EDITH COWAN UNIVERSITY
School of Natural Sciences
Faculty of Computing, Health and Science

Centre for Marine Ecosystems Research

RESEARCH HIGHLIGHTS 2010 – 2011

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PRINCIPALS' REPORT

2010/2011 was another productive period for CMER staff and students. Two Western Australian Marine Sciences Institute (WAMSI) projects were finalised: one examined the role of herbivory in maintaining coral reefs at Ninglaoo Reef, while the other examined the potential effects of rock lobster fishing on temperate, shallow water ecosystems. Similarly, a CSIRO Flagship project examining the role of herbivory and hydrodynamics in ameliorating the impacts of nutrient enrichment in marine ecosystems ended.

The completion of the projects meant that some Postdoctoral Fellows moved on to other positions. Adriana Vergés left to take up a teaching and research position at the University or New South Wales, while Thomas Wernberg gained a Postdoctoral Fellowship at the University of Western Australia and has since been awarded an ARC Future Fellowship – congratulations Thomas. Pippa Moore left at the end of 2010 to take up a lectureship at Aberystwyth University in Wales. All three will be missed, but at the same time it is wonderful to see our colleagues being recognised for their work and we wish them the best in their future careers. Britta Munkes also went back to Germany to finish her Marie Curie Postdoctoral Fellowship over there. In terms of research students, Adam Gartner gained his PhD and has since moved to Oceanica Consultants, while Carli Telfa successfully completed her Masters by Research, and continues to work at the Department of Fisheries.

CMER members maintained their strong track record in external research income, with grant income in excess of $2.5 million during 2010-2011 from a wide range of industry and national competitive sources. One of the most exciting initiatives has been the funding obtained under the Commonwealth's Collaborative Research Nertworks (CRN) program to support a collaborative research programme with UWA. The program involves researchers from UWA's Oceans Institute and the School of Environmental Systems Engineering, and while we have previously worked closely with these colleagues, the CRN is opening up a raft of new and exciting research opportunities in coastal connectivity and eco-hydraulics. CMER members continued to publish extensively in high quality ecology and management journals. A notable, and continuing feature of our publications is the large number of collaborative papers, reflecting the close and complementary research occurring within the centre and with external research collaborators.

Through its research activities, CMER has maintained strong engagement with WAMSI. CMER members have been involved in the negotiation of the re-funding bid (WAMSI 2), and with the development of the new WAMSI research nodes on Dredging Science and the Kimberley Marine Research Program. CMER staff have also assisted the Department of Environment and Conservation with data collection for the Walpole-Nornalup Inlets Marine Park, involving 3rd year students to achieve research-informed teaching outcomes. Glenn Hyndes was invited to spend his study leave at the University of Otago, New Zealand in 2010, with Associate Professors Catriona Hurd, Russel Frew, and Dr Rebecca McLeod.

As mentioned above, much of our productivity in 2010-11 was attributable to a group of dedicated and talented post-doctoral researchers. While some of those have now moved on to academic positions elsewhere, we are looking forward to the arrival of new postdoctoral researchers in 2012. In particular, we look forward to welcoming Dr Oscar Serrano Gras from Spain, who will bring expertise in carbon storage, and Dr Christin Säwström (from Sweden via UWA) who brings environmental microbiology into the CMER. It promises to be an exciting year as these new researchers join us and our Collaborative Research Network.

Glenn Hyndes and Paul Lavery
Co-Principals, Centre for Marine Ecosystems Research

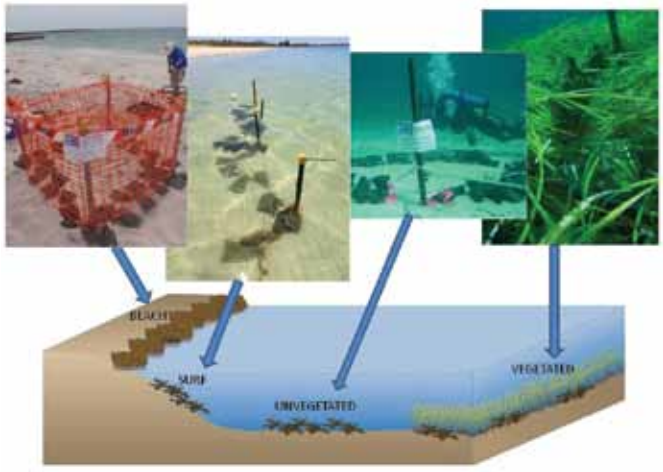
HIGHLIGHTS
in Habitat Connectivity and Trophic Interactions

Habitat connectivity and trophic interactions form a main focus of research in CMER. A range of projects were being carried out in 2010/11, including 'trophic interactions of western rock lobster on seagrass ecosystems', 'Trophic effects through herbivory at Ningaloo Reef', 'The influence of drift kelp on seagrass systems' and 'Seagrass wrack dynamics in Geographe Bay'. A student project embedded in the last of these projects forms this year's highlight.

DEGRADATION OF SEAGRASS WRACK

In 2010, Masters Student Candace Willison wrapped up a field study looking at spatial and temporal variations in seagrass wrack degradation. This project was part of a program investigating seagrass wrack dynamics being lead by Paul Lavery and Kathryn McMahon. Seagrass wrack accumulates in a variety of coastal habitats, potentially providing an important trophic subsidy. Biological, chemical and physical processes degrade wrack, and are part of the process that allows this material to enter the detrital food webs or be recycled.

The amount of wrack accumulating on beaches and elsewhere is affected by export rates and degradation, which may vary significantly through the year and in different habitats. Where export is disrupted (e.g. when structures interfere with long-shore currents), degradation becomes the major means through which wrack is eventually removed, emphasising the importance of understanding this process. While many studies have examined degradation of algal wrack, little is understood about seagrass wrack degradation and what has been studied is largely confined to beach ecosystems, ignoring sub-tidal habitats.



Candace investigated how quickly seagrass wrack degrades and how this varied among beach, surf-zone, and sub-tidal habitats (pictured).

In-situ litterbag experiments were conducted for sixteen weeks in both summer and winter. Permutational Analysis of Variance (PERMANOVA) indicated degradation rates varied significantly *($p<0.05$)* between summer and winter and among habitats. As illustrated in Figure 1, biomass loss was greatest in the surf zone, followed by vegetated and unvegetated sub-tidal habitats. The lowest degradation rates were measured on beaches. These findings may have profound implications for management of wrack on beaches, where typically it is simply removed. Options for increasing degradation include promoting movement of wrack between beach and surf-zone habitats, ensuring that the nutrients bound up in wrack can be recycled rather than being permanently lost from the system. The findings also provide new insights into the rates of degradation, which previously were based on beach studies; clearly these are representative of degradation rates in other habitats.

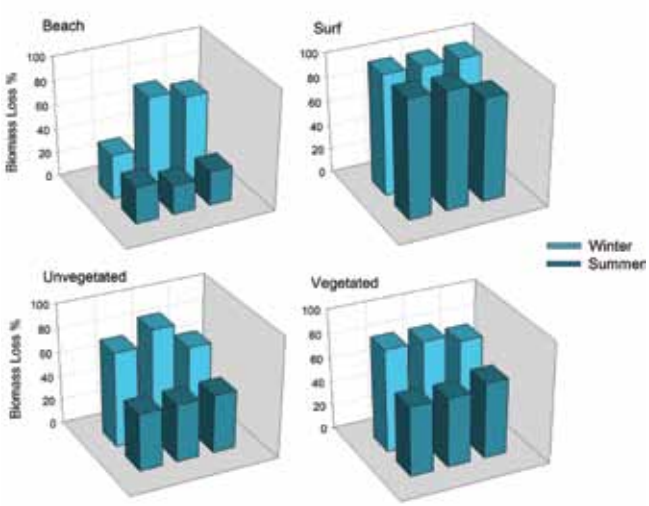


Figure 1: Biomass loss (%) of seagrass wrack in four key coastal marine habitats at three sites (each bar represents a site) in summer and winter. Beach, Unvegetated sub-tidal and Vegetated sub-tidal show substantially greater loss rates in winter than summer; in contrast, Surf habitats shows a slight difference between seasons with the highest loss percent rate overall.

OF WRACK AND FLIES AND SANDY DUNES

Kajsa Mellbrand had visited CMER to work on the role of marine wrack as a subsidy to beach ecosystems. Kajsa had earlier looked at the role of midges in transferring marine production into forests and grassland areas in the Stockholm Archipelago, Sweden. We wanted to know just how far inland the influence of our beach-cast kelp and seagrass wrack could be detected.

Nutrients and energy derived from marine wrack can increase the productivity and biodiversity of areas they drift into. While wrack does not normally 'drift' into sand dunes and beyond, the wind does occasionally blow it there. More importantly, vectors such as flies can grow fat on these foods then fly inland, where predators can be sustained by this marine-subsidised prey.

We used stable isotopes to examine the roles of insect and spiders in carrying marine-derived nutrients inland in two contrasting ecosystems: shore meadows in Sweden with marine inflows of algae and emerging chironomid midges; and sandy beaches and dunes in south-western Australia with marine inflows of algae and seagrass.

We found that in both systems the inland reach of the marine subsidy was greater than could be accounted for by deposited macrophytes on shores alone, and that flies and spiders facilitated the inflow. Our results indicate that marine inflows are important for near-shore terrestrial ecosystems well above the water's edge, and that beach dune systems are dependent on wrack. The most immediate implication of the work is in relation to beach management and the practice of removing wrack because it may be viewed as 'unsightly'. Beauty, as always, is in the eye of the beholder. The work was published in *Ecosytems* in 2011.

Kajsa and colleagues sampling beach and dune systems to determine the inland extent of wrack influence on dune ecosytems.

HIGHLIGHTS in Conservation and Fisheries Biology

This broad research theme encompasses a diversity of projects in CMER, ranging from studies of marine mammals, such as the New Zealand fur seal, to fisheries projects on the reproductive biology of coral trout at the Abrolhos Islands and the impact of rock lobster fishing on benthic ecosystems. Our highlights focus on projects examining the charter boat industry, as well as the movement patterns of dugongs in the Kimberley, and distribution of New Zealand fur seals. We've also included some insightful work helping to define the species boundaries in our seagrasses.

SPECIES BOUNDARIES IN THE POSIDONIA SEAGRASS GENUS

Seagrass meadows provide valuable ecosystem services and recent losses of significant areas have emphasised the need to carefully manage the remaining meadows in temperate Australia. Management of ecosystems is generally applied at the species level, however, there is uncertainty regarding the number of species in the most common seagrass genus in this region, Posidonia. This research carried out by Kathryn McMahon in collaboration with Michelle Waycott from JCU aimed to resolve the number of species of *Posidonia*, their distribution, and defining characteristics. Traditional morphological characteristics combined with a modern molecular approach (DNA barcoding) was used to resolve the taxonomy.

In Australia the genus *Posidonia* comprises two species complexes (groups of species): the *P. australis* complex, including *P. australis*, *P. angustifolia* and *P. sinuosa*, and the *P. ostenfeldii* complex, including *P. coriacea, P. kirkmanii, P. robertsonii, P. denhartogii* and *P. ostenfeldii* (Figure 2). Recent studies using morphological, allozyme marker and molecular sequencing (nuclear and chloroplast DNA) data have questioned the taxonomy of the *P. ostenfeldii* complex (Campey et al., 2000, Waycott et al., 2006). Within the *P. australis* complex, *P. sinuosa* is supported as a species, and although *P. australis* and *P. angustifolia* show little difference, they too are supported as species, potentially sister species (Waycott et al., 2006). However, within the *P. ostenfeldii* complex, the five described species do not separate from each other based on morphological or allozyme characters (Campey et al., 2000). Molecular sequencing data on limited samples suggests the existence of a single species with small, indistinct morphological variations (Waycott et al., 2006).

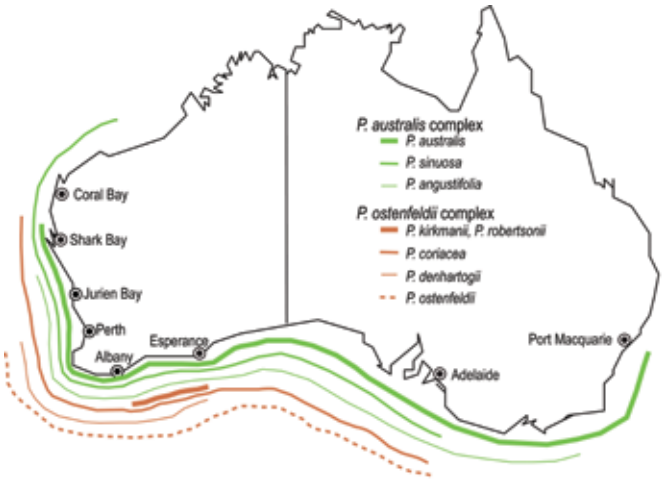


Figure 2: Distribution of the two species complexes of the genus *Posidonia: P.australias and P.ostenfeldii.*

For Kathryn's research, samples of all *Posidonia* species (~145 in total) were collected from Coral Bay in the north of WA, to Esperance in the south. This research used a different set of molecular markers to those used previously, barcodes as proposed by the International Consortium for the Barcode of Life (CBOL).

Two markers (rpoC, ycf5) clearly separated some species in the *Posidonia* genus *(P. sinuosa, P. angustifolia, P. australis)*, however, there was no separation of described species within the *P. ostenfeldii* group. In addition, morphological characters did not separate these described *P. ostenfeldii* species either. The large morphological variation within the P. ostenfeldii group across the large sampling range was represented by a continuum of morphological characters.

The results of this research are providing much greater clarity about the species of *Posidonia*, in particular supporting the idea that the *P. ostenfeldii* complex may, in fact, be a single species.

SPATIAL ASSESSMENT OF CHARTER BOAT FISHING IN THE WEST COAST BIOREGION OF WESTERN AUSTRALIA

In Western Australia, the Tour Operators and Aquatic Eco-Tourism (Charter Boat) industry forms part of the fishing community and has provided recreational anglers and tourists with opportunities to explore and utilise the marine environment for decades. Management of the industry aims to ensure its long-term sustainability together with the natural resources it depends on.

Masters student Carli Telfer, supervised by Glenn Hyndes, Ute Mueller (ECU) and Brent Wise (Department of Fisheries) undertook a study to assess the charter industry's species catch rate data between 2002/03 and 2007/08. Carli used sophisticated geostatistical techniques to determine how the spatial structure of catch rates changed over time and space. Knowledge of temporal and spatial distribution of fishing characteristics is essential when trying to better understand the impact on fish populations and the environment.

Experimental semi-variograms (see Figure 3) were constructed to assess the spatial continuity of the charter industry's catch rate data for three key indicator species (pink snapper, baldchin groper and dhufish) in the West Coast bioregion over a six-year period. The models showed an increase in the range for baldchin groper catch rates, whilst there was no consistent pattern in the ranges for dhufish and pink snapper.

Geostatisical analysis highlighted changes in local catch rates within the bioregion, independent of the species. Overall, the spatial structure of catch rates from the charter boat industry in the West Coast bioregion has undergone moderate changes over the study period (Figure 3). Between 2003/2004 and 2005/2006, there was a marked drop in the range over which catch rate data were similar, followed by a restitution from 2006/2007. Further investigation showed that this change was largely caused by changes in the Perth metropolitan area and Bunbury region, while the northern part of the west coast bioregion retained the same features throughout the study period. The study has highlighted that geostatistical analysis can provide managers with additional tools to assess the spatial impacts of fishing, and inform the long-term, sustainabile management of fish stocks and industry.

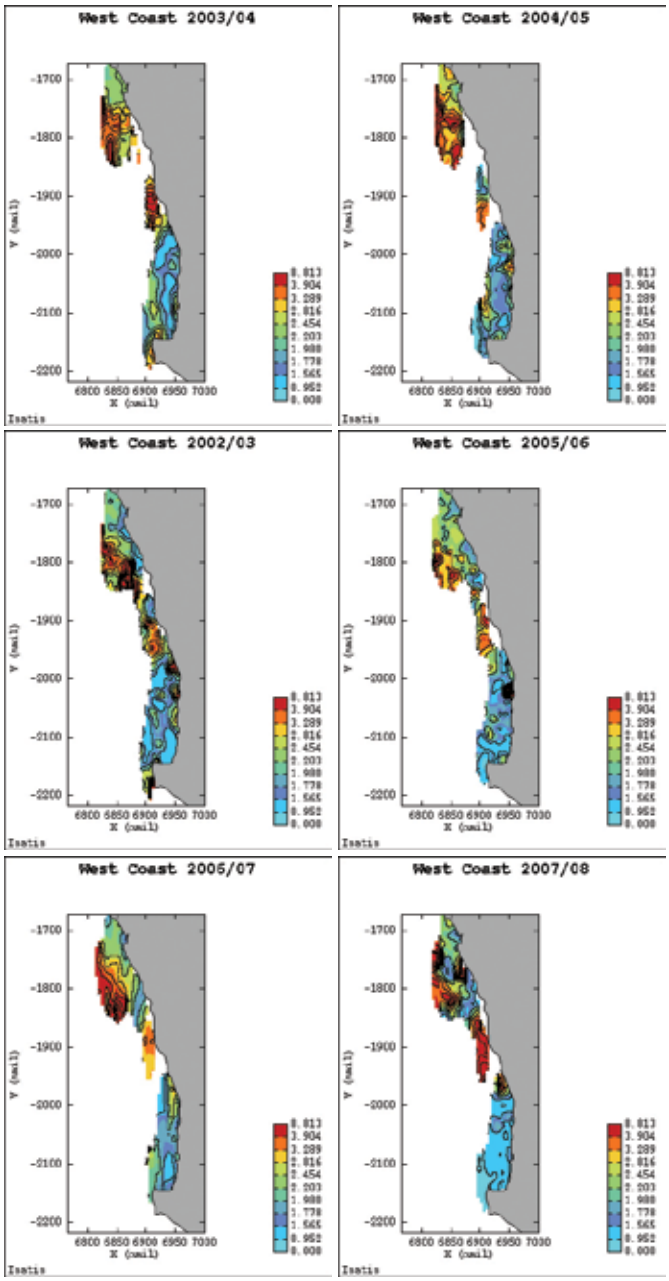


Figure 3: Spatial maps showing West Coast charter catch rate estimates from 2002/03 to 2007/08 (x- longitude, y-latitude). Isolines highlight areas of the same value.

DUGONGS – COLLABORATIVE RESEARCH PROVIDES TWO-WAY LEARNING ABOUT DUGONGS IN OUR NORTH-WEST

Dugong are an important cultural and natural resource for indigenous people across northern Australia. They have been traditionally hunted and utilised for millennia and Australia is one of the last refuges for large, stable populations of this species in the world. Dugongs inhabit nearshore habitats where they feed on seagrass. As such, they are potentially impacted by natural and human-induced activities which affect seagrass meadows.

CMER researcher Richard Campbell has been investigating the movement and diving behaviours of dugong in the west Kimberley. In a collaboration with the indigenous ranger groups on Bardi-Jawi and Nyul-Nyul native title claimant areas and staff from the Department of Environment & Conservation (DEC) the movement and diving behaviours of dugong in the west Kimberley has been examined for the first time.

Eight dugongs were captured and tracked using GPS satellite units and a subset deployed with time-depth recorders. Tagged dugongs generally showed strong site fidelity, preferring foraging areas within the capture sites at Beagle Bay and Pender Bay (Figure 4). There was a strong association between spatial habitat use and tidal cycles. These patterns reflected the traditional knowledge of dugong behaviour in the area. Some animals displayed large distance movements away from the capture sites moving over 500 kilometres along nearshore habitats. A number of animals utilised areas in close proximity to the proposed industrial site at James Price Point and spatial analysis shows the close association between core foraging areas and seagrass patches.

The community approach and collaboration between indigenous ranger groups and researchers allowed for ‘both ways’ learning and provided important information on the movement and habitat requirements of dugongs in the sea country of a number of indigenous communities in the west Kimberley region. Further research programmes involving the first study of the foraging behaviours of juvenile green turtles ‘on country’ with the Bardi-Jawi rangers proceeded in 2011 in collaboration with Woodside Energy as the industry partner.

Bardi-Jawi rangers make a deep water capture of a dugong in Beagle Bay using the rodeo capture technique and are in the process of restraining of it prior to attaching the GPS satellite tag.

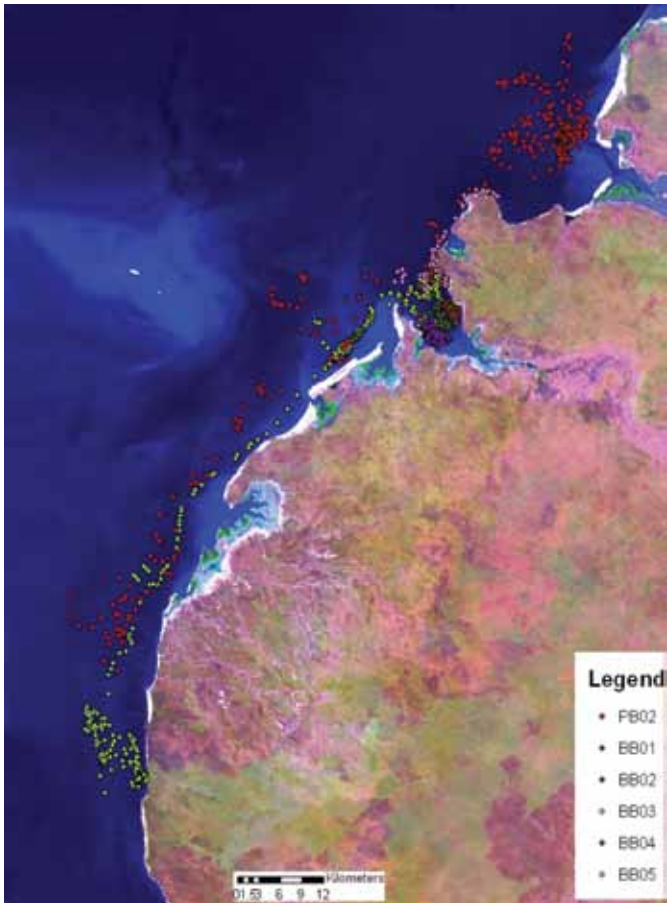


Figure 4: GPS locations of all tagged dugong in Beagle Bay (2009-light blue, 2010-dark blue) and Pender Bay (2010-red). One dugong from the 2009 deployments travelled further south than James Price Pt as recorded here to a final recorded location over 400 kilometres from the capture location in Beagle Bay. Locations of sites in the Kimberley are shown in the map to the right.

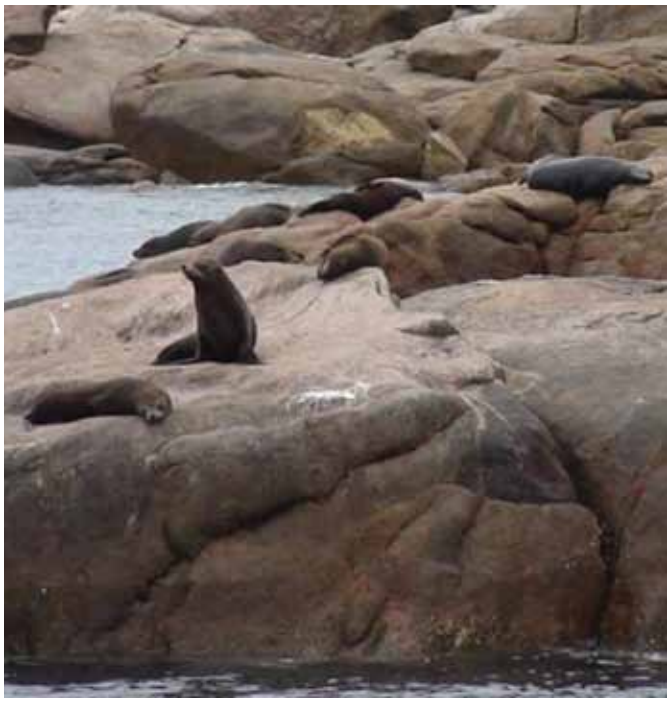
DISTRIBUTION AND ABUNDANCE OF FUR SEALS AND SEA LIONS IN WESTERN AUSTRALIA

A research team of DEC staff lead by DEC/CMER Post-doctoral Fellow Richard Campbell completed a comprehensive survey of New Zealand fur seal pup production at the 20 known breeding sites in WA.

The team counted 3,518 newborn pups, which translated into an estimate of approximately 17,500 fur seals in Western Australia. This represented an exponential growth rate over the past twelve years of approximately 1.5% per annum, a significant reduction from the estimated exponential rate of 10% per annum between the 1989-1999 period. These new data might indicate that the population of fur seals in WA is getting close to its current carrying capacity.

Clusters of colonies showed significant declines in pup production compared to 1999, while at others, pup production had grown at a maximum rate of 6-9% p.a. over the last 12 years. New breeding colonies were discovered, including one large colony at Chatham Island, the seventh largest colony in WA. The establishment of a new breeding colony at Bunker Bay near Cape Naturaliste and a permanent haulout at Cathedral Rocks on Rottnest Island demonstrate a westward and northward extension of the species' distribution. The colony growth rates and distribution expansion patterns suggest fur seals may be limited for marine prey resources throughout most of its current range along WA's south coast.

We also surveyed Australian sea lions. Preliminary results show that the population is still under threat and may even be declining in some areas. Breeding activity was discovered at Draper Island for the first time, some good news for the species. The northern expansion of breeding and haulout ranges is interesting in the context of global climate change. The survey was undertaken during a time of near record high sea surface temperatures and Leeuwin Current flow rates due to a strong La Niña effect, which may have had some effect on pupping rates.



New Zealand fur seals hauled out on Figure of Eight Island in the Recherche Archipelago on WA's south coast.

HIGHLIGHTS
in Human Impacts on Ecosystem Processes

A number of projects that CMER researchers undertake in this theme highlight the range of human impacts in coastal marine systems. Laboratory-based studies are assessing the impacts to and resilience of seagrass communities under predicted climate change scenarios, particularly focussing on the potential stressors of ocean acidification and increasing temperature. Large scale field manipulations are being used to assess the role of grazers in mediating the effects of eutrophication in seagrass systems. Finally fishing pressure is another activity that can impact marine systems. Field studies are being used to assess the effect of marine protected areas on rocky reef and seagrass communities. These three studies led by post-doctoral researchers are being show-cased in this report.

CLIMATE CHANGE

Understanding the implications of environmental change for the biodiversity and ecosystem functioning of marine systems is vital for developing adaptive management strategies.

Over the last year, a research programme within CMER has been developed to investigate the implications of ocean acidification and global warming on the physiology and ecology of temperate seagrass assemblages. Initial research led by Dr Pippa Moore, and involving Natasha Dunham and Guilhem Marre (an intern from SupAgro Montpelier), investigated the consequences of the predicted changes in ocean carbonate chemistry (ocean acidification) on the growth and mortality of two abundant gastropod grazers in seagrass meadow; *Cantharidus sp.* and *Pyrene bidentata*. Environmental conditions within mesocosms were manipulated to represent current (~380ppm CO_2; pH 8.3) and future (~1,000ppm CO_2; pH7.75) conditions by regulating the diffusion of CO_2 directly into seawater via pH probes and automatic solenoid valves.

Initial experiments demonstrated significant negative impacts of increased CO_2 on shell growth in *P. bidentata* (Figure 5). Subsequent experiments investigating both *P. bidentata* and *Cantharidus sp.* produced more complex results with no significant effect of altered carbonate chemistry on shell growth in either species, although in the case *P. bidentata*, growth was always less in the high CO_2 treatments. There was, however, a significant reduction in the calcification rate of both species (Figure 5). Interestingly, and surprisingly, there was also increased mortality of Cantharidus sp. in the high CO_2 treatments (Figure 6).

Cantharidus sp. is considered to be an important food source for *Panulirus cygnus* found in shallow-waters and preference experiments have previously shown that *P. cygnus* preferentially consumes *Cantharidus sp.* over *P. bidentata*. Further experiments tested whether ocean acidification would alter *P. cygnus* prey

choice, however, there was no evidence of altered prey choice with *P. cygnus* preferentially consuming *Cantharidus sp.* irrespective of exposure to different CO_2 treatments (Figure 6d).

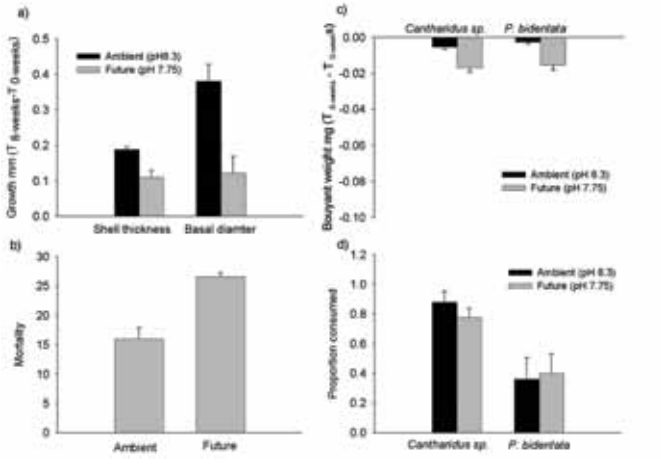


Figure 5: The effects of eight-weeks exposure to ambient and future seawater carbonate chemistry on a) *Pyrene bidentata* growth b) *Cantharidus sp.* and *P. bidentata* calcification rates c) *Cantharidus sp.* mortality d) consumption of *Cantharidus sp.* and *P. bidentata* by *Panulirus cygnus* in feeding choice experiments. Different letters above bars represent significant differences between treatments. Comparisons were not made between shell thickness and basal diameter or between the buoyant weights of *Cantharidus sp.* and *P. bidentata*.

Ongoing research led by Dr Kathryn McMahon and involving Drs Pippa Moore and Adriana Verges as well as Prof Peter Ralph from UTS, NSW is investigating the ecophysiological responses of seagrasses to ocean acidification and global warming. This research will also determine the implications of warming and increased CO_2 on the concentration of nutrients and secondary metabolites within seagrasses providing insights into the potential trophic implications of future environmental change. Seagrasses are predicted to benefit from increased carbon dioxide absorbed into the ocean, as it is likely to reduce carbon limitation and increase photosynthesis. However, increased temperature could have a direct negative effect, if the temperature is outside of the plants tolerance range, or indirectly by increasing biological activity in sediments where seagrass grow, which can draw down the oxygen in the sediments resulting in the release of sulfides that can have toxic effects on the seagrass. Preliminary investigations have found no effect of ocean acidification on *Zostera muelleri* seagrass survival, however temperature increased seagrass mortality. (Figure 7)

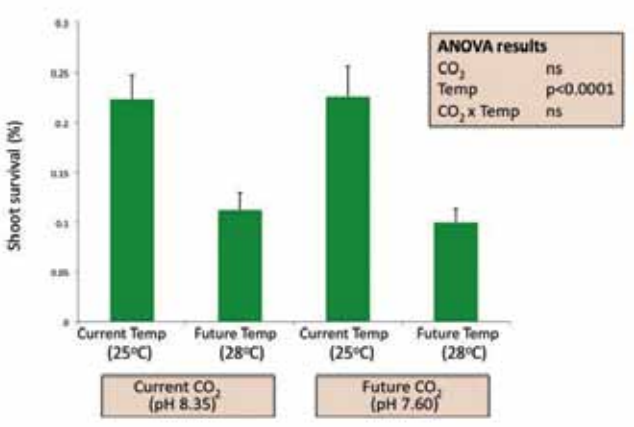


Figure 6: Reflects the percent effect of increases in Carbon Dioxide (CO_2) and Temperature on mortality (shoot survival) of *Zostera* seagrass. Rise in Temperature is shown to increase seagrass mortality where CO_2 levels have no or little effect.

THE EFFECTS OF FISHING PRESSURE ON COMMUNITIES AND ECOLOGICAL INTERACTIONS

Sanctuary zones (no-take MPAs) have shown patterns of higher abundances and biomass of previously exploited consumers in comparison to fished areas, but few have examined the possible repercussions fishing may have on ecological processes and biodiversity through indirect interactions or top-down control within and across one or many ecosystems. In this study, we compared the potential effects of sanctuary zones on consumer abundances and their effects on benthic assemblage structure both on limestone reefs and in adjacent *Amphibolis spp.* meadows.

Underwater visual census (UVC) transects were performed to compare consumer assemblages, while the epibenthic assemblage were sampled using quadrats on the reefs and in adjacent seagrass meadows at a range of sites in sanctuary and fished zones in Marmion Marine Park (MMP) and Rottnest Island Marine Reserve (RIMP) over three seasons. While not statistically significant ($p>0.05$), Permutational Analysis of Variance (PERMANOVA) indicated that sanctuary zones had higher total mean abundance of rock lobsters (Figure 7) and biomass of fish compared to adjacent fished zones. Consumers also demonstrated an overall decreasing trend in abundance with increasing distance away from the reef in Amphibolis meadows. Kingston Reefs sanctuary zone contained the greatest abundance, biomass, and species richness of consumers across all seasons.

While sanctuary zones had substantially higher densities of consumers in close proximity to reefs than in fished areas, it was expected that predation levels would be higher in sanctuary zones and would decrease with increasing distances away from the reef. However, this was not reflected in the epibenthic fauna and flora abundance and taxa richness. Much of the variability in consumers and epibenthic assemblage was primarily due to the high degree of variability among sites and among seasons. These differences could be due to site-specific characteristics, including age, size, and the geographical location of sanctuary zones, and the structural complexity of the habitat. A consumers' direct influence on prey abundance, richness, and distribution was not detected in this study, which may have been masked by their feeding habits, and level of mobility. The study has highlighted the level of complexity of food web structures with consideration of other environmental and biological factors. The effectiveness of MPAs in conserving ecological processes and broader biodiversity requires managers to acknowledge natural variations in marine ecosystems, such as the life-history traits of individuals, as protection may be suitable for some species and inadequate for others.

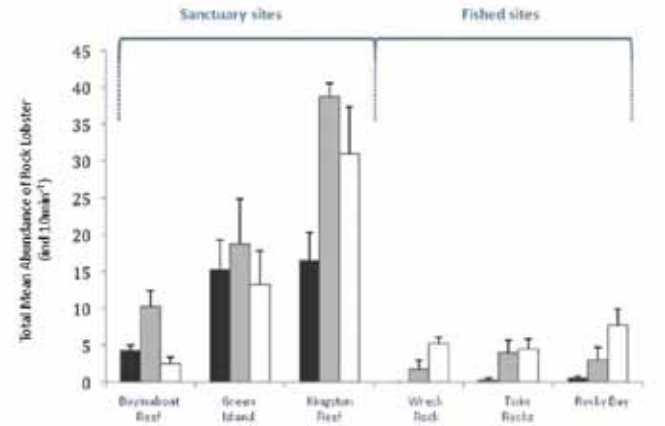


Figure 7: Mean (+S.E.) abundance of western rock lobster *(P. cygnus)* per 10 minute timed search in sanctuary zones: Boyinaboat Reef, Green Island, and Kingston Reefs, and in fished zones: Wreck Rock, Twin Rocks, and Rocky Bay.

THE ROLE OF MESO-GRAZERS IN OFFSETTING EFFECTS OF NUTRIENT POLLUTION IN MARINE ECOSYSTEMS

Seagrass meadows play an important structural and functional role in coastal ecosystems. Nevertheless, these ecosystems are threatened worldwide, with eutrophication (nutrient pollution) one of the most serious threats.

Nutrient enrichment stimulates the growth of more competitive micro- and macro-algae, which grow on the seagrass leaves and lead to the shading and strong impairment of seagrass leaves. Among the factors influencing seagrass susceptibility to nutrient enrichment, is the diversity and abundance of small herbivores. Previous studies have shown that small benthic herbivores such as amphipods and isopods feed preferentially on epiphytic or benthic algae, facilitating seagrass growth by releasing it from algal competition. However, recent studies show that the impact of grazer communities on algae growth seems to be complex and moderated by other factors.

Post-doctoral Fellow Britta Munkes, along with Paul Lavery and Mathew Vanderklift (CSIRO) have been undertaking a project to understand the effect of different grazer species, grazer diversity, seasonality and hydrodynamic environment (waves) on grazing intensity. They conducted a set of field experiments to examine the role of small herbivorous grazers in compensating effects of eutrophication in seagrass ecosystems. They found strong negative effects of moderate nutrient enrichment on seagrass health (leaf length, biomass and growth), but strong positive effects on epiphytic algal biomass, particularly for red algae. Eutrophication also led to an increase in epiphyte diversity. Without any mesograzer being present, both micro- and macroalgae flourished in treatments with nutrient enrichment. Interestingly, only amphipods were able to significantly suppress epiphytic algal growth (Figure 8). This is especially surprising, as in Western Australia, amphipod communities consist nearly solely of tiny individuals, often much smaller than 500µm. Summarizing our work gives a new understanding in the effect of mesograzer and provides evidence about their important role in ameliorating eutrophication effects and thereby stabilizing seagrass ecosystems.

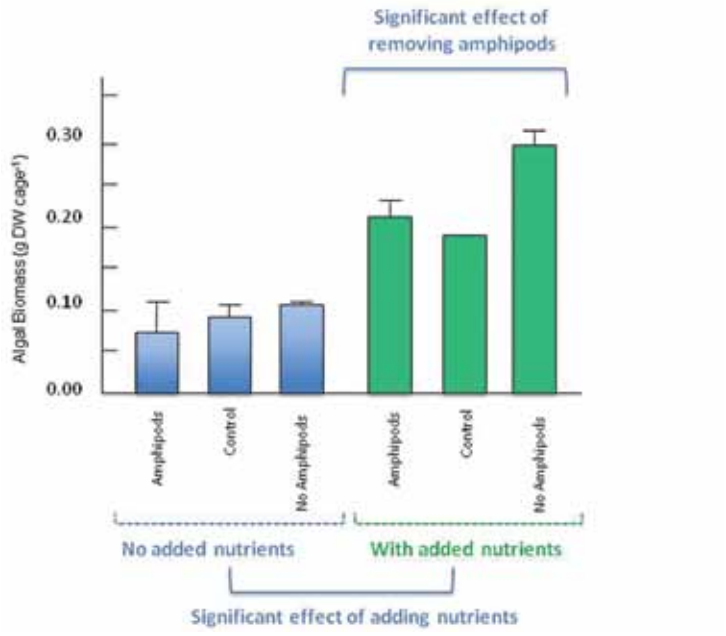


Figure 8: Combined effects of nutrients (enriched and ambient) and amphipods (grazers) on epiphytic algal growth on seagrass leaves in control-treatment experimental plots.

NEW PROJECTS

IMPROVING CAPACITY TO PREDICT IMPACTS OF DREDGING – MODELLING THE LIGHT ENVIRONMENT IN RELATION TO SEAGRASSES

Dredging for construction and maintenance of ports is crucial for maintaining Australia's export industry. However, dredging occurs in marine areas highly valued for their ecosystem services and often results in impacts due to reduced light or increased sediments. Improved capacity to predict the impacts of dredging is significant for permitting the on-going development of the export sector as well as protecting the environment from related unacceptable impacts.

Over the past decade, management of dredging has improved significantly, largely through improved ability to predict the spatial extent and intensity of turbid plumes (stress fields) but also through a greater understanding of the potential impacts on marine biota. However, for some globally important coastal habitats, such as seagrass meadows, the susceptibility to environmental changes caused by dredging is not well understood. One reason for this is that the interaction of light through the water column that has particles suspended in it, and with canopies of submerged vegetation is a physically complex situation. For example the amount of light received by a seagrass leaf is dependent on the canopy structure, the constituents of the water column and the sea surface state, sun position and cloud cover. These factors interact to produce a characteristic light environment at the seabed or the surface of plant canopies growing on the seabed, referred to as the 'benthic light field'. To date, the complexity of these interactions has prevented reliable estimates of how much light plants receive during dredging events, and how that will impact on their survival.

Recent advances in modeling light in three dimensional aquatic canopies provide for the first time the ability to factor canopy morphology and its interaction with the benthic light field into assessments of plant responses to altered light conditions. The proposed research will bring together innovative new light-modeling software and a unique data set of seagrass responses to light conditions in order to model the response of seagrass to dredging-related changes in light climate. ECU will apply innovative aquatic canopy modeling software produced by ARGANS Ltd., UK to undertake retrospective and predictive investigations of canopy-scale light interactions during dredging events that occurred at Geraldton Port and will occur at Oakajee Port during the course of this study. This work will build upon the ECU expertise of Kathryn McMahon and Paul Lavery in seagrass environmental impact assessments and involves collaborations with Oceanica in WA (Luke Twomey and Mark Westera), a consultancy company who is regularly involved in dredging projects, ARGANS Ltd. in the UK (John Hedley) and Curtin University (Peter Fearns).

INTERNATIONAL INTERNSHIPS

CHANGES IN GROWTH, EROSION, PRODUCTIVITY AND MORPHOLOGY OF ECKLONIA RADIATA ALONG A HYDRODYNAMIC GRADIENT

Jeremie Godefroy from the *Université de la Rochelle – France* arrived in Perth to pursue a short internship of 3 months (June-August 2010) under the supervision of Thibaut de Bettignies and Dr Thomas Wernberg within CMER. His research project was looking at changes in growth, erosion, productivity and morphology of *Ecklonia radiata* along a hydrodynamic gradient during a winter period. Jeremie found that these changes did occur and were relatively severe. Individual algae individual biomass was reduced by 40% for all 9 reefs surveyed in early winter in only two months and was the result of an intense lateral rather than distal erosion of the kelp thallus. The subsequent reduction in kelp thallus size and biomass made them less susceptible to severe drag forces generated by later winter storms. The main results of his project were presented at the Australasian Society of Phycology and Aquatic Botany (ASPAB) national conference as a poster. Together with Thibaut's talk, they received a student prize for best presentation. In addition to his project, Jeremie helped to deploy *in situ* hydrodynamic tools to measure wave conditions during stormy weather in winter and the resulting dislodgement of kelp from reefs. In spite of rough weather conditions, they managed to gather general and maximal *in-situ* water velocities together thanks to his experienced diving skills. These were the result of a successful deployment of maximum velocity recorders and gravitational loggers during the most significant winter storm (5 to 6m swell height offshore). The resulting oscillatory force generated by waves on one reef is represented in Figure 9.
In addition, to study the disturbance generated by waves on the kelp forest, they estimated the dislodgment rates for different reefs and hydrodynamic conditions (sheltered to exposed reefs), quantified as the number of remaining kelp tagged after the storm. Figure 10 summarises our findings and indicates a linear trend for the relationship between water velocity and dislodgment rate. In general, Jeremie Godefroy's contribution added to finalising some of Thibaut's ongoing research and highlighted the need for further investigations on the erosion process (currently being tested).

Thanks to his work within our group, Jeremie gained an intensive experience in the field (diving) and managed afterwards to obtain a French scientific diving certificate.

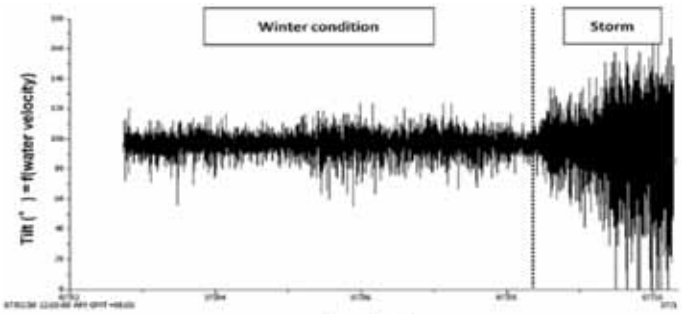


Figure 9: Gravitational loggers output during winter from 2nd to 10th July 2010

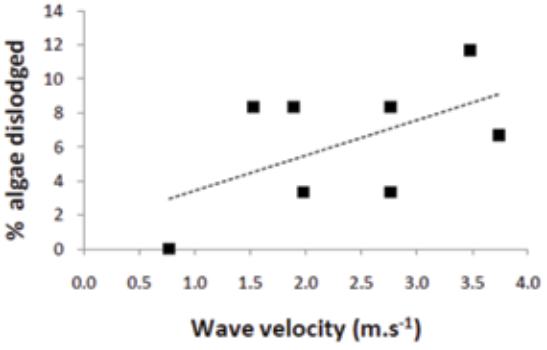


Figure 10: Test of dislodgment rate as a function of wave exposure (water velocity)

VARIATION IN NUTRITIVE QUALITY OF ECKLONIA RADIATA OVER ITS MAIN GROWTH PERIOD

Bastien Debeuf from the *Agrocampus Ouest – France*, came for an internship of 5 months (summer 2010). Bastien's research project investigated variation in nutritive quality of *Ecklonia radiata* over its main growth period, under the supervision of Thibaut de Bettignies, Dr Thomas Wernberg and Professor Paul Lavery. Along with recent findings and after Jeremie's project, it became important to understand how kelp regrow after this previously described erosion peak/ winter period; and whether or not the nutritive value of kelp tissue change temporarily and spatially over the main growth period. In a context of trophic connectivity mediated by kelp detritus, it was important to estimate the nutritive quality of this material likely to be exported later in the year. Bastien successfully managed to quantify carbon, nitrogen, phosphorous, pigments content (Chlo a, Cho c and Fucoxanthin) and total sugars of kelp tissue. From early September to early December 2010, Bastien sampled and monitored any change of kelp tissue quality at 4 different reefs in different environmental conditions and measured any change in environmental variables such as light, temperature and wave exposure.

Bastien found that variations in kelp tissue did not occur spatially in Marmion Lagoon but the tissue quality changed temporally during his study. He noticed a general increase of the C:N ratio from 25 up to 40 and a significant increase in total sugars from 2 to nearly 15 $\mu g.g^{-1}$ of fresh weight in only 3 months, meaning that kelp accumulated a significant reserve of energy in the form of sugars. However, the quality of kelp tissue decreased as the C:N ratio increased, resulting in the material being less palatable for later consumers. Further analysis was done to understand these variations with regards to environmental changes. Thanks to these promising results obtained by Bastien, sampling is still on-going to extend his data set for a further year to understand these seasonnal changes better in relation to environmental parameters. Finally, Bastien's work brought additional and interesting perspectives to Thibaut's PhD project.

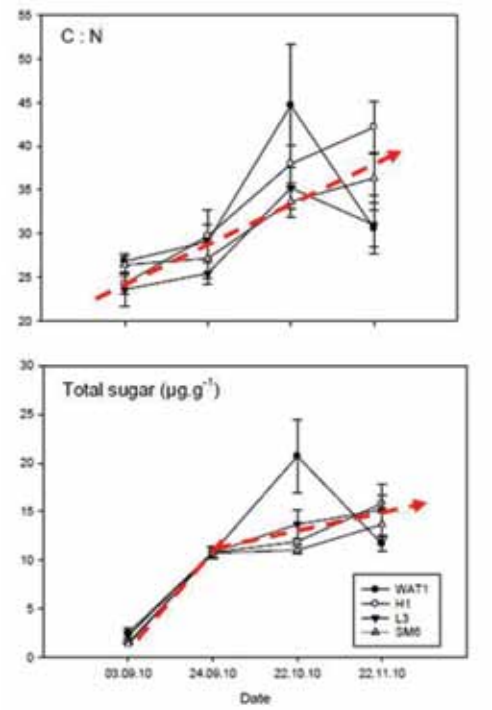


Figure 11: C: N ratio and Total sugars variation in kelp tissue over its main growth period.

HIGHLIGHTS
Research Training

ADAM GARTNER: TROPHIC IMPLICATIONS OF LIGHT REDUCTIONS FOR *AMPHIBOLIS GRIFFITHII* SEAGRASS FAUNA

Adam Gartner has punctuated two successful research degrees at ECU with a period as an Environmental Officer in the Department of Environmental Protection. In 2000, Adam gained a First Class Honours in Environmental Management for his research on the use of stable isotopes to map sewage effluent in the marine environment. He then worked for several years with the Department of Environmental Protection, where he was heavily involved in the production of the State of the Environment Report. He then returned to ECU to undertake his Ph.D. research, shifting his focus from isotopes to macro-invertebrates.

The mining boom in WA is heavily dependent on the export of minerals through ports. A massive programme of port development has required major dredging programmes that release sediments into the water column, the resultant turbidity reducing the light penetrating to seagrasses on the sea floor. It is well understood that plants, such as seagrasses, will die if starved of light. Much less well understood is the flow-on effect of this for other organisms higher up the food chain. For example, many local fishermen will want to know what the effect of losing seagrass is on their ability to catch snapper?

Adam took advantage of a major experiment examining the effect of light reduction on seagrasses to look at the impact on macro-invertebrates. He then worked with CSIRO colleague Hector Lorenzo to develop an ecological model that extended his insights up the food chain to high order predators, such as snapper and groper, insights that would be impossible to obtain through traditional experimental approaches.

Adam's work has extended our knowledge on the flow-on effects of seagrass loss to higher trophic levels and provides compelling evidence that the impacts are significant, but not necessary consistent for different fauna. At lower trophic levels, animals dependent on seagrass ecosystems disappeared rapidly as the epiphytic algae growing on the seagrasses disappeared. However, these organisms recovered quickly once the seagrass meadow began to recover. The predatory fish, however, showed an initial resilience to loss of seagrass, but some then showed a delayed response, sometimes not apparent for many months or years after the initial impact. This produces complex flow-on effects for higher trophic levels, and the modelling Adam has included in his thesis points the way forward in predicting wider ecosystem effects of benthic primary producer habitat loss.

Some of Adam's work was recently published in MEPS:

> **Gartner A**, Lavery PS, McMahon K, Brearley A, Barwick H (2010). *Light reductions drive macroinvertebrate changes in Amphibolis griffithii seagrass habitat.* Marine Ecology Progress Series 401: 87-100.

Adam is now working at Oceanica Consulting as a Senior Marine Ecologist. From all at CMER, congratulations to Adam and best wishes for his post-CMER career.

CMER MEMBERS

ECU STAFF

Mr Pierre Bouvais

Pierre arrived in Australia and joined the ECU CMER group in 2010 after completing his Master in Marine Biology at University of Pierre and Marie Curie. He worked on research projects with Dr Britta Munkes and Dr Pippa Moore concentrating on grazing in temperate seagrass meadows. In 2011, Pierre took a lead role in our project examining the effects of nutrient enrichment on reefs. Pierre was successful in obtaining an International Postgraduate Research Scholarship and will commence his Ph.D. studies in 2012, examining the effects of dredging on benthic fauna communities.

Dr Richard Campbell

Richard joined CMER in late 2010, as a collaborator from the Department of Environment and Conservation. He is interested in bridging the gap between science and its application to effective conservation of marine species and communities. His research generally focuses on the ecology and conservation of marine vertebrate fauna. Currently he is researching the demographics and foraging ecology of pinnipeds (seals), dugong and sea turtle in Western Australia all of which are at risk from human activities. A recent collaborative research programme with the Bardi-Jawi indigenous rangers in the West Kimberley on dugong foraging ecology has highlighted the need for western science to incorporate different approaches to developing meaningful and sustainable conservation management.

Mr Rob Czarnik

After completion of a Post Graduate Diploma of Science (Biological Sciences) Rob was employed as a research assistant for Dr Britta Munkes, Dr Pippa Moore, Dr Adriana Vergès and Dr Christine Hanson. Most of his work has concentrated on grazing in both tropical and temperate seagrass meadows. Rob has also provided support for aquaria feeding experiments and aquaria Ocean Acidification experiments. Outside his research duties Rob is also a first year demonstrator and the School of Natural Sciences' Field Safety and Support Officer.

Associate 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.

Ms Karina Inostroza

Karina was working as a part-time research assistant for Dr Pippa Moore on the rock lobster project, examining the impact of Panulirus cygnus removal through fishing on the benthic assemblage. She subsequently completed her Honours in marine ecology, examining the impact of spatial management on higher-order consumers and its effect on community assemblage and ecological interactions in seagrass meadows. Karina has since been appointed to the position of Research Survey Officer in the Dept. of Fisheries WA, where she is involved in stock assessment and data analysis.

Professor Paul Lavery

Paul's research interests relate to the functioning of benthic marine ecosystems and how they respond to human-induced pressures. His research has focused on seagrass ecosystems and how to improve the way we predict, monitor and manageme impacts. 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 (in collaboration with Glenn Hyndes). Much of this work has relied on stable isotope and other biomarker techniques to understand how materials transported from one habitat supporting productivity in adjacent habitats; and (3) the carbon capture and storage potential of seagrass ecosystems, and their role in offsetting the impacts of atmospheric carbon emissions.

CMER MEMBERS

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 phylogenetics. 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, Kathryn uses molecular tools to investigate the relationship of seagrass taxa.

Dr Pippa Moore

Pippa's research focuses on the effects of anthropogenic impacts on shallow water marine community dynamics and ecosystem functioning. In particular she is interested in the role of fisheries in altering key ecosystem processes (e.g. predation) and how this affects benthic assemblages. She is also interested in the effects of climate change on marine biodiversity and more particularly how changes in biotic interactions may affect the structure and functioning of marine systems. In 2011, Pippa was appointed to a lectureship in Aquatic Biology at Aberystwyth University, Wales, where she is pursuing research on climate change impacts and the value of engineered structures for habitat enhancement.

Dr Britta Munkes

Britta is a benthic ecologist, interested in community processes. Her research focuses on the impact of human-induced environmental stressors (nutrient pollution and altered food webs) as well as interacting physical factors on benthic communities. Britta is particular interested in the effects of these stressors on the resilience and biodiversity in seagrass communities. Her goal is to understand about processes leading to changes in competition strength between seagrasses and algae, between top-down (grazers) and bottom-up (nutrient enrichment) effects. Britta has returned to Germany to complete the final phase of her Marie-Curie Fellowship, but will return to CMER to pursue research into the effects of wave movement on plant-grazer interactions.

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.

Mr Aldo Turco

Aldo arrived in Australia and joined the ECU CMER group after completing his Master in Marine Biology at University of Pisa. He started his collaboration as volunteer for Dr Thomas Wernberg, helping Thibaut De Bettignies with his PhD project and shortly after he was employed as a part-time research assistant for Dr Pippa Moore and Dr Britta Munkes during 2010. He started his Ph.D. at ECU in 2011.

Dr Adriana Vergés

Adriana's research focuses on the ecology and evolution of marine trophic interactions, i.e. who eats who in the sea, and why. The main bulk of her current research focuses on the topic of fish herbivory in the Ningaloo Reef Marine Park. Other particular topics of interest are seagrass ecology and physiology and the effectiveness of marine protected areas to protect biodiversity and ecosystem functions. Adriana took up a lectureship at University of New South Wales in late 2010.

Dr Thomas Wernberg

Thomas has a range of research interests including: the effects of climate change on temperate reef communities; the influence of scale, extent and environmental stressors on trajectories of recovery following physical disturbances to algal habitats; the morphological variation and architecture in canopy-forming algae and its consequences for the ecology of the understorey; the trophic linkages between kelp beds and adjacent habitats in the form of detached reef algae; the biomechanical properties of macroalgae and the prediction of physical disturbances; and the ecology of invasive macroalgae and their impacts on native algal assemblages. Thomas is now a Postdoctoral Fellow at the University of Western Australia.

Ms Candace Willison

Candace took up the administration role within CMER in early 2010 until June 2011. In late 2010 she also began working as a part time research assistant for Prof. Paul Lavery and Asst. Prof. Glenn Hyndes, looking at kelp wrack subsidising seagrass meadows. Candace is completing a Master's in Environmental Management, looking at the spatial and temporal variations in seagrass wrack degradation in south Western Australia.

ADJUNCT STAFF

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.

Mr Dave Holley

Dave's main focus of research is on the foraging ecology and habitat utilisation of marine mammals, in particular species such as the dugong, seals and sea lions. He is interested in understanding the movements of these species and the forcing factors behind them through the use of technology such as satellite and GPS tags and time depth recorders. Dave works closely with local Indigenous communities throughout NW WA, an important component of any dugong related research activity given the importance of dugongs to coastal Aboriginal groups. Working together also provides for a meeting point of traditional knowledge with modern science.

Dr Ray Masini

Ray is based at the Office of the Environmental Protection Authority. His research has focused on Western Australian marine ecosystems generally, with particular emphasis on the tropical arid ecosystems of the central west and north-west coasts. More recently this focus has moved north to the tropical Kimberley coast. 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 as they relate to the three-way interaction between research, environmental policy formulation and environmental management.

Dr Mads Solgaard Thomsen

Mads's research focuses on how anthropogenic stressors, in particular bio-invasions, nutrient pollution and climate change, impact the structure, productivity and biodiversity of aquatic communities. Mads combines manipulative experiments, analysis of long-term monitoring data and literature-based meta-analysis to test how patterns in biological communities are generated and maintained. This research provides predictions on how coastal habitats will respond to anthropogenic stressors and recommendations for conservation strategies needed to ameliorate their impacts.

Dr Fernando Tuya

Fernando's research is driven by the need to develop rules and models to explain the patterns of organization of marine populations and communities from local to macroecological (biogeographical) scales. From this general interest, Fernando is particularly interested in ecological processes shaping temperate reefs from small to large geographical scales, 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. As a tool to improve the public perception and awareness of marine biodiversity, he has contributed to the dissemination of the marine flora and fauna of the Atlantic Ocean through books and open-access monographs.

Dr Mat Vanderklift

Mat is a marine ecologist based at CSIRO Marine & Atmospheric Research. His research interests include ecological linkages between habitats, the use of stable isotopes to study trophic ecology, factors influencing the abundance of flora and fauna, the ecological importance of consumers (herbivores and carnivores) and the effects of human use of marine ecosystems.

POSTGRADUATE RESEARCH STUDENTS

Gary Choney (Masters)

Impact of swan grazing on the seagrass *Halophila ovalis* in the Swan-Canning Estuary. (completed)

Audrey Cartraud (Hons)

The role of allochthonous kelp in increasing productivity in a seagrass ecosystem.

Adam Gartner (PhD)

Trophic implications of seagrass habitat disturbance from reduced light.(Completed)

Karina Inostroza (Hons)

The effects of spatial management on communities and ecological interactions in seagrass meadows in southwest WA. (Completed)

Peter Kiss

The role of allochthonous kelp in subsidising Amphipods inhabiting *Amphibolis* seagrass meadows. (Completed)

Andrew Mackey (PhD)

Spatial and temporal variability in ^{13}C and ^{15}N stable isotope signatures of primary producers and consumers on temperate reefs

Charu Lata Singh (PhD)

Kelp wrack as a trophic subsidy in seagrass ecosystems.

Aldo Turco (PhD)

The role of *Kyphosus* spp. in reef ecosystems

Candace Willison (Masters)

Rates and processes of *Posidonia sinuosa* degradation in south-west Australia.

Thibaut de Bettignies (PhD)

Source and supply of seaweed wrack to adjacent habitats.

Ainslie Denham (PhD)

Geostatistical spatiotemporal modelling of king prawn catch rate in the Shark Bay managed prawn fishery.

Jason How (PhD)

Assessing the potential benefits of marine protected areas to adjacent fished areas.

Mohammed Rozaimi Jamaludin (PhD)

Carbon preservation in seagrass meadow ecosystems.

Michael Mulligan (Masters)

Indicator of sub-lethal stress following imposed light reduction on the seagrass *Amphibolis griffithii*.

Carli Telfer (Masters)

The Western Australian charter industry: Working towards long-term sustainability. (Completed)

Federico Vitelli (Masters)

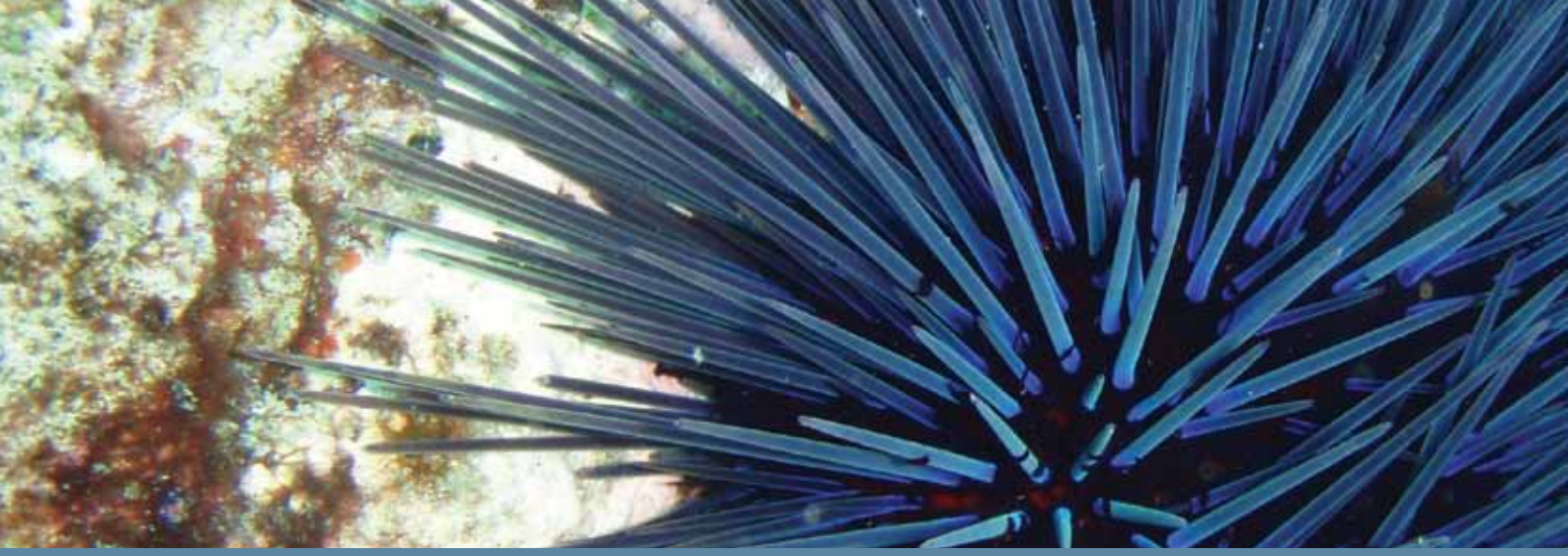
Feeding ecology of *Parma mccullochi* (Pomacentridae) and its impact on temperate algal dominated reefs.

Justin King (Masters)

Factors affecting *Artemia franciscan* culture and comparison between feeds and strains.

CURRENT RESEARCH PROJECTS

Project	Funding Body	Investigators	Income
Improving the experiential design and statistical rigour for estimating state-wide recreational catch by boat based anglers	Dept of Fisheries	Lavery, Graham, Mueller, Hyndes	1,392,000
Protection of coastal ecosystems and marine resource management	Dept of Innovation, Industry, Science and Research	Lavery, Hyndes, McMahon (ECU) Kendrick, Oldham, Ghisalberti (UWA)	890,684
Survey of New Zealand fur seal in south-west Western Australia	Dept Environment and Conservation and ECU	Hyndes, Campbell	103,000
The role of herbivory and hydrodynamics in ameliorating the impacts of nutrient enrichment in marine ecosystems	CSIRO (Flagships Collab.)	Lavery, Munkes, Vanderklift	100,000
Quantification of the Biodiversity of the Lake MacLeod Northern Ponds	Dampier Salt Limited	Horwitz, Hyndes, Froend, McMahon	76,475
Trophic Interaction and Ecosystem Modelling	WAMSI and ECU	Hyndes, Moore	65,018
Developing indicators of nutrient enrichment impacts on near shore coastal reefs	Commonwealth Dept of Defence and ECU	Munkes, Lavery, McMahon	58,937
Improving capacity to predict impacts of dredging – modelling light and the response of seagrasses	Oceanica Consulting; ECU Industry Collaboration	McMahon, Henley, Lavery, Twomey	25,000
Predicting climate change impacts on seagrasses – the effect of temperature and ocean acidification	Oceanica Consulting and ECU	McMahon	24,995
Carbon preservation in seagrass ecosystems – characterising Australia's Blue-Carbon reserves	Australian Institute of Nuclear Science and Engineering	Lavery, Jamaludin	14,240
Source and supply of seaweed wrack from reefs to adjacent habitats	Ph.D. study	de Bettignies	12,272
Ecological interactions in coastal marine ecosystems: Trophodynamics	WAMSI and ECU	Hyndes, Verges	5,000
Rates and processes of *Posidonia sinuosa* degradation in south Western Australia.	ECU	Willison, Lavery, McMahon	3,000
Seagrass Monitoring Program for Geographe Bay	Dept of Water WA	McMahon	3,121



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JOURNALS

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Smale DA., Kendrick GA., **Wernberg T.** (2011) Subtidal macroalgal richness, diversity and turnover, at multiple spatial scales, along the southwestern Australian coastline Estuarine Coastal and Shelf Science. 91 (2): 224-231

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Mellbrand, K., **Lavery, P.**, **Hyndes, G.** and Hambäck, P. (2011). Linking land and sea: different pathways for marine subsidies. Ecosystems 14: 732-744

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Bennett S., **Verges A.**, and Bellwood D (2010). Branching coral as a macroalgal refuge in a marginal coral reef system. Coral Reefs. 29: 471-480.

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Svensson C., **Hyndes G.**, and **Lavery P** (2010). An efficient method of collecting large samples of live copepods free from detritus. Marine and Freshwater Research. 61: 621 – 624.

Thomsen M., **Wernberg T.**, Altieri A., **Tuya F.**, Gulbransen D., McGlathery K., Holmer M., and Silliman B (2010). Habitat cascades: the conceptual context and global relevance of facilitation cascades via habitat formation and modification. Integrative and Comparative Biology. 50: 158-175.

Thomsen M., **Wernberg T.**, **Tuya F.**, and Silliman B (2010). Ecological performance and possible origin of a ubiquitous but under-studied gastropod. Estuarine Coastal and Shelf Science. 87: 501-509.

Tuya F., **Vanderklift M.**, and **Hyndes G** (2010). Proximity to rocky reefs alters the balance between positive and negative effects on seagrass fauna. Marine Ecology Progress Series. 405: 175-186.

Vanderklift M., and **Wernberg T** (2010). Stable isotopes reveal a consistent consumer–diet relationship across hundreds of kilometers. Marine Ecology Progress Series. 403: 53–61.

Vergés A., Alcoverro T., and Romero J (2010). Plant defences and the role of epibiosis in mediating within-plant feeding choices of seagrass consumers. Oecologia. 166: 381-390.

Wernberg T., **Thomsen M.**, and **Tuya F** (2010). Decreasing resilience of kelp beds along a latitudinal temperature gradient: potential implications for a warmer future. Ecology Letters. 13: 685 – 694.

Wernberg T., and **Vanderklift M** (2010). Contribution of temporal and spatial components to morphological variation in the kelp Ecklonia (laminariales). Journal of Phycology. 46: 153–161.

NON REFEREED PAPERS/ PROCEEDINGS

de Bettignies T, Wernberg T, Lavery PS, Vanderklift M (2010). The importance of storms in driving export of organic matter (kelp wrack) from rocky reefs. WAMSI Young Career Researchers Symposium, 3rd November 2010, Edith Cowan University, Joondalup.

de Bettignies T, Wernberg T, Lavery PS, Vanderklift M (2010). The importance of storms in driving export of organic matter (kelp wrack) from rocky reefs. Australasian Society for Phycology and Aquatic Botany (ASPAB), 15-18th November 2010, Rottnest Island.

de Bettignies T, Godefroy J, **Wernberg T, Vanderklift M** (2010). Changes in growth, erosion, productivity and morphology of Ecklonia radiata along a hydrodynamic gradient. ASPAB, 15-18th November 2010, Rottnest Island.

McMahon K (2010). Seagrass wrack dynamics – Australian Marine Science Association.

Vanderklift M, Babcock R, Bearham D, **de Bettignies T**, Kendrick G, Wernberg T (2010) A single species, the kelp Ecklonia radiata, is disproportionately important in coastal marine ecosystems. ASPAB, 15-18th November 2010, Rottnest Island.

Wernberg T, **de Bettignies T**, Morhing M, Benett S (2011) Continental-scale pattern of ecological processes in kelp beds. Third Annual ANNIMS Conference 2011, December 2011, Perth.

de Bettignies T, Wernberg T, Lavery PS, Vanderklift M (2011) Spatial subsidies provided by organic matter export from kelp forests: importance of storm-driven pulses verses chronic export. Third Annual ANNIMS Conference 2011, December 2011, Perth.

de Bettignies T, Wernberg T, Lavery PS, Vanderklift M (2011) Spatial subsidies provided by organic matter export from kelp forests: importance of storm-driven pulses verses chronic export. International Temperate Reef Symposium 2011, June 2011, Plymouth, UK.

REPORTS

Verges, A., **Hyndes G.** and **Vanderklift M.** (2011) Trophic effects through herbivory at Ningaloo Reef. Final report for WAMSI Node 3.2: Biodiversity assessment, ecosystem impacts of human usage. Centre for Marine Ecosystems Research, Edith Cowan University

Lavery P. (2011). Monitoring on seagrass meadows on the eastern shore of Garden Island, Western Australia. Centre for Marine Ecosystems Research, Edith Cowan University.

Lavery P., and **McMahon, K.** (2011). Review of Cockburn Sound SEP Seagrass Monitoring Program. Centre for Marine Ecosystems Research, Edith Cowan University.

Moore P. and **Hyndes G.** (2011) Trophic interactions of rocklobster in shallow-water. Final report for WAMSI Node 4.3 Project: Trophic interactions and ecosystem modelling for ecosystem-based fisheries management. Edith Cowan University

Campbell R., **Holley D** and Bardi-Jawi Rangers (2010). Movement behaviours and habitat usage of West Kimberley dugongs: A community based approach. Dept. of Environment & Conservation/Edith Cowan University, Report to the Australian Marine Mammal Centre, pp. 52.

Lavery P., and **Munkes B** (2010). Monitoring on seagrass meadows on the eastern shore of Garden Island, Western Australia. Centre for Marine Ecosystems Research, Edith Cowan University.

Oldham C. E., **Lavery P. S.**, McMahon K., Pattiaratchi C., and Chiffings T. W (2010). Seagrass Wrack Dynamics in Geographe Bay, Western Australia – Report to Dept. of Transport and Shire of Busselton.

CONFERENCE ATTENDANCE & PRESENTATIONS

WAMSI show and tell, Fremantle. February 9th, 2010.
Gary Choney, Glenn Hyndes, Pippa Moore and Britta Munkes.

International Seaweed Symposium, Mexico. February 18-28, 2010.
Thomas Wernberg.

Special meeting on Marine-Costal Sciences – Coastal Zone Rehabilitation and Investigation of land-Sea Interactions of Pilot Areas for Economic Recovery along the Eastern-Southern Mediterranean (CORER), Lebanon. March 24-29 2010.
Britta Munkes.

NCEAS meeting, Santa Barbara, U.S.A. April 16-24 2010.
Pippa Moore.

AMSA National Conference, Wollongong. July 4-8, 2010.
Kathryn McMahon, Britta Munkes, Candace Willison and Adriana Vergés.

ARC Australian Coral Reefs
Adriana Vergés.

International River's Symposium, Perth. October 2010
Gary Choney (pictured) awarded special recommendation for his poster, 'Black swan abundance and grazing pressure in the Swan River estuary

WAMSI Young Career Researchers Symposium, Edith Cowan University. November 3, 2010.
Thibaut de Bettignies.

ASPAB Conference, Rottnest Island. November 15-18, 2010.
Thibaut de Bettignies (pictured receiving award) and Kathryn McMahon attended. Thibaut was awarded Best Student Presentation.

World Seagrass Conference and 9th International Seagrass Biology Workshop, Phuket. November 21-29, 2010.
Attendees (Left to right) – Candace Willison, Gary Choney, Glenn Hyndes, Paul Lavery, Britta Munkes, Kathryn McMahon, and Rozaimi Jamaludin.

9th International Temperate Reefs Symposium held in Plymouth, UK, July 2011
Thibaut de Bettignies was the Bursary winner at the International Temperate Reefs Symposium 2011 MBA (Marine Biological Association of the UK) bursary competition, Plymouth (July 2011), UK.

48th Annual AMSA Conference held in Fremantle, 3rd – 7th July 2011
Left to right – Aldo Turco, Andrew Mackey, Pierre Bouvais, Rozaimi Jamaludin, Fede , Gary Choney, Candace Willison (Winner of Ron Kenny Award), Britta Munkes, Paul Lavery, Kathryn McMahon, Adam, Richard Campbell (not pictured) and Glenn Hyndes (not pictured).

SEMINAR SERIES

EXTERNAL SPEAKERS

Dr Michael Bunce (Murdoch University) – Ancient DNA preservation “down under”.

Prof. James W. Fourqurean (Florida International University) – Blue carbon in seagrass ecosystems: how much is there and what’s it worth?

Dr Brezo Martinez (Universidad Rey Juan Carlos): Distributional shifts of Macroalgae to global change: Assessing habitat models projections using physiological thresholds.

Dr Donald Phillips (US Environmental Protection Authority) – Advances in satble isotope mixing models for partitioning of sources to mixtures.

Dr Kor-Jent Van Diik (James Cook University) – Species determinations in seagrasses using molecular techniques

Dr Stephen Mudge (Environmental Practice UK) – Multivariate techniques for the fingerprinting of chemical mixtures

Dr Mark Brown (ECU – School of Excersise & Health Science) – Flow cytometry; an update of the technique and its application.

RESEARCH LINKS

GOVERNMENT

- Australian Institute of Marine Sciences (AIMS)
- Cockburn Sound Management Council
- Department of Defence, Navy
- Department of Environment and Conservation (WA)
- Department of Fisheries (WA)
- Department of Natural Resources and Environment, Victoria
- Department of Planning and Infrastructure (WA)
- Geraldton Port Authority
- Great Barrier Reef Marine Park Authority
- Queensland Environmental Protection Authority
- Swan River Trust (WA)

AUSTRALIAN RESEARCH

- ARC-NZ Vegetation Function Network
- Fisheries Research and Development Corporation
- Tasmanian Aquaculture and Fisheries Institute
- Western Australian Marine Sciences Institute (WAMSI)
- CSIRO Marine and Atmospheric Research
  - Wealth from Oceans Flagship
  - Strategic Research Fund for the Marine Environment (SRFME)

INTERNATIONAL

- Université de Nice, France
- Université P Sabatier – Toulouse III, France
- Otago University, New Zealand
- CIIMAR, University of Porto, Portugal
- Spanish Council for Scientific Research (CISC), Spain
  - Centre for Advanced Studies of Blanes (CEAB)
- University of Barcelona, Spain
- University of Las Palmas de GC, Spain
- Stockholm University, Sweden
  - Stockholm Marine Research Centre
- Dauphin Island Sea Lab, USA
- University of Florida, USA
- University of South Alabama, USA
- University of Virginia, USA

INDUSTRY

- Chevron
- Oceanica Consulting Pty Ltd
- Woodside Oil and Gas

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

COMMUNITY ENGAGEMENT

Body/Event	Role	Name
Seminars • Biomarkers in food-web ecology: good food or a pain in the gut? Chemistry Dept, Uni Otago • Pathways of connectivity in marine landscapes. Botany Dept, Uni Otago • Marine (Coastal) Systems. Rio Tinto	Speaker	Glenn Hyndes
Marine Reference Group, Perth Region NRM.	Chair	
Perth Region NRM.	Board member	
Reference Group for River Symposium 2010.	Member	Paul Lavery
Revision of ANZEC Water Quality Guidelines. The Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council Working Group – Biological Assessment and Monitoring and Assessment 2009-11	Member	
Presentation to Busselton Naturalist Club on seagrass wrack dynamics and wrack management.	Speaker	Kathryn McMahon
Busselton Dunsborough Mail newspaper article: Port Geographe groyne reconfiguration. A two year study has recommended structural changes to the groynes to remedy long term seagrass accumulation problems by UWA, ECU and independent research company DHI who undertook the study.	Author	
Radio Interview ABC Bunbury.	Interviewee	
AMSA Annual Postgraduate Symposium.	Invited Speaker	Pippa Moore
Talk to National Institute of Accountants (WA) on 'Accounting for Biodiversity' at AQWA.	Speaker	
Profile interview of an early career researcher for COSMOS magazine.	Interviewee	
20th International Seaweed Symposium, Mexico.	Invited presenter	Thomas Wernberg
CSIRO research meeting.	Invited presenter	
Reviewed report of the Swan River Trust.	Reviewer	

ALUMNI – WHERE ARE THEY NOW?

Helen Barwick (Honours)
MWH Global, Nelson, NZ

Dr Muriel Brasseur (PhD)
Oxfordshire Animal Behaviour Centre, United Kingdom.

Dr Catherine Collier (PhD)
James Cook University, Qld (Postdoctoral Fellow).

Dr Karen Crawley (PhD)
Oceanica Consulting Pty Ltd.

Mr Chris Doropoulos (Honours and Research Assistant)
University of Queensland (PhD).

Mr John Eyres (Masters)
Department of Fisheries, WA.

Dr Adam Gartner (PhD)
Oceanica Consulting Pty Ltd.

Ms Emily Gates (Honours and Research Assistant)
Australian Institute of Marine Science.

Ms Sophie Harrison (Masters)
Sinclair Knight Merz Engineering Consultant

Ms Karina Inostroza (Honours)
Department of Fisheries, WA

Dr Pippa Moore (Postdoctoral Fellow)
Aberystwyth University, Wales (Lecturer)

Peter Kiss (Masters)
Germany

Ms Rebecca Ince (Honours)
Department of Planning, WA.

Dr Alan Kendrick (Postdoctoral Fellow)
Department of Environment and Conservation, WA.

Dr Lachlan MacArthur (PhD)
Sinclair Knight Merz Engineering Consultant.

Mr Peter Michael (Honours)
Sinclair Knight Merz Engineering Consultant.

Dr Rory McAuley (PhD)
Department of Fisheries, WA.

Ms Nadia Tapp (Masters)
Department of Fisheries, WA.

Mr Andrew Tennyson (Research Assistant)
Sinclair Knight Merz Engineering Consultants.

Dr Mark Westera (PhD)
Oceanica Consulting Pty Ltd..

Mr Nick Wood (Honours)
Scitech

Dr Adriana Vergés (Postdoctoral Fellow)
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