# Reef Conservation UK
# 8th – 10th December 2020
## #RCUK2020

## Abstract Booklet



## Tuesday 8th December 2020

**10:00 Welcome and overview of #RCUK2020**

**10:10 Plenary speaker I [Chair: Hannah Gilchrist, *Blue Ventures*]**

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| *10:10* | *Morena Mills* | Insights for catalysing environmental conservation | *Imperial College London* |

*Despite billions of dollars spent annually on environmental conservation initiatives, such as private or state-led protected areas and community based resource management, we have very little knowledge of why some initiatives take off and spread around the world while others languish and disappear. In this talk, I will present new insights from an interdisciplinary research project on the factors that increase the speed and extent to which environmental conservation initiatives are adopted and spread. I will also tell some of the stories behind the conservation initiatives that have had rapid and widespread adoption, with potential to transform the relationship between people and nature. This project is a partnership between academic institutions and NGOs around the world, seeking to learn and develop the evidence-base needed for more effective steps towards sustainable resource use.*

**10:40 Session I: Reefs in a Changing World – Part I [Chair: Hannah Gilchrist, *Blue Ventures*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
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| *10:40* | *Amber L.Carter* | Assessing opportunities to support coral reef climate change refugia in MPAs: A case study at the Revillagigedo Archipelago | *University of Edinburgh* |

*Coral reef refugia are habitats which possess physical, biological and ecological characteristics that make them likely to be relatively resilient to future climate change. Identification of refugia locations will be important to ensure suitable marine conservation planning is undertaken to protect sites where coral ecosystems will be better preserved now and in the future. This paper presents (1) a review of current knowledge of the oceanographic conditions and coral community in the Revillagigedo Archipelago Large Scale Marine Protected Area, (2) the first assessment of the potential for the Revillagigedo Archipelago to act as a climate refugia site for corals and coral reefs in the eastern*

*tropical Pacific, and (3) consequent management and learning opportunities, to inform reef conservation both locally and globally. Through utilising published literature, remote and in situ environmental data, and field observations it was found that the Revillagigedo area exhibits a combination of distinctive characteristics in the coral community and in oceanographic processes which support conditions of refugia. The potential for refugia is further enhanced due to the absence of significant secondary anthropogenic stressors. This leads to a recommendation to establish the Revillagigedo as a globally significant 'sentinel site' where, through long-term monitoring of oceanographic conditions and of the coral and associated ecosystems, the effects of climate change can be quantified, and the effectiveness of specific refugia attributes established. This information may then be used to underpin the recognition of potential coral refugia elsewhere, and to guide MPA designation and management decisions to enhance their effectiveness.*

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| *10:52* | *Mark Hamilton* | Climate-induced regime shifts and recovery trajectories of coral reefs determine fisheries productivity and turnover | *Lancaster University* |

*Following coral bleaching events, the resulting state of reef habitats leads to alterations of fish assemblages which impact the yields of local fisheries that target them. Many previous studies have focused on biomass trends of exploited fish populations, however recent investigations into the productivity and turnover of fish assemblages have highlighted the importance of considering these metrics in a fisheries context. Here we compare post-bleaching fish productivity and turnover trends over a 24-year time series, between reefs where hard coral recovered and those that regime-shifted to a macroalgal state. We found that the productivity of fished assemblages was significantly higher on recovering reefs compared to pre-bleaching levels suggesting a greater rate of biomass accumulation post-bleaching, while regime-shifted reefs returned to pre-bleaching productivity levels and stabilised. On recovering reefs, overall increases in productivity post-bleaching were observed for piscivores, grazing herbivores, omnivores and mobile invertivores, as well as a long-term increase in net turnover for mobile invertivores. On regime-shifted reefs we found productivity had increased for mobile invertivores and decreased for planktivores, while net turnover increased for omnivores and sessile invertivores. The productivity of grazers was significantly higher on recovering reefs compared to regime-shifted reefs by the end of the time series, however the opposite was true for turnover which was consistently higher on regime-shifted reefs post-bleaching, suggesting that although growth rates were higher on recovering reefs, the replenishment of standing biomass was more readily sustained on regime-shifted reefs. These findings highlight the differences in responses of exploited reef fish assemblages between post-bleaching reef states and provide an indication of which species groups may sustain fisheries in the long-term following disturbances.*

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| *11:04* | Q and A session |

**11:10 Morning break**

**11:30 Session I: Reefs in a Changing World – Part I – continued [Chair: Hannah Gilchrist, *Blue Ventures*]**

| ***Speaker*** | ***Presentation title*** | ***Institution*** |
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| *Tim Gordon* | The changing song of the sea: reef soundscapes as indicators and drivers of ecosystem change | *Mars Sustainable Solutions* |

*Healthy coral reefs are alive with sound: a range of reef organisms produce snaps, whistles, pops and grunts, creating a loud and diverse soundscape. Many fishes and invertebrates spend their larval stage in the open ocean, and then listen for this soundscape to detect, orient toward and settle to suitable reef habitat. However, coral reefs worldwide are degrading rapidly, altering ecosystem functioning. Here, we present three empirical field studies that demonstrate the value of using bioacoustic approaches to understand and mediate the responses of coral reefs to rapid ecosystem change.*

*First, we show that reef soundscapes are altered by climate change impacts. On the northern Great Barrier Reef, recent cyclone and bleaching damage caused significant and consistent changes to soundscapes across multiple acoustic parameters: post-disturbance reefs were less acoustically complex and 75% quieter than their pre-degradation states. In complementary field experiments, we found that young fishes are significantly less attracted to these post-degradation soundscapes, threatening to reduce recruitment and jeopardise reef recovery.*

*Second, we show that at the world's largest coral reef restoration programme, local recovery can be measured by passive acoustic monitoring. Reefs restored by rubble stabilisation and coral transplantation sound quantifiably similar to nearby naturally healthy reefs, but different from nearby damaged reefs.*

*Finally, we present evidence that loudspeaker playback of healthy reef sound can increase fish settlement and retention to degraded habitat, potentially enhancing local-scale restoration efforts. Over the course of six weeks, acoustic enrichment caused a doubling in overall abundance and 50% greater species richness of juvenile fishes on acoustically enriched habitat patches compared with acoustically unmanipulated controls.*

*In conclusion, bioacoustics offers novel methods to monitor and actively manage coral reef ecosystems. In a world where reefs are changing at unprecedented rates, much can be achieved by learning to listen.*

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| *11:42* | *Nathan Price* | Algal Reef Fishes and Behavioural Responses due to Coastal Development | *Tunghai University* |

*The Taoyuan Algal Reef is a biodiverse coralline algal reef in northwest Taiwan that is currently threatened by coastal development and industrial waste runoff. Knowledge of the reef is limited and has until recently, long been regarded as a barren environment. Recent studies have revealed that the reef is inhabited by a diverse array of organisms, particularly at Datan, where a natural gas receiving terminal has recently begun construction. Here, we investigated the potential impacts of coastal development through fish abundance and diversity surveys and manipulation experiments to investigate behavioural changes. We did this by first, documenting fish assemblages from five sites along the algal reefs. Due to challenging environmental conditions, we supplemented our traditional sampling methods (clove oil, netting and pole-and-line fishing) with otolith assemblage and soundscape analysis. Secondly, we investigated changes in foraging and chemical alarm cue response of fishes (Epinephelus coioides and Bathygobius spp.) under sediment and noise manipulation experiments. In our survey results, we observed a number of fish species that had not been recorded in previous surveys. Predatory reef fishes such as groupers (Serranidae) and snappers (Lutjanidae), as well as several small endangered scalloped hammerheads (Sphyrna lewini) were recorded at Datan G2, where otolith assemblage analysis also indicated predatory activity. However, fewer individuals and species were recorded from tidal pools across all sites compared to previous surveys, suggesting a loss of biodiversity. Our manipulation experiments indicated increased sediment levels led to decreased fish foraging activity. Elevated noise levels did not appear to alter either fish foraging behaviour or alarm responses under any sound treatments. If construction work resumes, it will likely have adverse consequences for the reef and the local fishermen that rely upon it.*

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| *11:54* | *Holly Baigent* | An investigation into the transmission of stony coral tissue loss disease (SCTLD) across the Caribbean, with a focus on the Turks & Caicos Islands. | *University of Plymouth* |

*Stony coral tissue loss disease (SCTLD) has been responsible for severe negative impacts to already fragile Caribbean reef habitats. Impacts include the mortality and morbidity of reef-building corals, resulting in reduced coral cover, density and diversity. SCTLD is predominately reported as spreading naturally via direct contact and through the water column. However, sporadic appearances of SCTLD infected reefs across the Caribbean suggest the involvement of additional modes of transmission, anthropogenic or natural. In order to tackle this virulent disease, a competent understanding of its spatial distribution and transmission on a regional and localised scale is essential. In order to assess any correlative patterns in the spatial dynamics of SCTLD, the first official reports of SCTLD infected reefs within each impacted Caribbean country were plotted and overlaid with prevailing currents, shipping traffic data layers, and major port locations. Similar research was undertaken across the Turks and Caicos Islands, assessing the localised spread of SCTLD across the archipelago alongside additional benthic analysis. Across the Caribbean, there was limited long-distance association found between the initial occurrences of SCTLD and prevailing currents. Shipping traffic appeared to have a stronger correlation to SCTLD spatial transmission. Additionally, infected reefs were commonly located near major ports, indicating that ballast water discharge may contribute to the transmission of the disease. In terms of small-scale transmissions, the Turks and Caicos investigation suggested that currents may be influencing SCTLD distribution. Similarly to the Caribbean, shipping traffic could be an additional vector, possibly explaining counter-current shifts in distribution. No significant relationship between benthic habitat classes and the prevalence of SCTLD. However, four geomorphic zones were found to have a significant impact on SCTLD occurrence. This research is vital for increasing our understanding of the spatial dynamics of SCTLD to enhancing our ability to accurately predict and protect vulnerable reef systems.*

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| *12:06* | *Nadia Santodomingo* | Ancient and recent turbid reefs in the Coral Triangle: 30 million years of coral resilience | *Natural History Museum* |

*The identification of potential ecological refugia for coral reefs is a high priority under the current climate change crisis. Recent work suggests that shallow turbid habitats may play a critical function and act as refugia habitats. The fossil record of the CT shows that the first coral assemblages appeared 30 million years ago, and they were mainly low-relief patch reefs that developed in low-light with high sediment inputs – conditions that have been shown to mitigate thermal stress on corals. These ancient turbid habitats hosted a high diversity with most of the coral taxa (85% genera) still occurring today. We surveyed a mosaic of turbid reefs in Sabah (East Borneo) to assess their current status and better understand the role of light, temperature and sediments as drivers for their resilience. Detailed light profiles and sediment analyses are used to characterise the sources of turbidity: urban, mangroves, coastal runoff, and river inputs. Video transects were used to estimate coral cover and diversity. Comparisons of ancient and modern turbid reefs show similarities in richness and fauna composition. Live coral cover varies from 36% in the most turbid locality to 48% in the least turbid locality, in contrast to 30% in the clear-water site. Community composition also varies within this spectrum: massive and branching Porites are dominant in less turbid settings, while foliose and platy forms of Leptoseris and fungiids are dominant in the most turbid sites. Acroporids are common in the clear-water site, and they showed a high impact (53% of colonies) during the 2020 bleaching event respect to the low impact in the most turbid site (10-20% of colonies). Through the combination of fossil and modern data, we have strong evidence that turbid reefs have played an important role during the origins and maintenance of coral diversity in the CT.*

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| *12:18* | Q and A session |

**12:30 Lunch break**

**13:30 Plenary speaker II [Chair: David Curnick, *ZSL*]**

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| *13:30* | *Al Harborne* | The complexity of complexity: The importance of habitat structure for fish abundance and behavior in the Florida Keys | *Florida International University* |

*Many reefs have been impacted by multiple stressors, leading to lower coral cover and a concomitant loss of three-dimensional structure. Although the link between habitat complexity and fish abundance is well established, the full implications of losing structure on fish assemblages and behavior are poorly understood. In the Florida Keys, we first examined the importance of structure as a driver of fish abundance. Using surveys from along the reef tract we modelled fish biomass, demonstrating that benthic complexity was the most important correlate for multiple species groups. These statistical models also allowed estimates of potential biomass under different management scenarios: no fishing, coral restoration, and addition of artificial structure. The addition of structure, which is a rarely used management tool, was predicted to have the largest impact on fish biomass suggesting it should be more widely considered as a restoration method. Furthermore, the effects of losing structure clearly vary across the fish assemblage, but we are currently unable to generalize the patterns. Building species-specific models we isolated the importance of complexity to 118 species and correlated these to fish traits. 'Losers' of flatter reefs had particular traits including rounded body shapes and being herbivores or piscivores, while 'winners' were small generalists. Thus the effects of losing complexity can be predicted using functional traits and will impact specific ecological functions. Finally, new technologies (three-dimensional modelling) allow us to examine how fish use habitat structure in unprecedented detail. Tracking graysby around patch reefs, we show that these meso-predators prefer 1m$^2$ areas with greater maximum height and more crevices, both of which may decrease in the future. As reefs get flatter, we need to move beyond a simple sense that structure is important and towards an understanding of when, where, and why it is particularly beneficial, and the full implications of habitat degradation.*

**14:00 Session II: Reef Ecology [Chair: David Curnick, *ZSL*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
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| *14:00* | *Débora Silva Ferrari* | Functional and trophic structure patterns of reef fishes reveal vulnerability at the remote Ascension Island. | *Federal University of Santa Catarina* |

*Ascension Island is one of the world's remotest island, located in the Mid-Atlantic Ridge, about 1130 km from St Helena Island and 2400 km from the Brazilian coast. Due to its isolation, small size, low human density, and recent the Marine Protected Area establishment, the island is still little affected by anthropogenic events, showing distinct ecological mechanisms. A baseline on the trophic and functional trait structure of reef fish in this remote island is crucial to further understanding of highly isolated marine systems. Here, we provide the first comprehensive data on biomass, abundance, feeding pressure, and functional diversity metrics of the reef fish assemblage of Ascension Island. Our results show that from all trophic groups, the omnivores were the most important due to high abundance and biomass, as well as the highest feeding pressure on the benthos. These patterns are driven by the large schools of Blackfish Melichthys niger. The energy flux is mediated by the ominivores that feed on algae, small benthic invertebrates, and zooplankton. When compared to other oceanic islands, the functional richness and redundancy of Ascension Island was very low, on the other hand, the functional vulnerability was high. We highlight that Ascension Island exhibits extreme functional indices, ranking 7th when compared to the other 73 oceanic islands worldwide. Thus, similarly to the other islands of the Mid-Atlantic Ridge, Ascension is likely to benefit from localised conservation and management strategies.*

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| *14:12* | *Christina Hunt* | Temporally offset additive models show invasive lionfish drive fish community shifts across the western Atlantic | *University of Oxford* |

*Lionfish (Pterois volitans and P. miles) have become invasive across the western Atlantic and are believed to have caused up to 94% declines in fish abundance in some areas. However, their impacts are mostly estimated from small-scale patch reef studies over short timescales (weeks to months). Given that patch reefs, as small, isolated reef systems, are particularly vulnerable to invasive predator arrival, it has been suggested that regional lionfish impacts have been drastically overestimated. To investigate regional-scale lionfish impacts beyond patch reefs, we used an 18-year dataset comprising 11,000 transects, representing multiple reef types from eight countries. We gathered regional remote-sensed and modelled data to control for 14 biophysical, social and management variables known to affect reef fish communities. Initial lionfish invasion occurred over six years in our dataset, thus reducing the chance of large-scale point impact events (e.g hurricanes, bleaching) confounding our results. We centred data on year of lionfish arrival and used a combination of multivariate statistics and Generalised Additive Models (GAMs) to assess lionfish impacts on native fish communities. We detected clear shifts in native fish communities between pre-invasion and two or more years post-invasion, indicating a region-wide lionfish impact on native fish communities that resulted in a permanent and stable post-invasion fish community. Our GAMs indicated that prior to lionfish arrival, most reefs were showing steady increases in fish abundance, species richness and diversity. These increases continued following initial lionfish invasion, however, we detected simultaneous declines in all metrics five years after invasion. With our staggered invasion dates and comprehensive set of contextual variables controlled for, our results strongly suggest a regionally significant negative impact of lionfish five years post-invasion. Our study builds on previous small-scale studies that have shown lionfish impacts over weeks or months, by identifying regional scale impacts detectable several years post-invasion.*

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| *14:24* | Q and A session |

**14:30 Afternoon break**

**14:45 Session II: Reef Ecology – continued [Chair: David Curnick, *ZSL*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
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| *14:45* | *William F Precht* | Catastrophic Impacts of Stony Coral Tissue Loss Disease in the Caribbean | *Dial Cordy and Associates, Inc.* |

*Anomalously high-water temperatures, associated with climate change, are increasing the global prevalence of coral bleaching, coral diseases, and coral-mortality events. Coral bleaching and disease outbreaks are often inter-related phenomena, since many coral diseases are a consequence of opportunistic pathogens that further compromise thermally stressed colonies. Yet, most coral diseases have low prevalence (<5%) and are not considered contagious. By contrast, I documented the impact of an extremely high-prevalence outbreak of a white plague-like disease (now referred to as Stony Coral Tissue Loss Disease) at 14 sites off southeastern Florida. The first signs of active disease were observed near Virginia Key, Florida, in September 2014, and after five years had spread the length of the Florida Reef*

*Tract from Key West in the south to Martin County in the north. The disease outbreak directly followed a high temperature coral-bleaching event and has now affected >20 coral species. Eusmilia fastigiata, Meandrina meandrites, and Dichocoenia stokesi were the most heavily impacted coral species and were reduced to <3% of their initial population densities in Miami-Dade County. Several other coral species, including Colpophyllia natans, Pseudodiploria strigosa, Diploria labyrinthiformis, and Orbicella annularis were reduced to <25% of their initial densities. Observations by other researchers throughout Florida revealed similar results. Importantly, there appears to be a strong phylogenetic preference to disease susceptibility and mortality patterns observed regionally, however, to-date a putative pathogen has not been isolated. The high prevalence of disease, the number of susceptible species, its transmissibility, and the high mortality of corals affected suggests this disease outbreak is arguably one of the most lethal ever recorded on a contemporary coral reef system. Recent reports of continued spread through other regions of the Caribbean (Jamaica, Grand Cayman, Yucatan of Mexico, the Bahamas, the USVI, St. Maarten, and numerous other sites) is troubling indeed and may be the coup de grace to a reef system already at risk.*

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| *14:57* | *Alexandra Hiley* | Spatiotemporal patterns in an octocoral assemblage facing local and global stressors in Southeast Florida | *Nova Southeastern University* |

*In the tropical Western Atlantic region, local and global stressors have driven significant declines in stony coral cover in recent decades, resulting in phase shifts of benthic community composition. Although coral-algal shifts have been the most commonly observed, shifts towards dominance of other taxa have been reported, including significant increases in octocoral cover and density. The Southeast Florida Reef Tract (SEFRT), which falls within the Southeast Florida Coral Reef Conservation Area, is an expansive barrier reef system that lies adjacent to the highly populated South Florida coastline, subjecting it to a suite of stressors that have contributed to long-term declines in stony coral cover. Recent thermal anomalies and disease outbreak have prompted long-term spatiotemporal analyses of the stony coral assemblage, however, the same has yet to be conducted for the octocoral assemblage. This study examined multi-year patterns of the octocoral assemblage within the SEFRT and considered its resistance and resilience to environmental stressors that recently impacted the stony coral community. Total octocoral density and colony condition (e.g. presence of bleaching and disease) of three target species were recorded annually from 2013-2019. Mean octocoral density increased by 40% and the prevalence of bleaching and disease on target colonies remained at or below 1%. Octocoral density declined briefly as a result of physical disturbance from Hurricane Irma before returning to nearly pre-storm levels by 2019. This density increase and low prevalence of bleaching and disease during stressful events suggest resistance and/or resilience of octocorals to some drivers of local stony coral decline. With widespread declines in stony coral cover, it is imperative to understand the ecosystem services provided by remaining taxa, like octocorals. The SEFRT appears to support a resistant high-density octocoral community, offering the opportunity to further investigate these services on coral reefs with degraded stony coral assemblages.*

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| *15:09* | *Ronen Liberman* | Spatio-temporal reproductive phenology of a soft coral across depth | *Tel Aviv University* |

*Coral reef ecosystems are facing severe decline due to rapidly increasing environmental disturbances which are directly related to anthropogenic activities, particularly an increase in sea-surface temperature. The latter plays a major role in regulating the phenology of coral reproduction, including synchronizing gonad development and maturation along with determining the timing and synchrony of breeding events. The reproductive phenology of many other taxa has been affected by environmental changes, but our understanding of these aspects among tropical corals is limited. Thus, monitoring their spawning and concurrent environmental factors across depth may provide insights into the factors which control reproductive phenology. To this end, we studied the surface brooding soft coral, Rhytisma fulvum, to examine the effects of temperature regime from the shallow reef (0.5 m) to the upper mesophotic coral ecosystem (MCE, 45 m), taking advantage of this mode of reproduction which is very distinctive and easily visualized on the reef. The study was conducted at Eilat (Israel, northern Gulf of Aqaba). During 2016-2020 surface brooding was monitored alongside the respective seawater temperature. The results revealed (1) significant temporal differences in breeding activity between the shallow and the upper MCE populations, (2) a strong correlation between the timing of onset of surface brooding events and increase of seawater temperatures and, (3) reduced spawning intensity in the upper MCE compared to the shallower reef. Our study contributes to the understanding of the reproductive phenology of corals along depth and supports the hypothesis that changes in seawater temperature may lead to temporal differences in the timing and synchrony of coral breeding events.*

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| *15:21* | *Paris Stefanoudis* | Deeper reef ecosystems in the Indian Ocean: addressing the great unknown | *University of Oxford* |

*Indian Ocean coral reef ecosystems are one of the least explored, least funded and least protected reefs worldwide. The "First Descent: Seychelles" expedition in 2019 sought to address that gap by exploring reef habitats in seven remote coral atolls across the Exclusive Economic Area of Seychelles, a Large Ocean State located just south of the equator in the Western Indian Ocean. A combination of divers, submersibles and remotely operated vehicles were deployed between 10-350m to investigate the biodiversity and connectivity patterns of benthic and demersal fish communities across depth and location. Preliminary results indicate distinct faunal and floral groupings across depth, corresponding to biological depth zonation patterns reported from other (sub)tropical locations across other ocean basins. There was some variability between atolls likely related to unique local conditions (e.g. topography, hydrodynamic regime) as well as level of management and protection status. Since the majority of reefs in the Indian Ocean, including those of Seychelles, have never been systematically explored beyond recreational SCUBA depths (i.e. 30m) before, it is expected that the resulting datasets from this expedition will provide important baseline information on the status of deeper reef ecosystems across the region, which will be of value to existing, ongoing and future marine spatial planning exercises of Indian Ocean coastal states.*

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| *15:33* | Q and A session |

**15:45 Late afternoon break**

**16:00 Workshop I**

| | ***Workshop title*** | ***Institution*** |
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| *16:00* | MERMAID: An open source data platform for coral reef data collection and visualization | *WWF & WCS* |

*Reef scientists have historically used slates to record their findings underwater before manually transferring that data from paper into Excel, spending hours sorting and editing data to organize their findings, remove typos, and formatting for further analysis. This leads to vast amounts of data stored in offline databases, spreadsheets, and other disconnected systems that is difficult to access and at risk of loss, limiting collaboration and our understanding of coral reefs. This workshop introduces the Marine Ecological Research Management Aid (MERMAID; https://datamermaid.org) – a free online-offline web application for coral reef data collection and visualization developed in a partnership between the Wildlife Conservation Society, World Wildlife Fund, and Sparkgeo. MERMAID supports benthic cover, coral bleaching, and fish visual census data – managing this data throughout its lifecycle, from field collection to long term archiving, to ensure its usefulness and enable easy collaboration. With MERMAID, field scientists input their observations directly into the platform whether online or offline – avoiding data entry into spreadsheets. MERMAID automatically reviews the data and flags mistakes at entry, ensuring complete transect data, avoiding duplicates, and standardizing scientific names for benthic and fish species – enabling users to jump into analysis. MERMAID is based around collaboration, with multiple researchers able to input data for collation, and projects fully sharable. MERMAID exports data in machine readable formats, and a MERMAID-specific R analysis package is currently under development. In addition, a global MERMAID dashboard shows real-time key indicators of coral reef health for data users choose to make public. This interactive workshop will introduce how to use MERMAID, taking attendees step-by-step through data management workflows, available tools, data sharing options, and data export. Attendees will follow along using MERMAID on their computers during the workshop, and will finish fully equipped to start using MERMAID to support their research.*

**17:30 Workshop ends**

# Wednesday 9th December 2020

**10:00 Welcome address**

**10:05 Plenary speaker III [Chair: Bry Wilson, *University of Oxford*]**

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| *10:05* | *Sarah Lemer* | Insights into bleaching disparity among conspecific corals | *University of Guam Marine Laboratory* |

*Reefs around the world are experiencing severe declines in health and diversity due to rising sea surface temperatures. Bleaching susceptibility is typically not equal between coral species, geographic areas or even among conspecific colonies. There are a slew of different mechanisms that promote coral resilience to rising temperatures. Most interesting is the discrepancy in bleaching susceptibility among conspecific corals living in the same geographical area and thus experiencing similar stressors while sharing a similar set of molecular mechanisms. These striking differences suggest that multiple factors are at play in corals' ability to mitigate stress. Such factors may include phenotypic variability, microhabitat or environment stability, life history traits and colonies' past experience. Here, I explore the molecular mechanisms behind some of these factors in an attempt to understand how some corals can or cannot acclimate to increased sea surface temperatures during their lifetime. I will illustrate the impact of small variations in habitat stability, different color morphs and contrasting past experiences on the molecular responses to bleaching of conspecific Acropora corals.*

**10:35 Session III: Molecular Approaches to Coral Reefs [Chair: Bry Wilson, *University of Oxford*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
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| *10:35* | *Benjamin Douglas Young* | Can we use gene expression to identify disease resistance in *Acropora palmata*? Current knowledge and future directions. | *University of Miami* |

*Acropora palmata is a keystone species in the Caribbean that has seen up to 90% declines in coral cover caused primarily by disease outbreaks. These decreases have led to it now being one of the focal species in Caribbean restoration projects. Despite this, little is understood about the molecular underpinnings of the disease response in this species. Here we characterise the gene expression disease response of 12 A. palmata genotypes and their dinoflagellate symbiont, Symbiodiniaceae, in two disease exposure experiments run in 2016 and 2017 at an in-situ coral nursery in the Florida Keys. We identified year was the strongest determination of gene expression in A. palmata and the Symbiodiniaceae, matching observed increased virulence in 2017 compared to 2016. Disease response was the second factor determining gene expression but was only observed in A. palmata. We identified sets of differentially expressed genes between Baseline and Exposed corals, with a core set of 422 genes shared between corals showing No Transmission of disease, and Transmission of disease. Further coexpression analysis identified two modules positively correlated to disease exposure, with genes implicated in lipid biosynthesis and innate immune processes. Our results indicate that A. palmata mounts a core immune response to disease exposure despite differences in virulence and disease type. Currently, we are incorporating these results into additional field and laboratory-based experiments to identify gene expression signatures of disease resistance in a subset of A. palmata genotypes from this initial experiment. We hope to identify core genes pathways to be used as putative biomarkers for health and disease resistance in the future. This work will contribute to the scientifically driven restoration work being undertaken in the Caribbean and provide information to help inform future outplanting efforts.*

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| *10:47* | *Rosa van der Ven* | Differences in genetic diversity and divergence between brooding and broadcast spawning corals across two spatial scales in the Coral Triangle region. | *Vrije Universiteit Brussel* |

*The Coral Triangle region contains the world's highest marine biodiversity, however, these reefs are also the most threatened by global and local threats. A main limitation that prevents the implementation of adequate conservation measures is that connectivity and genetic structure of populations is poorly known. The aim of this study was to investigate the genetic diversity, population structure and connectivity patterns of tropical corals in Indonesia on two*

*different spatial scales, as well as by comparing two different reproduction strategies. Genotyping was based on microsatellite markers for 316 individual Seriatopora hystrix colonies and 142 Acropora millepora colonies sampled in Pulau Seribu and Spermonde Archipelago in 2012 and 2013. Differences in allelic diversity and a strong signature of divergence associated with historical land barriers at the Sunda Shelf were found for the brooding coral Seriatopora hystrix. However, differences in diversity and divergence were not pronounced in the broadcast spawning coral Acropora millepora. Within Spermonde Archipelago, two groups were identified: (I) sites of the sheltered inner-shelf and mid-shelf, which were found to be highly interconnected and (II) mid-shelf and outer-shelf sites characterised by higher differentiation. These patterns of contemporary dispersal barriers and genetic diversity can be explained by the differences in life history of the corals, as well as by oceanographic conditions facilitating larval dispersal. The contemporary dispersal barriers found within the Spermonde Archipelago emphasise the need for incorporating connectivity data in future conservation efforts.*

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| *10:59* | Q and A session |

**11:05 Morning break**

**11:15 Speed networking**

**12:00 Session III: Molecular Approaches to Coral Reefs – continued [Chair: Bry Wilson, *University of Oxford*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
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| *12:00* | *Bethan Greenwood* | Corals at the extreme: microbial community dynamics of mangrove-influenced corals in the Seychelles | *University of Essex* |

*Scleractinian corals associate with a broad array of microorganisms, forming a meta-organism termed the coral holobiont. While coral holobionts are known to change in response to environmental conditions, little is known about the holobionts of mangrove- versus reef-dwelling corals. Therefore, reciprocal translocations of the reef-building coral, Porites lutea, within Curieuse Marine National Park, Seychelles, sought to address whether the abundance, diversity, and composition of the coral microbiomes differed between mangrove and reef habitats, and whether they could flexibly reorganise based on the prevailing habitat. Amplicon sequencing of coral-associated bacteria and Symbiodiniaceae revealed that the bacterial community composition of Porites lutea was habitat-driven and highly flexible, while the algal symbionts were habitat-influenced but showed greater host-fidelity, remaining more stable over time. Hahellaceae which contains the known bacterial endosymbiont, Endozoicomonas, dominated the bacterial assemblage of Porites lutea from both habitats. However, corals from the mangrove also featured high relative abundances of Rhodobacteraceae (14%), Flavobacteriaceae (10%), Alteromonadaceae (6%), and Vibrionaceae (6%) – taxa sometimes linked to diseased coral. Within 20 hours of translocation to a new habitat, the once distinct coral-associated bacterial communities had become highly similar. It is not known whether the habitat-distinctive microbial communities hosted by Porites lutea aid coral survival and promote local adaptation to specific habitats or whether the assemblages are opportunistic. There was little evidence of local adaptation as all corals survived translocations of one year, though other trade-offs should be studied. Such rapid reorganisation of coral-associated bacterial communities continues to provide hope as an adaptive strategy to survive fast-changing environmental conditions.*

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| *12:12* | *Margaux Steyaert* | Uncovering the genetic diversity of benthic invertebrate and microbial communities across a remote Indian Ocean reef system | *University of Oxford/ ZSL* |

*The need for sustained and accurate biomonitoring of coral reefs is now critical in order to mitigate biodiversity loss in the coming decades. In order to successfully monitor the biodiversity and health of coral reefs across the globe, a solid understanding of local species composition and diversity patterns is crucial.*

*Benthic invertebrates form the largest component of metazoan diversity in tropical coral reefs and perform vital functional roles as ecosystem engineers, detritus-eaters and prey for reef fish. Microbes associated with these sessile and motile organisms also hold vital roles as nutrient cyclers, carbon-fixers and symbiotic partners. Whilst these two*

*communities underpin key ecological processes within tropical coral reefs, they are understudied and under-represented in genetic databases in comparison to other groups such as reef fish and scleratinian corals.*

*We wish to present a first look at the diversity of benthic invertebrate and microbial communities across shallow reefs of the Chagos Archipelago, Indian Ocean. Using Artificial Reef Monitoring Structures (ARMS), high resolution photo analysis and both barcoding and metabarcoding tools, we analysed the recruitment success, composition and genetic diversity of benthic cryptic communities and their associated microbiomes. We demonstrate that these communities within this Marine Protected Area (MPA) are highly diverse and differ significantly across different reef systems. We wish to present new genetic barcodes from various sessile and motile organisms and discuss patterns of recruitment and succession across different taxonomic groups.*

*Our work provides the first in-depth analysis of these hidden communities and will eventually provide a baseline for future exploratory studies or monitoring efforts within the Chagos Archipelago and the wider Indian Ocean.*

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| *12:24* | *Giulia Puntin* | How to survive high nutrients: holobiont interplay in the photosymbiotic jellyfish Cassiopea xamachana | *Justus Liebig University Giessen* |

*Marine holobionts depend on microbial partners for health and nutrient cycling. This is particularly evident amongst cnidarian-Symbiodiniaceae symbioses, where nutrient acquisition is facilitated. However, the symbiosis is sensitive to environmental change - including eutrophication – that cause dysbiosis and host mortality, which contributes to global coral reef decline. Yet, some holobionts exhibit resistance to dysbiosis in eutrophic environments, including the obligate photosymbiotic scyphomedusa Cassiopea xamachana. To investigate the mechanisms that underpin this resistance and the role of the microbiome, we measured assimilation of 13C and 15N-labelled inorganic (bicarbonate and nitrate) and organic (Artemia salina) resources in C. xamachana with 16S rRNA amplicon sequencing and predicted bacterial functional differences between symbiotic and aposymbiotic states. We demonstrate that symbionts acquired carbon autotrophically and the host heterotrophically. However, while photosynthesis sustained efficient carbon cycling, heterotrophy alone led to continuous body mass loss even though organic N was well distributed between both partners. Nitrate from the medium increased in the host tissue with concentration, but there was limited enrichment of algae indicating an effective host control. Associated bacterial communities resembled those reported for corals and other model cnidarians. Differences in their composition corroborated nutrient deprivation in aposymbiotic medusae where putatively sulfur-metabolism was enriched and N-metabolism depleted. Remarkably, C. xamachana's dominant bacterial taxa (~90%) were linked to N cycling, including denitrification and N2-fixation. Considering denitrifiers and diazotrophs, the associated microbial community may be the key to thriving in nutrient-rich as well as in rather oligotrophic environments.*

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| *12:36* | *Daisy Buzzoni* | A novel field-based method of vectoring thermotolerant algal symbionts (family Symbiodiniaceae) into coral colonies | *University of Miami* |

*Durusdinium trenchii is known to confer greater thermal tolerance to its coral hosts than other common Caribbean algal symbionts and shows transient increases in abundance on reefs following bleaching events. In the lab, some corals can be induced to host >99% D. trenchii through controlled bleaching and recovery, but the stability and persistence of these communities is not well understood. This study, building on previous laboratory experiments, aimed to test the ability of D. trenchii to infiltrate field colonies, through its introduction in tissue implants. We collected replicate 2.5cm-diameter cores of Montastraea cavernosa, Siderastrea siderea, and Orbicella faveolata from reefs off Miami and used controlled laboratory bleaching and recovery to manipulate these cores in favour of D. trenchii. We then implanted cores back into their parent colonies, and symbiont communities within the cores and in the surrounding tissue were monitored using qPCR. This experiment was repeated twice, with implants being introduced near seasonal temperature maxima (31°C - August) and minima (24°C - February). Temperature regime following implantation and population sizes of competing symbionts were considered factors influencing the loss, persistence or spread of D. trenchii. Background levels of D. trenchii have spread from implants into the surrounding tissue in M. cavernosa, and D. trenchii has remained dominant in implants for at least 7 months, even throughout the winter. We expect the spread of D. trenchii from implants during the summer to have been even more pronounced. These results provide a proof-of-concept for the vectoring of symbionts into field colonies using tissue implants. This has ramifications not only for the symbiont competition dynamics that shape D. trenchii's abundance on Caribbean reefs but may also provide an intervention mechanism by which colonies' symbiont communities may be altered in situ to increase their resistance or resilience to the stressors of a changing ocean.*

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| *12:48* | Q and A session |

**13:00 Lunch break**

**13:30 Workshop II**

| | ***Workshop title*** | ***Institution*** |
|---|---|---|
| *13:30* | Using storytelling to engage in science and conservation | *Blue Ventures* |

*Having a compelling message behind your work is important. Why should people care about your project? What is the relevance of your work? Whether you are looking to improve the way you communicate, or engage people to take action and get involved in marine conservation or science, doing so in a storytelling style can be incredibly powerful. In this 90 minute workshop, we will explore the principles behind storytelling approaches to communication, the tools and media you can use, and case studies you can learn from. Through a mixture of presentation and breakout discussion, we hope to equip you with the knowledge to communicate powerfully to engage others in science and conservation.*

**15:00 Afternoon break**

**15:30 Workshop III**

| | ***Workshop title*** | ***Institution*** |
|---|---|---|
| *15:30* | Building a Better Fieldwork Future: Preventing & Managing Sexual Harassment and Assault in the Field | *UC Santa Cruz* |

*Fieldwork is an important and often necessary component of many scientific disciplines, yet research suggests that it presents a high-risk setting for incidents of sexual harassment and assault. This 90-minute workshop has been developed by a team of field researchers at UC Santa Cruz. It identifies the unique risks posed by fieldwork, and offers a suite of evidence-based tools for field researchers, instructors and students to prevent, intervene in, and respond to sexual harassment and assault. Through a series of practical intervention scenarios, this workshop guides participants in how to be an active and engaged bystander, how to report incidents, and how to plan field settings to minimize risk. Armed with these tools, participants can play a role in ensuring that field settings are safer, more equitable, and more welcoming for the next generation of field scientists.*

**17:00 Workshop ends**

# Thursday 10th December 2020

**10:00 Welcome address**

**10:10 Plenary speaker IV [Chair: Dominic Andradi-Brown, *WWF*]**

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| *10:10* | *Srey Oun & Matt Glue* | Signs of recovery for the coral reefs of Cambodia | *Fauna & Flora International* |

*Coral reefs in Cambodia are among the least studied in Southeast Asia. Long-term monitoring programmes are relatively new and do not date back beyond a decade. Moreover, evidence indicates intensifying threats to Cambodia's reefs, including illegal and destructive fishing, unsustainable coastal development and chronic plastic pollution. As part of a longstanding collaborative marine conservation programme, the Cambodian government, Fauna & Flora International (FFI), local NGOs and private sector actors have addressed key knowledge gap through extensive coral reef surveys. These have focused on the Koh Rong Archipelago, the site of Cambodia's first large-scale Marine Protected Area, and the Koh Sdach Archipelago where establishment of a further MPA is underway, with both sites surveyed in 2019. Data were collected on coral, fish and invertebrate assemblages, using modified Reef Check methods.*

*In Koh Rong, biological monitoring aims to answer a key question; what effect has MPA establishment in 2016 had on the coral reef ecosystem? Surveys revealed degraded reefs, with low indicator fish species biomass demonstrating likely impacts of historical overfishing. However, temporal comparisons showed that ecosystem condition had stabilised across most indicators, with tentative upwards trends in grouper abundance, parrotfish abundance and hard coral cover. This suggests that the MPA, through participatory design and co-management approaches led by communities, NGOs and government partners, has succeeded in reducing overfishing and destructive fishing practices.*

*In Koh Sdach, baseline reef surveys generated key ecological evidence in support of MPA design and management planning. Results were encouraging, with localised high abundance of key fish families, and one site recording the highest coral coverage yet observed in Cambodia. This reinforces the importance of Koh Sdach for both fisheries management and conservation, and will be triangulated with socio-economic data and maps of community fishing grounds to produce MPA zoning schemes.*

*This presentation will share key findings from the surveys described above, and lessons learned from the wider FFI Cambodia marine programme. These will be used to make recommendations in support of coral reef conservation both in Cambodia and elsewhere.*

**10:40 Session IV: Coral Reef Conservation [Chair: Dominic Andradi-Brown, *WWF*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
|---|---|---|---|
| *10:40* | *Michael Williamson* | Application of earth observation data and Google Earth Engine for monitoring coral reef exposure to environmental stressors | *King's College London/ ZSL* |

*Satellite remote sensing has become a valuable tool for the conservation and management of Marine Protected Areas and for monitoring important marine habitats. Coral reefs are critical ecosystems for marine fauna and biodiversity, however, they are significantly threatened by anthropogenic stressors such as climate change. This study aimed to develop a tool for monitoring coral reef stress remotely by mapping coral exposure to environmental stressors using readily available satellite Earth Observation (EO) data analysed in the Google Earth Engine (GEE) cloud-based geospatial processing platform. Based on a review of the literature, this study identified 11 environmental variables, known to cause stress in coral reef systems, that could be estimated from EO data and were available in GEE. These variables were grouped into three categories; 1) stress factors, 2) reinforcing factors, and 3) reducing factors. Using fuzzy logic (discontinuous functions) and thresholds obtained from the literature, coral exposure to each of these variables was quantified for three case study reef systems in: the British Indian Ocean Territory, the Galapagos; and Thailand. Each variable was given a stress score between 0 and 1, with a final mean coral stress exposure score calculated for each reef system. The method was evaluated by comparing the predicted coral stress exposure index to in situ coral cover data. The stress exposure index identified periods of high stress during known stress events, such as El Nino years, and complemented trends in coral cover. However, the accuracy of this score can be improved with site*

*specific thresholds for each stress variable. The tool developed in this study can be applied to any reef system using globally available remote sensing datasets analysed in GEE. This will greatly aid the monitoring of reef systems as well as providing a free and open access tool for researchers.*

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| *10:52* | *Marie Seraphim* | Short- and medium-term recovery of fish communities on restored coral reefs | *University of the West of Scotland* |

*The majority of the world's coral reefs are threatened by human activities and it is increasingly recognised that passive conservation measures alone are insufficient. Coral reef restoration may help reverse some of the current trends in reef degradation through the transplantation of stony corals; while restoration techniques have been extensively reviewed in relation to coral survival, research into the effects on fishes of adding live coral cover and complexity is in its infancy. To address this knowledge gap, we monitored short- and medium-term changes to fish assemblages around two Indonesian islands. Over a six year period, 0.5 ha of reef was restored as part of the world's largest reef restoration programme. On Pulau Bontosua, we monitored newly restored sites from pre-restoration to 1 year post-restoration while on Pulau Badi, we investigated mature restoration sites of up to 4 years of age. Using non-linear regression models, we investigated recovery of reef fish assemblages via a range of metrics in relation to days following restoration. At the newly restored Bontosua Island, changes over time occurred, including a rise in fish biomass from ~62 to ~187 g per m2. Furthermore, there was a shift in fish assemblage composition in as little as 1 month following restoration interventions. In comparison, the longer-term restoration at Badi Island exhibited more widespread trends in recovery with time for fish density, biomass and species richness. Increases in density were also noted when fish were subset into trophic groups, age groups, size classes, abundant fish families and species. Our results indicate that by adding coral cover and complexity, large-scale coral reef restoration schemes are likely to have positive effects on fish assemblages, with changes in fish composition occurring in the short-term (<1 year) and more fundamental recovery of overall fish assemblages appearing in the longer-term (1-4 years).*

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| *11:04* | Q and A session |

**11:15 Morning break**

**11:30 Session IV: Coral Reef Conservation continued [Chair: Dominic Andradi-Brown, *WWF*]**

| | ***Speaker*** | ***Presentation title*** | ***Institution*** |
|---|---|---|---|
| *11:30* | *Ana Pinto* | Establishing Locally Managed Marine Areas in Mozambique: A new toolkit featuring lessons learnt from Our Sea Our Life's approach to community-based marine conservation in Cabo Delgado | *ZSL* |

*Northern coastal Mozambique has the highest levels of marine biodiversity in East Africa, with fewer anthropogenic impacts and evidence of resilience to coral bleaching. Human communities here are among the poorest in Mozambique, and highly dependent on marine resources. Increasing development from the gas sector in northern Mozambique in preparation for a scheduled start to production in 2022, and rapid population growth is significantly increasing pressure on this fragile marine biodiversity hotspot.*

*Our Sea Our Life is a collaborative project that brings together global and regional expertise in community-based marine conservation in Cabo Delgado. Between 2013-2018, we successfully piloted a scalable, LMMA model in 8 villages, benefitting over 6,000 people and protecting more than 10km2 of no-take zones and 40km2 of sustainable-use zones. Enforcement is achieved by the Community Fisheries Council (CCP) members and law enforcement agencies. To ensure successful replication of the approach and to build capacity for LMMA implementation in Mozambique, we have created a toolkit specific to the Mozambique context as a main guide for local practitioners. We have started to scale up this approach in phase 2 of the project since 2019, to make it nationally significant, expanding the network of legally-recognised LMMAs in northern Mozambique, building resilience in local and migrant communities and protecting vulnerable marine species and habitats.*

*We will present the challenges and opportunities for implementing LMMAs within Mozambique, emphasising the key lessons learned and recommendations for the future. Specifically, we will cover community engagement in LMMA design; ensuring gender equity in decision-making and benefit sharing; effective involvement of local authorities in*

*remote areas of Mozambique; tackling the issue of migrant fisherfolk; and connecting marine conservation with community needs for financial services and food security.*

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| *11:42* | *María Arteaga* | Moving from site-based conservation measures to integrated seascape management mechanisms in the southern tip of the Mesoamerican Reef, Honduras | *LARECOTURH* |

*There is growing recognition of the need to move away from the traditional site-based approach when designing management interventions for coral reefs and associated habitats. Marine protected area (MPA) systems need to be designed and managed in a way that takes into account the high levels of ecological connectivity within reefs and with the wider marine environment. Equally importantly, we now recognise the value of ensuring strong connections between the management entities of an MPA system. This approach is being implemented through the development of a "seascape approach" to managing three MPAs in Honduras that lie along the southern tip of the Mesoamerican reef. Threats to these reefs include illegal and destructive fishing and wildlife exploitation, unregulated tourism, pollution and sedimentation from agriculture.*

*The three MPAs - the Bay Islands Marine National Park, the Cayos Cochinos Marine National Monument and the Cuero-y-Salado Wildlife Refuge - are managed through a co-management mechanism, whereby the government has devolved management responsibility to an NGO at each location. The three NGOs have been working together since 2016 to develop management measures and address problems of joint concern affecting the individual MPAs as well as the adjacent shared waters and reef systems. This has led to a reduction in the use of damaging fishing practices and to decreased water pollution becoming a clear shared objective. A major threat to reefs in Honduras is the growth in microalgal blooms, which are a direct consequence of the increasingly contaminated and untreated water runoff from the mainland. In addition, a body known as the Seascape Committee and consisting of representatives of some 20 organisations, has been established for the area with the mandate of ensuring the participation of a wider range of stakeholders. They each bring diverse expertise to enable effective solutions and create participative, lasting governance mechanisms.*

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| *11:54* | *Megan K. B. Nolan* | Species distribution models to inform coral relocation, restoration, and habitat enhancement planning. | *KAUST* |

*The field of conservation is currently shifting from primarily protecting ecosystems, to more active management approaches in order to restore and enhance marine habitats, aligning with the UN's decade on restoration beginning in 2021. These approaches are of particular interest to coral reef science due to numerous threats to coral habitats, including warming and acidifying seas, invasive species, coastal development and overfishing. Marine spatial planning is an important part of coral restoration and enhancement, but this technique requires substantial amounts of data, which are often lacking. To overcome this issue, here we show how species distribution models can be incorporated into the process to expand the utility of data available. Our case study focuses on the Al Wajh lagoon, which is being developed under The Red Sea Project, a regenerative travel destination development as part of Saudi Arabia's ambitious Vision 2030. We use ensemble modelling to identify ecologically suitable habitats for coral in general, before selecting 19 common genera of the Northern Red Sea and training the model for each individually, to determine their potential range within the study area. We identify areas where shallow sand habitat, appropriate for establishment of reef enhancement structures, overlaps with high habitat suitability for certain genera, and recommend these areas for coral reef enhancement moving forwards. By integrating extensive baseline assessment information planned over the coming year, our modelling approach can be used to facilitate coral reef enhancement efforts for The Red Sea Project, with potential to expand the methodology into other marine habitats, including biologically-diverse and ecologically-important seagrass meadows and mangroves.*

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| 12:06 | | Q and A session |

**12:20 Lunch break**

**13:00 Lightning Talk Q and A**

**13:45 Break**

**14:00 Session V: Reefs in a Changing World – Part II [Chair: Sebastian Hennige, *University of Edinburgh*]**

| | *Speaker* | *Presentation title* | *Institution* |
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| *14:00* | *Nadia Jogee* | How corals can 'cheat' the intermediate disturbance hypothesis | *University of Edinburgh* |

*Many coral reefs are undergoing shifts in species composition due to increases in both the frequency and intensity of coral bleaching events. The intermediate disturbance hypothesis (IDH) suggests that under such frequent events species diversity in the benthos will be low. This is due to the exclusion of species that cannot recolonise rapidly. The Maldives has been hit with successive mass bleaching events over the last five years. This has presented an opportunity to examine whether the IDH can help predict which species are 'winner or losers' post disturbance. Here I present results from benthic surveys from two islands in the Maldives across five years. These results show that the scleractinian Porites rus¸ not considered a typical rapid coloniser, can aggressively expand its range by 458% in just one year through its propensity to readily form unattached coralliths. This allows P. rus to 'cheat' what we would expect of the IDH. This has resulted in a reduction of the 3D structure and a loss of functional diversity in scleractinia on these reefs. Using RDA analysis the link was examined between a change in the hard coral cover and the direct impact this has on the fish communities in the area. Due to the rapid expansion of corallith forming species, such as Porites rus, coralliths should be included in coral reef surveys in order to help manage and predict future winners on reefs post disturbance.*

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| *14:12* | *Konstantinos Georgoulas* | Modelling how corals apply the Goldilocks Principle to engineer their habitat | University of Edinburgh |

*The importance of the growth, proliferation and longevity of reef-forming cold-water corals is paramount as they support various complex biodiverse habitats and provide many essential ecosystem services. These cold-water coral reefs consist of layers of living coral tissue that grow above large masses of coral skeleton. Here, the Goldilocks Principle is used in order to model how these cold-water corals engineer their habitat in order to slow down incoming flows that are usually an order of magnitude higher than the optimal flow conditions for catching prey. The numerical model is based on the Smoothed Particle Hydrodynamics method and it investigates the effects of local hydrodynamics on coral growth. The growth and death of the simulated coral colonies depend on the dynamically changing energetic reserves and the ability of the coral particles to store energy in optimal conditions. A further improvement on this model is the introduction of a 'nutrient rule'. With this added condition, coral growth now depends not only on local hydrodynamics but nutrient availability as well. This new rule allows investigations of how coral particles within a colony compete for the available resources or even how multiple colonies compete among each other for the finite nutrient resources.*

*Ocean acidification is a major threat to cold-water coral reefs as the ever shallowing aragonite saturation horizon could leave up to 70% of cold-water corals in aragonite under-saturated zones by 2100. In these more acidic conditions coral prosperity becomes more difficult, as coral skeletons can be dissolved in aragonite under-saturated waters and may lead to a net loss of reef accretion. Modelling the mechanisms behind coral skeleton dissolution in various acidification scenarios is a helpful way to visualize the effect of ocean acidification to cold-water coral reefs and help determine reef recovery times and conditions.*

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| *14:24* | *Adriana Humanes* | Can we select for heat stress tolerant corals within a population before a bleaching event? Implications for coral reef conservation in the face of climate change | *Newcastle University* |

*Catastrophic coral mortalities due to sea water warming events are increasing in magnitude and frequency, highlighting the urgent need to decrease total greenhouse gas emissions. In addition, innovative approaches to help reefs withstand future warming events are being considered. Proposed approaches include the generation of corals preadapted to higher temperatures via selective breeding. To do this, we need methods to identify more tolerant coral individuals coupled with a greater understanding of the biological mechanisms underlying increased heat tolerance. Potential approaches to selecting more heat tolerant corals include monitoring in situ survivorship during a natural heat stress event, selecting colonies from different populations with distinct thermal regimes, and developing biological markers of stress tolerance. Each of these approaches has limitations, moreover we know little about temporal consistency and heritability of heat tolerance. Here we use a simple methodology to predict heat stress tolerance within individuals of one population of Acropora digitifera in Palau as part of a broader research program to assess the feasibility of selective breeding as a conservation tool. Bleaching, mortality responses and colour change*

*during temperature stress experiments under tank controlled conditions were used to estimate heat tolerance categories on fragments from 160 adult colonies in two consecutive years. Our results show that a) in large healthy Acropora populations, there appears to be sufficient phenotypic variation in heat tolerance to provide material for selective breeding crosses, and b) around 42% of response to temperature stress appears to be determined by intrinsic characteristics of individual colonies. The identification of more heat tolerance individuals within a population is fundamental to study the mechanisms that drive such differences and to investigate the feasibility of using selective breeding approaches to restore coral reefs.*

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| *14:36* | | Q and A session | |
| *14:45* | *Julia Strahl* | Individual physiological plasticity of high and low heat tolerant *Acropora digitifera* colonies within a population in Palau | *University of Oldenburg* |

*During coral bleaching events, it is common to observe healthy coral colonies adjacent to severely bleached ones, demonstrating the capacity for substantial variation in heat tolerance among individuals from the same population. While the cause of differences in bleaching response to heat stress between taxa has received considerable attention, less is known about the cause of individual differences in heat tolerance within populations. In marine ectotherms, high phenotypic plasticity is an important strategy to acclimatize to rapid environmental changes. But plasticity of physiological functions (e.g. standard metabolic rate, energy gain and storage, cell protective capacities) that increase individual heat tolerance may be energetically costly and lead to trade-offs. To assess if physiological performance correlates with increased individual heat tolerance in corals, we studied a population of the corymbose scleractinian coral Acropora digitifera in a near shore reef in Palau. Overall 94 independent adult colonies were tagged and live branches of each colony (6 per colony) were exposed for four weeks to temperature stress (+3.5°C above ambient sea surface temperatures) in a controlled aquarium experiment. Based on their mortality and bleaching response to gradually increasing temperatures, we identified 11 high (= no mortalities throughout experiment) and 10 low heat tolerant colonies (= all branches gradually bleached and died). To understand underlying mechanisms of individual heat tolerance, we investigated seasonal variations in coral health and energy storage capacities in these colonies in June and September. Branches of the respective tagged mother colonies at the study site were snap-frozen to determine biomass, total lipid and protein content and fatty acid composition. Our results suggest that high heat tolerance in A. digitifera is associated with effective internal regulatory mechanism in response to changing environmental conditions (e.g. efficient switch between heterotrophy and autotrophy), high and stable energy stores such as lipids and proteins and high cell protective capacities. Meanwhile, energy stores seasonally differed in the low heat tolerant colonies, either due to an insufficient autotrophic energy production at low food availability, or higher energetic costs during the dry season (e.g. increased investment into cell maintenance). The results of this study increase the understanding of: 1) an individual natural ability in reef corals to acclimatize to climate change impacts and 2) the underlying physiological mechanism of higher heat tolerance in corals. Correlations in physiological performance and individual susceptibilities within populations might therefore provide material for selective breeding of more heat tolerant coral individuals.*

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| *14:57* | *Liam Lachs* | Trade-offs between coral traits: implications for natural selection and assisted evolution | *Newcastle University* |

*All organisms balance energy allocation between vital physiological processes, but trade-offs between adaptive traits like heat-tolerance, growth, and reproduction can have individual-, population- and even ecosystem-level consequences. Under climate change and the increasing frequency and severity marine heatwaves and resulting mass coral bleaching events, it is yet unknown whether the energetic costs of heat tolerance in corals could have adaptive or ecosystem implications. Caribbean corals associated with Durisdinium algal symbionts (formerly clade-D Symbiodinium) are known to have enhanced heat tolerance at the expense of photosynthetic efficiency and coral growth. However, unravelling whether such trade-offs exist independent of symbiont type is key to understanding: (1) the natural adaptation of corals to climate change, and (2) the success of restorative efforts such as assisted evolution (selective breeding for heat-tolerance) or assisted gene-flow/migration, which both aim to boost natural adaptation rates. This study investigates whether trade-offs exist between heat-tolerance and adaptive fitness traits, specifically growth and fecundity, for a population of the reef-building Acropora digitifera on shallow reefs in Palau, Western Pacific Ocean (100 tagged adult colonies). Heat tolerance was determined using ex-situ long-term heat stress experiments on replicate coral fragments, which showed a wide range of bleaching and mortality responses. Growth metrics (surface area and volume) were derived from repeated in-situ 3D photogrammetry surveys. Fecundity (eggs/polyp) was determined from 1165 polyp dissections of replicate coral fragments taken just prior to spawning. Further work will identify symbiont type using ITS2*

*sequencing. Preliminary results do not indicate any major trade-offs between heat-tolerance and fecundity or growth, although further 3D growth models are still being processed to confirm these results. This has important implications for understanding the capacity of corals to adapt and acclimatise to the increasing magnitude and frequency of marine heatwaves and for programs that aim to assist adaptation through restorative actions.*

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| *15:09* | | Q and A session | |

**15:15 Afternoon break**

**15:45 Plenary speaker V – Closing plenary [Chair: Sebastian Hennige, *University of Edinburgh*]**

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| *15:45* | *Jamie Craggs* | Ex situ coral reproduction: a platform for diverse research approaches | *Horniman Museum and Gardens* |

*Successful reproduction is the fundamental process by which any populations or species continue over time. Concerns over declining global coral populations have fuelled new areas of coral reproductive research in order to deepen our understanding of the threats facing coral and to investigate ways in which we might mitigate against this loss. Of the wide range of reproductive modes that are characterised by reef building corals, broadcast spawning, the release of gametes (eggs and sperm) into the water column during annual events, is the most widely express and these events strongly correlate with a number of seasonal environmental signals (temperature, solar irradiance, lunar and diel cycles).*

*Due to technical challenges associated with inducing broadcast spawning events ex situ, historically research that focuses on sexual reproduction has been concentrated in locations close to natal reefs. In 2012 I developed techniques to predictably induce broadcast coral spawning events ex situ. This novel approach has provided a platform to study many areas of reproduction, independent of the need to be located in the tropics. To date, at the Horniman Museum and Gardens, London, 24 Indo-Pacific species, and through partnership with Florida Aquarium, a further 10 Caribbean species have spawned all in closed system research aquaria. Areas of research covered in this time have focused on fundamentals of coral reproductive biology, development of methods to alleviate post settlement mortality pressures, omics, seasonal manipulation of spawning periods and spat production for active in situ reef restoration purposes.*

*The urgent need to slow the loss of reef habitats has seen reef restoration groups dramatically increase across the world and more recently a call for new bio banking facilities to be built to preserve genetic material. Ex situ management of coral broodstock, and their reproduction, will likely play an increasing important role in future.*

*During this talk Dr Craggs will give an introduction to ex situ broadcast spawning methodology developed over the past eight years, present results from a number of studies and discuss the potential future directions for ex situ coral reproductive work.*

**16:15 Student prizes and closing remarks**

**16:30 Conference end and online afterparty**

**#RCUK2020**
**@ReefConsUK**

# Lightning Talks

| *Speaker* | *Presentation title* | *Institution* |
|---|---|---|
| *Louise Anderson* | Coral reef community structuring and trait responses to a bleaching event | *University of Leeds* |

*The increasing rate and severity of climate impacts is driving changes in coral reef ecosystem functioning. These disturbances are reorganising species assemblages and altering how energy moves through ecosystems, with repercussions for the food security and livelihoods of millions of people. The impacts of bleaching events on species assemblages is well documented, but we do not yet have a thorough understanding of how species traits and functions are affected.*

*Using a trait-based approach, we assess how the functional structure and cross-taxa associations of coral and fish communities on a Pacific reef are affected by a coral bleaching event. We find that coral and fish communities are structured across habitat types and survey locations, and whilst coral functional structure changed significantly following the bleaching event the fish community was less affected, possibly due to the distortive effects of fishing pressure. Additionally, we find that pre-bleaching trait associations between the two communities largely break down, with a reduction in shared structuring post-bleaching.*

*These results reveal a simplification of the reef community, as assemblages shift towards more resistant traits post-disturbance and associations between fish and coral traits are decoupled. The relative robustness of the fish functional community suggests that fishing is likely a more significant driver of structuring at this scale, and that important opportunities for management and resource provisioning still exist in the context of rapid environmental change.*

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| *Elizabeth Beauchamp* | Within population-variation heat-tolerance in *Goniastrea retiformis* to a short-term heat stress | *Newcastle University* |

*Climate change is the single biggest global threat to coral reefs. As marine heatwaves increase in frequency and severity, widespread bleaching events are becoming a regular occurrence causing catastrophic declines in coral reef cover. Heat tolerance is known to vary among species as well as between populations experiencing different thermal regimes. Much less is known about variation in heat tolerance within the same population experiencing identical environmental conditions. There are still many issues to reliably characterise individual heat tolerance, as experimental procedures vary markedly in length and severity of heat stress. Identifying variation within a single population and from a variety of species can inform us how well a population is likely to adapt to climate change and identify where interventions such as selective breeding may be successful.*

*Here we examine within population variation to a short term (7-day) heat stress for a single population of the stress tolerant species Goniastrea retiformis in Palau, Micronesia. We developed multiple methods for classifying and quantifying heat tolerance including categorical and continuous approaches using bleaching and survival rates.*

*Of the 33 colonies in the experiment, five colonies (15%) were categorised as relatively high heat tolerant (RHHT)(i.e., all replicate fragments survived) whereas six colonies (18%) were relatively low heat tolerant (RLHT)(i.e., all fragments died).*

*These results highlight the considerable variation in heat tolerance found within a population, describe a method to accurately quantify heat tolerance and offers a way to choose corals for selective breeding programs.*

*Increased heat tolerance may trade-off with other adaptive traits such as growth or fecundity. Therefore, we also quantified fecundity at the polyp level for each colony. We will discuss these results in context of how selecting for beneficial traits, such as increased heat tolerance may have unforeseen consequences if they lead to resource trade-offs.*

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| *Or Ben-Zvi* | Experimental evidence of temperature-induced bleaching in two fluorescence morphs of a Red Sea mesophotic coral | *Tel-Aviv University* |

*Mesophotic coral ecosystems (MCEs) found between 30 and 150 m are characterized by blue-shifted, low-light conditions. Those underexplored reefs are considered less affected by anthropogenic disturbances, wave action, and climate change due to their depth and distance from shore.*

*In the past decades, mass coral bleaching events (associated with elevated temperatures) caused the loss of ~75% of corals globally. The grave status of shallow reefs led to the suggestion that mesophotic corals may possibly replenish shallow reefs in the case of severe loss or that mesophotic reefs may serve as a temporary refuge.*

*Mesophotic corals present remarkable fluorescence polymorphism, attributed to fluorescent proteins produced by the corals. As fluorescence was previously suggested to serve as a potential indicator for coral health, we aimed to examine the effect of elevated temperatures on highly-fluorescent (HF) and low-fluorescent (LF) morphs of the mesophotic coral Alveopora ocellata from the Red Sea. We found that A. ocellata bleached after a short-term (14 days) thermal stress of +4°C above ambient sea temperature. Under higher temperature, corals gradually lost their algal symbionts (7.7×106 to 14×106 cells per cm2), cellular photosynthetic pigments (6.6×10-7 to 3.4×10-7 µg chlorophyll a) and presented reduced maximal quantum yield (Fv/Fm). Throughout the experiment, HF corals presented 44 ± 6 % lower zooxanthellae densities, 117 ± 33% higher cellular chlorophyll a concentration, and six-fold higher fluorescence. The differences found between the two morphs suggests that fluorescence may be favorable under thermal stress. Furthermore, this demonstration of a bleaching process in a mesophotic coral, demonstrates the vulnerability of MCEs to the predicted global warming.*

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| *Nauras Daraghmeh* | Reliving the Caribbean catastrophe? The collapse of urchins and rise of macroalgae and cyanobacterial mats in reefs of the Gulf of Aqaba, Red Sea | *University of Bremen* |

*Coral reefs of the Gulf of Aqaba (Red Sea) have shown high tolerance to thermal stress. Recent research is proposing corals from this area as super corals to potentially repopulate degraded reefs. However, the health status and long-term community dynamics of reefs in the northern Red Sea are poorly documented and understood, while pressure from coastal development, tourism and overfishing is increasing. Thus, we used an extensive long-term monitoring dataset to analyze changes in benthic, fish and invertebrate assemblages of reefs around Dahab (South Sinai, Egypt) between 2009 and 2019. We also studied individual trajectories of benthic categories, key invertebrate and fish species and their relationships. As site emerged as the main factor explaining the variability in reef communities, we identified three clusters of sites with similar assemblages. Macroalgae and cyanobacterial mats increased significantly and accounted for 6-15 and 6-12 per cent, respectively, of benthic cover in the site clusters in 2019. Although not observing a significant reduction of hard coral cover, macroalgae and cyanobacterial mats cover were significantly negatively related to hard coral cover and coral disease occurrence. Soft coral cover decreased significantly in two site clusters and was negatively related to macroalgae and cyanobacterial mats cover. Significant declines in grazer urchins were observed at all site clusters. A strong negative relationship was found with macroalgae and cyanobacterial mats cover, suggesting urchin decline as a main driver behind algal increases. Site clusters had different fish trajectories, with only damselfish densities significantly decreasing at all sites. A significant decrease in damselfish densities was related to increases in cyanobacterial mats. Our findings suggest that if macroalgae and cyanobacteria continue to increase, Dahab reefs could undergo degradation. The collapse of urchins may act as a precursor of events resembling the disastrous Diadema antillarium mass die-offs throughout Caribbean reefs in the 1980s.*

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| *Neus Figueras* | Storytelling that pays tribute to coral reefs and inspires climate action | *Lorac* |

*Earth with all its life is our only home and livelihood, and we must protect it. Coral reefs are projected to be lost almost completely at 2 ºC warming, a threshold that will be reached within the life times of many of us unless there is more global action on climate change.*

*The general public, however, often needs more than rationality to respond to this call because data, facts, and figures are highly informative but lack humanity.*

*Stories are a way to convey information while adding to our personal experiences. They appeal to our empathy and self-reflection to humanize this issue, and make us care enough to do something about it.*

*Marine scientist and writer Neus Figueras puts together her knowledge of the marine environment, storytelling skills, and imagination to present her novel "Lorac", a tribute to corals and a way to inspire connection with the marine world and climate action.*

*It's a story for teenagers and adults that begins with the traditional life of an indigenous community of sea nomads (the same tribe that survived the devastating Indian Ocean earthquake and tsunami because they knew how to read nature), then follows to the underwater realm to show the secrets of the coral reefs, and finally, climate change and pollution come into play, sending the protagonist out into our world on a mission to restore the balance of nature.*

*The impact it is having on its readers has been greater than any of the many scientific speeches or talks between friends Neus has made.*

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| *Jan-Christopher Fischer* | How do volcanic activities affect coral reefs? – A rapid impact assessment in the Coral Triangle | *University of Bristol* |

*The 'Coral Triangle' region is a global hotspot of marine biodiversity containing over three quarters of all known coral and coral reef fish species. This Asian-Pacific region is also a hotspot for volcanism, forming the westernmost edge of the Pacific 'Ring of Fire' and hosting 25% of the world's volcanoes. Consequently, almost half of the coral reefs within the 'Coral Triangle' are located within 250 km of an active volcano. Geological impacts are not normally considered in local coral reef hazard assessments and ecosystem management plans. However, given the conservation priority and potential for volcanic activity in the region, I am addressing the need to quantify the risk of episodic volcanic perturbations to 'Coral Triangle' reefs. Volcanic ash fall does not only directly impact coral communities by smothering entire reef zones but also induces additional secondary effects resulting in large-scale variations in water quality. Eutrophication, increased turbidity and thermal alterations may ultimately reduce coral reef health and resilience. Those effects are assessed based on a set of case studies including selected data sets of transient oceanographic conditions and feedbacks (e.g. chlorophyll a as a productivity proxy) before, during and after well-documented volcanic eruptions. Integrating the episodic but abrupt impacts of volcanic disturbances on coral reefs into local coral hazard assessments is another factor to consider in site selection and conservation of Marine Protected Areas.*

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| *Nanne van Hoytema* | Fishing gear dominates marine litter around Oman's unique single species foliose Montipora sp. coral reefs | *CEFAS* |

*The remote Wetlands Reserve in Al Wusta Governorate on the Arabian Sea is a vital habitat for local and migratory marine life and birds. In particular, it is home to the region's and possibly the world's largest single species coral reefs consisting of an unidentified foliose Montipora species. The reserve is open to fisheries and land-based tourism activities, potentially impacting these important habitats. Lost fishing gear and general litter from local or remote sources accumulate in the reserve, harming its unique wildlife but data on this marine litter in the reserve, and wider region, are rare. To address this, seven beaches around the reserve were surveyed for litter in February 2020. Abundance and weight of litter were categorised along 100 m transects. Abundance ranged from 0.1 to 1.4 items per square metre and weight ranged from 3.2 to 170.4 gram per square meter. Plastic was the dominant material in abundance (84.4 – 97.7%) and weight (71.3 – 99.3%). Top categories in abundance and weight were fisheries-related, water bottles and caps, and food packaging. Fisheries-related litter comprised 19.6 – 36.7% of all in abundance, but 41.4 – 94.4% in weight, mostly consisting of abandoned, lost or discarded fishing nets which could easily entangle and damage the foliose structure of the reserve's coral reefs. The conservation of these unique reefs would be greatly supported by practical disposal facilities for unwanted and broken fishing gear, as well as outreach to local fishers on the environmental effects of lost gear around the region.*

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| *Hedwig Krawczyk* | High-resolution climate data reconstruction from Porites corals from Browse Island, North Western Australia | *University of Leicester* |

*Ocean heatwaves pose a great threat to reefs, often causing coral bleaching. Recurring climate anomalies on top of human-induced warming lead to more frequent bleaching events worldwide. Better understanding and possible predictability of these events, through model-based climate change process studies, heavily depend on reliable climate records. Massive stony corals provide a useful archive of past environmental variability and thus can compensate for the scarcity of long instrumental climate data for the tropical oceans. However, replication studies of the geochemical proxies from several coral cores are necessary to validate the relationship between each proxy and environmental parameter.*

*The isolated coral reefs of the Northwest Australian shelf are situated in a key region for Indo-Pacific climate connectivity at the edge of the Indo-Pacific warm pool extension into the eastern Indian Ocean. Ocean heatwaves related to El Niño Southern Oscillation have caused severe mass coral bleaching along the NW Australian shelf in recent years. In this study we examined monthly variations of Sr/Ca and δ18O of two cores from Porites sp. corals at Browse Island, NW Australia. We assessed the reliability of the coral-based climate records through cross-validation of the geochemical data from the two colonies, as well as through calibration/comparison with instrumental sea surface temperature (SST) records over several decades. Further, paired Sr/Ca and δ18O analysis enabled the reconstruction of the oxygen isotopic composition of the seawater (δ18Osw) and thus provided information about changes in the hydrological balance, mainly driven by evaporation and precipitation and potentially ocean advection from the*

*Indonesian Throughflow. Our results show that reliable climate records can be generated from the Browse Island coral cores. Such a replication study is of immense importance prior to generating longer proxy records which significantly extend the short instrumental record, leading to a better understanding of the climatic and oceanographic processes. This can help stakeholders in decisions regarding reef protection and management for the future.*

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| *Chancey MacDonald* | Depth-mediated avoidance of degraded resources among coral obligate fishes | *California Academy of Sciences* |

*A key ecological question in the Anthropocene is how organisms respond to increased disturbance pulses and novel or newly ephemeral ecosystem states. One emergent feature of coral reefs is the near-future annual bleaching of most reef regions, globally. A poorly understood outcome of annual coral bleaching, particularly where corals recover, is the likely emergence of newly seasonal pulses in resource availability and quality for coral-obligate organisms. In order to assess persistence outcomes for this emerging pressure, it is first necessary to understand how behavioural plasticity may facilitate short-term adjustments to novel resource pulses following disturbances. However, relatively little is known about the behavioural responses of coral-obligate reef fishes during and immediately following bleaching periods or how impacts and responses may be mediated by depth. Here, we provide supporting evidence that coral-obligate reef organisms in deeper waters may have greater opportunities to avoid the use of degraded coral resources following warm-water stress events. Using a natural experiment along a broad depth gradient, in Mo'orea, French Polynesia, we demonstrate that while obligate corallivorous butterflyfishes actively avoided feeding on bleached corals, in favour of non-bleached corals, depth-related attenuation in the bleaching of key coral resources resulted in ubiquitous increases in the relative proportion of bites taken from healthy coral colonies at deeper depths. We propose that strong selection of non-bleached coral food sources is indicative that obligate corallivores will experience frequent pulse reductions in their resource base - due to frequently recurrent coral bleaching in the near future. We further suggest that deeper coral reef habitats may provide energetic buffers for some coral obligate populations that provide direct trophic links between corals and higher consumers on coral reefs.*

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| *Walid Naciri* | Increased sediment discharge and soil erosion in Borneo recorded by massive coral Ba /Ca ratios | *University of Leicester* |

*Industrial-scale deforestation in Malaysian Borneo has impacted both terrestrials and marine ecosystems since the 1970s (Gaveau et al., 2016). Biodiversity loss as well as land erosion are two of the many consequences forest clearance has had for the last 50 years. Deforestation has created erosion hotspots and models estimated it to be responsible for the loss of 28 t h-1 year-1 of soil in 2017 in Malaysian Borneo (Vijith et al., 2017). However, this model heavily relies on the accuracy of the satellite and topographic data as well as soil maps. Additionally, it is very limited in time by the availability of observational data.*

*In this study we circumvent the issue of data scarcity and use the skeletal barium to calcium ratio (Ba/Ca) in massive Porites corals off the coast of Miri in Malaysian Borneo as a proxy for river discharge and land erosion. This record allows us to uncover past variations and thus compare soil loss and its impact on local corals from the beginning of industrial-scale deforestation to the present.*

*Results show a 1.72 fold increase in Ba/Ca values between pre-1991 and post-1991 periods. As this significant increase is not reflected in freshwater discharge or salinity values, it is indicative of a steady rise in land erosion and soil loss through time. This increase exposes the non-linear behaviour of industrial scale deforestation as demand in palm oil rises.*

*This showcases the need for new deforestation regulations to limit the human impact on marine ecosystems as increased sediment discharge directly impact corals' light availability and could add yet another threat to coral ecosystems.*

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| *Ana Samperiz* | Do Fijian coral skeletons record watershed environmental changes? | *Cardiff University* |

*The Fiji archipelago includes approximately 35% of coral reef area in the southwestern Pacific that provides essential ecosystem services for the livelihoods of Fijians. However, these reefs are at risk of irreversible damage due to global (e.g. seawater warming, ocean acidification) and local stressors (e.g. overfishing, poor water quality). Local organizations routinely survey coral reef ecosystem health, but these provide only a limited snapshot of the current ecosystem state. Here we show records from massive reef-building corals demonstrating the influence of historic watershed land use on the local inshore reef environment, and the impact of short-lived intense events such as*

*cyclones. Fourteen coral cores from massive Porites colonies, spanning up to ~90 years of growth, were collected from inshore reefs experiencing a range of different catchment environments at five locations around the island of Viti Levu. We combined skeletal UV luminescence and computed tomography (CT) to explore relationships between coral colony response to water quality and climatic events. Results show that corals in inshore reefs contiguous to watersheds with extensive anthropogenic impact exhibited lower growth rates than those colonies located in reefs with limited local anthropogenic influence. In the current scenario of climate change management of anthropogenic local stressors might play a key role in limiting the decline of inshore reefs in Fiji.*

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| *Natasha Senior* | The response of shallow-turbid reefs to sedimentation in the Coral Triangle | *Natural History Museum / University College of London* |

*Shallow-turbid reefs have been recently recognised as potential climate-change refugia habitats. Sediment particles can reduce irradiance and photophysical stress, although coral smothering may remain a prevalent threat. Generally, fewer coral species are thought to be able to withstand these harsher turbid conditions, but recent evidence from the fossil record indicate that high diversity can be sustained under high sediment inputs. We test these hypotheses by studying turbid reefs in Darvel Bay, Malaysia. Here, we show that high-turbid reefs host the most diverse community (H=2.14), compared to low-turbid reef sites (H=1.14 – 1.9). We found a clear disparity within their sediment regimes with increased turbidity associated with higher sediment accumulation rates (maximum: 7.8 mg cm-2 d-1), smaller particle sizes (D50 =31.8 µm) and three-fold higher organic matter (12.9%). Ordination analysis identified similar diverse benthic communities between high- and low- turbid reefs, where communities were predominantly influenced by fine silt (8 – 16 µm). Platy Leptoseris species could tolerate high silt contents, optimised by their funnel-shape, while the abundant Porites may have a limit of tolerance to siltation. This study provides important evidence for shallow-turbid reefs as refugia habitats, while highlighting that their resilience may be threatened by enhanced terrestrial runoff from land use and urban development. Further research should establish regional thresholds of environmental parameters for defining shallow-turbid reefs and their refugia tipping points.*

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| *Maria Ulfah* | Status of Coral Reef Ecosystems in Simeulue Island MPAs, Aceh, Indonesia | *FFI* |

*The establishment of inclusive and equitable MPAs in remote areas is critical to protect coral reef ecosystems whilst safeguarding fisheries which provide economic support for surrounding communities. In Simeulue Island, at the western tip of Indonesia, small-scale coral reef fisheries have historically been managed through unique customary frameworks (the "Panglima Laot" or Sea Commander), but these are increasingly challenged by destructive fishing pressure and limited support from top-down governance. The purpose of this study was to assess the status of the coral reef ecosystems within MPAs in Simeulue Island, and to examine the impacts of community-led management efforts on reef health indicators.*

*Retrieval of coral cover data was conducted using the point intercept transect method, while diversity and abundance of reef fish was determined using the underwater visual census method. Observations were made across 53 stations, of which 41 were in waters designated as MPAs, with a further 12 survey stations in open access areas. The results of analysing the coral reef condition in MPAs and open access areas showed the status of hard coral cover to be "moderate" across both, with 47 genera of hard coral observed. However, the most encouraging results related to reef fish abundance within the MPAs, which was observed to be significantly higher than the open access areas. This suggests that collaborative management efforts by communities, government, universities and NGOs are positively influencing coral reef condition and deterring destructive fishing.*

*This talk will share detailed results from the Simeulue Island study, and discuss the implications of this research for coral reef conservation and small-scale fisheries. This is particular timely for Aceh as the provincial government moves to deliver its 2018 commitment to an MPA network across Acehnese waters.*

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| *Ellie Vaughan* | Nitrogen enrichment in macroalgae following mass coral mortality | *Lancaster University* |

*Scleractinian corals are key ecosystem engineers on coral reefs which provide both structural complexity as habitat and sustenance through release of organic and inorganic matter for other reef-associated organisms. However, coral reefs are facing multiple pressures from climate change and other stressors, which can result in mass coral bleaching and mortality events. Mass mortality of corals results in enhanced release of organic matter, which can cause*

*significant alterations to reef biochemical and recycling processes. There is little known about how long these nutrients are retained within the system, for instance within the tissues of other benthic organisms. We investigated changes in nitrogen isotopic signatures (δ15N) of macroalgal tissues (Sargassum sp.), ~3 months after the peak of a bleaching event in Mo'orea, French Polynesia, and ~1 year after a bleaching event in the Seychelles, West Indian Ocean. In the Seychelles, there was a strong association between absolute loss in both total coral cover and branching coral cover and absolute increase in macroalgal δ15N between 2014 and 2017 (r2 = 0.83, p = 0.004 and r2 = 0.88, p = 0.002, respectively). In addition, a short-term transplant experiment conducted in Mo'orea showed a significant increase in δ15N in Sargassum mangarevense after specimens were deployed on a bleached reef for ~3 weeks (p <0.05). We suggest that coral-derived nutrients can be retained within reef nutrient cycles, and that this can affect other reef-associated organisms over both short- and long-term periods, especially opportunistic species such as macroalgae. These species could therefore proliferate on reefs that have experienced mass mortality events, because they have been provided with both space and nutrient subsidies by the death and decay of the corals themselves.*

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| *Melissa Vezard* | Estimating Vital Rates Across Species for Corals in Maui, Hawaii | *California State University Monterey Bay* |

*Anthropogenic climate change is increasing ocean temperatures and negatively impacting coral reefs worldwide through coral bleaching; however, some coral populations are known to be more resilient to heat stress than others. To better understand and predict why some populations fare better, we compared vital rates (growth, mortality, recruitment) of two coral species off the coast of Maui, Hawaii, Montipora capitata and Porites lobata before and after a bleaching event. We used Structure-from-Motion photogrammetry to create 3D models of coral reefs and monitor the effects of bleaching events on coral demographics. NOAA SCUBA divers took thousands of photos of the same coral reef off the coast of Maui annually from 2014-2018. For each year, the photos were stitched together to create 3D models and 2D reconstructions called orthoprojections. We measured changes in vital rates by outlining >= 40 patches of live tissue per target species within 10 randomly dropped circular plots on the 2D othroprojection in ArcMap. We simultaneously used Viscore, a program to view the coral reefs in 3D, as a visual guide while outlining the patches in ArcMap. We followed the same patches over time to calculate change in area and measure growth, mortality, or a recruitment event. We found M. capitata had lower growth, higher recruitment, and higher mortality relative to P. lobata. Our results suggest that P. lobata may be more resilient than M. capitata to rising temperatures after a bleaching event due to its higher growth and survival rates. Since P. lobata appears to be more resilient, managers could target this species for conservation practices.*

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| *Aisyah Wan* | Evaluating Pulau Bidong's coral reefs and the effects of site use on reef composition | *University of York Alumni* |

*Coral reefs provide a range of ecosystem services, such as economic returns through fisheries, tourism, and coastal development. However, large-scale change is occurring to reefs worldwide, caused by ocean temperature increase, ocean acidification, and the growth of coastal developments. Fast-track development of the tourism industry and its associated infrastructure is a key driver in the degradation of Malaysia's coral reefs; annual studies have shown the Terengganu islands, on Peninsular Malaysia's east coast, are experiencing decreasing cover of live coral. Pulau Bidong and its surrounding reefs are relatively less well studied than the other Terengganu islands. In this study, I compared coral cover and benthic composition at two sites on Pulau Bidong – one more frequently used than the other – and compared two depths (0.5m and 2m) at each site. Using five 20-metre transects at each site and depth, an analysis of the benthic composition was conducted to determine the effects of site use and depth on coral cover. Live coral cover was generally low across all sampled areas (5.9-12.2%), and site and depth factors had no significant effect on cover (2-way ANOVA, p>0.05). Dead coral and algae and zoanthid cover differed significantly by site (2-way ANOVA, p=0.001; Kruskal-Wallis, p=0.001 respectively). Low live coral cover may be attributed to storm Pabuk, which hit Pulau Bidong in January 2019. Malaysia's reefs are inherently at risk of degradation from natural stressors, which is further increased by human activity. Assigning Pulau Bidong as a marine protected area has been suggested to increase reef resilience to future disturbances, but it is essential to closely monitor reef activity once protection is established. Local communities should be involved in decision-making in reef management as to reduce stakeholder conflict. Protection may be supplemented by reef restoration methods to aid the rate of recovery, if protection alone is insufficient.*

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| *Karolina Zarzyczny* | The role of herbivores in shaping subtropical coral communities in warming oceans | *University of Leeds* |

*Tropicalisation is rapidly restructuring subtropical communities, leading to changes in herbivory underpinning ecosystem stability. Consequently, subtropical algal beds are being displaced by tropical corals seeking refuge from thermal stress. Understanding herbivory pressure across the latitudinal gradient will help to predict how this process may change with further tropicalisation. Identifying the relationship between herbivory and coral reef characteristics is necessary for understanding how coral communities will respond to ocean warming. Typically, the relationship between herbivores and coral reef characteristics is assessed in terms of herbivore diversity or abundance. However, the actual herbivory pressure exerted by fishes and urchins across this latitudinal gradient remains unquantified. Using in-situ feeding observations coupled with theoretical methods we quantify fish and urchin herbivory pressure across seven sites, across subtropical and tropical coral reefs in Japan. Following a series of reef surveys, we assess the relationship between fish and urchin community structure, herbivory and coral reef characteristics. We find that fish and urchin community structure differ more strongly among reefs than between the regions. Coral cover and rugosity differ between reefs but not between regions. Consistent with our prediction, we find that urchin herbivory is greater in the subtropics; a result which is reversed for fish herbivory. We also find that overall herbivory pressure is greater in the tropics than subtropics. Furthermore, we find evidence for the relationship between herbivory pressure and reef characteristics. The findings of our study provide a foundation for understanding how coral communities may respond to ongoing tropicalisation, given the fish and invertebrate herbivores they host.*