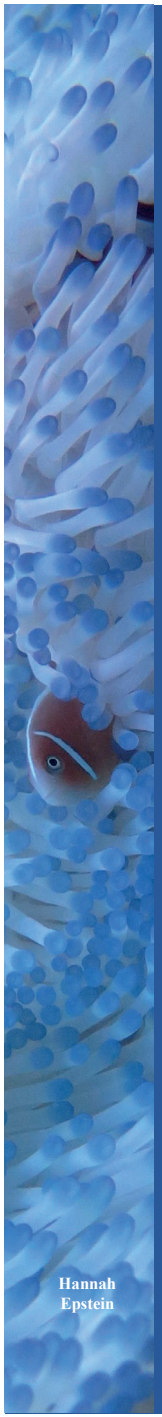
AIMS@JCU

2019 Student Seminar Day

Abstract Booklet

Townsville
Yacht
Club



AIMS@JCU

Student Seminar Day 2019
Friday, 8th November

Townsville Yacht Club

Time	Title	Presenter
Midday	**Lunch**	
12.30pm	**Opening address, AIMS@JCU Research Director**	**Libby Evans-Illidge**
	Seminar presentation session 1:	
12.45pm	Cumulative impacts of sedimentation and climate change on *Acropora millepora* juveniles	Christopher Brunner
1.00pm	Comparing phylosymbiosis across diverse coral reef invertebrates	Paul O'Brien
1.15pm	Deadly Science Getaway: Elevating and connecting Aboriginal and Torres Strait Islander Women across the generations through science and authentic conversations	Blanche D'Anastasi
1.30pm	**Poster session 1**	
	Seminar presentation session 2:	
2.00pm	Genomic and seascape studies support differentiation patterns across a high-gene flow region in the Great Barrier Reef	Rodrigo Gurdek
2.15pm	Smooth reconstruction of time series NDVI data using wavelet approach	Dharini Jha
2.30pm	A simulation approach to infer the processes behind macroecological patterns of commonness and rarity of species.	Alfonso Ruiz Moreno
2.45pm	Predicting subsurface water temperature from sea surface temperature in the Great Barrier Reef	Rae Quinlan
3.00pm	**Poster session 2**	
3.30pm	**Keynote speaker**	**Dr. Monica Gagliano**
	Speed talk session:	
4.00pm	Augmented coral health: from planktonic prey to the procurement of putative probiotics	Julia Saper
4.05pm	Application of Hyperspectral imaging for coral reef morphology using drones in Great Barrier Reef	Dharini Jha
4.10pm	Bioaccumulation, biomagnification and trophic transfer of microplastics: A meta-analysis	Michaela Miller
4.15pm	Compositional and temporal stability of fecal taxon libraries for use with SourceTracker in sub-tropical catchments	Christian O'Dea
4.20pm	Benthic light from space	Marites Canto
4.25pm	Revealing connectivity patterns of a coral reef fish in the Great Barrier Reef	Rodrigo Gurdek
4.30pm	Predicting the spatial distribution of crown-of-thorns starfish (COTS) for effective management	Samuel Matthews
4.35pm	**Closing Remarks**	**Libby Evans Illidge**
4.45pm	**Judges deliberation; presentation of awards and prizes**	
5.00pm-8.00pm	**End of day function with drinks and canapés provided**	

JAMES COOK UNIVERSITY AUSTRALIA

Australian Government

Australian Institute of Marine Science

12.45pm

Cumulative impacts of sedimentation and climate change on *Acropora millepora* juveniles

Christopher A. Brunner[a] & Andrew P. Negri[b], Mia Hoogenboom[c], Sven Uthicke[b] & Elena Rovenskaya[b]

[a]*AIMS@JCU*
[b]*Australian Institute of Marine Science*
[c]*ARC Centre of Excellence for Coral Reef Studies*

Coral reefs are globally threatened by rising water temperatures and ocean acidification. Locally, they are furthermore exposed to coastal development and associated sediment-runoff. Cumulative effects of climate change and sedimentation on the post-settlement life stage of corals are not well understood. However, as the survival of coral juveniles represents a bottleneck in successful coral reproduction, underlying mechanisms must be investigated to promote sustainable management. In this study, the resistance to sedimentation of up to three months old *Acropora millepora* juveniles was tested in three climate scenarios (elevated temperatures and pCO_2) that are expected to occur by the end of this century. In addition, coral juveniles were periodically exposed to environmentally relevant sediment concentrations (0, 5, 10, 20, 40, 80 mg/cm²) to simulate major sedimentation effects that may occur following floods, dredging operations or natural resuspension events. Results of a Generalized Linear Mixed-Effects Model show that the survival of two-month-old corals following sedimentation was significantly greater than of one-month-old juveniles. Two-month-old corals raised at current climate tolerated significantly more sediment (10% effect concentration [EC_{10}]: 20 mg/cm²), than juveniles raised in the 2100 climate scenario (EC_{10}: 9 mg/cm²). Only juveniles raised in current climate, which were not smothered before reaching two-months in age, survived (mean survival: 28 ± 34%) the greatest tested sediment concentration (80 mg/cm²). This demonstrates that climate and sedimentation interact significantly, with coral juveniles suffering the most from elevated sedimentation rates shortly after their settlement, as well as in climate scenarios predicted for the end of this century.

1.00pm

Comparing phylosymbiosis across diverse coral reef invertebrates

Paul A. O'Brien[a,b,c,d], Tan Shangjin[e], Chentao Yang[e], Pedro R. Frade[f], Nikolaos Andreakis[a,], Hillary A. Smith[a], David J. Miller[a,g], Nicole S. Webster[c,d,h], Guojie Zhang[e,i,j,k] & David G. Bourne[a,b,c,d]

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Microbiome assemblages of plants and animals often show a degree of correlation with host phylogeny; an eco-evolutionary pattern known as phylosymbiosis. Terrestrial host-microbe relationships have revealed the prolific nature of phylosymbiosis, demonstrating that host evolutionary history has an important role in shaping the microbiome. However, it is unclear whether the microbiome of marine organisms follow similar patterns. Using 16S rRNA gene sequencing to profile the microbiome, paired with COI and 18S rRNA host phylogenies, phylosymbiosis was investigated in four groups of coral reef invertebrates (scleractinian corals, octocorals, sponges and ascidians). We tested three commonly used metrics to evaluate the extent of phylosymbiosis: a) intraspecific versus interspecific microbiome variation, b) topological comparisons between host phylogeny and hierarchical clustering (dendrogram) of host-associated microbial communities, and c) correlation of host phylogenetic distance with microbial community similarity. In all instances, intraspecific variation in microbiome composition was significantly lower than interspecific variation. Similarly, topological congruency between host phylogeny and the associated microbial dendrogram was more significant than would be expected by chance. All but the ascidians showed a significant positive correlation between host phylogenetic distance and associated microbial dissimilarity. Additionally, higher intraspecific variability in microbial composition was associated with higher levels of incongruence, often due to changes in the relative abundance of the common symbiont *Endozoicomonadaceae*. Our findings provide new perspectives on the diverse nature of marine phylosymbioses and the complex roles of the microbiome in the evolution of marine invertebrates.

1.15pm

Deadly Science Getaway: Elevating and connecting Aboriginal and Torres Strait Islander Women across the generations through science and authentic conversations

Blanche D'Anastasi[a,b,c] & Bianca McNeair[a,b,e,f,g]

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[d]*Board of Malgana Aboriginal Corporation (PBC), Gutharraguda (Shark Bay), WA, 6537, Australia*
[e]*Northern Agricultural Catchments Council Ltd, Geraldton, WA, 6530, Australia*
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**Deadly Science Getaway is a collaboration between James Cook University, Transition Support Services - Education Queensland and Malgana Community.*

Deadly Science Getaway is an immersive field science program. Through field science in wild places in Queensland and Western Australia, we provide a spark to support Aboriginal & Torres Strait Islander women from remote communities to ignite their passion for science, careers that inspire them, leadership and mentoring. Since our inception in 2012, we have held 13 getaways in two states. We have worked with over 110 women who are typically aged 12-18, the first in family to complete grades 10-12, and likely to be an at risk young person. We provide a nourishing space where our young women can connect with women across generations, First Nations leaders and scientists. Our graduates express feeling increased confidence, and feeling empowered to drive change with their unique perspective, connection to community and their traditional cultural ecological knowledge of land and sea country. The ongoing success of Deadly Science Getaway is underpinned by the extraordinary young women that we work with; the team we choose to deliver the program; our communication principles; and the way we structure activities. Here we share an overview of the key factors that make Deadly Science Getaway impactful.

2.00pm

Genomic and seascape studies support differentiation patterns across a high-gene flow region in the Great Barrier Reef

Gurdek, Rodrigo[a], Benthuysen, Jessica[b], Zenger, Kyall[d], Harrison, Hugo[d] & van Herwerden Lynne[c]

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[b]*Australian Institute of Marine Science, Perth, Western Australia, Australia*
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[d]*ARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Queensland, Australia*

Coral reef fish populations experience different levels of genetic differentiation affected by life-history characteristics, larval connectivity and ecological factors. Investigating the genetic structure using genomic markers, and analyzing geographic and biophysical factors, can help us to better understand the connectivity patterns of species in different coral reef ecosystems. Here, we analyzed the population genetic structure of adults and several spatial and temporal recruit groups from an abundant Great Barrier Reef (GBR) predatory fish, the stripey snapper *Lutjanus carponotatus*, using single nucleotide polymorphisms. Additionally, we evaluated isolation by distance and larval dispersal patterns along approximately 800 km of the GBR. Genetic structure based on neutral loci was weak, albeit significant between most regions, following an isolation by distance pattern (Mantel, $r = 0.65$, $p < 0.01$). Loci putatively under selection revealed greater population structure (F_{ST} range: 0.001 – 0.108), which increased with geographic distance (Mantel, $r = 0.76$, $p < 0.001$). Genetic differentiation patterns of outlier and neutral loci were correlated (Mantel, $r = 0.46$, $p < 0.05$). Larval connectivity estimates from biophysical modelling identified the potential for direct larval dispersal between adjacent regions, suggesting that intermediate reefs enable gene flow among more distant ones. Comparing genetic differentiation between adults and recruitment groups revealed greater genetic similarities within than between GBR sectors. Significant spatial and temporal genetic variability existed between different recruitment pulses. This study highlights that integrating genomic analyses from different life stages and modelling larval transport better elucidates connectivity patterns when examining high-gene flow marine species.

2.15pm

Smooth reconstruction of time series NDVI data using wavelet approach

Dharini Jha[a] & C. Jeganathan[b]

[a]*AIMS@JCU*
[b]*Birla Institute of Technology, Mesra*

Analysis of NDVI time series data is extremely important for studying the phenological parameters in vegetation dynamics. However, the noise degrades the datasets and hinders analysis. The present study aims to quantify such noises and to reconstruct high quality NDVI time series MODIS data. Several methods have been proposed to remove such noises. The present study focuses on smoothing of NDVI data by using wavelet approach. This method can be categorized into two methods: First, Temporal smoothing where all NDVI data in individual pixel is considered and wavelet decomposition, thresholding and reconstruction is performed by selecting specific wavelet filters. Second, Spatial filtering where all data in a particular band is considered and image level smoothing for different crop growing seasons is done. Four families of wavelet filters namely Haar, Daubechies, Symlet and Coiflet are applied on a raw NDVI image and the best performing members in wavelet familes are determined. Also, the comparison between these two approaches is performed by estimating statistical errors. Then, the reconstructed smoothened image is compared with Fourier results. The results indicate that wavelet method has ability to remove noise for areas with lesser complexities. Fourier smoothing technique can both smooth the image as well as retain the inherent feature properties unlike the wavelet technique.

2.30pm

A simulation approach to infer the processes behind macroecological patterns of commonness and rarity of species

Alfonso Ruiz Moreno[a,b,c] & Sean R. Connolly[b,c]

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[c]*Marine Biology and Aquaculture, College of Science and Engineering, James Cook University, Townsville, QLD 4811 Australia*

Ecological studies have revealed a few key rules describing patterns of commonness and rarity within ecological communities and between environments. Statistical models have successfully described the shapes and trends of these patterns, across a wide range of taxa and environments. However, statistical models are agnostic about the processes and mechanism driving patterns of commonness and rarity. Different theories of biodiversity have been proposed to explain the processes driving species abundance distributions and patterns of aggregation. However, up to date, no theory has successfully included a combination of ecological processes that explain several macroecological patterns simultaneously. We propose a framework using simulations and statistical modelling. We simulate time series data from a different array of assumptions and check if the simulated data resembles ecological data. At the current stage of this research, we implement metapopulation niche models with different types of density dependence, random sampling with sampling effort, different combinations of distributions for species differences and environmental noise. The simulations produce macroecological abundance patterns found in empirical data, such as negative binomial distribution for intraspecific aggregation and lognormal or gamma distribution for species abundance distributions. This research highlights the importance of species differences and environmental noise in producing realistic patterns of commonness and rarity. Further research requires exploration of process-based models with no species differences to test the importance of species differences in driving these patterns and also explore the effects of species competition in these models.

2.45pm

Predicting subsurface water temperature from sea surface temperature in the Great Barrier Reef

R. Quinlan[a,b], B. Robson[c] & J. Benthuysen[c]

[a]*James Cook University*
[b]*AIMS@JCU*
[c]*Australian Institute of Marine Science*

Coral reefs are at risk due to climate change, specifically extreme ocean warming events. Understanding how water temperature varies vertically in the Great Barrier Reef (GBR) lagoon is important for understanding the potential threat to coral reef ecosystems. Predictive modelling can be used to assess extreme temperature high risk areas. This study had two aims: (1) to compare vertical temperature profiles predicted by the eReefs 1 km resolution (GBR1) hydrodynamic model with observed temperature collected by Slocum gliders on the Great Barrier Reef (GBR); (2) to create a simple statistical regression model to quickly predict subsurface temperature on the GBR during the wet season down to 40 m given sea surface temperature (SST). First, profiles of eReefs and glider temperature from different regions, seasons and time of day were compared using bias, Root Mean Square Error (RMSE) and Willmott's Skill Score. Results show that temperature profiles predicted by the eReefs GBR1 hydrodynamic model are sufficiently accurate for the purpose of estimating impacts on corals. We then developed a new statistical model, Generalised Additive Modelling (GAM) was selected due to the nonlinear relationships between the subsurface temperatures and the explanatory variables. The GAM model built used five variables: SST, depth, time (days since October 1st) and location (as latitude and longitude) to predict temperature. The model produced RMSE values below 0.5°C and Pearson's correlation coefficients between predicted and observed temperatures above 0.90. This study provides a simple and accurate statistical model allowing prediction of subsurface sea temperature from observed or modelled surface temperature.

4.00pm Speed Talk

Augmented coral health: from planktonic prey to the procurement of putative probiotics

Julia Saper[a,b], David Bourne[a,b], Lone Hoj[b,a] & Craig Humphrey[b]

[a]*James Cook University,Townsville, QLD, Australia;*
[b]*Australian Institute of Marine Science, Townsville, QLD, Australia*

Optimal nutrition is paramount to the health of all organisms. The purpose of this study is to characterize and improve the nutritional status of corals in experimental systems. Aquarium trials will subject coral fragments to different feeding regimes including, live zooplankton, novel formulated diets, and putative bacterial probiotics. Results from this study will demonstrate how various feeding regimes may benefit corals' energetically and result in the acquisition of beneficial microbes. Insights into nutritional supplementation as a means to augment holobiont health could allow for the direct application of feeds on a larger scale to increase resilience in populations under environmental stress.

4.05pm Speed Talk

Application of Hyperspectral imaging for coral reef morphology using drones in Great Barrier Reef

Dharini Jha[a], Karen Joyce[b], Jonathan Kok[c], Manuel Gonzalez[c] & Mia Hoogenboom[b]

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[b]*James Cook University*
[c]*Australian Institute of Marine Science*

Coral reefs are highly productive and diverse ecosystem. Hence, its degradation has prompted a need for a detailed study. Remote sensing has great potential for obtaining vital information about coral reefs. Moreover, hyperspectral data with fine resolution can achieve in-depth information to identify and discriminate between different benthos. Space-borne data with low spatial resolution covers large areas, while, in situ survey provide high spatial resolution for limited areas. Alternatively, drones can acquire high quality data for larger areas than in-situ survey. This study exploits high resolution drone data to extract coral morphological information on Heron reef using machine learning techniques.

4.10pm Speed Talk

Bioaccumulation, biomagnification and trophic transfer of microplastics: A meta-analysis

Michaela E. Miller[a,b,c], Mark Hamann[c] & Frederieke J. Kroon[a,b]

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[b]*AIMS@JCU, Division of Research and Innovation, James Cook University, Townsville, Queensland 4811, Australia*
[c]*College of Science and Engineering, James Cook University, Townsville, Queensland 4811, Australia*

Microplastic intake has been well documented, yet the intricacies related to potential trophic transfer are largely unknown. A meta-analysis was done to examine whether current evidence supports microplastic transfer, accumulation, and biomagnification across a general marine food web. Microplastic intake data were obtained and standardized from a total of 288 publications. Species were assigned to trophic level, and data were then critically examined. While microplastics are ingested across all trophic levels, there is little evidence of biomagnification. Laboratory studies have demonstrated successful trophic transfer of microplastics, yet exposure concentrations are not reflecting those reported for the marine environment.

4.15pm Speed Talk

Compositional and temporal stability of fecal taxon libraries for use with SourceTracker in sub-tropical catchments

Christian O'Dea[a,b,c]

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[b]*Young Water Professional student, Water Research Australia, Adelaide, SA, Australia*
[c]*AIMS@JCU, James Cook University, Townsville, QLD, Australia*

High-throughput amplicon sequencing is an emerging approach for microbial tracking of fecal pollution. This study used SourceTracker software to examine temporal and geographical variability of fecal bacterial community profiles to identify pollutant sources in three freshwater catchments in sub-tropical Australia. Fecal bacterial communities from animal species, humans, and wastewater samples were characterized and compared to freshwater samples using 16S rRNA sequencing. SourceTracker predicted occasional fecal detection of deer and flying fox sources in water samples. Results suggest temporal instability of fecal taxon libraries among tested sources and highlight continual evaluation of community-based MST using confirmatory qPCR analyses of marker genes.

4.20pm Speed Talk

Benthic light from space

Marites M. Magno-Canto[a,b,c], Lachlan McKinna[d]; Barbara Robson[b,c] & Katharina Fabricius[b,c]

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[b]*AIMS@JCU, Australian Institute of Marine Science, College of Science and Engineering, James Cook University, Townsville, QLD 4811, Australia*
[c]*Australian Institute of Marine Science, PMB3 Townsville, QLD 4810, Australia*
[d]*Go2Q Pty Ltd, Sunshine Coast, QLD, Australia*

The availability of sufficient light is essential for growth of benthic organisms. Light requirements of important corals and seagrasses have been examined on small scale scenarios but detailed spatial and temporal dynamics of this important energy resource has remained less understood, including in the Great Barrier Reef. Fortunately, remote sensing presents a solution to obtain crucial dataset that can bridge this knowledge gap. We hence developed a physics-based benthic irradiance model to estimate benthic light values from ocean color data and the resulting spatio-temporally rich dataset would now allow us to extend our understanding about this important physical parameter.

4.25pm Speed Talk

Revealing connectivity patterns of a coral reef fish in the Great Barrier Reef

Gurdek, Rodrigo[a], Benthuysen, Jessica[b], Zenger, Kyall[d], Harrison, Hugo[d] & van Herwerden Lynne[c]

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Larval transport represents an important process in coral reef ecosystems since it facilitates replenishment and long-distance dispersal of organisms, enhancing the capacity of populations to recover following disturbance. Determining levels of connectivity between populations informs species management and conservation. Given that following oceanic larvae is unrealistic, we used information on genomics and ocean currents to assess population connectivity of an ecologically important fish in the Great Barrier Reef over space and time. Population genetic differentiation and larval tracking simulations identified a well-connected network in terms of gene flow and accounted for various climate and environmental scenarios that influenced connectivity patterns.

4.30pm Speed Talk

Predicting the spatial distribution of crown-of-thorns starfish (COTS) for effective management

Samuel Matthews[a,b], Camille Mellin[c] & Morgan Pratchett[b]

[a]*AIMS@JCU, James Cook University, Townsville, Queensland 4811 Australia*
[b]*ARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Queensland 4811 Australia*
[c]*The Environment Institute and School of Biological Sciences, University of Adelaide, Adelaide, South Australia, Australia*

Of the major contemporary threats to the Great Barrier Reef, outbreaks of Crown-of-thorns starfish (COTS) are both one of the most destructive, and the only disturbance amenable to direct local action. Prioritising this action across a marine park spanning ~2300km and over 3800 reefs presents an enormous problem to management and researchers alike. While extensive monitoring exists for the GBR, this only covers a small proportion of reefs (~10%) with patchy spatial and temporal resolution. The goal of this research is to predict the likely spatial distribution of COTS to refine how reefs are prioritised for COTS control.

Poster

Modelling the responses of marine ecosystems to climate change impacts

Chinenye J. Ani[a,b,c], Stephen Lewis[d], John Brodie[e], Scott Smithers[d] & Barbara Robson[b]

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[b]*Australian Institute of Marine Science, Townsville, Australia*
[c]*AIMS@JCU, Townsville, Australia*
[d]*Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER), James Cook University, Townsville, Australia*
[e]*ARC Centre of Excellence for Coral Reef Studies, James Cook University, Townsville,Australia*

Climate change has tremendous impacts on marine ecosystems and on the economic and social services they provide. To predict the effects of climate change on marine ecosystems and the effectiveness of intervention strategies, we need reliable marine ecosystem response models that reproduce climate change effects and frame predictions in ways that make them suitable for policy decisions. Complex biogeochemical models are used to predict marine ecosystems' responses to impacts of climate change. In this systematic review, we considered the representation of climate change in marine biogeochemical models. We identified well-implemented aspects of marine ecosystem modelling: these include scenario analysis using long continuous runs, assessment of model performance against quality-controlled observational data, coupling of biogeochemical models with physical-ocean-atmosphere models and adequate representation of changes in river discharge and nutrient loads. However, important aspects of marine ecosystem modelling have often been neglected: these include the use of multiple IPCC scenarios to assess the range of possible outcomes, ensemble modelling to evaluate uncertainty, use of independent validation datasets, the consideration of the effects of changes in cloud cover, evaporation, wind speed, sea level, storm frequency and storm intensity, the incorporation of species' adaptation to changing environmental conditions, and inappropriate representations of species' temperature and ocean acidification responses. Implementing these outcomes could help improve the reliability and accuracy of marine ecosystem response models.

Poster

Cumulative effects of light limitation and climate change on coral post-settlement survival

Christopher A. Brunner[a], Andrew P. Negri[b], Mia Hoogenboom[c], Sven Uthicke[b] & Gerard Ricardo[b]

[a]*AIMS@JCU*
[b]*Australian Institute of Marine Science*
[c]*ARC Centre of Excellence for Coral Reef Studies*

Changing climate, sediment runoff and associated light attenuation are grave threats for the survival of coral juveniles. After their settlement, juvenile corals rely increasingly on the uptake of *Symbiodinium*, as a functioning coral-algae symbiosis may covers the entire energy requirement of the coral. Suspended sediments create great temporal and spatial light attenuation, which may decrease photosynthesis yields. For sustainable reef management, it is important to understand how future climate conditions affect light attenuation thresholds for juvenile corals; the survival of which is critical for successful reef replenishment. In this study, *Acropora millepora* juveniles were exposed for three months to current climate, and to temperature and pCO_2 levels that are expected to occur by 2050 and 2100. Responses to light attenuation were tested by exposing one-month-old juveniles to environmentally relevant light intensities (0.1, 0.5, 1, 2 and 4 Daily Light Integral [DLI]). Following that 30-day light limitation period, the corals were monitored for one more month. A Generalized Linear Mixed-Effects Model shows no significant difference between the light intensities and climates during the light limitation period. One month following the light attenuation period, a significant decrease in survival of coral juveniles exposed to lower light intensities (0.1 to 1 DLI) was observed in the 2100 climate scenario compared to the current and 2050 climate. This demonstrates that climate and light limitation interact and may have long-term effects on the survival of coral juveniles.

Poster

Measuring benthic light from space: model results and future applications

Marites M. Magno-Canto[a,b,c], Lachlan McKinna[d], Barbara Robson[b,c] & Katharina Fabricius[b,c]

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[d]*Go2Q Pty Ltd, Sunshine Coast, QLD, Australia*

Light is an integral requirement for the growth of benthic marine organisms. To date, however, we do not have sufficient datasets at relevant temporal and spatial scales for the Great Barrier Reef. To address this, we have developed, evaluated and employed a simple yet robust physics-based remote sensing model to derive benthic light from publicly available MODIS satellite ocean colour data. Remote sensing offers a method for obtaining both spatially- and temporally-resolved estimates of oceanic parameters including benthic light. Our model results thus provide the first ever picture of light levels at the seafloor from space across the entire GBR for the last 16 years from July 2002 to December 2018. The data revealed strong seasonal variability due to both seasonal variations in incident light at the surface and the effects of land-derived materials associated with wet season river flows. The data can be used to derive insights into the locations which should be given management priority in relation to variable light levels and presence of important benthic habitats. This dataset also provides the opportunity to develop a new GBR water quality index based on light availability, understand the effects of long-term light levels on seagrass growth and distribution, and explore and understand the contribution of light levels on coral bleaching as an added stressor to sea surface temperature in a scale that has never been possible before.

Poster

Exploring small-scale spatial variability in benthic carbonate chemistry on coral reefs

Stephanie DiPerna[a,b,c,d], Mia Hoogenboom[a,b], Joy Smith[c] & Katharina Fabricius[c]

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[b]*ARC Centre of Excellence in Coral Reef Studies, James Cook University, 1 James Cook Drive, Douglas, QLD 4814*
[c]*Australian Institute of Marine Science, PMB3, Townsville, QLD 4810*
[d]*AIMS@JCU, James Cook University, 1 James Cook Drive, Douglas, QLD 4814*

Carbonate chemistry of the coastal oceans is dynamic and often highly variable, predominantly driven by the metabolism of the benthic community and the hydrodynamics of the system. However, the extent of small-scale carbonate chemistry variability within habitats (scale of centimetres to meters) is still relatively unexplored in coral reefs, although it may influence the structure and resilience of the reef. In this study we investigated the influence of boundary layer flow and benthic metabolism in situ on small-scale spatial variability of carbonate chemistry on a select inshore and mid-shelf reefs in the central Great Barrier Reef. Water samples were collected over three benthic substrata (coral, turf/macroalgae and sediment) at eight reefs during the winter of 2018. At each site, sampling occurred 1.5cm and 50cm above the substrata, and ~50cm below the surface, with replicate samples collected 2-3 times per day during peak daylight hours to observe reef metabolism. Oceanographic instruments were deployed to link the water chemistry to local environmental conditions (light, flow, depth, temperature). Chemical boundary layers in total alkalinity, pCO_2 and pH were found at some of our sites, providing evidence of active benthic metabolism. Tidal height, light availability and substrata had significant influences on the trends of small-scale variability in different carbonate chemistry parameters, and we found greater variability between reefs than between sampling events within reefs. Our results demonstrate that even at a small scale, hydrodynamics and physical parameters of the system are critical to understanding variability in carbonate chemistry and the influence of benthic metabolism.

Poster

Microbes: a new tool to monitor the reef?

Bettina Glasl[a,b,c], David G. Bourne[a,b,c]
& Nicole S. Webster[a,c,d]

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Coral reefs are facing unprecedented pressure on local and global scales. Sensitive and rapid markers for ecosystem health state are urgently needed to underpin effective management and restoration strategies. Although the fundamental contribution of microbes to the stability and functioning of coral reefs is widely recognised, it remains unclear how different reef microbiomes respond to environmental perturbations and whether microbiomes are sensitive enough to predict environmental anomalies that can lead to ecosystem degradation. However, the lack of coral reef microbial baselines hinders our ability to study the link between shifts in microbiomes and ecosystem health. Therefore, this PhD thesis aims to establish the first taxonomic and functional microbial baseline for the Great Barrier Reef (GBR) using state-of-the-art meta'omic sequencing techniques, and to identify the most suitable reef microbiomes for future microbial indicator programs. Overall this study provides a comprehensive microbial reference dataset spanning multiple free-living and host-associated microbiomes for selected GBR sites. My results suggest that there is realistic scope to enhance long-term reef monitoring initiatives by incorporating seawater microbiome observations for rapid and sensitive identification of early signs of declining ecosystem health. The establishment of microbial observatories for long-term monitoring will be paramount to successfully infer environmental perturbations that can lead to shifts in ecosystem health state. I therefore recommend timely integration of microbial sampling into current coral reef monitoring initiatives.

Poster

Microbial contributions to environmental tolerance of reef species

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The survival of coral reefs in the face of climate change depends largely on the ability of reef species to adapt or acclimatise to ocean warming and acidification. When considering acclimatisation, the microbial community offers significant yet unrecognised potential. Host-associated microorganisms contribute critical functions that underpin holobiont health, and environmentally induced changes in microbial communities represent a potential source for new metabolic features in holobionts. Microbial changes may facilitate holobiont tolerance to altered environmental conditions but it remains unknown whether any newly acquired microbial functions contribute to environmental acclimatisation of reef species. Here we explore potential direct and indirect microbiome-mediated mechanisms that may contribute to environmental tolerance of reef species. These mechanisms include increasing energy metabolism in the host, reduction of oxidative stress, balance of Ca^{2+} homeostasis, and increased antimicrobial resistance. We also propose a robust experimental strategy to test how microbial metabolic pathways may facilitate environmental acclimatisation of reef taxa. Understanding the mechanisms of microbiome-mediated acclimatisation will be critical for predicting reef ecosystem dynamics under future climate scenarios, and applying effective reef conservation strategies.

Poster

Batoid nurseries: definition, use and importance

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Nursery areas are crucial for many elasmobranchs, providing benefits that increase fitness and survival. Shark nurseries are well studied and our knowledge of their function and importance has expanded over the past decades. However, little attention has been given to batoid nurseries, with studies covering less than 6% of the 663 described species. Threats of extinction faced by batoids reinforce the importance of defining these critical habitats. This review synthesises current knowledge of batoid nurseries to provide a better understanding of their ecological roles and importance. Historically, different criteria have been used to define viviparous and oviparous batoid nurseries, causing confusion that could lead to failure of conservation and management strategies by under- or overestimating the importance of areas and delaying effective action. We suggest the criteria used to identify shark nurseries be applied to batoids, standardizing this nursery definition for all elasmobranchs, but we also advocate for a second set of criteria that identifies egg case nurseries. Batoids are thought to play 3 main ecological roles in nursery areas: energetic links, bioturbators and mesopredators. Biotic and abiotic features affect abundance and distribution of batoids within nurseries and likely play a key role in their habitat use. However, analysis of batoid ecological roles in nursery areas is limited by the lack of research on their early life history stages. Thus, identification of areas that support sensitive life stages and an improved understanding of early life history are crucial for the efficient management and conservation of batoid species and their nurseries.

Poster

Climate Change, UV and Oil – A hot and sticky mess for corals?

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Petroleum oil extraction and use in the vicinity of coral reefs is likely to continue for the foreseeable future and oil has been recognised as an emerging contaminant in the Great Barrier Reef region. However, information on the effects of petroleum oil toxicity to tropical marine species, including corals, is very limited. Coral reefs are also under increasing pressure from global climate change and there is even less known about potential interactions between oil toxicity and elevated temperature to tropical marine species. Here we present the results from the first study of the cumulative effects of exposure to heavy fuel oil (HFO), elevated temperature and ultraviolet light on a reef-building coral. *Acropora millepora* larvae were exposed to seven concentrations of dissolved aromatics from HFO at three treatment temperatures for 48 h under visible light in combination with medium or low intensity UV. Inhibition of larval settlement was observed at low concentrations for all treatment combinations. However, larval survival was not significantly affected under any combination of light or temperature treatment, at any concentration tested. These results provide insights into how the risks posed by oil spills may change in the coming century and could be applied to re-evaluate the risks associated with oil spills under marine heatwave conditions during the annual coral spawning season.

Poster

Comparing phylosymbiosis across diverse coral reef invertebrates

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Microbiome assemblages of plants and animals often show a degree of correlation with host phylogeny; an eco-evolutionary pattern known as phylosymbiosis. Terrestrial host-microbe relationships have revealed the prolific nature of phylosymbiosis, demonstrating that host evolutionary history has an important role in shaping the microbiome. However, it is unclear whether the microbiome of marine organisms follow similar patterns. Using 16S rRNA gene sequencing to profile the microbiome, paired with COI and 18S rRNA host phylogenies, phylosymbiosis was investigated in four groups of coral reef invertebrates (scleractinian corals, octocorals, sponges and ascidians). We tested three commonly used metrics to evaluate the extent of phylosymbiosis: a) intraspecific versus interspecific microbiome variation, b) topological comparisons between host phylogeny and hierarchical clustering (dendrogram) of host-associated microbial communities, and c) correlation of host phylogenetic distance with microbial community similarity. In all instances, intraspecific variation in microbiome composition was significantly lower than interspecific variation. Similarly, topological congruency between host phylogeny and the associated microbial dendrogram was more significant than would be expected by chance. All but the ascidians showed a significant positive correlation between host phylogenetic distance and associated microbial dissimilarity. Additionally, higher intraspecific variability in microbial composition was associated with higher levels of incongruence, often due to changes in the relative abundance of the common symbiont *Endozoicomonadaceae*. Our findings provide new perspectives on the diverse nature of marine phylosymbioses and the complex roles of the microbiome in the evolution of marine invertebrates.

Poster

Assessing ecological risks of microplastic contamination to coral reefs at Lizard Island, Great Barrier Reef, Australia

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Marine debris, in particular plastic, has recently gained increasing attention as a new anthropogenic threat to the marine ecosystems of the Great Barrier Reef World Heritage Area (GBRWHA). In light of that, we are examining potential ecological risks of microplastic (i.e. plastics <5 mm) contamination to coral reef ecosystems in the GBRWHA. Specifically, this work aims to provide a baseline of microplastic contamination on coral reef ecosystems at Lizard Island Marine National Park. Lizard Island is located at the far northern GBR, > 250 km from the largest and closest urban centre (Cairns), and thereby expected to have low microplastic contamination. Microplastic contamination are being quantified in water and sediment samples, in reef-building organisms such as hard coral and sponges, and in reef organisms with different feeding mechanisms such as sea cucumbers, sea squirts and coral reef fish. Putative microplastics have been detected in all samples, and their polymer type have been confirmed using via Fourier transform infrared spectroscopy (FTIR). Preliminary results confirm contamination of seawater with secondary microplastic fibres and particles of a diverse range of polymer types, at concentrations that could be considered high for this relatively remote location. Combined, the quantification of microplastic contamination in water, sediment and biota samples provide baseline exposure information, and contribute to improved future ecological risk assessments of microplastic contamination to coral reefs on the GBRWHA.

Poster

A machine learning framework for automated quality control of oceanographic sensor network data

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Automated quality control processes play an essential role in the availability of real-time data from sensor networks. In this work, a machine learning framework is proposed for oceanographic time-series analysis which can highlight anomalies and classify them as sensor failures or environmental events. Specifically, the methodology identifies and interprets abnormal values by considering each sensor's historical data and the natural relationship between this sensed measurement and other meteorological and oceanographic variables. The approach is applied to meteorological and oceanographic time-series data from two monitoring sites within the Australian National Mooring Network (a facility of the Australian Integrated Marine Observing System). The results show that the framework can automatically learn the relationship between conductivity and water temperature at diverse depths across both mooring sites, and use this model to detect a conductivity sensor failure. Furthermore, this framework successfully detects and confirms an anomaly in significant wave height as a real weather event.

Image courtesy of
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