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Abstracts booklet

DISCOVER WITH PLYMOUTH UNIVERSITY MARINE INSTITUTE

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Talks

Session 1: Anthropogenic Impacts 1

Guillermo Porrinos
University of Exeter

Participatory approaches for co-management and marine conservation in Príncipe Island, São Tomé and Príncipe

People and nature are inseparable. Thus, an integrated socio-ecologic perspective is essential to understanding systems that involve people and natural resources; instead of focusing on the effect of people on the environment or the conservation interventions on people. For example, to approach sustainability of fisheries, biology of fish populations must be considered alongside the livelihoods and food security of coastal communities. Improved socio-ecologic approaches used extensively will benefit natural resource management, affecting both biodiversity and human welfare. Using artisanal fishing and marine conservation in Príncipe Island as a case-study, we explore interactions between artisanal fishing and conservation interventions; as well as consequences for protected species (such as sharks) and the livelihoods of local communities. Using a multidisciplinary approach, we explore the use of marine resources by coastal communities using participatory techniques, study communities' livelihoods using socio-economic surveys and collect baseline ecological information on the status of the marine environment around the island. Our results show benefits and help us identify challenges of using socio-ecologic participatory approaches to improve marine conservation and biodiversity and identify lessons for conservation projects with fishing communities in developing countries.

Thomas Stamp

Plymouth University

The role of managed re-alignment schemes as compensatory habitat for estuarine fish

Estuaries across Europe provide critical nursery and feeding habitat for numerous commercially important fish species, e.g. European bass (*Dicentrarchus labrax*). In particular intertidal habitats, such as saltmarsh are thought to provide enhanced feeding opportunities and may therefore significantly contribute to local fish production. Despite their importance ~85% of estuaries in the UK have been heavily impacted by historic land claim, which has resulted in an estimated loss of 25-80% intertidal habitat extent. Managed re-alignment is a habitat loss mitigation technique, whereby low lying coastal land is intentionally flooded to encourage the development of intertidal habitat. The UK government has committed to “re-align” 10% of the UK coastline by 2030, and therefore the construction rate of managed re-alignment schemes is likely to increase in the future. It is therefore critical to assess the role of managed re-alignment schemes as compensatory fish habitat. Fish feeding success and diet has been compared between multiple managed re-alignment schemes and surrounding/local established saltmarsh. Initial results suggest that predatory fish have lower feeding success, and have different diets, within managed re-alignment schemes when compared to established saltmarsh. With continued monitoring the relative value of these novel habitats for fish feeding will be assessed as they continue to develop into the future.

Amy Cartwright

Plymouth University

Assessing ecological responses to wave energy developments to inform future management

The development of Marine Renewable Energy Installations (MREIs) is set to increase as “clean” alternatives to fossil fuels are sought. Concerns exist that MREIs will negatively impact marine fauna and habitats through a multitude of factors e.g. collision, electromagnetic fields, noise and physical disturbance from cables and moorings. It is also anticipated that positive impacts may arise as MREIs displace fishing activity, creating de facto MPAs, and introduce structure which may act as artificial reefs. The European Marine Energy Centre and Wave Hub are wave power MREI in the UK. Clean Energy from Ocean Waves (CEFOW) is an EU funded Horizon 2020 Project that provides the opportunity to study the cumulative ecological impacts of an array of wave energy converters, in the first project to deploy multiple grid-connected devices in the UK. Using video data collected via a towed, flying HD video system the study firstly assessed any changes to benthic biodiversity and any associated ecosystem responses at the sites. Secondly, a study, comparing species assemblages on the cable rock armouring up to five years after deployment with control areas was conducted at the Wave Hub site, Cornwall to assess changes in the benthos associated with the cable route. The issue of decommissioning MREIs is a new question in the renewables sector, with the first global wave of MREIs coming towards the end of their life cycle (20-30 years). The results of this work will help to inform relevant stakeholders in the renewables industry, so that positive effects can be enhanced, and negative effects mitigated for at all stages of the development of MREIs, including installation, maintenance and decommissioning. This is of particular relevance as wave power developments are set to be scaled up into larger ‘wave power parks’ to contribute to the energy mix of the future.

Session 2: Microbiology 1

Kimberley Bird

Marine Biological Association UK & University of East Anglia

An interdisciplinary approach to studying the sea surface microlayer reveals the complexity of physicochemical influences on bacterioneuston

The sea surface microlayer (SML) is an intrinsic physical boundary between the atmosphere and hydrosphere, generally defined as the upper most 1-1000 µm of the surface ocean. The SML influences everything that passes through the air sea interface and has distinct biological, physical and chemical properties that differ significantly from the underlying water. Covering 70% of the Earth's surface, the SML plays a major role in global biogeochemical and climatological processes; however relatively little is known about the SML. This study uses multidisciplinary data collected during the Schmidt Ocean FK161010 Air to Sea cruise in 2016. We used state-of-the-art autonomous sampling equipment to collect co-occurring in situ physiochemical data to inform high-throughput sequencing of the microbial community. We used these data to demonstrate novel interactions and relationships between the bacterial community and the physicochemical properties of the SML. We found a significant enrichment in the SML of the bacterial orders Alteromonadales, Trichodesmium, Bdellovibrionales, Bradymonadales, Oceanospirillales, Pseudomonadales, Sphingobacteriales and Pseudoalteromonadales. We show distinct differences in bacterioneuston composition in response to different physical stresses acting at the air sea boundary. For example the order Alteromonadales is enriched under lower shear stress and periods of combined low buoyant and sheer stress enabled large Trichodesmium blooms to form in the SML. Co-occurring enrichment of chromophoric dissolved organic matter (CDOM) during a large Trichodesmium bloom and a significant correlation between surfactants and Alteromonadales suggest these enriched taxa are an important component of the carbon cycle in the open ocean with potential to influence bacterial community structure, air-sea gas exchange and near surface biogeochemical processes.

Ellen Harrison

Plymouth University

Understanding the signalling mechanism of the marine diatom Phaeodactylum tricornutum for sensing phosphorus

Phosphorus is a crucial element for life, needed in the production of cellular membranes, nucleic acids and many other cellular processes. Phosphorus limitation therefore has the potential to affect ecosystem functioning by altering phytoplankton growth and community structure. Phytoplankton, including diatoms are at the base of the marine food web and are involved in global biogeochemical cycles. While there is growing appreciation of the importance of phosphorus in structuring marine microbial communities, there is little understanding of how certain species sense and respond to fluctuations in phosphorus concentrations. Diatoms are a successful, diverse group of eukaryotic organisms and so it is important to understand how they sense various biotic and abiotic stresses. Calcium signalling is widespread across both the animal and plant kingdom for range of functions. There is evidence that diatoms use calcium signalling in response to biotic, and environmental changes, such as osmotic shock and fluctuations in iron levels. The aim of this research is to investigate the use of calcium signalling in sensing phosphorus in the marine diatom Phaeodactylum tricornutum. Since the release of its genome, P. tricornurum has become a commonly used laboratory model for studies investigating diatom physiology. This research aims to use ultrasensitive R-GECO transformed P.tricornutum, which allows the detection and quantification of calcium signalling, to fully characterise the use of calcium signalling for phosphorus sensing in this species of diatom. This has many implications: from the evolution of calcium signalling mechanisms; to ecological models of marine microbial communities.

Jack Dickenson

Marine Biological Association

The Role of NADPH Oxidase in Diatom ROS Signalling

Reactive oxygen species (ROS) are a group of chemically reactive, oxygen containing molecules, created as a by-product of respiration and photosynthesis. While previously thought to cause only detrimental effects to cells, they are now seen as important signalling molecules. In plant and mammalian cells, ROS can be actively generated by NADPH oxidase (NOX) enzymes in response to different stimuli, triggering a cellular response. However, little work has investigated ROS signalling in unicellular organisms, such as marine diatoms. Enhanced nutrient uptake, removal of excess electrons from photosynthesis or a defence mechanism against competitors have been suggested as potential roles. Using transcriptome and genome analysis, our work has found a surprising diversity of diatom NOX enzymes, with 3 distinct classes identified. Each class possesses significant structural differences between each other and to mammalian and plant NOX enzymes. The different classes suggest significant mechanistic differences in how diatoms produce extracellular ROS. We shall measure extracellular ROS and plasma membrane electron transport to visualise and quantify extracellular ROS production, using diatoms from each NOX class. The distinct NOX classes may contribute to different functional and ecological roles for diatom ROS production and thus influence their wider interaction with the marine environment.

Elise Laetz

Zoological Research Museum Koenig

Advancements in Understanding Solar-powered Sea Slugs

Solar-powered sea slugs (Gastropoda: Sacoglossa) are the only animals known to steal functional chloroplasts from their algal food and withstand months of starvation, presumably due to these stolen chloroplasts. For many years, this ability, termed functional kleptoplasty, was attributed to a lateral gene transfer of algal genes to the slug. This would allow the retention and maintenance of these foreign organelles once incorporated in the slug, however, subsequent multi-gene studies failed to support this hypothesis. Recent investigations have sought new hypotheses by focusing on identifying which sacoglossan taxa are solar-powered and which are not, investigating physiological aspects of the slug/algal species, and examining slugs throughout starvation periods. These investigations have revealed that functional kleptoplasty is a complex process that evolved independently in at least six lineages. Other investigations have now shown an accumulation of photosynthetic products (in some species) located inside incorporated chloroplasts during starvation periods suggesting a quantifiable benefit to performing functional kleptoplasty that occurs later in a starvation period. Other investigations have explored digestive and metabolic activity, finding that each species regulates metabolic processes differently, with species capable of longer starvation survival having an initial reduction in digestive and metabolic activity followed by a subsequent increase. The algal species ingested also plays a critical role in a slug's ability to perform functional kleptoplasty due to physical and physiological differences in chloroplast structure. When combined, these investigations begin to form a picture of how functional kleptoplasty occurs in solar-powered sea slugs and the benefits they likely receive, however there are still many unknown aspects of this enigmatic interaction.

Session 3: Climate change

Axelle Amstutz

Plymouth University

Slopes' orientation on rocky shores: predicting future changes in biogeography linked to global warming?

Temperature and light intensity are known to trigger species distribution as they affect the performance of every living organism. Slope inclination and orientation (aspect) modify them, and influence the time species are exposed to those abiotic parameters. This is critical to intertidal species, which, despite their marine origin, must regularly contend with terrestrial conditions during each low tide. A rocky shore survey has been undertaken in the SW of England, in order to looking at the impact of rock orientation (e.g. north- and south-facing) on species' distribution. The sunnier south-facing rocks were about 2°C warmer than the shadier north-facing ones. Aspect had a significant effect on the distribution of some intertidal species, which also might have broader impacts on the whole community. These results can help us understand how species respond to different climatic conditions. As the different temperature according to aspect is similar to the IPCC expected increase in temperature, the use of slopes and their orientation could be used as a global warming indicator for species distribution in the rocky intertidal.

Daniel Sadler

University of Liverpool

Ocean acidification affects the biological functioning of Mytilus edulis

The input of carbon dioxide into our oceans is continuing at an unprecedented rate reducing ocean pH. For many species, this is having negative physiological consequences on their fitness and resilience to environmental change, but less is known about the ecosystem effects of these changes. In this study, we assess how ocean acidification conditions predicted for 2100 affects the biological functioning of an important habitat-forming species Mytilus edulis and its susceptibility to predation by a key predator. Change in three physiological parameters in Mytilus were assessed: (1) shell thickness, (2) mass and (3) feeding rate, as well as susceptibility to predation by the predatory gastropod, Nucella lapillus. Shell thickness, body mass and feeding rate of Mytilus all reduced under OA conditions indicating reductions in individual fitness. Predation risk also increased by ~26% under OA, including large Mytilus that are currently at low risk from predation, suggesting increased susceptibility and/or altered predator foraging behaviour. The results suggest OA will impact upon ecosystem structure and functioning and the continued provision of ecosystem services associated with Mytilus reefs.

Michael Carter-Gates

Marine Biological Association

Winners and losers of a changing Arctic microbiome

The global decline of biodiversity is one of the most critical challenges of the 21st century, but little focus has been given to the largely understudied impacts to marine microbial communities. This is especially a concern within the Arctic Ocean which is being impacted at a higher rate than any other Ocean. Here we use a Next Generation Sequencing approach to describe the microbial diversity present across a transect covering a temperature front in the Norwegian Sea. We show that the microbial communities of the region form three distinct assemblages closely associated with the dynamic topography and sea surface geographical-thermal boundaries in this region. These associations are present across the whole community and within the majority of major taxonomic groups in our dataset. Furthermore, individual OTUs were found to display strong station specific abundance patterns which also highlights the need for high level taxonomic resolution when considering the response of taxa to environmental disturbance. These findings have significant implications for the vulnerability of Arctic community assemblages, which may become displaced under the predicted warming Arctic scenario.

Maria Loreto Mardones Velozo
National Oceanography Centre

Thermal tolerance of larvae and early juveniles of the European sting winkle, Ocenebra erinaceus Linnaeus, 1785 (Neogastropoda, Muricidae)

Environmental temperature plays an important role in shaping the distribution and abundance of ectothermic organisms. As a general rule, larvae and juveniles are more sensitive to thermal stress than adults and, as a consequence, represent key life stages that determine the geographic range of a species. Identifying critical thermal limits during ontogeny allow the prediction of the potential impacts of climate change on the distribution of marine ectotherms. Ocenebra erinaceus is a predatory species that has caused significant damage to shellfisheries in Europe. It is native to the UK and France where females spawn one clutch of capsules between April and May. In this study, we compared the thermal tolerance response of two populations from the UK and France with different thermal history in terms of: development time, embryo size, capsular mortality, and hatching time. Results showed that intracapsular development was faster at higher temperatures (16 - 20 °C) in both populations; however, embryo size was not affected. Capsular mortality was high at extremes of the temperature range (10 and 18° C) in the colder (UK) population. However, embryos from the warm-water acclimatised population (France) showed high survival at the same range of temperature. In both populations, larvae exposed to higher temperatures (18 – 20 °C) took more time to settle than larvae exposed to medium temperatures (14 °C). Importantly, we note that dispersal polymorphism was not observed at hatching time in both populations. Our results suggest that high temperature cause detrimental effects on intracapsular development of O. erinaceus, potentially restricting the distribution of this species to temperatures representative of the centre of its geographic range.

Daniel Montgomery
University of Exeter

Multi-stressor impacts of the ‘deadly trio’ on hypoxia tolerance and aerobic performance of the European seabass, Dicentrarchus labrax

Concern about the impact of anthropogenic stressors in aquatic ecosystems includes the unpredictability of combined interactions to multiple environmental factors. Anthropogenic climate change is causing a ‘deadly trio’ of effects in marine systems, comprising warming, increased carbon dioxide (CO2) and decreased oxygen (O2). These changes co-occur, and responses of marine fish will be a result of these multi-stressor interactions. During future hypoxic events, fish will be exposed to warmer temperatures as well as elevated CO2 (from both globally increased atmospheric concentrations and local bacterial respiration related to the hypoxic event). Higher temperatures and elevated background CO2 may increase susceptibility of fish to hypoxia through increased oxygen demand and decreased capacity of oxygen supply. Additionally, aerobic performance of fish in future oceans may be impacted by combined changes in all three of the deadly trio. I will present initial results from a combined programme of research to assess whether combined changes in temperature and CO¬2 interact to impact upon hypoxia tolerance (Pcrit) of European seabass (Dicentrarchus labrax), and investigate whether changes in Pcrit¬ are linked to blood acid-base balance and oxygen affinity of haemoglobin. Additionally, we will quantify interactive effects of the deadly trio on metabolic rate, aerobic scope, and recovery from exercise, with an overall aim to contribute novel physiological data to inform predictive models or fish populations and fisheries. With the increased emphasis on integrating physiological data into predictive models, quantifying interactive effects of the deadly trio will improve forecasting of future impacts on fish populations.

Session 3: Microbiology 2

Matthew Speight
University of Oxford

Why Do Whales Exist? Cancer Resistance in Cetaceans

If all mammalian cells have approximately equivalent probabilities of cancer-associated gene mutation then, all else being equal, the number of cells susceptible to transformation should scale with body size and longevity, implying larger, longer-lived mammals such as whales are disproportionately more prone to cancer than smaller mammals, such as mice, simply due to lifespan and cell number alone. Simple models suggest all whales should die from cancer relatively early into their lifespans, however empirical evidence to date does not support these predictions – indeed, we know many species live into the centuries. This disparity between theory and observation is known as Peto's paradox. Here I describe my own research on resolving Peto's paradox, expanding on three avenues of investigation: i) the development of a novel quantitative model, incorporating metabolic scaling, to accurately predict lifetime risk of cancer in mammals, based upon life history traits; ii) genomic analyses highlighting evolved genetic redundancy, accelerated selection and convergent and parallel evolution on cancer-associated genes in large mammal genomes; iii) the functional manifestation of these supernumerary and altered genes via more efficient DNA repair and higher rates of induced apoptosis during in vitro experiments.

Robyn Wright
University of Warwick

Artificial ecosystem selection for marine polymer degradation

Approximately 8 million tons of plastics (synthetic polymers) are thought to enter the oceans every year, and this figure is increasing. Plastics in the marine environment are notoriously difficult to degrade and may therefore persist indefinitely. In order to learn about the likely fate of these synthetic polymers in the ocean, we may be able to look at the fate of natural marine polymers, which are already degraded by marine microorganisms. When compared with single strains, microbial communities and consortia have previously been found to degrade environmental contaminants more efficiently, and artificial selection of whole ecosystems has been used to evolve communities of microorganisms that are better able to degrade contaminants than their original counterparts. Here, we present a method in which a microbial community, that was taken from colonised coastal marine debris, may be artificially selected to be better able to degrade polymers, using chitin, an abundant but recalcitrant natural polymer, as proof of concept. We found that, not only could a community be selected and evolved to have higher chitinase activity, and therefore potential to degrade chitin than the original environmental community, but MiSeq amplicon sequencing showed there to be an enrichment of groups that have been previously shown to be capable of degrading chitin. It was found that an important methodological caveat was that regular testing for the optimal incubation time of communities should be carried out, so as the next generation may be taken at the time of the peak in chitinase activity. This is because of microbial community succession; after an initial peak in community members that are able to produce chitinases, these are overtaken by "cheaters". The results of this study indicate the potential of microorganisms to develop the ability to better degrade more recalcitrant marine polymers.

Gabriel Erni Cassola
Warwick University

Not so fantastic microplastics and where to find them

Marine plastic debris is a global environmental problem. Surveys have shown that plastic particles known as microplastics (<5 mm), are significantly more abundant in surface seawater and on shorelines than larger plastic particles. Nevertheless, quantification of microplastics in the environment is hampered by a lack of adequate high-throughput methods for distinguishing and quantifying smaller size fractions (<1 mm), and this has probably resulted in an underestimation of actual microplastic concentrations. I will present a method that allows high-throughput detection and automated quantification of small microplastic particles (20–1000 µm) using the dye Nile red, fluorescence microscopy, and image analysis software. This method has proven highly effective in the quantification of microplastics, which frequently occur in the water column. Preliminary results from sea surface tows show a power-law increase in small microplastics (i.e., <1 mm) with a decreasing particle size. Hence, the data help to resolve speculation about the “apparent” loss of this fraction from surface waters. Deep sea sediments have been suggested as a potential final sink for microplastics; this will be discussed in light of new data from my meta-analysis. The data show that in terms of relative abundance, buoyant microplastics dominate sea surface- and intertidal samples, but are relatively rare in subtidal sediments.

Session 4: Anthropogenic Impacts 2

Katie O'Shaughnessy

Plymouth University

Beta diversity measures can reveal patterns in biological community assemblages between natural and artificial habitats

Urbanisation, energy extraction and food production have led to a global proliferation of artificial structures (e.g., seawalls, breakwaters) in the marine and coastal environments (recently termed “ocean sprawl”). Artificial structures typically have steep profiles and reduced surface area and complexity, and as such, they generally support fewer species than natural habitats in similar environmental settings. Ocean sprawl has subsequently resulted in fragmentation of natural coastal habitat with implications for coastal and nearshore biological communities and their associated ecosystem services (i.e., nursery habitat provision, water filtration, primary production). Plymouth Sound, UK is no exception, as much of the harbour is armoured by artificial structures in order to support a range of activities including military, recreational boating and commercial shipping and fishing. Beta diversity is a useful tool in assessing species assemblages in community ecology, and can reveal at what scale species assemblages differ between natural and artificial habitats. Beta diversity is defined as the variation in the identities of species among sites. In this study we surveyed 58 sites (two habitats: natural, n = 29 sites; artificial, n = 29 sites) within Plymouth Sound with an aim to identify the variation in species assemblages between natural and artificial habitats using beta diversity measures. Results revealed that species assemblages between the two habitats were significantly different, with greater species diversity observed within natural habitats. Preliminary results from beta diversity analyses showed that variation in species assemblages among sites is much greater within artificial habitat than within natural habitat, suggesting that habitat fragmentation may limit larval dispersal and artificial habitat is not a surrogate for natural rocky shore.

Svenja Tidau

Plymouth University

To group or not to group? Effects of anthropogenic noise on the grouping behaviour in the European hermit crab

The decision on whether to group with or avoid conspecifics might be based on information about access to resources. Joining a group could reduce the chance of capture by a predator but could lead to increased competition for resources. Human induced rapid environmental change such as noise, however, has been shown to alter sensory environments and thus may change decisions on grouping behaviour. We investigated the effects of ship noise and gastropod shell quality on grouping behaviour in the European hermit crab Pagurus bernhardus. Here, gastropod shells represent a key resource that offer protection form predators. Crabs occupied shells of either 75% or 100% of their optimal shell size and were exposed to either ship noise or ambient sound. These focal crabs were placed in the centre of the arena, the neutral zone, and then chose a neutral zone, a zone containing a single conspecific or a zone with a group of 5 conspecifics. Under ambient sound, crabs in optimal shells spent most of their time in the single zone, while crabs in small shells showed no clear preference for the any one zone. Under ship noise, this pattern was reversed, with crabs in small shells preferring the single zone and those in optimal shells showing no clear preference. Regardless of the conditions and shell quality, most crabs avoided the larger group of conspecifics. Thus, the normal decision to join a group depends on the eventual size of the group and resource quality but the influence of resource quality is altered by noise pollution. Possible explanations are that ship noise changes the crab's perception of the benefits of joining a group, or that it distracts the crabs leading to less appropriate decisions. What is clear is that the influence of resource value on grouping behaviour is altered by noise pollution.

Graham Epstein

Marine Biological Association

Assessing the ecological impact and management feasibility of the global marine invader Undaria pinnatifida ('Wakame')

Prioritisation of invasive species management is becoming of increasing importance to environmental managers. The Asian kelp Undaria pinnatifida is one of the most widespread marine invaders, yet it has received little targeted management. Here, the southwest UK is used as a case region in order to better understand the spread, population dynamics, ecological impact and management feasibility of Undaria. A mixture of manipulative experiments, surveys and population studies have been carried out in both anthropogenic and natural habitats. The findings show that ports and marinas act as beachheads for the spread of Undaria into natural habitats. On rocky-reef Undaria does not appear to drive ecosystem change, but may compete with native species of high functional similarity. Undaria also shows highly plastic population dynamics, exacerbating its limited management feasibility. Although there may be opportunities to reduce the spread and proliferation of Undaria, it seems that one of the 'worlds worst' invasive species could become officially unmanaged in parts of its non-native range. In some cases, this highly-productive, habitat forming species could have significant economic and even environmental benefit. How science and policy reacts to the continued invasion of Undaria may influence how similar marine invasive species are handled in the future.

Izzy Lake
Newcastle University

Investigating potential anthropogenic impacts on the biomass and health status of seagrass (Thalassia testudinum) pastures around southern Eleuthera

Coastal ecosystems around The Bahamas are vital for many marine organisms. Mangrove creeks and seagrass pastures dominate the south Eleuthera coastline, stabilising sediment, providing food and acting as nursery grounds for juvenile sea turtles and reef fish. Little is known about the potential anthropogenic impacts on these ecosystems in areas of low human population density. Anthropogenic activity causes elevated nutrients to be introduced to seagrass pastures, leading to a potential increase in seagrass biomass and macroalgae-dominated habitats. These changes affect both the palatability and availability of Thalassia testudinum for endangered juvenile green sea turtles, with evidence of habitat displacement and local declines as turtles seek alternative pastures to feed on. A decline in seagrass pasture biomass and the marine organisms that inhabit them has socio-economic implications, given ecotourism is an important industry the Bahamas relies upon. The objective of this research was to estimate seagrass pasture biomass around southern Eleuthera. Eight sites bordered by the Atlantic Ocean, Bahama Banks and Exuma Sound were mapped around the southern coastline of Eleuthera. These habitats are located within a gradient of proximities to human settlements ranging from 0km to 8km. A quadrat was placed every 100m along a grid reference in each sampling location. Percentage cover of three seagrass species, along with macroalgae, sessile organisms, sediment cover and type, were measured. Additionally, three biomass core samples of Thalassia testudinum were collected in 1km increments from nearby human settlements. The methods used have the potential to be replicated in similar islands, possibly reducing the time needed to assess seagrass pastures. This research aims to provide data for more effective conservation and management efforts around Eleutheran coastlines. Furthering this, the research will contribute towards a better understanding of anthropogenic activity and the effects it has on coastal ecosystems.

Session 5: Spatial Ecology 1

Chloe Game

Plymouth University

Spatial Transferability of Species Distribution Models for a Vulnerable Marine Ecosystem in the deep North-east Atlantic

In light of increasing anthropogenic pressures to deep sea habitats, the reliability of species distribution models (SDM) to aid resource management and conservation planning has to be investigated more carefully. The aim of this study was to investigate whether a SDM for Lophelia pertusa (Linnaeus, 1758) reef can accurately predict their distribution outside of the model calibration region. Thereby exploring the applications and usefulness of model transferability within deep-sea habitats, targeting current data limitations. This was undertaken within the Rockall Trough region of the NE Atlantic deep sea (within the UK continental shelf limit). The SDM was created using a randomForest regression. Both topographic (bathymetry, slope, rugosity, curvature, plan curvature, profile curvature, broad-scale, and fine-scale bathymetric position index) and oceanographic (temperature and salinity) predictor variables were used. Model calibration was performed on NE Rockall Bank and Anton Dohrn Seamount, with transferability assessed on Rosemary Bank Seamount. Models are evaluated by repeated 70/30 training/test data partitions and determination of AUC, sensitivity, specificity and percent correctly classified. Transferability was assessed using the same performance metrics along with calculation of transferability indices. Performance metrics of the model were good within the calibration region, exhibiting high accuracy for both presence and absence of Lophelia pertusa reef. Model transferability was also high, predicting the presence of Lophelia reef best. However, spatial predictions of suitable reef habitat were reasonably broad and indicated a strong emphasis of depth as a predictor variable. This demonstrates some limitations to the model and results should therefore be used cautiously. Comparison of thresholding approaches (Sens=Spec, MaxSens+Spec and PredPrev=Obs) has since revealed that the choice of method may strongly influence predictive extent by up to 143.5%. Further exploration alongside the investigation of alternative model algorithms is recommended, due to the potential impingement upon marine spatial planning.

Vanessa Yepes Narvaez
Manchester Metropolitan University

Species distribution model: an approach based on environmental variables for predicting spatial extent of three widespread bryozoans (Watersipora subatra, Bugula neritina and Tricellaria inopinata) in the Atlantic Ocean and its possible distribution under climate change

The predicted distribution of three widespread bryozoans was modelled using several algorithms with inputs consisting of occurrence information and bioclimatic datasets. A global species distribution model was developed and projected into the Atlantic Ocean to provide a visualization of suitability for the species in current and future conditions based on the environmental variables of their current niche of occurrence. To ensure model robustness, occurrence data was checked for redundancy and spatial autocorrelation. Two models with different environmental sets were evaluated, one using all available environmental variables and the other using only selected variables. The final maps predicting suitability resulted from the weighted average of the best performing algorithms selected based on performance measures including AUC, Kappa and TSS and applied to the better performing environmental model set. Results show a general expansion of range and movement of the presence area to the Northwest Atlantic under future climate conditions. The range expansion and movement of the central Atlantic species was lesser compared to the South Atlantic species. The movement magnitude and direction of predicted presence area for bryozoans supports these animals as possible indicators of climate change.

Bethanie Francis
Bangor University

Deepwater Signals of the Island Mass Effect

Phytoplankton biomass is known to be a key driver of the trophic structure of marine ecosystems. Higher primary production is thought to result in increased diversity and abundance of higher trophic levels. The Kona coast of the Island of Hawai`i is known for supporting a high abundance of cetaceans and pelagic fishes but the drivers of this are currently unknown. However, coral reef islands and atolls across the Hawaiian Archipelago have shown a particularly pronounced signal of nearshore enhancement in primary production near to islands and atolls caused by interacting biogeophysical factors, known as the Island Mass Effect (IME). The biological effects of gradients in production driven by the IME are not yet fully understood, but may explain the abundance of higher trophic level species along the Kona coast. Using a combination of mid-water trawling and active acoustic survey techniques, we show that within known “hotspot” areas of primary production there is a threefold increase in the abundance of micronekton (small pelagic organisms) relative to areas outside of the hotspot zones. In all sampling years acoustic backscatter, indicative of micronekton biomass, was very high at depths of 400 to 600m nearshore. Midwater trawls at ~500m sampling the deep non-migratory biomass nearshore (within 5 km) and offshore (>20km), showed a significant increase in the abundance and biomass of micronekton near to shore relative to offshore in both years. Moreover, higher biomass of prey near to shore correlated with a higher abundance and biomass of predatory fishes. These findings highlight the likely importance of the IME in driving the structure of nearshore marine ecosystems, ultimately driving food web dynamics and supporting the high abundance of marine mammals and pelagic fishes in the region.

Session 6: Microbiology 3

Samantha Treagus
University of Exeter

Hepatitis E in the Aquatic Environment?

Hepatitis E virus (HEV) is an emerging pathogen affecting the liver. It causes acute hepatitis, which can be fatal in approximately 1% of the infected population but causes higher mortality rates in the immunocompromised and pregnant women (Peron et al., 2007). HEV was previously thought to cause UK infections in people who had travelled abroad to endemic areas, but it has been identified that autochthonous cases occur; specifically, with genotype III (GIII) HEV. Recently, a study of UK pigs identified an anti-HEV antibody seroprevalence rate of approximately 92.8%, suggesting that undercooked pork may be a significant route of transmission of GIII HEV to humans (Grierson et al., 2015). Other evidence has also emerged which suggests that shellfish could also be a route of HEV transmission; with possible contamination routes including human sewage or farm and slaughterhouse waste run-off into water courses. In Scotland, a small number of samples of mussels harvested from five separate sites showed a contamination rate of 85.4% (Crossan et al., 2012). A separate study also showed that 2.9% of a larger number of shellfish samples purchased in Scottish supermarkets contained HEV (O'Hara et al., 2018). However, a large study which assesses the presence of Hepatitis E virus in oysters at point of harvest across the UK has not yet been performed; this will be addressed within this PhD. In addition to quantification, any HEV-positive shellfish or water samples will be sequenced and subjected to phylogenetic analysis to determine whether the identified strains are genetically similar to those found in UK pigs or human sewage. The locations at which positive samples were collected will also be subjected to GIS analysis to determine the proximity to pig farms, slaughterhouses and human combined sewage overflows, and assess the contribution of these risk factors to aquatic HEV contamination.

Poppy Best

Plymouth University

Culturing deep-sea sponge associated microbes: systematic assessment of culturing methods

Deep sea organisms have been hailed as a new frontier for the discovery of new medical compounds produced by the phylogenetically diverse communities of microbes. Despite the culture-independent approach gaining momentum, there is an inconsistency in the methods used in order to culture and analyse sponge-associated microbes. From the seabed to the lab bench there is a need for a systematic review and testing of the published protocols to assess what generates the greatest diversity of recovered isolates. Following and altering published methods previously used for the study of deep-sea sponges and their microbial communities, we systematically tested their effectiveness in the culturing of microbes from Pheronema carpenteri sponges (n = 4) collected at around 1,200 meters from the North Atlantic. Treatments included a wash stage using a range of buffers (Ca and Mg free sea water, artificial sea water, filter sterilised seawater and distilled water), the inclusion of an enrichment stage prior to plating, incubation at various temperature (5, 10, 15, 20 and 38°C), the addition of differing vitamin solutions, aerobic versus anaerobic conditions, salinity and pH. Sponge-associated bacterial culture optimisation revealed that low-nutrient media proved the most efficient in terms of abundance and diversity (A:D). The inclusion of natural sea water, aqueous sponge tissue, spicules and silica had a positive impact on the A:D of recovered bacteria. Additionally, a higher A:D was observed in correlation with lower temperature, reflective of the natural environment of the sponge sample. Optimising culturing methods through the mimicry of the sponge habitat to generate greater isolate diversity has implications in the discovery of novel compounds. Improving on existing methods may permit for the recovery of more isolates relevant for microbial conservation efforts and understanding the microbial process of the deep sea sponge microbiome.

Session 7: Spatial Ecology 2

Jenny Bortoluzzi

Plymouth University and Marine Biological Association

Changing tides: contrasting spatial dynamics of two sympatric shark species at a remote coral atoll

Understanding how animals move around their environment is essential to manage and protect species and ecosystems effectively. Movements in time and space can be triggered by various physical, biological and environmental factors so animal-borne tags are increasingly used by scientists to collect data to track movements and establish where, and for how long, animals spend their time. Network analysis using acoustic telemetry data provides a way to study long-term, fine-scale spatial dynamics of multiple reef shark species. In D'Arros and St Joseph Atoll in the Amirantes (Seychelles), sicklefin lemon sharks (Negaprion acutidens) share their activity space with the smaller blacktip reef sharks (Carcharhinus melanopterus). Our study aims to determine how these two species co-occur at this location without apparently outcompeting each other. With these objectives in mind, 91 sharks were tracked between 2012 and 2017 using passive acoustic tags and an array of over 80 acoustic receivers. The analysis considered factors such as tidal height and sex. We present findings of sexual segregation in both species and evidence of the tidal cycle as a driver of activity space use within the atoll. The Indian Ocean is currently data deficient in many areas of elasmobranch research and the work carried out here contributes to filling such gaps about shark space use and potential movement driver. While the studied atoll is currently protected by a Marine Protected Area, this new understanding of reef shark movement ecology identified here provides us with a model that may, in turn, be applicable to similar locations in the Indian Ocean and tropical reef ecosystems globally.

Tracey Dornan

British Antarctic Survey / University of Bristol

Acoustically cryptic fish mask Southern Ocean mesopelagic biomass

Active acoustics provides an unparalleled method of assessing abundance and distribution patterns of marine fish across oceanic scales. It is used to estimate biomass of mesopelagic fish species, where in general higher levels of acoustic backscatter are considered to indicate greater mesopelagic biomass. However, acoustic signal reflection is largely linked to body morphology and density, and species with a gas filled swim bladder return a considerably stronger acoustic signal than those without. Thus, an acoustic assessment of Southern Ocean mesopelagic fish biomass needs to account for this variation. Improvement to acoustic methods for mesopelagic biomass estimation requires information on the tissue density and swim bladder composition of constituent species. Thus, we used X-ray Computed Tomography, together with a modified density bottle method, to quantify tissue density and swim bladder condition of dominant mesopelagic fish species in the Scotia Sea. We found considerable differences between species in these key density and swim bladder characters, which we relate to patterns of habitat occupation. Together, these results have significance for how we interpret large scale patterns in the Southern Ocean. Acoustic data from the Scotia Sea indicates a decrease in total water column backscatter with an increase in latitude. While this could signify a decrease in fish biomass toward the Antarctic continent, our results suggest this may also represent a community shift from acoustically dominant gas-bladdered fish species at the polar front, to acoustically cryptic non-gas-bladdered fish species further south. These results should

help improve estimates of biomass from long-term acoustic monitoring of fish within the Scotia Sea and wider Southern Ocean.

Saoirse Pottie

Swansea University

Population structure and distribution on zebra shark (Stegostoma fasciatum) in the Mozambique channel

Substantial population declines and local extinctions have led to zebra sharks (Stegostoma fasciatum) being classified as endangered by the IUCN. Zebra shark are fished throughout its range, the subpopulation in the Indian Ocean - Southeast Asian is estimated to have declined by at least 50% over the last 3 generations. The IUCN have highlighted the Indian Ocean as data deficient area; this study is the first substantial assessment of the population structure and distribution of zebra shark in Africa. A photo - ID catalogue and database was created using information collected from structured dives and citizen scientists. The project also utilized local knowledge by conducting interviews with fishermen about historic and current catches. This information was used to describe the occurrence of this shark in the coastal waters in Mozambique. Specifically, this study described (1) the spatial and temporal distribution, (2) the effectiveness of interviews with artisanal fishermen to monitor the presence of zebra shark in Mozambique, (3) the degree of site fidelity and home range of individuals and (4) determined the relative importance of environmental predictors on the occurrence of zebra shark. 2224 structured dives were conducted during the study period (01 January 2010-01 January 2018); zebra shark were encountered 163 times at 8 dive sites and 170 photographs were collected from MMF (n=87), Citizen Scientists (n=48) and from All out Africa (n=35). Zebra shark showed a clear gradient towards the northern sites; combined northern dive sites had the highest encounter rates (n = 147; 90% of total encounters). There were two peak encounters one in summer/late summer (December – April) and in August. 39% of individuals were recaptured between 2–17 times during the study; the longest duration between first and last capture being 2638 days (7 years).

Posters

Elina Apine

Plymouth University

How suitable is the mud crab Scylla serrata as a sustainable livelihood resource in south-west India?

The mud crab (Scylla serrata) is an economically important species found in estuaries and mangrove ecosystems in the Indo-Pacific region and is an important livelihood resource and a source of protein in some areas. However, while coastal communities in some Indian states of are extensively involved in mud crab collection and small-scale farming, in Karnataka it is far from exploiting the potential. Socio-economic constraints such as lack of knowledge, training, and access to land together with gaps in knowledge about mud crab biology are recognised as main reasons for this disparity. Therefore interdisciplinary social-natural science approach will be used to assess the feasibility of Scylla serrata as sustainable livelihood resource. The first study is a preliminary assessment of the feasibility of Scylla serrata as perceived by the local fisher-folk communities in Karnataka. Surveys and focus group discussions were conducted in Uttara Kannada district, where small-scale farming systems such as fattening and grow-out are not common and most of the crabs are fished by simple gear. The results indicate that 71% of fishers have noticed the decrease in S. serrata population and explain it by high fishing intensity due to increasing market demand and relatively high purchase rate. More than two thirds stated that crab collection is profitable but unstable due to the seasonality. The majority of respondents know about farming methods but only 9% would consider undertake such enterprise. Lack of land and financial resources are the main reasons for not being interested. Further studies include gut microbiome sequencing and mesecosm experiments. Gut microbiome 16s rRNA amplicon sequencing will reveal whether geographical distribution, habitat conditions and diet influence susceptibility of mud crabs to disease. In mesocosm experiments we will assess mud crab ecophysiological susceptibility to climate change parameters and the interaction of these with toxin producing microalgae and harmful bacteria.

Emily Carter

University of Exeter

The effect of shipping noise on colour change and camouflage in the shore crab, Carcinus maenas

With the continuing rise in anthropogenic activity and marine exploitation, the ocean is becoming an increasingly noisy place. Several negative effects have already been documented, but much of this work focuses on species and behaviours dependent on acoustic cues for success. Species for whom this is not the case have been generally overlooked, despite the large overlap in the frequency range of anthropogenic noise and their hearing sensitivity. We aim to determine the extent to which shipping noise, a major source of noise pollution already found to increase stress in marine crustaceans, affects colour change and consequent camouflage in the shore crab. Preliminary results of an 8 week, tank-based experiment suggest that shipping noise initially significantly reduces colour change, but that neither loud natural sounds or quiet natural sounds have any effect. This not only indicates that negative effects are a result of anthropogenic noise specifically, not just loud noise in general (a distinction that has not been made in previous studies), but also that such negative effects are more widespread than previously thought, with potential survival implications across several taxa. Finalised results will be discussed further.

Jessica Rudd

University of Exeter

Using multi-channel biologging to describe the spatio-temporal occurrence and energetics of breaching behaviour in Basking Sharks

Some marine vertebrates, including cetaceans, are known to “breach” – a spectacular display behaviour lunging above the sea surface. Breaching may have important roles in communication, mate-guarding, play or parasite dislodgement, but little is known of breaching behaviour in non-air breathers, such as sharks. Basking sharks (Cetorhinus maximus), the UK’s largest shark species, is anecdotally known to breach. While recent tracking has explained many facets of their spatio-temporal movement ecology, their courtship and breeding behaviour remains largely unknown. This study uses state-of-the-art satellite tracking and movement tags to provide fine-scale information on the spatio-temporal variation of their breaching behaviour. Three sharks were tagged in the Hebrides, a key regional hotspot for basking sharks in the north-east Atlantic. Sharks breached throughout the diel cycle with breaching occurring predominantly during the day. One shark breached 60 times over 32 days with up to 4 consecutive breaches in 47 seconds. Breaching is an energetically demanding behaviour for sharks compared with surface foraging; requiring over 100-fold more energy to propel themselves out of the water from up to 57 meters deep. Through multidimensional spherical representation, the daily behaviour of basking sharks is represented, highlighting the frequency and extreme energetic requirement of breaching. By elucidating the timing and location of breeding behaviour, adequate protection can be provided to important life stages of an endangered marine species.

Caitlin Allan

Plymouth University

Habitat preferences of sperm whales (Physeter macrocephalus) in the North Atlantic

The distribution and habitat preferences of sperm whales (Physeter macrocephalus) found in the deep waters off the west coast of Scotland are poorly understood, but important to understand for conservation management. Therefore the habitat preferences of sperm whales will be modelled in relation to a range of environmental factors to determine the distribution, habitat preferences, and help define critical areas for sperm whales in the waters off the west coast of Scotland. Data was collected from hydrographic surveys off the west coast of Scotland between 2003-2016 using a passive acoustic towed array. Sperm whales make loud near-continuous echolocation clicks, making passive acoustics the most reliable method of detecting animals. Sperm whale distributions will be modelled with a range of bathymetric and oceanographic variables including: depth, slope, sea surface temperature (SST), sea surface height (SSH) and distance to and strength of fronts. Sperm whale distribution will be modelled using Generalised Additive Model (GAM) coupled with Generalised Estimating Equations (GEE) to account for autocorrelation that results from hearing sperm whales over large distances. Preliminary findings suggest that sperm whales distributions are driven both by topography, and oceanographic features that aggregate or enhance their cephalopod prey such as found around sea mounts and along steep-sided deep slopes. This study will improve our understanding of the distribution and biology of sperm whales off the west coast of Scotland and help to identify critical foraging areas that could help in conservation management for the species.

Christina Muller-Karanassos

Plymouth Marine Laboratory

Antifouling paint particles – concentrations in intertidal sediments and ingestion by benthic organisms

Antifouling paint is applied to the hull of ships, boats and other submerged artificial structures in order to prevent biofouling. Antifouling paint particles (APPs) are produced during maintenance and cleaning of these structures in boatyards and marinas and are often transported from hard-standings and slipways into the marine environment via wastewater runoff. Once in the environment APPs can accumulate in marine sediments and may be ingested by benthic organisms. This study was carried out to quantify the concentrations of APPs found in intertidal sediments and to determine if sediment-dwelling biota are ingesting these particles in the natural environment. Sediment samples were collected in the vicinity of marinas and boatyards in the Plym Estuary as well as a site with minimal boating activity in the Erme Estuary. Samples of the deposit- and suspension-feeding ragworm, Hediste diversicolor, were also collected at each sampling site. Results indicate that APPs are present at much higher concentrations in intertidal sediments around areas of high boating activity compared to the area of minimal boating activity. Metal analysis of digested H. diversicolor samples also indicates that this benthic organism may be ingesting APPs. Further work will involve a lab-based experiment to examine the health and behavioural effects of APP ingestion on H. diversicolor.

Amelia Bridges

Plymouth University

Use of predictive habitat modelling to assess the extent and distribution of vulnerable marine ecosystems across UK Overseas Territories in the South Atlantic

Although Regional Fisheries Management Organisations & United Nations member states have been tasked with adopting the precautionary approach to protect Vulnerable Marine Ecosystems, little is known about their distribution in the South Atlantic Ocean. Using a Maximum Entropy approach, we predicted habitat suitability of reef-building Scleractinian corals within the Exclusive Economic Zones of 3 UK Overseas Territories in the South Atlantic (Ascension Island, St. Helena and Tristan da Cunha). The model was created using ecologically relevant environmental predictors derived from high-resolution multibeam data (e.g. rugosity, slope etc.), with presence records compiled from analysis of images. Model parameters were chosen based on performance evaluation, and accuracy was evaluated using standard performance metrics (AUC). The model performed well, and predicted high habitat suitability (>0.8) in topographically interesting areas such as seamounts, and in areas reasonably close to the shore, likely due to the steep sloping nature of the islands. High habitat suitability on seamount complexes suggests that there is some level of interaction between deep-sea fisheries in the South Atlantic, and VMEs. Suitable VME habitat was also predicted to occur on areas identified as likely suitable for deep-sea mining. This multiple stakeholder scenario may result in challenges managing different restrictive legislations for miners, fishers, and conservationists in a single area.

Kimberly Nielsen

Plymouth University

In search of harbour porpoises (Phoceona phoceona): how changes in detection probabilities affect models of spatio-temporal abundance in dynamic seas

Understanding how organisms interact with their environment and respond to change is the foundation of ecology, providing core information essential for effective management and conservation. This poses a challenge for the study of highly mobile predators like cetaceans, as their ranges may span ocean basins, and distributions are linked to complex hydrography driving patchily distributed prey. The harbour porpoise (Phoceona phoceona) is a protected species, but given their geographic extent and inconspicuous behaviour, large knowledge gaps still remain in their fine-scale, temporal distribution and abundance. This study aims to derive valuable quantitative information related to harbour porpoise abundance and density in waters surrounding the UK. Using distance sampling methodology, sightings data was collected from 2006-2017 by dedicated citizen scientists along ferry crossings in the North Sea, English Channel, Celtic Sea, and Irish Sea. The ability to accurately detect small, mobile porpoises in a dynamic environment is influenced by a variety of covariates, from local oceanographic conditions, to survey vessel and animal behaviour. By incorporating significant covariates responsible for variation into detection function models, we account for animals missed along the survey route and estimate more accurate detection probabilities. Here, we present data on how continuous small-scale surveys can provide power to identify early population changes - possibly as a result of anthropogenic threats - by using more robust detection functions to generate spatial models and estimate relative abundance beyond the surveyed transects. This study will aid in identifying important areas of high density habitat-use, supporting conservation measures, and deepening the available ecological knowledge of harbour porpoise populations in UK waters.

Lauren Henly

University of Exeter

Cleaning in the cold: An exploration of cleaning behaviour and function in temperate wrasse

Cleaning symbiosis in coral reef fish has been observed and reported extensively in the literature. It is generally considered that cleaners are more likely to be dedicated cleaners in tropical regions than those in temperate waters, obtaining a greater proportion of their nutrition from their clients during such symbiotic interactions. Despite this, there is a rapidly growing trend for using cleaner fish in commercial aquaculture in temperate regions as an alternative to chemical control of parasites. Temperate cleaners used in aquaculture, particularly wrasse and lumpsucker, are assumed to be largely facultative in their cleaning behaviours in their natural environment, but have been shown to exhibit reliable and frequent cleaning behaviour when used in aquaculture systems. I am embarking on a programme of research that will tackle fundamental questions regarding the behavioural and ecological processes that underpin cleaning activity for these cleaners in both the natural environment and in captivity. My research will include in situ observations and experimentation, aquarium-based cleaner-client behavioural studies and forensic analysis of gut contents. Understanding the underpinning cognition, behaviour and functional ecology of these cleaners is critical, not only to ensure that their use in aquaculture continues to be effective, but also for developing sustainable management of this emerging and potentially insufficiently regulated fishery.

Vanessa Yepes Narvaez

Manchester Metropolitan University

The Lophos project: A community engagement initiative focused on marine bryozoan's biodiversity and conservation

"Lophos" was created to involve the Greater Manchester school students into science and education in partnership with the Manchester Metropolitan University in which most of the work has been developed. During the past year several colleges and primary schools have been participating in this project, learning about the biodiversity of marine invertebrates, specially bryozoans and their significance in the ecosystems they inhabit. The aims of "Lophos" include creating interest in taxonomy and ecology on the British fauna using ludic approaches for children such as "learn while playing" and "look and discover" activities as well as more serious laboratory work for college students in which they learned how to differentiate sessile fauna attached to natural and artificial substrates collected all around the United Kingdom, identifying to the lowest level possible the animals and making aware of the threats those animals are facing under climate change. The first phase of "Lophos" involved four last year students from Bolton College which spent two months learning about British biodiversity and Ocean acidification while they identified bryozoans. The results of this phase included a publication of their findings in an academic magazine. This activity also counted as their first scientific writing and experience. The subsequent two phases of this project included community engagement events in the Manchester Museum and the Science and Industry Museum in which around thousand children and their families learned about the importance of preserving the marine fauna and stop contamination.

Linda Westermann

University of Warwick

Novel metal containing enzymes: missing links in the marine P cycle?

Even though phosphorus is one of the most common elements in the Earth's crust, it's availability is limited. It is a key component of RNA and DNA, provides energy to cells in form of ATP and is an important element of cell membranes. In marine environments, phosphorus occurs in different variations of inorganic (Pi) and organic forms. Pi concentrations in ocean surface waters can vary widely, with North Atlantic waters (< 1 nmol L-1) at least a magnitude lower than those in the North Pacific (> 1 µmol L-1). As a result, organisms have had to adapt to those low Pi environments. Cyanobacteria, which play an important role in the marine primary production, developed high-affinity Pi uptake mechanisms to survive in oligotrophic oceans. The two major primary producers are members of the phototrophic genera Synechococcus and Prochlorococcus. Synechococcus is more widely distributed, however, its abundance is about one magnitude lower than Prochlorococcus. There are three major strategies microbes elicit in nutrient limited conditions: (i) altering cell physiology, e.g. decrease cell growth or adjust protein composition (ii) synthesis of high-affinity transporters, (iii) recycling of internal resources by degradation, e.g. replace phospholipids with non- Pi-containing lipids. Strategies (i) and (iii) will be investigated in different contexts i) investigating the trace metals required for phosphatase activity and iii) elucidating how Synechococcus and other marine heterotrophic bacteria acquire P from phospholipids.

Davis Laundon

Marine Biological Association

Developing a model system and experimental 'toolkit' to investigate the biology and ecology of marine chytrid-diatom interactions

Chytrids are zoosporic fungi that have been reported as saprotrophs and microalgal parasites in fresh water and marine ecosystems. Spatiotemporal metabarcoding surveys of marine fungi have revealed a massive diversity of as yet uncharacterised chytrid taxa, some of which are correlated in abundance with diatoms. Chytrid parasites therefore have the potential to greatly impact biogeochemical cycling in marine systems. At present, there is a limited understanding about the fundamental physiological and biological basis of chytrid-diatom interactions – including infection processes and host response. We aim to bridge this knowledge gap by establishing a morphologically and genetically characterised chytrid 'BioBank' of chytrid-diatom parasites. From the 'BioBank', novel model parasite-host systems for cell physiology will be developed. In tandem with environmental metabarcoding of fungi and cultural isolation of phytobenthic diatom communities, we are developing a 'toolkit' for investigating aquatic chytrid biology, including quantitative live-cell imaging, fluorescent labelling of subcellular structures, cryopreservation and experimental culturing techniques. Using these tools, we have been able to map and quantify the life cycle of the model saprotrophic chytrid Rhizoclosmatium globosum JEL800, optimise protocols for lipid, chitin, and plasma membrane visualisation and have developed an optimised protocol for the cryopreservation of zoospores. The results of these investigations will form an invaluable toolkit in the investigation of parasitic marine chytrids and allow us for the first time to explore the biology of these enigmatic and ecologically-important fungi.

Jess Bone

Bournemouth University

Behind Anemone Lines: Determining the environmental drivers influencing lagoonal benthic communities, with special reference to the anemone Nematostella vectensis

Lagoons are a rare ecosystem in the UK and occur on just 5.3% of Europe's coastline and host an equally rare macrozoobenthic community due to their stochastic environmental variables. As a transitional habitat threatened by sea-level rise and coastal development, their ecological health should be quantified to provide a greater understanding of how to manage an ecosystem prone to dystrophic events. Poole Park recreational lake is a man-made sluiced lagoon located in Dorset, England, that has suffered from macroalgal blooms that interfere with watercraft use, swarms of midges, and unpleasant smells from hydrogen sulphide. Recent funding to the local council has provided the opportunity to investigate the status of its benthic fauna, with special reference to the cryptic protected starlet sea anemone (Nematostella vectensis). This research comprehensively maps the distribution of Poole Park lagoon's macrozoobenthic biota and determine the abiotic factors influencing their spatial distribution, including aquatic and edaphic factors. This was achieved with the standardised method of suction core sampling. It is anticipated that proximity to the sluice gate will be the predominant factor dictating the spatial distribution of species diversity. Results thus far indicate that species richness and density is greater in areas of a lower percentage of silt content (<63µm) and organic matter content (% LOI). Higher silt and organic matter content is concentrated in the south west corner of the lagoon, which correlates with the prevailing wind direction. The results from this study will improve the understanding of the abiotic factors that drive macrozoobenthic distribution in temperate lagoons.

Vun Wen Jie

Plymouth University

The differential light preference between the biphasic life cycle of Coccolithus pelagicus

Coccolithophores are important for the biogeochemistry of the ocean as they play an important role in the carbon, calcium, and sulfur cycle. Coccolithophores are major pelagic calcifiers and contribute approximately half of the global calcium carbonate export. Most of coccolithophore calcite is produced by the diploid life cycle stage which produces relatively heavy hetero-coccoliths. The haploid life cycle stage produces lighter holo-coccoliths or is coccolith-barren. The ecological and evolutionary significance of the two life cycle stages is poorly understood. Based on distribution patterns it is usually inferred that the diploid and the haploid have different preferences for e.g. light or nutrient levels. However, little is known about the responses of the two life cycle stages to environmental changes, especially in species other than E. huxleyi. . In this study, we looked at the light preference of both life stages of Coccolithus pelagicus to five light treatments. The light treatments were 300, 50, 20, 10, 0 µmolphoton-1s-1. Diploid C. pelagicus was found to have a maximum growth rate at 50 µmolphoton-1s-1 whereas the haploid has a maximum growth rate at both 50 and 300 µmolphoton-1s-1. Apart from that, we also looked at differences in volume that were calculated from the width measurements acquired from mesolens images. It was found that the diploid have the largest volume at 50 and 20 µmolphoton-1s-1 while haploid have the highest at 300 µmolphoton-1s-1. It seems that in terms of light intensity preference, haploid C. pelagicus favour higher light intensity than the diploid.. The difference in physiology between life stages might confer an ecological and evolutionary advantage.

Jacob Bedford

Plymouth University

Plankton as prevailing conditions: a surveillance role for plankton indicators within the Marine Strategy Framework Directive

The Marine Strategy Framework Directive (MSFD) applies an indicator approach to ecosystem assessment, where indicators of ecosystem state are assessed as to whether they are in 'Good Environmental Status' relative to prevailing oceanographic conditions. Here we use examples from the literature to illustrate that climate-driven plankton community changes are necessary prevailing conditions that need to be understood for more effective ecosystem assessment, and are therefore useful as surveillance indicators. Plankton indicator surveillance could provide useful diagnostic information for assessing GES, both within pelagic habitats and other MSFD components. It also has the potential to have a more strategic role in the assessment of other MSFD components by affecting targets and influencing the programmes of measures needed to restore or maintain Good Environmental Status.

Molly James

Plymouth University

Assessing the role of active larval movement in vertical distribution profiles: implications for dispersal modelling

Biophysical modelling is a well utilised tool for predicting the dispersal of marine larvae. However, replication of the patterns observed in nature is often not achieved, potentially due to incorrect parameterisation of larval behaviours. Behaviours are often inferred from laboratory based studies and follow ‘rules’ within models that may not be reflective of behaviour in situ. Using a numerical approach, we explored the vertical movements that larvae must undertake in order to achieve the observed changes in vertical distribution patterns over time. Particle movement was simulated for a range of realistic vertical velocities for Mytilus edulis veligers using a novel particle tracking model within a Large Eddy Simulation (LES). Modelled distribution profiles were compared to those observed in situ using ANOVA and differences in proportion over depth were explored using Tukey’s Post-hoc analyses. Gaussian distributions were fitted to likelihood of difference vs. vertical velocity plots to determine the velocities that generated profiles that best matched the observed distributions for each tidal state. Results showed that speed and direction varied greatly dependent on the state of the tide, and did not align with directional swimming predicted by Tidal Vertical Migration (TVM). A hierarchal cue response may be causing larvae occupying surface waters to actively swim downwards between high water slack and mid-ebb but not during any other period. Using an exploratory approach to mechanistically determine larval movement could mitigate the need to understand behavioural responses to cues, and when paired with empirical data to correct model inaccuracy, could greatly improve the precision of larval dispersal estimations.