Aquatic Biodiversity & Ecosystems

Liverpool, UK. 30th August - 4th September 2015

Compiled and edited by Hanna Schuster

Contents

1 Welcome

Welcome to the Aquatic Biodiversity and Ecosystems Conference!

We are delighted that you could join us in the UNESCO World Heritage Site of Liverpool for what is sure to be a fantastic meeting, showcasing the best aquatic science from around the globe. As a one-off meeting with we are very proud to have attracted nearly 300 delegates from 114 institutes in 30 countries.

We feel that we have a balanced programme with representation across a range of freshwater, transitional and marine habitats from industry, students, early career and established scientists. We are also very proud to say that we have excellent gender balance with almost 50% female delegates.

The overarching theme of this conference is "evolution, interactions and global change in aquatic ecosystems", with the following themes:

- Evolutionary Biology
- Dispersal and Connectivity
- Food Webs and Trophic Dynamics
- Biodiversity, Ecosystem Functioning Services
- Global Environmental Change
- Fisheries and Aquaculture
- Conservation, Management and Policy

Inside this booklet you will find all of the necessary information required to navigate around the conference throughout the week. There are too many restaurants to even begin to try to advise you where to eat, but rest assured that there is plenty of choice to suit every palate. Please also see the Liverpool Pub Guide for suggestions of places to visit on the "Cultural Walk: the Imbibing Emporiums of Liverpool". We have specifically selected some cracking pubs that touch on some of the historic and cultural aspects of the city. We hope that you enjoy the walk and get an appreciation for this fantastic city.

Please feel free to come and chat to any of the organising committee if you need information on anything throughout the week.

Louise Firth on behalf of the Organising Committee

Hanna Schuster, Katrin Bohn, Ian Donohue, Chris Frid, Martin Genner, Iwan Jones, Tony Knights, Nessa O'Connor, Leonie Robinson, Gray Williams and Steve Hawkins

Welcome to Liverpool and the Aquatic Biodiversity and Ecosystems Conference 2015.

We hope you enjoy the city and the conference.

The University of Liverpool has a long tradition in both marine and freshwater science that continues strongly to this day. The first Oceanography Department in the UK was opened in 1919 supported by strong endowment from Sir William Herdman FRS. Herdman who was Professor of Zoology at the University College Liverpool was also a leading light in the Liverpool Marine Biology Committee which ran a laboratory on Puffin Island off Anglesey and then founded a Marine Biological Station on the Isle of Man in 1892. This was subsequently transferred to the University in 1919 on formation of the Oceanography Department.

The laboratory became the first department in the United Kingdom offering single Honours degrees in Marine Biology. Sadly the Port Erin Marine Laboratory closed in 2006, but Marine Biology has successfully transferred to the main campus in the School of Environment, benefitting much from its co-location with the oceanographers. The National Oceanography Centre, Liverpool (formerly the Proudman Oceanographic Laboratory) has a long history going back to the Liverpool Observatory and Tidal Institute focussing on tidal predictions, sea level measurements and modelling nearshore and shelf shore oceanography and sediment dynamics.

Equally strong is the history of work on algae and aquatic plants in both marine and freshwater systems in the former Botany Department. In Zoology, Noel Hynes pioneered the use of biological indicators of water quality and much else in the 1950s and 1960s. There was ground breaking work on freshwater fish by Jack Jones and colleagues. Brian Moss has continued the tradition with work on still waters in recent years.

Thus Liverpool is a fitting venue for a meeting deliberately setting out to link marine and freshwater ecology. Several of the organising committee have links with Liverpool - directly or indirectly. My personal links stretch back to 1973 when as a 17 year old I came to Liverpool to study (well some of the time) marine biology - but also did much freshwater biology in the first two years.

Thus on behalf of the organising committee - welcome to the Aquatic Biodiversity and Ecosystems Conference 2015.

The meeting partially follows up on the Plant-Animal Interactions conference that was run 25 years ago. It is deliberately broader in scope - hopefully integrating concepts and practice across freshwater and marine ecology. Just as important, it is an opportunity to sample what the city has to offer - some of it in Imperial rather than SI units.

Steve Hawkins

2 Organising Committee

Conference Chair:

Dr Louise Firth
School of Geography, Earth & Environmental Science, Plymouth University, UK

Scientific Committee:

Prof Steve Hawkins
Ocean & Earth Science, University of Southampton, UK
Dr Hanna Schuster
Ocean & Earth Science, University of Southampton, UK
Dr Katrin Bohn
Ocean & Earth Science, University of Southampton, UK
Dr Ian Donohue
School of Natural Sciences, Trinity College Dublin, Ireland
Prof Chris Frid
School of Environment, Griffith University, Australia
Dr Martin Genner
School of Biological Sciences, University of Bristol, UK
Dr Iwan Jones
School of Biological & Chemical Sciences, Queen Mary University London, UK
Dr Antony Knights
School of Marine Science & Engineering, Plymouth University, UK
Dr Nesssa O'Connor
School of Biological Sciences, Queens University Belfast, UK
Dr Leonie Robinson
School of Environmental Sciences, Liverpool University, UK
Prof Gray Williams
Swire Institute of Marine Science, University of Hong Kong, PR China

3 Supporters and Sponsors

4 Programme Overview

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning				
Theatre A: Welcome	Theatre A: Housekeeping	Theatre A: Housekeeping	Theatre A: Housekeeping	
Theatre A: Housekeeping	**Theatre A: Plenary**	**Theatre A: Plenary**	**Theatre A: Plenary**	
Theatre A: Plenary	Parallel sessions A: Global Environmental Change B: Biodiversity, Ecosystem Functioning and Services C: Conservation, Management and Policy D: Dispersal and Connectivity	Parallel sessions A: Global Environmental Change B: Dispersal and Connectivity C: Conservation, Management and Policy D: Fisheries and Aquaculture	Parallel sessions A: Global Environmental Change B: Biodiversity, Ecosystem Functioning and Services C: Conservation, Management and Policy D: Evolutionary Biology	Parallel sessions A: Global Environmental Change B: Biodiversity, Ecosystem Functioning and Services C: Conservation, Management and Policy D
Parallel sessions A: Global Environmental Change B: Dispersal and Connectivity C: Fisheries and Aquaculture D: Food Webs and Trophic Dynamics	**Theatre A: Plenary**	**Theatre A: Plenary**	**Theatre A: Plenary**	**Theatre A: Short Plenaries** End of Conference
Lunch				
Afternoon				
Parallel sessions A: Biodiversity, Ecosystem Functioning and Services B: Conservation, Management and Policy C: Evolutionary Biology D	**Theatre A: Plenary**	**Theatre A: Plenary**	Workshops B: Interactions in the marine benthos: a regional and habitat perspective D: - Freshwater biodiversity loss: how do we tackle it? (FBA workshop)	Workshops B: Interactions in the marine benthos: a regional and habitat perspective D
	Parallel sessions A: Global Environmental Change B: Biodiversity, Ecosystem Functioning and Services C: Food Webs and Trophic Dynamics D	Parallel sessions A: Global Environmental Change B: Biodiversity, Ecosystem Functioning and Services C: Conservation, Management and Policy D		
Theatre A: Plenary	**Theatre A: Plenary**	**Theatre A: Plenary**		End of Workshops
Cultural Walk: The imbibing emporiums of Liverpool	Poster Session	Free Evening	Conference Dinner	

5 Plenary Speakers

Welcome plenaries: a regional perspective

STEVE HAWKINS

Steve Hawkins started research on rocky shores at the University of Liverpool in 1975, inspired by a field-course project supervised by George Russell on limpet-seaweed interactions. His final year project and PhD (both with Richard Hartnoll at Port Erin) explored distribution patterns on rocky shores, using field experiments on interactions between species to explore patchiness and zonation. A NERC personal post-doc fellowship at the Marine Biological Association (MBA), Plymouth with Alan Southward prompted an interest in biogeography and climate change. A move to a permanent job at Manchester in 1980 led to work on urban water quality restoration in disused dock basins. Subsequently at Port Erin (1987 - 1995) and Southampton (1995 to 1999) he continued work on experimental ecology and long-term change as well as developing interests in shellfisheries (particularly limpets in the Azores) and pollution of the coastal zone as well as dabbling in freshwater (with George Turner and Martin Genner).
He was appointed to the Directorship of the MBA in 1999, concentrating on continuation and restart of the MBA's long-term data sets both offshore and on rocky shores (with Alan Southward) as well as more applied work on environmentally sensitive design of sea defences. Since 2007 at Bangor and subsequently at Southampton he went down the dark-side of senior University management (PVC, Dean) - but throughout this period he has continued to collect long-term data on rocky shores himself, working with Nova Mieszkowska, Mike Burrows and Louise Firth. He is particularly proud to be part of the J.H. Orton (MBA-Liverpool) lineage (Alan Southward, N.S. Jones, Richard Hartnoll) which has radiated quite a bit in recent years (e.g. Mike Burrows, Ricardo Santos, Mark Davies, Richard Thompson, Stuart Jenkins, Martin Genner, Pippa Moore, John Griffin) as a consequence of the over 75 PhD students he has supervised.
In addition to well over 250 papers and book chapters, two books on intertidal ecology have been produced, one (Raffaelli and Hawkins, 1996) being translated into both Japanese and Korean. In 1995 he received the International Recognition of Professional Excellence Prize for Marine Ecology, from the Ecology Institute Germany. In 2011 he received a lifetime achievement award at the International Temperate Reefs Symposium. He has also done much international grant committee and advisory work, particularly in Portugal - where he is now so conflicted due to his ex-PhD students that he cannot act anymore...
He intends to return to research full-time in January 2016.

Rocky shores of the North-East Atlantic: a long-term and broad-scale perspective on pattern and process

Hawkins SJ

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Rocky shores of the North-East Atlantic have a long history of study encompassing classic qualitative descriptions of distribution patterns, pioneering studies of biogeography and some of the earliest manipulative field experiments on biological interactions. There are also some extensive long-term data sets showing responses to climate fluctuations and recent more rapid climate change. The underlying biogeography of the region is summarised and recent insights from phylogeographic studies provided. The North-East Atlantic is a region of overlap of clades that invaded the North Atlantic from the North Pacific and others that came from the South in the Atlantic. The pool of species resulting from the collision and overlap of northern and southern clades responding to successive glacial cycles interact with the environment and each other to set patterns and determine process. Patterns in response to environmental gradients of tidal elevation, wave action and latitude will be briefly outlined. The underlying causes of these patterns will be explored from local scale experiments up to those at a European scale. Examples of temporal changes in response to climate will be given. The consequences of changes in assemblage composition for community structure and ecosystem functioning will be discussed.

BRIAN MOSS

Brian Moss was Holbrook Gaskell Professor of Botany at the University of Liverpool since 1989 and theoretically retired in 2008. In practice he works just as hard as he always did but on less than half of the income. He has taught or carried out research or both on six continents over fifty years. His interests are catholic but include eutrophication, lake restoration and climate change and in addition to the conventional long list of papers in learned journals, he has published a well-known textbook on the Ecology of Freshwaters (Fourth edition, 2010), a New Naturalist book on 'The Broads', and a manual for shallow lake restoration. He is much concerned with global environmental problems, the use of the arts to convey messages about the environment to the wider public, and the problems that scientists have in the way they write. He also plays the contrabass (inexpertly) and is Chairman of the Southport Orchestra. He has been President of the British Phycological Society, Vice-president of the British Ecological Society and President of the International Association for Limnology (2007-2013). He was awarded the Association's Naumann-Thienemann Medal in 2007 and the 2009 International Institute of Ecology Prize for excellence in ecology, the outcome of which is a book entitled 'Liberation Ecology' (2012). In 2010 he was awarded the annual medal of the UK Institute for Ecology and Environmental Management. 'Liberation Ecology' was awarded the British Ecological Society/Marsh Christian Trust prize for the most influential book on Ecology published in the last two years at INTECOL in London in 2013. A new book, Lakes, Loughs and Lochs, in the New Naturalist series, will appear in May 2015.

Reference states, mammals and the mitigation of climate change

Moss, B

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European legislation requires consideration of the meaning of quality of aquatic habitats, and the reference conditions against which quality must be judged. The concept of these has been particularly compromised, compared with the legislation's aspirations that reference conditions should be negligibly influenced by human activities.

The stringency demanded for reference conditions has been unambitious, but even so there has been a major omission: the potential role of large mammals. Their effects, particularly on floodplain systems, are reviewed in light of their near-complete attrition as agriculture and forestry have converted virtually all European biomes to anthromes. Large mammals transfer nutrients within catchments and may have maintained an original condition of turbid water and algal blooms in shallow floodplain lakes that currently we perceive to be in a reference state when dominated by submerged plant communities in clear water.

This may seem to have little practical relevance because the reference state has become a pragmatic and political construct rather than an ecological one. I counter this by arguing that mitigation of climate change must require replacement of carbon sinks, that restored biomes are likely to be the most effective, and that their restoration must involve rewilding with large mammals.

Biodiversity, ecosystem functioning and stability

EMMA JOHNSTON

Emma Johnston is Professor of marine ecology and ecotoxicology at the University of New South Wales and Director of the Sydney Harbour Research Program for the Sydney Institute of Marine Science. Emma investigates human impacts in marine ecosystems and has conducted research from the tropics to the poles. Emma has forged an innovative research program that combines the tenets and approaches of ecology and ecotoxicology in order to investigate 'stress ecology'. By intertwining these largely disparate fields, Johnston and her group have identified new drivers of invasion success, indirect effects of environmental stress, important stressor interactions and plasticity of environmental niche space. Emma's research has extended to evolutionary ecotoxicology and the development of molecular bio-functional monitoring tools. Emma completed her doctorate at the University of Melbourne in 2002. In 2010 she was awarded an Australian Research Council Fellowship and in 2014 she was awarded the inaugural Nancy Millis Medal from the Australian Academy of Science. She has published more than 90 peer-reviewed papers and is Regional Editor for Conservation Biology. Emma is a passionate advocate for science, she is an expert advisor to both industry and government, Vice-President of Science and Technology Australia and appears regularly in the media.

Muddy Waters: Biodiversity, bioinvasion and ecosystem functioning in multiply stressed coastal systems.

Johnston E

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Estuaries are among the most highly disturbed of all aquatic environments due to their proximity to urban, agricultural and industrial activity. Aquatic communities are exposed to multiple stressors and it is vital that the ecological consequences are identified and distinguished using a range of observational and manipulative techniques. I will present our research, combining the disciplines of ecology and ecotoxicology, to identify drivers of marine invasion success, the plasticity of environmental niche space, stressor interactions and contaminant impacts on ecosystem functioning. In addition, I will detail how molecular approaches (targeted gene, metagenomics and meta-transcriptomics) are enhancing our capacity to observe biodiversity, community connectivity and ecological change. Molecular approaches are now sufficiently advanced to provide, not only equivalent information to that collected using traditional morphological approaches, but an order of magnitude bigger, better, and faster data.

KEVIN MCCANN

Dr. McCann is a theoretical ecologist that focuses on the role food web structure plays in mediating aquatic ecosystem stability and function. McCann's lab employs a combination of theory, lab experiments and field work. While McCann works frequently on aquatic ecosystems, his research is highly collaborative and includes work across a broad range of ecosystem types including soil ecosystems and food webs of the human body. His research has played a significant role in the understanding of the role interaction strength plays in mediating stability as well as linking empirical data to food web theory. McCann recently published a synthetic book entitled Food Webs for the prestigious Princeton University Monographs in Population Biology series. McCann was elected as a lifetime fellow of the Ecological Society of America in 2013 and holds a Canadian Research Chair in Biodiversity. Over the last 10 years, McCann's lab has concentrated on Canada's Boreal lake ecosystems and their response to natural and human-impacted gradients. His research has recently taken on a more applied focus including a collaborative research project in the Tonle Sap lake in Cambodia, a floodplain lake ecosystem connected to the Mekong River. The Tonle Sap is responsible for supplying 90% of the animal protein to Cambodia yet this system is under numerous looming human impacts like dams and climate change that threaten the flood pulse that sustains this ecosystem.

Lake Food Web Expansion and Contraction: Nature Flexes its Muscles

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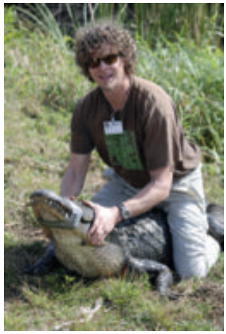
Food webs have historically been considered largely from a static perspective. Importantly, recent work has begun to broaden the perspective to include studies that look at how a given "systems responds" to both natural environmental gradients and human impact gradients. Here, using a combination of theory and field work, we look at how Canadian Shield food webs respond to natural variation, before employing these results to argue for a mechanism that allows us to then predict the impacts of climate warming on these lake food webs. We end with a natural spatial climate warming experiment that tests these emergent predictions. We find that the results resonate with the mechanisms governing a food web's response to natural variation and further argue that this aquatic ecosystem loses critical adaptive capacity to respond to variation under reasonable climate warming scenarios.

BRIAN SILLIMAN



Brian Silliman is the Rachel Carson Associate Professor of Marine Conservation Biology. He holds both B.A. and M.S. degrees from the University of Virginia, and completed his Ph.D. in Ecology and Evolutionary Biology at Brown University. Dr. Silliman was named a David H. Smith Conservation Fellow with The Nature Conservancy in 2004 and a Visiting Professor with the Royal Netherlands Society of Arts and Sciences in 2011. He has also received several awards, including the Young Investigator Award from the American Society of Naturalists (2006), a Young Investigator Award from the Andrew Mellon Foundation (2007), and a NSF Career Grant Award (2011). Dr. Silliman has published 13 book chapters and co-edited two books: Human Impacts on Salt Marshes: A Global Perspective (with T. Grosholtz and M. D. Bertness, University of California Press, 2009) and Marine Community Ecology and Conservation (with M. Bertnes, J. Bruno and J. Stachowicz). He has published over 100 peer-reviewed journal articles. His teaching and research are focused on community ecology of coastal ecosystems, conservation and restoration, physical-forcing and disease-mediated control of food web dynamics, plant-animal interactions, and evolution and ecological consequences of positive interactions.

Climate Change, Trophic Feedbacks and New Theories in Ecology

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Global change has led to increased physical forcing in many natural communities. How this increased physical stress will impact food web interactions that control ecosystem structure and function is less well known. In this talk, I present a new understanding of trophic interactions in salt marsh systems and how increasing physical stress can impact the nature and strength of those interactions. I then test hypotheses generated from his food web work in salt marshes on the nature of trophic-physical coupling using meta-analyses across marine and terrestrial systems. Results from this work both challenge and lead to conceptual expansion across diverse theories in ecology.

Responses to environmental change: norms, extremes and stochastic events

DAVID DUDGEON

David Dudgeon is Chair Professor of Ecology and Biodiversity at the University of Hong Kong (HKU). There, he has spent 30 years researching and writing about the streams and rivers of monsoonal East Asia, and the invertebrates and vertebrates that live in and around them. His work ranges over a variety of topics from the autecology of benthic macroinvertebrates and small fishes, through manipulative field experiments that examine predation, competition and grazing in streams, to studies of food webs, and broader-scale analyses concerning the conservation of freshwater biodiversity. In 2000, he received the Biwako Prize in Ecology. Dudgeon's books include Tropical Asian Streams (1999), The Ecology and Biodiversity of Hong Kong (2005), and an edited collection, Tropical Stream Ecology (2008). A further tome, Freshwater Biodiversity Conservation, is in preparation and overdue at the publisher.
Dudgeon is a member of committees tasked with addressing freshwater issues under the auspices of the international biodiversity organization DIVERSITAS, the Global Water System Project (GWSP), and the Group on Earth Observations Biodiversity Observation Network (GEO BON). He sits on the editorial boards of several international journals, such as Aquatic Conservation, Aquatic Sciences, Hydrobiologia and recently took on the role of Editor-in Chief of Freshwater Biology. Dudgeon is active on committees and advisory groups that deal with matters relating to biodiversity conservation in Hong Kong, and he is a Trustee and Executive Council member of the World Wildlife Fund (HK). During his tenure at HKU, he has served, *inter alia*, as Department Head (repeatedly), Science Faculty Chairman, and Associate Dean. Dudgeon is also a published songwriter (although commercial success has not yet beckoned) and, after many failed attempts, hopes one day to be able to play guitar adequately.

Can We Conserve Freshwater Biodiversity in a Rapidly Changing World?

Dudgeon D
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Human impacts on the biosphere are both sustained and pervasive, giving rise to the notion of a new geological epoch - the Anthropocene - in which Earth system processes are increasingly affected by anthropogenic influences. On-going climatic warming offers a clear exemplar of Anthropocene transformation of the atmosphere. Globally, fresh waters exhibit conspicuous Anthropocene signatures, and inland waters are hotspots of endangerment of biodiversity. The ~125,000

freshwater species that have been described represent almost 10% of known animal species, including one third of vertebrates, notwithstanding the fact that inland waters cover $<1\%$ of the Earth's surface. Freshwater species are generally far more imperiled than their terrestrial or marine counterparts, and population trend data over recent decades indicate that declines in freshwater species are around twice as high as their counterparts on land. Globally, as many as 20,000 freshwater species may be imperiled and, in intensively-developed regions, more than one third of the species in some taxa are threatened with extinction. Inadequate knowledge of tropical freshwater biodiversity means that the global threat extent may be even greater than supposed. The extinction of the Yangtze River dolphin can be considered as emblematic of an on-going loss of charismatic freshwater megafauna. Other notable examples of species declines include amphibians and large river fishes worldwide, and freshwater turtles in Asia.
Trajectories of human population growth, water use and consequential disturbance and degradation of inland waters have risen steeply during the Anthropocene. Such changes can be projected to continue in the near future as water-security needs for people are addressed, and 'hard-engineering' adaptations to climate change are adopted. They will undoubtedly impose greater stress on freshwater ecosystems, leading to additional species declines and adding to a substantial (perhaps unquantifiable) extinction debt associated with human actions that have been taken already. The likely consequences of climate change for water availability in lakes and rivers do not augur well for biodiversity, and scenarios for native freshwater biotas in places where the human footprint is already pervasive are especially bleak. As we face a no-analogue future, can we resolve the conflict between conservation of freshwater biodiversity and the imperative to meet human water needs? How can we halt the ongoing replacement of lakes and rivers that are rich in species with novel or profoundly-transformed ecosystems that host a mere fraction of their original faunal complement? And, does the notion of ecosystem-service provision by fresh waters offer an opportunity to leverage conservation of their biodiversity?

BRIAN HELMUTH

Dr. Brian Helmuth is a Professor at the Marine Science Center at Northeastern University in Boston, Massachusetts, with a joint appointment in the Department of Marine and Environmental Sciences and the School of Public Policy and Urban Affairs. Helmuth's research and teaching focus on predicting the likely ecological impacts of climate change on coastal ecosystems, and on the development of products that are scientifically accurate, understandable, and useful by a diverse array of stakeholders. Specifically, he uses a combination of theoretical and experimental techniques to predict where, when and with what magnitude climate change is most (and least) likely to affect natural and human-managed ecosystems, including protected areas and aquaculture facilities. While much of his work has focused on North American rocky intertidal ecosystems, his lab also collaborates with researchers on every continent. He is a co-founder of INSHORE, an international network of marine scientists across the globe dedicated to the development and implementation of cutting-edge techniques for monitoring and forecasting the impacts of climate change in coastal ecosystems, with an emphasis on making technology accessible to scientists from developing nations.
Helmuth is a Fellow of the Aldo Leopold Leadership program, which trains select scientists to interact with policy makers, journalists and the public and in 2011 was named a Google Science Communication Fellow in the area of climate change. He also served as a lead author on the Technical input document for the inaugural Oceans chapter of the US National Climate Assessment.

Moving beyond means: Making biological sense in a rapidly changing world

Helmuth B
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Biological responses to climate change are typically communicated in generalized terms such as poleward and altitudinal range shifts, but adaptation efforts relevant to management decisions often require forecasts that incorporate the interaction of multiple climatic and nonclimatic stressors at far smaller spatio-temporal scales. We argue that the desire for generalizations has, ironically, contributed to the frequent conflation of weather with climate, even within the scientific community. As a result, current predictions of ecological responses to climate change, and the design of experiments to understand underlying mechanisms, are too often based on broad-scale trends and averages that at a proximate level may have very little to do with the vulnerability of organisms and ecosystems. The creation of biologically-relevant metrics of environmental change that incorporate the physical

mechanisms by which climate trains patterns of weather, coupled with knowledge of how organisms and ecosystems respond to these changes, can offer insight into which aspects of climate change may be most important to monitor and predict. This approach also has the potential to enhance our ability to communicate impacts of climate change to nonscientists and especially to stakeholders attempting to enact climate change adaptation policies.

Evolutionary biology: speciation, phylogeography and biogeography

CHRISTINE MAGGS

Christine Maggs' PhD in Galway, Ireland, on the ecology and systematics of the seaweed communities associated with unattached coralline algal beds (maerl), included the discovery of previously undescribed species and unrecognized life history phases revealed in culture. In Canada (1986-88) she had the opportunity to incorporate molecular methodology and since then molecular systematics has been an important component of her research. Molecular and traditional approaches, such as laboratory culture studies and nomenclatural studies employing the type method are explored with colleagues and international collaborators. Some of this has focused on invasive seaweeds. Understanding seaweed distributions and origins led her into phylogeography, again with international collaborators with diverse skills. Throughout her career she followed a parallel interest in applied research on seaweeds (e.g. coralline algae as bone and dental replacements; as sources of bioactives; conservation of marine algae; effects of climate change on keystone brown seaweeds) and on invasive species (e.g. economic and ecological consequences of invasive species). She has been closely linked to all the major phycological societies, carrying out society and editorial roles, and was awarded the three major awards of the Phycological Society of America, most recently the Award of Excellence (2014). Christine was Head of the School of Biological Sciences in Queen's University Belfast and has recently taken up the post of Dean of Science & Technology in Bournemouth University.

Phylogeny and biogeography of seaweeds: a rapidly changing picture

Maggs C
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Our understanding of the phylogenetic relationships within and between macroalgal lineages has advanced in leaps that followed developments in relevant technology: light microscope, scanning electron microscope, Sanger sequencing, polymerase chain reaction, next generation sequencing. I will present some comparative examples in the red algae of the picture as it is developing, using information from projects including the NSF-funded red algal Tree of Life and a current phylogenomics study in the Rhodomelaceae for which >20 plastid genomes are available. Biogeographic and molecular ecological studies of seaweeds have also benefitted greatly from sequence data, now often obtained with bar-coding approaches. I will provide a few case studies in the green algae, e.g. *Ulva*/*Enteromorpha*: molecular ecology of freshwater lineages and spreading non-native species. Current explorations in red algal biogeography include the demonstration that a species previously known as *Gymnogongrus devoniensis* and thought to be a trans-Atlantic introduction is a new species and genus that originated in the Pacific Ocean.

GEORGE TURNER

George Turner is the Lloyd Roberts Chair of Zoology at Bangor University. He is, some might say obsessively, interested in the biology of African cichlid fishes. He focusses in particular on the role of behaviour in the spectacular adaptive radiation and rapid speciation of the cichlid fishes of Lake Malawi and neighbouring water bodies. He started working on cichlid fish behaviour as an undergraduate at Glasgow University in the 1980s and then through his PhD at Bangor University, using fish he had bred in his own home aquaria. He then moved on to a postdoc working on ecology and taxonomy of Lake Malawi tilapias, which introduced him to fieldwork in Malawi, where he spent two years working on a fisheries project for the United Nations Food and Agriculture Organisation. He then returned to the UK to take up a lectureship at Aberdeen and decided to focus on cichlid adaptive radiation. He moved to Southampton University, where he obtained a Chair, then to Hull University, before moving back to Bangor in 2007 for a 7-year spell as Head of the School of Biological Sciences, and a concurrent 2-year period as co-ordinator of the university's Research Excellence Framework submission. Now free from major administrative responsibilities, he is again focussing on cichlid fish research, with major collaborative projects looking at the genomic basis of ecological speciation in recently discovered crater lake radiations in southern Tanzania and at a survey of the tilapia resources of Tanzania. He has had two Lake Malawi cichlid fish species and a fish parasite named after him.

Evolutionary genomics of ecological speciation in crater lake fishes.

Turner GF

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Freshwater lakes, especially volcanic crater lakes, can be very isolated from nearby river catchments, but may still be colonised by aquatic organisms including fish. Many such lakes contain fish populations that are phenotypically and genetically divergent from riverine relatives. A few contain multiple closely-related species that appear to have undergone *in situ* sympatric speciation, while others appear to be in the process of diverging through ecological selection. I will briefly review some case studies, before giving details of a collaborative study in progress looking at a pair of incipient species of haplochromine cichlid fishes from Lake Massoko in Tanzania, employing morphological, ecological, behavioural and molecular methods, including population analysis of full genome sequences.

LYNN VAN HERWERDEN

I focus on tropical marine biodiversity hotspots and the processes implicated in generating this biodiversity. I focus on well sampled reef fish families and genera, for which comprehensive dated phylogenies are available and for which ancestral ranges have been reconstructed. Accordingly, I consider known environmental upheavals (geographic and climatic), which appear to have been implicated in the observed diversification. Subsequently, I compare this historic diversification to phylogeographic insights of widespread species from the taxa examined and relate recent and ongoing speciation processes to previously reconstructed speciation processes of established species. Finally, insights gained from transcriptomic studies of focal species are presented to address questions about present day responses to changes in the face of contemporary climate change, as informed by experimental studies.

Understanding the processes generating coral reef fish biodiversity over space and time

Van Herwerden L
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lynne.vanherwerden@jcu.edu.au

Coral reefs are one of the most biodiverse aquatic environments. Tropical marine biodiversity hotspots appear to be implicated in generating some of this biodiversity. I combine phylogenetic, phylogeographic, genomic and transcriptomic approaches to examine the processes responsible for generating this biodiversity over space and time. Required are comprehensively sampled coral reef fish taxa (families and genera) along with dated phylogenies and reconstructed ancestral species distribution ranges. Environmental (geographic and climatic) upheaval has been instrumental in the observed diversification of well-established species. Comparing such reconstructed historic speciation processes to phylogeographically structured populations of widespread reef fish species permits insights into ongoing speciation processes. Both biogeographic and environmental factors are also implicated in generating distinctive populations/species. Last but not least, experimental studies of focal species from different environments within their range are used to drill down further, to address questions about population responses to sea surface temperature changes expected during the 21st century (due to contemporary climate change). Physiological, genomic and transcriptomic insights of these focal species reveal how present day populations respond to and are affected by such environmental change.

Conservation, management and policy

DAVID LODGE

Professor David Lodge is one of the world's leading experts on aquatic invasive species, with extensive research experience on a wide variety of vectors, taxonomic groups, and ecosystems. His research focuses on ecological forecasting to better inform environmental risk assessment, natural resource management, and policy. Lodge has testified numerous times before the U.S. Congress, served as an expert witness in federal court, and served as the first chair of the U.S. government's national Invasive Species Advisory Committee (2000-01). He led the freshwater biodiversity component of the United Nations' Millennium Ecosystem Assessment (2000-05), and served on a committee providing advice to the U.S. Environmental Protection Agency on ships' ballast-vectored invasions (2010-11). Lodge has published more than 200 scientific papers, and has edited two books. He is a member of the scientific advisory boards of the US National Oceanic and Atmospheric Administration and the International Joint Commission. In 2014-2015, he served as a Jefferson Science Fellow in the US Department of State. As a Rhodes Scholar, Lodge received his doctoral degree from the University of Oxford. He has been a faculty member at the University of Notre Dame for 30 years, where he is the Galla Professor of Biology, and the Director of the University of Notre Dame Environmental Change Initiative

Science, Management, and Policy of Invasive Species

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In a world of increasing temperatures and increasingly globalised economies, more plants and animals are being moved around the planet and finding new habitats. Some of these species, including parasites and pathogens, cause harm and are referred to as invasive species. Invasive species are one of the top drivers of global environmental change, and cause great harm to biodiversity, ecosystem function and ecosystem services. Reducing the impact of biological invasions will require international cooperation, already outlined in multiple international agreements, informed by recent scientific advances. Examples of scientific advances that can serve policy goals include: risk assessment of species that can inform decisions about species importation; genetic based surveillance programs that can inform rapid response to incipient invasions; analysis of transportation networks that respond to climate change and trade patterns, and that can be used to prioritise the geographic focus of slow-the-spread efforts; species distribution models incorporating climate change; and bioeconomic analyses that can guide allocation of resources. A major conclusion of recent research is that a greater policy emphasis

on preventing invasions - rather than trying to control outbreaks and epidemics after they get started - would bring the greatest societal return on investment.

JAKE RICE

Dr. Jake Rice has served as Chief Scientist of the Canadian Department Fisheries and Oceans for ten years. He received a B.Sc in Conservation from Cornell University in 1970 and a PhD in Ornithology from U of Toronto in 1974. He has held both university positions and positions with the Canadian Government, working on a range of ecological issues in forests, deserts, and the Atlantic and Pacific coasts of Canada and in Europe. Since 1997 he has been based at DFO Headquarters, coordinating the application of marine science to policy and management. He has worked extensively at the international scale, with the DFO, CBD, IOC and UN working groups on the Ocean, including on the Group of Experts for the World Ocean Assessment, trying to integrate science-based policies for conserving biodiversity with sustainable uses of marine resources . He has over 170 primary publications, including co-editing the 2014 book Governance of Marine Fisheries and Biodiversity Conservation, and has received the ICES Outstanding Achievement Award, the American Fisheries Society Award of Excellent, and the Queen's Jubilee Medal from the Canadian Government.

Marine Biodiversity and Policy: Coherence of Policies to Use and Policies to Conserve

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It is well documented that marine biodiversity is indeed diverse but poorly quantified. Furthermore documentation is accumulating that its values both inherent and in terms of ecosystem services to humanity are comparably diverse and even more poorly quantified. Marine policy is made inside this nexus of high complexity and poor quantification, both ecologically and socio-ecologically. Moreover the complexity is amplified because historically marine policy was not made in intrinsically coherent ways. Rather, policies for the conservation of biodiversity were primarily promoted through governance streams focused on protection of special species, special habitats, and more recently special ecosystems, whereas policies for the uses of biodiversity were made through governance streams focused on just keeping the perturbations caused by sectoral activities (fishing, seabed mining, etc) within sustainable bounds. The results have been policies that, as a collection, were typically inefficient (sometimes even contradictory) and sometimes ineffective.
Over the past decade attention has increasingly focused on the costs - both to marine biodiversity and to human society - of these inefficiencies and incomplete effectiveness. Momentum has grown both inside ocean regulatory agencies and in the public and expert communities, for making marine policies more coherent and thereby, it is hoped, more effective. Even these efforts, however, have taken

different pathways, with different priorities and even more different expectations of what can be achieved, how quickly, and at what costs to what interest groups. For the past decade much of my time as been spent as a science advisory in this policy realm. My talk will first illustrate the past policy trends described above, followed by a summary of the multiple present initiatives to address the perceived problems with existing marine policies for conservation and sustainable use. The summary will introduce some shortcomings that persist in these newer initiatives, and what may be realistic and unrealistic about the expectations that are being raised. The final part of the talk will highlight components what I consider a feasible way forward to actually increase coherence and thereby efficiency and effectiveness of future marine policy for conservation and sustainable use of marine biodiversity.

6 Oral contributions

Global Environmental Change

KEYNOTE SPEAKER: AMANDA BATES

Dr. Amanda Bates is a Lecturer in Marine Ecology at the University of Southampton, UK. She is interested in cross-ecosystem comparisons to reveal novel ecological patterns that will advance our capacity to tackle conservation challenges. Her research aims to identify characteristics of species that are shifting their distribution in response to warming and how species redistribution is altering global biodiversity patterns.

Rocky reef biodiversity in transition: interacting effects of ocean warming and protection across trophic levels

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Shifts in the abundance and location of species with warming have been documented globally. Given that such shifts lead to community restructuring and changes in trophic interactions, it is presently unknown whether biodiversity responses will be coordinated in diverse taxa and across trophic groups, and whether habitat protection will promote community stability. Here we take advantage of a natural experiment to test for biodiversity responses in temperate reef communities in southeast Australia that have undergone rapid warming, protection from fishing, and invasion by a barren-forming urchin. Overall, a tropicalization signal has occurred in the algae, invertebrates and fishes. Even so, protection from fishing has strongly influenced the structure of these transitional communities. Protected communities are distinguished by showing less change in some aspects of diversity, greater gains in canopy forming algae, and resistance to colonization by small foliose algae and warm water fishes, as well as impeding the range-extending urchin. By contrast, herbivorous and omnivorous invertebrates have declined, in particular with protection, as well as in response to warming. Our findings therefore implicate the role of trophic interactions to exacerbate range contractions and the potential for habitat protection and warming to interact, altering climate-mediated biodiversity dynamics.

KEYNOTE SPEAKER: REBECCA KORDAS

Rebecca is generally interested in how climate change (warming, acidification, changes in salinity) will affect the structure of aquatic communities. Her research programme experimentally quantifies pathways through which environmental stressors impact community organisation via direct (e.g. organismal responses) and indirect (e.g. shifts in interaction strengths among species) effects. Much of her graduate work (at the University of British Columbia) was conducted in the marine intertidal of the NE Pacific, where she found that experimental warming altered community structure and successional pathways. Rebecca is currently a National Science Foundation Fellow at Imperial College London. She has recently been working in geothermally heated streams in Iceland to determine how interspecific variation in thermal sensitivity structures freshwater communities.

Environmental warming mediates the effect of herbivory on community succession

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Although increasing temperature will simultaneously affect many aspects of ecological communities, disentangling the abiotic and biotic contributions will allow for more accurate predictive models of how climate change will affect natural systems. To determine how warming modified the effect of species interactions on community dynamics, we manipulated temperature and herbivore (limpet) access to settlement plates, in a 16-month long field experiment in the rocky intertidal zone of Salt Spring Island, Canada. Warming modified the effect of limpet herbivory on the successional trajectory of community structure over the duration of the experiment. This was likely because warming modified the effect of herbivores on leverage species (barnacles), resulting in markedly different trajectories. Barnacle survival and growth were lower in warmed communities and disturbance was higher in communities with herbivores, thus communities disturbed by herbivores, but lacking the habitat complexity attributable to barnacles, exhibited higher species turnover. Despite this stochastic nature of development, the structure of warmed communities with herbivores became homogenized after 16 months. These results illustrate how environmental change can affect organismal physiology and alter species interactions, with cascading impacts on community dynamics.

Long-term time-series reveal multiple drivers of spatial synchrony in intertidal ectotherms

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Despite the occurrence of spatial synchrony, in which populations fluctuating in near unison across large geographical distances, throughout almost all known taxonomic groups, attempts to determine the relative influences of the processes underlying these patterns have had limited success. Due to the logistical challenges in collecting sufficient data for conclusive analysis, current research has generally utilised either long-term data sets collected by a large number of volunteer observers, or datasets of relatively short temporal length.
The MarClim time-series, a unique multi-decadal time-series documenting the biogeographic distributions of intertidal species in the northeast Atlantic, has been collected by the Marine Biological Association of the UK since the 1950's.
Three species of cirripedes with differing thermal evolutionary origins have overlapping distributions in the UK and directly compete for space where they co- occur across a major marine biogeographic transition zone. The trailing range edge of the Boreal *Semibalanus balanoides* has retreated north in recent decades, whereas the leading range edges of the Lusitanian *Chthamalus montagui* and *C. stellatus* have extended to higher latitudes in response to warming of the marine climate.
Long-term time-series data were used to analyse the degree of observed intraspecific population synchrony in *S. balanoides* and *Chthamalus* spp. populations in conjunction with extrinsic and intrinsic variables to indicate the relative influence of regional vs. local scale processes in observed patterns of spatial synchrony. Processes highlighted will inform the direction of future mechanistic studies. Knowledge derived from this study can be scaled-up and incorporated into models forecasting future biogeographic responses to global environmental change to improve predictive accuracy.

The interaction between intraspecific genetic diversity and global environmental change in early life-stage *Fucus vesiculosus*

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Early life-stage macroalgae *Fucus vesiculosus* is highly influenced by the global change factors temperature, pCO2 and eutrophication. Baltic *Fucus vesiculosus* populations have a lower genetic diversity compared to e.g. Atlantic populations, which may reduce their potential for adaptation. To assess the role of intraspecific genetic diversity on the resistance towards environmental change we manipulated the diversity: Plots with full-sibling groups of *Fucus* germlings each originating from one parental pair represent the low diversity level, whereas plots with multiple parental pairs represent the high diversity level.
Climate change was simulated in the near-natural scenario Kiel Benthocosms by maintaining the natural fluctuations of the Baltic Sea and adding 5°C warming, 600 μatm pCO2 and doubling the nutrient concentrations. Warming led to germlings' higher mortality, but increased their growth rates. Acidified conditions enhanced growth rate due to fertilisation effects. During a summer heat wave, germlings' mortality was alleviated under eutrophic conditions. The considerable variation among sibling groups' performance indicates higher adaptation potential for genetically diverse populations. Thus high diversity levels survived better under warmed conditions, facilitation processes may have occurred. To detect whether high diversity was maintained or selection processes have taken place, microsatellite genotyping is in progress.

Foraging decisions of a native whelk, *Trochia cingulata*, and the effects of invasive mussels on prey choice

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Impacts from non-native species are particularly pertinent to species interactions, such as those between predators and prey. The impacts of invasive prey on native predators however have been largely overlooked. Here we investigate the impact of invasive mussel species on foraging decisions of a native predatory whelk, *Trochia cingulata*, on the West Coast of South Africa. We compared present day survey data with that from 30 years ago and found significant changes in the mussel assemblage available to the whelk. In particular, there were reduced abundances of the natives *Aulacomya atra* and *Choromytilus meridionalis*, and increases in the invasive *Mytilus galloprovincialis*, with the detection of a second invader *Semimytilus algosus*. In laboratory feeding trials when presented with both single and multiple prey species, whelks consumed greater numbers of the invasive mussels compared to *A. atra*, the previously preferred prey. Chemical cue trials indicated that whelks did not select prey based on chemical recognition, indicating that tactile stimulation was an important driver of prey choice. Notably, familiarity with one invasive mussel appears to have facilitated the assimilation of a second morphologically similar invasive mussel into the diet of whelks.

Recovery of Maldivian coral reefs after the mass bleaching and mortality of 1998

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Climate change is causing coral reef degradation worldwide. Estimating magnitude, pattern and trajectories of change requires information on previous conditions of coral reef communities, but unfortunately this kind of historical data are rare for most regions of the world ocean. Since 1989 we have been studying the ecology of coral reefs in the Maldives (Indian Ocean). We have therefore collected data on the state of coral reefs before, during and after the big bleaching event of 1998, which caused widespread coral mortality (up to 95% for branching corals). By 2002, the three-dimensional structure of the reef was largely lost due to the destruction of dead colonies, which were reduced to rubble. As early as 1999, recolonization started and many newly settled colonies were recorded. The taxonomic composition of recruits shifted from a dominance of Agariciidae in the early stages of recolonization toward a dominance of Acroporidae and Pocilloporidae by 2009. By 2007, the coral reef community exhibited manifest signs of recovery and in 2014 showed similar to that existing before the bleaching, although Millepora had not returned yet. Coral cover, which dropped to less than 10% after the bleaching, returned to pre-bleaching values of >50% by 2013-2014. The recovery of Maldivian coral reefs after the mass-mortality of 1998 may therefore be considered attained after about 15 years, but may also be considered unachieved, as there are species that have not come back yet and reef complexity is still reduced. This capacity of coral reef resilience may not be enough to cope with the expected frequency of climatic events and the increased intensity of local human pressures, due especially to tourism development. Long term monitoring remains the only means to track the future evolution of coral reefs in the Maldives.

The interplay of latitude, tidal level and microhabitat on heat stress and thermal profiles of intertidal barnacles, *Tetraclita species*, in the West Pacific

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The rocky intertidal is an excellent model to study and predict the effect of global warming in marine systems. A common prediction of the impact of global warming in marine systems is a poleward shift of species to avoid increased heat stress at lower latitudes. Recent studies have, however, shown that this is an over simplification, and that latitudinal gradients are often composed of a mosaic of "hot" and "cold" spots that do not correlate with the latitudinal gradient of temperatures. The West Pacific is a global marine biodiversity hotspot with complex climatic zones and ocean currents. To investigate patterns of thermal stress in the West Pacific and the possible impacts on the distribution of intertidal barnacles, biomimetic loggers (Robobarnacles) of the widely distributed genus, *Tetraclita*, were deployed at nine rocky shores along a latitudinal gradient from Taiwan (25°20' N) to Hong Kong (22°13' N) and Thailand (13°09' N). At each shore 4 robobarnacles were established in the high, mid and low intertidal on east and west facing shores in the stressful season, from June-October 2012 ($\Sigma = 4$ Robobarnacles x 3 tidal levels x 2 aspects = 24). During hot days with daytime low tides in July and August, Robobarnacles temperatures were often >40°C for 1-2 hours per day. Contrary to the latitudinal gradient, however, the frequency of >40°C for 1 hour in July were higher in NE Taiwan than the southern locations in Hong Kong and Thailand. Mean temperatures of Robobarnacles also did not follow a latitudinal gradient, with relatively low (30°C) in July and August being recorded in Taiwan as opposed to Hong Kong and Thailand. At each location, tidal height showed a clear influence on temperature, with high shore Robobarnacles experiencing hotter temperatures than their lower counterparts. Mean temperatures also varied between east and west aspects, but such between-aspect patterns were not consistent across locations. Classification and regression tree (CART) analysis showed that local air temperatures accounted for a large amount of

variance in Robobarnacle temperatures at all locations, especially for high shore individuals emersed in the afternoon. Patterns seen in the West Pacific, therefore, support previous observations that heat stress experienced by intertidal species does not follow a simple linear latitudinal gradient and local conditions need to be factored into predictions of how species may be affected by global warming.

Mechanisms of coping with climate change in the common shore crab *Carcinus maenas*: evidence from gene expression under long term acidification and salinity reduction

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Assessing impacts of climate change on coastal ecosystems requires an understanding of how organisms respond to multiple environmental factors in the long term. We examined responses of the common shore crab *Carcinus maenas* to a 2100 climate change scenario of long term decreases in pH and salinity, by measuring expression of selected genes as sensitive indicators of coping mechanisms. Crabs were exposed to factorial combinations of pH (8.1 and 7.68) and salinity (33 and 25) for 12 months. Posterior gills were sampled periodically for qPCR targeting genes putatively involved in ion regulation, acid-base balance and immune function. We found little evidence for differences in gene expression among salinity and pH treatments overall. A limited increase in the ion transporter Na^+ K^+ ATPase was detected at low salinity, consistent with active ion uptake by osmoregulating crustaceans, such as *C. maenas*, under seawater dilution. This gene was also down-regulated under low pH, suggesting a role in acid-base regulation. Gene expression patterns across treatments changed little after exposure for 1, 3, 6 or 12 months, suggesting that exposure duration does not influence mechanisms of coping with climate change. Ongoing work is examining how responses differ between crab species.

Does a warming ocean threaten the survival of a key habitat-forming alga?

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Intertidal macroalgae play an important role for a wide variety of species as habitat, food and even a mode of dispersal when it breaks from shore and drifts at sea. Many species may be susceptible to climate change, although the impacts of a future ocean are difficult to predict. *Phyllospora comosa* is a key habitat-forming macroalga along the southeast Australian coast. It has disappeared from sections of the coastline and questions remain how it will cope with a warmer ocean. I examine the ability of this species to acclimatize to seasonal water temperatures and tolerate thermal stress. Additionally, I have built a model to predict the impact of climate change on its survival. The model incorporates predictions from the IPCC Assessment Reports such as carbon emissions, SST and storm intensity as well as nutrient availability, environmental protection status and urbanization. *Phyllospora* was strongly negatively affected by thermal stress. The model predicts a moderate to severe decline in *Phyllospora* cover and a decrease in drift longevity in the future. This loss is expected to impact many of the 80+ drift-associated invertebrate species it supports. This model serves as a tool to provide insight into mitigation and management options, preserving future biodiversity.

Grazing overwhelms the impact of extreme climatic events on intertidal microphytobenthos

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Extreme climatic events (ECE) are becoming more frequent with global change, increasing the chance of multiple ecological impacts. Although this topic is receiving increasing attention, our understanding of the compounded effects of multiple ECE is limited. We performed field manipulations to evaluate the effects of warming and sediment deposition on rocky intertidal epilitic microphytobenthos (EMPB). We tested whether effects varied depending on the nature of ECE (warming/sediment), their order of occurrence (all combinations) and temporal clustering (perturbations one week or one month apart for the clustered and non-clustered scenarios, respectively). The experiment was repeated twice to test for generalities (or lack thereof) of outcomes. In the first trial, the effects of ECE on EMPB were largest in the clustered than in the non-clustered scenario, whereas the opposite occurred in the second trial. EMPB had recovered completely from the first non-clustered ECE event in the first, but not in the second trial. Intense grazing from littorinids likely slowed recovery in the second run, increasing the susceptibility of EMPB to non-clustered perturbations. These results suggest that increasing ECE frequency may be more detrimental for populations with high recovery rates, and show how biological processes can modulate the compounded effects of multiple perturbations.

Early warnings of a critical transition in biodiversity from compositional disorder

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Ecological theory of community dynamics under environmental forcing predicts an early replacement of slowly-replicating and weakly-competitive 'canary' species by keystone competitors, and eventual collapse of the keystone species in a regime shift. We find a diagnostic signal of these changes in the coefficients of a correlation between compositional disorder and biodiversity. Compositional disorder reflects unpredictability in the composition of a community, while biodiversity reflects the number of species in the community. Together they express community entropy and the number of states associated with that entropy. In a stochastic simulation, sequential correlations over time switch from positive to negative as keystones prevail over canaries, and back to positive as weedy types dominate at the critical transition. The model finds support in empirical tests on multi-decadal time series of fossil diatom and chironomid communities from lakes in China. The characteristic switch in the sign of correlation coefficients occurs for both communities up to two decades preceding a critical transition to eutrophic state. This diagnostic tool is robust to unequal time increments that beset early-warning signals from other environmental variables.

Climate change and human activities on biogeography of rocky intertidal species along China coast

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Most coastal areas in China have had and will suffer from global warming, ocean acidification and extreme climate events. Furthermore, with the development of coastal economy, more and more artificial structures, including harbors, dams and bridges, are constructed along the China coast. These artificial structures, especially seawalls on the muddy shores, will provide suitable substrates for rocky shore species, and potentially play crucial roles as stepping-stones for species distribution shifts. There are clear biogeographic barriers for some rocky shore species along China coast. Phylogeographic studies of some widely distributed intertidal limpets and snails showed the populations can be divided into southern and northern groups with Yangtze River estuary as a barrier. The formation of the barrier is due to multiple factors, including historical events, ocean current, freshwater discharge and substrate. One of the most important factors for formation of the barrier is the unsuitable substrates in the Yangtze River Delta. From Lianyugang, Jiangsu Province to Qidong, Jiangsu Province, there are extensive muddy shores, which can affect the distribution of rocky shore species. The construction of artificial structure on the muddy shore can provide suitable habitats for rocky shore species. So it is important to know the roles of these artificial structures on the biogeography of rocky intertidal species along China coast.

High water temperature decreases growth rate but increases concentration of defensive compounds in the brown alga *Eisenia bicyclis*

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Global warming is predicted to strengthen marine plant-herbivore interactions through increasing both consumption rate of herbivores and palatability of plants. Kelp and fucoid brown algae are dominant plants on rocky shores and contain phlorotannins, which can act as herbivore deterrent. Although some studies showed no effect of temperature on phlorotannin concentration in four fucoid species, little has been known about the effect on kelp species. In the present study, we cultured the juvenile kelp *Eisenia bicyclis* at two different temperatures (23 and 26°C) for 24 days, and then compared relative growth rate (RGR), phlorotannin concentration, and consumption rate by the common sea urchin *Mesocentrotus nudus* between the treatment groups. RGRs were significantly higher at 23°C than 26°C. In contrast, phlorotannin concentrations were significantly higher at 26°C (19.7 $\pm$ 5.2 %) than 23°C (15.3 $\pm$ 2.9 %). Although the effect of temperature on consumption rate by the sea urchin was not detected, a negative correlation between the phlorotannin concentration and consumption rate was detected. These results suggested that warming has negative effect on growth rate but it might strengthen anti-herbivore defense of the kelps through increasing phlorotannin concentration.

Historical comparisons reveal multiple drivers of decadal change of an ecosystem engineer at the range edge

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Biogenic reefs are important for habitat provision and coastal protection. Long-term datasets on the distribution and abundance of *Sabellaria alveolata* (L.) are available from Britain. The aim of this study was to combine historical records and contemporary data to (1) describe spatiotemporal variation in winter temperatures, (2) document short-term and long-term changes in the distribution and abundance of *S. alveolata* and discuss these changes in relation to extreme weather events and recent warming, and (3) assess the potential for artificial coastal defense structures to function as habitat for *S. alveolata*. A semi-quantitative abundance scale (ACFOR) was used to compare broadscale, long-term and interannual abundance of *S. alveolata* near its range edge in NW Britain. *S. alveolata* disappeared from the North Wales and Wirral coastlines where it had been abundant prior to the cold winter of 1962/1963. Population declines were also observed following the recent cold winters of 2009/2010 and 2010/2011. Extensive surveys in 2004 and 2012 revealed that *S. alveolata* had recolonised locations from which it had previously disappeared. Furthermore, it had increased in abundance at many locations, possibly in response to recent warming. *S. alveolata* was recorded on the majority of artificial coastal defense structures surveyed, suggesting that the proliferation of artificial coastal defense structures along this stretch of coastline may have enabled *S. alveolata* to spread across stretches of unsuitable natural habitat. Long-term and broadscale contextual monitoring is essential for monitoring responses of organisms to climate change. Historical data and gray literature can be invaluable sources of information. Our results support the theory that Lusitanian species are responding positively to climate warming but also that short-term extreme weather events can have potentially devastating widespread and lasting effects on organisms.

Furthermore, the proliferation of coastal defense structures has implications for phylogeography, population genetics, and connectivity of coastal populations.

The trophic dimension of ocean acidification: macroalgae and grazers

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Ocean acidification (OA) is widely accepted as a threat to the integrity of marine ecosystems. Recent reviews have concurred that OA, in conjunction with other climate parameters such as temperature, has the potential to effect significant changes in the taxonomic, functional and morphological composition of benthic macroalgal assemblages. In particular, fleshy forms such as Fucales and Laminariales are predicted to be OA winners with calcified taxa the biggest losers. However, the full effects of OA upon macroalga dominated assemblages remain poorly understood. Shifting ocean chemistry, in particular changes in the size and relative composition of the inorganic carbon pool is likely to have effects upon seaweed biochemistry, energy allocation budgets, production of anti-herbivore defences, nutritional value to grazers and, ultimately, intra-benthic and benthic-pelagic trophic linkages. We used seaweeds collected along natural acidification gradients generated by Mediterranean CO_2 seeps to demonstrate changes in grazer behaviour, macroalga consumption rates, and trophic preference patterns concordant with changes in the nutritional and defensive composition of the seaweeds. We hypothesize that macroalga-dominated ecosystems of the future could differ from those of the present-day in both composition and function by virtue of both top-down and bottom-up processes mediated by OA-induced biochemical changes.

Unexpected relative stability of sublittoral macrobenthos in response to climate change in a biogeographical transition zone after a forty years period

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In the North-East Atlantic, the English Channel constitutes a biogeographical transition zone between the cold-temperate Boreal province in the North and the warm-temperate Lusitanean province in the South. Historical works have shown that the distribution of macrobenthic invertebrates in the Channel was influenced by thermal gradients from West to East so that many species were here in their southern or northern range limits. In parallel, long-term environmental monitoring highlighted an increase in the sea temperature during the last 30 years and a thermal regime shift in the North-West Europe since the 1980's. Accordingly, major changes on the distribution of subtidal macrobenthic fauna are expected as documented for fish, plankton and intertidal organisms. Our results based on a comparison of data collected for molluscs, echinoderms and decapods during a cool period in the 1970's and the present (2012-2014) at 444 and 254 stations distributed along three transects from the Iroise Sea to the central Channel did not confirm this expectation. On the contrary, they suggest only few distribution shifts, not clearly associated to warming but a decrease in the occurrence for most species. These results will be discussed in the light of spatial heterogeneity in climate change and fishing pressure.

Impacts of discarded plastic bags on marine assemblages and ecosystem functioning

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The accumulation of plastic debris is a global environmental problem due to its durability, persistence and abundance. Although effects of plastic debris on individual marine organisms, particularly mammals and birds have been extensively documented (e.g. entanglement, choking), very little is known about effects on assemblages, and consequences for ecosystem functioning. In Europe, around 40% of plastic items produced are utilised as single-use packaging, which rapidly accumulate in waste management facilities and as litter in the environment. A range of biodegradable plastics have been developed with the aspiration of reducing the persistence of litter, however their impacts on marine assemblages or ecosystem functioning have never been evaluated. A field experiment was conducted to assess the impact of conventional and biodegradable plastic carrier bags as litter in the environment on benthic infaunal assemblages and biogeochemical processes (primary productivity, redox condition, organic matter content and pore-water nutrients) on an intertidal shore. After nine weeks, the presence of either type of bag created anoxic conditions within the sediment along with reduced primary productivity and organic matter and significantly lower abundances of infaunal invertebrates. This indicates that both conventional and biodegradable bags can rapidly alter marine assemblages and the ecosystem services they provide.

I spy, ecosystem engineers, with my drone's eye

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Edge relationships between distinct habitats within ecosystems are poorly understood. How these relationships adjust to climate change will likely have large community wide implications. Climate change is driving current sea level rise and increased storm frequency and intensity. This trend is predicted to intensify and will have a dramatic effect on coastal habitat patterns. While landscape ecology provides a useful toolbox for studying environments, where patch, edge and matrix relationships can be observed over large spatial scales by remote sensing, it is underdeveloped in coastal environments. Here we apply landscape ecology methods to study spatial relationships between plant and invertebrate ecosystem engineers across an estuary. Ecosystem engineer spatial patterns within an ecotone were documented using aerial photography, and observed to change across intertidal and estuarine scale gradients. Manipulative field experiments were used to take a closer look at coupled ecosystem engineer interactions within the ecotone, and mutualistic relationships were found. However, additional field and mesocosm experiments suggest that this relationship decouples when predicted elevated temperatures are simulated. This will likely be exacerbated by storms and sea level rise, and will likely have dramatic effects on community structure and function.

Linking the individual to population-level responses to ocean acidification

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Ocean acidification, the change in seawater carbonate chemistry associated with increasing levels of atmospheric CO_2, is predicted to have detrimental effects on many marine organisms and ecological processes. Despite rapidly growing evidence for the direct impacts on individual species, few studies have considered the long-term consequence of ocean acidification, and empirically linked the energetic consequences of the individual to the contemporary demographic processes of the population. Here, we show that ocean acidification, against a background of unrestricted gene flow, increases energetic demands of individuals resulting in altered energy allocation, revealed by reductions in shell size and thickness but increased body size. When scaled up to the population-level, long-term exposure to ocean acidification reduced population size and altered population demography with evidence of a reduction in the proportion of females in the population and genetic signatures of increased variance in reproductive success among individuals. Such increased variance leads to greater levels of short-term genetic drift that is predicted to oppose adaptation. Importantly, this study shows that even against a background of high gene flow ocean acidification is capable of driving individual and population level changes that will alter eco-evolutionary trajectories.

Are temperature- and latitude-size clines driven by the same selective pressures?

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Two major intra-specific patterns of adult size variation are plastic temperature-size (T-S) responses and latitude-size (L-S) clines. Yet the degree to which these co-vary and share explanatory mechanisms has not been systematically evaluated. We present the largest quantitative comparison of these gradients to date, and find that their direction and magnitude co-vary among 12 arthropod orders ($r^2 = 0.72$). Body size in aquatic species generally reduces with both warming and decreasing latitude, whereas terrestrial species have much reduced and even opposite gradients. These patterns support the prediction that oxygen limitation is a major controlling factor in water, but not in air. Furthermore, voltinism explains much of the variation in T-S and L-S patterns in terrestrial but not aquatic species. While body size decreases with warming and with decreasing latitude in multivoltine terrestrial arthropods, size increases on average in univoltine species, consistent with predictions from size vs. season-length trade-offs. The close match between T-S responses and L-S clines suggests that both may be driven by the same selective pressures, and provides a conceptual unification of the two size rules in Arthropods.

Modelling aquatic biodiversity and ecosystem intactness related to global-scale anthropogenic drivers

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World-wide changes in land-use, hydrology and climate continue to compromise the biodiversity and functioning of aquatic ecosystems. In this study we describe a model framework that links aquatic biodiversity and ecosystem services to anthropogenic drivers at catchment to global scales. Projections for the main drivers of change (population, land use, climate) feed into a global hydrological and nutrient transport model (at 5 arcminutes resolution), which describes changes in wetland area, river discharge (as a result of land-use changes, climate change and dams), water temperature and nutrient concentrations. In a next step, the GLOBIO-Aquatic model calculates the change in biodiversity of lakes, rivers and (the remaining) inland wetlands by empirical relationships with these environmental factors, based on meta-analyses of local case studies. Biodiversity indicators include the 'intactness', taken as the mean abundance of original species compared to a natural benchmark ('MSA', scaled 0-1) as well as species richness, functional indicators (e.g. algal blooms) and 'policy indicators' such as the Ecological Quality Ratio. Model results for current and some future scenarios for 2050 show in what areas the largest decline of aquatic biodiversity is to be expected and due to which pressures. Some of the tropical regions seem to be especially vulnerable.

Transition from kelp bed to turf algae represents a phase shift with hysteresis and alternative stable states, and risk of transition increases non-linearly with multiple stressors

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Ecosystem phase shift from kelp-beds to turfing algae on shallow temperate reefs is increasingly reported around the globe, and represents a significant loss of biodiversity and ecosystem services. Effective management of this issue requires knowledge of (1) whether the shift is continuous in response to a changing environment or instead represents a discontinuous shift with hysteresis so that either state can persist stably under identical environmental conditions; (2) whether anthropogenic stressors influence the likelihood of the shift from a kelp- to turf-dominated state; and, if the shift is discontinuous, (3) where the tipping points in the system lie. Validated simulation models can provide useful answers to all three questions provided independent parameter estimates are available. We modelled kelp (*Ecklonia radiata*) - turf dynamics on shallow South Australian reefs which showed clearly that the kelp-turf transition in this region represents a discontinuous shift with hysteresis and thus that the kelp and turf states represent alternative stable states, and that the likelihood of a shift to domination by turf algae increases with nutrification, acidification and warming. Moreover, the increase in risk of transition is non-linear as multiple stressors arise, and tipping points shift so that the transition to turf is much more likely.

Impacts of logging and oil palm plantations in Malaysian Borneo on stream environmental conditions and macroinvertebrate communities

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Catchment land use change poses one of the greatest threats to stream ecosystems, causing dramatic changes in flow, inputs of sediment and organic matter, and changes in temperature. In Southeast Asia there has been rapid expansion of rainforest logging and oil palm cultivation, but research into the impacts of these activities on tropical rainforest streams has been very limited.

We studied streams in pristine forest, logged forest of varying quality, oil palm plantations with riparian buffer strips and oil palm with no buffers, at the Stability of Altered Forest Ecosystems (SAFE) Project, in Sabah, Malaysia. We consider how riparian and catchment-scale land use affect in-stream environmental conditions, associated macroinvertebrate communities, and the ecosystem functions that they perform.

Streams in more disturbed catchments showed substantial changes in in-stream environmental conditions, and in the macroinvertebrate communities that were able to persist. Furthermore, both riparian and catchment-scale forest quality had significant impacts on the streams. This indicates that recent logging and oil palm expansion in Malaysian Borneo, and likely wider Southeast Asian tropical forests, has significant impacts on in-stream conditions and freshwater biodiversity, and that a range of conservation strategies including riparian buffers strips and catchment-scale management should be developed further.

Adaption potential of the laminarian *Ecklonia radiata* to climate change in southeastern Australia

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Kelp ecosystems are pervasive around southern Australia and support high temperate reef biodiversity over a wide latitudinal band. Over the coming century, south-eastern Australian kelp populations will be subject to ocean warming rates $\sim$3.8 times the global average, with concomitant reduction in ambient nitrate levels, reduced pH and kelp canopy thinning (increased light). Plastic response to novel stressors is well known in the common kelp *Ecklonia radiata* (hereafter *Ecklonia*), but the capacity of this species to adapt to climate change stressors over short time scales is unknown. While population-level genetic diversity may characterise resilience to novel stressors, genetic variance (heritability) of key fitness traits indicates the potential for an adaptive response to the novel selective pressures to occur. A series of experiments show strong temperature effects on juvenile *Ecklonia* physiology, with synergistic and antagonistic effects of light, nitrate and pH when subject to novel stressors in combination. Further, we used a series of experiments to assess the heritability of key life-history and physiological traits in microscopic stages of Tasmanian sourced gametophytes and sporophytes. Results indicate strong family-level variation in important reproductive and photosynthetic traits of high-latitude *Ecklonia*, thus indicating the potential for a response to selection.

Interactions between multiple stressors and the stability of biological communities

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Perturbations seldom occur in isolation but rather as interactions among multiple stressors. One of the greatest challenges facing ecologists is how to detect and predict species and community responses to specific disturbance events against a multitude of concurrent and potentially interacting environmental, biotic and anthropogenic pressures. Freshwater ecosystems are among our most valuable and vital resources in terms of the services provided. They are also some of the most vulnerable to anthropogenic change. Two of the most important perturbations affecting freshwater systems globally are water level fluctuations and nutrient enrichment. The combined effects of these two stressors are likely to have profound impacts on the biodiversity, stability and functioning of ecosystems worldwide. We examined experimentally the individual and combined effects of water level fluctuations and nutrient enrichment on the stability and functioning of primary producer and consumer assemblages. We investigate whether these perturbations have antagonistic or synergistic effects on multiple measures of ecological stability, and whether these effects vary among trophic levels.

Photosynthetic response to ocean acidification in temperate macroalgae

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Marine macroalgae dominate intertidal and subtidal rocky coasts and reefs, where they provide food (primary production), form habitat structure, and influence local environmental factors including light, nutrients, water movement, and intertidally, temperature and moisture. It follows that macroalgal responses to climate change are thus likely to affect the structure and function of coastal communities. Macroalgae employ a variety of Carbon Concentrating Mechanisms (CCMs) that enable the use of bicarbonate as a source of carbon for photosynthesis. As the macroalgae are extremely ecologically, physiologically, and phylogenetically diverse, there exists a great variety of CCM machinery, even among closely related species. These pathways may differ in energetic investment and response to small changes in the relative concentrations of inorganic carbon species in seawater, specifically carbon dioxide and bicarbonate. Here, we identify changes in CCM pathways linked to changes in photosynthetic rates responding to laboratory acidification in the temperate macroalgae *Himanthalia elongata*, *Fucus vesiculosus*, *Chrondrus chrispus*, *Mastocarpus stellatus*, *Osmundea pinnatifida*, and *Corallina elongata*.

Simple biological patterns need not reflect simple drivers: an example from intertidal mussels

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Perceptions of community dynamics depend on temporal and spatial scales of observation and of taxonomic resolution and simple patterns in nature may not reflect simple processes. We synthesise research on the distribution of the invasive mussel *Mytilus galloprovincialis* in South Africa, examining processes at multiple scales from centimetres to thousands of kilometres and minutes to evolutionary time scales.
Over 40 years, *Mytilus* has invaded much of the South African coast, reaching apparently stable limits and co-existence with the native mussel *Perna perna*. The simple patterns of distribution and co-existence emerge from variations in multiple biotic and abiotic interactions occurring at different, sometimes nested scales. Importantly, abiotic conditions modulate interactions, making species-specific responses to environmental conditions important. Although in flux at small scales, these patterns have been stable at larger scales for decades, reflecting place-specific balances among the interacting factors, though the same pattern can emerge for different reasons. Detailed observation and experimentation are necessary to avoid assuming that species' arrangements emerge from simple drivers. This has clear implications for predicting distributions under climate change.

Influence of hypoxia on the success of egg hatching and embryogenesis fatty acid remodeling in Greenland halibut (*Reinhardtius hippoglossoides*)

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Greenland halibut (*Reinhardtius hippoglossoides*) eggs are subjected to hypoxia in the deep waters of the Estuary and Gulf of St. Lawrence during their development. The aim of this study was to determine the hatching success (HS) and the potential of fatty acids (FAs) remodeling in eggs exposed to several levels of dissolved oxygen (DO). Fertilized eggs were exposed to five DO levels: severely hypoxic (10 and 20 % sat [percent saturation]), moderately hypoxic (35 and 50 % sat), and normoxic (100 % sat). Eggs were highly tolerant to hypoxia, with hatching occurring at 20 % sat. No FAs remodeling was observed in eggs submitted to the different DO levels. However, FAs composition differed according to HS (high: 38.9 ± 3.9 %, medium: 12.6 ± 2.5 %, and low: 4.2 ± 4.1 %). Polar lipids were dominant: the most abundant FAs were docosahexaenoic (22: 6 n-3) and eicosapentaenoic (20: 5 n-3) (26 and 22 %, respectively), the later being positively correlated with HS. The results suggest that severe hypoxia may result in reduced recruitment and abundance if the decreasing trend in DO levels continues in the future. Other species that share the similar life histories may also be at risk.

Climate change, ocean acidification and microplastics: how global stressors exacerbate impacts of local pressures on commercial shellfish

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Climate change and ocean acidification are altering the performance, survival and ultimately biogeographic distributions of marine species globally, with some of the fastest responses being recorded for intertidal ectotherms living within the highly variable boundary between marine and terrestrial systems. In addition to physiological stress caused by these rapid changes in environmental conditions, coastal species are also being exposed to increasing anthropogenic pressures at local scales.

Synthetic plastic materials currently comprise 60-80% of marine debris, with microplastic particle concentrations from cosmetics and degradation of larger products increasing within transitional and coastal water bodies. Experimental mesocosm studies show that uptake and retention of microplastics by commercial species of filter feeding bivalves increases in warmer, more acidic conditions associated with climate change.

Dynamic Energy Budget modeling of *Mytilus* spp. exposed to a range of temperature, pH and microplastics treatments highlights the synergistic effects of climate stressors on microplastic uptake and retention, with resultant changes to physiological performance, condition and morphology. DEB-derived measures of performance are used to parameterise mechanistic species distribution models capable of forecasting future biogeographic distributions of this commercial resource, highlighting areas of high vulnerability within the distributional range to aid future management of both commercial stocks and regional biodiversity.

Global stress, local relief: an ecosystem engineer acts as a refugium for a keystone species undergoing range contraction

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Climatic change affects ecosystems at global scales. However, local biotic interaction networks may respond to climatic conditions, and thereby modulate ecosystem stability. Range contractions and local extinctions associated with recent climate warming trends have been reported for several species along northern Atlantic shores. Amongst these, the keystone intertidal macroalga species *Fucus vesiculosus* has retreated northwards by around 1200 km over the last 30 years. At the retreating southern edge, an extant population once common on mudflats is now restricted to small and isolated patches higher on the shore, but sheltered among meadows of the cordgrass *Spartina maritima*. We explore the protective role provided by *S. maritima* and its contribution to the persistence of *F. vesiculosus* at the southern range margin. *S. maritima* canopies significantly ameliorated microhabitat conditions by lowering thermal and light stress intensity and facilitated post-stress recovery, ultimately enhancing growth and survival rates of the macroalga. While climate change is having direct, global effects on the biogeographic range of this focal species, biotic interactions may serve to modulate climate impacts at local scales and contribute to the net effect of climate on the species persistence.

Effects of ocean acidification and increased temperature on juvenile bivalve molluscs

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Anthropogenic activities since the industrial revolution in the Anthropocene have resulted in a progressive increase in atmospheric carbon dioxide (CO_2). Approximately 30% of emitted CO_2 has been absorbed by the world's oceans, mitigating in some part the warming effect induced by increasing CO_2. This has resulted in a continuous decline in surface-ocean pH, which has decreased from 8.2 to 8.1 over the last 200 years. By the year 2100, mean surface-ocean pH is predicted to continue to fall to ∼7.68. Concomitantly mean surface-ocean temperatures are expected to rise by 2-4°C by the end of the century. An increase in seawater CO_2 concentrations leads to a reduction in the concentration of carbonate ions, and the saturation states of major carbonate polymorphs (e.g. calcite and aragonite). As a result, calcifying organisms such as bivalve molluscs are considered especially vulnerable to the effects of ocean acidification (OA). We report on laboratory studies into the effects of ocean acidification and increases in ambient seawater temperature on the incremental growth, shell thickness, shell microstructure, and physiological condition of juvenile blue mussel, *Mytilus edulis* and European common cockles, *Cerastoderma edule* held under controlled conditions of tidal emersion and OA under a seasonal temperature cycle.

Effect of local deforestation on the diversity and structure of Medittrrranean rocky reef community, from meio- to mega benthos

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In the Mediterranean, sea urchin outbreaks can promote shifts in benthic communities: from a complex state, dominated by a stratified assemblage of several erect algae, to a simpler one, the barren, dominated by few encrusting algae. Algal forest is expected to be a diverse and productive system. On the other hand, barren is structurally simple and it seems to be characterised by low productivity and diversity. Although barrens are nowadays geographically widespread and can persist for long periods, diversity, biomass and production of the different trophic component of barrens are still largely unknown.

In order to assess the effects of local deforestation on the community structure of Mediterranean rocky reefs, we evaluated abundance, biomass and diversity of meio- to megabenthos in algal forest and barren systems in the Mediterranean. We found differences for the all the variables studied between the two systems across areas. As expected, diversity, abundance and biomass of algae and small invertebrates resulted higher in algae forest systems. Whereas benthic invertebrate megafauna was abundant in the barren system, suggesting that barrens are more diversified and productive systems than previously thought.

Preliminary studies on impacts of ocean acidification on diversity of fish species landed by artisanal and semi-industrial fisheries in Ghana

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Increased absorbance of carbon dioxide from the atmosphere has led to the changing of the chemistry of the oceans worldwide. In addition to already existing stressors, the resultant ocean acidification poses multiple threats to marine species biodiversity. The study set out to determine possible impacts of this phenomenon on the abundance and diversity of fin- and shell-fish species and ichthyoplankton in the artisanal and semi-industrial fisheries of Ghana. Fish, ichthyoplankton and water samples were simultaneously collected from the two fisheries for the lean and peak fishing seasons of year 2013. Fish species were identified, counted and diversity indices calculated for each fishery and season, while water samples were analysed for physico-chemical parameters. Four parameters (pH, carbonate ion concentration, total alkalinity, Revelle factor) out of six principal components were identified to contribute significantly (RELATE, $r = 0.955$, $P < 0.05$) to biological variations observed in the two fisheries and a Canonical Correspondence Analysis was used to identify factors influencing fish species. A decreasing trend in ocean acidification indicators was observed for both fisheries and variations observed in species abundance between seasons and fisheries, which indicate possible occurrence of ocean acidification in Ghanaian waters and likelihood of impacts on fish diversity.

Ocean warming and multi-species collapses at the edge of the Mediterranean Sea - indicators of climate change impacts?

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One of the most fundamental effects of climate change on earth's biota is shifts in species distributional range. So far, shifts have been mostly demonstrated as species range expansions, in both terrestrial and marine systems, while contractions have been understudied. Using satellite and in-situ SST measurements, and historical biological data and data from current extensive surveys on coastal reefs, I show evidence for an exceptional warming of the southern Levant coastal waters - the southeastern trailing edge of most Mediterranean species - and for population collapses of four non-harvested, ecologically - important rocky reef species: an ecosystem engineer, two herbivores and a predator. I infer many more collapses from the absence of dozens of native molluscan species once-described as abundant, and from the total domination of invasive species in molluscan assemblages on subtidal reefs. These findings are evidence for a multi-species range contraction at the edge of the Mediterranean Sea, adding to the regional ecosystem phase-shift already driven by massive bioinvasions. With additional warming, these collapses may advance west and impact the rest of the reefs in the Mediterranean. Lab performance curve experiments indicate that for most tested native species current summer maxima is way beyond their optimum while most invasive species are still at optimum performance in the summer.

Hybridisation and the global redistribution of species

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Hybridisation, or the production of viable offspring as a result of crosses between different species, is an increasingly frequent phenomenon as a result of human activities. Opportunities for hybridisation are greatly enhanced by habitat alteration (e.g. removing physical barriers) or human-mediated transport (intentional or unintentional) of species globally. In addition, human-induced climate change forces species to migrate away from their native habitats, which may lead to hybridisation among previously isolated species. Human activities are thus providing opportunities for hybridisation at an unprecedented level. This has important conservation implications as hybridisation directly increases extinction rates of rare / endangered species and causes major alterations in species distributions. Here we propose a multidisciplinary approach that combines genetic data (genome-wide genotyping and gene expression), experimental studies and modelling techniques to predict future changes in species distributions. For this, two techniques that have emerged in recent years (next generation sequencing and species distribution modelling) are used to foresee the potential for large-scale hybridisation events and evaluate the links between hybridisation and global change. An improved understanding of these concepts is fundamental to guide future conservation efforts and prevent economic hazards in key activities such as aquaculture and agriculture.

Losing ecosystem resistance to change: when grazers fail to compensate for primary productivity

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Future temperature and CO_2 are predicted to change the structure and function of marine ecosystems by altering rates of both primary productivity and consumption. Metabolic theories predict that increases in consumption should outstrip that of production, but this assumes that physiological rates will increase in consumers more than primary producers. I will draw together the results of several of our experiments assessing the effects of elevated temperature and CO_2 (ocean acidification) in subtidal marine systems, from physiological to ecosystem levels. We show that under near-future scenarios herbivory provides ecosystem resistance by countering increased primary productivity in algal species which dominate under altered conditions. Interestingly, both metabolic rates and consumption of algae by gastropods reach thresholds, and decline, at cooler temperatures than primary productivity. In regions where the dominant grazers are molluscs, these results suggest that the ability of grazers to compensate for increasing primary production may be reduced under end of century conditions and, consequently, their ability to maintain ecosystem structure and function compromised.

Unlocking algal invasion mechanisms: adaptation of invasives to new abiotic and biotic stressors?

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Seaweeds account for a substantial proportion of all introduced species. Originating from East Asia, the red macroalga *Gracilaria vermiculophylla* has successfully invaded several temperate areas of the Northern hemisphere and has been listed among the 4 most potent invaders out of 114 introduced algal species in Europe. High tolerance towards both abiotic and biotic environmental stressors could possibly explain the invasion success of *Gracilaria*. To test this, we compared the stress resistance of native and invasive *Gracilaria* populations towards abiotic (heat shock and UV-C-radiation) and biotic factors (herbivores and foulers). All native populations showed a considerably higher sensitivity to heat stress than all invasive populations - suggesting that heat shock resistance may have been selected during the invasion process. Resistance towards UV-C radiation was not significantly different among native and invasives. Invasive populations exhibited significantly stronger antifeeding defenses as compared the native populations. Intriguingly, invasive populations were well defended against bacterial foulers in their new habitat but had lost their defense capacity against bacterial foulers from their native habitat. This means, that the invasives apparently have acquired potent defenses against new enemies. Such a rapid change during an invasion process has not been shown yet with regard to chemical defenses.

Metabolic responses of two species of brachyuran crustaceans to multiple-stressors

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Our oceans are changing and will become undersaturated with respect to carbonates as CO_2 increases. Organisms residing in temperate coastal environments may struggle to maintain homeostatic and biomineralising processes under these conditions. Current research needs in this field are those of long-term exposures to determine the sustainability of physiological flexibility/acclimation and energy requirements.
We address these needs by presenting the responses of a slow-growing benthic invertebrate - the sea urchin, *Psammechinus miliaris*. These urchins were reared under IPCC forecasted carbonate saturation states and under present-day seasonal temperatures for long periods (several years) and their physiological, energetic and reproductive responses assessed. Additionally the next generation of urchins were reared under these conditions through to full maturation, an approach not previously utilised for marine macro-invertebrates.
We show that *P. miliaris* can acclimate to laboratory conditions and this is sustained when exposure is extended to several years and across generations. We also see differing responses across generations such as seasonal disturbances. We show that different responses can be achieved from short/long term studies and across generations. Therefore careful consideration is needed when predicting organismal responses based from short-term data. This long-term study contributes significantly to our current understanding of organismal responses under a future climate.

Membrane pacemaker theory of aging in bivalves: Insights from 7 arctic species in a global climate change context

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Many theories attempt to explain the variability in species longevity. The membrane pacemaker theory of aging proposes that, in mammals and birds, membrane fatty acid composition influences metabolic rate (via effects on the physical properties of membrane bilayers) and the degree of oxidative stress and damage to cellular molecules (via the peroxidative susceptibility of fatty acyl chains). Bivalve molluscs are newly discovered models of natural aging, but no study focused on this group in regards to the membrane pacemaker theory of aging. This study used 7 arctic bivalves species to verify that the theory fits this group of ectotherms. The growth performance index ϕ (phi) is derived from the Van Bertalanffy's growth function and is calculated via sclerochronological analysis of shell growth increments. It comprises two parameters; one considering maximal shell length ($L\infty$) and the other considering the speed at wich this length is attained (K). Growth index was negatively corellated to the unsaturaton index of fatty acids from polar lipids in gills, as stated by the membrane pacemaker theory. Differences in species diets using fatty acids as trophic markers in relation to the new dynamic of food availability and selective transfer from reserve lipids to gills membrane are discussed.

Re-inventing the wheel of ecological experimentation: are we making any methodological progress?

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Coastal marine ecology has been an intensively experimental science for the last sixty years. Experimental analyses have repeatedly been demonstrated to be necessary to unravel the numerous mechanisms proposed to explain observed patterns. Considerable effort and research grants have been expended on improving the ways in which experiments are designed and interpreted. It is, however, not clear that advances made in these areas of methodology are actually being used. Several areas of experimental ecology were examined in recent literature. These include pseudoreplication, analyses of competition and of preferences for habitat or for prey. Such studies have been the focus of considerable attention over the years and there has been a lot of work to improve them.

The experiments in recent papers involving these topics were examined. Results are not encouraging. There are still far too many problems in the designs of the experiments - in many cases, problems which were solved and agreed about long ago. The consequences of this outcome will be considered, including whether ecology has ceased to be concerned with the value of data (as opposed to ideas) and what might be wrong with postgraduate training programmes that do not cause advances to stay advanced.

How do intertidal communities respond to changes in environmental conditions?

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Canopy algae are considered ecosystem engineers since they modify environmental conditions affecting the survival and presence of other organisms. Canopies, however, have declined in temperate shores as a consequence of several anthropogenic impacts. In Azores, canopy alga *Fucus spiralis* is near its southern range limit and thus particularly vulnerable to climate change. This study assessed the community-level consequences of the loss of *F. spiralis* on Azorean rocky shores. We simulated the complete (CR) and partial removal (PR) of *F. spiralis* mimicking, respectively, extreme and moderate conditions of loss due to storminess that rips off the entire plant and desiccation. Thinning of macroalgae cover could also mimics the grazing by herbivorous fish. The cover of *F. spiralis* varied over time in way that could be divided in 3 distinct periods: 1st rapid response to treatments; 2nd recovery; and 3rd convergence (stabilization) with unmanipulated controls. Analysis showed complete removal, but not algal thinning led to significant community-level effects that were easily identified during the 1st and 2nd periods of fucoid recovery. Some understorey species responded positively to the loss of *F. spiralis*, whilst others responded negatively. Results suggest that *F. spiralis* loss may result changes in the structure of Azorean rocky intertidal.

Thermal vulnerability and acclimation capacity of tropical and temperate coastal organisms

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Understanding the impact of global warming on biodiversity is one of the most important challenges faced by mankind. Equally important is the identification of which ecosystems and species are more vulnerable to this threat. The rate of climate warming is predicted to be lower in the tropics than in temperate zones, however, species that live in aseasonal environments may suffer disproportionally from small increases in temperature. Additionally, thermal limits and acclimation capacity remain largely unknown for most species hindering projections of future distribution ranges. The aim of the present work was to (1) estimate the critical thermal maximum (CTMax), (2) the intraspecific variability in upper thermal limits, (3) the warming tolerance (Maximum Habitat Temperature - CTMax) and (4) the acclimation capacity of gastropods, crabs, shrimp and fish commonly found on tide pools in tropical and temperate areas. CTMax was higher for tropical than temperate species. Acclimation capacity, warming tolerance and intraspecific variation was higher for temperate species than for tropical species. Our results strongly suggest that tropical tide pool species are the ones in greatest jeopardy towards future climate warming.

It's getting hot in here! Are heat waves a driver of change in intertidal mudflat communities?

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The frequency and intensity of extreme climate events are increasing as a result of global climate change, however marine climate change experimental studies have largely assessed gradual sea warming and ocean acidification impacts on marine organisms and not extreme events. This study aims to improve knowledge on the potential impacts of heat wave events on intertidal mudflat macroinvertebrate communities. Intertidal mudflats are protected in the UK and the macroinvertebrates are a vital component of the coastal system. A series of outdoor mesocosm experiments will be conducted to evaluate the impact of a simulated heat wave event on the short-term and long-term physiology of mudflat invertebrates in spring, summer, and autumn. Single species trials will use the polychaete *Alitta virens*, the bivalve *Cerastoderma edule*, and the amphipod *Corophium volutator* and a community trial will use core samples from the field. Survivorship, biomass, and metabolic profiles will be compared for heated and control organisms in the single species trials. A comparison of community composition will be made in the community trials in order to identify heat wave 'winners' and 'losers' and the functional traits they exhibit, which has implications ecosystem functioning. Methodology and results from spring and summer trials will be presented.

Costs associated with physiological responses of marine invertebrates to multiple stressors

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Physiological studies are invaluable because they provide a mechanistic basis for understanding differences in the sensitivity of marine invertebrates to environmental change. Compensatory adjustments can be metabolically demanding and result in the allocation of energy away from other energy demanding processes such as growth. In order to assess whether the costs associated with compensatory adjustments are detrimental in the longer term, several species (*Mytilus edulis*, *Cancer pagurus*, *Carcinus maenas*) were exposed to ocean acidification plus one other environmental factor, either warming or reduced salinity, for 6 to 12 months. Short-term exposure to ocean acidification decreased metabolic rates but rates recovered on further exposure. Under combined conditions of OA and warming, temperature rather than OA, had a negative effect on compensatory capacities, growth and survival in *M. edulis*. In the crab species, OA and reduced salinity had different effects depending on the ability of the crabs to compensate for change. Reduced salinity increased metabolic rates in *C. maenas* (good compensator) but not in *C. pagurus* (poor compensator). OA had little effect on metabolic rate but did cause subtle changes in cellular energy allocation in *C. pagurus*.

Local human impacts decouple natural biophysical relationships on Pacific coral reefs

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Human impacts homogenize and simplify ecosystems, favoring communities that are no longer naturally coupled with the background environmental regimes in which they are found. Such a process of biophysical decoupling has been explored little in the marine environment due to a lack of replication across the intact-to-degraded ecosystem spectrum. Using 39 Pacific islands, 24 unpopulated (relatively free from local human impacts) and 15 populated (local human impacts present), spanning 45°of latitude and 65°of longitude, we ask, what are 'natural' biophysical relationships on coral reefs and do we see evidence for their human-induced decoupling? The percent cover of benthic groups were related to multiple physical environmental drivers using mixed-effects models and island mean condition as the unit of replication. Models across unpopulated islands had high explanatory power, identifying key physical environmental drivers of variations in benthic cover in the absence of local human impacts. These same models lost explanatory power when fitted anew to populated islands. Furthermore, key biophysical relationships at populated islands bore little resemblance to the baseline scenarios identified from unpopulated islands. Our results highlight the ability of local human impacts to decouple biophysical relationships in the marine environment and fundamentally restructure the natural rules of nature.

Ocean acidification impacts (and adaptation responses) by organisms, ecosystems and society

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Our understanding of ocean acidification has come a long way in the past ten years, during which time the number of publications has increased exponentially. But most studies have been short-term, on single species with single stressors. The UK Ocean Acidification research programme (co-funded by NERC, Defra and DECC) has made much progress in expanding the scope of research, to include temperature interactions, whole-community experimental treatments, and high-resolution regional modeling of future ocean acidification impacts. There has also been strong policy contributions by UKOA at the national and international level, including engagement with the Intergovernmental Panel on Climate Change, the Convention on Biological Diversity and the UN Framework Convention on Climate Change - recognising that ocean acidification and climate change share a common driver, increasing atmospheric CO_2. Key priorities for future research relate to the adaptive capacity of organisms, ecosystems and human society. Issues relating to sensitivity and resilience will be discussed in the context of multi-stressor interactions, global socio-economic consequences, and the design of cost-effective monitoring programmes to distinguish ocean acidification impacts.

Cool parasites: Indirect positive effects of endolithic parasitism on intertidal mussels

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Climate change influences ecosystems globally, but its effects can be compensated or even reversed by very local interactions of distinct ecosystem components. Host-parasite relationships are complex ecological phenomena with lethal or sub lethal negative effects on the host. In this context, we tested the idea that parasite infestation can have indirect positive effects by moderating the impact that extreme climate has on their hosts. We focused on a system composed of *Perna perna* and *Mytilus galloprovincialis*, two mussel host species and their endolithic shell boring parasites on intertidal rocky shores in South Africa.
Endolithic infestation significantly reduced the body temperatures of both solitary and aggregated mussels. Moreover, parasitised individuals suffered lower mortality rates during heat waves than non-parasitised hosts. Finally, the interstitial temperatures in aggregations of infested mussels were significantly cooler than those in beds of non-parasitised mussels, potentially affecting the abundance, species diversity and the structuring of infaunal assemblages.
The study illustrates a case where parasites may indirectly improve host survival rates. Such effects will be more pronounced in areas where the impact of extreme condition events is expected to be highest.

Biodiversity, Ecosystem Functioning and Services

KEYNOTE SPEAKER: LISANDRO BENEDETTI-CECCHI

Lisandro Benedetti-Cecchi (LBC) is Associate Professor in Ecology at the University of Pisa. LBC's lab uses marine coastal plants and animals as experimental model systems to address fundamental ecological questions, including the causes and consequences of loss of biodiversity and the ecological impacts of climate change and species invasions. A major goal is to provide experimental tests of theories that are rarely examined in the field, such as the role of environmental variance and regime shifts in shaping the spatial and temporal structure of natural communities. LBC has published +100 papers in peer reviewed ecological journals and 10 chapters in books. He is member of the Editorial Board of the ISI Journal Marine Ecology Progress Series and past member of the Editorial Board of Marine Ecology an Evolutionary Perspective, Estuaries and Coasts and Phycologia. LBC is member of the ERC Review Panel LS8 of the IDEAS program (starting and consolidator grants) and past member of the Review Panel of the European Science Foundation for the EuroDeep programme. LBC has coordinated national and international projects, including Euro-NaGISA, a Census of Marine Life project on marine coastal biodiversity and BIOFUSE, a responsive mode project within the MARBEF network of excellence.

Regime shifts and the maintenance of alternative states on rocky reefs in the NW Mediterranean

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Regime shifts are increasingly observed in marine coastal environments. A typical example is the transition from algal canopies to barren habitat. Sea urchins are a main force transforming canopy-dominated reefs into barrens. However, algal canopies may also collapse in response to deteriorating environmental conditions and algal turfs may become established in areas where anthropogenic pressure is high. Although the mechanisms that trigger these shifts have been identified, a clear understanding of the conditions under which they operate has remained elusive. Here, we test alternative hypotheses about the mechanisms maintaining algal canopies, barren habitats and turf-forming algae as alternative states on subtidal reefs in the Tuscany Archipelago and along the main coast of Tuscany (Italy). Using data from a long-term sampling program and path analysis we found evidence suggesting that: (1) wave exposure positively affects the abundance of sea urchins that in turn contribute to the maintenance of the barren habitat; (2) anthropogenic pressure is the primary cause of canopy loss and (3) algal turfs become established as a direct consequence of canopy loss. Experiments are in progress to substantiate these findings, but the evidence already suggests that preserving algal canopies will be difficult in the face of increasing environmental degradation.

KEYNOTE SPEAKER: GUY WOODWARD

Gene-to-ecosystem responses to climate change in freshwaters

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The higher-level, multispecies, responses to climate change are still poorly understood in aquatic systems. Our understanding of the role of interactions in food webs is especially limited, even though we know they are critically important in determining community dynamics, ecosystem processes and services. Here, I will review the current state-of-the-art in this field and will highlight new research directions and how we might start to fill these knowledge gaps, using freshwaters as model systems, in the next few years. As part of this, I will review how we can start to link across multiple spatial and temporal scales, organisational levels, and approaches to develop the integrated approach that is needed urgently, but which is currently lacking.

Rules of interaction for mechanistic models of benthic biodiversity: application to the Rance estuary

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Our work primarily aims at reproducing the dynamics of benthic macrofauna diversity, through the development of a mechanistic modelling framework. The grouping of species observed in the Rance estuary, France, in 1995, allowed us to reduce the system to its principal functional components. The formulation of mechanistic models based on the processes that control the dynamics of these functional groups, requires a set of rules which define the way they interact with their environment and among themselves. The first set of rules is derived from the values of 15 traits, which were selected as representative of key community assembly mechanisms. These rules define prey-predator interactions, dispersal potential and the regulating role of the organisms' position in the sediment. Another set of rules is derived from observed associations between traits and environmental variables and represents processes of environmental filtering along with the way the environment modulates biotic interactions. Finally, ecological theories, like the concentration reduction and the mobility-mode hypotheses, which are supported by associations among relevant traits, are employed to describe processes, like resource competition and biogenic habitat modification. The validity of these rules is tested through the analysis of qualitative models, which combine them with the previously built functional groups.

Functional responses of an estuarine sediment community to pulse disturbances using metatranscriptomics

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Metatranscriptomics are a powerful technique to measure functions of an entire community, which can be used to assess responses of communities to environmental and anthropogenic stressors. Soft sedimentary environments contain diverse communities and are highly productive. In heavily modified estuaries these communities are under stress from historical legacies of contaminant input and are periodically exposed to contaminant pulses, e.g. storm water. We investigated the impact of storm water on sediment community functions, focusing on biogeochemical pathways. Samples were taken from two embayments at two distances from large storm water drains and at two different time points. Metatranscriptomics were used to measure microbial community function and for the assessment of the gene expression of biogeochemically significant pathways. We also conducted 16S sequencing to describe community structure and made a series of direct functional measures. We found substantial changes in community structure and function with distance from drains in both embayments at both times. Sediment ecosystems regulate ecosystem processes and are closely coupled to the water column and atmosphere. Therefore, disrupted sediment ecosystem functions potentially affect the entire biosphere. Our study enhances the understanding of how pulse stressors affect sediment ecosystems and will enable a more sophisticated parameterisation of estuarine ecosystem models.

Ecosystem engineering by oysters across ecosystems and environmental gradients

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Ecological theory predicts that interactions among species will vary with biotic and abiotic context. Yet, there are few empirical tests of how facilitation varies across different ecosystems or across large-scale environmental gradients. We assessed how facilitation of invertebrates by the Sydney rock oyster, *Saccoastera glomerata*, varies between rocky shores and mangroves, and across 800 km of the temperate east Australian coast. At all 32 sites sampled, invertebrate assemblages were significantly denser and more speciose in oyster than bare microhabitat, but differences between microhabitats were greater on rocky shores than in mangroves. On rocky shores, effects of oysters on intertidal invertebrates decreased with latitude, as the maximum temperatures experienced by intertidal organisms diminished. By contrast, in shaded mangrove forests, where maximum temperatures were cooler and humidity greater, we found no evidence of latitudinal gradients in oyster effects. On both rocky shores and in mangroves, patch-scale variation in invertebrate communities was less in oysters than in bare microhabitats. Our results suggest that the strength of positive interactions between oysters and associate invertebrates vary according to abiotic stress. In reducing the high temperatures and desiccation stress experienced by intertidal invertebrates at low tide, oysters may help to mitigate the effects of environmental change.

Fish-seastar facilitation leads to algal forest restoration on protected rocky reefs

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Although protected areas can lead to recovery of overharvested species, it is much less clear whether the return of certain predator species or a diversity of predator species can lead to re-establishment of important top-down forces that regulate whole ecosystems. Here we report that the algal recovery in a Mediterranean Marine Protected Area did not derive from the increase in the traditional higher predators, but rather from the establishment of a previously unknown interaction between the thermophilic fish *Thalassoma pavo* and the seastar *Marthasterias glacialis*. The interaction resulted in elevated predation rates on sea urchins, responsible for algal overgrazing. Manipulative experiments and field observations revealed that the proximity of the seastars triggered an escape response in sea urchins, extending their tube feet. Fishes exploited this behavior by feeding on the exposed tube feet, thus impairing urchin movement, and making them vulnerable to predation by the seastars. These findings suggest that predator diversity generated by MPA establishment can activate positive interactions among predators, with subsequent restoration of the ecosystem structure and function through cascading consumer impacts.

How increased suspended sediment impacts on benthic suspension-feeders: a structural and functional approach.

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Increased suspended sediment in the water column has the potential to significantly impact marine environments through increases in turbidity, light attenuation, smothering of the benthos and changes in food resources. Due to their relative immobility, suspension-feeders are likely to be negatively impacted by increased sedimentation through coastal development such as land use, road building, logging, mining and dredging... For the same reason they are assumed to be good candidates to indicate changes in ecosystem functioning. This project aims to understand the mechanisms through which increased suspended sediment can impact suspension-feeder assemblages and their key functions in the ecosystem. My presentation will outline the structural and functional diversity of the suspension-feeder assemblages along a gradient of suspended sediment concentration. In addition, impact of increased suspended sediment on the feeding activity and plasticity of the suspension-feeders will be examined in order to evaluate the functional consequences for the ecosystem trophic web. For this project, I am using stable isotopes and flow cytometry analysis to understand feeding ecology of suspension-feeders. Stable isotopes analysis are not only used to trace C and N pathways or determine contributions of food sources. But I am also trying to develop new approaches coupling these results with flow cytometry analysis to better understand how co-occurring suspension-feeders species can share or not their food and if suspended sediments could affect these processes. The poster summarises the mechanisms of impact, clarifies the pressure/response relationships between suspended sediments and suspension-feeders and outlines the approaches being used to understand how shallow marine ecosystems could be affected.

Combined effects of temperature and nutrient increases on ecosystems: the role of species interactions and consequences for ecosystem functioning

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The interactive effects of global and localised stressors on ecosystems can be complex and difficult to predict and may result in ‘ecological surprises’. Species densities or abundances are known to dictate to a large extent the strength of species interactions and hence are likely to affect ecosystem processes. Here we tested experimentally how increased temperature and/or nutrients would (a) differentially influence the performance of monocultures comprising different species of macroalgae, (b) vary in effect relative to variation in the density of species in monocultures, (c) change the nature of interactions between pairs of species, and (d) vary in effect across different functional measures. We found both individual and combined effects of elevated temperature and nutrient increase on the functioning of both monocultures and species mixtures. The effects of these stressors were not necessarily modified by the addition of another species, but rather depended not only on the identity of the species (either in monoculture or within the mixture) but also on the functional measure in question. Additionally, those effects were modified by changes in the relative density of the species and in some cases resulted in shifts from negative (competition) to positive (facilitation) interspecific interactions or vice versa.

The cladoceran community in different habitats in Thale-noi Lake, Patthalung Province.

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This study aims to investigate the cladoceran community and factors affecting on their community in different habitats (H). The samplings were carried out every month between May 2014 and February 2015. The cladocerans were collected by funnel trap in three different habitats which are difference in dominant species of submerged macrophyte (H1; *Hydrilla* and *Ceratophyllum* patch, H2 *Hydrillla* patch and H3 *Uticularia patch*). A total of six families 26 genus and 38 species of Cladocera were recorded. Of which, two species is new record in Thailand, *Leydigia australis* Sars, 1885 and *Diaphanosoma celebensis* Stingelin, 1900. The abundance are difference between H1 and H2 and H2 and H3 ($p<0.05$). Species richness and abundance are highest in H3 (31 species, 335 ± 338 individual /$0.03m^2$). There are high correlation between cladoceran community and three environment factors including pH, Chlorophyll a and transparency. Moreover, the Cluster analysis shows no similarity between the cladocerans community in H2 and other habitats. The results indicate that the composition and abundance of cladocerans are difference in different habitat in Thale-noi Lake. However, the cladoceran composition in Thale-noi Lake seems to be affected by the environment parameters but not affected by macrophyte species.

Species densities, biological interactions and benthic ecosystem functioning: an *in situ* experiment

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Understanding biotic influence over ecosystem functioning is imperative if we are to predict the impact of ongoing biodiversity change on ecosystem service provision. Evidence from marine sediments - the most widespread habitat on earth - suggests that functioning is primarily driven by the presence and density of particular species. However, most experiments have been conducted for short durations ($<$ 4 weeks), under homogenous environmental conditions, and with controlled density treatments. In nature, the impact of changing density in one species may depend on consequent changes in the density of others, while evidence from vegetative systems suggests that complementarity among species increases over time and in heterogeneous environments. We simulated a realistic pattern of biodiversity change by transplanting the macroinfaunal bivalve *Scrobicularia plana* into an intertidal mudflat at various densities. The impact on redox potential discontinuity (RPD) depth (a proxy for benthic functioning) was measured at 1, 5 and 9 weeks. Causal Mediation Analysis revealed that increasing *S. plana* density negatively impacted RPD depth (i.e. RPD depth became shallower) by causing the density of a functionally dominant species *Corophium volutator* to decline. A general linear model revealed that the influence of density-dependent interspecific interactions (among macroinfauna) on RPD depth became increasingly positive over time. Our results therefore reiterate the direct functional importance of certain species and highlight the importance of other species to which their density is tightly coupled. An implication is that species loss may enhance functioning if it causes the density of other, functionally dominant, species to increase. Nevertheless, the apparent temporal emergence of interspecific facilitation suggests that diverse species assemblages promote high function delivery.

Spatio-temporal variation of intertidal macroalgal diversity on Southwestern Atlantic rocky shores

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The recognition of species associated with environments is the cornerstone for conservation approaches. Biodiversity studies are crucial for establish the threatened status of species, permitting wider comparisons in biogeographical, macroecological, and evolutionary contexts. Areas within transition zones, such as subtropical ecosystems can potentially have a high gamma diversity while being likely to present a complex of species both from temperate and tropical domains. Six shores were sampled in Southeastern Brazil during 12 months in order to characterize macroalgal diversity patterns according to wave exposure. A total of 129 macroalgae species from 21 orders, and 71 genera were found in sampled areas. The highest diversity values found in the intertidal zones were associated to the sublittoral fringe of sheltered shores. The temporal variation in species composition was similar among sites within same wave exposure range, but different between shore heights. Main changes in composition were associated to shifts in the dominance of winter, and summer annual species. These changes in composition are likely to influence consumers' guilds and trophic interactions seasonally. Furthermore, the establishment of diversity patterns in transition zones can help to fill gaps in large scale patterns (e.g. latitudinal trends), and trace shifts in communities in a changing world.

The context dependent influence of coastal upwelling on sandy beach macrofaunal assemblages

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Upwelling often drives local productivity, but alterations to upwelling systems are anticipated under climate change. Food availability can alter the structure of macrofaunal assemblages and the allochthonous nature of sandy beaches makes them particularly vulnerable to changes in food supply. Despite this, the response of sandy beach macrofauna to enhancement of productivity by coastal upwelling has received little attention. The presence of multiple upwelling cells around South Africa allowed us to test the generality of upwelling effects on sandy beach assemblages across a variety of spatial and temporal scales. Four regions were examined across two biogeographic provinces, removing temperature as a confounding factor, and limiting biogeography-specific effects. A nested hierarchical design allowed both large and small scales to be examined and generalities about upwelling effects to be derived. Additionally, sampling was conducted in two seasons in each of two years, to test the persistence of effects. Biogeography and region had the strongest influences on macrofaunal biodiversity. Upwelling influenced macrofaunal assemblages in every region, however the particular effect, positive or negative, differed among regions and between response variables. The results indicate that upwelling influences sandy beach ecosystems, but alterations to upwelling regimes will affect them in ways that are context dependent.

Testing the waters: impacts of contaminants on ecosystem structure and function in urban waterways

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Estuaries are diverse and productive ecosystems that are subject to high levels of disturbance from multiple human stressors. These ecosystems are exposed to multiple stressors such as legacy contaminants in sediments and ongoing inputs of nutrients and metals via stormwater. Such anthropogenic modifications are likely to impact both ecosystem structure and function. However, most assessments of waterways only measure ecosystem structure and we are not yet able to predict anthropogenic effects on ecosystem function. We surveyed sediment communities at four locations with large stormwater drains in Sydney Harbour, Australia. Locations were either embayments and were poorly flushed or were open channels and were well flushed. Sediment was collected monthly for 6 months from 3 sites within each location at increasing distance from the stormwater drain (0, 200 and 1000 m). Next-generation sequencing was used to characterise the sediment microbial community together with traditional morphological identification of infauna. Sediment was subsampled for a range of sediment characteristics including metals, total organic carbon, total nitrogen and phosphate, and chlorophyll-a. Sediment cores were also collected to measure biogeochemical processes including primary productivity, community respiration and nutrient cycling. Preliminary results suggest trends of decreasing community respiration rates away from storm drains and lowest rates of primary production during base flows (lt;5mm rainfall/day). Rarely have observations been collected of both structure and function in conjunction with ecological processes. The results have implications for future management practices in estuaries and increase our understanding of the relative impacts on benthic estuarine communities of stormwater run-off and contamination from industrial practices.

A comparative study of periphyton and phytoplankton communities in a nutrient-rich estuarine creek in the upper Bonny estuary, Niger Delta

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The periphyton and phytoplankton community characteristics of the Azuabie creek in the upper Bonny estuary of the Niger Delta, which receives industrial and municipal effluents, were studied over a period of one year. The relative compositions of these groups were determined from ten sites within the creek to cover its upper, middle and lower reaches, and to capture the effects of land-based sources of contaminant inputs into the creek. Surface water, phytoplankton and periphyton were collected and analysed. Data were analysed using univariate and multivariate statistical methods. Nutrient parameters showed generally high values, with overall monthly values (mean $\pm$ SD) as follows: nitrate - 3.05 $\pm$ 1.1 to 8.67 $\pm$ 1.75 mg/L; phosphate - 0.37 $\pm$ 0.08 to 0.73 $\pm$ 0.44 mg/L, silicate - 1.75 $\pm$ 0.33 to 2.95 $\pm$ 0.32 mg/L, ammonium-nitrogen 1.10 $\pm$ 0.29 to 1.66 $\pm$ 0.28 mg/L. Pooled annual data on abundance indicate that the phytoplankton was predominantly composed of bacillariophyceae which accounted for 88.3%. Conversely, the most dominant group in the periphyton was chlorophyceae (63.8%). Nutrient levels and other physico-chemical variables were key determinants of the phytoplankton community structure, while the periphyton dynamics was also largely influenced by interspecific competition for space on the nypa palm substrate.

Global patterns in mangrove macrobenthos: A new approach for assessing macrobenthic diversity and functions

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Increasing evidence is revealing the importance of macrobenthos for mangrove ecosystem structure, functioning and services. Uncertainties however remain on central ecological questions such as the relative significance of macrobenthic diversity and community composition in driving mangrove ecosystem functions as well as causes and consequences of variations within- and across biogeographic regions. One reason is that datasets are often not readily comparable. Using data from 13 own study sites, we developed a "Fingerprint to Footprint Approach" (FFA) based on the structured assignment of mangrove macrobenthos to mutually exclusive "ecological trait groups" (ETGs), depending upon how species modify physical habitat structure, and their main diet. By then using an a priori "Functional Role Template", designed after own expert knowledge and literature, the translation from "who you are" to "what do you do" to "what is your impact" was greatly facilitated across all sites. Such approach will help to generate much-needed globally comparable datasets, and, by scaling up from fingerprint (species identity/richness) to footprint (functional diversity) promote our understanding of the ecosystemic importance of mangrove macrobenthos in different environmental contexts. FFA will also help to evaluate the vulnerability of macrobenthic performance to global human-driven environmental change, a topic only poorly understood.

Navigating the complexity of ecological stability

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Human actions challenge nature in many ways, of different spatial extents, periods, durations, frequencies and intensities. Natural responses are irrevocably complex and are encapsulated by different components of ecological stability. However, relationships among those components can change in response to disturbances. The multifaceted nature of both disturbances and stability therefore demand a multidimensional approach to their measurement. In spite of this, our understanding is limited almost entirely to one-dimensional approaches to both disturbances and stability. This means that we underestimate the impacts of perturbations and cannot identify the mechanisms that underpin the overall stability of ecosystems. The lack of exploration of the multidimensional nature of ecological stability means that our ability to optimise the overall stability of ecosystems for different management and policy goals is at present extremely limited. If the science of ecology is to support and inform robust and successful policy, this situation needs to be rectified.

Biotic and abiotic processes influence on fucoid biogeographical patterns

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The structure of rocky shore assemblages is determined to a large extent by abiotic and biotic processes. The impact of these processes in shaping fucoid vegetation from local to European scales was assessed. Results from a large-scale survey showed that despite local variability, total fucoid biomass was similar in the British Isles but declined in Portugal. Field and laboratory based experiments on ascertain causes for such decline, showed that tide-out summer physical conditions in Portugal affect the photosynthetic performance of adult fucoid populations. Fucoid reproductive traits were also distinct from northern populations, indicating a possible reduction in reproductive capacity. Recruitment success, which was strongly regulated by grazing pressure in northern regions, was shown to be significantly lower in southern populations; ameliorating physical conditions and reducing grazing pressure in Portugal did not improve recruitment success rates. These results suggest that fucoid populations near the southern edge are under increased pressure, which is especially important under the current scenario of climate change. Moreover, it also emphasizes that both abiotic and biotic processes can directly affect biomass of fucoid algae, though the impact of such processes varies throughout their distribution range with implications for their important role as ecosystem engineers and primary producers.

Effects of freshwater input on nektonic community of a temperate Estuary. Management implications

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A long term ecological research program is developed monthly at the Guadalquivir since 1997 to date in order to assess the nekton (fish, decapod crustaceans) response to freshwater inputs (dam discharges) in a temperate estuary with regulated riverine inflow. River discharges are regulated mainly for economic purposes. Such water management usually causes a decrease in the freshwater input to estuaries and an increase in the residence time of suspended matter and organisms within estuaries altering estuarine natural hydrological regime. In other cases, whether discharges occur in summer for crop rice irrigation may also result in negative (osmotic stress due to salinity fluctuations) effects on larval and juvenile survival of marine species, especially for those with a stronger salinity-related distribution. An additional negative effect of freshwater discharge was an unusually high and persistent turbidity event which may negatively impact the nursery function of estuaries either by decreasing prey availability or by decreasing survival/arrival of marine recruits. The anthropogenic pressures that may stimulate unusual decreasing of salinity in the warmer season and the occurrence of high and persistent turbidity events (HPTEs) should be avoided in order to preserve the nursery function of temperate estuaries.

Ascension Island land crabs: phylogeography, sustainability, and ecological change

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Ascension Island is a small (1500 km from either the American or African shores. However, it supports a substantial population of the gecearcinid land crab *Johngarthia lagostoma*: the only other populations of this species occur on three smaller Brazilian offshore islands.
How did this crab reach Ascension, when and from where? These questions are addressed in the context of the phylogeography of related Atlantic land crabs, the geological history of the areas involved, and the potential for planktonic larval dispersal. Ongoing genetic studies are reviewed. Population structure indicates possible recruitment problems. Historical data on both population size and recruitment are limited. However, new data on age structure and recruitment patterns are evaluated to assess population sustainability. Finally anthropogenic changes in the island's ecology are reviewed in relation to the crab's population size and trophic relationships. Have there been major changes, and are these still ongoing?

Importance of odonata in biomonitoring of wet habitats

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Introduction:
Freshwater ecosystems include many types of life, of which Odonata, this group of insects are known as dragonflies and damselflies present a strong dependence to wet habitats.
Objective:
Our objectives were detecting areas of development of zygoptera and improve our information around this group of insects than use these insects to evaluate the quality of wet habitats.
Materials and methods:
This study deals for the first time the odonatofaune in some wetlands in the drainage system of Tiaret-Algeria, this work was carried out by a systematic monitoring in 2013 at 09 stations, of which the objective principal is to explore the areas localization and reproduction Odonata and know the state of diversity in localized stations.
Odonata adults are sampled by a strategy based on direct observation of individuals in areas located along the banks of water bodies, according to the method presented by (Oertli et al., 2000) and applied (Gordeau, et al., 1999) and (Oertli, 1994).
In second time, to conduct a study on the environment, we take water echantillons from the same station to analyse the parameters: pH, dissolved oxygen, salinity, temperature, redox, salinity, conductivity, resistivity, and biological oxygen demand.
Results:
The study focuses exclusively on adult stages (mature and immature) Odonata. The comprehensive inventory of Odonata has established a preliminary list of 11 species: *Sympcma fusca*, *Platycnemis subdilatata*, *Calopteryx haemorrhoidalis*, *Coenagrion mercuriale*, *Coenagrion caerulescens*, *Ischnura graellsii*, *Ischnura pomulio* include in 07 families : Lestidae, Platcnimydae, Calopterigidae , Coanagronidaes, Ashenidae, Libelliludea and Gomphidaes.
Conclusion:
Freshwater ecosystems need to be studied, to protect life in there, Odonata play an important role in maintaining balance in aquatic ecosystems, and their reduction disappearance will have negative impacts on all living beings in the same medium.

Temporal dynamic of macrophyte communities in shallow lake ecosystems: 30 years of vegetation survey

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Shallow lakes provide multiple ecosystem services, and macrophytes are key elements of these systems. Understanding the processes behind their species assemblages is thus essential for lake management. In this study, we surveyed macrophyte communities of 14 lakes and ponds in South-Western France since 1984 and explored their structure and composition change with time. We used a set of physical, anthropogenic and landscape variables to understand processes driving local species assemblages. Abundance of invasive species was also included as explanatory variables. Species richness, rank-abundance curves and non-metrical multidimensional scaling were used to investigate macrophyte diversity, and the coefficients of these metrics were correlated with previous explanatory variables. We did not find a common temporal response of communities. However, some variables, such as residence time, watershed and lake areas were found to be important factors in explaining community changes across time and led to suggest either an important influence of physico-chemistral variation or regional-dispersion processes. Also, the presence of invasive species and their abundance explained some patterns of macrophyte diversity underlying the importance of biotic interactions. These results suggest that both biotic and abiotic processes influence local macrophyte assemblages and provide new insights in terms of lake management for biodiversity conservation.

Geographical patterning nematode assemblages in *Corallina officinalis* in the English Channel and in South Korea

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Cosmopolitan habitat forming species of algae such as Corallina provide an opportunity to compare patterns of biodiversity over wide geographical scales. Here we compared the nematode fauna inhabiting the cosmopolitan algae *Corallina officinalis* in the English Channel with that of the south coast of Korea. A fully nested design has been used with 3 regions in each country, 2 shores in each region and 3 patches on each shore. Species composition varied at each spatial scale (patches, shores, regions and countries). Patterns of alpha, beta and gamma diversity were compared as well as patterns of composition and diversity along the environmental gradients in each country. There were taxa endemic to each country, as is expected of species with limited dispersal abilities such as nematodes. However, we also found cosmopolitan dominant taxa in both countries. Despite of the dissimilarity of nematodes communities at each spatial scale, the functional diversity of nematode communities was similar at all.

Ecological relationships and patterns in biodiversity of benthic marine nematode assemblages in the Gulf of Mexico

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Nematode assemblages were collected at 54 - 187 m depths on the northern Gulf of Mexico (GOM) continental shelf in 2013. Sediment was collected from 21 locations with a multicorer on the NOAA ship Pisces. The sediments were analysed for grain size characterisation, organic carbon content, and trace metals. Nematode density and community structure was examined at these sites, resulting in 13 new genus records for the GOM among the 122 genera and 30 families recorded. Cluster analysis and non-metric multidimensional scaling revealed distinct nematode assemblages in the eastern study areas (Florida) versus western areas (Louisiana-Mississippi) that correlated strongly with two distinct sediment profiles. Those sediment profiles were characterised by high silt+clay percentages with high levels of aluminosilicate-bound trace metals in the west, and lower silt+clay percentages with higher calcium and strontium concentrations in the east. Four distinct pairs of sites were present in the western areas in which nematode assemblages were similar ($>$ 63%, SIMPER analysis). The most abundant genera from all sites combined were *Sabatieria*, *Dorylaimopsis*, *Tricoma*, *Pselionema*, and *Halalaimus*. Overall, a number of factors correlated with nematode assemblage patterns, particularly trace metals, sediment grain size, and water depth.

Upwelling areas are refugia along the contracting southern range edge of the macroalga *Fucus guiryi*

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Climate change has profound and diverse effects on biological diversity. Identifying present-day climatic refugia is an increasingly recognised strategy for the management of biodiversity loss. Such refugia are seen as potential safe havens that enhance environmental diversity by buffering the effects of large scale change, facilitating species persistence at regional scales. The ecological effects of upwelling are well studied, but the potential of upwelling centres as refugia in a scenario of global warming remains largely unexplored. We compared changes in distribution of the canopy forming macroalga *Fucus guiryi* with sea surface temperature patterns in four upwelling systems and nearby warmer areas along southern Iberia and northern Africa. Correlated with warming trends over the past thirty years, *F. guiryi* has disappeared from large expanses of non-upwelled shores (100s km), currently persisting in areas characterised by strong upwelling and reduced, non-significant or relatively lessen magnitude of warming rates. Furthermore, genetic characterisation of populations using nine microsatellite loci revealed distinct genetic groups associated with each upwelling system. Within a large region of predominantly changing climate, we highlight the fundamental importance of upwelling areas as favourable, stable climates where this species may retreat and persist, preserving unique portions of the species' genetic pool.

Long- and short-term disturbances affect diversity and functional relationships on intertidal mudflats.

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Estuarine communities show spatial and temporal variations over time and it is well known that high levels of contaminants and other environmental stressors reduce faunal biodiversity. Abundances of dominant organism can however remain high thus retaining the functional and trophic relationships. This presentation uses case studies from a temperate estuary in New Zealand where over the past 100 years there have been changes in anthropogenic inputs and associated management regimes to improve water quality. Following removal of treated waste water from the estuary in 2010, nutrient levels were expected to decline but a series of earthquakes interrupted the recovery. Earthquake disturbances included violent seismic shaking, sediment input and increased nutrient levels. Benthic communities were related to tidal level, habitat (mudflat, shellfish and seagrass beds), salinity regime, water depth and sediment composition. The effects of long term changes over 30 years and short term changes, 1 week to 3 years, following earthquake activity are compared in terms of functional relationships and ecological services. The results suggest that estuarine communities are resilient to environmental change and those habitats which have a high degree of structural organisation are the most resistant to environmental stressors.

Microbial diseases and declines of habitat-forming macroalgae

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Despite the importance of these underwater forests in marine systems, little is known about the processes that influence their declines. Disease is an ecological process that has been linked to declines of other key habitat-forming organisms, such as corals in the tropics, but it has been largely overlooked in temperate marine systems. The surfaces of macroalgae are colonised by highly diverse microorganisms, which interact with their host influencing survival, development and condition. Disruptions to these interactions via environmental change can lead to higher incidence and severity of disease, affecting the resilience of macroalgal populations. We have identified putative disease phenotypes of three common Australian macroalgae: the dominant kelp *Ecklonia radiata*, the fucoid *Phyllospora comosa* and the red algae Delisea pulchra. Putative disease phenotypes were common and widespread, and in some cases greater in summer or on urbanised shorelines. Surface-associated microbial communities on "diseased" algae differed consistently from those on "healthy" algae, even at a continental scale. Inoculation experiments have identified bacterial and fungal pathogens, as well as some important algal chemical defences against pathogens. Some diseases increased algal mortality, whilst others affected performance and fitness, suggesting that disease may be an important process contributing to declines of macroalgal forests.

Complexity of alpine springs: a case study from the Alps of Slovenia

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Springs are key research environments in freshwater ecology and biology as they are located at the interface between groundwater and surface water. It is important to understand and assess the impacts on the spring habitat and their complexity and vulnerability. Therefore, the role of habitat structure on the community composition was studied with macroinvertebrate fauna in alpine springs of Slovenia. Springs were selected from three mountain ranges (the Julian Alps, the Karavanke and the Kamnisko-Savinjske Alps) that are different in terms of geology, hydrology and climate. Species distributions were mostly driven by flow permanence and substratum type, resulting in distinct hydro-geological and environmental factors. The overall results indicated markedly the importance of habitat complexity of alpine spring ecosystems.

Marine microbial assemblages associated with diseased Porifera (Sponges) in Skomer Marine Nature Reserve (SMNR), Wales. Microbial community changes in the sponge holobiont may provide early warning of diminished resilience in temperate benthic ecosystems

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Healthy, functional sponges drive biogeochemical cycles, bentho-pelagic coupling and provide essential ecological services to the marine environment. Sponges filter large volumes of seawater consuming the microbes there in, and are often implicated in water quality control. During 2013/14, black necrotic tissue, and heavy fouling (notably by barnacles or red algae) were observed in *Cliona celata* at several locations across SMNR. Sponge tissue necrosis is a stark and worrying indication of reduced resilience and function in one of the most important groups in benthic marine communities. Sponge disease and mass mortality have been associated with extreme sea surface temperature (SST) events in the Mediterranean and tropical waters. This, however, is the first record of sponge disease in the UK. The cause is unknown, but is not presently correlated with abnormal SST. We present 16S rRNA based metagenomic analysis of microbial communities in fouled, healthy and necrotic *Cliona celata* sponges from SMNR, in relation to the microbial community of the host seawater. This research provides a greater understanding of the microbial mechanisms of sponge disease in temperate marine systems and could provide the basis of an early biomarker for shifts in benthic ecosystem functioning linked to climate stressors.

Collapse of kelp beds to turf-dominance is mediated by urchin overgrazing not water-quality alone

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Coastal water-quality has declined worldwide due to increasing urbanisation of coastal environments and associated catchments. While many studies have examined effects of single urban-associated stressors on the resilience of marine ecosystems, relatively few have examined interactions between multiple stressors on the disturbance-recovery dynamics of kelp beds. We used multi-factorial manipulative experiments to simultaneously test the effects of nutrients, sedimentation, canopy clearance and urchin grazing on kelp bed communities in Australia's largest urbanised embayment (Port Phillip Bay [PPB], Victoria). Sedimentation at double the ambient load had little impact, while elevated nutrients reduced cover of kelps (by attracting increased sea urchin abundance) and increased cover of turfing-algae. However, when nutrients were elevated in combination with disturbance to remove kelp, turfing algae dominated the reef. Transplants of kelp to reefs experiencing both high and low urchin abundance across a gradient in water-quality further confirmed that urchin grazing, and not water-quality per se, is responsible for collapse of kelp beds in northern PPB. However, nutrification then favours dominance by turfs, which appears to inhibit kelp recovery. Results show kelp beds to be resilient to decreasing water-quality, but losses due to disturbance, chiefly intense urchin grazing, enables turfs to dominate urbanised temperate reefs.

Assesmnet of Physico-Chemical Properties in Tropical Semi-Enclosed Bay, Malaysia.

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Cowie Bay is a typical tropical semi-enclosed bay, located on the south-east coast of Sabah, and part of the Malaysian Coral Triangle Initiative. It is oblong-shaped with a total area of 1,200 km^2. The northern part of the Bay is fed by more than 12 river systems contacted and its depth ranging between 2 m to 36 m. This Bay is among the highest marine and terrestrial biodiversity in Sabah and is extensively used by coastal shrimp trawlers, motorised vessel traffics and sea port activities shared with neighbouring Indonesia. High freshwater, nutrient and sediment inputs and human modifications of the catchment area may already have an influence on the physico-chemical properties of the Bay. The impacts are variable due to different seasonal monsoons. To date, there are no detailed research conducted on the physioc-chemical properties of seawater that most marine life in the bay depended on. The objective of this research is to investigetion the spatial and temporal distribution of physico-chemical properties of seawater during the northeast monsoon (NEM) and southwest monsoon (SWM). For this study, the Bay was divided into inner (S1 to S8) and outer Bays (S9 to S23) with a total of 23 sampling stations with approximately 3.0 km interval. Field measurements were conducted on a monthly basis from May 2009 to April 2011 (24 months). In-situ measurement of water temperature, salinity, pH, dissolved oxygen (DO), and total suspended solid (TSS) were measured using multi-parameter (HANNA model HI-9828). Reading were taken at surface (0.5 m depth) and bottom (0.5 m depth above bottom) using depth sounder (Model SM-5). Temperature (°C) in SWM was relatively higher than NEM ($F(6,460)=50.09, p < .01$). Generally, higher temperature were measured in the inner and decreases towards outer Bay (F (2,4600=9.53, p $< .01$), however, the mean value was significantly lower in inner than outer areas. The pH and DO (mg/L) values in the inner part of the Bay were significantly lower than the outer parts. The mean values of TSS were significantly higher in the inner and outer part of the Bay at different seasonal monsoons. The average trend indicates that most of the physico-chemical properties were decreased from inner to outer part of the Bay and fluctuated at S14 onwards to entrance of the Bay except for water temperature. Human activities and climate change (rainfall pattern) may contribute to physico-chemical properties change in the Bay. This research provides baseline data of physioc-chemical facet which is important for the sustainable development and management of the Bay. However, further studies are suggested in the

outer part in order to understand the impacts of physico-chemical properties particularly TSS on coastal fisheries and other marine life in the Malaysian Coral Triangle area.

Disentangling the effects of eutrophication and natural variability on benthic community structure in French Mediterranean lagoons

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The increase of anthropogenic nutrients inputs into the coastal environment has led over the past decades to a worldwide increase of eutrophication events. Coastal lagoons, at the interface between continental and marine systems, are confined habitats that are particularly vulnerable to eutrophication-induced disturbances. Moreover, because of their small size and depth, these ecosystems are naturally variable, making it difficult to distinguish the effects of anthropogenic disturbances (e.g. eutrophication) from those of natural variations. Here, we show, using an extensive dataset on macrobenthic communities from 22 French Mediterranean lagoons, that disentangling the effects of these two sources of disturbance is possible, provided that the dataset covers a sufficient range of both eutrophication levels and natural variability . Hierarchical clustering analyses showed that benthic communities were classified in 3 groups, representing (1) large (i.e. with low natural variability) unimpacted lagoons, (2) small (i.e. with high natural variability) unimpacted lagoons and (3) eutrophicated lagoons. Classical benthic community indices failed to discriminate between small eutrophicated and unimpacted lagoons. Partial redundancy analyses showed that 30% of the total variability in benthic communities was due to non-anthropogenic factors, while 15% was due to eutrophication. These results significantly improved our understanding of the effects of eutrophication on coastal lagoons. Moreover, this approach provides promising insights towards the development of macrobenthos-based indices of ecological conditions, which is a requirement of various current EU directives.

Diversity and darker waters: responses of algal assemblages in compromised light environments of the coastal zone

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Of the numerous anthropogenic stressors affecting coastlines worldwide, one of the most pernicious is a compromised light environment in the coastal zone. As light penetration decreases, there is a shallowing of the depth distribution of algal beds and species composition can be affected. However, it is not just the amount of light that decreases with depth but also the penetration of different wavelengths. To understand the consequences of changing light, we have revisited classic studies on how different macroalgae use light and the ecological role of species in assemblages. Here, we discuss how layered species in vertically structured assemblages contribute to primary production and community dynamics. We show there are unexpected compensatory dynamics of light use among canopy and subcanopy species and that the loss of key species has cascading long-term effects.

The fractal ocean: the math behind the bugs, past and future applications and challenges

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Most intertidal organisms exhibit a vast behavioural repertoire. They do not move following straight lines, but along pathways that can be more or less convoluted, they alternate periods of activity with periods of relative stasis, and when they move their speed highly fluctuates, irrespective of the tortuosity of their trajectories, hence may often be incompatible with a description based on mean speed. In this context, we describe three families of approaches that allow an objective behavioural quantification without any a priori assumptions of (i) the geometric complexity of movement pathways, (ii) the stochastic complexity of the alternation of activity and stasis bouts in activity budget, and (iii) the stochastic nature of successive moves. The numerical methods needed to describe and quantify behavioural complexity are illustrated on the basis of behavioural changes observed in situ and ex situ in diverse organisms (e.g. foraminifera, copepods, hard and soft-bodied gastropods, mussels, crabs, dolphins, whales and sharks). We also illustrate how the geometric and/or stochastic nature of behavioural complexity may be induced by and/or shape environmental complexity. We finally discuss the adaptive value of the observed behaviours in terms of optimal foraging and how they may relate to biodiversity patterns and impact ecosystem functioning.

Shifts in habitat-forming species in UK kelp forests: implications for biodiversity and productivity

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Kelp forests dominate shallow rocky habitats across much of the world's temperate coastline. As foundation species, kelps support high levels of primary productivity, magnified secondary productivity, and provide habitat for a highly diverse associated assemblage. However, the abundances and distributions of habitat-forming kelps are responding to global environmental change stressors, including ocean warming, extreme climatic events and the spread on non-native species. In the southwest UK, the abundance of the 'warm' water kelp *Laminaria ochroleuca* has increased significantly in recent decades, as has the distribution of the invasive kelp *Undaria pinnatifida*. Conversely, the abundances of several northerly-distributed species (e.g. *Laminaria digitata* and *Alaria esculenta*) are expected to decrease under climate change scenarios. The wider implications of shifts in habitat-forming kelp species are poorly understood. Here, I summarise recent research on the likely impacts of shifts in kelp forest structure on local biodiversity and primary productivity. Evidence-to-date suggests that observed and predicted shifts in kelp species distributions may lead to impoverished assemblages in some reef habitats, and altered timings of primary productivity. Greater understanding of the (often subtle) community and ecosystem-level consequences of shifts/replacements of habitat-forming species is needed to better predict the overall impacts of global environmental change.

Triggers and thresholds of multiple shifts between benthic assemblages of Mediterranean shallow rocky reefs

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Benthic assemblages of temperate rocky reefs undergo drastic changes in structure driven by natural and anthropogenic stressors. Assemblages dominated by canopy-forming macroalgae may switch to alternative, less-productive systems: either barrens, dominated by encrusting corallines, or assemblages dominated by algal turfs. We experimentally investigated the separate and combined effects of physical disturbance, grazing intensity, and nutrient addition in triggering the shift from canopy-dominated to alternative assemblages. Following a factorial design, we removed canopies at different density levels (0%, 30%, 70%, 100%) from transects exposed to different grazing regimes (no sea urchins, natural densities or densities enhanced to simulate outbreaks) and nutrient enrichment levels (control, addition). Preliminary results showed significant combined effects of canopy density and grazing regimes on assemblage structure, while nutrient enrichment had limited effects. Also, to examine the relationship between the density of the most common Mediterranean sea urchin species (*Paracentrotus lividus* and *Arbacia lixula*) and the extent of barren patches surrounded by different algal matrices, we performed a correlative study. A hierarchical sampling design at different spatial scales (100s, 10s and <1 km) and habitats (canopy or algal turfs) was used to assess variation in transition thresholds between habitats and whether transitions exhibit hysteresis in both systems.

Compensatory responses mean that the ecosystem consequences of species loss diverge from expectation

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Current consensus on the ecosystem consequences of biodiversity loss is that a reduction in the number of species leads to an accelerating decline in ecosystem functioning, but this conclusion is based on the results of short-term experimentation that has not accounted for post-extinction compensatory mechanisms. Here we use data from marine benthic invertebrate communities to parameterise how randomised and ordered species extinctions with and without compensatory processes (based on species abundance, biomass or functional traits) will affect sediment bioturbation, a key determinant of biogeochemical cycling. We show that important aspects of the biodiversity-function relationship change when species exhibit compensatory behaviour and that the form of the biodiversity-function relationship is highly dependent on the mechanism of compensation. Our findings indicate that, contrary to present expectations, the ecosystem consequences of altered biodiversity are not likely to follow a saturating response curve.

Functional diversity of fish in estuaries at a global extent

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Biodiversity is currently viewed as a framework encompassing multiple facets of the variety of life, including taxonomic and functional aspects. Species richness and composition of fish assemblages in estuaries is defined by global to local processes acting on community colonization. The present study further investigates how biodiversity of fish assemblages varies among estuaries globally, by simultaneously analysing taxonomic and functional richness and diversity of assemblages. A comprehensive worldwide database was compiled on the fish assemblage composition and environmental characteristics of estuaries. In addition, functional attributes of the fish species were characterized such as body size, habitat use and trophic ecology. We investigated the relationship between taxonomic and functional aspects of biodiversity, i.e. the match or mismatch between the two. We also explored how functional diversity of fish assemblages varied among estuaries globally and related to environmental features of estuaries, i.e. historic and contemporary, global and local constraints. The results are explored in the context of ecosystem functioning and resilience, and outcomes relevant to assist in prioritising conservation efforts are highlighted.

The recent knowledge on the biodiversity of Ponto-Caspian gobies

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In the XXI century the number of goby species recognized in the Ponto-Caspian basin significantly increased. Several Mediterranean species (*Gobius cruentatus*, *G. xanthocephalus*, *Gammogobius steinitzi*, *Millerigobius macrocephalus*, *Pomatoschistus bathi*) were first discovered in the Black Sea. The reproducing population of accidentally introduced Pacific species *Tridentiger trigonocephalus* was found in the Crimean area. The mtDNA cytochrome b gene analysis revealed that the genus *Proterorhinus* is not monotypical but includes at least three morphologically similar species: *P. marmoratus*, *P. nasalis*, and *P. semilunaris*. In addition to three previously accepted freshwater Caucasian goby species (*Ponticola constructor*, *P. cyrius*, and *P. rhodioni*) two new species were described from the Black Sea in Turkey (*P. rizensis* and *P. turani*) and the last one - from the Iranian coast of the Caspian Sea. New tadpole-goby *Benthophilus ragimovi* was described from the Middle Caspian. Our recent karyological and molecular-genetic studies proved the validity of *Ponticola iljini*, previously included in the synonyms of *P. gorlap*. Both these species are very similar in external morphology, but have different karyotypes and form separate lines of the same subclade in the phylogenetic gobiid tree, obtained for cytochrome b gene, and thus they represent cryptic species.

Successional changes of holdfast communities of the cultivated kelp *Alaria esculenta* (Linnaeus) Greville

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Recently, there has been an increase in kelp cultivation research in Europe with a focus on an increase in production efficiency to supply biomass for established uses (e.g. food, fertilizer and pharmaceutical products) and potential new uses (e.g. biofuels) . The growth of this sector has implications for the structuring and functioning of the ecosystem services in the local area. Observations of the fauna inhabiting cultivated macroalgae suggest that both the longline infrastructure and the growing kelp may function as an important habitat or refuge for species.
Macroalgae are cultivated in Ventry Harbour, Co. Kerry on the SW coast of Ireland on a commercial scale, in an 18 ha site. Species currently cultivated include *Alaria esculenta* and *Saccharina latissima*. We conducted an assessment of the holdfast macrofaunal communities found on *Alaria esculenta* and followed their development over the typical growing season until harvest. We hypothesise that the richness and abundance of the communities to increase over time. Preliminary results will be presented from two, three and four months of growth after deployment until harvest. The broader implications of this study will also be discussed in relation to ecosystem structure and functioning and management practices.

The resilience of benthic organisms in Polar and Tropical regions following environmental changes

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A comparative study was carried out to determine the impacts environmental changes on the diversity of benthic communities in polar and tropical regions. Study in polar region was carried out by mean of impact of glacier melting on benthic communities in Marian Cove, West Antarctic Peninsula. Sampling were done at stations representing different distances from glacier melting. Study in tropical region was done to determine the impacts of rainy season on the benthic diversity in Bidong Island, Malaysia. The benthic organisms in both studies were hand-picked and photo-recorded by SCUBA diving. The identification of benthic organisms was done to the lowest taxonomic levels and several diversity indices were applied. Benthic communities in Marian Cove were taxonomically and functionally less diverse following the impacts of ice melting whilst it was also the case for the communities in Bidong Island where the diversity of the organisms was affected by the rainy season. It was showed that other environmental factors such as grain size and organic content also had a significant impact on the organisms. This study showed that both communities in polar and tropic regions responded in a similar way to a suite of environmental changes.

Influence of mussel-modified habitat on a canopy-forming macroalga

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The influence of habitat modification by *Mytilus edulis* on the settlement and subsequent development of *Fucus serratus* populations was investigated on rocky shores of Anglesey. Fucoid settlement was higher inside mussel assemblages than outside on one of two shores studied. The role of environment and grazing in determining early post settlement survival was examined by transplanting fucoid germlings into and outside mussel assemblages, with and without grazers. In the absence of grazers survival was higher inside mussel reefs, but in the presence of grazers survival was low in both microhabitats. Investigation of mussels as a substrate for fucoid development revealed greater numbers of fucoids growing directly attached to rock. Moreover individuals larger than 60 cm were found only on the rock. As reproductive tissue develops mostly in larger thalli, this finding indicates that mussel beds negatively impact Fucus reproductive output. In situ pull-tests showed less force was required to detach large fertile thalli growing on mussels than those on rock; adhesion was generally broken between the mussel and rock rather than between the holdfast and mussel. The results suggest a negative effect of mussel-modified habitat on adult fucoids but the effect is unclear in juveniles.

Faunal mediation of ecosystem properties depend on differences in trait expression that relate to how individuals interact with abiotic and biotic context

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Current consensus on the role of biodiversity in mediating ecosystem properties stems largely from manipulative experiments performed in homogeneous environments that do not incorporate environmental context, variation in community composition or different trophic levels. Here, we investigate how changing community structure constrained within a fixed level of total community biomass and exposed to alternative abiotic (resource quantity and quality) and biotic (predator presence/absence) conditions, modifies the ecosystem properties (bioturbation, bioirrigation, nutrient release) of a model benthic ecosystem. We find that the relative performance of the community is highly dependent on the rank order of biomass distribution as well as the abiotic and biotic setting. The presence of a predator and algal enrichment significantly reduce both bioturbation depth and bioirrigation activity, but exacerbated species-specific effects on sediment nutrient generation. Our findings indicate that the faunal mediation of important ecosystem properties is not dependent on the presence of particular functional effect traits, rather it represents differences in trait expression that relate to how individuals interact with abiotic and biotic context. We conclude that re-distribution of functional traits, and how they are expressed, in natural systems will need to be prioritised when considering the ecological consequences of altered biodiversity.

Arenicola marina: functional diversity and 21st century regime change along the Atlantic coast of Europe

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The ecosystem engineer *Arenicola marina* is a dominant bioirrigator of soft-sediments along the Atlantic coast of Europe but its geographic distribution appears to be shrinking due to climate change and regional warming. If *A. marina* disappears from a geographical region, are there functional replacements? What differences would one expect? Possible replacement taxa that drive bioadvection in sediments like *A. marina* belong to three categories: (1) those like *A. marina* which inject water at depth and turn over large amounts of sediment, (2) those which inject water at depth but stabilise sediments via tube-building activities, and (3) those which inject water at depth and turn over little sediment per individual. Deposit-feeding callianassid crustaceans are the closest to *A. marina* in activities, but they inject water deeper, replace much more of the sediment with burrows, and eject sediment into the overlying water; so, if their abundances were to increase, systems would change significantly. However, based on the present biogeography of the discussed functional equivalents it is more likely that already co- occurring sediment stabilisers without bioadvective impact will take over - with dramatic consequences for soft-sediment biogeochemistry and ecology along the Atlantic coast of Europe.

Conservation, Management and Policy

KEYNOTE SPEAKER: LAURA AIROLDI

Laura Airoldi is Associated Prof. in Ecology and Marine Ecology at the University of Bologna, Italy. She received a Ph.D. in Marine Science from the University of Genova, and carried out research at several institutions in Italy, Australia, USA and UK. She was a Fulbright Research Fellow at Stanford University. She is Coordinator and/or PI in several (inter)national research projects and initiatives and serves the Editorial Board of 3 international journals. She is author or coauthor of > 200 publications, including peer reviewed papers, books chapters, technical reports, conference proceedings, general articles and conference abstracts. Her work has been cited >3800 times and has received prices and special mentions. Her research focuses on understanding what are the consequences of multiple anthropogenic impacts - emphasizing coastal urbanization, invasive species, enhanced loads of sediments, habitat loss and climate change - and what factors facilitate the recovery and restoration of damaged ecosystems, finalized to the management and conservation of marine biodiversity.

Integrating green engineering into conservation and restoration projects for coastal urban areas

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The proliferation of artificial structures, such as breakwaters, ports, seawalls and offshore installations, is becoming spatially significant in many coastal areas globally, and is one of the leading causes for loss of natural habitats and their associated species. Preserving biodiversity and ecosystem functioning in urban environments is a pressing challenge. We introduce a conceptualframework for designing marine developments that provide multiple functions, and offer some examples of green engineering approaches from our work, aiming at integrating coastal defence with the maintenance or restoration of ecologically relevant habitat-forming biota. We show experimentally that, whenever engineering based intervention is needed, then adequate substrates, transplantation techniques and sound management can be combined to facilitate native foundation species, such as canopy-forming seaweeds or filter feeders, and their associated ecosystem services.

KEYNOTE SPEAKER: JENNIFER DODD

Jennifer Dodd is a freshwater ecologist with a wide range of interests. After completing her PhD, Long term changes in river invertebrate communities, at the University of Glasgow in 2011, Jennifer moved to Cambridge University to investigate the impacts of the killer shrimp, *Dikerogammarus villosus*, which had just been recorded on mainland UK. Jennifer is currently involved in a large EU funded project using applied research to provide management solutions for aquatic resources. More specifically, Jennifer is interested in freshwater community ecology and the ecology of restoration. Using long-term benthic macroinvertebrate records, Jennifer is investigating the relationship between human mediated impact and community recovery. Understanding this relationship and the mechanisms underpinning it is pivotal to accurately measure ecosystem recovery. The results from her research evaluate the validity of the reference condition approach to monitor ecological status.

Ecological responses in a recovering river system

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Predictions of macroinvertebrate community structure based on reference condition models (like the River Invertebrate Classification Tool) are the foundation for monitoring the ecological state of river systems in the UK and Europe. Measurements of river health are based on the assumption that, following restoration, the structure of a recovered macroinvertebrate community will closely resemble astructure had the community not been impacted (i.e. the reference condition). In this study we show that, compared with the reference condition, significant differences in macroinvertebrate community structure, in areas that have recovered from environmental disturbance, are related to the pollution tolerance of community members and details of the initial impact. We also investigate some of the potential mechanisms that may be driving these differences.

Substrate and density alter aggregation behaviour of mussels

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Biogenic reefs are important components of the marine ecosystems supporting a large diversity of species. Understanding the conditions and mechanisms underlying how these reefs are formed is needed for conservation and restoration efforts. We studied how substrate-type and density affect how mussels aggregate using two mesocosm experiments. The two species of mussels used were the edible mussel *Mytilus edulis* and the horse mussel *Modiolus modiolus*, two biogenic-reefs forming Mytilids. The first experiment assessed the effect of substrate type and had three treatments: no sediment, sediment and sediment with shells. *M. modiolus* moved less in soft-substrate and shell addition did not increase movement but substratum did not affect the percentage of aggregated mussels. *M. edulis* moved the same distance but aggregated less when shells were present. A lower percentage of *M. modiolus* attached to shells than *M. edulis*. The second experiment tested the effects of density on *M. modiolus* aggregation with three treatments: 100, 200, 300 mussels m-2. *M. modiolus* moved the same distance across all density treatments, however it aggregated more in the high-density treatment, suggesting that encounter rate of individuals is a driving factor for aggregation. We discuss the implications for the recovery of fragmented beds and for restoration.

The contribution of urban biodiversity to ecosystem services in disused docks following restoration

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Disused docks are an unusual marine habitat due to their variable salinity regimes and the presence of a variety of artificial hard structures that may support a diverse benthic community. Many disused docks have undergone extensive redevelopment for recreation. The maintenance of their aesthetic appeal is of particular importance if their recreational value is to be maintained. The Liverpool Docks underwent complex redevelopment in the 1980s. Research carried out during that time found that water quality was greatly improved through biofiltration by large populations of *Mytilus edulis*. To study the contribution of urban biodiversity to ecosystem services and the long-term stability of these benthic communities in the Liverpool Docks, we re-surveyed the *M. edulis* populations and associated epifaunal communities in 2012, to compare to historic data. We found that, 30 years following its completion of redevelopment, the Liverpool Docks still support a healthy biological community with high biofiltration potential. *M. edulis* remains the dominant species. Age structure of the *M. edulis* populations varied between the Docks, with $>$ 10 year old specimens in certain locations. Similarly, composition of the associated epifaunal communities also differed between the Docks. These spatial differences likely reflect differences in time since redevelopment and different management practices.

Successful conservation management of protected biodiversity hotspots: considering the fitness of biogenic reefs to their environmental conditions

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This study demonstrates that ecologically important *Modiolus modiolus* (L.) reefs vary in terms of population structure, shell morphology and growth rates as a result of differing environmental conditions. Shell dimensions were recorded from mussels at Llŷn peninsula, Port Appin and Scapa Flow. Growth rates were determined using acetate peels of sectioned shells. Flow rate and density estimates were also measured at each reef. Lower recruitment was observed in Scapa Flow. Small, narrow-shaped shells were found to be characteristic of mussels at Port Appin and Llŷn peninsula, and larger, globular-shaped shells were characteristic of mussels at Scapa Flow. Mussels at Scapa Flow were slower growing, yet reached a longer asymptotic length ($L\infty$) than mussels at Port Appin and Llŷn peninsula. Growth curves from sites within this study were compared to other published data. A trend of higher $L\infty$ at higher latitudes and lower flow rates were observed. Variations in growth and age are hypothesised to be related to flow regimes, connectivity to other reefs, density and latitude. Changes in these conditions could result in a loss of fitness, so it is important to consider how changes in these variables will affect *M. modiolus* reefs, and hence aid successful conservation management.

Coastal habitat mapping with comparisons of community structures between natural and artificial coasts in Penang Island, Malaysia

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Natural coastal habitats all around the world are at risk due to the rise in human population and urbanization with 44% of the world's population living within 150 km of the sea. In Penang Island, coastal ecosystems have been altered or destroyed for the past two and a half decades to make way for development . Land has also been reclaimed from the sea for this purpose in efforts to "enlarge" the island at the expense of its coastal habitats. The building of several artificial islands have recently been initiated in order to increase land space and make way for high-rise residential buildings and recreational facilities. This highlights the need for incorporating "Green Technology" by building in beneficial features, promoting the protection of coastal habitats and protecting vulnerable organisms living in these areas. Little is known about the extent of reclamation and the associated loss of valuable coastal marine habitats. A combination of walk-around surveys and data extracted from Google Earth revealed a XXX% gain in areal extent of Penang Island since 19XX. Seawalls and rock armour have replaced natural rocky shores and beaches in urban areas and a number of these have been identified as candidate locations for the implementation of ecological engineering techniques to mitigate for their construction. A pilot study was also conducted to compare community structures of these artificial habitats in comparison to natural rocky shores. Preliminary results from a macroinvertebrate community study revealed that artificial habitats had 35.72% less species compared to natural habitats. Diversity and evenness was also lower by 22.92% and 17.87% respectively, in artificial habitats. Polychaetes and amphipods were common and sampled in both natural and artificial sampling sites indicating their robustness for being able to survive under different conditions. Organisms like *Nerita* spp., *Solen* sp., *Umbonium* sp., *Zeuxis* sp., and *Patelloida* spp. on the other hand, were only found in natural, undisturbed areas indicating their sensitivity to anthropogenic disturbances. This study provides the first map of coastal habitats along the coast of Penang Island and novel insights to community structures between natural and artificial coasts.

Benthic interactions with renewable energy installations in a temperate ecosystem; the Wave Hub experience

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Marine Renewable Energy Installations (MREIs) provide clean electricity but can also cause physical disturbance to the local environment. Wave Hub is a MREI off the South West Peninsula of the UK. Wave Hub's seabed infrastructure, including the main connection unit and 18 km of seabed cable, was deployed in 2010. To enhance knowledge on the potential future impacts of MREIs the effect of the power cable on assemblages was quantified, along with its associated 80,000 tonnes of rock armouring. A flying video array was used to survey the macro epi-benthos in 2009 before the installation of the cable and after the installation of the cable in 2010, 2012 and 2014. The species assemblages present within the Wave Hub development zone were assessed in the context of the ecological processes they contribute to local ecosystems. Two treatments (Cable bouldering and Controls) were sampled to test the hypothesis that the cable bouldering could act as an artificial reef, providing refuge and feeding grounds for marine fauna in a de facto marine protected area.

Recurrent physical impact drives decline in reefs formed by *Sabellaria alveolata*

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Physical disturbance is a localised but common occurrence on reefs formed by the polychaete worm *Sabellaria alveolata*. These reefs are an important example of habitats that elevate local diversity, but are found in highly dynamic environments that can be heavily impacted by disturbance from waves and human trampling. Several experiments were conducted on reefs at Llanddulas, North Wales, using an approach to simulate recurrent disturbance in a quantifiable and repeatable way. Three weights (5.3, 2.7 and 0.5 kg) were dropped from a set height (1.5 m) over three timescales (daily, fortnightly and once a month), followed by a fortnightly survey for a further month to assess the recovery of the structure. Exposure to a daily impact from a 5.3 kg weight destroyed the reef structure, with no recovery in the following month but lesser impact force (0.5 kg) showed recovery and continued persistence. Disturbance on larger *Sabellaria alveolata* structures, for example 20 cm from the edge of a large reef, demonstrated greater resilience to damage than impact at the edge of the reef. Repeated impact from high forces drives substantial decline in the persistence of *S. alveolata* reef, we must reduce impact where possible, such as from avoidable human trampling.

Sargassum muticum invasion alters polyphenolics in *Zostera marina*

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Polyphenolic compounds are common in seaweeds, seagrasses and other higher plants and are known for their defensive properties. They can inhibit settlement and growth of epifauna and flora and deter predators such as grazers through reduction of food quality and interruption of physiological processes. Defence strategies based on the production of carbon-rich phenolic compounds allow plants and algae to respond rapidly to changing biotic and abiotic conditions, and phenols can therefore be used as biochemical indicators of plant and/or algal condition. Previous studies have reported elicitation of polyphenol up-regulation in seagrasses and algae in the presence of invasive marine macrophytes, and the rapid proliferation of *S. muticum* into seagrass beds within the UK raises questions regarding such effects upon *Z. marina*. To determine how *S. muticum* may affect the phenolic production of *Z. marina*, a four year field study was conducted in conjunction with laboratory experiments. Contrary to predictions, results from both field and laboratory studies showed significantly lower phenolic levels in *Z. marina* growing in close conjunction with S. muticum. We conclude that the invasion of *S. muticum* may directly affect the biochemistry of *Z. marina* with as yet unknown consequences for carbon allocation patterns and defence mechanisms.

Does a conservation assessment protocol based on vegetation communities adequately assess aquatic invertebrates in dune slacks?

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Cross congruence is a measure of the degree to which diversity (number or composition of species) of different taxa follow broadly similar patterns. Within the EU, principals of cross congruence are used to fulfil habitat monitoring commitments under the Habitats Directive and conservation assessments are based primarily on plant species. Habitat heterogeneity and environmental stress can reduce the correlation of diversity among different taxonomic groups. Temporary ponds experience both environmental stress (flooding and desiccation) and temporal habitat heterogeneity, so should principals of cross congruence be used when assessing their conservation status? This experiment investigated patterns of diversity among three different taxonomic groups in temporary ponds in sand dune systems (dune slacks), and whether environmental factors had an impact on the degree of cross congruence observed. Communities of plants, snails and water beetles in twenty-four dune slacks in Ireland were compared using diversity indices and ordination techniques. The influence of environmental factors relating to water chemistry, landscape features and management were also explored using multivariate techniques. The results of this research will help to evaluate current monitoring techniques which are in use throughout the EU and guide monitoring approaches for dune slacks, an EU Annex I habitat, in Ireland.

Space, the final frontier! - competitive colonization between invasive and native species

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Space can be a limiting factor in intertidal communities and competition for this resource can determine community composition. Invasive species are known to be opportunistic, and are capable of rapidly colonising free space. Since its introduction to Europe, over seventy years ago, the invasive barnacle species, *Austrominius modestus* has become widespread on European coasts and is now the dominant barnacle species at numerous locations here. However, little is known about its competitive interactions with native barnacle species. During this study, 18 removal plots (25 cm^2) were created at 7 sites in southwest Ireland, including both artificial structures and natural rocky shores. Monthly monitoring of these plots over 14 months revealed that, despite high recruitment of native species seasonally, *A. modestus* outnumbered natives in removal plots at four sites. The invasive species increased in its relative abundance at three sites, but did not entirely displace natives at any site. The ability of native recruits to survive, even in plots dominated by the invasive species, in addition to low levels of *A. modestus* recruitment at sites dominated by natives, indicates that competition at the recruitment stage may play an important role in controlling the abundance of the invasive *A. modestus*.

Broad-scale patterns of aquatic biodiversity associated with man-made structures and landscapes: Benthic invertebrate assemblages of Atlantic saltworking sites

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Few studies have investigated the broad-scale geographical pattern of aquatic biodiversity associated with man-made structures and landscapes. We investigated the diversity and biomass of benthic macroinvertebrate communities associated with lagoons and ponds of coastal saltworking sites along European Atlantic seaboard between Andalucía, Spain (36°N) and the south coast of England (50°N). These regions are important for breeding and migratory shore birds and yet habitats are threatened from a variety of disturbances and environmental change. Therefore an important motivation for this work was to investigate how food resources for migratory coastal shore birds also varied between structures, sites, and location. Our main hypotheses were that 'species richness, community composition and biomass are primarily dependent on the type of pond and the current and historic use of the sites'. We collected spring and autumn benthic core samples from water bodies across 20 active, abandoned and historic salt working sites in 5 coastal regions. We also measured a range of abiotic parameters including salinity, temperature and macrophtye cover. Our findings may have implications for the management of biodiversity in coastal saltworking regions and the creation of new lagoons.

Fifty years of marine biodiversity conservation - has science made a difference?

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Although concerns about human impacts on what is now termed 'biodiversity' in the marine environment can be traced back to the 14th century in Britain, it is in the past 50 years that there has been acceptance of the need for action. That 'action' has progressed from proposals for voluntary marine protected areas through the statutory establishment of many varieties of those MPAs; the listing of species and habitats deemed to be 'threatened' through to their inclusion in directives, conventions and statutes; to more general measures that are aimed at improving the quality of the whole marine environment. Scientific knowledge has informed some of those measures but the drivers for conservation action are often socio-economic including tourism or fisheries, and policy: achieving the requirements of directives and conventions. Scientific knowledge is often ignored when goals and objectives are identified leading to ineffective measures and to 'blind alleys' being followed. The challenges now are to focus on what has worked and will work in the future, to influence users of the marine environment to act responsibly, and to discard or revise time-wasting and ineffectual measures.

From Muck to Brass: Making aquatic ecosystem services pay for local community benefit

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Most scientists recognise the importance of ecosystem services for human welfare. This understanding has not translated into changes in policy and practice as rapidly as we might wish. Ecosystem services continue to be undervalued in management decisions, reflecting ignorance as well as political interests in favour of short term decision-making. Local communities may recognise the importance of some services but lack the institutional and financial resources to manage them. Whilst ecologists reveal the processes underpinning ecosystem function, poor locals may legitimately ask 'how does this science benefit me?' This talk describes 'Mikoko Pamoja', a mangrove conservation and community development project based in southern Kenya that is supported by money from carbon offsets. We use this to explain how the science of ecosystem services (and particularly of carbon stocks and flows) can be linked to conservation and management objectives. After outlining the latest evidence on mangroves as important natural carbon sinks the key challenges - scientific, social and political - in establishing and maintain such a project are discussed. We then consider prospects for expansion and replication of similar projects as a new tool for mangrove conservation.

Managing the impact of fine sediment on river ecosystem

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Sediment plays a pivotal role in determining the physical, chemical and biological integrity of aquatic ecosystems. However, human activities have increased loads of fine sediment, such that it is now one of the most widespread and detrimental forms of aquatic pollution. Given its key role in determining water quality, and the spatial scale over which mitigation must be implemented to achieve reductions in inputs, a sound evidence base is critical to understanding the impact of fine sediment. Enhanced sediment inputs impact adversely upon aquatic ecosystems both by degrading habitat condition and by directly impairing biota. Furthermore, the biological impact of fine sediment is likely to be a consequence of a combination of the source of fine sediment and both the amount and rate of delivery and retention, as well as the susceptibility of the resident community. We present an extensive research programme into the impact of fine sediment on aquatic systems involving national-scale field survey identifying sources and impacts of fine sediment, and field scale experimental manipulations. We have developed and tested an empirical index relating invertebrate community structure to pressure from fine sediment, and have coupled biological endpoints (invertebrates and fish) to a landscape-scale modelling framework to explore the impact of land-use management interventions at the national scale.

Recognising Essential Fish Habitat in MPAs: the impact of marine management measures on rural communities.

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Biogenic reefs, such as those formed by horse mussels (*Modiolus modiolus*), are biodiversity hotspots and recognised for their conservation importance. They are protected as 'reefs' in under the EU Habitats Directive and a Priority Marine Feature in Scotland. However, very little is known about the functional importance of such reefs and the ecosystem services that they provide to society. The Pen Llŷn horse mussel reef covers a total of 500 hectares of the seabed. The area in this study has been closed to mobile fishing activity since November 2012, however, the use of static gear is permitted and common whelks (*Buccinum undatum*) have been harvested from this area for the past 25 years. The aim of this study was to find out if the North Llŷn horse mussel reef is an essential habitat for whelks and to investigate the functional role this habitat plays in the production of whelks. By working with the local whelk fishermen data were collected on whelk catch rates, size distributions and growth rates at stations on and off the reef using baited pots. Ultimately, understanding the functional role of this horse mussel reef and the benefits that it can provide to local communities, can make an important contribution to conservation management. Involving stakeholders in the process of gathering the evidence that underpins the MPA network can facilitate effective management of MPAs in the UK.

Geospatial Smartphone Apps and the use of crowd sourcing for the recording of invasive species

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Obtaining accurate data about the distribution of invasive species is of paramount importance when it comes to assessing impact and formulating an appropriate response. But data provision is often patchy and records are usually unverifiable and lacking accurate geographic reference.
The Nature Locator team has addressed these problems by combining the development of case specific smartphone applications with the power of crowd-sourcing. The apps enable high quality data to be collected by both scientists and the public in the field. Critically, the majority of records collected are verifiable since they comprise a photograph, along with other relevant metadata such as number or amount of each species seen. Records are also accurately and conveniently geo-located via the phone's GPS.
The Nature Locator team, together with the Environment Agency, Scottish Natural Heritage and the Scottish Environment Protection Agency, have developed an app to monitor approximately 20 freshwater invasive species including many fish species, *Dikerogammarus villosus*, *Pacifastacus leniusculus* and *Eriocheir sinensis* among others. It is anticipated that data from the app will act to enhance our understanding of current species distributions, provide high quality data for research and also function as an early warning system for those species spreading to new areas.

An exposure-effect approach for evaluating ecosystem-wide risks from human activities

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Ecosystem-based management (EBM) is promoted as the solution for sustainable use. An ecosystem-wide assessment methodology is therefore required. In this paper, we present an approach to assess the risk to ecosystem components from human activities common to marine and coastal ecosystems. We build on: (i) a linkage framework that describes how human activities can impact the ecosystem through pressures, and (ii) a qualitative expert judgement assessment of impact chains describing the exposure and sensitivity of ecological components to those activities. Using case study examples applied at European regional sea scale, we evaluate the risk of an adverse ecological impact from current human activities to a suite of ecological components and, once impacted, the time required for recovery to pre-impact conditions should those activities subside. Grouping impact chains by sectors, pressure type, or ecological components enabled impact risks and recovery times to be identified, supporting resource managers in their efforts to prioritize threats for management, identify most at-risk components, and generate time frames for ecosystem recovery.

Evaluation of the effectiveness of the artificial reef installed in Souiria K'dima (Safi - Morocco)

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As a part of its new strategy for the development of small-scale fisheries, Morocco has launched in 2009 its first experimental artificial reef project in the fishing village of Souiria K'dima (Atlantic coast). This reef encompasses protective structures (anti-trawling) covering the core of the reef composed of productive structures (blocks). This project aims to preserve and strengthen the marine biodiversity and to improve the income of local artisan fishermen.
In order to assess the effectiveness of that artificial reef, a scientific monitoring (underwater videos, experimental fisheries) as well as a social and economic evaluation (landings data, surveys) were made since 2010.
The recorded results showed that the reef area (4 km^2) that was once poor has become a very rich ecosystem with a seasonal variation in fish populations occupying it.
In addition, the socioeconomic survey conducted among local fishermen showed that their incomes have improved (catches increased, high commercial value species and costs decreased ...) Moreover, the majority of fishermen have testified to the success of this experimental project and the local cooperative has even made its extension in 2013.

Ecological traps in the marine environment: implications for the design of artificial reefs

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Humans are altering coastal ecosystems at an unprecedented rate. One such change is the proliferation of artificial reefs (ARs), which have become a common management tool for stock enhancement of recreational fisheries and habitat restoration. The benefits of ARs, however, depend on their suitability as habitat for marine species. ARs could result in the provision of seemingly suitable habitat that provides lower fitness advantages. If animals preferentially colonize such structures, this could result in an ecological trap. Here we investigate whether ARs can act as ecological traps for fish populations and present a new artificial reef design that takes into consideration the specific shelter needs of many different fish species. We assessed fish recruitment, diversity, abundance, and individual fitness components (recent growth, condition, survival) at three locations in Port Phillip Bay, each containing replicate Reef Balls, an alternative AR design and natural reef. New ARs and natural reef displayed higher recruitment and survival rates for several fish species in comparison to Reef Balls, indicating they likely do not suitably mimic the complexity of natural reefs. Understanding the effects of human caused habitat modifications on marine ecosystems, particularly the design and placement of artificial reefs, is vital for developing successful conservation and management strategies.

Pollution Havens: the effects of economics and the law on the global migration of river pollution

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The pollution haven hypothesis, discussed since the 1980s, proposes that polluting industries relocate from regions with strict and costly pollution control legislation to countries with less stringent or even deliberately lax regulation, specifically aimed at attracting foreign investment. The evidence is regarded as controversial by some authorities. During analyses of long-term river quality data from the English Midlands it was evident that localised GDP and both chemical and biological water quality were related. Also it was clear from the literature and press reports that as rivers in the UK and the industrialised West became cleaner, rivers in countries developing at the time such as China and India, became progressively more polluted. This paper examines some of the evidence for the pollution-haven hypothesis in relation to rivers and speculates on where the next major pollution havens might be occurring and if they are preventable.

Allis shad: A concrete example of how niche shift modelling studies could help in the definition of conservation measures

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For most species, only the realised climate niche can realistically be estimated through correlative distribution models. For some species, it has become possible to determine the fundamental niche based on physiological information and a mechanistic understanding. Predicting the future species distributions using both correlative and mechanistic distribution models under climate change scenarios remains as such a rare application. The Allis shad (*Alosa alosa*) benefited from the attention of the scientific community given its dramatically decreasing trend in all Western European fresh waters. Conservation and restoration measures for the species are undertaken in two key systems of its distribution range where the species was formally a highly abundant exploited natural resource. Both types of distribution models were developed for allis shad and used for predictions but conclusions were never confronted. In the present study, a joint analysis of their results were undertaken to refine conservation actions in the light of climate change impacts. We raised two main concerns regarding: (i) the potential local adaptation of northern populations and (2) the importance of managing a target watershed considering potential existing neighbouring sources of migrants.

Do trophic- and habitat-cascades shape fouling communities in harbours?

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Artificial coastal structures are expanding as a response to human activities and needs for protection against environmental perturbations. Novel habitats are thus colonised by fouling and mobile assemblages, including numerous non-native species, whose structure and functioning (e.g. interactions between local and non-native species) is still to be explored. Although a few studies addressed the weak interaction between mega-predators and fouling communities in temperate regions, the role of mobile macro-invertebrates has been overlooked. If these organisms use sessile taxa both as food and habitat, they may be involved in trophic- and habitat-cascades. To explore these processes, an in-situ experimental set-up crossing 'predation' and 'habitat complexity' factors has been developed. The primary colonisation by mobile macro-invertebrates was facilitated using 15x15 cm panels covered (three levels) by turf mimics, crossed with exclusion treatments and deployed for 2.5 months within two harbours in Brittany. A total of 42,391 individuals belonging to 144 species were identified on 72 panels. While richness, density and community structure were not driven by mega-predation, they were all significantly explained by habitat complexity due to the measured interstitial volumes formed by sessile taxa. Such cascading effects should be further explored to understand invasion dynamics on artificial structures around the world.

An Interdisciplinary analysis of the impact of shore-parallel breakwaters: integrating hydrodynamic, sedimentary, and ecological characteristics of the surrounding sea bed.

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Shore-parallel breakwaters are an increasingly prevalent strategy for coastal flood risk management on sandy shores. While the impact of these structures is well documented, the analysis of impacts is traditionally isolated to separate academic disciplines. This study aimed to investigate impact using an interdisciplinary methodology. It combined site specific hydroinformatic models with sedimentary and ecological data collected in the field at two locations; Sea Palling in East Anglia and Elmer in West Sussex. The potential of abiotic characteristics to predict ecological characteristics to provide a novel tool for coastal managers was explored.
The study found that hydrodynamic characteristics were strongly linked to location within the breakwater scheme, whereas sedimentary and ecological characteristics were more weakly linked. Additionally only very weak correlations were found between the abiotic characteristics tested and the infaunal community assemblage at both study sites, suggesting that abiotic characteristics are not always good predictors about the infaunal community assemblage; the possible reasons for this are discussed. This study also highlights the unique nature of sandy shore ecosystems and the need for further research to enhance interdisciplinary development of tools to inform and aid coastal management decision making.

Enhancing biodiversity on tropical seawalls

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In highly urbanised Singapore 'hard' engineering mitigation strategies, such as increasing structural complexity, remain the most viable option for enhancing seawall biodiversity. However, complexity comprises of multiple parameters and it is critical to disentangle their relative effects. Towards this end, we developed the software 'CASU' and used it to design concrete tiles of different complexities. These were deployed for one year to test the effects of complexity and structural component type on intertidal diversity and community composition. Our results demonstrate that structures with greater informational complexity (specifically, increased microhabitat size variability) can support greater diversity and different communities and that these effects are independent of surface area. In addition, we show how the type of structural component can have an effect on diversity that is independent of complexity. In a follow-up study, we increased the scale of structural manipulation and found similar results to the first experiment. Incorporating the results of both studies, we designed a composite tile ('BioBoss') to test the effects of different deployment densities and spatial arrangements. 720 BioBoss tiles were installed on seawalls in nine different plot configurations and left in-situ for one year. The preliminary results from this most recent experiment will be presented.

The ecology and conservation of limpets in the Azores

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Arguably, the largest anthropogenic impact in the Azorean intertidal is the overexploitation of the keystone patellid limpets. Heavy exploitation of limpets for human consumption over more than 30 years has caused extensive declines of these populations. Experimental work on the importance of top-down control by intertidal grazers throughout NW Europe strongly suggest that patellid exploitation is likely to have a strong impact also on the structure and functioning of Azorean rocky shores. Here I present an overview of the work that has been done over the past 10 years and that includes investigating: the community-level effects of chronic exploitation, the effects (or lack of) of marine reserves, the quality of limpets for human consumption, the role of limpets as habitats, coastal engineer as a tool to enhance limpet stocks, the level of molecular differentiation among islands as well as the impacts of climate change on limpet phenology. We have now gathered a considerable body of knowledge that allows to forward strategies that foster the sustainable exploitation of limpets but also the conservation the Azorean rocky intertidal as a whole.

Distribution models of temperate rocky reef habitat-forming species on the continental shelf in eastern Australia: setting the baseline to monitor and predict future changes

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Habitat-formers (e.g. kelp beds, corals, sessile invertebrate assemblages) are key to the structure and functioning of reef ecosystems worldwide. In southeast Australia, a region identified as a global hotspot for climate-driven ocean warming, the structure and distribution of deep (> 30 m) benthic sessile communities are poorly known given these habitats are hard to quantitatively survey. Using high-resolution imagery of the seafloor from a recent national-scale AUV-based survey program, we establish a critical baseline about the latitudinal gradient in benthic community composition from 27°S to 43°S on the eastern seaboard of Australia. Large-scale latitudinal variability between three major community types (sub-tropical, warm temperate and cool temperate) mostly correlates with primary productivity and temperature climatology, while local scale variability relates well with depth. Using environmental variables that capture past climatology both in terms of mean and extreme conditions, we develop alternative distribution models for several habitat-forming species. We compare model performance, discriminate between different types of latitudinal distribution (e.g. truncated or continuous), and discuss these results in the context of ongoing and future ocean changes. Our study provides an important benchmark to detect and predict future climate-driven changes in SE Australia, and our methodology has general applicability for monitoring of deep reef environments.

Urban sprawl in marine systems: impacts, consequences and mitigation options

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The loss and modification of coastal habitats due to urbanisation is a global issue and likely to increase, given the need for improved defences for coastal areas from both rising sea levels and increasingly severe coastal storms and flooding. However, these marine artificial structures, such as seawalls and breakwaters, support novel ecosystems unlike any that exist naturally and are often associated with habitat and diversity loss. In order to design artificial structures with increased contributions to ecosystem services, we need to understand how these novel systems function. We have therefore evaluated the functioning properties of two important habitat-forming species in artificial and natural habitats in Sydney Harbour, Australia. We measured the growth and erosion rates of the kelp *Ecklonia radiata*, as well as their photosynthetic efficiency, using the hole-punch method and a diving PAM, respectively. Also, clearance rates of the oyster *Saccostrea glomerata* were measured in situ using enclosure chambers. Results of this work can be used as baseline on how to ecologically engineer artificial structures so they minimise adverse ecological impacts and incorporate other functions than solely engineering, e.g. maintenance and/or restoration of local and regional diversity, water quality improvement, food production, educational and recreational opportunities.

Using ecological enhancements to increase biodiversity in urban systems

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The replacement of natural foreshores by seawalls is a significant and developing issue worldwide. Seawalls support considerably fewer species, notably mobile animals, in comparison to natural rocky shores. The objective of this project was to quantify the ecological benefits of engineering intertidal habitats into seawalls, and at what scale these benefits become detectable. Precast 'flowerpots' that retain water were deployed onto seawalls; these enhancements were designed to incorporate artificial rock-pools into seawalls, increasing the range of habitat types present on seawalls. Here, we summarise a three-year project that specifically aimed to: 1. Compare the assemblage and recruitment processes of these artificial systems with natural systems, 2. Detect whether the biodiversity benefits of this enhancement occur at a scale beyond the flowerpot itself, and 3. Quantify the effects of the flowerpots on higher trophic levels, focusing on fish assemblages. Results show that the flowerpots significantly increase the number of species found in the vicinity of the seawall, and are therefore a relatively simple, cheap and effective tool to help mitigate the impacts of artificial structures by retrofitting biodiversity.

Measuring functional redundancy in chronically trawled benthic communities

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Functional redundancy, i.e. different species sharing similar functional roles, is a community property that contributes in the assessment of benthic ecosystem integrity. This property highlights the importance of exploring the performance of different approaches to measure functional redundancy. In this study we suggest that redundancy may be achieved through trait abundance (i.e. large amounts of a trait), what we called "common traits", or through trait richness (i.e. large numbers of distinct taxa exhibiting the same trait), what we called "widespread traits". We assessed the variability of both measures on the epifaunal communities inhabiting eight sites located in four Mediterranean soft-bottom areas subjected to different levels of trawling effort. Both redundancy measures were based on the analysis of twenty biological traits linked to key soft-bottom's functions such as nutrient cycling, bentho-pelagic coupling and habitat provision. Common traits and Widespread traits measures provided complementary information on epifaunal functional redundancy, thus we suggest that a combination of the two measures should be used to appropriately assess ecosystem resilience in trawling grounds.

Understanding the population dynamics of invasive seaweeds in marine coastal environments.

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Seaweeds are major primary producers in coastal areas, and large-scale substitution of dominant native seaweeds by invasive species can consequently alter coastal productivity and food web structure, thus impacting ecosystem services. In this study, an agent-based modelling approach has been taken to study the impact of the Asian kelp seaweed *U. pinnatifida* (an emblematic invader in European waters) on native biodiversity. We have developed an individual-based model of population dynamics for investigating the underlying mechanistic basis for ecological features and invasive potential of this species. The model includes explicit representations of the various life stages of *U. pinnatifida* (microscopic gametophytes and macroscopic sporophytes) and their responses to environmental parameters such as light and temperature using empirical data from the literature. Our model framework can be used to explicitly represent complex spatial and temporal patterns of invasion in order to be able to make quantitative predictions about the impact of these factors on invasion dynamics of *U. pinnatifida*. This would be a useful tool for making accurate risk assessments of invasive potential under different environmental conditions and for choosing optimal management strategies in order to minimise future control costs.

Piecing together the water quality deterioration in the Doñana Marsh (southwestern Spain) over the past 20 years

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The Doñana Marsh is the largest area (30,000 ha) of one of the most important wetland complex in Western Europe: the Doñana Natural Area. This World Heritage Site is identified as under high threat by UNESCO because of long term and continuing reduction in water quantity and quality. These processes have been associated with the development of agriculture and increasing urban pressure in the watershed which have reduced flow and increased nutrient inputs into the entry streams. In this study we aimed at investigating the driving factors influencing the deterioration of the water supplies into the natural marshes of Doñana. First, we present a summary of the spatial and temporal patterns of eutrophication based on nutrient concentration data collected over the past two decades. Second, we present the results of a time series analysis on the effects of land use change on concentrations of different nutrients, while controlling for variation in predicted flow rates based on variation in rainfall and in increasing exploitation of the underlying aquifer over time. This study highlights the long term effects of human activities in Doñana and provides key information for the future management of this emblematic wetland ecosystem.

Perspectives on an integrated ecosystem assessment for regional seas: the ODEMM approach

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An Integrated Ecosystem Assessment has been variously described, including approaches that focus on descriptions of the ecosystem (ecosystem overviews), through to policy-led and management-focused assessment methodologies that may or may not be based on complex or rather simplistic models. The FP7 project ODEMM developed an approach that focuses on achievement of policy objectives and then provides a number of linked structured assessment methodologies to capture how state and change in the different elements of the ecosystem influence this (where humans and their activities are viewed as integral). ODEMM's approach assesses the state of relevant policy objectives, then provides a methodology for identifying threats to these, and from this an approach to elaborate an operational process of creating, appraising and choosing management options, where full consideration of trade-offs across ecological, economic and social issues, and evaluation of the governance complexity surrounding this, are all considered. There were some key principles that framed the ODEMM approach, including the need to be holistic and inclusive, even in data-poor situations, and the influence of these principles on the overall assessment methodology and thus also its potential scope and use, is discussed in light of the role for integrated ecosystem assessments.

Skyscrapers to bungalows: sequential invasions change rocky shore ecology

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Worldwide, marine rocky shores are being modified by alien species, but their successive impacts are rarely recorded. We documented sequential invasions of Marcus Island on the west coast of South Africa by comparing communities from 1980 (pre-invasion), 2001 (after invasion by the mussel *Mytilus galloprovincialis*) and 2012 (following invasions by another mussel, *Semimytilus algosus*, and the barnacle *Balanus glandula*). Their influence on habitat complexity was measured with a novel technique enabling retrospective calculation of historical complexity. In 1980, habitat complexity, invertebrate abundance and species richness decreased from the low-shore to the high-shore, but became more homogeneous in 2001 after *M. galloprovincialis* invaded and elevated habitat complexity across most of the shore. In 2012, these variables returned to pre-invasion patterns, after *M. galloprovincialis* declined in the high-shore and was replaced there by *B. glandula*. Community composition differed significantly among nearly all years and zones and some once-dominant native species, in particular *Aulacomya atra*, *Choromytilus meridionalis* and *Scutellastra granularis*, were negatively affected by the invasions. Changes in habitat complexity induced by the sequential invasions could reliably predict changes to invertebrate abundance and species richness, but could not alone predict changes in community composition.

Sliding baselines' in marine protected areas: the European native oyster as a case study

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Marine Protected Areas (MPAs) are becoming a mainstream global management tool. Special Areas of Conservation (SACs) constitute almost half the area of UK MPAs. Baselines for 'Favourable Conservation Status' (FCS) in SACs are usually the condition at designation. Anecdotal evidence suggests that native oysters *Ostrea edulis* once formed extensive reefs in the North Sea and around the UK. In the present study an SAC in FCS with no contemporary records of oyster reefs was opportunistically selected. Systematic search and evaluation of archaeological, historical, current ecological records and directed surveys revealed that it is highly likely that oysters were once a significant ecological component of the SAC. Museum specimens and accounts showed that native oysters were part of the Dornoch Firth since the Neolithic. Human populations ate them and records were matched by oyster shell finds in targeted surveys. Environmental conditions remain appropriate for oysters. The loss of a keystone suspension feeder probably had significant ecological consequences. Choosing convenient baselines for 'Favourable' condition may have overlooked former healthier ecosystems with greater biodiversity and resilience. The present study illustrates a classic 'sliding baseline' scenario for MPA management. Restoration of native oyster populations in European MPAs would be a management phase-shift.

Resilience of maerl infaunal assemblages to experimental habitat removal and replacement

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A potential mitigation strategy to protect the surface layer of dead maerl habitat from dredging operations was tested within Falmouth Harbour, UK. The mitigation strategy was to remove the surface layer of maerl, allowing the channel to be deepened before replacing the maerl. The trial tested the feasibility of this strategy by assessing the resilience (resistance and recovery) of the habitat and associate faunal assemblage to this disturbance. Six sites each had a Treatment area where maerl (top 0.3 x width 5 x length 5 m) was removed and replaced, and a Control area, each sub-divided allowing three sampling times (baseline, 5 weeks and 44 weeks after re-lay). Approximately 45 % of taxa and individuals were lost between baseline and Week 5 following the trial dredge, recovering by Week 44. Assemblage composition followed the same pattern, with a significant difference in Week 5 between Treatment and Control, but no such significant difference apparent by Week 44. The trial demonstrated that removing and replacing the top 0.3 m of maerl habitat is technically feasible and whilst some differences in the habitat structure following re-laying were evident this did not seem to affect the habitat quality enough to prevent re-colonisation of infauna.

Gyrodactylus salaris recorded by analysis of eDNA in water samples from an infected river

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Gyrodactylus salaris is a freshwater parasite highly virulent towards Atlantic salmon and has caused major damage to Atlantic salmon river strains with near extermination of the host in a few years after infection. In order to improve a monitoring program for detection of the parasite, we here report a method for recording the presence of *G. salaris* in a river by real-time PCR analysis of environmental DNA (eDNA) isolated from water samples from the river. The method showed high sensitivity, and the analysis detected *G. salaris* DNA at all studied locations in the infected Lierelva river (Norway, south east), whereas none of the water samples from the non-infected river Mandalselva (Norway, south) were found to contain DNA from the parasite. As a control, eDNA from Atlantic salmon and brown trout was detected in water samples at all locations in both rivers. These results are promising in the development of a tool that can complement existing monitoring methods for recording of the presence of *G. salaris*.

Effects of trawling ban on the diversity of demersal crustaceans (orders: Decapoda and Stomatopoda) in the marine environment of Hong Kong

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Bottom trawling has been demonstrated to be one of the most destructive fishing methods to marine benthic communities. Since the 1970s, marine fishery resources in Hong Kong, especially large predatory species, have been overexploited by non-selective fishing gears including bottom and pelagic trawlers. To mitigate such impacts, the Government of the Hong Kong Special Administrative Region has implemented a territory-wide trawling ban in local waters since 31 December 2012. This study aims to investigate whether crustacean resources, in particular of the orders Decapoda and Stomatopoda, could recover after the implementation of the trawling ban in Hong Kong waters. During July to November 2012 and June 2013 to November 2014, 60 surveys were conducted at eastern, western and southern coastal water zones of Hong Kong using a commercial shrimp trawler (with scientific research permit). A total of 210 crustacean species from 36 families were recorded. Differences of community structure were identified among years 2012 (before trawl-ban), 2013 and 2014 (after trawl-ban) based on the results of multivariate statistical analysis. During the wet season, overall abundance of crustaceans from all three zones in 2014 was higher than that in 2012, while biomass, species richness, species diversity and evenness indices, and Warwick statistic remained unchanged. Trophic levels and population dynamics of selected crustaceans will also be studied in order to evaluate the effectiveness of the trawl-ban policy.

Aiding conservation effort with insights gained from biodiversity partitioning

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Aquatic habitats can have a major contribution to the regional biodiversity of landscapes. However, in highly modified landscapes found in the majority of Western-Europe a multitude of demands are imposed on the landscape (e.g. agriculture, irrigation water supply, water safety and recreation). This creates a challenge for nature managers in protecting and conserving biodiversity within these landscapes. Effective conservation on a regional scale can benefit from a thorough understanding of the architecture of biodiversity. Regional biodiversity (gamma) is shaped by the local community at a site (alpha) and the difference in community composition between sites (beta). These different components are influenced by different processes (e.g. alpha: local habitat quality, beta: environmental heterogeneity), allowing for relevant insights to be gained from this partitioning. Beta diversity, in turn, may be partitioned further into a nestedness and a turnover component, which are affected by different spatial and environmental gradients. By means of a large field survey (21 regions, 24 sites per region) in ditch network systems in the Netherlands, we illustrate the value of diversity partitioning in understanding and conserving regional biodiversity. We identify important gradients affecting diversity and contrast results of multiple organism groups (helophytes, aquatic macrophytes and zooplankton).

The bottom line in baselines

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Gardline Environmental Ltd has been conducting marine environmental surveys globally for over 30 years. The scope and layout of our surveys are determined by local and international regulations and, ultimately, by the client needs. Such surveys require establishing existing baseline conditions of the survey area in biological, geophysical and oceanographic terms. Depending on the survey requirements, a variety of methodologies can be used, resulting in diverse data sets, often with interdisciplinary techniques combined. The advantages of generating comprehensive baselines are clear; case studies show that combining acoustic data with seabed imagery data can help define the extent of environmentally sensitive areas protected under legislation, and where using methodologies such as quantitative seabed imagery analysis, acquired via towed and static camera systems, can help assess large seafloor areas, or where sampling may not be an option. The need for comprehensive baselines is apparent, particularly when facing issues such as climate change, where the accuracy of measuring change depends on the baseline data quality. However, a comprehensive baseline alone is not sufficient, it is crucial that data are comparable, allowing future monitoring. Standardisation of methods locally, if not globally, would maximise the use of available data, as well as the requirement for data to be made publicly available.

The harvest of *Ascophyllum nodosum* in eastern Canada: can the industry operate under an ecosystem approach?

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The harvest of the brown seaweed *Ascophyllum nodosum* (Rockweed), has been a traditional fishery for more than 50 years in eastern Canada, providing jobs for hundreds of coastal residents. Originally used as a raw material for manufacturing alginate and "kelp" meal, today this resource is used to produce a biostimulant extract for crops and animal feed supplements. This single species is the major economic resource of the local seaweed industry in Canada. The management of marine plants was, until the late 80s, based on the traditional single species approach. In the early 90s, and after a devastating socio-economic experience caused by the collapse of important groundfish fisheries in eastern Canada, stakeholders and environmental groups demanded tighter regulations with a more integrative approach to marine resource management. The ecosystem aspect is critical for the management of marine plants, especially kelps and large fucoids such as rockweed; they have been recognized as both a resource and a habitat. Consequently, under the new Ocean Act regulating marine resources in Canada, these seaweeds cannot be exploited under the concept of single species resource sustainability. Thus, the industry is now trying to operate under a different management paradigm: the ecosystem approach. An evaluation of the successes and challenges of this new approach to rockweed resource management in eastern Canada is presented here.

Improving the interoperability and public availability of aquatic taxonomic species registers

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The use of organism names is ubiquitous in a wide range of scientific and policy domains. Specialist taxonomic databases and tools to query these data are essential for ensuring the quality of biological data from collection and generation to data management. Species information systems - e.g. for monitoring biodiversity status and trends - and those dealing with policy concerns benefit from such high quality tools and databases ensuring the interoperability of the data. The World Register of Marine Species (WoRMS), the Register of Antarctic Marine Species (RAMS) and the Freshwater Animal Diversity Assessment (FADA) database are three major Global Species Directories hosted in Belgium. They consist of authoritative taxonomic data curated by international experts and contribute to several European and global initiatives. Given the potential overlap in taxonomic specialists and the complex nature of the data, exchanging expertise and data among these initiatives is highly beneficial for all parties involved. Through the LifeWatch and AquaRES projects, the interoperability and public availability of these aquatic species databases is being ensured and enhanced. Tools and services are guaranteeing the automatic and timely exchange of data between WoRMS, RAMS and FADA, but also expose the data for use in other initiatives and applications.

Long term dynamics and spatial pattern of diversity around offshore oil platforms in the North Sea

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The pattern of the benthic community composition around offshore oil platforms gradually changes through time at different spatial scales. We assessed long term dynamics of spatial pattern around the offshore oil platforms in the North Sea using the data from the Norwegian Environmental Monitoring Database (MOD). We modelled environmental and diversity gradients around the oil platforms using generalised additive mixed models (GAMM). The total hydrocarbon concentration (THC) linearly decreased as distance from the oil platforms and gravel content increased. It non-linearly depended on sand, Pb, total organic carbon, and duration of production. Shannon-Wiener diversity increased on gravel, decreased on sand, non-linearly decreased with THC, and fluctuated with oil production duration. We described the spatial pattern strength around oil platforms using semi-partial Mantel correlations of community, environmental and geographical distances. Strength of the spatial pattern did not depend on production duration. We identified the scales where community composition varied using partial Mantel correlograms, and modelled the effect of duration on spatial pattern with GAMM. The trends differed between the regions. The models predicted positive spatial correlation of community structure at lags from 200 m up to 1600 m, the extent of effect varied with duration of oil production.

Evaluation of ecological integrity on regional scale with the use of participatory approaches

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As a contribution to applied methods of interdisciplinary research, this work is taking a holistic approach to ecosystem state and services valuation, using participatory mapping (PPGIS) and expert knowledge in context of a landscape. In an web-based survey, ecosystem services are being mapped by stakeholders from important landscape management sectors of the study region. Paralell to this survey, environmental experts are asked to valuate integrity of the subject landscape ecosystems, expressed as percentage of a potential natural state and with ecological integrity orientors. The ecosystem services demand is expressed as hotspots using kernell densities calculation, related to the associated land cover. The state of the ecosystems, classified as vegetation cover and land use, and the demand for ecosystem services constitute an approach to connect ecosystem services demand and provision and address their relationship in a scientific manner. There is a lasting debate about data insufficiency for mapping ecosystem integrity and non-monetary valuation of ecosystem services methods. An attempt to design a quantitative index of regional ecological integrity is presented, understanding the socio-ecological system as a whole; the key is to identify and understand different stakeholder preferences and, according to related ecosystem capacities, set landscape management goals for environmental planning

Dispersal and Connectivity

KEYNOTE SPEAKER: STUART JENKINS

Dr Stuart Jenkins is a reader in marine ecology at the School of Ocean Sciences, Bangor University. His PhD and post-doc positions were conducted at Port Erin Marine Laboratory on the Isle of Man, after which, in 2001, he was appointed a Fellow at the Marine Biological Association of the UK. In 2007 he moved to Bangor where he leads a group in coastal ecology. His research interests are in experimental ecology, particularly in the use of the intertidal rocky shore as a model system to develop and test ecological theory. His research has developed in a number of distinct areas, including biodiversity-ecosystem functioning relationships, supply side ecology and the generality of ecological processes over broad geographical scales. This pure research has also informed more strategic and applied research on long term change in relation to a changing climate, fishing pressure on sub-tidal soft sediment systems, invasion of non-native species and general management of near-shore and coastal ecosystems.

Linking planktonic and benthic processes to understand climate change impacts on marine benthos

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Observations to address the impact of changing climate on marine benthic invertebrates have unequivocally demonstrated changes in the distribution and relative abundances of ‘northern’ and ‘southern’ species. Such observations are usually combined with speculation regarding the mechanisms of such change, focusing on different life stages from planktonic larvae to mature adults. Here I review a range of empirical and modelling work on larval dispersal, connectivity, planktonic and post settlement processes which contribute both directly and indirectly to our understanding of how a changing climate may impact the distribution and population dynamics of marine benthic invertebrates. It is clear that advancing our understanding of the linkage between life history stages and specifically between planktonic and benthic forms is a fundamental requirement to predict and manage the influence of a changing climate on marine benthic populations.

KEYNOTE SPEAKER: STEPHEN SWEARER

Stephen Swearer is Associate Professor of marine biology at the University of Melbourne, Australia and Program Leader for the estuarine fish and pollutants group in the Centre for Aquatic Pollution Identification and Management (CAPIM). He is a marine population ecologist whose research has focused on how larval dispersal, settlement, and recruitment influence population replenishment and connectivity in marine ecosystems and the ecological and environmental factors that influence these processes. His current research is informing water, pollution, and fisheries management policy by identifying the primary causes of extinction vulnerability in coastal marine ecosystems.

Realising connectivity- the influence of early life history on the dynamics of marine metapopulations

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The replenishment of benthic marine populations is the culmination of many processes that influence the production, dispersal, settlement and survival of larvae to maturity. Although there have been recent advances in our understanding of dispersal and its importance to population connectivity, to date no study has attempted to evaluate all early life-history processes to assess their relevance to the maintenance of marine metapopulations. Using a model temperate reef fish species, the southern hulafish (*Trachinops caudimaculatus*), we present data on larval vertical distributions, larval settlement behaviour from choice experiments, and spatial population structure and integrate these empirical results into a coupled biophysical connectivity framework. We then compare modelled estimates of connectivity to larval dispersal patterns from otolith microchemistry. Our findings reveal that realistic estimates of connectivity depend on a high degree of biological complexity, highlighting the importance of empirical validation of biophysical models of larval dispersal.

Does connectivity increase resilience of biodiversity against eutrophication in networks of shallow lakes?

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Enhanced connectivity between habitats is widely promoted in conservation and restoration science, yet the consequences of connectivity between lakes for plant dispersal and biodiversity are poorly understood. Here, we assess the importance of connectivity for aquatic plant diversity for a total of 92 lakes (1-50 ha) in two lake districts: the Upper Lough Erne area, Northern Ireland, UK, and The Broads system, England, UK. Using generalised linear models, we determine whether aquatic plant diversity is driven by connectivity and/or other environmental variables, such as water chemistry and lake morphology, in each lake district for two time periods: 1983-1990 and 2006-2014.We found that connectivity plays a significant and complex role in determining aquatic plant diversity. In the Upper Lough Erne system hydraulic and aerial connectivity acted synergistically and explained a significant ($p < 0.01$) amount of diversity variation along with other environmental factors. In The Broads, the importance of connectivity changed over time in response to water quality improvement. Our findings make a significant contribution to understanding the balance between the positive and negative effects of connectivity on lake biodiversity and associated ecosystem services in freshwater landscapes.

Connectivity and persistence of a biogenic reef forming species, *Sabellaria alveolata*, within the Irish Sea

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Within Europe, the honeycomb reef worm, *Sabellaria alveolata*, is protected in its adult form as a habitat forming species. Like many coastal benthic invertebrates, *S. alveolata* feature a complex life-cycle, with a planktonic larval stage, in addition to a sessile bottom dwelling juvenile and adult stage. Populations of this biogenic reef forming species show variability on a short-term small-scale but persistence on a long-term broad-scale. This pattern of short-term small-scale change is largely driven by settlement success. We monitored fecundity in adult worms and larval abundance offshore, from three known Abundant sites (Dunraven, Aberarth, and Llanddulas) on a latitudinal gradient within Wales, monthly from March to September 2014. We also modelled predicted larval dispersal from numerous Abundant sites over a large spatial scale on the west coast of the UK, using a high resolution hydrodynamic model combined with a passive Lagrangian Particle Tracking Model. Poorly synchronised seasonal spawning was demonstrated, with regional temporal differences. Larval source and sink sites were identified, with connectivity between regional populations predicted, but limited between regions, specifically (i) north Devon and Cornwall; (ii) South Wales; (iii) Cardigan Bay and (iv) North Wales and northeast England. Predicted dispersal north of the current range limit was minimal.

Spatio-temporal trends of species specific recruitment in intertidal rocky shores

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Community dynamics in intertidal rocky shores are regulated by local to large scale processes occurring in benthic and pelagic systems. In this study we assessed the temporal synchrony of recruitment rates of intertidal barnacles and bivalves among sites (km) and between coastal islands (100 km) within the same oceanographic region. Our results evidence that recruitment variation is regulated by a balance between local and regional processes. Recruitment was not synchronic on the islands, with differences in the length of the recruitment seasons, the number and timing of recruitment maxima. Site and inter-specific differences were also important sources of variation, affecting the magnitude of recruitment rates as well as the temporal trends. The oceanographic patterns registered during this study explain recruitment variability at the local scale, which might be caused by differences in the pelagic conditions between islands. Regional coincidences were detected, suggesting that larger scale processes are also involved in population regulation. Within the same taxonomic group, barnacles or mussels, the recruitment of most species did not coincide, what may indicate an evolutive mechanism to reduce inter-specific competition at the settlement.

Settlement of *Chthamalus* spp. during daylight flood: a global pattern to a higher post-settlement success?

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Intertidal barnacles of the genus *Chthamalus* have an extensive global geographical distribution. Previous observations indicate that *Chthamalus montagui* settlement in Portugal is much higher during daylight flood than during daylight ebb or night. The generality of this pattern was tested in three locations/species (*C. montagui*, Portugal; *C. dalli*, USA; *C. dentatus*, South Africa). Settlement of *Chthamalus* during 6 hours on artificial plates was measured in these locations considering several dates and three treatments: daylight flood; daylight ebb; and night. In the large majority of dates, settlement was higher during daylight flood than during the next or previous daylight ebb or at night. Additionally, we investigated whether this pattern could enhance *C. montagui* metamorphic success, based on the fact that the submersion period following settlement is longer when cyprids settle during the flood instead of during the ebb. Ebb and flood (control) treatments were manipulated by transplanting settlement plates to tide-in and tide-out conditions at Sines (Portugal). Overall, 88% of the "flood" cyprids turned into juveniles 15 h after settlement, while only 57% of the "ebb" cyprids completed metamorphosis in the same period. The initial amount of submersion time after settlement is a factor to be considered as influencing juvenile survival.

Does source-sink dynamics facilitate the invasive success of *Micropterus dolomieu*?

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Source-sink theory has been extensively utilized to explain ecology, evolution and population dynamics, while source-sink models have been employed to investigate landscape heterogeneity and the conditions promoting local adaptation and phenotypic plasticity in an attempt to characterise dispersal patterns. Invasive species experiencing rapid range expansion provide an ideal opportunity to examine the source-sink theory, as they often spread into a broad range of habitats and environments that may or may not resemble their native range. Recently, aquatic studies have observed morphological variation between source and sink populations, attributing the observed population dynamics to these differences. Furthermore, it has been postulated that adaptive plasticity in morphological traits could enhance the establishment and persistence of individuals in sink populations, while adaptive divergence of fitness-related traits at fine spatial scales may occur in a limited number of generations. Surprisingly, no study to date has looked at the effect that source-sink dynamics might have on invasive aquatic species and how this could drive a species' invasive success. Here, we investigate the impact of source-sink dynamics on invasion dynamics by employing mathematical modelling, morphometrics and geomorphometric techniques. Results will be discussed.

Dispersal and connectivity of limpets in the Azores (NE Atlantic)

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Limpets have traditionally been collected as a food resource in the Azores (NE Atlantic), and in the last decades, stocks have undergone a dramatic decline, showing clear signs of overexploitation. New conservation actions are urgently needed and should be based on a multidisciplinary framework towards the understanding of population dynamics and connectivity of such keystone grazers, within and across the Macaronesian archipelagos. Here, we develop and describe the use of microsatellite loci to study the genetic structure and connectivity between limpet populations in the Macaronesia, and in Azores in particular. The use of novel molecular tools developed for *Patella aspera* and *Patella candei* showed significant population genetic differentiation across archipelagos (Madeira, Azores and Canaries) for both species, but not within archipelagos. At the archipelago level, the exchange of individuals from islands where exploitation is less intense can contribute for stock integrity in islands where populations are heavily exploited. Even so, a large deficit in heterozygosity was commonplace across markers and samples, probably arising as a consequence of complex population processes resulting from overexploitation as well as from the usual null allele impact in molluscan microsatellites. The coupling of genetic, biological, ecological and oceanographic information will be considered in addressing the dispersal and connectivity of limpet populations throughout Macaronesia.

Positive effects of larval quality on early barnacle recruitment through adaptive substrate selection

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Larval supply to nearshore waters is often weakly correlated with early benthic recruitment for different marine invertebrates. Although largely untested, one possibility is that the quality of approaching larvae is variable, affecting their capacity to select suitable habitat patches for settlement and subsequent benthic performance. We report results on intertidal barnacle recruitment consistent to this hypothesis. Along a 26 day sampling period, we found no significant correlation between supply and overall settlement rate on experimental arenas divided into four surfaces of contrasting microtopography. Average larval quality, proportional to lipid contents, was also unrelated to settlement rate but it strongly affected early benthic performance. Altogether, larvae preferably settled on any rough surfaces compared to smooth ones, but substrate selectivity varied substantially, positively matching the oscillation of larval quality for the first 15 day, before thick biofilms coated the plates. Early benthic performance (5 d) after two settlement events indicates adaptive substrate selection; survival and recruit size were substantially higher for individuals settling on rough surfaces (70%, 340-350 μm) compared to those settling on smooth surfaces (30%, 250 μm). Pelagic surveys indicate that the share of cyprids capable of substrate selection decrease from 61% in coastal waters to only 17% in the nearshore.

Does larval quality influence dispersal outcomes? Assessing phenotypic variability in the early life history of a temperate reef fish

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Larval dispersal is a key process in determining population connectivity, community structure, and biodiversity. It has recently been established that the environment encountered by dispersing larvae can contribute to differences in the quality of dispersers (disperser phenotype) and can lead to carry-over effects such as post-settlement survival and/or decreased fitness in subsequent life-stages. Although recent research has focused on quantifying the environmental determinants of dispersal outcomes, very little is known about how individual variability (e.g. size, growth rate) influences this process. We investigate what factors affect this dispersal experience for an individual larval fish by assessing the influence of disperser phenotype on the vertical distribution throughout the water column. Using a series of 24-hour depth-stratified ichthyoplankton sampling periods and a 3-dimensional bio-physical larval dispersal model, we quantified disperser phenotypes (based on larval condition indices and otolith growth history), their vertical distribution patterns (sampling depth), and potential dispersal outcomes (dispersal model) for the southern hulafish, *Trachinops caudimaculatus*, in Port Phillip Bay, Australia. Preliminary analyses reveal significant patterns in the depth distribution of hulafish larvae, and stratification related to larval size. Understanding the influence of larval phenotype on dispersal outcomes will contribute to our understanding of marine population connectivity and persistence.

Post-settlement growth of hake from the Norwegian coast based on otolith microstructure analysis: evidence for counter gradient variation?

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Little is known of the life history of European hake (*Merluccius merluccius*) in the northern parts of its range - especially in contrast to the extensive literature on populations in the Mediterranean and Southern Europe. Small hake are consistently found in the fjords of Southern and South-Western Norway, but it is not clear whether these are resident fish or whether these areas are simply nursery grounds for a larger migratory population. Conditions in the fjords are generally colder than the areas inhabited by juvenile hake in other areas, and if these are resident populations, then some local adaptation may be expected. Counter gradient variation (CGV) is a common phenomenon in fish with a wide latitudinal range, and is often manifested as an increased growth rate in the most northerly populations. We might expect hake to exhibit a similar pattern. Otolith primary increment analysis has been successfully applied to measure growth in small (young of year, YOY) individuals in the Mediterranean, Bay of Biscay, and English Channel. Here we conduct a similar analysis of YOY hake from Norwegian fjords, and combine our findings with published data to test for higher individual growth at higher latitudes, as consistent with CGV.

Large scale patterns in larval quality along a gradient of productivity

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In marine invertebrates with complex life cycles, variations in the traits of critical life history stages, such as settling larvae, can affect the fate of individuals after metamorphosis. We quantified scale-dependent patterns of energetic traits in settling cyprids of *Semibalanus balanoides* from populations located along two regions of Scotland characterised by high vs. low productivity (SW and NW coast respectively, determined from satellite based estimations of chlorophyll-a). We hypothesised that cyprids from the region of high productivity would show increased trait values (size, body mass, carbon and nitrogen content). Sampling was carried out in two consecutive years (2011 and 2012) in three locations per region; larvae were collected in two shores per location. At times, variation at the scale of regions dominated over variation at smaller spatial scales. However, contrary to expectations, cyprids collected in the less productive region showed significantly larger size, body mass, C and N content than those located in the more productive SW region. Our study uncovers an important pattern of variation in key traits in a critical life history stage of *S. balanoides*; such variation may be important for the fate of individuals after metamorphosis. However, alternative explanations are required for the observed correlations between energetic traits and coastal productivity.

Influence of lake chemistry and avian vectors on connectivity among native and alien *Artemia franciscana* populations

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Artemia franciscana (Anostraca) is a highly invasive species that has spread worldwide through its use as fish food in aquaculture. We present information on its genetic diversity in its native North America, particularly in prairie Saskatchewan where the species is widespread in natural hypersaline lakes with relatively undeveloped catchment areas. Using a combination of microsatellites and mitochondrial DNA, we describe the population structure among 20 lakes. We show a high level of structure, even though this crustacean is readily dispersed by abundant migratory waterbirds (as viable resting eggs in bird faeces). Isolation by ecology is more important than isolation by distance. Genetic differences between lakes are strongly related to divergent water chemistry, which derives from relatively recent glaciations in that region, with some influence of potash mining. We compare our results with those found for introduced populations of *A. franciscana* in the Mediterranean region, especially the Iberian peninsula. Movements of waders and flamingos play a major role in explaining spread of the species there and the genetic patterns observed. The resistance of certain populations of native *Artemia* to invasion may be explained by strong local adaptation to metal contamination. We present experimental evidence to support this mechanism.

Distribution of bivalve larvae and their recruitment into adult populations

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The relationship between larval availability and recruitment into intertidal adult populations has been difficult to ascertain. The spatial scale of larval distribution nearshore is unclear; numerous potential mechanisms may concentrate larvae into patches such that recruitment is episodic. Likewise the surf zone may be semipermeable such that there is only a weak relationship between settlement and the availability of larvae close to shore. Evaluating the relationship between larval availability and settlement has typically been plagued by low resolution sampling which often obscures settlement patterns and confounds possible explanations for variation in larval settlement. We used high temporal resolution sampling of mussel larval settlement at multiple spatial scales within a region of Southwest England that includes a typical larval transport "neighbourhood". We also quantified larval abundance in the same region at different spatial scales. By comparing high resolution patterns of settlement and nearshore larval availability we test the hypothesis that fine-scale circulation patterns effectively obscure any relationship between larval availability and settlement. We also test the hypothesis that larval populations are well mixed in the nearshore water to assess the contribution of larval patchiness in the plankton can explain temporal and spatial variation in larval settlement into adult mussel populations.

Eco-ethological approach of bivalve post-settlement migrations in highly dynamic coastal systems

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The DRIVER's project focuses on the role of both environmental and anthropogenic constraints on recruitment dynamics of wild bivalves in a highly dynamic archipelago of the English Channel (Chausey, Normany). First results showed that secondary migration processes could totally change the initial patterns of natural recruitment. In order to assess the role of such processes in bivalve assemblages of temperate coarse sediment tidal habitats, we develop coupled *in situ* and experimental approaches. During the summer 2014 (5 months), we firstly monitored the dynamics of drifters, in relation to continuous acquisition of environmental parameters, through the use of three types of traps settled for a 48 h period at a 2 weeks interval. Comparisons of such data with the BBL dynamics were performed to discriminate passive (erosion due to tide and waves) from active migrations related to the behavior of bivalve post larvae. To assess such ethological responses in function of the size and behavior of the recruits (valves opening, byssus thread secretion), we conducted also fall velocity measurements' experiments on several species with either living or dead bivalves which were allowed to sink into a 5 m long Plexiglas cylindrical chamber. Both *in situ* and experimental results will be discussed in the context of management of such wild populations which constitute in coastal French zones a source of both commercial and recreative fishing

Interplay between dispersal ability, habitat isolation and size mediates responses to habitat-loss

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The structure of local communities has often been thought to be the result of local interactions between environmental and biotic factors, but recent theoretical advances have emphasized the role of dispersal in structuring communities. Understanding how these communities are structured is increasingly important taking in account the growing impacts on benthic communities. In this talk, I will present the results from three manipulative experiments investigating the effects of dispersal ability, habitat isolation and size in structuring macro-invertebrate benthic assemblages inhabiting artificial mimics of macroalgal turfs. The overall response of macrofauna to changes in habitat configuration was the result of the combined responses of species with different dispersal strategies: Isolation influenced numbers of sessile species, whilst habitat size influenced the numbers of motile species. Short-term responses were consistent with the longer-term results highlighting the role of colonisation for community assembly. Finally, habitat-loss led to significant reductions in diversity regardless of species dispersal ability. These results suggest that dispersal traits are important to understand colonisation but that the response of organisms to habitat-loss is complex and a single trait cannot may not fully explain all the types of biotic responses.

The future in store for autumn-spawning herring: from the frying-pan into the fire?

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Herring (*Clupea harengus*) can be found spawning through all months of the year, in various parts of the North Atlantic. There is a latitudinal gradient to the spawning times with summer spawners occurring as far north as Iceland and winter spawners extending further south, often as far as the Bay of Biscay or English Channel. Spring spawners are generally found everywhere, however, autumn spawning fish are generally found only in the middle of the latitudinal range. This latitudinal 'sorting' of autumn (southern) and spring (northern) may be due to environmental conditions which can be 'typified' by temperature. In a warming scenario, autumn spawners are predicted to shift further and further north, but their distribution northward may be limited by other factors. We ask whether autumn spawning herring have a latitudinal constraint due to the annual light regime in high latitude environments critically affecting the survival of the early life history stages. We speculate whether autumn spawning herring will ever be established above 70°latitude, even under warming conditions predicted in climate change scenarios

From East to West: new insights of the transoceanic migration of green turtles in the Atlantic using genetic markers

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Green turtles are highly migratory establishing multiple connections between distant areas, through oceanic migration corridors. To improve the knowledge of connectivity between Atlantic rookeries and foraging areas we analysed the genetic composition of the third largest Atlantic green turtle rookery, at Poilão Island, Bijagós Archipelago, Guinea-Bissau. We amplified long sequences (850 bp), of the mitochondrial DNA control region containing the short (390 bp) haplotypes used in previous studies. As described earlier, haplotype CM-A8 was dominant and we found two long variants of this haplotype: CM-A8.1 (97.4%) and CM-A8.3 (1.3%). Importantly, we also identified in Poilão the haplotype CM-A42.1 (1.3%), which was an orphan haplotype, to date found only in juveniles from Argentine and Brazilian foraging aggregations. A mixed-stock analysis (MSA) revealed the foraging grounds used by the green turtle population of Poilão, confirming the connectivity between South America and West Africa, proposed in previous works. Our study expands the knowledge on migration patterns and connectivity of green turtles in the Atlantic, evidences the importance of using more resolute markers (i.e. long sequences) and larger sample sizes, and emphasises the need for more genetic sampling at West African foraging and nesting grounds to further resolve the connectivity puzzle.

Larval transport in dynamic nearshore flow: stochasticity, behaviour or fast tracking currents?

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The scales of dispersal of propagules influence connectivity, dynamics and structure of many benthic populations. Limited dispersal, controlled by behaviour, is revealing the importance of nearshore hydrodynamics in governing cross-shore transport of larvae. We examined the distribution of larvae of several invertebrate taxa along a 300 km stretch of coastline in South Africa, sampled in grids in bays and on the open coast. Simultaneous measurements of the current speed and direction were used to determine a potential link to larval distribution. Preliminary analysis on the physical data shows the presence of dynamic and fast flowing nearshore currents (between 900 and 2.4 km offshore) at the open coast sites. Larval distribution was variable and patterns differed among taxa in relation to such fast flow, but generally the mean larval depth positively correlated with layers of waters moving onshore. Passive taxa did not respond clearly to the fast flow while the active groups avoided the bottom depths. These results indicate the role of taxon, ontogeny and behaviourally mediated vertical control of position when evaluating the influence of nearshore flow on the direction and magnitude of larval transport, with repercussion on cross-shore transport, alongshore transit and potential delivery of benthic larvae to adult sites.

Predicting recolonization following local extinction using physical circulation models and graph theory

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In coastal marine systems, physical transport via transport in ocean currents is a major driver of population connectivity and contributes to setting the range limits of marine species. In variable environments, range limits may change over short timescales as local extinction events may be followed recolonization. Such events are mediated by population connectivity and larval dispersal. Here we use population connectivity models to predict the progress of recolonization after local extinction events, using the barnacle *Semibalanus balanoides* in Southwest England as a case study. Connectivity matrices were generated by releasing simulated larvae into velocity fields generated using two circulation models of differing spatial scales. Using a graph theory approach, the resulting connectivity matrices were used to (1) classify sites into regions with low connectivity among regions, identifying potential barriers to dispersal and recolonization, (2) examine the number of generations required to recolonize sites within and between regions, and (3) identify central sites in the connectivity matrices that represent areas that would prevent recolonization if they were to become inhabitable. Recolonization predictions generated by the connectivity matrix analysis showed a similar pattern to observed recolonization events by *S. balanoides* in Southwest England.

The role of meta-community dynamics in the recovery of damaged river systems: evidence from long-term data

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Polluted rivers in heavily industrialised regions can lead to highly specialised meta-communities. Where such communities are extensive, there exist few locations in which different species from clean-water meta-communities can colonise reaches once polluting discharges are controlled or removed. Analyses of long-term (multi-decadal) data from rivers in the English Midlands indicate that the rates of ecological recovery of hitherto polluted rivers can vary widely; recovery rates may depend on the proximity of clean rivers or reaches from which new colonisers can originate. It is well known that flying insects of various species can colonise across landscapes where there are proximal streams and that the sequence of colonisation can vary across streams. Where colonisers have come from other watersheds, recovery may, of course, be very much slower. In such circumstances, is the ecological recovery of rivers quantifiable to the extent that we can predict the rates of recovery in various situations? This paper examines groups of polluted rivers and streams in the Midlands of England over 50 - 60 years and compares the recovery rates in relation to the proximity of cleaner rivers and reaches as a means to assess the feasibility and value of long-term predictions of ecological responses to improving water quality.

Dispersal upon returning to the sea

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The dispersal of three species, all with terrestrial ancestors and relatively wide distribution, was investigated in shallow waters of Dongsha Atoll, South China Sea. The turtle grass, *Thalassia hemprichii*, relies on adult plants and seedlings for long distance dispersal, since the lacunae in their leaves and stems are filled with gas and allow dislodged plants to float. They remain floating for months and maintain the capability to grow in a suitable habitat. The function of seeds, in contrast to its land ancestors, is to fix to the substrate as soon as possible. The earthworm, *Pontodrilus litoralis*, could survive relying only on seawater. Wood provides lodging, travel and food. The marine midge, *Pontomyia oceana* inhabits shallow reefs and has a planktonic stage of 2 - 3 days. Once dispersed in the sea, individuals are unlikely to encounter one another during the short adulthood of 1 - 2 hours. Floating wood may be used to make their long distance dispersal practical since larvae could settle en masse and develop on wood surface. The wood keep developing sessile larvae and pupae together as a dispersing unit until the last hour when emergence and mating occurs. In all three examples, the originally "benthic" stages are the stage travelling.

Tracking larvae with molecular markers to estimated recruitment success of different cohorts and potential connectivity in soft-shell clams, *Mya arenaria*

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The partial spawning strategy can lead to the production of many distinct pools of larvae within a single reproductive cycle. Following the fate of these larval groups from birth to settlement with molecular markers might shed light on mechanisms regulating their population recruitment. Measurements of prodissoconch I (estimation of egg size) and prodissoconch II (estimation of size at metamorphosis) on newly settled post-larvae allowed us to estimate larval and post-larval growth rates, as well as dates of spawning and metamorphosis using retro-calculations. Each weekly samples were sorted according to size and genotyped at seven microsatellite loci for comparisons among samples and with adult reference samples. Egg size from all cohorts measured were similar, but size at metamorphosis decreased during the settling season coinciding with an increase of temperature. While traditional differentiation statistics suggested the absence of sweepstakes reproductive success, the level of relatedness found within and among larvae and recruit samples suggested otherwise. Our results suggest that the first larvae produced in the season were the most successful to survive recruitment. Results also show direct evidence for larval retention and demonstrate for the first time larval and post-larval kin aggregation in a marine bivalve.

Food Webs and Trophic Dynamics

KEYNOTE SPEAKER: EOIN O'GORMAN

Eoin O'Gorman is a NERC independent research fellow at Imperial College London. His research is focused on understanding the role of trophic interactions in mediating ecosystem-level responses to global change. He worked on Lough Hyne marine reserve in Ireland as part of his PhD with Mark Emmerson at University College Cork, where he manipulated the diversity of marine benthic predators in sub-tidal cages to show that weak trophic interactions are important for the stability of complex food webs. He developed his interest in assessing the impact of multiple environmental stressors during his first fellowship with Tas Crowe at University College Dublin. Experiments manipulating nutrient enrichment and top predator body size have demonstrated the potential for trophic cascades and alterations to food web structure. Most recently, he has collaborated with Guy Woodward on a natural warming experiment in Iceland. Here, a catchment of streams in the geothermal Hengill valley exhibits a temperature range from 5 - 25°C, without any other confounding physical or chemical features. This system has proved invaluable for demonstrating important exceptions to temperature-size rules, how population and community structure vary with warming, and the temperature dependence of biomass, growth, and production across multiple trophic levels in a natural setting.

Changes in food web structure along a natural temperature gradient

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The Earth is currently undergoing a level of atmospheric warming unprecedented in historical times. Research to date on the biological impacts of climate change has largely focused on the phenology and physiology of individuals, as well as changes in species range shifts and distributions. However, impacts of environmental stress on higher levels of organisation such as communities and ecosystems cannot be predicted from effects on individual organisms alone. As such, it is imperative that we consider the consequences of future climate change scenarios on the structure and complexity of whole systems. Most studies investigating climate change impacts at the community level are limited by the use of tightly-controlled laboratory conditions or tend to be temporally or spatially confounded. Here, we overcome these limitations by using a geothermal stream system to show that warming simplifies ecological network structure and alters the flow of energy through food webs. These effects will have profound consequences for stability, resilience to extinction, and the continued delivery of ecosystem services. Given the universal projections of rapid warming over the coming century, these results provide an early warning signal of impending ecological change.

KEYNOTE SPEAKER: PIPPA MOORE

Dr Pippa Moore is a marine community ecologist with particular interests in climate change ecology, ecological sensitive design of coastal and offshore infrastructure and trophic dynamics in shallow-water ecosystems. She is part of the Hawkins stable and was his 50th PhD student. Pippa is now a Reader in Marine Ecology at Aberystwyth University.

Is herbivory an important regulating process in UK kelp forests?

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Herbivory can be an important structuring process in kelp forests with urchin herbivory in particular leading to strong cascading effects. In the UK there is little evidence for the presence of strong urchin herbivory with only a few limited examples of urchin grazing leading to barren formation. It has therefore been suggested that herbivory is not an important structuring process in UK kelp forests. *Patella pellucida* is an obligate mesoherbivore of *Laminaria* as an adult and can be found in very high densities on kelp laminas. Here we show that *P. pellucida* graze considerable amounts of kelp biomass, leading to slower growth rates and reduced photosynthetic performance. While the importance of mesoherbivore grazing as a regulating process in kelp forests needs further research, our results suggest that it should not be ignored. Moreover, evidence suggests that mesoherbivores may preferentially consume different kelp species, likely as a consequence of differences in the concentration of anti-herbivory secondary metabolites. This is particularly interesting as in a biogeographic transition zone, the trailing edge species, *L. digitata*, is preferentially grazed over the leading edge species, *L. ochrelueca*, with potential implications for competitive interactions between these two kelp species.

Incorporating intraspecific variation and metabolic theory into our understanding of consumer-plant interactions

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While the direction and strength of trophic interactions is a widely investigated concept in ecology, how variability is generated within a single interaction remains less explored. Two possible drivers of this variability include consumer population density and body size, which often exhibit heterogeneity or patterns across space and time. Using field enclosures placed in a southeastern US salt marsh, we orthogonally manipulated the body size and population density of a dominant primary consumer (snail) and measured the subsequent effects (leaf damage and final biomass) of consumer grazing on cordgrass plants. After three months, we found that increasing body size and density multiplicatively reduced plant biomass and shifted the sign of consumer plant interactions from positive (enhanced plant biomass) to strongly negative. However, when both consumer body size and density were incorporated into a single metric, metabolic biomass (mass 0.75), we were able to parsimoniously explain the response of plant biomass to the manipulated consumer populations. These findings suggest that, when quantifying consumer-plant interactions, we must also consider intraspecific variation within consumer populations. In addition, there remains a need to further understand how metabolic demand may constrain consumer populations and shape species interactions, especially in the context of environmental change.

Regime shifts in the southern Benguela inshore region

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Overfishing and human-induced climate change are putting severe pressure on marine ecosystems. In the southern Benguela, a number of key species have undergone spatio-temporal changes over the last three decades. We focus on the inshore ecosystem, and using empirical and modelling approaches, we identify shifts in key marine resources and associated kelp beds, possible effects of overfishing and corresponding shifts in climate. The West Coast rock lobster is an important species both in terms of its commercial value and the role it plays in structuring benthic communities. Its decline on the west coast and concurrent increase along the south-west coast has led to a regime shift of kelp ecosystems in the south, with ominous repercussions for abalone populations, which have suffered the combined effects of illegal fishing and indirect effects of the lobster 'invasion', because lobsters consume urchins, and urchins provide essential protection to juvenile abalone. We developed an ecosystem model that gives insights into this regime shift and the role of overfishing the ecosystem. Coinciding with the shift in rock lobster and other key species, we detected shifts in the South Atlantic High Pressure system, winds, and upwelling, all of which support observations that ocean temperatures are cooling in this region.

Seasonal variability of trophic structure in two mid-intertidal *Fucus* spp. communities using a δ^{13}C and δ^{15}N approach

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Canopy-forming macroalgae are of major importance for coastal areas since they exhibit a high photosynthetic activity, allowing large storage of organic carbon. Nevertheless, their role as organic matter supplier within their communities remains poorly understood. Moreover, numerous processes in these communities are under seasonal control and could potentially lead to strong modifications in their trophic structure. This study aimed to investigate the food web structure of the two widespread mid-intertidal *Fucus vesiculosus* (Linnaeus, 1753) and *Fucus serratus* (Linnaeus, 1753) communities along the rocky coast of Brittany (France), with a special attention to their temporal fluctuation. Focusing on the dominant species of macroalgae and macrofauna, the food webs of these communities were studied in September and December 2013 and March and June 2014 using an isotopic (δ^{13}C and δ^{15}N) approach. Both communities exhibited nearly the same food web structure with several trophic pathways. The canopy-forming algae, i.e. *Fucus* sp., were not acting as the dominant suppliers of organic matter for consumers while they represented the most abundant algal species. Finally, the trophic structure of these communities did not fluctuate seasonally, even though some variability in isotopic ratios was found for several species.

The effect of material fluxes from artificial structures on neighboring infaunal communities in an urban subtidal landscape

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One of the main ways in which marine environments are altered by urbanization is through the addition of artificial structures. In the complex patchwork of soft sediment and artificial structures that results from the urbanization process, material fluxes and cross-habitat interactions may be frequent. In subtidal surveys of the Seattle area (Washington, US), we found that red macroalgae and shell material from artificial structures become incorporated into adjacent soft sediments. To test the effect of these material fluxes on neighbouring infaunal communities, we conducted a series of enrichment plot experiments. Experimental plots were treated with shredded red macroalgae (*Chondracanthus exasperatus*, *Polyneura latissima*, and *Sarcodiotheca gaudichaudii*) and shell hash (>1mm), and were evaluated for macrofauna composition and phaeopigment concentrations. Single enrichment events had no significant effect on infaunal community composition, regardless of the time since enrichment. Additionally, phaeopigment concentrations decreased rapidly following enrichment with red macroalgae, suggesting that algal material may be broken down or extricated from sediments over extremely short time scales. We discuss these findings and present preliminary results from a follow up study conducted in summer 2015 to evaluate the effect of repeated enrichment events on soft sediment communities in urban subtidal landscapes.

Biotic invasions can alter interaction networks and nutritional composition of zooplankton communities

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Quantifying the changes to biotic interactions modulated by invasions of non-native species in the context of other environmental pressures has become a key challenge in predicting the structure and dynamics of ecological communities. We used multivariate autoregressive models with detailed time-series data from the upper San Francisco Estuary to assess the topology, direction and strength of biotic interactions following major invasions of non-native zooplankton. We simultaneously compared the effects of fish and clam predation, environmental temperature, and salinity intrusion. We found changes in the networks of biotic interactions in the freshwater and brackish regions of the estuary after the invasions. Our results suggest intensified negative interactions between native herbivores and other groups, increased bottom-up influence of juvenile copepods, but weaker influence of phytoplankton following the invasions. We identified salinity intrusion as a primary pressure but showed relatively stronger importance of biotic interactions. We also showed differences among species in trophic position, elemental stoichiometry and fatty acid composition, confirming the taxon-specific differences in nutritional composition. Our findings highlight the importance of integrating nutritional quality into the long-term community dynamics.

An herbivorous starfish unexpectedly shown to be an equal competitor to grazing limpets

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Competition between herbivores is known to be an important mechanism that affects the distribution of benthic assemblages. Limpets, such as *Cellana tramoserica*, are efficient grazers due to their feeding apparatus, which allows them to scrap deep into rocky substrata removing microalgae and macroalgal spores. This, and previous work, indicates that *C. tramoserica* is a strong competitor for food when competing with other gastropods. It is not known, however, how limpets interact with herbivorous starfish. The starfish *Parvulastra exigua* coexist in high abundance with the limpet *C. tramoserica* on intertidal rocky shores in SE Australia. This starfish has the potential to remove large amounts of microalgae from the surface of the rocks, and is known to remove substantial biomass of microalgae from rocky substrata. Potential competition between these species is not understood as previous studies were contradictory and confounded by experimental artefacts and lack of controls. Here we tested the prediction that *C. tramoserica* would have a negative effect on growth of *P. exigua* when competing for food whereas *P. exigua* would have a neutral effect on *C. tramoserica* growth. The results did not support our hypothesis, but demonstrated a reciprocal negative effect of interspecific competition between these two grazers.

Community reorganisation in response to declining predator size, nutrients and warming

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Although it is widely accepted that increases in temperature regimes associated with climate change will affect ecological communities, ecosystems are simultaneously exposed to numerous other sources of stress and so it is important to address the effects of climate change in the context of many different stressors. It is also important to know whether the long-term indirect effects of warming will be as ecologically significant as short-term physiological effects and whether nutrient enrichment can offset some of the demands increased temperature can exert on ecological systems. To address these issues, we examined the impacts of warming (a direct effect of anthropogenic climate change), eutrophication (resulting from the fertilization of land) and altered patterns of population body size (the expected indirect result of longer-term warming) in an outdoor array of marine mesocosms, comprising a predator (the shore crab *Carcinus maenas*), an assemblage of grazing detritivores (amphipods), and algal resources. Warming increased mortality rates of crabs, but had no effect on their moulting rates. Nutrient enrichment and increased temperature had near diametrically-opposed effects on the assemblage, confirming the notion that the ecological effects of warming and eutrophication can cancel each other out. This suggests that nutrient enriched systems might act as an energy refuge to populations of species suffering the effects of longer term warming. Decreasing crab size caused a trophic cascade that led to a reduced abundance of certain algae, though the extent of this effect was mediated by nutrient enrichment. This suggests that the long-term decreased body size effect of warming is of similar ecological consequence to any short-term direct effects of higher temperature that might be experienced by individuals, and should thus be considered in future experiments attempting to unravel the ecological effects of climate change.

Kelps or fucoids? How herbivore preferences affect the structure of canopy-forming algal communities on the Tohoku coastline.

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Urchin barrens are a feature of many temperate marine reefs worldwide, although in some regions they are considered ephemeral rather than a long-term feature. Seasonal changes in urchin abundance and grazing along the Tohoko coast of Japan have been observed. In this study we examined the grazing preferences and rates of the urchin *Hemicentrotus pulcherrimus* in a laboratory experiment during late autumn. The stipe and laterals of the fucoid alga *Sargassum confusum* and of the laminarian *Eisenia bicyclis* were provided to compare rates of consumption. The consumption of *Eisenia bicyclis* was more than double that of *Sargassum confusum*. The laterals were consumed nearly double that of the stipe for *Eisenia bicyclis*; and more than double in *Sargassum confusum*. Results will be discussed in context with the implications for canopy-forming algal communities.

Spatio-temporal effects of upwelling on the fatty acid composition of benthic filter feeders in the Benguela Current ecosystem

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Temporal and spatial variations in mesoscale nearshore oceanographic conditions play an important role in the distribution of primary production, and thus resource availability for intertidal consumers. Advection of nutrient rich waters by upwelling allows the proliferation of diatoms, later replaced by dinoflagellates. We examined upwelling effects on intertidal filter feeder diets on the west coast of South Africa, investigating the fatty acid (FA) composition of the adductor muscles and gonads. Tissues differed strongly with the gonads presenting a higher proportion of essential FAs. This could relate to faster turnover rates of gonad, or preferential retention of specific FAs for reproductive purposes. FA composition did not vary as a function of upwelling or upwelling season, but there were strong dissimilarities among sites. Adductor muscles were characterized by diatom trophic markers at one non-upwelling site, and dinoflagellate markers at one upwelling site. Mussel tissues showed consistent FA proportions, indicating similar food quality and quantity across summer and winter and under upwelling and non-upwelling conditions. Although not significant in any analysis, FA signatures indicate that upwelling played a role at all sites, influencing upwelling and non-upwelling sites similarly. This suggests that the influence of upwelling on this coast is pervasive and diffuse, rather than discrete.

Towards a holistic view of a lake food web - the importance of including benthic habitats and parasites

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The majority of published ecological networks are food webs, host-parasitoid networks, or mutualistic networks. Thus, they are typically delimited to a single type of interaction, and by more or less clear temporal and spatial boundaries. There is an increasing awareness of these limitations, and a general plea for including more than one type of interaction in ecological networks. Parasitism is a common way of life for many species in every ecosystem. Several aspects of food web structure may be altered when parasitic interactions are combined with traditional predator interactions in food webs. Most established food webs from lakes are restricted to the pelagic habitat. Recently, lake research has taken a more holistic view, with increasing awareness that benthic processes are important and tightly connected to the pelagic food web compartment. In this study we expand the traditional pelagic free-living lake food web to include both benthic and parasitic organisms, and we explored their importance for the food-web structure of a sub-arctic lake in Northern Norway. Pelagic and benthic compartments were interconnected by species interacting across habitat boundaries. Such coupling of spatially separate habitats may have important implications for the structure and dynamics of the recipient systems.

"Think I'll go eat worms?..": does nutrient pollution transform upper trophic levels of estuarine food webs?

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Eutrophication of estuarine environments is a global conservation concern. As a consequence of excess nutrients extensive intertidal macro-algal mats can develop. These can cause anoxic conditions within the sediment and potentially transform the composition and diversity of benthic invertebrate communities. This could have implications for higher tropic levels and the functioning of the estuarine food web. In Poole Harbour (UK) mats of green algae now develop from spring and persist into the autumn months, thereby coinciding with the arrival of nationally and internationally important populations of migratory coastal birds (waders and wildfowl). To determine the impact of algal mat development in the harbour on bird feeding behaviour the abundance and biomass of benthic invertebrate prey was measured over two winters at three locations that were colonised by algal mats. This was combined with monthly bird counts and video of bird behaviour to determine the species' functional response. The invertebrate communities were highly variable yet showed that abundances and biomass of important bird prey species declined with increasing macro-algal coverage and biomass. Field observations and video analysis of the coastal birds revealed that some species are adapting their feeding behaviour to cope with substantial algal mat coverage.

Grazing impact of microzooplankton on phytoplankton in a subtropical coastal embayment in Hong Kong

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Microzooplankton consist mainly of phagotrophic protists and metazoan larvae <200 μm. In this study, dilution method, combined with phytoplankton size fractionation (20 - 200 μm, 5 - 20 μm) and 400% of primary production on alloxanthin indicates strong selection toward cryptophytes. Our results suggest that microzooplankton play important role in controlling phytoplankton growth in pelagic food webs in subtropical coastal embayments.

Evolutionary Biology

KEYNOTE SPEAKER: ROMINA HENRIQUES

Dr. Henriques has a MSc (Lisbon) in Conservation Genetics and a PhD (London) in Molecular Ecology. She has been an active researcher in aquatic sciences for the past nine years, working and lecturing in the fields of freshwater and marine biodiversity, population genetics, evolution, fisheries management, phylogeography and molecular systematics. Her work focus primarily in understanding how oceanographic features can influence the evolutionary history of marine species, and assess how future climate changes may impact marine biodiversity in the southern African region. She is particularly interested in applying multiple molecular tools to investigate population genetic structure and connectivity in commercially exploited fish species, in order to inform management and fisheries policy. Dr. Henriques has worked with several commercial fishes such as the Cape hakes, geelbeck (Cape salmon), silver and dusky kob and garrick. She has published eight peer-reviewed papers, research reports, has been invited to peer-review for several accredited international publications, and supervised five postgraduate students. Dr. Henriques is currently a Postdoctoral Researcher at Stellenbosch University (South Africa) trying to understand how local adaptation and natural selection are shaping the evolutionary history of demersal fishes. Furthermore, she serves at the Scientific Advisory Panel of the Benguela Current Commission.

Pitfall of using hypervariable markers to detect hybridization in the marine environment

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Understanding how species evolve is the major focus of evolutionary biology. The classical paradigm of reproductive isolation leading to speciation has been challenged partially due to hybridisation and introgression events. In the marine environment, an increasing number of studies have documented the presence of hybrids using genetic markers. Here, hybridisation appears to occur preferentially between closely related sister-species, with the probability of introgression decreasing with an increase in genetic distance. Exceptions to this pattern were reported for the *Merluccius* genus, with hybrids detected between deeply divergent species. In particular, introgression was observed between the Cape hakes (*M.* and *M. paradoxus*), which, although sympatric, have been isolated for 3.5-4 My. Such level of divergence would not suggest that viable hybridisation was likely. As such, we analysed 1246 individuals using microsatellites and mtDNA to further assess the pattern of introgression between these species. Our results revealed that the number of hybrids identified varied with the type of analyses done. Sequencing of the flanking region of one of the microsatellite locus combined with the absence of mito-nuclear discordance suggests that the Cape hakes do not hybridise. Overall, these findings point to the need to exert caution when using hypervariable (and homoplasic-prone) microsatellite markers to examine hybridisation events between highly divergent species.

Origins and evolution of Southern African Laminaria (Phaeophyceae)

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Laminaria pallida is a major kelp forest dominant on the west coast of South Africa and Namibia. The species has a biogeographical gradient in stipe length, morphology and hollowness, which affects its ecological role. In its southern range plants dominating in deeper water have shorter solid stipes, whereas further north stipes are increasingly hollow. The species dominates inshore in the south, ultimately replacing *Ecklonia maxima* in shallow water kelp beds in northern South Africa and Namibia. Environmental data suggest that water turbidity best correlates with the change in form and species dominance. Molecular studies using four marker regions reveal that *L. pallida* with various stipe morphologies constitute a single clade, mostly closely related to warm temperate northeast Atlantic *L. ochroleuca* and southwest Atlantic *L. abyssalis*. It is hypothesized that the evolution of long hollow-stiped forms in both *Laminaria* and *Ecklonia* is an adaptation to conditions in the Benguela upwelling system. We produced a calibrated phylogeny consistent with hypothesized dispersal of *Laminaria* into the N. Atlantic from the N. Pacific after the opening of the Bering Strait ca. 5.5 Ma, and a later dispersal to the South Atlantic.

Fundamental species traits across a latitudinal gradient: does the competition-colonization trade-off hold true?

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One of the most common explanations for species coexistence is that trade-offs in species traits prevent any one species from excluding all others. The competition-colonisation trade-off is a classic example, whereby species can spatially coexist if there is an inverse relationship between colonising and competitive abilities. The strength of the trade-off is predicted to vary with latitude due to environmental and evolutionary gradients. In sessile invertebrates, patch size can be used as a tool to measure the strength of trade-off. This is because smaller patches are more difficult targets for larvae so are usually dominated by good colonising species with high fecundity, whereas good competitors with lower fecundity can more easily find larger patches where they can grow and dominate. We measured the strength of trade-offs across 20 degrees of latitude by deploying patches of various sizes in the field. There was clear evidence for the trade-off, and the strength varied with latitude. Latitudinal variation was likely due to variation in the rate of ecological processes, particularly resource acquisition and competitive exclusion. Trade-offs were most evident at locations where resource limitation had been reached, indicating that the strength of the trade-off is mediated by resource availability.

Ecological and evolutionary consequences of air-breathing by crabs in mangrove forests

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Mangroves play a fundamental role in oceanic and coastal abiotic and biotic fluxes. Being at the interface between terrestrial and coastal tropical ecosystems, mangroves provide a two-way bridge between marine and terrestrial lifestyles, and are a "natural laboratory" for evolutionary studies of the colonisation of land by marine invertebrates. In such systems, crustaceans, gastropods and even fish demonstrate evolutionary sea-to-land adaptations, ranging from tree climbing to air-borne odour detection. Such strategies are clearly demonstrated in the mangrove crabs, the embryonic and adult stages of which are predominantly air breathers. In East African mangroves, individuals of widespread, abundant crab species trap large amounts of air in their burrows at high tide. Corrosion casting techniques in combination with Micro Computed Tomography reveal that these crabs have evolved a well-developed lung in the gill chamber, which allows them to exploit this air reserve during immersion. Such terrestrial adaptations of mangrove crabs for air-breathing influence the availability and fluxes of oxygen in mangrove sediments, and may be an important co-evolutionary relationship involved in the radiation of semi-terrestrial crabs and mangrove trees in sheltered, tropical, ecosystems.

Metabolic plasticity, immunocompetence and the evolution of geographical range size

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Despite their close phylogenetic relationships, organisms often differ dramatically in geographical range size. Previous work has shown that organisms with wide distributions often tolerate a wider range of environmental conditions such as temperature. However, whether such features explain all variation in geographical range size remains unclear. This project aims to investigate the mechanisms which drive or control geographical range size through studying metabolic plasticity and immunocompetence in aquatic beetles from across Europe. Twelve species from the same genus were sampled from the centre of their ranges, and using a variety of methods their metabolic plasticity and baseline immunocompetence were assessed. In the species analysed so far we have found that one narrow range species has significantly higher ATP and lactate levels than other species, which decreased and increased respectively with temperature. However in the more widespread species' ATP and lactate showed no clear response with temperature. Preliminary analysis also showed that the same narrow range species had significantly lower antimicrobial peptide activity than the other species analysed and that species with better defences against parasites had lower antimicrobial peptide and phenoloxidase activity, suggesting a potential trade-off in immune defences. This work will contribute to our understanding of the mechanisms controlling distributional range size and shed light on whether common widespread organisms are generally better in terms of their metabolism and immune systems or whether there are energetic trade-offs at play.

Understanding decision-making and evolution in marine snails using computational techniques

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A relatively non-complex environment means high shore littorinid snails, in our case *Echinolittorina radiata* and *E. malaccana*, are good candidates for modelling behaviour based on simple movement rules, and model outputs match reality, in terms of distribution patterns, well. Such patterns during emersion include aggregations that appear to indicate self-organisation. Modelling allows us to conduct 'experiments' that are otherwise impossible and show how robust self-organisation can be established and sustained over evolutionary time: a mechanism for the evolution of co-operative behaviour. However, when species co-operate there is pressure for 'cheats' to evolve and by modelling the two species we found that a very high proportion of cheats can occur before the co-operative system collapses. That in silico studies can give us a fresh view of behaviour and its evolution is not in doubt. The issue is whether we trust the outputs of models: can we extrapolate the 'strong match' to reality, to situations where there is no reality to match to (and if there was we would not require the models)?

The eastern Pacific coast as a natural transect of the globe for macroevolution research: the 'Into the Tropical Museum' hypothesis

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A casual glance of the globe reveals that the eastern Pacific (EP) coast spans uninterrupted across nearly the entire north-south length of the planet - from Tierra del Fuego to Alaska. The denizens of this natural transect of the globe are ideally suited for testing basic, yet poorly understood concepts in macroevolution. For example, the processes driving the latitudinal gradient of biodiversity (higher species richness towards tropical latitudes) are elusive despite its near ubiquity. In this study, we assess the shape of the latitudinal gradient of diversity of rocky intertidal gastropods from 308 field sites spanning the EP. We then use the fossil record of this group to test for differences in the region (tropical vs. temperate) of origination of taxa, extinction rates between regions, and migration of taxa between regions over evolutionary history. Our results confirm the peak in species and higher taxa diversity within the tropics. Our fossil analysis reveals that origination rates are not different between regions, but extinction rates are lower in tropics. Moreover, many taxa that do originate within temperate latitudes tend to migrate towards tropical latitudes over time. We refer to this macroevolutionary dynamic as the "Into the Tropical Museum Hypothesis".

Turn and face the strain: investigating directional alignments between animals and environmental stressors

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One of the fundamental goals of ecology is to understand and explain patterns of distribution and behaviour of animals at different temporal and spatial scales. At the smallest scale, individuals often orientate with respect to a particular variable. Most studies on orientation have only focussed on environmental factors e.g. sun or waves. This has led to a distorted understanding of animal orientation, and this limitation has prevented a broader level of knowledge from being developed. It is true that habitat properties, interspecific interactions and intrinsic individual attributes may be equally important factors but their role is largely unknown; here I attempted to start to address this gap. Limpets play a fundamental role in structuring rocky intertidal shores. Using field experiments I found that habitat properties and individual attributes may be as important as environmental factors in driving orientation in the limpet *Cellana tramoserica*. Additionally, there were no physiological consequences of different orientations. By combining my experimental results and conclusions from the literature, I will discuss a conceptual framework based on the idea that patterns of orientation are set and maintained by a relationship between the ability of an animal to alter its orientation and the relative importance of environmental/habitat variation.

Did phenotypic plasticity precede adaptive trait divergence during the radiation of cichlid fishes? Evidence from the generalist Lake Malawi cichlid *Astatotilapia calliptera*

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Vertebrate adaptive radiations are characterised by substantial diversity in ecologically-important morphological traits such as body shape and jaw morphology. However, such traits are also known to exhibit considerable plasticity. The flexible stem model proposes that developmental plasticity in such traits in ancestral lineages directs later adaptive evolution. Here we investigated this concept in *Astatotilapia calliptera*, a "generalist" species from the Lake Malawi radiation with striking variability in morphology, diet and habitat use. We first show that morphological variation across 15 populations within the Lake Malawi catchment is strongly associated with dietary differences, consistent with observed morphological variation having a functional basis. We next tested if variation observed among populations in the wild was present in laboratory-reared populations. Our results clearly demonstrated that variation among populations of wild fish was exaggerated relative to that observed among individuals from the same sites reared in controlled laboratory conditions. These results are consistent with ecologically-relevant plasticity being a major driver of morphological variability within this Lake Malawi species, and support a flexible stem model of adaptive evolution. We propose that functional phenotypic plasticity within riverine founders of species flocks may have been an important prerequisite for rapid speciation and adaptive radiation

Ecological traps: current research and future directions

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Ecological traps occur when animals exhibit maladaptive habitat selection in the face of rapid environmental change and have serious implications for conservation and management. We critically evaluate the current state of ecological traps research, with the aim of providing suggestions for better understanding and managing these important phenomena. We review the ecological traps literature to: (1.) extract information about where and with which taxa studies have been undertaken, (2.) calculate effect sizes for fitness and habitat preference (the two key components of traps), and (3.) assess the methods that have been used to measure fitness and preference. We highlight four key findings: (1.) there have been few studies of traps in aquatic ecosystems, (2.) habitat preferences for traps and their fitness consequences are strongly, and negatively, related, (3.) the strength of their effects depends on how traps form, and the taxa they affect, (4.) methods that provide ambiguous information about habitat preferences may hinder the identification of traps. We use our key findings to show how traps could be better studied and managed in the future, by highlighting modifications to current methods used to study them and fruitful avenues for future research.

Processes underpinning reef cryptofauna community structure

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Cryptofauna are the small, hidden mainly invertebrates that live hidden amongst the reef structure, e.g. crabs, brittle stars. This component of biodiversity is greatly understudied despite comprising the majority of coral reef biodiversity and being crucial to ecosystem function. Over the last three years we have quantified the diversity of the two most numerous cryptofauna taxa inhabiting dead coral colonies, crustaceans and molluscs, from the Chagos Archipelago, Indian Ocean. One component of this work aims to understand the processes underpinning the composition of the Pontoniinae (a sub-family of cryptofauna shrimp) on dead coral colonies using a novel approach which links phylogeny, traits, environmental variables, and space. To do this we use the species composition of the Pontoniinae, their phylogeny coupled with select life-history traits for each species, and environmental variables. We explore whether species within a community (a dead coral colony) have similar life-history traits and if species within a geographical area show phylogenetic similarities, and if this changes over different spatial scales, from coral colonies to the Indian Ocean region. Finally we discuss whether any similarities in trait states among co-occurring species is due to environmental conditions and if these conditions act on species traits independently of the phylogeny.

Maternal effects and larval nutrition: plastic responses may favour recruitment success in a tropical barnacle

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Maternal effects on resource allocation to embryos, and pelagic food supply for larvae, may largely affect recruitment success by determining overall reproductive output and larval quality. However the interplay between these two processes is poorly known. In this study, we manipulated in a factorial design the food supply to adults and larvae of the barnacle *Chthamalus bisinuatus* and measured (i) naupliar development rate, and both (ii) the total yield and (iii) the quality of late stage larvae (the cyprid). Our results showed substantial plasticity on maternal allocation and larval development. Adults fed with a restrained diet released two times more larvae than adults given a high food supply, compatible to an anticipatory maternal effect (AME). In spite of equal mortality rates up to the cyprid stage, such surplus larval production rendered sub standard development rate under low pelagic food supply. Regardless of pelagic allocation, this AME strategy also rendered lower cyprid size. When fed a non-restrained diet, mothers producing larger cyprids may increase survival of recruits; a strategy compatible to a bet-hedging maternal effect.

Doing the right thing at the right time: behavioural partitioning in tropical littorinid snails

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To effectively partition fitness-associated activities such as feeding and mating within the narrow tidal activity window is crucial to intertidal animals, especially for high-shore species in the tropics where the physical environment is extremely stressful. We investigated how two littorinid snails, *Echinolittorina malaccana* and *E. radiata*, partition their behaviours within their potential activity window in summer (stressful season) and winter (non-stressful season) in Hong Kong. Similar behavioural patterns were exhibited by both species in summer, with males following female trails for mating whilst awash on the rising tide, and then individuals following each other, regardless of sex and species, to form aggregations on the receding tide. Behaviours such as standing and towering were exhibited during emersion periods, and thermal imaging techniques showed that these behaviours were associated with thermal regulation. In winter, however, both species spent most of the time aggregating in crevices throughout the tidal cycle, a pattern that is likely to be associated with avoidance of strong wave action. The behavioural and indeed life history patterns of these littorinids, therefore, show temporal plasticity at different scales (within a tidal window and also seasonally) which is closely linked to the variable physical environments experienced on seasonal tropical shores.

Caddisfly resource allocation to life history along a stream gradient

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Environmental conditions that influence how insects trade-off energetic allocations to survival and reproductive aspects of their life-history are still poorly understood. Here, we use stream caddisflies as model organisms to investigate resource investment in newly emerged adults along an altitudinal gradient in the temperate River Usk (Wales, UK). We predicted that thermal changes (13°C to 15°C) from higher to lower altitude should increase adult maintenance costs and reduce resource available for reproduction. In *Hydropsyche siltalai*, adults from higher altitude allocated more resources to protein, carbohydrate and lipid in reproductive tissue while those from lower altitudes allocated more to lipid and glycogen in somatic tissue. This implies that emerging adults at high altitudes can invest into early reproduction while those at lower altitudes reallocate resources into somatic maintenance. In contrast, resource allocation in adult *Rhycophila dorsalis* was unaffected by altitude, implying that environmental responses are species-specific. Different caddisfly species are likely to vary in their sensitivity and response towards changing environmental conditions, particularly stream warming. We advocate further investigations into insect resource allocations as they provide important insights into life history responses to global change.

Fisheries and Aquaculture

KEYNOTE SPEAKER: ANNE MARIE POWER

Anne Marie Power is a marine zoologist based at NUI Galway in Ireland for the last eleven years. Her research background is in marine and coastal ecology, spanning patterns and processes in rocky intertidal biodiversity and zooplankton dynamics. Anna has become interested in several aspects of applied research in recent years. Her PhD students have been working on basic fish biology that supports developments in aquaculture (e.g. reproductive biology of cleaner fish). But she is also interested in sustainable fisheries, including Dublin Bay prawns (*Nephrops*) and has been working with colleagues on these fisheries mainly, though not exclusively, on inshore populations. At NUI Galway, Anna leads the Biodiversity & Bioresources research cluster at the Ryan Institute and School of Natural Sciences (www.ryaninstitute.ie/research/biodiversity-and-bioresources).

Restocking potential of Dublin Bay prawn (*Nephrops norvegicus*) in inshore grounds

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The need to produce ever-increasing quantities of food for growing human populations at global coastlines means that there is a need to develop existing fisheries, without compromising sustainability. We present the results of an SME-led project www.nephrops.eu to enhance the production of Dublin Bay prawn in inshore grounds by enhancement of creeling activity. Re-stocking exercises demand several proofs-of-concept: Which grounds should be developed? Will stocked individuals remain resident? How fast will stocked individuals grow? What will be the economic return of this activity? Data is presented relating to the growth, residency and survival of the *Nephrops norvegicus* on the Irish west coast using a large-scale tag-recapture experiment. The majority of animals released were recaptured ∼275 m from the release point, indicating that residency over ∼one year was extremely high; provided that the original releases were carried out on suitable 'grounds'. Growth rates varied across size classes but the average growth achieved

within a year represented graduation into a new size-grading category and a corresponding increase in monetary value at sale. Several protocols were developed to ensure good practice in releasing *Nephrops* and ensuring local fisherman could test whether re-stocking would work on their own grounds.

Monitoring the effects of an offshore mussel farm in Lyme Bay

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The effects of a new offshore mussel farm in Lyme Bay, UK, on existing infauna assemblages were investigated within two test sites comprising two treatments; a Trial and a Control. Infauna samples were taken using a Shipek grab before (2013) and after (2014) the installation of three mussel ropes and subsequent spat settlement. Sediment sub-samples were also taken to investigate any changes in habitat. There was a 32% increase in infauna abundance in the two Trial treatments after the installation of mussel ropes. Interestingly, abundance decreased in the Controls. The two main groups dominating the samples were polychaetes and crustaceans. In the Trial treatments, average abundances of these groups increased; polychaetes by 40% and crustaceans by 34%. However, abundances of both decreased in the Control. This coincides with a greater increase in organic content in the Trial than the Control treatments from 2013 to 2014. The study showed that the mussel farm did not have a negative effect on infauna assemblages after its first year, despite sediment organic content increasing. However, monitoring will need to continue to investigate the full effects of the mussel farm on infauna assemblages as it becomes more established.

The use of vessel monitoring system and landings to describe temporal trends in fleet dynamics to support an ecosystem approach

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The European Commission Policy aims to implement an ecosystem-based fisheries management (EBFM) by 2020. In accordance with this policy and advancing towards an Ecosystem Approach to Fisheries (EAF) in the Mediterranean trawling fisheries, this study explores the relationship between: monthly position of trawl vessels using vessel monitoring system (VMS) and monthly position of catches of target species taking into account length frequency. The assessment was carried out with six trawlers from Cartagena port (Southwestern Mediterranean) during the period 2007 - 2010. The results showed a seasonality pattern on the fleet movement related with the lifecycle of the target species. The fleet worked on maërl areas coinciding with the recruitment period of some important target species such as *Mullus barbatus* and *Mullus surmuletus*. These maërl habitats constitute an Essential Fish Habitats (EFH) for both species and are particularly vulnerable to the impact caused by trawling. The linkage of fleet dynamics, biological data of exploited resources and habitat condition may provide a good tool for the management of this Mediterranean fishery and achieve a Good Environmental Status (GES).

Too much of a good thing: do eutrophic waters inhibit or encourage trematode infection?

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Parasites are increasingly recognised as important components and drivers of ecological communities. Their ability to castrate, immunocompromise and manipulate hosts has implications for community level interactions and potential ecosystem functioning. Eutrophication is a widespread chronic stress along many European coasts. It is likely to affect parasitic infection through productivity or host density. In this yearlong study, intertidal gastropods, the common periwinkle *Littorina littorea*, dog whelk *Nucella lapillus* and common limpet *Patella vulgata* were screened for parasitic infection. Gastropods were sampled monthly at three rocky shores of differing water quality and bimonthly in a marine reserve on the southwest coast of Ireland. The 3,509 gastropods screened to date have shown juvenile trematodes to be the dominant macroparasite present in all gastropods at all sample sites. Results suggest a difference in gastropod immunocompetence as trematode prevalence was low in *L. littorea* and *N. lapillus*, but high in *P. vulgata*. Of the nine trematode species recorded *Echinostephilla patellae*, found predominately in *P. vulgata*, was the most common. Lowest rates of trematode infection and species richness were recorded within the reserve. To better understand differing trematode occurrence, host, site and intertidal community characteristics are being examined. This study aims to evaluate the link between eutrophication and the trematode-gastropod-environment interface.

Genetic structures and divergent loci in the natural populations of walleye pollock, *Theragra chalcogramma*

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A weak genetic structure is generally reported for marine fishes and has been explained as a ubiquity of pelagic larval stage among marine fish, which promoted the extensive gene flow between populations. The evolutionary divergence among populations occupying ecologically distinct environments can occur even in the high gene flow populations. *Theragra chalcogramma*, a walleye pollock has a widespread geographical distributions and exploits different ecological niches from extremely low temperature in the Bering Sea to variable temperatures in the Japan waters (Northern Pacific Ocean and Sea of Japan). The inclusion of populations from latitudinal gradients provides natural replications of population to study the evolutionary response towards environmental gradients mainly in adaptive loci that associated with ocean temperature.

To examine genetic structure of the populations, we applied a new method (MIG- seq, multiplex ISSR Genotyping by sequencing, Matsuki and Suyama submitted) for detecting whole genomic SNP markers. Through genotyping by sequencing of 185 individuals obtained from both Japan and Bering Sea, a total of 160 - 340 SNPs were obtained and used to assess (Multiplex ISSR Genotyping by sequencing) tags were screened for SNPs and used to assess the fine-scale population structures among pollock. Population divergence and structuring were observed in both population, which confirmed the existing of genetic break between populations (FST: 0.05 - 0.07). The evidence of outlier SNPs revealed the dramatic divergence between Bering Sea and Japan water's populations (FST: 0.183 - 0.625). A significant correlation of allele frequencies at outlier loci with environmental parameters were assessed to supported the hypothesis that populations might be adapted to local conditions. This study highlights the usefulness of complementing genome scans and ecological data to identify selective pressures potentially acting upon candidate loci at a local scale.

Stock enhancement of *Homarus americanus* through the improvement of hatchery production

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The RPPSG, a non-profit association of lobster fishermen has developed an enhancement programme aiming to improve the number and the quality of *Homarus americanus* post-larvae released in southern Gaspé, Québec, Canada. The purpose of this programme is to develop an optimized protocol to ensure a highest survival of released postlarvae. Recent works have demonstrated that larval nutrition influence post-larval behaviour and could be an important parameter for their survival after seeding. Therefore, we focused on the development of an optimized diet ensuring the best post-larval quality. Lobster larvae were produced in strongly aerated 450 L conical tanks and their performances were compared when 1) fed freshly hatched *Artemia* or lipids-enriched *Artemia* and 2) cultured in green water or clear water. Better larval performances and four times higher lipid levels were observed for larvae fed with lipids-enriched *Artemia*. Also, no significant differences were found in the larval and postlarval performances or lipid profiles whether green or clear water was used to rear larvae. Lastly, to track hatchery-reared lobsters in the wild and evaluate the efficiency of post-larval seeding, we are developing a new marking technique based on feeding larvae with ^{13}C marked *Artemia*. We propose to determine the rate of preservation of the ^{13}C marking in different lobster tissues over a 2-year period to validate the potential of this mark.

Age determination of the common whelk, *Buccinum undatum*: developing tools to improve fisheries management

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The UK fishery for the common whelk *Buccinum undatum* is one of the largest in Europe, with a value of £13.7 million in 2013. The increase in overseas demand for whelks has driven an expansion of the fishery in recent decades, leading to several documented population declines. Stock assessment is problematic as length-based age and maturity assessments are ineffective, highlighting the need for a robust age determination method. The aim of this project is to validate the periodicity of growth rings present in the calcium carbonate statoliths located in the foot of the whelk. Analogous in function to the fish otolith, the statolith contains a high resolution archive of past growth. Through a complement of geochemical analyses including Secondary Ion and Isotope Ratio Mass spectrometry (SIMS and IRMS), the annual trace element and stable isotope profiles in both the shells and statoliths were reconstructed to validate the annual periodicity of the growth rings. The results indicate that the formation of the growth rings occurs during the winter following a slowing of growth. This validation of statolith growth rings provides a new age determination technique, which could potentially lead to improved management of *B. undatum* fisheries through robust stock assessment.

How sustainable are UK inshore fisheries?

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Inshore fisheries in the UK contribute to employment, income and regional identity but can come into conflict with environmental conservation objectives and other uses of coastal waters. Inshore fisheries fundamentally differ from offshore fisheries in that there is less information about the fish stocks and the activities of professional, part-time and recreational fishers. We have developed a sustainability framework based on objectively chosen criteria that consider the ecological, economic and social sustainability of inshore fisheries.

The sustainability framework was applied to the inshore fisheries in the northwest of England. In addition to ecological information, the status and vulnerability of the fisheries on the level of the individual fisherman were assessed by a livelihood survey and semi-structured interviews. Adaptive strategies varied greatly between different groups of fishermen. Using cognitive mapping as a semi- quantitative approach to analyse stakeholders' perceptions, trade-offs between the differing sustainability goals were segregated from other types of conflict. The sustainability trade-offs were modelled in a Bayesian belief network of the fishery to facilitate communication and consensus- building between stakeholders. The Bayesian belief network and the sustainability framework can be adapted to other small-scale fisheries for self-assessment or to promote sustainable seafood consumption.

Community structure and performances of periphyton-based biofilter for sustainable mariculture

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Effluent treatment and high-protein feed incur much of land-based aquaculture's operation cost, and influence their sustainability. Periphyton is a plant-dominant community of aquatic micro and macroorganisms that develops as natural film on various surfaces when exposed to elevated nutrient stream and light. Periphyton has been well demonstrated to serve as natural food source in aquaculture systems, while keeping water quality at high level. Knowledge on marine periphyton, however, is lack. In the current study we examined the growth performances and the nutrients removal efficiencies of a novel periphyton-based biofilter fed with mariculture effluent. Metagenomics analyses, supported with microscopy and chlorophyll profiling, were performed to study seasonal and other factors' effect on community composition and dynamics. Daily growth rates of periphyton were 2.7 and 5.6 g(DW) m^{-2} at autumn and spring, respectively. Ammonia uptake rates were correlated with growth showing highest daily uptake rates of 0.62 - 0.68 g TAN m^{-2} g^{-1}(AFDW). Protein levels reached 42% of total periphyton biomass. Community composition in periphyton consisted diatoms, cyanobacteria as well as other bacteria, flagellate, nematode, and ciliate. Microalgae, mostly cyanobacteria in the summer and diatoms in the autumn, were dominated young periphyton. Silica enrichment increased the periphyton's population diversity, enriched it with diatoms, and postponed appearance of macroalgae.

Effects of the trawling ban on demersal fish communities in the marine environment of Hong Kong, South China

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Fishery resources in Hong Kong have been over-exploited since the 1970s. In 2010, there were still around 400 trawlers operating in local waters. These trawlers non-selectively catch marine organisms of all sizes, while exerting severe physical damage to the benthic ecosystem. To mitigate the associated impacts of overfishing and trawling, the Government of the Hong Kong Special Administrative Region has imposed a territory-wide trawling ban across local marine waters since 31 December 2012. This study aims to investigate if the trawl-ban policy is effective to facilitate recovery of demersal fish resources, in terms of species diversity, abundance and biomass, in Hong Kong. Under an approved scientific permit, trawl surveys were conducted using a commercial shrimp trawler in eastern (EW), western (WW) and southern waters (SW) of Hong Kong from July 2012 to November 2014. A total of 244 fish species from 75 families were encountered. The fish communities in July-September (wet season) and October-November (dry season) between 2012 (pre trawl-ban), 2013 and 2014 (post trawl-ban) were compared. The results showed that there were significant differences in community structure of the demersal fishes among the three years and the three zones. In both wet and dry seasons, there was significantly higher Shannon's diversity index (Exp H') in 2012 and 2013 than in 2014. Significantly higher biomass and species richness of the fishes were also recorded in the dry season of 2013 when compared to 2012 and 2014. Spatially, the abundance, biomass and level of disturbance in EW were significantly higher than those of WW and SW, but the species richness, Exp H' and evenness index (J') of EW were the lowest among the three zones. The current trawl surveys will be continued until May 2016. Trophic levels and population dynamics of selected fish species will also be studied to verify if there is ecosystem recovery brought by the trawl-ban.

Peptidase compensation in the digestive system of the whiteleg shrimp *Litopenaeus vannamei* against the soybean trypsin inhibitor

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Peptidase inhibitors are present in every living organism and their function is to regulate active peptidases. Different families of peptidase inhibitors are known, especially from plants. The soybean meal, widely used in aquaculture, is rich in protein but contains peptidase inhibitors. The aim of this research was to study the effect of the soybean trypsin inhibitor (SBTI) in the digestive system of the whiteleg shrimp *Litopenaeus vannamei*. Adult shrimps were fed with 0.025, 0.05, 0.1 and 0.2% of SBTI to study the effect of the concentration of SBTI. Feces and digestive glands were sampled to prepare enzymatic extracts and trypsin, chymotrypsin and total proteolytic activity were quantified. In a second trial, adult shrimps were fed with 0.1 and 0.2% and digestive glands were sampled at 0, 1, 2, 4, 23, 24 and 48 h to study the effect of the SBTI during time in the gene expression and activity of digestive peptidases. The specific activity of trypsin and chymotrypsin decreased and the total proteolytic activity had no significant differences. Composition of peptidases was different among treatments; new peptidases were observed in feces and the digestive gland, indicating a peptidase compensation to counteract the presence of the inhibitor in the feed.

The Lyme Bay experimental potting project

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Marine Protected Areas (MPAs) have been identified as tools for marine conservation. In 2008 a 200 km^2 MPA was designated in Lyme Bay, England, banning all bottom-towed fishing; after which impacted reefs started to show signs of recovery (Attrill *et al.* 2011). However static fishing gear (mostly potting) continues to increase which could threaten recovery.
The impact of potting on the marine environment is not understood. The Lyme Bay experimental potting project is a 3 year programme, funded by Blue Marine Foundation, aiming to quantify the impact of potting on seabed features and associated target species to determine a sustainable level of potting for this region. Potting densities are manipulated within a range of 500 x 500 m experimental areas throughout the MPA from which data is collected. Underwater baited and towed videos are used to assess changes in benthic communities and populations of associated mobile fauna. Seasonal quantitative potting collects data on target species, bycatch and spillover.
Our results will help inform local and national management policy and provide evidence on potting impacts. Local fishermen are involved in designing and maintaining the project, as well as collecting data, as this project demonstrates successful collaborative science, a necessary approach for successful MPA success.

Role of membrane lipid during salinity adaptation in mud crab, *Scylla serrata* (Forskal)

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Importance of chloride cells of the gill epithelial tissue in osmoregulatory processes during salinity adaptation is well known. The mud crab, *Scylla serrata* is an economically important euryhaline estuarine species. The present paper emphasis the role of the plasma membrane of the chloride cell in osmoregulation during acclimation to high or low saline water in mud crabs. A significant variation in membrane fluidity, plasma membrane lipid composition, intracellular ion composition and the activities of Na^{+}-K^{+}-ATPases, Mg^{++}-ATPase and Ca^{++}-ATPase was observed in this crab when they were acclimated to 1 and 35 psu saline water. The changed membrane lipid composition and the fluidity of the plasma membrane of chloride cell help in modulating the activities of ATPases and thus regulate the ionic composition of the cell during salinity adaptation. Among the membrane lipid, the membrane cholesterol plays the significant role in adjusting the osmoregulation due change in the ambient environmental salinity. Upon exposition of the chloride cell in different saline media in presence of pravastatin (a potent blocker of cholesterol biosynthesis), the adjustment in the osmoregulatory process in the cell is lost.

Crassostrea virginica vs. *picoeukaryotes*: the assimilation quest

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Picophytoplankton (PPP) includes the smallest photosynthetic (0.2 - 3.0 μm) organisms consisting mostly of picocyanobacteria and picoeukaryotes. There is evidence that PPP can reach high biomass and dominate total phytoplankton biomass in nutrient-rich estuaries. However, little is presently known regarding the capacity of cultured bivalves to graze down PPP populations. In this study, we assessed the assimilation of picoeukaryotes by the eastern oyster *Crassostrea virginica*. The experiment integrated three different phytoplankton regimes comprising of isotopicaly labelled (δ^{13}C) PPP cells (*Nannochloropsis occulata*) mixed to various degrees with non-labelled nanophytoplankton cells (*Isochrysis galbana*). The extractions of five majors fatty acids (C18:1, C20:1, EPA, DHA and NMI) indicated that *C. virginica* assimilates PPP carbon in tissues. Interestingly, the nutritional regime with the lowest proportions of labelled PPP cells (20%) provided the strongest isotopic signatures. This result raises questions regarding interactions between pico- and nanophytoplankton, particularly in the context of anthropogenic perturbance in bivalve culture areas.

Bait worms: the world's most valuable fisheries and the implications for fisheries and conservation management

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Bait is integral to coastal life, but is a low value resource as fisheries are data-limited and unregulated even though the ecological impacts of collection are considerable. An assessment of three UK-based ragworm fisheries, combined with a meta-analysis of literature has produced the first global assessment of polychaete bait fisheries. Collector numbers, shore time and biomass removal rates were recorded using remote CCTV. Activity was considerable with a mean of 3.14 collectors per tide, removing 1.4 kg of *Nereis virens* per person per hour and digging up to three hours per tide, although intensity differed seasonally and between sites. Variability in collector activity and fishing preferences in conjunction with extended storage times makes it impossible to separate commercial and personal collection. The implications of these biomass removal levels, human activity distributions and personal/commercial delineation for fisheries and conservation management are explored. The five most expensive marine species sold on the global fisheries market are polychaetes. We estimate that 19000 t of *N. virens* per annum (worth £643 million) are landed in the UK with up to 400000 t globally. At local, regional and national scales polychaete bait fisheries are highly valuable and extract significant biomass, therefore, they require governance equivalent to other fisheries.

7 Poster contributions

The effects of managed and unmanaged pressures on the successful functioning of a marine protected area

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Marine Protected Areas (MPAs) have been created within the last 50 years to ensure the sustainable uses of the sea. This enables an improvement of the protection of our seas, the management of some MPAs fall short of what is expected. They are set up but then enforcements are not carried out. This leads to the original function to not to have been met. This paper examines the different pressures that an MPA can face, either endogenic (managed within the system) or exogenic (unmanaged outside of the system). These can be evaluated and the outcomes created by using the DAPSI(W)R framework, this evaluates the different activities and drives that create the pressures the MPA has to overcome. The framework is explained within the thesis. These activities can involve anything from the impacts of commercial fishing to the effect climate change is having on the fresh and salt water systems. The paper concentrates on the Dogger Bank within the North Sea as a case study as there has been plans for a 2000 turbine wind farm being created within the area, it will look at the effect this pressure will have on the MPA and the opinions of the Stakeholders involved.

Functional groups for mechanistic models of benthic biodiversity: the case of the Rance estuary (France)

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The goal of reproducing the spatial and temporal dynamics of benthic macrofauna diversity in the Rance estuary, France, has led us to adopt a mechanistic modelling approach, centred on the processes which are responsible for the observed biodiversity patterns. Aiming at a tractable version of the system, which would still retain most of the information on its functioning, we applied the emergent group hypothesis, based on 15 biological traits, which represent the most important community assembly mechanisms. The grouping of the 240 species observed in 1995 into 20 functional groups and the assignment of trait values to them based on the mass ratio hypothesis were found to preserve biodiversity patterns and were upheld, though not invariably, against both niche and neutral predictions of the emergent group hypothesis. The interactions of these functional groups with their environment and among themselves are contingent on their assigned trait values and are defined by general rules, derived from ecological theories and observed trait associations. Functional groups and rules of interaction are eventually combined into qualitative models of benthic macrofauna in the Rance estuary, generating an understanding of the system which will be employed for the construction of an agent-based model of functional diversity dynamics.

Seasonality does not affect the signature of macrobenthic assemblages associated with seagrass meadows in a hypersaline subtropical coastal lagoon

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The Red Sea is characterised by high temperature and salinity as well as low nutrients. In shallow coastal areas in the central Red Sea, salinity ranges from 35 to 40 while temperature varies from 23°C to 31°C. Despite these potentially harsh conditions, high biological diversity is known in the region. As in other sub-tropical and tropical areas worldwide, soft-sediment macrobenthic assemblages have received less attention compared to temperate regions or other habitats (e.g. coral reefs). Consequently, the factors driving macrobenthic dynamics in coastal lagoons are still poorly understood. This study applied a combination of uni- and multivariate analysis techniques to test the following hypothesis: that the patterns of biodiversity (α and β), composition and structure of macrobenthic assemblages do not change across different habitats (mangrove, seagrass meadows and bare sediment in the lagoon channel) or seasons. The study was carried out in the central Red Sea (~22 °N) in winter and summer 2014. Despite the seasonal variability in the seagrass biomass, seagrass cover had a consistent effect on the uni- and multivariate patterns of the associated benthic assemblages. Seagrass beds consistently supported higher diversity of taxa and number of individuals than mangrove and bare sediments in the lagoon channel.

Feeding habits of eight fish caught in a coral and no-coral deep-water area in the Eastern Ionian Sea (Central Mediterranean)

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The feeding habits of the eight most abundant or commercially important fishes (*Conger conger*, *Galeus melastomus*, *Helicolenus dactylopterus*, *Merluccius merluccius*, *Pagellus bogaraveo*, *Phycis blennoides*, *Polyprion americanus* and *Squalus blainville*) caught in adjacent coral and no-coral deep-water areas in the Eastern Ionian Sea were studied within the framework of the EU CoralFISH Project, in order to detect differences in the trophic strategies between species and areas through their diet. The samples were collected during experimental bottom long-line fishing in waters ranging between 300-855 m depth. Gut contents were examined from 1392 specimens. The prey items were identified to the lowest possible taxonomic level. Fullness indices and trophic indices (relative abundance, weight percentage, frequency of occurrence, alimentary coefficient and index of relative importance) were estimated by area in order to define the importance of different preys in the feeding habits of the examined species. The dbRDA analysis based on IRI index showed seven functional groups of predator assemblages based on dietary similarities. SIMPER analysis showed a dissimilarity of 64.96% between the two areas. However, PERMANOVA analysis did not show any statistical significant difference between the two areas ($p > 0.05$). Trophic diversity was higher in CA than in NCA for the whole community assemblage.

Habitat characteristics driving species richness in rock pools

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Often, patterns of species richness are attributed to heterogeneity across habitat. However, describing this heterogeneity-richness relationship requires an initial understanding of how species simultaneously respond to a multitude of habitat characteristics generated at different spatial scales (e.g. micro- vs. macro-habitat). Using intertidal rock pools as a model system, we surveyed multiple quadrats within individual pools to differentiate between micro-habitat characteristics which vary within the pool (i.e., surface complexity, depth, slope), and macro-habitat characteristics which pertain to the entire pool (i.e. elevation, volume, grazer abundance). We then applied mixed effects models to quantify the relative importance of each habitat characteristic in driving both algal species richness and individual species abundance. We found that aspects of both the micro- (i.e. slope and depth) and macro-habitat (i.e. elevation and grazer abundance) of these pools drive species richness, with effects for each covariate ranging in both sign and strength. These results suggest that habitat characteristics, which become biologically relevant at different levels of observation, may differentially influence individual species in addition to species richness as a whole. Therefore, the scales at which these characteristics affect the establishment and survival of various species will collectively dictate the patterns observed in species richness across a habitat.

Is there a relationship between biodiversity recovery and carbon sequestration trends following oligotrification in shallow lakes?

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While 20th century eutrophication of shallow lake is correlated with increased carbon sequestration, it had a devastating impact on aquatic plant diversity and abundance. Today, there are significant restoration efforts, e.g. in Europe, that led to oligotrification and to the partial recovery of biodiversity. However the impact of this recovery onto carbon burial is currently unknown. To address this gap in our knowledge, we investigate i) carbon burial (accumulation rates of organic carbon dry mass from 150 samples in 13 cores), ii) aquatic plant abundance and diversity (botanical surveys from 40 lakes and macrofossils from 12 cores) and iii) phytoplankton abundance (Chl-a monitoring) in the shallow lakes of the The Broads, England, between 1950 and 2010. Our results show the expected collapse of biodiversity during the 1980s, until water quality started to improve, followed by a slow and uneven recovery. Contrarily to our expectations, however, carbon burial did not decrease with this recovery. We infer that carbon burial is not directly driven by plant recovery but may be strongly influenced by dissolved organic carbon and particulate organic carbon from catchment input. These findings are an important contribution to accounting for ecosystem trade-offs in the management of eutrophic shallow lakes.

Different harbours, similar problems?

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Harbours and ports are important socio-economic complexes that often support high ecosystem values. Worldwide many harbours and ports have been exposed to intense and sustained anthropogenic pressure. In a review of harbours in the Asia Pacific region in 2006, Eric Wolanski noted that the footprints of harbours and coastal urbanisation have now merged. This is important as it means that the environmental legacy of shipping and industry, traditionally associated with harbours and ports, is merging with more general coastal pressures such as residential development, fishing, boating and other recreational uses.

Established in 2014, the World Harbour Project is working towards the development of resilient urban ports and harbours through a global network of collaborating scientists. Investigations of the socio-economic aspects of harbour development, environmental degradation and ecosystem restoration form an important component of the WHP, as do educational outreach and dialogue and collaboration with managers, industry and governments.

To date the project has 20 partner cities from Asia-Pacific, Americas and Europe. There are four working groups: Water and Sediment Quality, Green Engineering, Multiple Uses and Users, and Education and Outreach. Partners are involved in as many groups as they wish, with linkages and intersections between groups.

Using green engineering to restore natural communities in harbours and ports

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As on land, attention is turning to green engineering techniques to bring life back to artificial structures within the marine environment; to design structures that support rather than degrade surrounding ecosystems, and that incorporate multiple functions and that preserve vital ecosystem services. Breakwaters and foreshore developments provide an abundance of habitat that can be designed to restore or boost native biodiversity. Modifications include increasing the heterogeneity of surfaces to provide more sheltered microhabitats and building anchor points to transplant important native species.

The World Harbour Project, launched in November 2014, aims to tackle issues around multiple uses of harbours by bringing together international institutions. The project focuses on investigating and restoring ecosystem function and the development of management best-practices through working groups: Water and Sediment Quality, Green Engineering, Multiple Users, and Education.

The Green Engineering working group brings together ecologists and engineers at the forefront of this new wave of research. The group will explore the distribution and effects of artificial structures in global harbours and investigate materials and designs for green harbour structures. We will introduce a commercial partner - ECOncrete Technologies - that utilises principles of ecological engineering to enhance the biological productivity and ecological value of harbour structures.

Multiple paternity in green turtle (*Chelonia mydas*) in El Cuyo, Peninsula of Yucatán, México

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Multiple paternity is the result of female reproductive strategies, it has been demonstrated in other regions that green turtles are very promiscuous species, therefore they have high rates of multiple paternity. Our hypothesis is that we will find high multiple paternity rate in green turtle from El Cuyo, Yucatan, in consequence there will be more genetic diversity. To determinate the rate of multiple paternity we did a parentage analysis in 2014, collecting samples from 14 nesting females and their clutches, which allows us to detected 47 male genotypes by exclusion analysis, that mate with 14 females and made 58 different mating pairs. 15 out of 17 clutches present multiple paternity with an average of 3.1 males per female. Genetic diversity index (internal relatedness and homozigosity by loci) showed that observed means were significantly higher than expected in both cases ($p<0.001$) given the detected gene pool; although observed values suggest that population is still genetically diverse. Relatedness of mating pairs were also higher than expected, suggesting that a mating is not random. Results indicated that mating system for this population is both polyandry and polygyny with a male-biased operational sex ratio.

Homing in *Patella vulgata* and how climate change can affect its behavioural ecology

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Amongst the species of the intertidal shore communities the limpets are important keystone grazers. They are also good models for study behavioural ecology as their behaviour can be related to the environmental and biological interactions. Slow movements, limited foraging ambit and homing behaviour make them convenient subjects for analyses of movement patterns. This study analyses behavioural ecology of *P. vulgata,* particularly homing in *P. vulgata* and its ecology on its southern limits, in the Northern Europe (Portugal), where this species distribution can be easily influenced by climate change. This work tested the hypothesis that in protandrous species *Patella vulgata* young males would have a riskier behaviour than larger females as measured by changing home more often and making more foraging excursions at time of very low tide. This riskier behaviour leads to energy maximising, in contrast large females show greater homing fidelity to minimise risk. The other aim was to confirm the hypothesis that estuaries can be used as refuges by this species in increasing temperature and precipitation scenarios affecting also the relation with predators.

Macrozoobenthos biodiversity of Oran coastal area, Algeria (Mediterranean Sea)

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This study allows us to have an overall idea about the qualitative and quantitative status of macrozoobenthos that is rich and diverse. It is highly endangered due to human activities. The development of actions to promote conservation, including the establishment of a monitoring system and monitoring of key species is essential. The inventory macrobenthic species of the subtidal zone during four years 2009 to 2012 of follow-up shows the distribution uneven in different taxa by a dominance of sponges presented by 25 species, molluscs represented by 20 species then cnidarians by 15 and echinoderms by 9, crustaceans are the least represented, these figures reflect the strength from our quantifications and not reality. The results obtained after prospecting the sub-littoral different stations show a clear qualitative and quantitative difference between sites close to human actions (settlements, infrastructure, industry and pollution) and those far to the east and the West on the one hand and between sites hard or soft substrate on the other. The most represented groups correspond to sponges, cnidarians, echinoderms, crustaceans and mollusks bivalves and gastropods.

Metabolic responses of gammarid amphipods to salinity change and effects on growth

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The ability to osmoregulate against changing environmental salinity varies tremendously in marine crustaceans from those that are unable to maintain the osmolality of the body fluids as salinity is reduced to those that can hyper-regulate. Osmoregulation is known to be energetically costly because the mechanisms involved with ion transport require ATP to function. Hyper-regulation in dilute seawater can therefore lead to the re-allocation of energy away from other energy demanding processes, such as growth. Gammarid amphipods demonstrate a range of abilities to osmoregulate. *Gammarus duebeni* is the most tolerant and can survive salinities from freshwater to hypersaline conditions. However, they cannot reproduce when held in full strength seawater and the indication is that growth is also affected. Longer-term studies on *G. duebeni* reared at different salinities have demonstrated that this species is less likely to be able to acclimate to temperature change when held in full strength seawater. Further studies are underway to examine the effects on energy budgets and protein turnover in order to examine the mechanisms affecting the relationship between osmoregulation and growth.

Opinions and attitudes to marine non-native species and the implementation of biosecurity management

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The introduction and spread of marine non-native species is of increasing concern with wide ranging negative impacts on native biota and on coastal industries; the cost of non-native species to the British economy is estimated at approximately £1.7 billion. Biosecurity management measures can reduce the risk of introducing or spreading invasive non-native species but can have an impact on end-users of marine resources. This study focuses on the understanding of recreational boat owners and marina operators on marine non-native organisms and their opinions toward a variety of proposed biosecurity initiatives in Wales. An online survey was developed and implemented across Wales, and supplemented by face to face interviews in Welsh marinas. The results present the views shared by boat owners and marina staff. The interpretation of the results will serve to create an appropriate marine biosecurity plan with a good balance between voluntary good practice and compulsory procedures. The answers will help towards advising Welsh Government on developing an appropriate marine biosecurity plan with the least constraints possible while protecting the environment.

Evidence of change in large brown macroalgae in the British Isles

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The large brown seaweeds (macroalgae) are keystone species in both the intertidal and subtidal marine environments. Recently there have been several reports of changes in abundance in these species, within the northeast Atlantic. We assessed the changes in abundance of large brown seaweeds from historic survey data, in addition to oblique intertidal imagery. Species specific data were analysed for fourteen species of large brown macroalgae from the 1970s to the 2010s. Regional changes in abundance were demonstrated, with significant declines in abundance in the south for kelp species, and increases in northern and central regions for some species of kelp and wracks. Additionally change was assessed in a relative index of cover of large brown seaweeds, from sequential oblique imagery collected on rocky shores of the Isle of Man from the 1980s to the 2010s. A cyclic pattern of change through time was demonstrated when large brown macroalgae were considered as a functional group.

Seasonal and microclimatic acclimatisation effects on heat stress responses in the intertidal gastropod *Patella vulgata*

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Predicting species distributions in response to climate change has become an active area of research. Knowledge about the physiological capacities of organisms, specifically in response to heat stress events, is critical. We investigated physiological responses (respiration and heart beat rate) of the ectotherm limpet *Patella vulgata* to heat stress events and the role of seasonal and microclimatic acclimatisation. Individuals were collected from 5 different microhabitats in the high intertidal zone in winter and summer on a semi-exposed rocky shore. Upper thermal tolerance limits (heat coma temperatures, HCTs) and Arrhenius break temperatures (ABTs) were determined for individuals from each microhabitat in both seasons. Irrespective of seasons and microhabitats, respiration rates increased with temperature peaking at 40°C. Heart rates peaked at 34°C in winter and at 40°C in summer and rapidly declined at higher temperatures. Heart beat and respiration rates were significantly positively correlated with temperature below 34°C and 40°C in winter and summer, respectively. HCTs and ABTs were significantly higher in summer than in winter. HCTs and thermal safety margins significantly varied between microhabitats. This study highlights the variability in thermal sensitivity and physiological thermal limits in *P. vulgata* caused by seasonal and microhabitat specific temperature variability.

Mapping nursery habitat quality for juvenile fishes

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Inshore areas provide important nurseries for many species of fish, yet are subject to conflicting uses and intense human impacts. Prioritising coastal management to preserve nurseries is hindered by limited understanding of the patterns and causes of variation in nursery habitat quality. We provide a detailed, spatiotemporally-explicit description of nursery habitat quality based on growth dynamics of two ecologically and economically important fish species on the east coast of North America: striped bass *Morone saxatilis* and Atlantic menhaden *Brevoortia tyrannus*. Through a series of laboratory studies, we developed species-specific, RNA-based indices of short-term growth rate. Broad-scale application of indices to predict individual growth in Chesapeake and Delaware Bay nurseries showed considerable growth variation among tributaries and among years. Despite highly contrasting lifestyles and diets, temporal dynamics of RNA-predicted growth rates were remarkably similar for both species. Growth rate declined linearly from positive rates in mid-summer to zero or slightly negative rates in late summer. The speed of decline in growth rate varied spatially and inter-annually within each species. Our detailed mapping is revealing the spatiotemporal dynamics and underlying environmental drivers of nursery habitat quality.

Reading outside the box: researchers in marine ecology may not be reading as widely as they should

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A common dictum to budding marine and coastal ecologists when they start their career in research, is to read widely and not just on the topic area of a given project. So, it appears that we have a classic case of "do as I say, not as I do" where professional marine ecologists do not follow their own pedagogical advice. An observation was made that some coral-reef biologists appeared less knowledgeable about equivalent research having been done on in rocky systems and so using a systematic analysis of the literature, we tested the hypothesis that researchers working on recruitment ecology in marine systems would cite literature from their own system rather than across the wider range of marine ecology. The results indicated that this bias did in fact exist, but was much worse for researchers publishing results from studies on coral reefs than those working on rocky reefs. This study highlights that in spite of being in an unprecedented period in scientific history, where information has never been more freely available, researchers are still being parochial with respect to sources of knowledge.

Differential growth of juveniles of the stalked barnacle *Pollicipes pollicipes* in natural versus artificial conditions

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The stalked barnacle *Pollicipes pollicipes* is the most important intertidal economical resource on rocky shores of northern Spain and continental Portugal. The fishing pressure upon this species is intense and its commercial value can be very high (up to 200 euros per kg in restaurants). The distribution of *P. pollicipes* is restricted to very exposed shores. Growth of this species can be highly variable and one putative driving factor might be the amount and time of food availability. We will present results from an on-going project on the feasibility of the aquaculture of this species in which juvenile barnacles - that have settled onto natural and artificial substrates deployed on the rocky intertidal of a very exposed shore (Cape of Sines, Portugal) - were marked with calcein, relocated to their natural habitat or transplanted to artificial conditions (complete immersion in a floating platform located within a more sheltered environment in the lee of Cape of Sines), and left to grow for $\sim$3 months. Juvenile growth rates under both studied conditions were estimated by measuring the marginal increment of capitular plates after the calcein treatment. Preliminary results suggest that, despite large individual variability, average juvenile growth was higher under artificial conditions.

Experimental addition of intertidal rock-pools to breakwaters of an oceanic port (Sines, SW Portugal): effects on limpet abundance at the emersed-rock

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Microhabitat often acts as a structuring agent for patterns of spatial distribution of intertidal gastropods. In SW Portugal, rock-pools were found to be important nurseries for limpets. Most intertidal areas inside the Port of Sines are artificial substrata where rock-pools are rare. Mid-tidal levels of such areas have low limpet abundance, comparatively with nearby natural shores where *Patella depressa* and *Siphonaria pectinata* are common. A manipulative experiment was set-up within two breakwaters of the Port of Sines, in which two rock-pools were cored from mid-shore blocks (n=3) at two starting dates (Autumn 2009 and Spring 2010). Density of *P. depressa*, *S. pectinata* and limpets in general (*Patella* spp. and *S. pectinata*), estimated 48 months after the experiment, were analysed as response variables. The effect of rockpool addition on the emersed-rock was tested at two scales: a) small-scale, comparing areas adjacent to rock-pools with areas $<$ 10 cm away from rock-pool edges; b) larger-scale, considering areas $>$ 10 cm away from rock-pool edges versus areas within control unmanipulated blocks. Both scale effects were found for *P. depressa* and limpets in general. No small-scale effect was found for *S. pectinata* but this species was 16 times more abundant in blocks where rock-pools were added.

Effects of multiple stressors on the development and performance of the early life stages of decapod crustaceans

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Many marine decapod crustacean larvae develop in relatively stable pelagic environments; therefore, they are likely to be sensitive to perturbations in environmental conditions. The effects of climate change induced ocean acidification (OA) on decapod crustacean larvae are not well understood, particularly when combined with other co-varying environmental stressors. However, species and/or life history stages are not expected to respond uniformly to predicted changes (∼2100).

Early life stages of three decapod crustacean species common to Europe (*Palaemonetes varians*, *Palaemon serratus* and *Carcinus maenas*) were exposed to ambient (pH 8.1) and near-future (pH 7.7) OA conditions, in conjunction with variations in salinity, temperature and food availability. While larvae of *P. varians* develop in estuarine conditions, those of *P. serratus* and *C. maenas* develop in more stable coastal marine waters.

Responses varied across species, with no apparent affects on development and survival of the early life stages of *P. varians*, and varied affects on development and survival of both *P. serratus* and *C. maenas*. Effects were more apparent with multiple stressors.

Results suggest important intraspecific differences in the capacity to tolerate OA conditions, particularly when combined with other environmental stressors, perhaps reflecting phylogenetic or intraspecific differences in the larval adaptations to variable environments.

Terrestrial laser scanning as a tool for monitoring fine-scale dynamics in intertidal habitats

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The UK holds a great diversity of intertidal habitats, many of which are features of protected areas. Understanding and managing natural intertidal features for biodiversity conservation and coastal protection requires fast, effective and repeatable monitoring. Using traditional techniques such as quadrat surveys to achieve this is can be labour intensive and expensive, and often relies on significant levels of expert knowledge that may not be present or consistent over long time series. Here, we demonstrate terrestrial laser scanning (TLS) as an effective tool to detect and monitor fine scale change in the 3D structure of an intertidal *Sabellaria alveolata* reef habitat. Regular (4 - 8 week) surveys were conducted of a 1200m^2 area of reef at Llanddulas, North Wales over 6 months (August 2014 - February 2015). Change in the reef structure due to growth and erosion was detected on a millimetre to centimetre scale with high confidence. Natural variation in reef topography was quantified, and correlations were observed between change in elevation and physical morphological factors such as rugosity and reef block height. This study demonstrates that TLS is a robust, repeatable and cost-effective tool to monitor the physical structure of dynamic intertidal habitats.

Biodiversity of precious corals (Ocotocorallia: Coralliidae) and their conservation

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Members of Coralliidae, known as precious corals, have been harvested for hundreds of years. Due to resource depletion, their conservation has become a critical issue and their species delineation have been increasingly studied using molecular-based approaches. We used 110 specimens collected from major museums worldwide and newly collected specimens to study the systematics of Corallidae. Eight mitochondrial genes and one nuclear gene were applied as molecular markers to construct the phylogenetic relationship of coralliid corals. The phylogenetic trees of Coralliidae show that there are two monophyletic clades, and one includes two subclades (IA and IB). Species in Clades IA, IB, and II have unique morphological features that corresponding to those of *Corallium* Cuvier 1797, *Hemicorallium* Gray 1867, and Pleurocorallium Gray 1867, respectively. Therefore, we proposed to resurrect the 3-genera taxonomy of Coralliidae (Gray, 1867) to replace the 2-genera taxonomy of Corallidae (Bayer and Cairns, 2003). The diagnostic features of three genera are redefined based on detailed morphological studies. According to the revised taxonomic system, there are 7, 15 and 12 species in *Corallium*, *Hemicorallium*, and *Pleurocorallium*, respectively. This revised taxonomic system of Corallidae based on the coherence of phylogenetic relationships and morphological features can be applied to the assessment of population status and conservation of Corallidae.

The differential distribution of fiddler crabs: intraspecific responses to food resources

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The percentage of organic matter in sediment (POM) is the main food source of fiddler crabs (genus *Uca*). The variation of this resource may promote a differential distribution of individuals of different sizes. In this work, we examined whether the *U. thayeri* fiddler crab of different size classes (adults and juveniles) are distributed according to the POM. For this, we made 15 transects perpendicular to the water line in a Brazilian mangrove, where we placed one 75 cm square per meter. Thus, we obtained samples at different distances from the water line. Five sediment samples at 5 mm depth were taken per square to obtain POM and all crabs were captured for identification and measurement (carapace width CW). The farther from the water line, the lower the POM ($p < 0.05$; $r = -0.58$) and the greater the size of the crabs ($p < 0.05$; $r=0.26$). The abundance of *U. thayeri* increases because of the POM ($p < 0,05$; $r=0,26$), but only in juveniles ($F=18.14$; $p=0.004$). Based on this, and since the juvenile crabs have higher energy requirements, we suggest that the lower areas of the intertidal zone, where the POM is greater, favour the survival of juvenile fiddler crabs.

Assessing effects of beam trawl fisheries in the Sea of Marmara: Mismanagement and possible solutions

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Fisheries are one of the major economic activities along the Turkish coast and Sea of Marmara known as a very rich benthic and demersal biodiversity. The Sea of Marmara is an inland sea, and joined to the Black Sea by the Bosphorus and to the Aegean Sea by the Dardanelles. Although the Sea of Marmara has the smallest surface area and volume of the seas surrounding Turkey, it holds the second position, after the Black Sea, in terms of fishing. Beam trawling plays an important role for shrimp fishery in the Sea of Marmara especially the northern coast. The Turkish twin rigged beam trawl which has two identical nets rigged side by side on the same beam targets mainly the *Parapenaeus longirostris*, though some bycatch fish species have also become target species. Thus, landings of the shrimp beam trawling fleet also include some commercially valuable fish. Overall, this means that total catches comprised more non-target species than the target species.
In this work, we aimed to evaluate beam trawl fisheries in the Sea of Marmara in terms of sustainable fisheries management by the target and non-target (bycatch and discard) fish stocks, number of fishing boats and mesh size.

Stream macro invertebrates as indicators of mesohabitat: A comparison of taxonomic and trait based approaches

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Benthic macroinvertebrates are widely used as bioindicators to infer habitat quality. Invertebrate communities act to integrate physical and biological processes acting over a range of space and time. Biological and ecological traits have an advantage over taxonomic measures since they are mechanistically related to ecosystem processes and function. And as such are more ecologically meaningful to interpret.

This poster compares the sensitivity of taxonomic and trait composition and diversity to detect differences in mesohabitat quality, availability and short term dynamics. Work is presented from a study of small upland streams in the Cairngorms, Scotland. A gradient of channel morphological conditions were surveyed from 62 samples in 7 reaches, including sites recently subject to restoration measures. Invertebrates were assessed using 3 minute kick samples proportional to the habitat types present. River Habitat Survey data, pebble counts and a measure of interstitial fine sediment was also collected.

Taxonomic and functional diversity measures are compared for the sites and related to habitat variables and channel identity. Multivariate analysis and fuzzy coding is used to place samples in taxon and trait space, illustrating patterns of species composition and ecological function among sites and between streams.

Ubiquitous engineers, unique habitats: the importance of everyday ecosystem engineers on the species richness of UK rocky shores

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Ecologists have long accepted that in order to create resilient ecosystems functional biodiversity must be preserved, yet many conservation schemes focus only on species that are rare and charismatic. A similar pattern can be seen in European environmental policy, where ecosystem functionality is an important criterion for good environmental status but is assessed only using isolated groups of species.

Ecosystem engineers have substantial effects on ecosystem functionality through their roles in modifying, maintain and creating physical resources, such as the formation of novel, complex habitats. These organisms are ubiquitous across both temporal and spatial scales and, as common species, are often overlooked in the assessment and conservation of habitats. By directly or indirectly modulating the availability of resources to other organisms, ecosystem engineers promote biodiversity and, as such, should be considered as indicators for assessing ecosystem functionality.

To illustrate this point, a study was conducted to examine the effect of unique habitat patches created by common ecosystem engineers (*Ascophyllum nodosum* and acorn barnacles) on the overall species richness of a UK rocky shore. Significant differences in species composition and an overall increase in species richness were found in engineered patches, highlighting the importance of ecosystem engineers as potential conservation tools.

Temporal variation in limpet and barnacle recruitment in Azores (NE Atlantic)

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Recruitment in rocky intertidal organisms is an important determinant in shaping the spatial and temporal patterns of coastal communities. Larval supply, settlement rates and early settler mortality will ultimately affect adult abundance in coastal habitats. Here, we examine the temporal recruitment of the limpet *Patella candei* and the intertidal barnacle *Chthamalus stellatus* in the coastal rocky shore of S. Miguel Island in Azores (NE Atlantic). From September 2013, monthly survey counts of early recruits were performed in basaltic plates (7x7cm) distributed across four locations, using a hierarchical sampling design. Similarly, coverage of coastal assemblages were determined with transect photographs using random point count methodology. Early recruits from both species were found across all samples. A seasonal peak in the recruitment rate of *C. stellatus* occurred in late summer when sea surface temperatures get warmer and a phytoplankton bloom peak is known to take place. Recruitment in *P. candei* tend to peak in the winter months, where water mixing is higher. Noteworthy the timing and intensity in recruitment of a given species can vary over broad spatial scales. In fact, breeding cycles have been shown to differ for a particular species across their range of distribution, mainly because of geographical and annual differences in sea temperature.

Habitat slope, cause of differences in epibiota at artificial structures?

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Urbanisation of coastal areas is considerable and likely to increase worldwide to face increased storminess and sea-level rise. Urban structures can play an important role in modifying the structure and functioning of intertidal communities, providing steep additional hard substrata for epibenthic organisms. Some organisms are generally more abundant on horizontal substrates, whereas other dominate vertical cliffs. In addition, it has been hypothesised that competition among organisms is greater on vertical substrata due to reduced space availability, with urbanisation resulting in considerable changes to coastal ecology. Coastal defences can be made of local rock or concrete. We investigate the role of slope and material type on the patterns of distribution and abundance of intertidal communities on oceanic islands. An initial comparison of the organisms inhabiting artificial substrates revealed significant differences in patterns of distribution on different slopes, although some taxa showed variable results according to site. Transplants were also used to examine the role of habitat slope and material type in structuring mid-intertidal assemblages. Material type, but not slope, significantly affected the abundance of gastropods at mid-shore level, suggesting that choice of materials is of greater importance in determining the structure of intertidal assemblages on coastal defences.

ESManage: incorporation of ecosystem services values in the integrated management of Irish freshwater resources

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This is one of the twelve projects funded under the Environmental Protection Agency 2014 Water Research Call. It is a three-year project, commencing in February 2015, with the overall objective of harnessing the knowledge and tools required to embed the ecosystem services approach into policy and decision-making for sustainable management of water resources, as required by the Water Framework Directive. The project objectives will be achieved through stakeholder consultation and a synthesis of existing and new information from the physical/biological sciences and economics. A report on Irish freshwater resources in the context of ecosystem services, including identification of relevant data sources, will be produced. Existing and new biological data will be analysed to investigate biological responses (thresholds/resistance/resilience) to stressors/drivers and links to selected ecosystem services. Scenario analysis will show how delivery of ecosystem services may be affected by changes in drivers. The results of the analysis will be used to inform the valuation of key aquatic ecosystem services in Irish rivers. Finally, the outputs from these tasks will be used to develop a policy brief with recommendations on how the research (and more generally the ecosystem services approach) can best be embedded into policy and decision-making for the sustainable management of water resources.

Eco-engineering: design with nature

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Coastal defence structures are proliferating as a result of rising sea levels and stormier seas. With the realisation that most coastal infrastructure cannot be lost or removed, research is required into ways that coastal defence structures can be built to meet engineering requirements, whilst also providing relevant ecosystem services - ecological engineering. This approach requires an understanding of the types of assemblages and their functional roles that are desirable and feasible in these novel ecosystems. I summarise research carried out during the THESEUS project (2009-2014) which optimised the design of coastal defence structures with the aim to conserve or restore native species diversity. Native biodiversity could be manipulated on defence structures through various interventions: the team created artificial rock pools and on breakwaters and deployed a precast habitat enhancement unit (the BIOBLOCK) in a coastal defence scheme. Finally, I outline guidelines and recommendations to provide multiple ecosystem services while maintaining engineering efficacy. This work demonstrated that simple enhancement methods can be cost-effective measures to manage local biodiversity. Care is required, however, in the wholesale implementation of these recommendations without full consideration of the desired effects and overall management goals.

A study on seasonal distribution of Blenniidae and Gobiidae fish species for gillnet fisheries in the western Black Sea

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Of all the inland seas, the Black Sea is mostly isolated from the world oceans. It is a semi-closed basin with relatively great depths, and high bio-productivity of the shelf zone. Gillnet fisheries are one of the major economic activities along the Turkish coast of western Black Sea.
Data were collected from Western Black Sea by gillnets, over a one-year period monthly from June 2010 to June 2011. The sampling was conducted by monofilament and multifilament gillnets on rocky, sandy and muddy bottoms within 4.5 and 28 m depth. Surface water temperature, salinity and dissolved oxygen were recorded once during each tow. Fish catches at each sampling were registered in numbers of individuals per species, separated into mesh-type and mesh-size.
A total of 175 individuals (8354.08g), consisting of Blennidae and Gobiidae species, were caught by monofilament and multifilament gillnets. There are totally 8 species caught in the two types of gill nets which are *Lipophrys* sp., *Parablennius sanguinolentus*, *Parablennius tentacularis*, *Prablennius* sp., *Gobius niger*, *Mesogobius batrachocephalus*, *Neogobius melanostomus* and *Zosterisessor ophiocephalus*. The main objective of this study is to observe seasonal distribution and catch composition for mesh type of these discard species for the first time given in this area.

Species-specific (*Octopus vulgaris*, Lamarck 1798) commercial artificial reefs in Izmir Bay, Aegean Sea

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Artificial reefs are commonly used to protect sensitive marine habitats and to support small-scale fisheries. Recently, species specific artificial reef applications were realized to conserve marine animals by scientist and public institutions. Additionally, fishermen use them to improve catch efficiency. Octopuses (especially, *Octopus vulgaris*) have high commercial value in Turkey. By law, there are set limits and restrictions (size and seasons) on them. First scientific species specific artificial reef experiments have been started at 2000 by Ege University Faculty of Fisheries. In addition in the same region first commercial projects were realized at 2008-2009 by local fishermen. Both of them are located in Urla coast of the Izmir Bay in Turkey. The aim of present study is to give preliminary results of commercial octopus artificial reefs. During the study, size composition of octopuses, preferences of artificial nest depending on depth and substratum were recorded.

Gelatinous zooplankton community structure as revealed by size-spectral analysis

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Accurately characterising marine food webs is often complicated and labour intensive. However it is vitally important if we are to predict the likely consequences of environmental changes on marine ecosystem structure and functioning. Growing evidence shows that food webs in marine systems are strongly size structured and highly reticulate, making it difficult to predict the outcomes of perturbations to these systems. Recent advances in statistical modelling of marine systems have helped greatly to overcome such difficulties in understanding, with size-spectral analysis key among them. To date, the application of size-spectral analysis has centred largely on fish communities. However, such efforts to our knowledge have not been directed towards gelatinous zooplankton despite the diversity of the group and ubiquity in marine systems. Here we argue that such an approach would be logical given the trophic breadth of such species; from grazers to active predators of small fish. Within this context we applied contemporary size-based spectral analysis to determine whether the gelatinous community is structured akin to fish communities analogous to well-known ecological theory and secondly, whether intra and inter specific differences contribute to this size-based structure.

Establishment of networks of MPAs: Incorporating information on genetic connectivity of benthic ecosystem engineers in pilot projects

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Despite the increasing awareness of the importance of connectivity for MPA design, only very few MPA design processes have included connectivity into planning. Seagrasses are important ecosystem engineers in the coastal environment and designing MPAs to ensure connectivity of such ecologically-important habitat providing species is crucial given the major declines of seagrasses worldwide and their increasing fragmentation, which has important cascading effects on the associated ecosystem. Here, we focus on two seagrass species, which are affected by smaller sized habitats and increased isolation in two pilot project areas in the Black Sea and in the Adriatic. We aim to determine the extent to which the assessed populations (collected in established and suggested MPAs) are connected, given the environmental conditions present in each pilot project area and the demographic processes the different populations and species are affected by. Conserving populations in MPAs that are at a reciprocal distance that still allows gene-flow - given the environmental conditions of the area - is possibly the only way to maintain levels of connectivity that can avoid inbreeding, allow the spread of advantageous alleles and will allow a network of MPAs to work well in protecting biodiversity in and over its' boundaries.

Spatial scale dependence of the biodiversity structure and ecosystem function of the Mesoamerican Barrier Reef System

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Marine organisms respond to different scale-dependent variables, from environmental variables at local scales, such as coral cover and topographic complexity, to latitudinal gradients and regional-scale environmental variability. Multi-scale sampling approaches identify the scales at which communities are structured in relation to the biogeographical area sampled. The optimal scale should exhibit the spatial characteristics of habitat heterogeneity and species diversity within marine systems and the mechanisms that maintain this diversity. This study addresses the need to identify the relation between taxonomic composition, species richness, and ecosystem function in the Mesoamerican Barrier Reefs System, and considers the spatial distribution of species across habitat patches of different quality by comparing broad-scale relationships between occupancy and spatial abundance patterns, and to compare diversities found in different landscapes and regions. The study used a structured hierarchical experimental design. Location (five levels, random), site (four levels, random, nested in location), and habitat (three levels, fixed, crossed with all other factors). Multivariate analyses were performed using several transformations to examine differences in spatial patterns of variation from metres up to hundreds of kilometres and calculate biodiversity indices based on the taxonomic distinctness or relatedness of species, functional groups and habitats at different spatial scales.

Ecosystem-based assessment of a kelp-urchin-lobster system subject to multiple stressors drives spatial management of Tasmanian lobster fishery towards ecologically sustainable harvest rates

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Ecosystem-Based Fishery Management (EBFM) has been discussed as a necessity for the viable management of marine resources. However the concept remains difficult to implement despite increasing need for ecosystem-based management in the face of multiple environmental stressors. In eastern Tasmania, the valuable abalone and southern rock lobster fisheries are threatened by formation of sea urchin barrens as a result of overgrazing by the sea urchin (*Centrostephanus rodgersii*). This circumstance arises from the combined effects of (1) the sea urchin extending its range to eastern Tasmania as a result of ocean warming and shifts in oceanography, and (2) ecological overfishing of its key predator in Tasmania, the southern rock lobster. We developed two independent simulation models that capture the dynamics of the kelp-urchin-lobster system to assess management strategies. The models show that management to prevent urchin barrens forming is far more achievable than rehabilitating extensive barrens, and they provide clear guidance of targets and alternatives for different levels of risk of loss of kelp beds. Largely as a result of this work, recent changes to management of lobsters have focused on rebuilding biomass. This is one of the few cases of EBFM in practice, informed by modelling complex non-linear dynamics.

The effect of ocean acidification on the olfactory responses in the marine polychaete *Nereis succinea*

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An increase in atmospheric CO_2 has led to a decrease in ocean pH (ocean acidification). This affects all marine organisms but particularly those that cannot regulate their internal pH.
This study focussed on the effect ocean acidification has on chemical signalling and detection in *Nereis succinea*. Chemical signalling is important for reproduction, food detection in addition to other processes key to survival. A change in pH can alter the molecular form of a chemical which can affect the way a chemical fits into receptor proteins. This could potentially alter the organism's ability to detect chemical signals.
The following experiments focus on the olfactory processes of *N.succinea* used in the detection of food, detection of the reproductive chemical cysteine glutathione disulphide (CSSG) and the short and long term effects of low pH. *N.succinea* was also introduced to various neurotransmitters, in an attempt to determine which one is responsible for olfaction. Electrophysiology was used to determine the concentration of CSSG needed to induce an impulse at current and predicted future pH levels. A Fluorescent dye will be used to determine the percentage of CSSG that binds to receptor proteins under low pH conditions.

Crowd-sourcing data with apps to tackle freshwater ecological problems

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The Nature Locator programme (http://naturelocator.org/) comprises a collection of projects centred on crowd-sourcing data using bespoke smartphone apps.

Invasive Species

Two of our projects focus on engaging the public with mapping invasive species.

AquaInvaders (http://naturelocator.org/aquainvaders.html) supports the recording of 30 high priority, freshwater invasive species in the UK including *Pacifastacus leniusculus*, *Neovision vison* and several Ponto-Caspian invertebrates including *Dikerogammarus villosus*.

PlantTracker (http://naturelocator.org/planttracker.html) allows the recording of 21 invasive plants including *Impatiens glandulifera* and *Ludwigia grandiflora*.

River Obstacles

The River Obstacles project (http://www.river-obstacles.org.uk/), is a collaboration between a number of key UK agencies with the primary objective of crowd-sourcing data on barriers to fish migration in the UK's river systems.There are thousands of these obstacles in the rivers of the UK. Many of the man-made barriers perform important functions - for example dams, sluices, weirs and road culverts - but they can also cause problems such as restricting the movement of fish and damaging riverbanks and beds.

The information generated by this project will be used to identify obstacles that can be removed, and prioritise improvements to others that will yield the most significant environmental improvements.

Life at the edge: understanding thermal physiologies of species at their trailing and leading range edges

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Projected rises in ocean temperatures are set to cause the rapid redistribution of species across the world. Poleward advances and retreats are occurring at an unprecedented rate and are set to increase as future warming accelerates. Kelp forests are amongst the world's most ecologically important habitats, providing an extensive range of goods and services important to human society. Unlike mobile biota they must utilise physiological and biochemical pathways in order to deal with a changing thermal environment. Understanding these mechanisms is important as it allows us to begin to predict the adaptive capacity of species to future warming scenarios. Using a common garden experimental approach we quantified the upregulation of HSP70 mRNA at a range of temperatures to investigate the heat shock response of the cool water kelp *Laminaria digitata* at its trailing edge (SW England) and range centre (Scotland). Thus, allowing us to determine the responses plasticity and capacity of *L. digitata* to cope with future temperature rises. We then compare this with the HSR of the advancing warm water kelp *Laminaria ochroleuca* at its leading edge (SW England) and speculate what this means for future competition between the two species.

Drift-kelp suppresses sea urchin appetite for destruction

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Sea urchins can cause widespread overgrazing of kelp beds leading to an impoverished ‘urchin barren’ state, which can be very difficult to recover. It is therefore vital to understand the mechanisms leading to overgrazing in order to prevent it in the first instance. Here we show results form a suite of critical experiments in Port Phillip Bay, Victoria, Australia designed to understand triggers of overgrazing by the sea urchin *Heliocidaris erythrogramma*. We used time-lapse cameras to survey urchin movement in both barren and kelp habitats to reveal active movement of urchins towards kelp in both habitats. Furthermore, in the presence of drift-kelp, we observed less movement independent of habitat type. To further understand the role of drift-kelp in determining destructive grazing, grazing assays were performed, and showed that grazing rates were high for both drift and attached kelp on barrens, whereas in kelp habitat only drift kelp was consumed and almost no attached algae. Finally, time-lapse monitoring before and after the experimental addition of drift-kelp, clearly demonstrated suppression of urchin foraging in the presence of drift-kelp. Our collective results provide critical experimental support demonstrating that destructive overgrazing of standing kelp beds is triggered when drift-kelp becomes in short supply.

Estuarine benthic macroinvertebrates in a subtropical marine protected area

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Estuaries provide different ecosystems services and present considerable importance for coastal productivity. Benthic macroinvertebrates are important organisms in these systems and they are influenced by the salinity gradient. Thus, in a global changing world, they are affected by alterations in sea level and rainfall patterns. In this study, we aimed to evaluate the macrobenthic assemblages in a subtropical estuary within a MPA, in order to provide biodiversity data as support for management, in addition to the use of this biological model for long-term monitoring. We also aimed to note how the richness and organisms abundance patterns vary comparing different environments. Samples were collected in sandy-muddy flats divided in unvegetated and dominated by *Spartina alterniflora* within the Jureia-Itatins Ecological Station (protected area in São Paulo, Brazil). A total of 21 taxa was observed, with polychaetes and crustaceans as the main groups. Vegetated flats presented higher richness and abundance of organisms than unvegetated flats, mainly due to the increasing abundance of Tanaidacea crustaceans in sites with *Spartina alterniflora*. These results highlight the importance of salt marsh flats in maintaining the estuarine diversity and productivity and provide first insights for biological models to be used for sustainable observations related to temporal climatic variations.

Regional differences in feeding ecology of the edible sea urchin in European kelp forests

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Artificial coastal structures are expanding as a response to human activities and needs for protection against environmental perturbations. Novel habitats are thus colonised by fouling and mobile assemblages, including numerous non-native species, whose structure and functioning (e.g. interactions between local and non-native species) is still to be explored. Although a few studies addressed the weak interaction between mega-predators and fouling communities in temperate regions, the role of mobile macro-invertebrates has been overlooked. If these organisms use sessile taxa both as food and habitat, they may be involved in trophic- and habitat-cascades. To explore these processes, an *in situ* experimental set-up crossing ‘predation’ and ‘habitat complexity’ factors has been developed. The primary colonisation by mobile macro-invertebrates was facilitated using 15x15 cm panels covered (three levels) by turf mimics, crossed with exclusion treatments and deployed for 2.5 months within two harbours in Brittany. A total of 42,391 individuals belonging to 144 species were identified on 72 panels. While richness, density and community structure were not driven by mega-predation, they were all significantly explained by habitat complexity due to the measured interstitial volumes formed by sessile taxa. Such cascading effects should be further explored to understand invasion dynamics on artificial structures around the world.

Temporal and spatial variability in biodiversity and community structure in the Liverpool Dock System since it's restoration in the 1980s

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The Liverpool Dock System was originally constructed in 1715 and has a rich history as a hub for commercial shipping. The rise in large containerised vessels at the end of the 20th century led to a number of dock closures, which without maintenance became silt-filled, anoxic environments. Restoration of the docks 1981-1985 has created a unique ecological habitat characterised by dense populations of the filter feeder *Mytilus edulis* and an associated epibiont community. Part of the Liverpool dock system is now even classed as a UNESCO World Heritage Site.

Initial surveys were carried out at a number of docks in the 1980s and 1990s following restoration work and additional surveys in 2012 used destructive and photo-quadrat sampling to assess long-term trends. This paper aims to utilise the unique opportunity presented by the Liverpool Dock Systems to test hypotheses about changes in biodiversity in relation to physio-chemical variability and management practices. Data will also provide an updated inventory of benthic flora and fauna, with special exploration of the new and invasive species that have settled in the Liverpool Dock System. Preliminary results will be presented and discussed with a view to informing management practices in the restoration of other dock ecosystems.

Spatial variation in trophic structure of demersal fish communities in the marine environment of Hong Kong, South China

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Hong Kong's western coastal waters (WW) situated at the Pearl River Estuary are heavily influenced by freshwater and sediment discharges from the Pearl River, while its eastern waters (EW) are mainly affected by oceanic and tidal currents. The southern waters (SW) are positioned along this estuarine-oceanic salinity gradient. Such variations in hydrography and salinity drive differences in trophic structure in local marine ecosystems. This study aimed to investigate the spatial variation in trophic structure of six demersal fish communities in WW (inner and outer estuary), EW (inner and outer Tolo Channel) and SW (waters in southeast and around Lamma). Stable isotopic ratios of $\delta^{13}C$ and $\delta^{15}N$ of all benthic fishes caught in trawl surveys during July-September and November 2012 were measured. $\delta^{15}N$ range (NR), $\delta^{15}C$ range (CR), total area (TA), mean distance to centroid (CD) and mean nearest neighbor distance (MNND) were calculated from $\delta^{13}C$-$\delta^{15}N$ bi-plots to reveal trophic diversity and trophic redundancy. Preliminary results showed that the outer estuary in WW had the highest trophic diversity by having the largest NR, TA and CD, and the greatest niche diversification at the food web base as revealed by the largest CR. While inner Tolo in EW had the lowest trophic diversity as shown by the smallest NR, CR, TA and CD. The two communities in SW had the highest trophic redundancy by having the smallest MNND, which implied that more fishes in SW had similar trophic roles. The stable isotope library built in this study can serve as a baseline for evaluating the prospective recovery of demersal fishery resources brought by the territorial-wide trawling ban that has been imposed in Hong Kong's marine waters on 31 December 2012.

Metal concentration in the edible abalone *Haliotis tuberculata* Linnaeus from the Azores

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Abalones are considered a delicacy and are exploited for food worldwide. In many places, overfishing has led to the decimation of wild stocks of abalones and there is now an abundant source of animals that are reared in aquaculture systems. In the Azores, there is no tradition of eating abalones and the stocks of the *Haliotis tuberculata* are still virtually untouched. However, as tourism in the islands grows and the stocks of other shellfish diminish, there is an increasing pressure to find alternative edible resources and in the past few years there has been a rising interest in abalones. In the Azores, many other species including the locally highly appreciated limpets and the giant barnacle exhibit high concentration levels of some trace metals, which has been attributed to the volcanic origin of the islands. Here we analyse the metal concentration of the edible tissue in *Haliotis tuberculata* from São Miguel Island, Azores. We show that, similarly to other benthic organisms in the Azores, abalones have higher than normal concentration of some trace elements that are commonly associated with volcanic activity but that should be taken in account from a public health point of view.

Characterising context-dependent ecological thresholds and building resilience against climate-driven shifts in a temperate reef system

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As climate-driven environmental changes and anthropogenic perturbations increasingly affect ecological systems, the number of abrupt phase shifts in ecosystem dynamics is rising, with far-reaching ecological, economic and social effects. These shifts are notoriously difficult to study, anticipate and manage. Here we demonstrate the usefulness of case-specific simulation models to characterise tipping points in the dynamics of ecosystems and their variability with local conditions, and derive safe management targets associated with low risk of undesirable phase shifts. Under climate-driven ocean changes and fishing, inshore rocky reefs in eastern Tasmania can transition from dense seaweed beds to sea urchin 'barrens' habitat, realising severe local loss of habitat, productivity and valuable fisheries. Using Monte-Carlo simulations with a validated model of reef dynamics, we characterise the variability in ecological thresholds along the gradient of environmental conditions and define target points associated with low risk of undesirable widespread barrens formation. Prevention of ongoing sea urchin destructive grazing of macroalgal beds is achievable but, due to the strong hysteresis, the yet-to-be-observed restoration of seaweed beds from extensive sea urchin barrens is highly unlikely. Along with sea urchin culling, maintaining populations of predatory lobsters is key to mitigate sea urchin destructive grazing and maintain reef productivity.

Assimilation of shrimp-farms effluents by sea-cucumbers (*Holothuria scabra*) in a multitrophic integrated aquaculture framework: Insights from fatty acids and stable isotope analysis

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Integrated multi-trophic aquaculture (IMTA) systems represent a promising perspective to limit deleterious effects of aquaculture systems for their neighboring environments. In New Caledonia, shrimp-farming represents an important economic resource (2400 t y^{-1}, 22 MEuro y^{-1}) which represents an important input of organic matter to farming areas sediments, whose remediation requires farming ponds to be dried up for long periods. The co-production of sea cucumbers (*Holothuria scabra*) has been suggested to be an economically valuable alternative to farming ponds drying up. In order to assess the feasibility of such IMTA systems, we measured the growth, stable isotope and fatty acid composition of *H. scabra*, reared on shrimp-farming sediment with or without fish or maize-meal supplementation. Stable isotope data as well as fatty acid compositions suggested that sediment was the main source in all treatments. A significant inter-treatment variability was observed, suggesting that food supplementation affected the feeding of *H. scabra*. Finally, although the role of sea-cucumbers as sediment bioremediators could not be unequivocally evidenced, differences in fatty acid composition between the beginning and the end of the experiment suggested that they had an effect on the composition of sediment. More research effort is needed to clarify the effects of *H. scabra* on sediment characteristics.

How do fish communities change with depth in the deep sea?

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There are many ways to measure aspects of fish communities, and here we present several of those methods in order to describe changes in community ecology of deep-sea fish. Our study site is the continental slope of the Rockall Trough, Northeast Atlantic, at depths of 300-2000m. Across this depth range, environmental conditions change substantially: light, temperature and food availability decrease; pressure increases. It is therefore clear that demersal fish communities will vary along this gradient, and indeed changes in species composition are well documented. What is less clear is how alternative metrics respond to changes in depth, and which metrics capture the most variation. Such alternative metrics include using trait-based analysis, which summarises communities based on the traits, rather than the taxonomy, of the species therein, hence having greater generality to other systems and closer links to the function of the community. We use the trait-based approach to describe changes with depth of a new size-based metric and of functional diversity based on morphological measurements that may equate to function. We compare these metrics to traditional measures of community structure and relate the patterns seen to fish ontogeny and the non-linear patterns in resource use along the continental slope.

Biodiversity indices from the catch of square and diamond trawl codend meshes in the South Aegean Sea

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Differences in the diversity of the catch and escapees of square and diamond trawl codend meshes were investigated in the south Aegean Sea in autumn 2014. Experimental fishing was carried out, with a total of 81 hauls at depths between 50-350m. Three different meshes, 40mm diamond, 40mm square and 50mm diamond were used for the codend. The cover-codend method was used for the escapees study. Catch in the cover and codend was identified to the lowest possible taxonomic level, counted and weighed. Richness and Shannon diversity index were calculated per haul and their relation with sub-area, depth stratum, mesh type and target species was examined using GLM-ANOVA. In total, 451,325 specimens were collected, belonging to 236 taxa (173 identified species and 63 organisms of higher taxonomic level) and 20 faunistic categories (Algae, Porifera, Hydrozoa, Anthozoa, Polychaeta, Isopoda, Decapoda, Anomoura, Stomatopoda, Echinoidea, Asteroidea, Ophiuroidea, Holothuroidea, Ascidia, Bryozoa, Gastropoda, Bivalvia, Cephalopoda, Elasmobranchia and Osteichthyes). Statistical analysis showed that richness in the cover and richness and Shannon index in the codend were affected by mesh. In these cases, the 40D mesh differed significantly from 50D. The results are discussed under the frame of EU regulation stipulating the use of 40S in the Mediterranean.

Multitrophic diversity preserves the complexity of a marine food web

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In recent decades, there has been a proliferation of studies examining how biodiversity loss affects the structure and functioning of our ecosystems. There is, however, still a dearth of research examining biodiversity loss at multiple trophic levels. We carried out a field experiment in subtidal cages at Lough Hyne marine reserve in Ireland to tackle this issue. We manipulated the diversity of top trophic level fish and crabs in combination with intermediate trophic level fish and prawns. We measured the response of benthic invertebrate communities that settled in the cages over the 8 week duration of the experiment. We found that our highest diversity treatments had similar benthic invertebrate species richness and food web complexity to treatments with no manipulated predators present. Loss of one or more species from either trophic level led to a significant reduction in these properties. By quantifying the strength of trait mediated indirect effects in all our treatments, we show that antagonistic interactions between intraguild predators are critical in maintaining the complexity of these subtidal food webs. These findings highlight the potential for biodiversity loss to severely alter the structure of complex natural communities through both trophic and non-trophic pathways.

Range edge effects on the abundance and distribution of two congeneric limpet species in north-west Europe: a preliminary analysis

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Intertidal patellid limpets have been proposed as possible climate indicators. Investigation of the population dynamics at the range edge and range centre of northern and southern species, may allow insight into the mechanism by which species' geographical ranges shift. The northern limpet *Patella vulgata* and the southern limpet *P. depressa*, overlap in distribution across the British Isles with the leading range edge of *P. depressa* occurring in North Wales and SE-England. These limits have been expanding northward over the last 20-years. Despite having different large-scale geographic distributions, these patellid species coexist on small-scales, within areas found in the centre range of both species (i.e. SW-England), but also at both range edges of *P. depressa*. We tested the "abundant-centre" hypothesis around the overlap zone for both Patella species with abundance data from 2002-2014 (MarClim-project). Preliminary analyses indicate that the abundance and proportion of *P. depressa* compared to *P. vulgata* decline in a similar manner at both of its range limits. In contrast, in SW-England, toward the range centre of *P. depressa* abundances and proportions were similar. Future manipulative experiments within the overlap zone of both *Patella* species should shed light on the mechanisms that allow these two species to coexist.

Interstitial aquatic insects and physico-chemistry of selected mountain streams from Slovenia and Turkey

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The term insterstitial habitat indicates the permeable area of the substratum (Dole-Olivier and Marmonier, 1992) which contains rich and diverse macroinvertebrate fauna. These habitats act as refuge areas for macroinvertebrates. Interstitial aquatic insect larvae are occasional fauna which use this habitat during their development, such as growth of small instars. In this study, headwaters from alpine region in Slovenia and mountain streams from Blacksea region in Turkey were investigated. The collected fauna were representatives of Collembola, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera and Diptera. The results of analysis indicated that distribution of aquatic insects were affected by temperature and flow permenance in Slovenia while electrical conductivity and temperature were affecting the distribution in Turkey. Moreover, early instar larvae of insects may likely prefer interstitial zone as they are more sensitive to high flow velocities and bed movement than later instars.

Marine litter baseline: data from four trawling grounds in the Aegean Sea, Mediterranean

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Marine litter is a multifaceted universal problem and a growing threat to the marine environment. It is washed ashore, floating on the sea surface, sinking on the sea bottom, entangling marine animals and entering the food chain. The EU MSFD requires Member States to take measures to ensure that quantities of marine litter do not cause harm to the coastal and marine environment. Greece and other Mediterranean countries are also expected to develop national policies under the Regional Plan on Marine Litter Management. There is however lack of comprehensive baseline and comparable data to support policy requirements. Coverage of Greek waters is still very limited. This work reports on marine litter collected by trawl net (>80 hauls) in four areas of the Aegean (only one of which has been partially studied before). Only 5% of the hauls did not have any litter. Plastics, including bags and sheets indicative of urban and land-based uses, were dominant in all areas (>67% of litter items), followed by cloth/textile and metals. Fishing, food and smoking related items were recorded in all 4 areas. On average 130 items were collected per square km although numbers varied between areas.

Effects of experimental shading on intertidal biological communities

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The extensive occupation of coastal regions throughout the world promotes shading disturbance in coastal environments, changing productivity and community organisation. To understand the effects of shading on biological communities we conducted a manipulative study on a rocky shore of the subtropical southwest Atlantic. We manipulated light exposure in the infralittoral fringe and upper mesolittoral and quantified both biotic and abiotic changes. The experiment was designed to disentangle the effects of 'shading structures' (light + flow influence) from 'hydrodynamics influence' (just flow) by using a 'procedure control' for the latter. Both luminosity and temperature were higher in control and procedural control treatments than in shaded treatments. In the infralittoral fringe, macroalgae were quickly affected by shading, decreasing in abundance by 58% after 16 days and being completely eliminated in the shaded treatment after 191 days. In the upper mesolittoral, oysters increased in abundance, from 1% to 31%, after 191 days in shaded areas, while there were no changes in other treatments. Our results confirmed that shading is an important factor structuring rocky intertidal communities, by changing both physical environment and taxa abundance.

Temporal variability in gonad maturation in the abalone *Haliotis tuberculata* Linnaeus from the Azores.

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Abalones are considered a delicacy and are exploited for food worldwide, which has resulted in the collapse of wild stocks of abalones in many of such locations. In contrast, in the Azores there is yet no tradition of collecting abalones and the stocks of the *Haliotis tuberculata* remain virtually untouched. As tourism in the islands grows and the stocks of other shellfish diminish there is, however, an increasing pressure to find alternative edible resources and in the past few years there has been a rising interest in abalones as alternative seafood. The worldwide decline in stocks of most abalone species suggests that these species are particularly vulnerable to overexploitation. It is thus of fundamental importance to gather basic biological and ecological information in order to make informed decisions that foster the sustainable fishery and conservation of abalones. Here we investigated the reproductive cycle in *Haliotis tuberculata* over a period of one year in São Miguel Island, Azores using histological analysis to quantifying oogenesis and spermatogenesis of sampled individuals. Preliminary results showed that the species can potentially be reproductive year around, albeit showing two reproductive peaks in late autumn/winter and summer in both genders.

Limited bottom-up effects: changes in structure and functioning of ecosystems dominated by frondose brown algae and filamentous mats on shallow rocky bottoms of the Azores

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Large frondose macroalgae play a key role in the structure and functioning of shallow subtidal temperate reef ecosystems by modifying local environmental conditions and by providing food and habitat for a wide range of organisms. In many areas of the planet, however, anthropogenic-driven impacts are leading to the replacement of such frondose algae by opportunistic and less complex vegetation. In this study, we empirically compared the structure and functioning of two distinct shallow-water habitats present in the Azores: one dominated by frondose macroalgae (Dictyotaceae and Halopteris) and one dominated by low-lying turfs. Two replicated areas of each habitat were sampled twice in 2014 to assess spatial and temporal consistency of results. Significant differences were found between habitats in the structure of macrofaunal assemblages, but not on the structure of benthic fish assemblages. Net primary productivity (NPP) was significantly greater on frondose-dominated habitats but only when considering NPP on a per area basis. Water transparency was similar in both habitats. These results suggest that the type of vegetation can have important local effects on the structure and functioning of the ecosystem but that its effects are limited to the lower trophic levels.

The effects of pH on resource assessment and decision making in the shore crab, *Carcinus maenas*

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Ocean acidification by increased levels of atmospheric CO_2, has become a priority for politicians and scientists as awareness of the consequences of acidification, such as coral bleaching and habitat loss has increased.
This study examined the effect of reduced seawater pH on olfaction in the shore crab, *Carcinus maenas*, which will help understand the ecological impact that ocean acidification has on such invertebrates.
An initial study investigated how *C. maenas* in a static chamber alter the water due to their own respiration and excretion. Any such changes in pH, pCO_2 and ammonia concentrations would potentially invalidate subsequent behavioural studies that use animals acclimatised for extended periods in static chambers. It was found that over 120 minutes on average, pH decreased by 0.23 units, pCO_2 increased by 15809.9 μatm and the absorbency of ammonia increased by 0.004. The effects of these changes on feeding behaviour and predator detection will be presented.
A second experiment will be conducted to investigate the differences in decision-making in laboratory controlled pH conditions. A flow tank with two different pH flows will be used to assess decision making and risk assessment in *C. maenas* when it is presented with a food cue, predator odour or both simultaneously.

Research opportunity at an atoll

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A research station is established at Dongsha Atoll in northern South China Sea. It is run by National Sun Yat-sen University in Kaohsiung, Taiwan. Boats, scuba, dry and wet labs, and accommodation capacity of for up to 30 scientists are available. Scientists from more than 10 countries visited the atoll and the lab in the past two years. Biodiversity, ocean acidification, internal waves, seagrass beds, soft corals, stony corals, are among the keywords of studies executed on the island and the reef. Being part of a national park, and also a military zone, the reef is protected. To facilitate research, we have staff stationed on the island to help extend the study even when scientists have left.

Dongsha Atoll research station

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Dongsha Atoll, situated in north South China Sea, has a brand new research station that welcomes international scientists since 2013. Corals reefs and seagrass beds covers an area of about 500 square km. Stony corals, soft corals and seagrasses are the major constituents of the atoll. It is a military zone and a national park, thus biodiversity are protected. Studies of biodiversity started since 2007, and quite a few reports have been published. The atoll is also affected by internal waves of the greatest magnitude in the world. Current studies include miscellaneous topics, e.g. ocean acidification, seagrass bed dynamics and ecology, taxonomy, migrating birds, etc. Dongsha Atoll Research Station is operated by National Sun Yat-sen University in Kaohsiung, Taiwan, and is equipped with boats (7 ft to 38 ft), various probes, UAV, diving, dry and wet labs as well as able staff to help scientists. The facilities are accessible year round.

Acclimation in sea urchins and their trans-generational responses to future change

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Our oceans are changing and will become undersaturated with respect to carbonates as CO_2 increases. Organisms residing in temperate coastal environments may struggle to maintain homeostatic and biomineralising processes under these conditions. Current research needs in this field are those of long-term exposures to determine the sustainability of physiological flexibility/acclimation and energy requirements.
We address these needs by presenting the responses of a slow-growing benthic invertebrate - the sea urchin, *Psammechinus miliaris*. These urchins were reared under IPCC forecasted carbonate saturation states and under present-day seasonal temperatures for long periods (several years) and their physiological, energetic and reproductive responses assessed. Additionally the next generation of urchins were reared under these conditions through to full maturation, an approach not previously utilised for marine macro-invertebrates.
We show that *P. miliaris* can acclimate to laboratory conditions and this is sustained when exposure is extended to several years and across generations. We also see differing responses across generations such as seasonal disturbances. We show that different responses can be achieved from short/long term studies and across generations. Therefore careful consideration is needed when predicting organismal responses based from short-term data. This long-term study contributes significantly to our current understanding of organismal responses under a future climate.

Elucidating the food web structure of demersal crustaceans in Hong Kong's coastal watersusing stable isotope analysis

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In the marine environment of Hong Kong, western waters are strongly affected by seasonal discharges of the Pearl River while the eastern waters are predominantly influenced by oceanic currents. There is an increasing gradient of salinity from the western to eastern waters, with southern waters being a transition zone. This study aims to reveal and compare the food web structure and trophic diversity of benthic crustacean communities among these three zones using stable isotope analysis (SIA). Temporal, spatial and body size-dependent differences in crustaceans' stable isotope signatures are being investigated. So far, we have completed the SIA for crustacean samples collected during the dry season in 2012. Our results suggest that there are generally two main trophic groups of the encountered crustaceans, namely detritivores and omnivores. Based on multivariate statistical analyses, there are clear differences in crustacean diversity, functional identity of species assemblage and consequently, food web structure among the three spatial zones. We also compare four community metrics across the three communities: western waters have the greatest trophic diversity (i.e., higher nitrogen range, carbon range and total area of the SIA plot), while eastern waters have the lowest trophic diversity. Functional redundancy is somewhat similar among the three communities, suggesting that species in communities with higher crustacean diversity likely feed on different resources. The results will be discussed in the light of potential variations of trophic basis and food sources among the three zones.

Climate driven shifts in habitat-forming kelp abundances may deplete local biodiversity

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1) Habitat forming species, such as reef-building corals and canopy-forming macroalgae, can alter environmental conditions and provide habitat for a vast array of marine life, from invertebrates to marine mammals.
2) This investigation examines the consequences of recent shifts in the relative abundances of two species of kelp, a warm water species, *Laminaria ochroleuca*, and a cool water species, *Laminaria hyperborea*, by defining their properties as habitat-formers and comparing their epibiotic assemblages. Algal and invertebrate assemblages associated with kelp stipes and holdfasts were compared between the two species, and from two sites with differing environmental conditions.
3) Significant differences were found in the structure of assemblages inhabiting both the stipe and holdfast between species, and between sites. The results suggest that local environmental conditions influence the structure of these assemblages.
4) This study shows that changes in the relative abundances of habitat forming species, as a consequence of rapid environmental change, alter local biodiversity patterns and potentially lead to impoverished assemblages. Crucially, while the structure of habitat-forming species may appear broadly similar, their functioning as biogenic habitats for associated biota may differ considerably.

Temporal variation in reproductive phenology of *Patella* spp.: past and present

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Recent rapid climate change has driven shifts in the phenology of marine, freshwater and terrestrial organisms. These can have consequences on aquatic communities and ecosystems due to potential occurrence of trophic mismatches, leading to increased risks of recruitment failure. Phenological timing is critical for individual fitness, with potential community-level consequences depending on the capability of different species to adapt to modified environmental cues. Patellid grazers are keystone species and their removal/absence enhances algal growth affecting abundance of barnacles, changing dramatically the structure and the function of marine ecosystems. To determine consequences of recent rapid climate changes on communities and ecosystems and to understand and distinguish human-induced changes from natural fluctuations, long-term and broad-scale data are required. This work examines annual variation in gonad phenology of *Patella aspera* (Röding 1798) in the Azores archipelago overtime, hypothesizing that gonad phenology has varied over last 30 years. Overall, recent data showed a lower number of individuals reaching maturity not showing a clear peak in spawning in contrast with historic data. The resting period appears to have shifted, showing a delay compared with data from 30 years ago. These variations are very important and may affect the population dynamics of the species.

Large-scale processes underpinning fish species composition patterns in estuarine ecosystems worldwide

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Biodiversity is currently viewed as a framework encompassing multiple facets of the variety of life, including taxonomic and functional aspects. Species richness and composition of fish assemblages in estuaries is defined by global to local processes acting on community colonisation. The present study further investigates how biodiversity of fish assemblages varies among estuaries globally, by simultaneously analysing taxonomic and functional richness and diversity of assemblages. A comprehensive worldwide database was compiled on the fish assemblage composition and environmental characteristics of estuaries. In addition, functional attributes of the fish species were characterised such as body size, habitat use and trophic ecology. We investigated the relationship between taxonomic and functional aspects of biodiversity, i.e. the match or mismatch between the two. We also explored how functional diversity of fish assemblages varied among estuaries globally and related to environmental features of estuaries, i.e. historic and contemporary, global and local constraints. The results are explored in the context of ecosystem functioning and resilience, and outcomes relevant to assist in prioritising conservation efforts are highlighted.

The genetic mechanisms of sex determination in sturgeons: their evolutionary role and importance for aquaculture

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The sturgeons passed through several stages of polyploidisation in their evolution. At present their origin in an indirect polyploidisation by repeated interspecific hybridisations seems the most probable. However, in female heterogamety, hybrid tetraploids will always be females and male tetraploids are impossible. The elucidation of the genetic mechanisms of sex determination in sturgeons is also important for the cultivation of these fishes in aquaculture. Very interesting, but conflicting data have been obtained by induced meiotic gynogenesis and dispermic androgenesis in different sturgeon species. Males and females were observed in meiotic gynogenetic progenies of 250-270-chromosome species *Acipenser baerii* and *A. transmontanus*, thus female heterogamety should be concluded for both of them. However, the presence of female in dispermic androgenetic progeny of *A. baerii* presumes male heterogamety in this fish. To date, the data on sex determination are obtained for three 120-chromosome species: *A. stellatus*, *A. ruthenus*, and *Polyodon spathula*, as well as for *A. ruthenus* x *A. huso* hybrid (bester). All of them have female heterogamety. The sex ratio in the gynogenetic progenies of two last species and bester was about 1 male : 4 female. All-male gynogenetic progeny of *A. stellatus* indicates the absence of crossing-over and non-viability of WW-superfemales.

Temperature as a confounding factor in the use of oxidative stress biomarkers of habitat quality - testing the response of different fish tissues

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Oxidative stress biomarkers have been widely used in the development of indices of exposure to contaminants. However, temperature is known to also have a significant effect on oxidative stress biomarkers. This way, temperature is a confounding factor that may result in difficulties in the interpretation of oxidative stress biomarkers response patterns. Since climate change is expected to result in more frequent and intense heat wave events it is pertinent to investigate the effect of increasing temperature in the oxidative stress response of common aquatic organisms. It is also important to assess the differential response of different body tissues. This study investigates the effect of increasing temperature in the response of multiple biomarkers of oxidative stress in various tissues of a coastal fish, the rock goby, *Gobius paganellus*. The response of the oxidative stress biomarkers analysed were always higher in the gills than in the other tissues. Muscle tissue responded significantly to temperature, as did the liver, while the gills were unresponsive in terms of lipid peroxidation and glutathione-S-transferase. Unresponsive tissues to temperature may be particularly interesting as indicators of pollution, given that temperature will not be a confounding variable in their oxidative stress response.

Benthic trophic web of a pristine embayment within a disturbed estuarine environment

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The Sado estuary is subject to multiple sources of impact, however its environmental disturbance level is very heterogeneous. In this study, a pristine embayment within the Sado estuary was studied. This area, known as Caldeira de Tróia, harbours high biodiversity. The aim was to 1) describe the benthic trophic web and to 2) assess its level of anthropogenic inputs, using stable isotopic analysis. Nineteen food web nodes were isotopically characterised. Stable isotopic analysis revealed a relatively long benthic food web, longer than previously reported for other coastal areas in Portugal. The highest trophic level was 3.3, occupied by the gastropod *Nassarius reticulatus*. δ15N values were highest at the estuarine channel, lower at the river, even lower at the coastal sites, and lowest at the pristine estuarine embayment. This indicates that the major anthropogenic nitrogen input sources are located at the middle estuary, not at the incoming river waters. The very low level of anthropogenic nitrogen inputs observed in the study site is remarkable since it is located at a very small distance from the disturbed area. The importance of preserving pristine areas within overall disturbed environments was stressed and its value as reference sites for biodiversity conservation was discussed.

Does biodiversity promote recovery after ecological disturbances? Experimental tests of resilience in coastal systems

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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. Based on experimental manipulations of trophic-level diversity, coupled with artificial disturbances, we will quantify changes in assemblage structure and functioning and their recovery rates. We also aim to characterise the relationship between species diversity and community stability metrics. In addition we hope to test how these relationships vary with environmental context. By measuring multiple stability components we hope to capture a more realistic range of community responses to environmental perturbations, furthermore it will allow us to explore relationships between the various components of stability, thereby adding novel insights to the multi-dimensional concept of stability.

Effect of habitat on rocky intertidal species distribution of the Bay of Biscay

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A key factor influencing geographic distribution and population connectivity of intertidal species is habitat availability, yet its role has largely been ignored for the Bay of Biscay as a whole. Specifically, the 200km sandy habitat gap along the coast of Aquitaine has been poorly studied. Recent studies in the area principally focus on limpets, namely *Patella rustica*, which appears to be limited by the sandy habitat gap. My fieldwork (early August) will give some preliminary results concerning both habitat type and species assemblages at 18 natural rocky sites. Artificial hard substrate along the Aquitaine coast such as concrete bunkers will also be surveyed, showing whether they can act as an ecological corridor over the habitat gap. These will then be compared to historic distributions obtained both through examination of museum specimens and careful use of GBIF. Species abundances as well as size-frequency data will be mapped from these results. This may also shows age structure and therefore recruitment events to each of the sites.