in quantitative palaeoecology. **The Holocene** 25, 3-16.
9. Beerman J, Dick JTA, Thiel M. (2015). Social recognition in amphipods: An overview. In: Social recognition in invertebrates, Editors: Laura Aquiloni, Elena Tricarico, Springer International Publishing, pp. 85-100.
10. Bennett KD. (2015). Comment on "Sedimentary DNA from a submerged site reveals wheat in the British Isles 8000 years ago". **Science** 349, 247.
11. Berg S, Pimenov A, Palmer C, Emmerson M, Jonsson T. (2015). Ecological communities are vulnerable to realistic extinction sequences. **Oikos**.
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