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Centre for Marine Ecosystems Research

RESEARCH HIGHLIGHTS 2016-2017

Relevant research

Improved understanding

Better management

CONTENTS

DIRECTORS' REPORT

Director Prof. Paul Lavery and Deputy Director Dr Kathryn McMahon

This Research Highlights document covers the 8th and 9th years of CMER's activities. In many ways, 2016-17 was a coming of age of CMER; we have grown in size but also in the quality and quantity of our research outputs. This period saw the development of the Environmental Radioactivity Laboratory, which provide us with the capacity to undertake a wide range of analyses on environmental tracers and the dating of sediments. The appointment of Prof. Pere Masquè to lead this laboratory has also seen a dramatic boost in the research capacity of the Centre.

It was also a period in which the WAMSI Dredging Science Node (DSN) and the Kimberley Research Nodes were finalised. CMER led the 'Primary Producers' research theme within the DSN and 2017 saw the presentation of the findings as well as publication of the outputs and the graduation of students associated with the program. We remain strongly committed to the concept of WAMSI and its transition to the Marine Blueprint. We also look forward to the next stage of the dredging science node, which will see the translation of the research findings into a compendium of best practice to guide dredging proponents and regulators.

Our research on blue carbon allowed us to make a significant contribution to climate change mitigation policy in Australia. Following completion of the Coastal Carbon Cluster research program CMER researchers were contracted, with others, to provide advice to the Commonwealth government on opportunities to embed blue carbon in Australia's climate change mitigation program, the Emissions Reduction Fund. By late 2016 that advice had been provided and we are now advising government on the priorities for implementation. The two years covered in this Highlights also saw a dramatic expansion of our research network, with numerous visitors and exchanges of CMER staff and students to other research institutions. This has contributed to excellent opportunities to engage in world class research and has allowed our postgraduate students to interact with researchers from around the globe. Detailed in the Highlights are several outstanding achievements by our postgraduate students.

We hope you enjoy reading about CMER's exploits in 2016 & 2017 and thank you for your continued interest and support.

AT A GLANCE IN 2016-2017

Environmental Radionuclides Research Laboratory purposely built at the School of Science in partnership with seven other Universities and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) funded by the Australian Research Council. The Laboratory is one of the first in Australia dedicated to analysis of natural and artificial radionuclides.

Three new members joined the team, Professor Pere Masque from the Universitat Autonoma de Barcelona, Dr Viena Puigcorbé as a Post Doctoral Fellow and environmental engineer Gloria Salgado. We saw the departure of Dr Megan Huggett, CMER's lead researcher in Marine Microbial Ecology, to take on a Lectureship at Newcastle University.

Recognising and pursuing emerging research areas, CMER's focus on research has expanded to incorporate Blue Carbon & Paleo Reconstruction, and Marine Radioactivity and Tracers themes.

The sucessful award of several significant grants saw a number of new projects commencing. CMER researcher Dr Oscar Serrano was awarded the Discovery Early Career Research Award (DECRA), PhD candidate Charlie Phelps was successful in gaining the Max Day Environmental Science Fellowship Award.

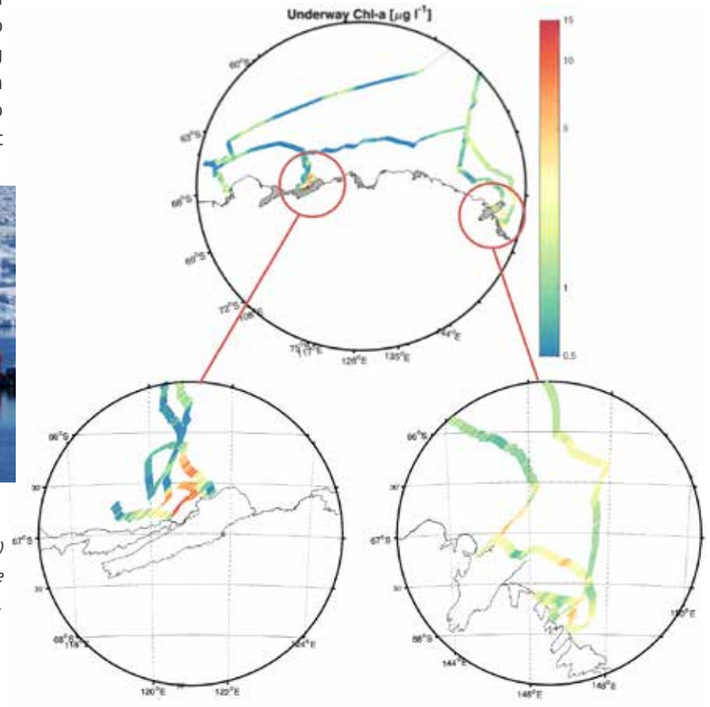
Two CMER researchers were recognised with promotion during 2017. Dr Oscar Serrano was promoted to Senior Research Fellow, following four very productive years at CMER. Glenn Hydes was promoted Professor and assumed the role of Associate Dean (Research) in the School of Science stepping down from Co-director of CMER though maintaining a strong presence in research and postgraduate supervision.

ANTARCTICA - LINKS BETWEEN THE IRON & CARBON CYCLES IN THE MARGINAL ICE ZONE

Dr Viena Puigcorbé

Dr Viena Puigcorbé was part of a team of international researchers investigating the impact of the changes in sea ice extent on primary productivity in the Southern Ocean through the assessment of the physical and biological drivers of both iron and carbon cycles in the marginal ice zone (MIZ). The MIZ is the transition between the open ocean and sea ice and, despite its potential to naturally fertilize the Southern Ocean with iron and to stimulate the biological carbon pump little research has been directed here. Samples collected will provide estimates of carbon and iron export in the water column that, combined with additional biogeochemical parameters analyzed by colleagues from UTAS-IMAS, will generate an improved understanding of the polar biogeochemical ocean processes required to constrain predictions of the changing sea ice habitat in the East Antarctic sector. The project is part of wider research from Professor Pere Masqué's team in the Centre of Marine Ecosystems Research at ECU's School of Science.

The oceans, like forests, can absorb carbon dioxide from the atmosphere through photosynthesis, however the incredibly low concentration of iron in the Southern Ocean limits the ability of plankton and microscopic algae to photosynthesise and absorb atmospheric carbon dioxide. Increases in melting sea ice could lead to greater absorption of carbon dioxide. The overall goal of this research is to provide a quantitative estimate of the amount of organic carbon being exported to great depths in the open ocean, where it will remain isolated from the atmosphere for long periods of time. The different processes influencing primary productivity in the study areas will lead to different carbon export efficiency and sequestration. Preliminary results indicate that the two areas sampled have contrasting phytoplankton biomass and primary productivity due to differences in water stratification, iron supply and grazing pressure, with one of the areas acting as a CO_2 sink whereas the other one was relatively neutral regarding CO_2 uptake/release. The project, led by Dr Will Hobbs and Dr Delphine Lannuzel, included scientists from the University of Tasmania, the ARC-funded Antarctic Gateway Partnership, the Antarctic Climate and Ecosystems Cooperative Research Centre, the Australian Antarctic Division, CSIRO, ECU, and universities from around the world.



Above: Researchers sampling ice in Antarctica
Right: Underway chlorophyll-a concentrations (ug L-1) along the research vessel's track (centre), and in more detail for the Dalton (left) and the Mertz (right) Polynyas. Figure provided by Dr. Moreau

WAMSI DREDGING PROJECT END 2017
RESULTS WILL AID BETTER MANAGEMENT

2017 saw the completion of a major research project examining the impacts of dredging on marine primary producers. Over 5 years, the WA Marine Sciences institution has run its Dredging Science research node. This large, multi-institutional programme of research aimed to increase the capacity of government and industry to predict and manage the impacts of dredging in WA's coastal environment. Dredging activity has increased dramatically over the past 15 years as the mining and oil and gas industries have need to construct new infrastructure for the processing and export of their products. CMER researchers led Theme 5 of the research program, which focussed on primary producers, and was undertaken in collaboration with colleagues at UWA and the CSIRO.

The research program comprised both field research and laboratory experiments. The field research program was particularly important in clarifying our understanding of primary producer habitats in NW Australia. What we learnt was that the composition and abundances of seagrasses can be highly variable among locations and so generalities from other regions of Australia do not necessarily apply to patterns of tropical seagrass occurrence in Australia. In particular, there appears to be a natural post-disturbance cycle, driven by events such as cyclones, in which seagrasses boom and then settle to background levels. Based on our new understanding of the natural dynamics of seagrasses in northwest WA, we were able to make a number of recommendation for improved management of seagrass ecosystems in the region, including the design of pre-development surveys.

Our surveys also revealed surprising differences in the level of genetic diversity among different seagrass populations in NW. It is understood that greater genetic diversity in seagrass populations can enhance their resilience to disturbance. Based on our findings we developed a genetic resilience assessment for seagrass meadows in the Pilbara, providing developers with a means of ranking locations according to the likelihood that they would recover more or less quickly following dredging impacts.

A series of laboratory 'mesocosm' experiments were undertaken to determine how the effects of dredging impact seagrasses, specifically the associated reductions in light and the smothering of seagrasses by sediments that are resuspended by dredging and then resettle. The experiments revealed that the effects of light reduction depend on the intensity and duration of light reduction but also, very importantly, the pattern in which the light reduction was delivered; extended periods of low light are not mitigated by short periods of high light. This has implications for how dredging programs are designed, and indicates that dredging would have less impact if extended periods of low light could be avoided. We recommended minimum light levels that plants should receive averaged over two week period, and also that seagrasses do not experience more than 5 consecutive days of low light (2–4 mol m^{-2} d^{-1}) within a two week period. Surprising, seagrasses were quite resilient to burial by re-settling sediments. However, a novel finding was that the type of sediment was important in determining the impact; there was a more negative impact when seagrasses were buried in organic-rich sediments than inorganic sediments.

Outer edge of dredging plume - Northwest Australian waters

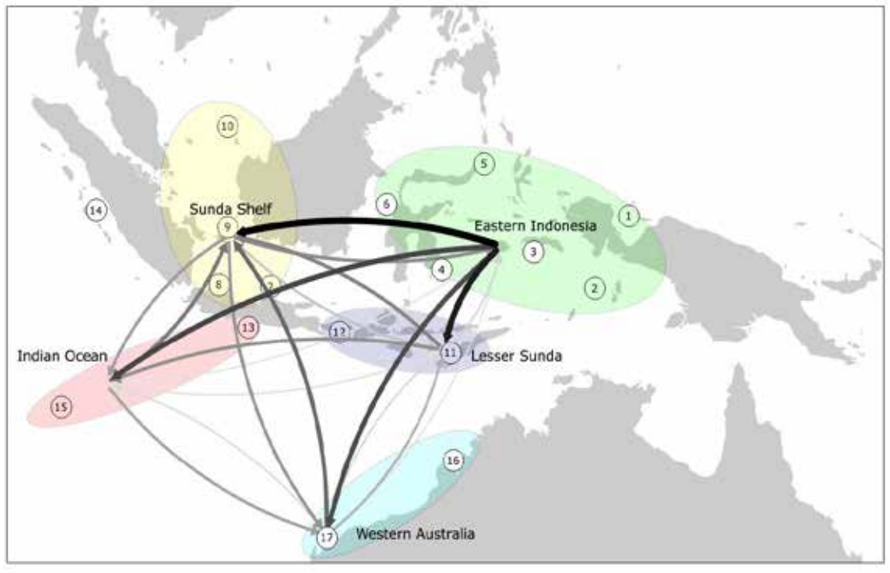
HIGHLIGHTS IN HABITAT CONNECTIVITY & TROPHIC INTERTACTIONS

Patterns in genetic diversity - implications for resilience

Understanding the pattern and drivers of genetic diversity is a key consideration for conservation, yet we have a very limited understanding for the globally important and highly threatened seagrasses. Resilience of these meadows is dependent in part, on the genetic diversity of populations to resist and recover pressures. Higher genetic diversity has been shown within some species to increase resistance to disturbance and has positive effects on ecosystem functioning particularly when exposed to environmental stress. The Indo-Pacific is a biodiversity hotspot for seagrasses with meadows threatened by human activities and global change. Research led by Dr Kathryn McMahon with colleagues from Department of Biodiversity, Conservation & Attractions, University of Western Australia, University of Adelaide and CSIRO have been examining the genetic diversity and connectivity of seagrass meadows from

Halophila spinulosa has large fleshy rhizomes which contain abundant starch reserves.

Indonesia through the Kimberley to the Pilbara in NW Western Australia. Three seagrass species with differing dispersal potential (*Thalassia hemprichii, Halodule uninervis, Halophila ovalis*) have been examined across a range of spatial scales (m's – 1000's km) using a combination of microsatellite markers and SNP's.



Genetic structure of the seagrass Thalassia hemprichii *and patterns of gene flow between Indonesia and north-western Australia.*

We found large variation in the number of individuals or clones (genotypic diversity) among populations, and also among species. Low genotypic diversity was more commonly observed in species with lower dispersal potential.

Genetic diversity, measured as allelic richness also varied among populations within species, and the western Kimberley had the lowest diversity. For *T. hemprichii* average allelic richness was 1.6 in the Kimberley compared to 3.0 in Indonesia and other areas of NW Australia, and *H. ovalis* was on average 3.0 in the Kimberley vs. 4.1 in other areas. A large-scale spatial pattern in allelic richness was evident in *T. hemprichii* with reductions away from the centre of diversity in the Coral Triangle towards the edge of the range, but the western Kimberley was an outlier due to its much lower allelic diversity. This lower diversity in the Kimberley is potentially driven by historical or oceanographic isolation.

Based on this information, we propose an index of genetic resilience taking into account the potential to resist and recover from disturbance and adapt to pressures over generational times which can be used to inform conservation and management of seagrass habitat.

This research has been funded by the Collaborative Research Network, Western Australian Marine Science Institution (Dredging Science Node and the Kimberley Marine Science Program) and Department of Parks and Wildlife.

Ghost crabs on mid-west beaches

Ghost crabs (*Ocypode* spp.) are highly abundant on beaches in locations throughout the world, where they have been shown to play an important role in cleaning beaches of carrion (dead animals) and providing a food resource for predators. However, little is known about the endemic species of Ghost crabs, in particular, the Golden ghost crab (*Ocypode convexa*) in Western Australia and its role as a vector for the movement of marine-derived nutrients inland. The broad aim of this study was to determine the role of ghost crabs as a consumer of detritus and/or carrion on sandy beach and dune systems in the mid-west region of Western Australia, and subsequently determine their importance in sandy beach food webs.

Baseline data on Ghost crab densities were collected on the beaches near Dongara, WA, across three sites on different occasions throughout 2015 and 2016. This illustrated *Ocypode* spp., particularly *O.convexa*, are abundant and reside along beaches with minimal foot- and four-wheel drive traffic and exist in the upper intertidal zone in comparison to zones within the dune environment.

In addition, based on stomach content and stable isotope data, as well as laboratory assays, *O.convexa* consumes material from the marine environment more so than the terrestrial. These results support the importance of marine detritus being washed onto beaches, and the significant role ghost crabs play as consumers within sandy beach ecosystems.

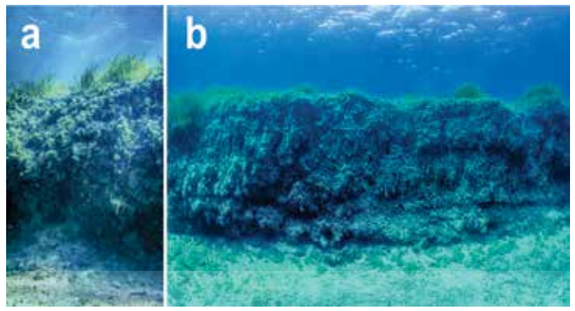
Ghost crab of the Dongara region, WA

This research was undertaken by Masters by Research Student Caitlin Rae and Prof. Glenn Hyndes.

HIGHLIGHTS IN CONSERVATION & FISHERIES BIOLOGY

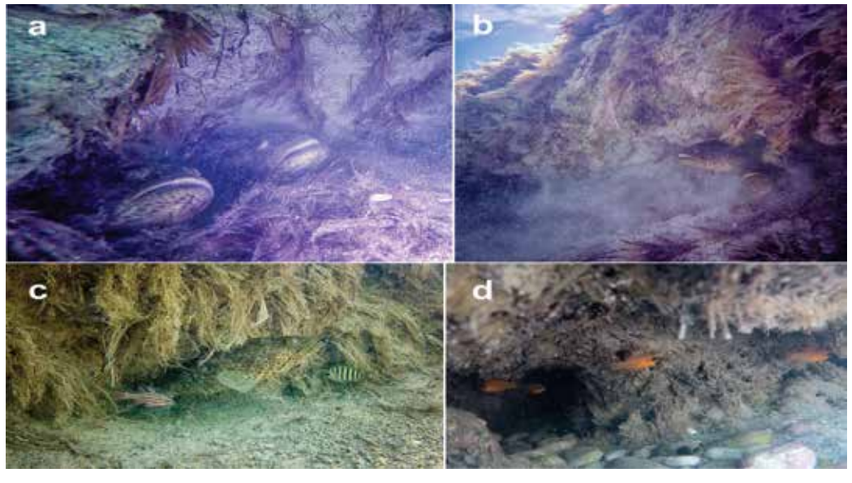
Seagrass meadows provide 3D habitat for large reef fish

Seagrass canopies typically provide a relatively uniform habitat on the seabed, which is not suitable for large reef fishes. However, seagrasses in the genus *Posidonia* can provide additional habitat complexity by forming organic-rich deposits known as mats (Figure 1). Mat escarpments have been described in shallow and highly productive *P. oceanica* meadows from the Mediterranean Sea, *P. australis* meadows from the Indian Ocean, and in *T. testudinum* meadows from the Caribbean. Erosional processes can scour channels through the mats, resulting in the formation of escarpments with caves. The mechanisms behind escarpment formation can be related to natural processes (e.g. wave action, tidal flow and hurricanes) or to anthropogenic activities, such as dredging, vessel groundings and propeller scars.



Erosional mat escarpments in seagrass Posidonia meadows. a) Posidonia australis mat escarpment in Shark Bay, Western Australia. b) Posidonia oceanica mat escarpment in Balearic Islands, Mediterranean Sea.

During a routine field trip to monitor seagrass meadows at Shark Bay (Western Australia), we discovered that escarpments supported abundant reef fish assemblages. Caves (up to ~1 m^3) found throughout mat escarpments were occupied primarily by groupers, with up to 10 individuals observed in a single cave (Figure 2). The characteristics of the cavities are highly variable, ranging from small-elongated holes to deep caves with large entrances. The origin of these caves (biological and/or geological) is unknown, but it is possible that fish behavior enhance their formation. This research provide evidence of a novel function of *Posidonia* escarpments, through provision of complex 3D habitat for reef fish that is not provided by typical canopy structure of seagrass. CMER researchers Dr Oscar Serrano, Prof. Paul Lavery and Prof. Glenn Hyndes studies are currently studying the natural history of seagrass escarpments and their ecological importance.

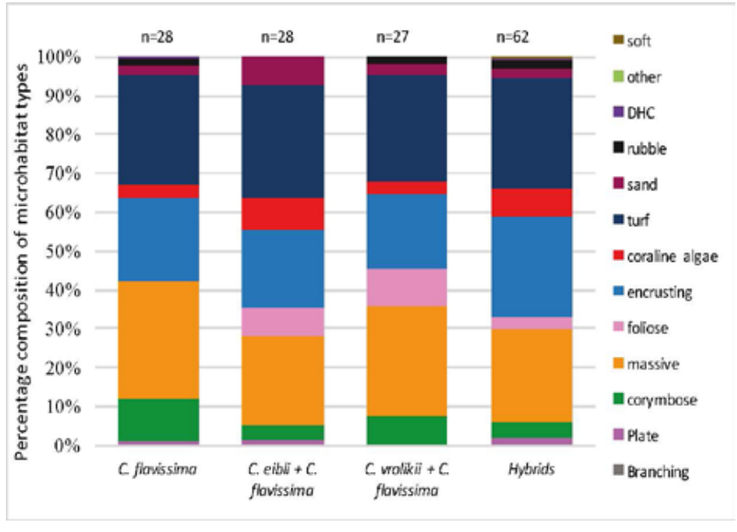


Reef-associated fish inhabiting caves within seagrass mat escarpments. a-c) Epinephelus coioides, Apogon angustatus and Abudefduf bengalensis in the Indian Ocean. d) Apogon imberbis in the Mediterranean Sea.

Hybridisation in angelfishes - Christmas Island WA

Hybridisation has traditionally been considered rare in coral reef fish until recent studies revealed that hybridisation is quite common highlighting the importance of understanding the causes of this process. Since the majority of fish hybrids in the marine environment have been reported from coral reef ecosystems, this is particularly an issue in conservation programs. Determining the factors that facilitate hybridisation provides an understanding of how marine fishes overcome the barriers of assortative mating, as well as predicting how hybrids will cope with changing environmental conditions, as is being seen in coral reef systems with climate change. The angelfishes (family Pomacanthidae) have the greatest proportion (~30%) of hybridising species with 26 species reported. Hybrids between three species of angelfishes have been observed in interbreeding, heterospecific harems and provide the unique opportunity to examine the ecological factors promoting hybridisation in coral-reef fishes. This study aimed to examine a range of ecological factors that are considered to promote hybridisation in terrestrial environments, and test these factors in the marine environment by studying hybridising angelfishes at Christmas Island (Indian Ocean). In collaboration with the Department of Fisheries of WA, Parks Australia and Curtin University, we studied temporal and spatial patterns in abundance of the three parent species from the genus Centropyge (*C. flavissima, C. eibli and C. vrolikii*) and their hybrids, which have been reported from Christmas island.

Mixed species harem: two individuals of Centropyge flavissima *(bottom left) swimming with a* C. eibli *(top right). The formation of mixed harems can facilitate hybridisation by increasing the chances of encounters between individuals of different species*



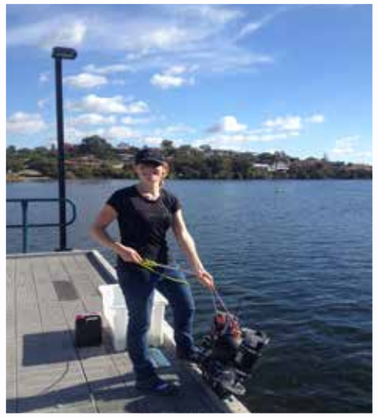
Percentage composition of microhabitat types within the territories of angelfish harems at Christmas Island. Harems composed by each of the parent species and hybrids are compared.

Funded by ECU researchers Fede Vitelli and Prof. Glenn Hydnes tested for overlapping patterns in habitat use and diet. Based on 14 years of surveys (2002-2015), *C. flavissima* was abundant, whereas *C. eibli, C. vrolikii* and all hybrid combinations were consistently rare. Parent species and their hybrids were more abundant at 20 m of depth compared to 5 m. All species and their hybrids had similar patterns of abundance around Christmas Island with the highest abundance recorded at the most sheltered sites. In addition, all parent species were recorded in similar microhabitats characterised by massive corals, encrusting and turf algae. Spatial and taxonomic patterns in abundance were consistent across surveyed years. Parent species and their hybrids also had similar diets that were comprised of a mix of green, red and brown algae. Thus, rarity of parent species and niche overlap help promote hybridisation in angelfishes at Christmas Island. This study provides empirical support that hybridisation in reef fishes conforms to terrestrial-based theories, and thus advances our understanding of the concept in coral reef systems. This research is ongoing, with the next aim to determine differences in the fitness of the three parent species and hybrids in terms of growth rates and histology.

HIGHLIGHTS IN MANAGEMENT OF HUMAN IMPACTS

Influence of light spectra (quality) on seagrass

This work formed part of a larger collaborative research project involving researchers from ECU, the University of Western Australia (UWA), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Western Australia Marine Science Institution (WAMSI) as we investigated how dredging affects primary producers in marine ecosystems. Dredging alters the colour of light that reaches seagrass meadows. Previous research has focused on assessing how the reduction in light caused by dredge plumes influences seagrasses, but information on how the altered colour or light quality affects them was largely unknown before this work. Therefore, Simone's PhD focused on the range of light quality that seagrasses receive along a local gradient and how changes in light quality influenced the adult growth, flowering, seed germination and seedling survival of seagrasses.



Dr Simone Stydom measuring light quality in the Swan River, WA

Simone found that the quality of light seagrasses are exposed to varies along a local natural estuarine-ocean gradient but the nature of the shift in light quality is also dependent on time of year. Additionally, human impact such as dredging can expose seagrasses to light quality shifts outside of the natural range detected in this study, and the magnitude of this shift is dependent on depth and suspended sediment concentrations. Her aquarium experiments showed that fast-growing species had reduced growth under blue, green and yellow light, while seeds and seedlings performed better under red and full-spectrum light. On the other hand, slow-growing species were not negatively impacted by any light colour.

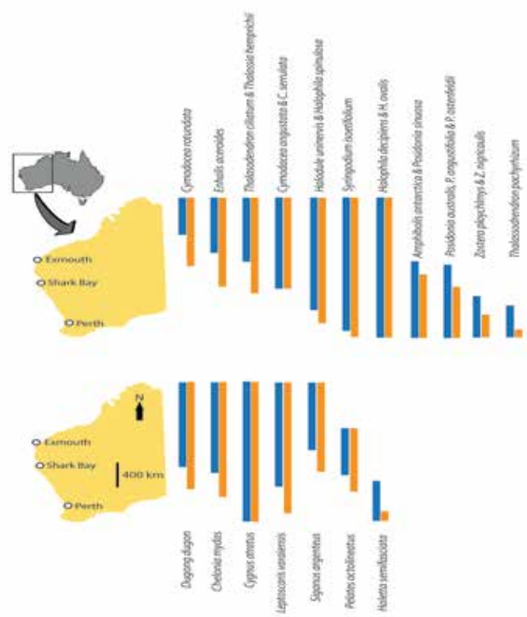
Seagrass growing in different colours of light

Overall, this research demonstrated that seagrasses have the capacity to acclimate to and/or tolerate extreme changes in light quality when the amount of light is sufficient for growth. However, as growth was impeded by some colours, this may affect the ability of seagrasses to maintain resilience against other stressors. The results from this project will be used to better inform managers regarding the time of year that is more appropriate to dredge in relation to the seagrass life cycle and which species are most likely to be impacted in relation to the duration and intensity of the change in light quality.

Tropicalisation of temperate seagrass

Climate-driven changes are altering production and functioning of terrestrial and aquatic ecosystems. Rising sea temperatures and warm water anomalies have led to the poleward shift in the distribution of a range of consumers. This shift in tropical herbivores to temperate coastal waters has had a detrimental effect on kelp in temperate algal ecosystems. In December 2015, Prof. Hyndes, Dr McMahon and Prof. Lavery hosted a range of researchers from USA (Profs Ken Heck and Bob Orth), NSW (Dr Adriana Verges) and Western Australian universities (Profs Gary Kendrick, Thomas Wernberg, and Euan Harvey) and government agencies (Drs Scot Whiting, Shaun Wilson, Mat Vanderklift and Alan Pearce) in a 2-day workshop to develop a journal paper on the effects of tropicalisation on temperate seagrass ecosystems. That paper was published in BioScience in 2016. In that paper, we developed generalized scenarios of tropicalisation through poleward shifts in tropical seagrasses and herbivores, and its potential impact on the structure and functioning of temperate seagrass ecosystems. We predicted that, initially, tropical herbivorous fishes would establish in temperate seagrass meadows, and subsequently megafauna such as turtles and dugongs.

We also predicted that tropical seagrasses would establish later, due to their more limited dispersal abilities. Food webs are likely to shift from those driven primarily by seagrass detritus to those driven more through direct consumption of seagrass. This would impact on a range of important ecosystem services that seagrasses provide, including carbon-sequestration, donation of organic matter to other ecosystems, and their nursery habitat role for fishery species. Studies are currently underway to test some of these predictions, with both Maria Samsonova (CMER PhD student) and Casper Avenant (CMER Masters student) carrying out studies on changes in grazing rates as tropical herbivores enter temperate regions, and the diets of those tropical grazers.



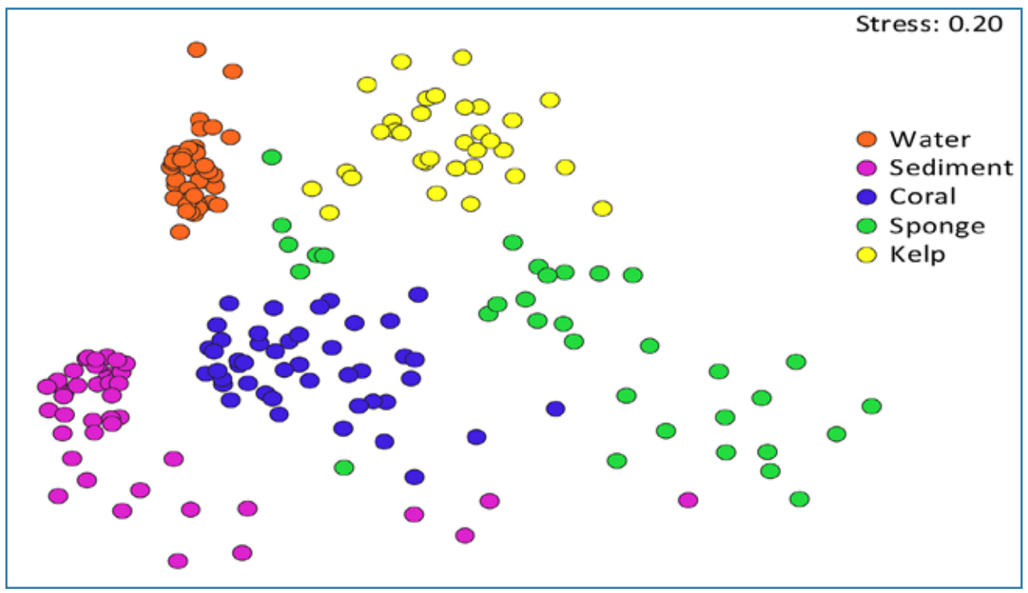
The current (blue) and predicted end-of-century (orange) distributions of seagrass (top) and herbivores (bottom) along the west coast of Western Australia.

HIGHLIGHTS IN MARINE MICROBIAL ECOLOGY

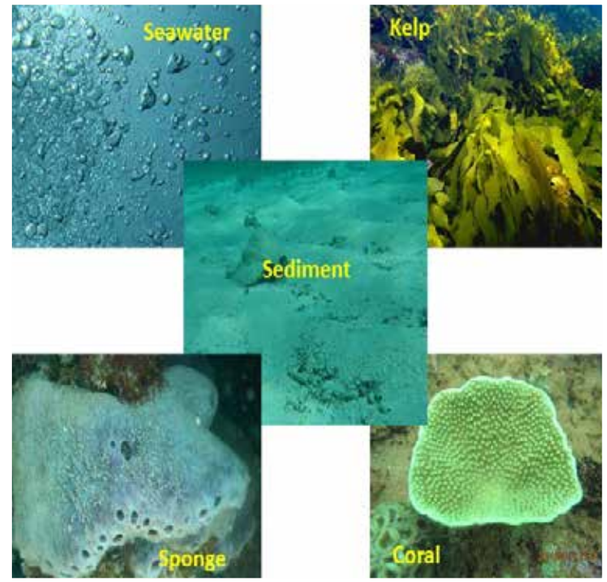
Bioplatforms Australia Marine Microbes

Marine microbes are key players in a range of important ecosystem functions. In seawater, where they occur in abundances of up to a million per millilitre, they are the main primary producers, fixing carbon dioxide into organic material, consuming of organic matter and respiring carbon dioxide to the surrounding seawater, and ultimately the atmosphere. Marine microbes also live in close association with higher organisms such as molluscs, polychaetes, sponges, bivalves, corals and macroalgae, where they are emerging as important partners that contribute to their "host" organisms health and nutrition. Given the global deterioration of marine ecosystems through climate change, anthropogenic effects and disease outbreaks, understanding the community ecology and function of marine microbial communities has become increasingly important.

In 2015 Dr Megan Huggett (CMER) became involved in a large collaborative research project funded by BioPlatforms Australia and involving marine microbial ecologists from around Australia. The project aims to compare microbial dynamics (composition and function) between the benthos and the water column, and between living and non-living habitats, over spatial, temporal and environmental scales and will involve a combination of environmental and microbial sampling with a focus on large scale use of next generation sequencing technology (tag sequencing, metagenomics and metatranscriptomics).



Samples for this project were collected during 2016 and 2017 and initial results indicate that the microbial communities associated with each habitat are distinct and that host-associated communities vary substantially through time. Two PhD students, Ms Rachele Bernasconi and Ms Charlie Phelps, are researching the dynamics of the coral and kelp associated microbial communities and are incorporating data generated from this project into their postgraduate studies.



Dr Megan Huggett steps east

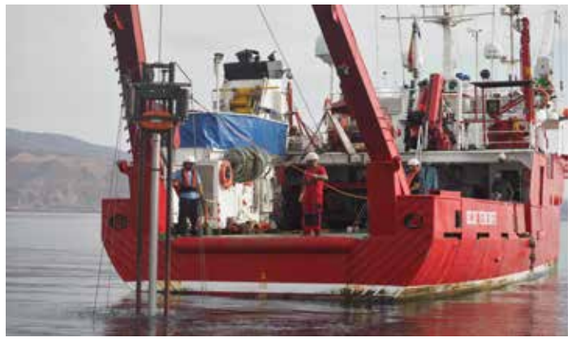
In a bittersweet moment we farewelled Dr Megan Huggett at the end of 2017. Megan was, quite deservedly, offered a lectureship at the University of Newcastle, in their Marine Science program. In her four years at CMER Megan developed an exciting research program in microbial ecology, bringing a wealth of knowledge and enthusiasm and allowed many existing areas of research to extend into microbial dynamics. Importantly, Megan has led ECU's involvement in the national Marine Microbial Bioplatforms initiative and has been a true champion for microbiome initiatives in WA and nationally.

Megan's departure is a very big loss to CMER but at the same time it is a wonderful opportunity for Megan to continue the development of her career. We are looking forward to continuing our existing and new projects with Megan.

HIGHLIGHTS IN BLUE CARBON & PALEO RECONSTRUCTION

Blue Carbon - GAME in Spain

In October 2017 CMER researchers Oscar Serrano and Paul Lavery joined colleagues from the GAME research group in Spain to undertake the final sampling for the Blue Carbon assessment of the Andalucian coast. Seagrass meadows have a phenomenal capacity to sequester carbon for thousands of year, and there is interest around the globe in how we can embed this potential into climate change mitigation programs. The sampling trip involved a 10 days research cruise along the Andalucian coast to sample a variety of seagrass meadows and document their carbon sequestration potential, funded through the EU-LIFE programme. The project brought together a multi-institutional team led by Dr Miguel-Ángel Mateo of the Spanish Research Council laboratory at Blanes, also a CMER Adjunct Professor. The team included CSIC and ECU researchers plus technical staff from the geotechnical company IGEOTEST. Seagrass meadows and deep sea sediments were sampled from the Research council's vessel the Garcìa del Cid, including healthy meadows in the Capo de Gata marine p+ark as well as sites impacted by trawling and eutophication.



Seagrass meadows were cored from the Garci del Cid using a 6 m long vibrocorer, as well manual coring undertaken by divers.

The GAME research team included researchers from the Spanish Research Council, CMER and Igeotest. Here the team are seen after hosting IUCN and Andalucian government staff.

Together, the findings will allow us to assess how the carbon stocks of the Andalucian meadows are affected by environmental factors and human impacts. The Andalucian Government is exploring the opportunities to bring seagrasses into a local carbon crediting scheme, and the LIFE project serves as a test project. The team was joined by representatives of the IUCN and the Andalucian government while coring shallow seagrass meadows off Almerìa, providing an excellent opportunity to demonstrate the blue carbon assessment methods and exchange knowledge of the local meadows.

Three shallow sediment cores collected by divers off the coast of Almerìa, ready to be transferred back to the Garcìa del Cid for processing. These cores will reveal the amount of carbon captured in Cymodocea *seagrass meadows and the rate at which that carbon is sequestered.*

Impact of mooring activities on carbon stocks of seagrass meadows, Rottnest Island WA

Among the multiple ecosystem services seagrass meadows provide, their capacity to sequester carbon dioxide (CO_2), stored as organic carbon (Corg) in seagrass sediment known as 'Blue Carbon', has generated considerable interest among scientists and policy makers due to its considerable potential role in helping mitigate climate change. At a global scale, seagrass absorbs carbon dioxide more than forty times faster than tropical rainforests. Consequently, when seagrass meadows are destroyed the carbon dioxide stored within the seagrass sediments, absorbed over hundreds of years, is released back into the atmosphere. This study presents the first estimates of loss of Corg stocks in seagrass meadows due to boat mooring activities in the bays of Rottnest Island WA.

Boating activities are prevalent off the shores of WA, especially around iconic tourist destinations such as Rottnest Island.

Mooring chain scraping across the seafloor uplifting seagrass.

Lead researcher Dr Oscar Serrano, with Professor Paul Lavery and Professor Pere Masqué, found the movement of around 900 mooring chains at Rottnest Island, mostly used by recreational boats, drift with the currents dragging across the seafloor and act like razors that have devastated approximately 48,000sqm of seagrass.

This mechanical destruction of seagrass habitat can trigger the erosion of sedimentary organic carbon (Corg) stocks and consequently contribute to increasing atmospheric CO_2. The study showed Corg stores have been compromised by the mooring deployment for several decades and that on average more than 75% of carbon stored in these seagrass meadows has been lost. Efforts to preserve seagrass meadows by using seagrass friendly mooring lines is resulting in the recovery of seagrass in some areas of the Island. The results provide key data for the implementation of Corg storage credit offset policies to avoid the conversion of seagrass ecosystems and contribute to their preservation in the journal Nature: Scientific Reports.

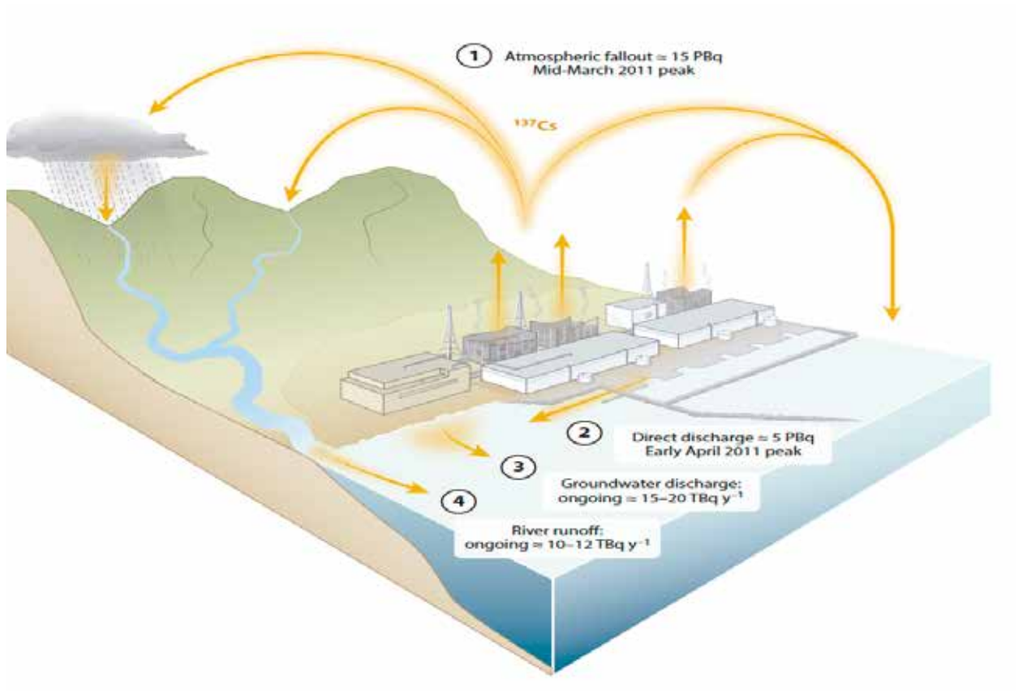
Boat moorings at Rottnest Island WA

HIGHLIGHTS IN MARINE RADIOACTIVITY & TRACERS

Fukushima Daiichi–Derived Radionuclides in the Ocean: Transport, Fate, and Impacts

The events that followed the Tohoku earthquake and tsunami on March 11, 2011, included the loss of power and overheating at the Fukushima Daiichi nuclear power plants, which led to extensive releases of radioactive gases, volatiles, and liquids, particularly to the coastal ocean. The fate of these radionuclides depends in large part on their oceanic geochemistry, physical processes, and biological uptake. Whereas radioactivity on land can be resampled and its distribution mapped, releases to the marine environment are harder to characterize owing to variability in ocean currents and the general challenges of sampling at sea. In collaboration with colleagues from several international research centers we reviewed what happened in terms of the sources, transport, and fate of these radionuclides in the ocean, as well as the potential health effects and societal impacts.

The major sources of contamination were found to be the direct emissions to the atmosphere, which largely were deposited onto the ocean, were the most substantial initially, and together with direct releases during the few weeks/months afterwards account for about 15-20 PBq of radiocaesium. Inputs via river discharge and surface water runoff had been estimated to account for about 1-2% of the total inventory accumulate on land, although shall be a continuous source of contamination for the decades to come. Inputs through submarine groundwater discharge, have been evaluated about 0.6 TBq·yr^{-1}, comparable to the river inputs and the ongoing releases from the plant. Inputs of 90Sr are lower, but are significant when leakages occur, and we estimated that they were of about 2-8 GBq·d^{-1} in 2013. We did not detect any signal of the presence of radionuclides such as ^{236}U and Pu isotopes.



Schematic of Fukushima Daiichi–derived sources of 137Cs to the environment. Atmospheric fallout (1) and direct discharge (2) are shown as total petabecquerels (PBq) released in the first month after the accident. Groundwater fluxes (3) and river runoff (4) are approximate ranges for the first year after the accident. Notice that (3) and (4) are expressed in terabecquerels (TBq). From Buesseler et al. (2017).

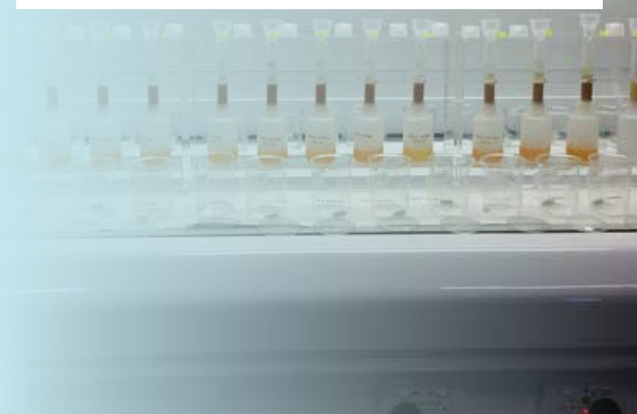
It is estimated that about 1 kg of I-129 was released immediately after the accident, and we found that about 0.1 kg had been released later. The fate of radiocaesium and 90Sr in the ocean is largely driven by the oceanic circulation, since neither of them is efficiently scavenged by particles.

However, significant concentrations of ^{137}Cs have been measured in bottom sediments off Fukushima, which serve as both a long-term repository and a potential source of contamination due to a variety of processes such as mixing caused by biota or physical forces. The uptake of radionuclides by biota was investigated using all available, published data, showing the expected decrease in concentrations with time. Modelling using D-DAT show that the sediments are likely slowing down this decrease, in addition to leakages that keep occurring. The radiological impact to fish was more significant for benthic species exposed to contaminated sediments, and after several years since the accident are below the ERICA no-effects dose screening level (10 µGy h^{-1}). Potential impact to humans due to ingestion of fish shows that this should not be of a concern at present time, since estimates of annual does would be a fraction of a mSv. Investigations should continue in the future to further understand the complex mechanisms involved in the transfer of the radioactivity still accumulated on land and groundwaters and bottom sediments to the water column and to marine organisms.

Professor Pere Masqué explains ^{210}Pb dating technique to Blue Carbon workshop participants

Environmental Radioactivity Laboratory LIEF GRANT

In 2017 CMER researchers Pere Masqué and Paul Lavery, together with colleagues from seven other universities and CSIRO, were awarded an ARC LEIF grant to enhance the facilities in the radioisotope laboratory. The funding allowed us to equip the laboratory with ultra-low background and high-resolution alpha and gamma spectrometry systems, radon detectors and radium delayed coincidence counters. This infrastructure provides Australia with the capacity to address a critical demand for precise analysis of a large suite of natural and artificial radionuclides, which can be used as tracers and chronological tools to investigate key questions in oceanography, mining and energy, archaeological, agricultural and forestry sectors. The facility will substantially increase expertise and training in radionuclides in Australia, and promote high-level research collaborations and outputs.



HIGHLIGHTS IN RESEARCH TRAINING

Dr Udhi Hernawan (PhD 2016)

Thesis: *Gene flow and genetic structure of the seagrass* Thalassia hemprichii *in the Indo-Australian Archipelago.*

Dr Udhi Hernawan graduated with his PhD from CMER in 2016 with his thesis entitled "Gene flow and genetic structure of the seagrass *Thalassia hemprichii* in the Indo-Australian Archipelago". Udhi joined CMER in 2013 after receiving a Collaboration Research Network International Student Scholarship. He was an active member of CMER contributing to many of our research activities including running mini-workshops on statistical approaches and genetic analysis as well as presenting at the annual ECU Research Week forum. His research was based mostly in Indonesia and through this link he also successfully attained funding through the Indonesian Endowment Fund for Education (LPDP-Indonesia). During his candidature he published one paper 'Historical processes and contemporary ocean currents drive genetic structure in the seagrass *Thalassia hemprichii* in the Indo-Australian Archipelago', submitted two others, which are under review and co-authored a book chapter on genetic connectivity of Australian seagrasses. Udhi is now employed as a Deputy Head of the Board of Planning, Monitoring and Evaluation for Research at the Research Centre for Oceanography in the Indonesian Institute of Sciences (LIPI) in Indonesia leading research into the conservation and management of Indonesia's valuable marine resources.

Charlie Phelps (MSc 2016)

Thesis: *Predicting the impact of future climate on ecologically important macroalgae.*

In 2016 Charlie Phelps, Supervised by Dr Megan Huggett and Dr Mary Boyce, completed her Masters Research project titled "Predicting the impact of future climate change on ecologically important macroalgae". Seaweeds play pivotal roles in ocean ecosystems, providing food, shelter and a nursery habitat for marine animals, including fish. Increases in water temperatures and ocean acidification (climate change) impact seaweed productivity and health, and can lead to higher consumption rates by herbivores. Charlie's Masters Research indicated that three ecologically important species of seaweed each respond differently to the effects of climate change. The three species of seaweed showed detrimental and distinct changes in growth, photosynthetic rates, bleaching and many more health measurements. Shifts in seaweed performance will impact benthic marine community structure and consequently may impact all marine life.

The results from Charlie's Masters Project have been published in the journal Marine Environmental Research, and in the second half of 2016 Charlie commenced her PhD project with CMER. For her PhD research Charlie is being supervised by Dr Megan Huggett and Dr Kathryn McMahon (ECU) and is co-supervised by Dr Thomas Wernberg (UWA) and Prof Peter Steinberg (UNSW). For Charlie's PhD project she will continue to pursue her interests in understanding the impact of environmental change on seaweed.

Dr Simone Strydom (PhD 2017)

Thesis: *Investigating the effects of changes in light quality on different life history stages of seagrasses.*

Dr Simone Strydom completed her PhD looking at the effects of altered spectral quality of light on seagrasses. Simone's thesis was highly regarded and won the School's Research medal for the most outstanding PhD research dissertation. Simone has since moved on to a position as Research Scientist with the WA Department of Biodiversity, Conservation and Attractions, where she conducts research on benthic marine ecosystems as well as running several of the Department's monitoring programmes.

Dr Maryam Abdolahpour (PhD 2017)

Thesis: *Residence time in coastal canopies.*

Dr Maryam Abdolahpour was also awarded her PhD in 2017, for her research on 'Residence time in coastal canopies'. This research explored how the flexibility of seagrass canopies interacts with hydrodynamic forces to affect the mixing processes and transport of materials in and above those canopies. Following completion of her PhD, Maryam moved to Melbourne where she worked at University of Melbourne before returning recently to WA to take up a postdoctoral fellowship at UWA.

Eric Aidoo (PhD 2016)

Thesis: *Geostatistical modelling of recreational fishing data: A fine-scale spatial analysis.*

Eric completed his PhD in 2016 examining the use of geostatistical modelling to analyse recreational fishing data in Western Australia, highlighting the inherent spatial variability in catch rate, fishing effort and species diversity, and the need to incorporate variability across space. The data provided the basis for studying spatial patterns in species diversity in the entire fishery, and revealed that species diversity, dominance and evenness display similar patterns. Eric is a Lecturer in Mathematics at the Kwame Nkurmah University of Science & Technology (KNUST) in Kumasi, Ghana.

Chanelle Websters (Honours 2017)

Thesis: *Freshwater future: the influence of extreme summer rainfall events on the resistance and recovery of an estuarine seagrass.*

Chanelle Webster was awarded a 1st Class Honours degree in 2017 investigating the response of seagrasses to an extreme summer rainfall event in the Swan-Canning Estuary in Western Australia. Results identified potentially vulnerable seagrass meadows that may be unable to cope with the emergence of more intense and frequent rainfall events predicted to occur in temperate climates such as this. Chanelle plans to undertake a PhD in 2018 with the aim to determine how local adaptation and genetic diversity may influence the ability of seagrasses to respond to emerging pressure.

Aldo Turco (PhD 2017)

Thesis: *Comparisons of habitat use and diet of herbivorous kyphosids (Genus Kyphosus) in tropical and temperate reefs.*

Aldo was awarded a PhD in 2017 for his research on the identification and characterisation of patterns in abundance, distribution and diets of herbivorous fishes in reef habitats across temperate and tropical areas. The study explored the main habitat features, differentiation of food resources, and species morphology of the *Kyphosid* in Western Australian waters, leading to better understanding of the different roles within functional groups in marine habitats. Results implied that species need to be identified in monitoring and research programs to avoid inaccurate estimates of herbivory activity. Following completion, Aldo spent the latter part of 2017 employed as an Instructor with the Council on International Educational Exchange before accepting a role in Melbourne as a Marine Scientist with Golder Environmental Services.

Nicole Said (MSc 2017)

Thesis: *Effects of temperature and location on the photosynthesis-irradiance relationship of the seagrass* Halophila ovalis.

Nicole completed her M.Sc. looking at the effects of temperature and location on the photosynthesis-irradiance relationship of the seagrass Halophila ovalis. This research focused on the impacts of light reduction, as well as giving possible insights for future climate change impacts on H. ovalis in Western Australia. Nicole has since been employed within the Centre as a Research Assistant, working on tropical seagrasses in the Pilbara region.

CMER MEMBERS

ECU Staff

Mr Rob Czarnik

After completion of a Post Graduate Diploma of Science (Biological Sciences) Rob was employed as a research assistant in CMER. Rob has since taken on the role of Field Safety and Support Officer where he provides expert advice and assistance to postgraduate students and staff on the preparation of Risk Analysis and Management Plans and ensures CMER operates under legislative, training and competency requirements. In addition, Rob is actively involved in the field operations of many of CMER's research projects.

Ms Natasha Dunham

After recently completing her Master's degree in 2016 at Edith Cowan University Tash began working for CMER as a Research Assistant. Her interest is in coastal marine ecology and Tash has assisted on a number of CMER projects. Tash is currently involved in the investigation on the effects of dedging specific to marine primary producers, part of a joint initiative with ECU, UWA and WAMSI.

Dr Megan Hugget

With more than a billion microorganisms per litre of seawater, the biodiversity of microbial communities and the functional roles that they play in the marine environment are enormously significant. Megan's research focuses on the function and diversity of marine microbes, and falls into two themes: prokaryote-eukaryote interactions in the marine environment and the function and diversity of bacterioplankton communities. Studies include genome content and architecture of bacterioplankton via whole genome sequencing projects, and investigating bacterioplankton diversity in response to a large storm event, and across coral atolls in the North-western Hawaiian Islands.

Professor Glenn Hyndes

Coastal marine and estuarine environments are highly complex systems prone to high levels of human disturbance resulting from the concentration of Australia's population along the coastal regions. It is, therefore, crucial to develop a high level of understanding of the complex ecological processes in these coastal environments. The movement of animal and plant material from one habitat to another forms an important process of habitat connectivity in the coastal, marine landscape. This forms the focus of Glenn's research activities. His studies have examined the trophic links among habitats using a combination of experimental and biomarker (stable isotopes and fatty acids) approaches to trace key food sources through the food web. Glenn's work has also examined the importance of different coastal habitats, particularly seagrasses, to fish communities, the ecosystem effects of consumers on shallow coastal biodiversity.

Professor Paul Lavery

Paul's research focuses on benthic marine ecosystems and how they respond to human-induced pressures, particularly seagrass ecosystems. Currently, he has three major areas of research interest: (1) The impact of dredging on seagrasses and other primary producer ecosystems, currently with a focus on tropical species; (2) Connectivity and trophic subsidies among coastal marine ecosystems, using stable isotope and other biomarker techniques to understand how materials transported from one habitat support productivity in adjacent habitats; and (3) the use of seagrass sediments as environmental archives to reveal past environment conditions and their ability to capture and store atmospheric carbon , thereby offsetting some of the impacts of global CO_2 emissions.

Professor Pere Masqué

Pere is a renowned expert in physics, environmental science and oceanography. Pere joined the team at CMER in 2016 bringing with him broad expertise in the use of both natural and artificial radioactive isotopes as tracers of environmental processes in the open oceans, along coastal regions, in lakes and peat. Locations include the Gulf of California and the eastern tropical North Pacific, Fukushima, the Mediterranean Sea, the Atlantic, the Antarctic and Arctic Oceans and the coasts Australia.

Dr Kathryn McMahon

Kathryn's main research area is coastal marine ecology, specifically focusing on seagrasses in both tropical and temperate environments following three main themes: human impacts in seagrass ecosystems; seagrass-grazing interactions; and genetics and connectivity. Her research into human impacts (e.g. nutrient enrichment, light reduction associated with dredging) has focused on developing ecophysiological tools to assess health or measure impacts. Secondly, with plant-grazing interactions Kathryn is interested in understanding the strategies plants use to cope with grazing, especially related to sexual reproduction. Thirdly, the genetic diversity connecting seagrass populations and the drivers of their patterns.

Associate Professor Ute Mueller

Geostatistical techniques were developed for the estimation and simulation of the spatial distribution of mineral reserves, but are equally applicable to other natural resources. Ute's research interests include the development and application of simulation and estimation of fisheries data.

Dr Viena Puigcorbé

In 2016 Viena secured a Post Doctoral Fellowship with the Centre after completing her PhD at the Universitat Autonoma de Barcelona in Spain. Her research interest includes marine biogeochemistry, natural radionuclides planktonic community structure and particle fluxes in the open ocean including the Southern Ocean, Arctic, North Atlantic Ocean, Mediterranean, and the Eastern Tropical North Pacific.

Ms Nicole Said

After completing her Master of Science at ECU in Marine and Freshwater Biology with a focus on temperature and latitude effects on seagrass, Nicole took up a contract position with CMER as a Research Assistant. She is involved in a major research project in the Pilbara region of Western Australia investigating the natural dynamics of seagrass habitat across the Pilbara, in particular how this influences distribution and habitat use of dugong at a local scale.

Ms Gloria Salgado

With vast technical background and experience systemising and managing science laboratories, Gloria has been pivotal in the realisation of the Environmental Radionuclides Laboratory at ECU.

Dr Oscar Serrano

Oscar joined CMER in 2012 with several years research expertise in marine ecology, palaeo-ecology and marine biogeochemical cycles. With a focus on carbon sequestration and paleo-ecological reconstruction from sedimentary deposits, Oscar's research includes investigating the capacity of seagrass ecosystems as a globally significant carbon sink, and the variability in carbon storage of seagrass habitats and between seagrass species. His research is largely centred on marine ecosystem response to climate change.

Ms Lorraine Wyse

Lorraine began working for CMER in 2010 as a Research Assistant mostly undertaking laboratory processing for various projects. In 2014 she assumed responsiblility for coordinating and providing research administration support for the Centre.

Adjuncts

Dr Ray Masini

Ray is based at the Office of the Environmental Protection Authority. His research has focused on Western Australian marine ecosystems, with particular emphasis on the tropical arid ecosystems of the central- and north-west coasts. More recently this focus has moved north to the tropical Kimberley coast. His research interests include nutrient-effects, ecological modelling and environmental management strategy and policy formulation. Ray has been centrally involved in the planning and management of a range of multidisciplinary marine environmental studies around the State's 13,000 km coastline. Ray's interests also include knowledge transfer and application, particularly related to the interaction between research, environmental policy formulation and environmental management.

Dr Fernando Tuya

Fernando's research is driven by the need to develop models that explain the patterns of organization of marine populations and communities from local to biogeographical scales. Fernando is particularly interested in ecological processes shaping temperate reefs, trophic linkages between reefs and adjacent seagrass meadows, effects of human perturbations on natural communities and the role of Marine Protected Areas in preserving marine biodiversity and fishery resources. He has contributed to the dissemination of the marine flora and fauna of the Atlantic Ocean through books and open-access monographs.

Dr Russ Babcock

Russ is based at CSIRO Marine and Atmospheric Research, and leads research to better understand how human activities influence coastal ecosystems such as kelp forests and coral reefs. Research programmes focus on issues such as fishing impacts and the effectiveness of marine reserves as conservation tools. Other projects have focused on the impacts of sedimentation on both temperate and coral reef ecosystems.

Professor Dr Miguel Angel Mateo

A lead researcher with Spanish Council for Spanish Research (CEAB), Spain, Miguel's focus is in the ecology and biogeochemical cycles associated with seagrass-dominated ecosystems, long term carbon budgeting, palaeoecological approach to the ecosystem of Posidonia spp based on pluri-millenarian peat-like deposits, and aquatic macrophytes as bio-indicators for environmental assessments.

Dr Pippa Moore

Pippa is a Lecturer in Aquatic Biology at Aberystwyth University, Wales. Research interests primarily lie in understanding how shallow-water marine systems are structured and function. This encompasses to climate impacts of global warming and ocean acidification, and coastal and offshore development effects on marine biodiversity

Postgraduate Students

Maryam Adolahpour (PhD - completed)
Residence time in coastal canopies.

Eric Aidoo (PhD - completed)
Geostatistical modelling of recreational fishing data: A fine-scale spatial analysis.

Casper Avenant (MSc)
Dietary comparison of the tropical herbivore Siganus fuscescens and a range of temperate seagrass-associated omnivorous fishes.

Rachel Bernasconi (PhD)
Characterisation of coral-Symbiodinium-bacteria networks on different investigation levels (geographical, temporal and environmental).

Pierre Bouvais (PhD - completed)
Impact of dredging activities in north-western Australia on filter feeders assemblages.

Shanna Fulwood (MSc)
Investigating habitat values of seagrass, macroalgae and wrack in the Swan Canning Riverpark.

Connor Campbell (MSc)
The role of nutrients in controlling periphyton abundance and composition to ascertain use as bio-indicator of a systems health.

Udhi Hernawan (PhD)
Gene flow and genetic structure of the seagrass Thalassia hemprichii in the Indo-Australian Archipelago.

Connor Gorham (MSc)
Carbon storage potential of temperate tidal marsh ecosystems in Western Australia.

Anna Lafratta (PhD)
Seagrass archives to reveal environmental history.

Jacquelyn Jones (Honours - completed)
The impact of range shifts on the stability of the gastrointestinal microbial community of the tropical herbivorous fish Siganus fuscecens.

Sian McNamara (MSc)
Blue Carbon – types of carbon compounds stored in marine sediments, do they change in composition over time and /or when released back into a marine environment.

Miss Roisin McCallum (PhD)
Identifying nutrient and organic matter sources in an impacted coastal wetland system.

Caitlin Rae (MSc - completed)
The role of ghost crabs (Ocypode spp.) as a potential vector for the trophic transfer of marine nutrients into terrestrial ecosystems in Western Australia.

Charlie Phelps (PhD)
Predicting the impact of future climate on ecologically important macroalgae.

Nicole Said (MSc - completed)
Effects of temperature and location on the photosynthesis-irradiance relationship of the seagrass Halophila ovalis.

Sam Ridgeway (PhD)
Blue Carbon – types of carbon compounds stored in marine sediments, do they change in composition over time and /or when released back into a marine environment.

Maria Samsanova (PhD)
The tropicalisation of temperate seagrass meadows in Western Australia: consequences to ecosystems and potential impacts.

Cristian Salinas (PhD)
Seagrass soils as biogeochemical sinks and palaeo-environmental tools for management.

Simone Strydom (PhD completed)
Investigating the effects of changes in light quality on different life history stages of seagrasses.

Charu Lata Singh (PhD)
Role of microbial assemblages in affecting the nutrient cycling associated with wrack and in supporting the food webs of surf zones and sandy beaches.

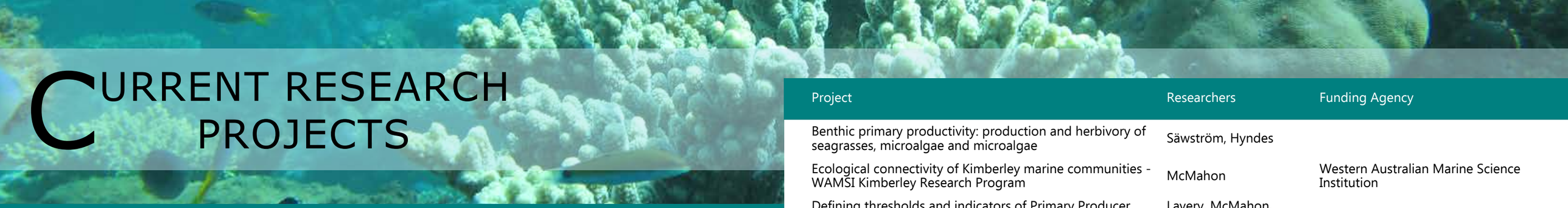
Aldo Turco (PhD - completed)
Comparisons of habitat use and diet of herbivorous kyphosids (Genus Kyphosus) in tropical and temperate reefs.

Flavia Tarquinio (PhD)
Ecological role of prokaryotes associated to seagrass leaves and their contribution to the plant's nutrient requirement.

Chanelle Webster (Honours - completed)
Effects of temperature and location on the photosynthesis-irradiance relationship of the seagrass Halophila ovalis.

Federico Vitelli (PhD)
Causes and consequences of hybridisation of Angelfish.

Alissa Tate (Masters - completed)
Assessing variability in standardised harvest rates from shore-based recreational fishing surveys.



CURRENT RESEARCH PROJECTS

Project	Researchers	Funding Agency
A multi-institutional environmental radioactivity research centre	Masque, Lavery	Australian Research
Novel approach to understand past and future dynamics in coastal ecosystems	Serrano	Australian Research Council DECRA
Marine Microbes	Huggett	Bioplatforms Australia
Dating of mangrove sediment cores from Madagascar by Pb-210	Masque	Blue Ventures Conservation
Dating of sediment cores from Exmouth by Pb-210	Masque, Salgado	CSIRO/University of Queensland
Dating of sediment cores from Broome by Pb-210	Masque, Salgado	CSIRO/WAMSI
Nutrient sources for primary producers in Roebuck Bay	McMahon	Department of Water and Environmental Regulation
Integrated state-wide survey of recreational fishing: boat and shore based activity - a long term profile	Hyndes, Mueller	Dept. of Agriculture and Fisheries Western Australia
Technical Review - Blue Carbon Emissions Reduction Opportunities	Lavery, Serrano, Masque	Dept. of Environment Regulation WA
Protection of coastal ecosystems and marine resource management	Lavery	Dept. of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
Investigating habitat values of seagrass, macroalgae and wrack in the Swan Canning Riverpark	Hyndes	Dept. of Parks and Wildlife WA
Microbes, the missing link in Coastal Landscape Connectivity	Hyndes, Säwström	
Conserving critical seagrass habitat for dugong: an integrated assessment across the Pilbara	Lavery, McMahon	
Provision of preliminary investigation into macroalgae and seagrass wrack at Jurien Bay Boat Harbour	Lavery, McMahon	Dept. of Transport
Impact of nutrients and stormwater on periphyton in a shallow embayment	McMahon	Dept. of Water (WA)
Genetic diversity and resilience of estuarine seagrasses	McMahon, Lavery	
Linking the iron and the carbon cycles in the Southern Ocean. Enhancing the collaboration with IMAS and ICM	Puigcorbe	ECU Collaboration Enhancement Scheme
Latitudinal gradients of host associated microbial diversity	Hyndes, Huggett	
Impacts of bottom trawling in deep-sea sediments: enhancing the collaboration with Dr. Pere Puig (Barcelona, Spain)	Masque	
'Keep Watch' Geographe Bay Seagrass Health Monitoring Program 2015/16	McMahon	Geographe Catchment Council Inc
Keep Watch - Searass Health Monitoring 2017-2021	McMahon	

Project	Researchers	Funding Agency
Benthic primary productivity: production and herbivory of seagrasses, microalgae and microalgae	Säwström, Hyndes	Western Australian Marine Science Institution
Ecological connectivity of Kimberley marine communities - WAMSI Kimberley Research Program	McMahon	
Defining thresholds and indicators of Primary Producer response to dredging related pressures	Lavery, McMahon, Strydom	
Australian-wide risk assessment of carbon dioxide emissions from seagrass habitat under current and future global change threats	McMahon	Edith Cowan University
Climate-driven transformations of temperate seagrass meadows: testing predictions	Hyndes	
Resilience of seagrasses in tropical systems exposed to human impacts	McMahon	
A novel approach to assess pollution in coastal ecosystems	Serrano, Lavery	
Revealing health and kinship in humpback whales using the microbiome of blow exhalation	Huggett	
Assessing the capacity of seagrass sediments to sequester carbon dioxide and metal pollution: past, present and future scenarios	Lavery, Serrano	Edith Cowan University South Australia Water Environmental Protection Agency
Ghost crabs on mid-west beaches	Hyndes	WA Landskills Inc
Coastal Carbon Opportunities: demonstrating additionality and potential for future offsets in South Australia	Lavery, Masque, Serrano	Goyder Institute
The effects of light quality caused by dredging on seagrass habitats	Strydom, McMahon	Holsworth Wildlife Research
Temporal and environmental patter of coral-Symbiodinium-bacteria network	Bernasconi, Huggett, Koenders	
Seagrass archives to reveal environmental history-reconstruction of metals contamination history at Port Pirie (SA)	Lafratta, Lavery, Serrano, Masque	
Dating of sediment cores from the Ebro Delta by Pb-210	Masque	Institute for Food and Agricultural Research and Technology
Determining the cumulative effect of putative pathogenic microbes, increased temperature and herbivory on the ecologically important kelp, Ecklonia radiata	Phelps	Max Day Environmental Fellowship Award
Beach Wrack Dynamics in Geraldton, WA	Hyndes	Northern Agricultural Catchment Council (NACC)
Vasse-Wonnerup Investigation Node	Hyndes, McMahon	South West Catchment Council (SWCC)
Millenary changes in the ecosystems of insular National Parks: perturbations, resilience, and trends after the seagrass archives (PALEOPARK).	Mateo, Serrano, Lavery	Spanish Government; Ministry of Agriculture and the Natural Environment
SUMILEN: Advances in sampling techniques, biogeochemical characterization, and quantification of the millenary deposits of seagrasses: critical update of their role and value as biospheric carbon sinks	Mateo, Serrano, Lavery	Spanish Government; Ministry of Economy & Competition
Establishing a 3D sensing, visualisation and analytics lab	Lavery	Strategic Initiative Fund
Dating of Sediment Cores from Costa Rica by Pb-210	Masque	Universidad de Costa Rica
Dating of mangrove cores from the Ecoregion eastern Brazil (NE) by Pb-210	Masque	Universidade Federal da Bahia

ENGAGEMENT

CONFERENCE ATTENDENCE & PRESENTATIONS

Australian Microbial Ecology (AusME) - a single stream conference on Environmental Microbiology and Microbial Ecology. Australian Microbial Ecology. Melbourne VIC, 13-15th Feb 2017 | *Presented: Dr Megan Huggett - The impact of range shifts on the stability of the gastrointestinal microbial community of the tropical herbivorous fish Siganus fuscescens*

Blue Carbon the role of coastal ecosystems in climate change mitigation and adaptation - Blue Carbon Workshop. Red Research Centre (KAUST) Saudi Arabia, 20th - 21st Mar 2017
Attendees: Prof. Paul Lavery, Prof. Pere Masque, Dr Oscar Serrano

COMET EU Final Event - Fukashima. Radiological Exchange. Burges BELGIUM, 25-27th Apr 2017 | Attendees: Prof. Pere Masue

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Melbourne VIC, Jun 2017 | Attendees: Pere Masque

ASM Annual Science Meeting 2017. Australian Society for Microbiology, Hobart. TAS 2nd – 5th Jul 2017 | Attendees: Dr Megan Huggett

Goldschmidt 2017. Geochemical Society. Paris, August 13-18th 2017
Attendees: Prof. Pere Masque

Conference Lascaux La Belle 2017. Paris France, 17-18th October 2017
Attendees: Prof. Pere Masqué

Australian Marine Science Conference 2017 Connections through shallow seas, Darwin NT, 2nd-6th Jul 2017 | Presenters: *Dr Kathryn McMahon (centre right) - Patterns in diversity of seagrass in the tropical East Indian Ocean; Anna Lafratta (right); Cristian Salinas (left); Caitlin Rae (centre left)*

Frontiers in Antarctic Science, developing research in an extreme environment. Australian Academy of Science. Hobart TAS. 13-15th Sep 2017 | *Presenter: Dr Viena Puigcorbé - Factors controlling primary productivity in the Mertz, the Dalton and the Ninnis polynyas*

2017 WAMSI Research Conference. Perth WA, 22nd - 23rd Nov 2017 | Presenters: *Prof. Paul Lavery - Defining thresholds and indicators of seagrass response to dredging: Synthesis of knowledge and considerations for management*

ASLO Aquatic Sciences Meeting: Mountains to the sea. Association for the Sciences of Limnology and Oceanography. 26th Feb - 3rd Mar 2017 | Attendees: Anna Laffratta, Nicole Said, Rachele Bernansconi

Combined Biological Science Meeting. University of Western Australia. Perth WA, 26th Aug 2016 | *Presenters: Simone Strydom - Annals of Botany Plant Science Poster Award; Flavia Tarquinio - Ecology, Environment and Evolution' Student Presentation Award: Rachele Bernasconi - CBSM Environmental Science Student Poster Award; Jacqueline Jones*

KAUST Research Conference, International Conference on the Marine Environmnet of the Red Sea. King Abdullah University of Science & Technology (KAUST). Saudi Arabia. 14-16th Nov 2016 | Attendees: Dr Oscar Serrano

Opportunities for Coastal Blue Carbon Activities in Australia. Department of Environment and Heritage, Canberra, Australia, 27-29th Jul 2016 | Attendees: Dr Oscar Serrano, Prof. Paul Lavery, Prof. Pere Masque

16th International Symposium on Microbial Ecology, Montreal, 21st – 26th Aug 2016 | Attendees: Dr Megan Huggett

IUR Regional Forum Strengthening Radioecology in the Asia-Pacific, International Union of Radioecology. Bali Indonesia, 4th Sep 2016 | Attendees: Prof. Pere Masquè

Australian Academy of Sciences Frontiers Microbiome Meeting, for outstanding early- & Mid-career researchers, Adelaide SA, 29th Nov – 1st Dec 2016 | Attendees: Dr Megan Huggett

ISBW12 - Securing a future for seagrass. Nant Gwrtheyrn Wales, 17th - 23rd Oct 2016 | *Presented: Dr Oscar Serrano (left) - Seagrass sediments reveal millennial-scale dynamics and processes in coastal ecosystems; Simone Strydom (centre) - Colour Counts! Light quality influences seagrass adults, seeds and seedlings (awarded 1st place poster).*

SEMINARS

Edith Cowan University Research Week

2016 September 19th – 23rd

Showcase: Putting Microbes on the Map in Coastal Ecosystem Management | Coordinator Dr Megan Huggett

Presentations: Dr Kathryn McMahon – One Minute Pitch It, awarded Second Place (joint)
TITLE: Managing human impacts in the coastal marine environment; Rachele Bernasconi (PhD Canditate) - Three Minute Thesis; Simone Strydom (PhD Candidate) - Three Minute Thesis

2017 September 18th – 23rd

Showcase: Resilience of northern Australian seagrasses to dredging– September 19th | Coordinator Prof. Paul Lavery (pictured above) & Dr Kathryn McMahon

Professor Paul Lavery | CMER: Protection of Coastal Ecosystems and Marine Resource Management: Outcomes and what's next

Ariane Arias-Ortiz | Autonomous University of Barcelona: Blue Carbon sequestration in seagrass sediments: Improved process-understanding of the capacity of seagrass meadows for CO2 emissions mitigation

A/Prof Marco JL Coolen | Curtin University: Climate oscillations reflected in the Arabian Sea subseafloor microbiome

Dr Matthew Adams | University of Queensland: An introduction to deterministic mathematical modelling of seagrass ecosystems

Professor Josep Gasol | Institut de Ciències del Mar, Barcelona: Aquatic microbes: new knowledge and changing paradigms

Professor Pere Masque | CMER: The Impact of the Fukushima Dai-ichi nuclear accident in the ocean

Professor Paul Lavery | The West Australian Lecture Series 2017: Australia's seagrasses and how they are helping us to fight global climate change

Dr Alison Roberston | University of Alabama: Ciguatera fish poisoning - unraveling the complexity of prevalence, exposure, and risk in tropical reef ecosystems

Dr Megan Huggett | CMER: Understanding future impacts of temperature on marine microbiomes

Dr Antonio Tovar-Sanchez | CSIC, Spain: (1) Impact of tourism in the marine coastal ecosystems: the threat of emerging pollutants (2) Fingerprinting environmental change

COMMUNITY ENGAGEMENT

Albany High School - Marine Research Program Annual Seminar held in 2016 and 2017 at ECU for Year 8-12 students end of year presentations Coordinated by Prof. Glenn Hyndes

Prof. Pere Masquè visited the Glyde Community Learning Centre in Fremantle during October 2017 to speak on Fukishima and our oceans.

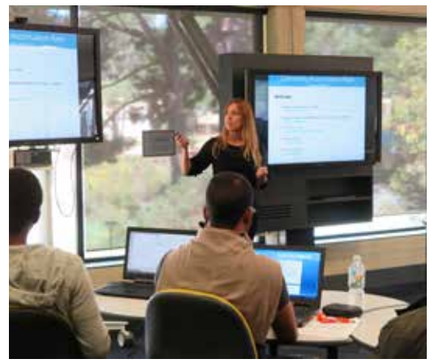
WORKSHOPS

Professor Josep Gasol
(Institu de Ciències del Mar, Barcelona)
1. Diversity of bacterial communities explored using high throughpout sequencing and 16SrRNA tags.
2. Single-cell studies with marine bacteria: Active and inactive bacteria and the probes to detect them.

Professor Pere Masqué (CMER)
International Atomic Energy Agency, Monoca Technical Meeting on Improving the Application of Radionuclides in Studies of the Carbon Cycle and the Impact of Ocean Acidification.

Dr Oscar Serrano & Prof. Paul Lavery (CMER)
Describe and classify the substrate where seagrass inhabit using a soil scientist approach.

Dr Viena Puigcorbé (pictured below), Dr Kathryn McMahon & Anna Laffratta (CMER)
Indian Ocean Fellows Blue Carbon Workshop & Environmental Radioactivity Laboratory tour.



CMER IN THE NEWS

ABC News
Professor Glenn Hyndes

Tropical marine species predicted to compete with western rock lobster for seagrass meadows

Dr Oscar Serrano

Phosphorus suffocating WA harbour seagrass: Edith Cowan University study

The Australian
Professor Pere Masqué

Pacific Ocean radiation levels 'near normal' after Fukushima

Perth Now
Dr Oscar Serrano

Boat mooring chains destroying seagrass on Rottnest Island

The Australian
Professor Pere Masqué

Pacific Ocean radiation levels 'near normal' after Fukushima

Sydney Morning Herald
Dr Oscar Serrano

Human Development mows down seagrass, threatening a natural source of carbon storage

Australian Geographic
Dr Oscar Serrano

Relax, the damage to Rottnest's seagrass isn't as bad as we thought

NATIONAL AND INTERNATIONAL VISITORS

2016

Sarah Paradis - PhD student at the Autonomous University of Barcelona

Professor Josep Gasol - Research Professor at the Institut de Ciències del Mar, Barcelona

Professor Kenneth L. Heck, Jr. - Senior Marine Scientist with the Dauphin Island Sea lab, Associate Director of the Alabama Centre for Ecological Resilience at Florida State University and Professor at the University of South Alabama

Professor Catherine Lovelock - Professor at the School of Biological Sciences, University of Queensland

Professor Antonio Martinez-Cortizas - Coordinator of the research group Earth System Science (ES2) at the Universidade de Santiago de Compostela, Spain

Dr Joey DiBattista - Early Career Research Fellow at the Department of Environment and Agriculture, Curtin University

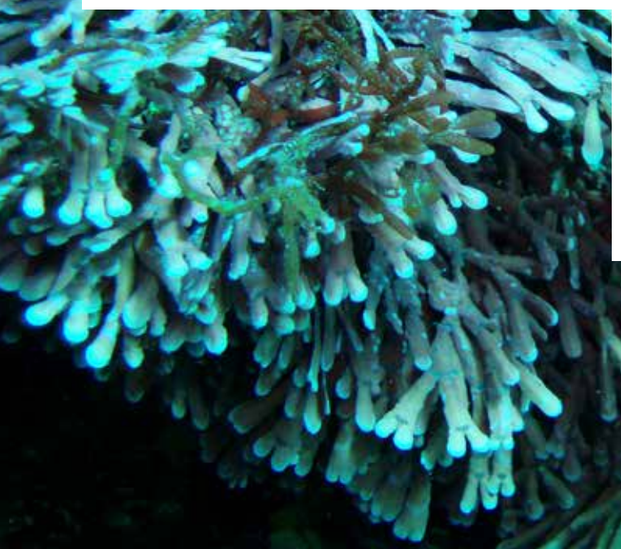
Dr Matthew Adams - Postdoctoral Research Fellow at the School of Chemical Engineering, University of Queensland

Ariane Arias-Ortiz - PhD student Autonomous University of Barcelona

Associate Professor Marco - JL Coolen Deputy Director of the WA Organic and Isotope Geochemistry Centre at Curtin University

Montserrat Roca-Marti - PhD student at Autonomous University of Barcelona

Dr Kathryn Dafforn - Senior Research Associate at the University of New South Wales



2017

Dr Jeff Baldock - Research Scientist with Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Professor Antonio Martinez Cortizas - Professor of Soil Science at the Faculty of Biology of the Universidade de Santiago de Compostela.

Dr Enric (Kike) Ballesteros - Research Scientist in Marine ecology at the Centre for Advanced Studies of Blanes

Professor Mark Taylor - Professor of Environmental Science at Macquarie University

Yaiza Ontario Gomez - PhD Student at the Autonomous University of Barcelona

Dr Montserrat Roca-Martí - Postdoctoral Research Fellow at the Autonomous University of Barcelona

Dr Alison Robertson - Assistant Professor at the University of South Alabama

Dr Catherine Collier - Principal Research Officer at James Cook University

Dr Kieryn Kilminster - Adjunct Research Fellow Biological Sciences, Department of Water and Environmental Regulation

Professor Gary Kendrick - research and teaching Professor at The Oceans Inststitute and the School of Plant Biology, University of Western Australia

Dr Paul Erftemeijer - Adjunct fResearch Fellow Biological Sciences, University of Western Australia

Dr Ray Masini - Marine ecologist with the Department of Water and Environmental Regulation

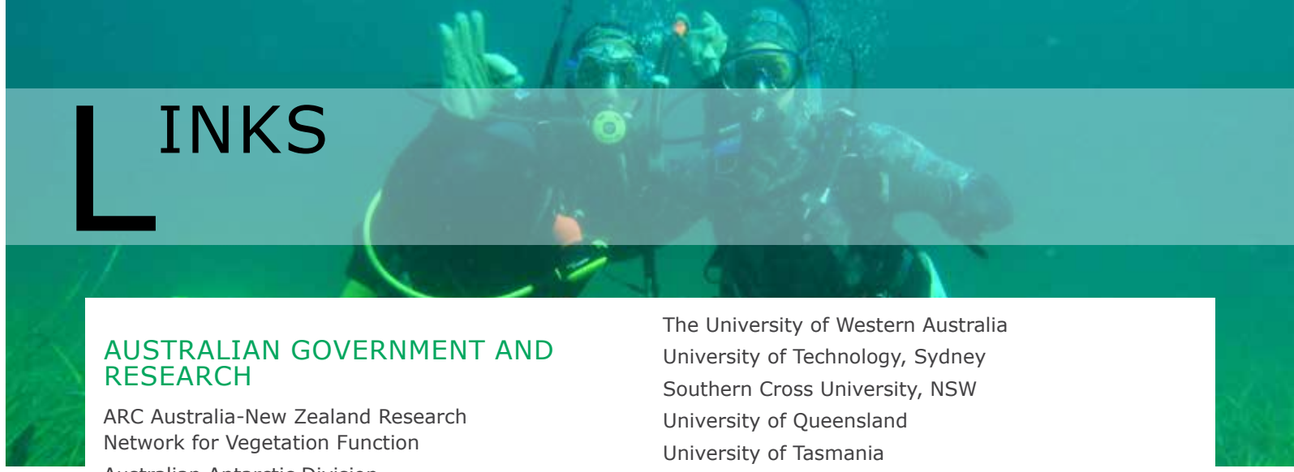
Dr Mat Vanderklift - Marine Ecologist with CSIRO

Dr Sebastian Thomas - Researcher at the University of Melbourne

Rhys Arangio with Austral Fisheries

Cindy Bessey - Marine Ecologist with CSIRO

Dr. Antonio Tovar-Sanchez - Spanish Research Council (CSIC)



LINKS

AUSTRALIAN GOVERNMENT AND RESEARCH

ARC Australia-New Zealand Research Network for Vegetation Function
Australian Antarctic Division
Australian Institute of Marine Sciences (AIMS)
CSIRO Marine and Atmospheric Research
Wealth from Oceans Flagship (Coastal Carbon Biogeochemistry Cluster)
Strategic Research Fund for the Marine Environment (SRFME)
Department of Parks and Wildlife (WA)
Department of Fisheries (WA)
Department of Primary Industries, Victoria
Department of Environmental and Heritage Protection (Queensland)
Environmental Protection Authority (South Australia)
Fisheries Research and Development
Geographe Catchment Council Inc
Great Barrier Reef Marine Park Authority
Institute of Marine Antarctic Studies
Northern Agricultural Catchment Council
Parks Australia
Rottnest Island Authority
South Australia Water
South Western Catchment Council (SWCC)
Swan River Trust (WA)
Tasmanian Aquaculture and Fisheries Institute
Western Australian Marine Sciences Institute (WAMSI)
Western Australian Museum

AUSTRALIAN UNIVERSITIES AND SCHOOLS

Albany Senior High School
Griffith University
James Cook University
Murdoch University
The University of New South Wales
The University of Queensland
The University of Western Australia
University of Technology, Sydney
Southern Cross University, NSW
University of Queensland
University of Tasmania
Deakin University
Curtin University

INTERNATIONAL

Aberystwyth University, UK
Autonomonous University of Barcelona, Spain
Centre for Advanced Studies of Blanes (CEAB)
CIIMAR, University of Porto, Portugal
Dauphin Island Sea Lab, USA
Department of Ecology, Environment and Plant Sciences
Helmholtz Centre for Ocean Research (Geomar) and Silversea Marine Cruises
Invemar - Institute for Marine and Coastal Research
Otago University, New Zealand
Spanish Council for Scientific Research (CISC), Spain
UKM (National University of Malaysia)
Université de Nice, France
Université P Sabatier – Toulouse III, France
University of Barcelona, Spain
University of Florida, USA
University of Las Palmas de GC, Spain
Stockholm University, Sweden
University of Santiago de Compostela, Spain
University of South Alabama, USA
University of Virginia, USA
Woods Hole Oceanographic Institute

INDUSTRY

Bioplatforms Australia
Chevron
Hydrobiology QLD Ltd Pty
In-situ Marine Optics
Oceanica Consulting Pty Ltd
Woodside Oil and Gas

PUBLICATIONS 2016-2017

Journal Articles

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Castrillejo, M., Casacuberta, N., Christl, M., Garcia-Orellana, J., Vockenhuber, C., Synal, H.A., Masqué, P., 2017. Anthropogenic 236U and 129I in the Mediterranean Sea: First comprehensive distribution and constrain of their sources. Sci. *Total Environ.* 593–594, 745–759. doi:10.1016/j.scitotenv.2017.03.201

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