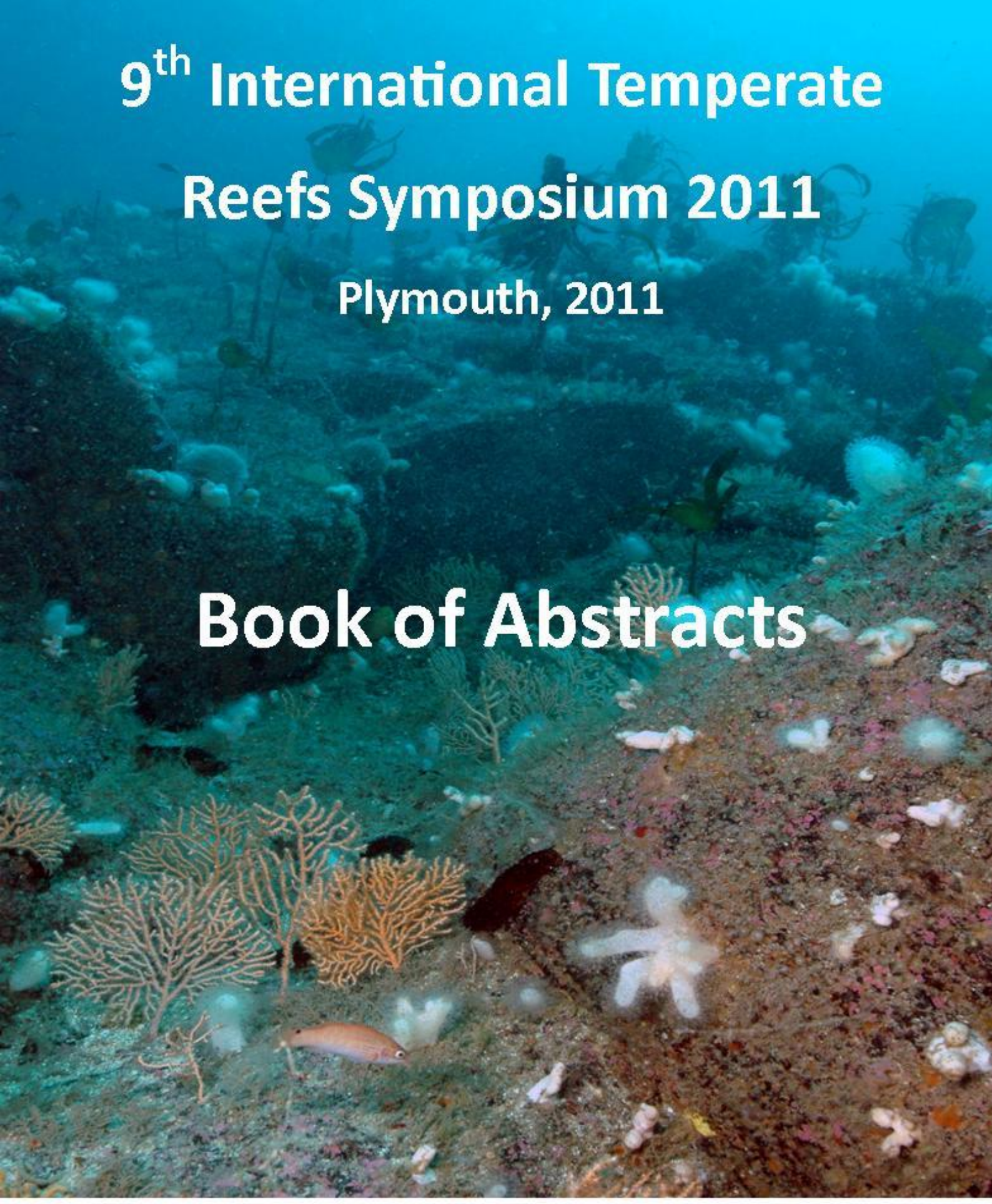
9th International Temperate Reefs Symposium 2011

Plymouth, 2011

Book of Abstracts



The University of Plymouth

The Marine Biological Association

9th International Temperate Reefs Symposium

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Plymouth, 2011

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9th International Temperate Reefs Symposium
Plymouth, England 2011

9th International Temperate Reefs Symposium

27 June - 1 July 2011

University of Plymouth, UK

CONFERENCE OVERVIEW

Sunday 26 June 2011	**17:00—19:00**	**Registration and drinks, Sherwell Conference Centre**
Monday 27 June 2011	**08:00—09:00**	**Registration, Sherwell Conference Centre**

Presentations may be uploaded daily between 08.00—08.45 and during the lunch break.
All refreshments and lunch will served in the Sherwell Conference Centre.

Day	Room	09:00	11:00	13:30	16:00	Evening
Monday	Lower			Larval Ecology		*Reception at the National Marine Aquarium - buffet dinner included*
	Upper	Temperate Reefs & Ecological Theory I	Temperate Reefs & Ecological Theory II	Temperate Reefs & Ecological Theory III	Temperate Reefs & Ecological Theory IV	
Tuesday	Lower		Propagules, populations and productivity	Propagules, populations & productivity/Macro & General Ecology/Climate		*Drinks reception at the Marine Biological Association*
	Upper	Propagules, populations & productivity/Macro & General Ecology	Macroecology & Modelling	Macroecology & Modelling / Ecology I	Global Change (Climate & Ocean Acidification) I	*Free time*
Wednesday	Lower		Global Change (Climate & Ocean Acidification) III	Global Change (Climate & Ocean Acidification) IV		*Poster Session with wine reception*
	Upper	Global Change (Climate & Ocean Acidification) II	Ecology II	Ecology III	Ecology IV	*Free time*
Thursday Session and refreshment times will differ on this day - see full schedule	Lower	Exploited Populations	Restoration & Management	Disturbance		*Conference Dinner at the Holiday Inn, Plymouth*
	Upper	Management & Conservation Reef Building Organisms	Deep-sea Reefs	Artificial Structures	Close of meeting	
Friday		*Organised excursion to Brixham, Dartmouth and Totnes - **advanced booking only***				

Lower - Lower Lecture Theatre Upper - Upper Lecture Theatre

Oral Presentations

In alphabetical order by presenting author

Functional identity and functional structure of a molluscan herbivore assemblage change drastically through algal succession

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Despite the great interest in determining the functional structure and resilience of functional groups in natural communities, few studies have examined in which way the role and functional relationships among intertidal herbivores change during algal succession. Variation in algal traits that characterize different phases and stages of community succession are likely to influence the magnitude, direction of effects, and the level of redundancy and complementarity in these assemblages. Through a series of field and laboratory experiments we quantified changes in both the magnitude and direction of herbivore effects on early and late successional stages in central Chile. During the colonization phase (~0-3 months) of early succession, all herbivore had similar effects on the abundance of green ephemeral ulvoids. Once these algae were established (i.e. adult plants ~3-6 months) only one herbivore was able to control their abundance. During late succession, dominated by the corticated alga *Mazzaella laminarioides*, only *Fissurella crassa* reduced significantly adult plant biomass. Our results show moderate redundancy in effects of herbivores during the colonizing phase of early succession with high potential for compensation, which changes to a more complementary role on established algae and to a keystone effect during late succession. Differences in foraging behaviour, body size and buccal morphology of herbivores, altogether, likely account for variation in the effects through succession. Our study emphasizes the need to evaluate herbivores roles through different times of community succession and through experimental manipulations, to make even broad predictions about the resilience or vulnerability of intertidal assemblages to human disturbances.

Functional roles along a tidal gradient: effects of algal functional diversity and environmental stress on community structure and dynamics in southern New Zealand intertidal assemblages

Alestra, T. and Schiel, D.R.

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Intertidal habitats in southern New Zealand host diverse and highly structured algal communities, composed of a heterogeneous mosaic of species with different life histories and morpho-functional traits. On the basis of physical attributes and the way they use and compete for resources, we identified three functional groups: a basal layer of encrusting and turf-forming coralline algae, a sub-canopy containing small fleshy algae that form a secondary cover, and a canopy of large fucoid algae. We tested the nature and strength of interactions among the three functional groups and how these are modulated by the physical stress of the intertidal environment, by selectively removing all possible combinations of canopy, sub-canopy and basal layer at two shore heights. Removal of canopy and basal layer produced the most dramatic alterations in assemblage structure: these two groups play a pivotal role, exerting a strong influence over each other and affecting abundance and composition of the sub-canopy. The sub-canopy showed variable and complex responses to experimental manipulations, depending on the harshness of the environment. In the mid-intertidal zone, most species depended on the presence of the canopy and were not able to tolerate its removal. In the low intertidal zone, many species rapidly took advantage of canopy removal, but the response of the system varied substantially depending on basal layer manipulation. Our results suggest that structure and dynamics of these assemblages are shaped by the degree of physical stress and by the abundance of few structure-forming species, which regulate resource availability and drive patterns of recruitment and growth of associated species.

What the heck is beta diversity, anyway?

Anderson, M.J.

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There has been a great deal of recent interest in the topic of ecological beta diversity. Just what is it and how can it be measured? To avoid achieving the status of a Hurlbertian "non-concept", the meaning of beta diversity needs clarification. In this seminar, I will outline the dual fundamental concepts of beta diversity as (i) variation in community structure or (ii) turnover, and will also give a practical guide to appropriate statistical methods for modelling these. The flexibility of a concept with multiple meanings and interpretations can be an advantage, when navigated well. I will demonstrate analyses of beta diversity for gaining key insights into the salient patterns of ecological beta diversity in fish assemblages on temperate reefs at multiple scales across gradients in depth, latitude, longitude and through time, using data from New Zealand, Australia and North America.

Ostreopsis ovata blooms: an emergent phenomenon threatening temperate reefs

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Blooms of benthic dinoflagellates belonging to the tropical genus *Ostreopsis* have been reported in many temperate regions. In the Mediterranean Sea, the genus *Ostreopsis* has been recorded since the '70s, but large bloom events have been reported only in recent years. The occurrence of harmful algal blooms (HABs), increasing worldwide in terms of frequency, magnitude and geographic distribution, represents a probably still underestimated threaten for temperate reefs communities, causing mass mortalities of marine organisms and, possibly, triggering changes in ecosystem functions and services. The factors involved in bloom occurrence are still debated: a relationship with sea water temperature has been highlighted in some areas, but other factors, such as wave exposure, nutrients and salinity, are also potentially involved. In order to describe *Ostreopsis ovata* bloom dynamics and provide a better understanding of factors involved in blooms, we collected a time series of data in Genoa (North-western Mediterranean), from summer 2006 to summer 2010. Cell abundances in water column and on macrophytes were assessed throughout the year, concurrently with related physical and chemical features. We elaborated a predictive model, realizing multiple correlations between bloom magnitude (maximum cell concentration) and length (extent of the bloom event) and water/meteorological features; in an ecological, economic and sanitary perspective, this model could be used for *O. ovata* blooms prediction and may represent a good base for managers in the attempt of forecasting toxic events.

Genetic tests for the dispersal of barnacles across the south eastern Australian biogeographic barrier

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The rocky intertidal fauna of south eastern Australia shows a change in community structure between the shores of Victoria and New South Wales reflects the impact of a major biogeographic barrier. The barrier includes the site of a past palaeogeographical barrier in the Bass Strait region, the Bassian Isthmus and is maintained at present by the 90 Mile Beach and the waning influence of the south flowing Eastern Australian Current. The barrier is believed to have been intermittently in existence for millions of years and in its current form for at least the last 10000 years. We have previously used mtDNA COI gene sequence information to test the assumptions that species showing little morphological differentiation truly form single panmictic populations that span the barrier and to determine if life-history is a good predictor of dispersal across the barrier. These genetic data together with the observed occurrence of ephemeral populations outside accepted ranges and reveal that a suite of south eastern Australian barnacle species appear to display widely differing abilities to cross the barrier. Here we use a combination of mtDNA and nuclear (microsatellite) data to determine whether the separation of northern and eastern lineages of the barnacle *Catomerus polymerus* are maintained by selection or restricted dispersal.

Anthropogenic pressures along the Portuguese coast: integrating information for MPA planning

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Anthropogenic pressures on the ocean have been increasing in the last decades, stressing the need for adequate management of ecosystem sustainability. The knowledge on location and intensity of human impacts on the marine ecosystems is thus critical to effective marine management and conservation. In the present study, a methodology to characterise human pressures on coastal areas was developed in order to be used in MPA processes. The method considers ten major threat categories and consists in four main steps: (i) main sources of impact are identified and located, by coastal sectors and impact categories (e.g. fishing, industrial activities); (ii) an index of pressure intensity is computed, using several metrics for each impact category; (iii) a social-economical indicator is calculated also by sector and impact category, in order to obtain the ratio among ecosystem damage and economical benefits of each impact category; (iv) the information obtained in the previous steps is integrated in a GIS together with spatial characterization of habitat categories (based on physical factors). An integrative map, including pressure distribution and intensity and level of habitat sensitivity, is the final output of the method. The application of the method developed in this study used data for the Portuguese coast, which is located in the Temperate Northern Atlantic marine ecoregion. The final map provides information on the most impacted areas and their proximity to ecological important sites. This approach will be a good decision-support tool in the design and management of future MPA.

Cross-shelf comparisons of NE New Zealand kelp forest communities provide insight into reef ecosystem function

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Subtidal rocky reefs are a central element of near-shore coastal ecosystems around most of the New Zealand coastline, supporting diverse plant and animal communities that contain many species highly valued by humans. Many near-shore rocky reef systems in New Zealand are increasingly affected by human activities such as fishing and sedimentation from land-use changes. We investigated how some of these anthropogenic stressors influence the structure and functioning of rocky reef systems. The Hauraki Gulf, in north-eastern New Zealand, was chosen as a study site due to the extensive history of marine research in the area, the presence of marine reserves and the availability of rocky reefs in a gradient from inshore (urbanised) areas to remote offshore islands. Anthropogenic sources of both carbon and nitrogen were apparent in many key reef species within the Hauraki Gulf, particularly at the more inshore of the study sites. A qualitative model suggested that the trophic cascade from urchin barrens to algal forests, mediated by the presence of urchin predators, inside marine reserves has low predictability of occurrence. Otolith chemistry results showed that key reef fish species, the predatory sparid *Pagrus auratus* (snapper) and the herbivorous girellid *Girella tricuspidata* (parore) inhabit low salinity estuarine environments as juveniles. This demonstrates the importance of knowledge of connectivity between habitats and the need to consider life histories of key taxa within marine reserves.

The influence of habitat on the spatial distribution of benthic communities: a case study with rock lobster

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Western rock lobster, *Panulirus cygnus* is distributed along the west coast of Australia from North West Cape to Cape Leeuwin. As a major benthic consumer this species is ecologically important and the target of substantial commercial and recreational fisheries. Previous research has focused on the biology of the species with little known about its ecology, specifically size specific habitat preferences. The present study addressed this gap by quantifying the relationship between the abundance and size of lobster and the habitats were they are found. Two methods of habitat classification were also assessed to determine cost effective options for long term monitoring. The lobster data used in this study were derived from the independent breeding stock survey at Jurien, Western Australia, while habitat data were derived from a towed video survey and a full coverage habitat map based on multibeam hydroacoustic data. Our results demonstrate that lobster abundance and size are driven by habitat, with 74% of the variation explained by a combination of *Ecklonia* and sponges. Secondly, the two different methods of habitat assessment provided comparable results, but have associated advantages and disadvantages in terms of cost, expertise required and outputs. Therefore, researchers have a range of tools to choose from depending on the outputs required. Therefore, both the amount and configuration of habitats influenced the abundance and size of lobster. Our research also illustrated that incorporating knowledge of the distribution and densities of preferred habitats is essential in designing long term monitoring programs to detect change.

Linking patterns and processes across scales: the application of scale-transition theory to algal dynamics on rocky shores

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[3]University of South Carolina

Understanding the link between patterns and processes across multiple scales is one of the greatest ecological challenges. Through the integration of population models, correlative analyses and experiments, scale-transition theory (STT) provides a powerful approach to address scaling problems in ecology. STT predicts the large-scale (e.g. regional) behaviour of a system on the basis of nonlinear population models describing local (e.g. patch-scale) dynamics and the interaction between these nonlinearities and spatial variation in population abundance. Here, we use SST to predict the dynamics of turf-forming algae on rocky shores of Capraia Island, in the north-west Mediterranean. We developed a model of algal turf dynamics that included the effects of logistic growth and local interactions with canopy algae (*Cystoseira amentacea*). The model was parametrized with field data from a canopy removal experiment and a hierarchical sampling design that provided estimates of spatial variances and covariances between turf and canopy cover at multiple spatial scales. The model was then used to scale-up the dynamics of algal turfs from the patch scale (plots of 50 x 50 cm) to the island scale (kilometres). The interaction between nonlinear algal growth and spatial variance in abundance emerged as a key term to translate the local dynamics of turf-forming algae from the plot to the island scale. These results illustrate how STT can be used to identify the relevant mechanisms that drive large-scale changes in an ecological assemblage and the data needed to link patterns and processes across multiple scales.

Vertical structure of very-nearshore temperate fish larval assemblages sampled with tow nets and light traps

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In the past decades the use of new sampling methods has allowed a better understanding of relevant ecological patterns during the pelagic larval phase of reef fishes which can be important in regulating these communities. Some of these studies have shown that fluctuations in larval supply can regulate replenishment patterns or that larval retention and self-recruitment close to natal reefs can be more frequent than previously thought. Much less is known on the occurrence and distribution of temperate perciform larvae close to the reefs as studies have been hampered by difficulties in sampling very-nearshore in these environments. We investigate vertical patterns in the composition of very-nearshore reef fish larval assemblages in the fully protected area of the Arrábida Marine Park, sampled with two methods during June 2008: plankton nets attached to an underwater scooter, and light traps. Most of the larvae captured with both methods were perciform species hatching from demersal eggs; furthermore, a small number of species dominated the assemblages. The vertical structure of the assemblages was similar with both methods: the tripterygiid *T. delaisi* dominated the surface samples both during the day and at night; while gobies were the most abundant larvae collected with both methods in the bottom samples. Larvae were found in different developmental stages and sizes with both methods deployed very close to the reefs, confirming previous studies and indicating local growth and development within the fully protected area of this Marine Park.

Consumer-resource interactions at the edge: ecological processes and biogeographic range limits in four intertidal species

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A narrow biogeographic transition zone is located along the coast of Central Chile ~30-32S. We studied two herbivore-algae pairs that inhabit the mid and low intertidal zones, respectively, and coexist only in this transition zone. Grazers find their poleward range limit and the algae find their equatorial range limit. We carried out field experiments using grazer enclosures and exclusion at a site where all species coexist. Results showed that low intertidal species interacted strongly and the chiton *Enoplochiton niger* was capable of inhibiting settlement of the bull kelp *Durvillaea antarctica* inside enclosure plots over experiments lasting >140 days. However, grazing by the limpet *Scurria viridula* in the mid intertidal zone facilitated the establishment of *Mazzaella laminarioides*. Field surveys over multiple sites showed that both invertebrate species decreased in density towards the edge of the range and *S. viridula* size distribution became skewed towards smaller individuals. Algal species showed no clear spatial pattern in density or size. Our results suggest that ecological interactions (i.e. grazing by chitons) seem to influence the equatorward edge of the range in *D. antarctica*. It is not clear what factors determine the range edge in *M. laminariodes*, but our field experiments and previous studies suggest short time positive effects of grazing by limpets. Recruitment limitation or physiological processes may influence the distribution of both invertebrates. Our results indicate that local ecological interactions cannot be overlooked as drivers in geographic range limits and need to be incorporated into species distribution modelling.

Water-tight solutions to engineering intertidal biodiversity in our cities

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Novel ecologically-informed engineering reduces loss of intertidal biodiversity on artificial shorelines. Increasing coastal urbanisation, growing populations and environmental impacts of climatic change, are causing 'pristine' biodiverse intertidal habitat to be replaced with expensive, but necessary infrastructure. Experiments in Sydney Harbour manipulated the façades of featureless, species-poor seawalls by adding experimental habitats of varying size to mimic rock-pools at 2 different heights on the walls. Numbers of species increased by 110 % in these engineered habitats and this biodiversity was further augmented by transplanting animals from natural rocky shores into these experimental rock-pools. These advances provide new insights about habitats essential for survival of organisms on seawalls and show how creating artificial habitats on infrastructure increases urban biodiversity.

Recruitment and survival of *Fucus* embryos: Understanding physiological adaptation in an environmental context

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Populations of fucoid algae show distinct distributions along gradients of tidal immersion in north temperate regions and have for many years provided a paradigm for studies of interactions between biotic and abiotic factors in determining species distribution patterns. We have studied the cell physiological adaptation mechanisms of three key fucoid algae (*Fucus serratus, F, vesiculosus and F. spralis*) with a particular focus on adaptation to osmotic stresses likely to predominate at different shore heights. Physiological expereimnts indicate the these three closely related species employ fundamentally different strategies to cope with the extreme osmotic conditions in the intertidal which are consistent with the types of osmotic stress likely to be encountered. We confirm that early developmental stages are particularly vulnerable to abiotic stress and that adaptive strategies have implications for resource allocation and resistance to biotic factors. In order to relate these physiological observations to recruitment and survival rates in natural populations, we have developed high throughput image analysis tools to enable species-level identification of zygotes and embryos. These studies enable supply and recruitment of different species to be assessed in the field and, coupled with manipulative field experiments, are providing new insights into the interactions between propagule supply, adaptive strategies and recruitment.

The abundance of the invasive isopod *Cirolana harfordi* in different habitats

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Cirolana harfordi is native to the Boreal Pacific. It was first recorded as a non-indigenous species in Australia in 1972. It is found in great densities, which may impact local assemblages and affect native species. Despite its substantial abundance in invaded systems such as Sydney Harbour, little work has been done to assess its potential impact on local assemblages and systems. In addition, introductions of marine isopods are poorly studied worldwide. The aims of this study were to determine the densities of *C. harfordi* in different intertidal habitats in Sydney Harbour and to relate its densities to the densities of other organisms in the assemblage. The densities of species usually vary among different habitats. Hence, the models of this study are (a) the density of *C. harfordi* varies among different habitats; (b) the densities of this species are related to those of other organisms. Oyster-beds, mussel-beds, coralline turfs and boulder fields were sampled in June 2010 with oyster-beds and boulder fields each being re-sampled in October 2010 and January 2011, respectively. The densities of *C. harfordi* were not different amongst habitats. *C. harfordi* was found under boulders only in the second sampling. We found no relationship between the density of *C. harfordi* and that of other groups of organisms, indicating that effects of the isopod, if they exist, are very weak. Future studies need to assess other ecological variables of the native assemblage such as fecundity and growth to test for the lack of impact of *C. harfordi* on other species.

Facilitation in marine environments: switches in species interactions along gradients of consumer pressure and physical stress

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The formulation of the stress-gradient hypothesis (SGH) has advanced our understanding of the mechanisms regulating switches in species interactions. In the last decade, research, mostly performed in terrestrial environments, has attempted to assess how factors such as life-history traits of interacting species and the nature of the stress can alter predictions from the SGH. Little attention has been, however, devoted to establish how the co-occurrence of different types of stress influences switches in species interactions. On subtidal rocky reefs, the direction and intensity of the interaction between two primary space occupiers, turf-forming macroalgae and tube-building Vermetid gastropods, were investigated in conditions generated by crossing a gradient of consumer pressure (grazing by sea urchins) and a gradient of physical stress (sediment deposition). Negative effects of Vermetids on macroalgae in the absence of herbivores switched to positive at intermediate grazing pressure, but sedimentation determined their intensity. When consumer pressure was extreme, facilitation persisted at natural and moderately enhanced sedimentation only if Vermetid cover was reduced. These results suggest that shifts in the direction and intensity of species interactions are regulated by the interplay of biological and physical factors and that density-dependent processes are more likely to shape species interactions at extreme ends of gradients of stress.

Wave fetch, tidal flow and ocean colour as influences on subtidal rock communities

Burrows, M.T.

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Community assemblages on subtidal rock change markedly along gradients of wave energy, tidal flow and turbidity. The importance of these assemblages for rare and delicate species, for shellfish, as nursery areas for fish and for their contribution to ecosystem functioning in coastal areas has long been recognised, and much assemblage data has been collected in the UK to support conservation. To derive site-specific conditions for subtidal biodiversity records, I applied a rapid method of calculating a large high-resolution (200 m scale) map of wave exposure < 5 km from the UK coastline. Satellite-derived estimates of ocean colour, influenced by phytoplankton and suspended sediment, and tidal flows from hydrodynamic models were also extracted for each site. Regression analysis on community ordination scores showed species composition and abundance shifting from algae to suspension feeding animals with depth and in areas of high chlorophyll and tidal flow, and a major shift in the assemblage along wave action gradients: from delicate forms in wave-shelter to robust species able to take advantage of the high flows found in wave-exposed communities. The strongest positive influence on species diversity was found to be the presence of the kelp, *Laminaria hyperborea*: sites with 0 % cover had a median of 6 species, while those with > 40 % cover had a median of 22 species. *L. hyperborea*, and thus the most diverse communities, are found in areas of estimated low chlorophyll concentrations and in the most wave-exposed environments, which are often but not always in areas of high tidal flow.

Diseases affecting habitat-forming seaweeds: complex environmental effects on pathogens and hosts

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Disease is emerging as a major factor in the decline of many species worldwide. The impacts of disease are arguably more severe when habitat-forming organisms are affected, as any negative effects of disease could cascade throughout other levels of the food web. On temperate rocky reefs, macroalgae are the dominant habitat-formers and evidence of their decline is being reported worldwide. Often, diseases are implicated in these declines, but this is rarely followed-up or confirmed experimentally. Here, we present descriptive evidence of disease-like symptoms affecting three habitat-forming seaweeds (*Delisea pulchra*, *Ecklonia radiata* and *Phyllospora comosa*; the latter two of which are in decline) from the south-eastern Australian coastline, a global-warming 'hot-spot'. We also present novel, experimental evidence of the involvement of bacterial pathogens in these seaweed symptoms and the complex influence of the environment (e.g. temperature, nutrients and light) on these macro-micro interactions. We also discuss the effects of proximity to urbanised areas on seaweeds and microbial pathogens. Generally, high temperatures lead to higher incidences of disease-like symptoms in these algae. Additionally, proximity to localised anthropogenic stressors (e.g. sewage outfalls) also affects the severity of stress and disease phenotypes in monitored macroalgae and can affect population structure. Understanding the mechanisms behind declines of important ecosystem engineers such as macroalgae is essential for their conservation and management in warming oceans.

Rocky intertidal metacommunity structure: evaluating ecological drift and local interactions as key process

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Intertidal metacommunity structure can be determined by physically modulated processes such as the arrival of individuals from a regional pool of larvae and by local interactions among adult individuals. There is debate centering on whether local biological interactions among species are necessary and sufficient to explain meso and regional spatial-scale community patterns or whether the patterns can be generated by the neutral interplay of dispersal and stochastic demography among ecologically identical species. Here we evaluate how much of the observed spatial variation within a rocky intertidal metacommunity along 800 km of coastline in central Chile can be explained by ecological drift in the structure of recruits across 15 local sites. Our results show that large spatial variation in recruitment rates do not explain the observed spatial variation in adult local structure and that, in comparison with the large drift in structure of recruits, local adult communities converged to a common, although not unique, structure across the region. Although there is no unique adult community structure in the entire region, the observed variation represents only a small subset of the possible structures that would be expected from passive recruitment drift. Thus, in this diverse system our results do not support the idea that rocky intertidal metacommunities are structured by neutral mechanisms.

Rocky shore fisheries in SW Portugal: effects of regulations on use and opinion on conservation and management issues

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On rocky shores of the SW Portuguese continental coast, intensive exploitation of living resources is made for subsistence, commercial use or recreation. Most of this coast is protected by a natural park (Parque Natural do Sudoeste Alentejano e Costa Vicentina – PNSACV) with a marine zone 2 km wide. In this park, most fishing regulations are national (e.g. recreational fisheries, since 2006) but some specific ones are in place since 2006 (stalked barnacles commercial fisheries) and 2009 (recreational fisheries). Spatial, temporal, taxonomic, bag and size, social and other limitations are implemented, including the designation of no-take zones and the need for a license. We studied interannual variation of rocky shore fisheries intensity (in the 1990s and 2000s) and users perception of management and conservation needs. In the northern part of this coast, abundance of shellfish collectors on rocky shores was lower in recent years, when comparing with observations made in the 1990s, probably due to regulations enforced since 2006. However, no significant interannual variation was found in the intensity of rocky shore angling and bait collection activities. From 2005 to 2010, direct inquiries were done in the northern part of this coast to know the opinion of rocky shore users on their fishing activity and on management and conservation issues related with this activity. Interannual variation was found in some questions, possibly due to regulations enforced since 2006. We discuss and present recommendations for the management of these fisheries and proposals for the conservation of marine PNSACV.

Zoogeography and connectivity of intertidal communities in the West Indian Ocean as determined by major oceanographic circulation systems: patterns from the widespread *Tetraclita* barnacles

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The West Indian Ocean is characterized by four distinct oceanographic systems, the Monsoonal Gyre, the Hydrochemical Front at around 10oS latitude, the Subtropical Anticyclonic Gyre and the West Wind Drift in the south. We studied the divergence of two mitochondria genes (12S rRNA and COI) and one nuclear gene (Histone 3) of the *Tetraclita* barnacles from 19 intertidal rocky shores in these four oceanographic systems, with a view to test the hypothesis that the distribution and population connectivity of intertidal animals are affected by the major oceanographic regime. Divergence in DNA sequences revealed the presence of seven evolutionarily significant units (ESUs), with their distribution sorted into distinct oceanographic circulation systems. *Tetraclita rufotincta* is distributed in the Monsoonal Gyre. Within the Monsoonal Gyre, an ESU denoted as *Tetraclita* sp. 1 is present in the Gulf of Oman and NW India. On the east African coast and Madagascar there is another ESU (*Tetraclita* sp. 2) associated with the Hydrochemical Front. *Tetraclita reni* is an oceanic species, confined to southern Madagascar and Mauritius waters, influenced by the West Wind Drift. The endemic *Tetraclita achituvi* is restricted to the Red Sea. *Tetraclita serrata* is common in South Africa and consists of two ESUs based on COI analysis, with one clade dominant over the other. Our findings suggest that geographical distribution of intertidal species in the West Indian Ocean are confined in each of the major oceanographic circulation systems which affect gene flow, but it is less influenced by the geological history of the region.

Experimental tests of the feasibility of restoring intertidal boulder-fields for rare and common species of molluscs

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Restoration of habitat is becoming an important conservation tool in an increasingly urbanized world. The practice and theory of restoration of marine habitats has lagged behind that of terrestrial habitats and has concentrated on habitats dominated by species that themselves create habitat, such as marshes, mangroves and coral reefs. Although a few species colonize such habitats rapidly, restoration is generally slow. Intertidal boulder-fields are occupied by many species of animals. A number of these are habitat-specialists in that they are relatively rare and seldom found in other habitats. Boulder-fields are subjected to many natural and anthropogenic disturbances, especially in areas of urban development and diversity in the special habitat can be reduced. This talk describes numerous experiments investigating the potential for restoring boulder-fields in Sydney, Australia. These range from adding novel habitat to enhancing existing boulder-fields and creating new habitat to test hypotheses about rates of colonization by rare and by common invertebrates. To date, experiments indicate that colonization by these fauna is rapid, irrespective of the features of habitat provided by the experimental treatments. Thus, in contrast to many other marine and terrestrial habitats, restoration of intertidal boulder-fields appears to be rapid and a cheap and successful option for replacing lost or damaged habitat.

Keeping up with the warming climate: the importance of thermoregulatory behaviours in the intertidal

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Behavioural adaptations of ectotherms to thermally heterogeneous environments are still overlooked in the literature despite the fact that organismal behaviour could enhance survival in the warming world. This is critical in the intertidal where most ectotherms live at, or near to, the upper limit of thermal tolerance. Here, thermal imaging was used to assess the space-time variability in both substratum and snail temperatures inhabiting tropical and temperate intertidal areas. Temperatures of two snail species (i.e. *Littoraria scabra* and *Nerita atramentosa*) and surrounding substratum were examined focussing upon the individual microhabitat position and status (i.e. solitary, aggregated). Substratum temperature appeared to be the main determinant of *N. atramentosa* and *L. scabra* body temperatures. This suggests that substratum temperature and others variables such as solar irradiance critically need to be integrated in climate change models that still used single climatic variables (e.g. air temperature) that are not necessarily correlated to individual body temperatures in nature. In addition, the mosaic of substratum temperature at the niche level reinforces the growing evidence that small spatial scale variations may surpass those observed at larger spatial scales. Thermoregulatory behaviours appeared to be species- and habitat-specific and also vary seasonally. Particularly, both species were able to select thermally favourable substratum under high thermal stress in order to thermoregulate. This ability to explore and take advantage of the thermal heterogeneity of the surrounding environment could potentially increase the local survival of mobile ectotherms in a warming world.

The role of broad scale factors in determining the spatial patterns of a dominant intertidal predator

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The question of scale of pattern and process has become a central theme in ecology. We evaluated the role of a number of biological and environmental factors operating over different scales in determining the demographics of a dominant intertidal predator, the dogwhelk *Nucella lapillus*. This was achieved through survey from North Wales to Northern Scotland. Our models confirm that density and size of dogwhelks are influenced by prey density and topography operating at meso and local scales, respectively. However in addition, we showed the importance of factors operating over broad scales in influencing predator dynamics. Pelagic primary productivity can be transferred through the food web to higher trophic levels, positively affecting size of dogwhelks. Additionally, there was a strong effect of SST on dogwhelk dynamics which showed a negative relationship with density and a positive relationship with adult size. Thus, in Northern Scotland, populations were characterised by dense populations of small animals. However, these relationships were not related to their reproductive output, since number and size of hatchlings varied weakly in relation to SST. Our results show strong effects of factors operating over a wide range of scales, that can result in differences among *Nucella* populations and consequently to the dynamics of rocky shore communities. An additional output of the work is that given the strong influence of SST, the mean of which varied latitudinally over the survey area by only 2°C, this predator-prey system may be used as a natural model for evaluation of possible impacts of climate change.

Seasonal changes in tidal cycle controls ingestion of macro or microalgae by an important intertidal consumer

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The omnivorous crab *Pachygrapsus transversus* is an important consumer on rocky shores of the subtropical coast of the south-west Atlantic. In this system, there is a differential vertical distribution of macro and microalgae, where biofilm dominate the low midlittoral, while macroalgae dominate the infralittoral fringe. Tidal amplitude is about 1 m with mixed semidiurnal tides that present inequalities by 30-40 cm in heights of successive low tides. Also, there is a seasonal change of the lowest tide, which is diurnal during the winter and nocturnal during the summer. We inspected the stomach of *Pachygrapsus* and found that, in sheltered shores, there was great ingestion of microalgae during the winter and macroalgae during the summer. As *Pachygrapsus* forages during the nocturnal low tides avoiding being immerse, we hypothesized that these seasonal changes in the lowest tide would be responsible for temporal changes in the ingestion of macro and microalgae. Thus, during the summer, when the animal would have more time to forage on lower levels of the shore, it would forage greatly on macroalgae beds. In fact, in a laboratory experiment, we showed that water level influenced the foraging rate of the consumer, which foraged more when emerged. However, in this experiment, macro and microalgae were equally offered in the different water levels and the foraging on both groups was similar. The seasonal changes in the level of nocturnal low tide can influence the feeding activity of this consumer and, consequently, influence intertidal assemblages throughout change in food web dynamics.

The importance of seaweed rafting in structuring intertidal species assemblages

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The vector of seaweed rafting is thought to be important for the dispersal and distribution of many invertebrate species around our shores, and it may have a great effect in structuring coastal biodiversity, yet remains one of the least understood dispersal mechanisms. Shores that collect high levels of drift material may be hotspots for species arriving on rafts from the ocean, which in turn could be important regions for the movement and connectivity of certain intertidal species. A comparison of high and low drift shores was used to examine the potential impact of rafting material on intertidal species assemblages to test for any biodiversity signature associated with drift. A hierarchical design was used on mollusc and crustacean counts from rocky shore algal canopy in County Donegal, Ireland, with a high drift-low drift pair of shores compared in separate regions. Multivariate tests of assemblage structure generally showed greater variation between pairs of shores (high drift-low drift) within a region than between regions. For crustaceans and molluscs lacking a larval stage (and therefore dependent on rafting) there were significant differences among high and low drift shore assemblages. Low shore brooding crustaceans also had higher species richness on high drift shores. Species abundances were characteristically higher on high drift shores. This did not appear to reflect changes in algal canopy structure, with a potential explanation being that drift increases abundance through influences on the immigration rate or food supply.

Induced predatory responses by bioengineers do not have cascading influences to associated fauna

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Mussels are considered important taxa on intertidal rocky shores due to their role as dominant occupiers of space, as prey for a wide range of predators, and as ecosystem engineers that provide habitat for diverse assemblages of organisms. Previous laboratory experiments indicate that mussels can exhibit induced responses to potential predators. It has, however, been suggested that such induced responses will be less pronounced where multiple predatory species are present, or in the field, where cues are more diffuse, or where the study mussel is a non-native species. In field studies done on shores in two separate continents, each with an introduced and indigenous species of mussel, we found that all species of mussels showed induced responses to predator-derived cues. Mussels indigenous to Australia (*Trichomya hirsuta*) and South Africa (*Perna perna*) and non-native to both countries (*Mytilus galloprovincialis*) had shorter byssal threads and greater numbers of byssal threads when predators were present. Despite this influence of predator presence on the complex byssal matrix of mussel beds, there were no effects on the associated fauna. Assemblages of fauna were similar among treatments open to predation and where predators were excluded. These results suggest that the presence of predators on ecosystem engineers do not necessarily have knock-on effects to associated assemblages. This may be due to associated assemblages being protected from the risk of predation by the habitat created by mussels or because they do not respond directly to the byssus matrix, but rather to other factors such as the arrangement or size-structure of the mussels themselves.

Generation of continental-scale patterns of diversity: ocean-footprints through local-interactions

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The similarity between two ecological observations tends to decrease as the distance between them increases. Biogeography recognises this concept as the 'distance-decay' which describes how similarity in species composition between two communities varies with geographic distance. With a team of people from across Australasia, we have been assessing patterns of species turnover of coastal plants to test hypotheses about biogeographic breaks and steepness of environmental gradients. We will present some of this work, particularly subtidal research into cross-scale patterns and processes; i.e. between genotype and phenotype of kelp, their morphology and strong control of key ecological processes, variation in strength of processes and biogeographic variation in ecosystem functions.

Impacts of multiple stressors on biodiversity-ecosystem functioning relationships

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Human activities impose a range of stressors on marine ecosystems, which often act simultaneously to affect both biodiversity and environmental conditions. The relationship between biodiversity and ecosystem functioning (BEF) has been the focus of extensive research in recent years. Although some important insights have been gained, the extent to which BEF relationships vary with environmental context is not yet clear. Similarly, despite long-standing debate, the potential for diversity to reduce the impact of disturbances on ecosystems is not well characterised. In this study, we used a field experiment to test the potential for multiple anthropogenic disturbances to modify BEF relationships in rock pools and to examine the capacity of biodiversity to reduce the impact of disturbance. We established plots with varying numbers and identities of algal species and subjected replicated sets of them to modified environmental conditions by simulating the individual and combined effects of two forms of anthropogenic disturbance: nutrient addition and canopy removal. Relationships between the diversity and the productivity and respiration of algal assemblages were modified by the disturbances we imposed. Outcomes varied depending on the functional response measured and the specific combination of disturbances involved. Although biodiversity conferred resistance to disturbance in some cases, its influence also varied with assemblage structure, functional response and disturbance treatment. These results show that our current framework for predicting consequences of biodiversity loss for ecosystem functioning needs to be improved by recognising the important influence of environmental context and the potential for complex interactive effects of multiple stressors.

Predation has an effect upon the distribution and abundance of the stalked barnacle *Pollicipes pollicipes* in Portugal

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The stalked barnacle *Pollicipes pollicipes* is a very important economic resource in SW Europe. Its distribution is restricted to very exposed rocky shores. Two theories were investigated to explain this pattern: higher predation in sheltered sites; and physiological limitation and consequently less survival in sheltered sites. Three manipulative experiments were performed in different years and locations in the west coast of Portugal (Berlengas and Sines). In all experiments, two habitats were considered: exposed with abundant *P. pollicipes*; and sheltered with rare/or no *P. pollicipes*. Individuals of this species were transplanted to these habitats by gluing rock chips with barnacle clusters to the substratum. The effect of predation was studied by considering the following treatments; cage (no macropredation); open cage (control to cage; not in all experiments); and controls (transplanted without cage and natural). Survival in cages was 100% in most of the replicates from both habitats. Survival in controls was less when animals were transplanted to the sheltered habitat. These results support the predation theory that predicts a reduction of predation effects with intensification of physical stress. Since *P. pollicipes* cyprid larvae settle heavily on conspecifics, namely on adult peduncles, we have also tested if recruitment on conspecifics varies between barnacles transplanted to exposed and to sheltered habitats. Recruitment to transplanted barnacles was observed at both habitats, but variable. Predation can also affect small-scale variation of recruitment of this species, as recruitment is mostly observed on conspecifics, crevices and rock fissures.

Coral gardens on Anton Dohrn Seamount

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Deep-sea reef habitats are slow growing and vulnerable to damage from anthropogenic activity, and are thus of conservation concern. The reef building coral *Lophelia pertusa* has been widely documented in the NE Atlantic, but little has been reported on coral garden habitats. Coral gardens are listed under OSPAR as 'threatened and/or declining species and habitats'. In the context of hard substrate, this habitat has been described as being dominated by gorgonian, stylasterid and/or antipatharian corals and can develop on exposed bedrock, boulders or cobbles. We present gorgonian dominated coral gardens from Anton Dohrn Seamount, which are the first reported coral gardens in the UK's deep-sea. The coral gardens were observed between 1311 and 1647m, deep on parasitic cone and radial ridge features on the NW flank of the seamount. The coral gardens had a high species richness dominated by gorgonian and antipatharian corals. The habitat supported a diverse range of fish including the false boarfish *Neocyttus helgae*, *Lepidion eques*, and orange roughy (*Hoplostethus atlanticus*). Its occurrence is discussed with respect to its association with distinct meso-scale geomorphological features and their use in mapping these vulnerable habitats.

Some like it hot: responses of molluscan embryos to a warming and acidifying ocean

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Our oceans are changing at an unprecedented rate. We sought to determine the vulnerability of early life history stages of rocky shore invertebrates to near-future climate change stressors. We exposed egg masses of two common rocky shore mollusc species - the opisthobranch *Dolabrifera brazeri* and the littorinid *Bembicium nanum* - to a combination of ecologically realistic or near future levels of UV radiation, elevated water temperate (26°C) and diminished pH (7.6). The quality of incident light was modified with UV 'cut-off' filters, while CO2 was bubbled to reduce pH. A given egg mass, once cut in pieces, was simultaneously exposed to 12 experimental treatments. We predicted that the most physiologically demanding conditions would produce the highest mortality and slow development significantly. This prediction was not borne out. For both species, temperature and pH stressors interacted, with mortality approaching 100% at the lower temperature (22°) and low pH (7.6). Spectral treatment had no effect on mortality. Predictably, the rate of development was significantly faster at 26°, and we detected a significant interaction between temperature and pH for both species. Exposure to full spectrum light (which includes UV radiation) slowed development in *B. nanum*, but not *D. brazeri*. It appears that elevated temperatures may compensate for the negative effects of an acidifying ocean. We conclude that abiotic stressors interact with organisms in complex ways.

Spatial subsidies provided by organic matter export from kelp forests: importance of storm-driven pulses versus chronic export

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Kelps (brown algae of the order Laminariales) are highly productive in temperate zones where they produce one of the largest biogenic structures found in benthic marine ecosystem. They play a key ecological role locally but are also important outside their own habitat, when part of their biomass is exported. The high productivity of kelps and their susceptibility to dislodgment and/or erosion (pruning) by waves and currents provides the opportunity for a strong subsidy of biomass to adjacent, relatively low productivity habitats (i.e. beach, surf zone). Because most observations of kelp export have been made on the shore, where kelps frequently accumulate after storms, many assumptions have been made regarding the importance of storms as a driver of kelp export. This study aimed to disentangle the role of storms on this export and the relative importance of two major pathways of transfer of organic matter, dislodgment of whole thalli and erosion of kelp tissue. Kelp dislodgement (over 4000 kelps tagged) and erosion rates (1000 kelps sampled) were measured at 9 subtidal reefs along a hydrodynamic gradient during a year. The results indicated that winter storms acted as small pulses of full plant but, dislodgment was a more chronic process occurring throughout the year in general. Contrary to our expectations the erosion was the major pathway, providing a massive pulse of material into the system before winter (First Flush Theory). This phenomenon resulted in a loss of 40% of the standing biomass and 20% of the annual production during the peak period.

Variability in rates of predation: doing the same experiment in 1996 and 2010

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Petraitis and Latham (1999) hypothesized that rockweed stands and mussel beds are alternative states on sheltered intertidal shores in the Gulf of Maine USA and predicted that the larger the perturbation, the more likely the system could be tipped from one community state to another. In order to test this idea, we created 48 clearings (1, 2, 4 and 8 m in diameter) in rockweed stands at 12 sites on Swans Island Maine in 1996; by 2009, 33 % of the larger clearings were mussel beds. In 2010, half of the clearings were re-scraped as new test, and data on mussel mortality – using the identical design used in 1996 – were collected. We predict the past will not predict the future if mussels and rockweeds are alternative states. The 1996 and 2010 rates of mortality due to predators were correlated in re-scraped plots but were not correlated in unscraped plots. Mortality varied with site in both years, but there was no agreement between the years. Size of clearing, scraping, and surface temperature affected 2010 rates of mortality. We conclude that it was not possible to predict the mortality rates in 2010 based on the 1996 rates, and the past does not predict the future.

Do barnacles have colour preferences in their choice of settlement substratum?

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Settlement into a benthic community is influenced by factors such as larval supply, light, presence of conspecifics and substratum characteristics. Colour of the substratum as settlement cue so far has been investigated from a human perspective, visual capabilities of the organism have been neglected. The aim of this study was firstly to determine if barnacle cyprids have a preference for different coloured surfaces in settlement. This would not necessarily mean that the larva uses colour vision but may be just distinguishing brightness levels of the substratum. Therefore the second aim was to determine if the settlement behaviour of the cyprid is influenced by the true colour of the substratum or by brightness levels. Colour preferences of cyprids of two barnacle species (*Amphibalanus amphitrite*, *Semibalanus balanoides*) in settlement substratum were tested in the field and in the lab. Tested colours were specifically selected based on presumptive spectral sensitivity of the visual receptors of the barnacle larval nauplius eye. The lab experiment was conducted as a 2-choice experiment. In the field settlement panels were randomly deployed. Statistical analysis was done using Exact test, ANOVA and Regression Analysis. Cyprids preferred to settle on the tested colours black, violet, red and green over dark blue and white. The colour of the substratum has an effect on the choice of settlement substratum for the two barnacle species tested. Brightness of the substratum is an important determinant for settlement, although true colour perception cannot be excluded.

Patterns in scavenging on southern Australian rocky shores: an under-appreciated trophic interaction?

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Much attention has been paid to predators and herbivores living on rocky seashores but there a far fewer studies of species acting as either facultative or obligate scavengers. In part this is due to an apparent lack of carrion on wave-swept shores but it could also be due to a highly-efficient scavenger guild that removes animal carcasses (especially in comparison to deposited wracks of plant matter, the other main basal component of the detrital food chain). Fast processing of dead animal material would have important consequences, especially where carrion is arriving from adjacent nearshore (subtidal) habitats. Such allochthonous inputs of energy to the shore could be an important subsidy on many rocky shores because the scavenging animals may be consumed by predators and thus enter the more conventional grazing food chain (as has been described for vectors of parasites). A series of studies at numerous sites in South Australia and Victoria, using new protocols for enumerating scavenger abundances and activities has identified a surprisingly diverse guild of animals that will come to baits and can feed quickly to remove them from the environment. Experimental protocols have been used to quantify the incidence of this scavenging and make contrasts that can characterise it as a foraging strategy. Comparison have also been made to soft-sediment or subtidal habitats where studies of scavenging are a little more common. Examples of such data will be given for the moderately-abundant buccinid whelk *Cominella lineolata* (Lamarck, 1809) scavenging on these rocky shores.

Two-way interactions of ecological theory with temperate reefs: collision course, dashed hopes, or fruitful symbiosis?

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Since the 1920s for intertidal seashores and the 1960s for subtidal reefs, our reef-based ecological studies have been a fertile ground for the testing and development of general theory in ecology. Key concepts that have prospered from this interaction include physiological tolerance, behavioural variation, keystone predation, inter- versus intra-specific competition, disturbance, patch dynamics, facilitation, alternative stable states, natural variability spectra and impact assessment protocols. It is less clear how much of this interaction has been a 2-way street. Variously we can see that episodes that could be construed as fruitful and alternating synergies between observation, experiment and theorising. Reefs also could give a dose of real-world checking of otherwise strange expectations, in particular due to empirical input from unexpected observations. There may even be some post hoc shoe-horning of theory into what has been carefully documented by field studies. Here I explore this history to draw lessons from key case studies of antiquated importance, invoking familiar names like Connell, Kitching, Southward, Paine, Dayton, Foster, Menge, Underwood, Sutherland, Sousa, Hawkins, Lubchenco, Petraitis and Bertness.

How will forecasted CO2 affect gastropod grazing?

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Grazing gastropods structure benthic communities by removing key primary producers known to drive phase-shifts. These calcifying organisms are, however, predicted to be negatively affected under forecasted climates. Elevated CO2, for example, could have a range of effects on calcifiers, including metabolic depression, which has been linked to suppressed feeding activity. In southern Australia, such an effect could result in the reduced consumption of turf-forming algae by gastropod grazers, leading to the expansion of algal turfs that facilitate kelp loss. This research, therefore, experimentally assessed whether grazers would continue to consume the same amount of turf when exposed to forecasted CO2. Contrary to expectations, we found that under forecasted CO2 grazers consumed more turf than under contemporary CO2. We investigated this result with a second experiment to test whether increased consumption of turf under forecasted CO2 was due to an effect of CO2 on either (a) grazers or (b) algae. Our results reveal that grazers are likely to remove more turf under future conditions not as a consequence of the effect of forecasted CO2 on grazers themselves, but rather as a function of the effect of CO2 on their food. We are now working to determine how CO2 influences turf characteristics, especially nutritional quality, with a view to develop an understanding of why grazers may consume more turf under forecasted CO2. This result indicates that under forecasted CO2 conditions, calcifying grazers may not only retain their ability to remove key primary producers, but consume them in greater quantities.

Restoration of degraded biogenic reefs: a pilot study using artificial reefs to kick start the regeneration of *Modiolus modiolus* biotopes in Strangford Lough, Northern Ireland

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Damaged biogenic reefs experience loss of relief (Schulte et al. 2009) and as a result, construction of 3-dimensional artificial reefs has become a widely used restoration approach. In Strangford Lough (Northern Ireland) the horse mussel *Modiolus modiolus* forms beds that can be classified as biogenic reefs under the European Habitats Directive. The *M. modiolus* beds once occupied an extensive area within the central part of the Lough but their extension and quality has greatly diminished in recent years. Three main restoration approaches have been tested by the *Modiolus* Restoration Research Group including 1) translocation of natural populations; 2) provision of additional substrate; and 3) hatchery production of *M .modiolus* spat. In 2009 the MRRG constructed an artificial *M. modiolus* reef to investigate the effect of elevation on mussel survival, faunal assemblage succession and natural recruitment. The reef was constructed using king scallop *Pecten maximus* shell as cultch while adult *M. modiolus* collected locally were re-laid over the experimental plots. Dive monitoring surveys revealed high survival rates in the translocated mussels which formed tight clumps over the cultch. Pseudo-faeces and sediment accumulated in the crevices increasing habitat complexity and attracting numerous species to an otherwise barren area within the historic range of *M. modiolus*. It is expected that the artificial reef will also enhance natural recruitment of *M. modiolus* spat, as field and laboratory trials showed a highly significant preference to settle amongst live adult horse mussels.

Bioconstruction processes in the northern Adriatic coralligenous reefs

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Bioconstruction by temperate reefs along the Mediterranean continental shelves are still poor documented. The northern Adriatic Sea is a sedimentary basin where subtidal biogenic reefs occur at 19-40 metres in depth. According to previous studies, three major typologies of coralligenous outcrops can be identified, mainly characterised by algal turf, sponges and calcareous algae. Bioconstruction and erosion processes were investigated in three reefs, belonging to the three different typologies that have been randomly selected. In August 2005, forty-eight travertine tiles were deployed at each study site in three randomly selected plots on the rocky bottoms. After three years, six tiles from each plot were collected for the laboratory analyses. The epi-flora and fauna were identified to the lowest possible taxonomic level. The epibionts contributions to bioconstruction were estimated by their inorganic mass remaining after incineration. The bioconstruction/erosion processes by the endobionts were estimated comparing the original mass of each tile with its mass after removal of external concretion and incineration. The bioconstruction/erosion balance by endolithic organisms was slightly negative or almost zero at all sites. The mean total inorganic mass production by epibionts was 375 g m^{-2} y^{-1} and their contribution to substratum accretion varied among plots and sites, depending on the species assemblages that colonised the tiles. The major contribution at all sites derived from serpulid polychaetes. Others important site-specific reef building taxa were calcareous algae and bryozoans, particularly in the offshore site; *Ostrea* sp., and sessile gastropods in the onshore; *Sabellaria* sp., sponges and bivalves in the intermediate site.

Multiscale population genetic structure of the stalked barnacle *Pollicipes pollicipes*

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The edible intertidal barnacle *Pollicipes pollicipes* is an important economic resource. Understanding the spatial scales over which genetic variability and population differentiation can occur, is an important tool for the management and conservation of this exploited species. The main objective of this study was to study patterns of genetic structure of *P. pollicipes* at different spatial scales using both mitochondrial (CO1 gene) and nuclear microsatellite (10 loci) genetic markers. We have done two studies (large and small spatial scale). At a large-scale, we have considered 10 sampling shores (≈ 300-1300 Km distant from each other) covering the entire geographical distribution range of *P. pollicipes* (from Brittany, France to Dakar, Senegal). At a small-scale and covering the Iberian coast, a hierarchical sampling design was used: 3 sampling regions (≈300 Km), 2 shores in each region (≈50 Km) and 2 sites per shore (≈200 meters). The sampling size was 50 individuals in both studies. Molecular analyses were performed in 15 individuals for mitochondrial CO1 gene and in 50 individuals for microsatellite loci.Genetic diversity indices, AMOVA, population differentiation, isolation by distance and demographic history of the populations were analyzed through traditional F-statistics and Bayesian approaches. Results will be discussed considering both historical (ex: founder events, bottlenecks, range expansions) and contemporary (ex: oceanographic barriers, patterns of larval dispersal and recruitment) processes.

Changes in rocky shore assemblages on a European scale: environmental or top down control?

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From the Arctic to Portugal there is a shift in preponderance of algal cover and biomass on rocky shores, which declines southwards. Major primary producing and habitat forming fucoids occur on more exposed shores in Norway, extend onto moderately exposed shores in the British Isles before, retreating into estuarine refuges in southern Portugal. The causes of these broadscale patterns are thought be driven by differences in climatic regime influencing the early survival, growth and persistence of intertidal macroalgae including fucoids combined with increasing grazing pressure further south in Europe as both, numbers and diversity of grazers increase. These assemblage patterns have major consequences for the functioning of coastal ecosystems since fucoids are a major primary producer and source of detritus. Although these patterns have been described qualitatively, there has been little work quantifying patterns of biomass and productivity, nor extensive work exploring the causes of these patterns. The grazing pressure and the balance between fucoid algae and sessile invertebrate cover over wave action gradients on a European scale (Scotland, Wales, England and Portugal) were quantified through field surveys. The data allow determination of the relationship between the local distribution of key fucoid species (*Fucus spiralis*, *Fucus vesiculosus*, *Fucus serratus* and *Ascophyllum nodosum*) at multiple European locations and different exposure gradients presenting diverse grazing pressure levels. Here we will show a broad-scale description of fucoid patterns and grazing pressure over a latitudinal gradient from northern Scotland to southern Portugal and the modifying influence of wave exposure.

Extreme environmental conditions & intertidal organisms: examples from two case studies in the sub-tropics

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Extreme weather events are expected to increase in frequency and intensity with global climate change. Fluctuations in temperature and precipitation can lead to thermal- and salinity stress for organisms inhabiting marine intertidal habitats. We demonstrate the effects of extreme environmental conditions on the persistence of intertidal marine species from two case studies carried out in the sub-tropics. In Hong Kong, the limpet, *Cellana toreuma* inhabits tidepools and undergoes summer mass mortality. Laboratory experiments were designed to mimic the effects of high thermal stress (and increasing pool salinity) and reduced salinity as a result of monsoon rains on *C. toreuma* in tidepools. Both increasing temperatures and reduced salinity had significant effects on mortality, whilst salinity had negligible effect. In Florida, the invasive mussel *Perna viridis* fouls hard substrates it undergoes winter mortality events. Little is known about the mechanisms behind these mortality events. Broadscale surveys carried out in winter 2007/2008 revealed a large-scale mortality event in Tampa Bay which coincided with extreme weather conditions when air temperatures dropped to near freezing. Further mortality events were observed in winter 2009 and 2010. We discuss two contrasting examples of extreme environmental conditions and their impacts on the survival of marine organisms. Extreme environmental conditions and weather events are expected to intensify with global climate change. It is important to distinguish between the effects of environmental conditions brought about by extreme weather events from those brought about by changes in the climate.

The factors influencing the dietary compositions of the reef fish, *Chrysophrys auratus* and *Pseudocaranx georgianus*, and their incorporation into a food web for the lower west coast of Australia.

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Chrysophrys auratus (Sparidae) is one of the most important recreational and commercial fish species and *Pseudocaranx georgianus* (Carangidae) is among the most important recreational fish species over reefs on the lower west coast of Australia. Intensified fishing pressure in recent years has resulted in a marked decline of the stocks of iconic species, including *C. auratus*, initiating the introduction of stringent management regulations aimed at restoring these stocks. The importance of *C. auratus* and *P. georgianus* led to governmental authorities funding a study of the diets of these species to ascertain their position in the food web and understand how their prey varied with important factors such as region, season and body size. The resultant stomach contents data could then be incorporated with those already recorded, for 28 co-occurring fish species, thereby enabling a reliable and detailed food web for reef environments on the lower west coast of Australia to be produced. In broad terms, *C. auratus* feed predominantly on echinoderms, decapods and teleosts, whereas *P. georgianus* ingest mainly amphipods, isopods and gastropods and bivalve molluscs. A novel multivariate approach in this context, has been developed to determine the extents to which the dietary data for each of 30 fish species can be pooled across seasons and size classes for determining the number of trophic guilds present on the lower west Australian coast. This approach reduces the extreme complexity of the food web produced and thus results in a more comprehensible understanding of the trophic relationships among the various fish species.

An integrative approach to model recruitment dynamics in barnacles

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Recent work suggests that recruitment of larvae and juveniles is affected by traits of organisms such as body size. We propose an integrative framework to study recruitment that incorporates organism traits. The main argument is that mortality should be affected by the product of population density and body size that define the amount of resource consumed by recruits. This amount defines the level of mortality due to resource limitation. We apply this model to the recruitment of the barnacle *Semibalanus balanoides* from two different shores. In both shores post-settlement survival is better explained by models based on density and operculum area as a trait as compared with models based on density alone. Operculum area, a trait that does not respond plastically to changes in barnacle density, is a better predictor than basal area that responds to density. Survival follows a sigmoid function with a threshold at 30-40% of percentage cover. In the future these models may incorporate physiological processes and evaluate the role of metabolism on recruitment patterns, facilitating the study of recruitment from the perspective of oceanographic- and climate-related processes, such as match-mismatch and temperature increase. More generally we stress the necessity of developing a theory of recruitment integrating individual variability to processes operating at the population level.

Contribution of biofilm to ecosystem functioning in rockpools and effect of different macroalgal assemblages

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Despite extensive research into biodiversity-ecosystem functioning relationships, the contribution of microorganisms remains poorly understood. This study is a first attempt to understand the role of epilithic biofilms in the functioning of rockpool ecosystems and their interactions with macroalgae. We designed a factorial field experiment establishing different macroalgal assemblages with or without biofilm in an array of constructed rockpools. The measured ecosystem processes were oxygen metabolism in terms of community (entire rockpool assemblage) and residual (rockpool assemblage without macroalgae) gross primary productivity and respiration. We also measured photosynthetic efficiency of the rockpool biofilm using PAM fluorometry. The percentage contribution of the biofilm to the community metabolism decreased with increasing number of macroalgae only in the case of primary productivity while the contribution of the biofilm to the residual metabolism decreased with increasing number of macroalgae only in the case of respiration. The presence or absence of biofilm, however, did not significantly interact with the different macroalgal assemblages in affecting the oxygen metabolism. Only the photosynthetic efficiency of the biofilm measured when both canopy and understory were present was significantly lower than with the other macroalgal assemblages, suggesting that this macroalgal assemblage significantly affected the composition or activity of the biofilm. The biofilm had a negligible contribution to rockpool metabolism compared to macroalgae but, in the short term, its composition or activity seemed to be affected by different macroalgal assemblages. Understanding the consequences of such changes in the longer term will help in predicting the effects of biodiversity change on marine ecosystems.

Annual carbon budget of a canopy-dominated intertidal community surpasses traditional estimates for macroalgae

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Quantification of an ecosystem's carbon balance and its components is essential for understanding both ecosystem functioning and the global carbon cycle. Published carbon-budgets of marine ecosystems usually include no information on macroalgae-dominated areas, and at best include rough estimates based on indirect measurements. This study modelled the annual carbon budget of an area dominated by the canopy-forming *Ascophyllum nodosum* macroalga. It is based on direct in-situ measurements of CO2 fluxes due to the benthic community and the canopy only. This calculation takes into account the natural variability of light and temperature both in the air and in the water as a function of the seasonal, diurnal and tidal cycles. Gross primary productivity (GPP) was estimated to be 1364 $gC.m^{-2}.yr^{-1}$ and 1982 $gC.m^{-2}.yr^{-1}$ under measured and theoretical (without clouds) irradiance respectively. In both cases, 92 % of GPP was due to the canopy and over 50 % occurred during immersion. Community respiration was estimated to be 1194 $gC.m^{-2}.yr^{-1}$, with 88 % due to the canopy and 18 % occurred during immersion, so that net primary productivity reached 158 $gC.m^{-2}.yr^{-1}$ and 787 $gC.m^{-2}.yr^{-1}$ under measured and theoretical irradiance respectively. This autotrophic carbon budget is comparable to *Laminaria*-dominated areas, with daily gross primary productivity and respiration values surpassing most benthic community estimates.

The reserve effect of a temperate MPA in the NW Atlantic (The Arrábida Marine Park, Portugal)

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The “reserve effect” on a temperate rocky reef fish community at the Arrábida Marine Park (AMP). The management plan of this marine park was approved in 2005, defining 3 distinct protected areas, one fully-protected area (FPA), four partially-protected areas (PPA) and three buffer areas (BA). We compared the abundance, composition, biomass and size structure of target and non-target species across seasons in the different areas of protection and between current and previous studies, performing GLMs (R) and PERMANOVA, BIO-ENV and 2STAGE (PRIMER 6.1.1). In order to account for habitat variability we also characterized algae and invertebrate cover and habitat physical structure. Preliminary results show that reef fish community composition, biomass, density and size structure varies significantly between seasons, suggesting that this factor should be considered when studying this region. Algae assemblages also differ between seasons and areas of protection but invertebrates do not. Results also suggest that the length structure in target species is distorted with a high proportion of small individuals in contrast to a similar proportion of all size classes in non-target fishes. Target species also show higher sizes in the FPA and PPA than in the BA. Both density and biomass of demersal target fishes decrease significantly from the FPA to the BA suggesting the influence of fishing mortality effects. Physical habitat structure differs between the BA and PPA but not between any other pair of protection areas. Both biotic and physical habitats are poorly correlated with fish community structure suggesting that differences in target and non target species across the AMP are mainly related to protection effects, even after a few years of protection.

Sicilian CO_2 vents show effects of ocean acidification on rocky shores.

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Anthropogenic carbon dioxide emissions are causing the oceans to acidify but studies on the biological effects are in their infancy. Laboratory studies show highly variable short-term organism responses and very little is known about the ecosystem effects of ocean acidification. A CO_2 vent system off Ischia (Italy) has shown dramatic effects of CO_2 on marine biodiversity but this work lacks the replication required to better constrain the predicted effects of ocean acidification. Here we build on this approach to test hypotheses (i) do increases in CO_2 levels result in predictable changes in benthic biodiversity? and (ii) do different CO_2 vents areas have similar shifts in benthic community structure along pH gradients? We assessed the composition and structure of intertidal benthic assemblages using visual census of quadrats along a pH gradient caused by CO_2 vents off Vulcano (NE Sicily) and Pantelleria (NW Sicily). Multivariate analyses showed that in both cases sessile benthic biodiversity and community composition exhibited significant shifts as CO_2 levels increased causing mean pH 8.16 to drop to mean pH 8.01 and 7.61 at Vulcano stations and mean pH 7.75 and 7.48 at Pantelleria stations. Acidified sites were characterized by dominance of turf algae and absence or low coverage of coralline algae, while at the reference sites coralline algae like *Jania rubens* and *Neogoniolithon brassica-florida* were abundant.

Impact of introduced Pacific oysters, *Crassostrea gigas*, on the recruitment of *Sabellaria alveolata* in boulder-fields

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Invasive species have been identified as a serious threat to global biodiversity. In coastal marine ecosystems invasive bivalves, such as the Pacific oyster, *Crassostrea gigas*, are of particular concern due to their ability to dominate large areas of the shore. These oysters not only displace existing species, but their physical structure can create novel habitats, supporting assemblages that differ from those in indigenous biogenic habitats. *C. gigas* may also alter the physical and chemical properties of the receiving environment through its biological functioning (e.g. filter-feeding and deposition of faeces and pseudofaeces). Wild populations of *C. gigas* have been found in intertidal boulder-fields in Ireland which are important habitats for many species including the Honeycomb worm, *Sabellaria alveolata*. *S. alveolata* creates biogenic reefs, protected under Annex I of the EU Habitats directive. Boulders on which *C. gigas* were found had less cover of *S. alveolata* than boulders without *C. gigas*. One model to explain this pattern is that, due to its physical structure or biological functioning, *C. gigas* reduces recruitment of *S. alveolata*. This was tested experimentally using live and dead oysters at different densities, to separate the effects of structure, functioning and densities of oysters on the recruitment of *S. alveolata.* Recruitment of *S. alveolata* was reduced in the presence of increasing densities of oysters, particularly live oysters. It is important that the potential effects of this invasive oyster on protected habitats created by *S. alveolata* are assessed in order to assist with management decisions in regards to its spread.

Climate driven changes in recruitment success of marine invertebrates: The role of food supply.

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A potential consequence of climate change on species with pelagic larvae is that shifts in the timing of larval release or of food availability may cause variation in recruitment governed by match/mismatch mechanisms. Species may avoid mismatch by synchronising larval release to pulses of food or may develop physiological adaptations to tolerate low food levels. The barnacle *Semibalanus balanoides* releases larvae in response to the spring phytoplankton bloom, while *Elminius modestus* releases larvae over a longer summer period. We experimentally tested if the pattern of larval release of *S. balanoides* in response to food density was related to larval food limitation and whether larvae of *E. modestus* show higher tolerance to food limitation than *S. balanoides*. Larvae of both species were reared under three food levels of *Skeletonema costatum* (4 x 105; 2 x 105 and 0.4 x 105 cells ml-1) reproducing those affecting *S. balanoides* larval release [Starr et al. (1991) Journal of Plankton Research. 13, 561-571]. Larvae were obtained from eight adults to account for parental influences on larval tolerance. Experiments were run at 15^0C where larval survival of both species is reportedly high. Duration of development was shorter for both species under highest food density. No differences in survival and success of metamorphosis to juvenile were observed for *E. modestus*. In *S. balanoides* the lowest food density led to a significant reduction in survival and rates of metamorphosis to juvenile. This pattern was consistent across larvae from different adults although there was a highly significant parental influence.

Cold-water coral reefs along the French margin in the Bay of Biscay (NE Atlantic)

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Cold-water coral reefs (CWC) are known to occur in the French part of the Bay of Biscay since the beginning of the 20th century. In this area, the margin is shaped by a succession of more than 130 deep canyons and interfluves. Until recent times very few benthic studies have been developed on this margin and only some historical dives acquired for halieutical or geological purpose were available. The main source of *Lophelia pertusa* occurrences used in the Ospar database (updated in 2008) comes from 1922 trawlings. However, since 2008, large multibeam surveys have been conducted in this area, allowing to create accurate Data Terrain Models and perform morphological analyse. Additionally, a lot of optical images of the seafloor have been acquired along transects crossing bathymetric lines over a depth range of 180-2000m. The image analysis has been conducted over 12 campaigns from 1996 to 2010, corresponding to more than 60 dives using Remotely Operated Vehicles, submersibles or towed cameras. The applied annotation procedure which has been applied is based on knowledge tables defined with others CoralFISH partners. Distribution of framework-building CWC has been updated with indication of the type of habitat, the bathymetrical and the geomorphological context. The proportions of the framework-building species have been precised, as well as the percent coverage, the main associated species and the areas with obvious anthropogenic impacts.

Revisiting Connell: Competition is not always the cause for barnacle zonation

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In his pioneering experimental-ecology studies Connell demonstrated the importance of species interactions to intertidal barnacle zonation leading to the accepted paradigm: the lower limit of intertidal species distribution is determined by biotic factors (competition or predation), while the upper limit is set by physical factors. Our objective was to test the generality of this model using two intertidal Mediterranean barnacles: *Chthamalus stellatus* dominates the lower zone, and *Euraphia depressa* occupies the highest zone, but is also common on lower cryptic surfaces. Similar to Connell, we use experiments to test if these patterns are determined by settlement patterns or by competition. Unlike Connell we also looked at the very early stages of settlement. Because spats could not be distinguished morphologically we developed species-specific molecular markers. Settlement and recruitment were assessed using settlement plates and competition was tested with reciprocal transplantation of settlers between zones. Results show that spats of C. stellatus settle on the front side of the plates, whereas spats of *E. depressa* on the back (cryptic) side or higher on the shore. Settlement habitat was thus determined at the earliest stages. Shifting *C. stellatus* individuals to the high zone resulted in high mortality, while exposing *E. depressa* that settled in cryptic low-zone niches had no effect on their survival (i.e., *C. stellatus* did not outcompete it). This surprising finding rejects the hypothesis that *E. depressa*'s lower limit is controlled by competition with *C. stellatus*, implying that Connell's model may not be generalized to all cases of intertidal zonation.

Effects of ocean acidification on temperate reefs

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The global oceans currently absorb over 25 million tons of CO_2 every day causing surface waters to become 30 % more acidic since wide-spread burning of fossil fuels began. Increased CO_2 levels are causing a decline in carbonate ions, an increase in bicarbonate ions and lowering calcium carbonate saturation states. Current research into ocean acidification is mainly being carried out using short-term experiments whereby CO_2 levels are manipulated in aquaria and enclosures. Our new approach uses volcanic vent systems as 'natural laboratories' as they create long-term gradients pCO_2. Macroalgae, seagrasses and a range of invertebrates have now been investigated at vents off Ischia island (Italy) revealing winners and losers on rocky reef and sedimentary habitats. All calcifiers (coralline algae, molluscs, polychaete spirorbids, foraminiferans) are strongly reduced in abundance or are absent from acidified areas (pH <7.7) and the overall benthic biodiversity is around 30 % lower than in normal conditions. However, 67 % of the species observed, including macroalgae (e.g. *Caulerpa racemosa*, *Sargassum vulgare*) and seagrass (*Posidonia oceanica*) are resilient to long-term exposures to CO2 levels predicted for the end of this century. Transplantations using corals (*Balanophyllia europaea* and *Cladocora caespitosa*) and bryozoans (*Myriapora truncata*) show that the combined effects of abnormally high summer temperatures and ocean acidification are detrimental to these key organisms. Work with many collaborators has shown that ocean acidification may combine with other stressors (e.g. temperature rise) to cause a decrease in marine biodiversity and lead to shifts in ecosystem structure. (Part funded by EU FP7 MedSeA grant 265307).

What, where and how bumpy? Spatial variation in species- and community-level biodiversity along topographically variable rocky shores

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Understanding what governs the spatial distribution of biodiversity is necessary in order to understand ecosystem structure and function and thus formulate cohesive and effective conservation strategies. In both marine and terrestrial ecosystems, topographic complexity is often crucial in dictating spatial variation in the colonisation and recruitment success of different component species. However, unlike benthic habitats, the relationship between topography and species distribution in the marine inter-tidal is less well understood. In this study we surveyed the mid-shore inter-tidal at 26 locations along the SW coast of England and 9 shores on the Isle of Man to examine the relationship between topographic complexity and the spatial patterns in varying levels of biodiversity; from individual species to community assemblage (represented by biotopes).

Ecological impacts of ocean acidification in the Northeast Pacific

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Ocean acidification has been identified as one of the most significant threats to marine life. Although individual-level effects are increasingly well documented, the responses of populations, communities, and ecosystems remain largely unknown. In Northeast Pacific benthic systems, calcified grazers may be particularly vulnerable to acidification. Sea urchin gamete fertilization efficiency and adult growth are both impaired by increased CO_2 in the lab, and decadal-scale reductions in pH are associated with reduced turban snail growth in the field. Although adult abalone growth appears to be unaffected by CO_2, larval abalone development is impaired and larval survival is significantly reduced in acidified conditions. In contrast to the negative effects of OA on heavily calcified herbivores, lightly calcified predatory sea stars actually grow faster when CO_2 is experimentally increased. The acidification-induced changes described here are likely to result in substantial shifts in the benthic ecosystem. Increasing predation pressure may further reduce the abundance of calcified grazers and filter feeders that are already suffering direct negative impacts of acidification. Declines in grazer populations may allow kelps and many kelp forest dependent species to become more abundant. On the other hand, mussel beds and their associated diversity may decline due to reduced mussel growth rates and increased loss to predators. The predictions outlined above should be viewed as preliminary due to large gaps in our understanding; refinements to our predictive framework will require additional modelling and empirical studies that move beyond individual organisms and specific life history stages.

A century of interactions of climate change and fishing on the pelagic and demersal assemblages adjacent to the Eddystone Reef and in the wider English Channel

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Observations on the English Channel started upon formation of the Marine Biological Association (MBA) and ahead of construction of the Laboratory in 1888. These became more formalised in 1903 when the MBA led the UK contribution to the International Investigations that led to the formation of the International Council for Exploration of the Seas. The region surrounding the Eddystone Reef has always provided a focus and a locus for observations off Plymouth. A brief summary of long-term observations made off Plymouth over the last one hundred years is given before focussing on fluctuations in plankton and fish. There has been a cold period either side of WWI, warming from the 1920s until the early 60s, a cooler period from 1962/1963 to the late 1980s and subsequent warming until the mid 2000s. Switches between coldwater Herring and warm water Pilchards (aka Sardines) have occurred with in parallel changes in the plankton. Historical records have shown such changes have been occurring since the Middle Ages. There have also been changes in composition in bottom living species of fish. Long-term data have enabled separation of the impacts of over fishing from climatic fluctuations. Small fish track climate but in larger species the climate signal is overridden by fishing pressure.

Predicting beta diversity in the marine environment: algal diversity patterns and their relationship with environmental variables on shallow subtidal reefs across southern Australia.

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Beta diversity, the variation in species composition among sites within a region, is a key concept for the conservation and management of biodiversity. However, beta-diversity is rarely studied across the large spatial scales relevant for management, particularly in the marine environment. We analyse and predict spatial patterns of turnover in community composition using two relatively new, but contrasting community modelling methods; (a) Generalised Dissimilarity Modelling (GDM), a statistical approach based on a matrix regression methods, and (b) Gradient Forest Modelling (GF), a machine learning approach using ensemble tree based methods. We use macroalgal data collated from an extensive spatio-temporal survey of subtidal reefs in southern Australia, a region with exceptional diversity and endemism. Using GDM and GF we modelled and depicted spatial patterns of beta diversity in algal communities over 5000 km of coastline, for over 180 species, representing the first broad scale quantitative analysis of algal beta diversity for this region. Patterns predicted by both methods were remarkably congruent. A striking change in community composition was evident from South Australia to Victoria and Northern Tasmania and especially high species turnover was predicted in the South Australian Gulfs. Changes in sea surface temperate and nutrients had the greatest effect on beta diversity for both methods. Changes in exposure also influenced beta diversity using GDM, whilst salinity was influential using GF. The congruence between methods suggests that strong environmental gradients are the common drivers of community change in this region. These tools advance conservation assessment in species-rich marine groups, but require further development.

Effects of a scallop dredging on temperate reef fauna

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Towed bottom-fishing results in a reduction in benthic biomass and production to varying degrees according to the environmental context in which they occur. Of these fishing techniques, scallop dredging is considered to be one of the most destructive, but empirical field evidence to support this assertion is limited, in particular for highly structured habitats. Here, we investigated the effects of scallop dredging on the fauna of a temperate stony reef through a comparison of areas subject to different levels of fishing activity. Significant negative effects of scallop dredging were evident for four of the nine species analyzed from video samples. Sessile emergent epifaunal species had significantly lower occurrences and abundances at fished sites compared to unfished sites, while commercial target species such as scallops and crabs were not significant affected by fishing. The pink seafan *Eunicella verrucosa*, a species of local conservation concern, contrary to expectation did not show a significant negative response with respect to abundance and average body size to the intensity of scallop dredging it had been subjected to. The absence of a clearly detectable fishing effect on this species may be related to its association with the topographically more complex areas of the reef in which the fishing efficiency of scallop dredges will be reduced. The evidence presented here demonstrated that not all species were equally affected by scallop dredging and that the complexity of stony reef habitats may provided some measure of protection at low fishing intensities.

The use of maximum entropy modelling in reef habitat mapping: the case of boreal *ostur*, a deep-sea sponge aggregation

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The need for comprehensive habitat maps to enable effective management of the marine environment is growing. The use of acoustic survey using multibeam, coupled with biological sampling or 'ground truthing', provides a means to map the distribution of reef habitat over wide areas by inferring some relationship between the observed reef communities and the acoustic signal. Historically this inference has been made manually using a rule based approach. However, the relationship between reef biotopes and multibeam data and its derived layers, can be formalised using a modelling approach. We present a method of mapping 'listed' reef habitat using maximum entropy modelling. The distribution of deep-sea sponge aggregations (boreal *ostur*) is mapped for parts of the UK's deep-sea from video transect data. Multibeam bathymetry is used to derive layers of slope, rugosity, bathymetric position index, aspect and curvature in ArcGIS 9.3. Multibeam bathymetry, back scatter and video and image ground truthing are interpreted to produce substrate and geomorphology shapefiles in ArcGIS. Environmental data rasters and point presence shapefiles are prepared for use in the Maxent modelling software. A model of the distribution of boreal *ostur* reef is produced as a map of probability of presence throughout the study area. The probability map is converted to a presence / absence using an appropriate threshold, in this study the average predicted probability of presence threshold was used. Map accuracy is assessed using cross validation and area under the curve AUC score, as well as measures of sensitivity, specificity, and percent correctly classified. The model performed well according to all metrics used. Boreal *ostur* reef is found in the Faroe-Shetland Channel in a narrow band centred on the 500m contour. Reef distribution is patchy but output maps, together with historical data suggest the habitat may form a continuous band on the UK continental slope. Jacknife plots suggest water mass structure is the most important variable determining reef distribution.

Cobble-filled collectors as a monitoring tool for biodiversity patterns in rocky subtidal habitats

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We possess very limited knowledge of the diversity and distribution of species living in our oceans, and it is critical that we inventory this diversity to be able to monitor its changes and minimize losses. We are developing and testing a tool based on settlement collectors to monitor and catalogue spatial and temporal patterns in biodiversity of hard-bottom marine invertebrates (and some fishes) in the southwest Bay of Fundy, Canada. These collectors, first developed by Dr. Rick Wahle to measure settlement of lobsters, consist of a large wire box (92 x 63 x 15 cm) filled with smooth rocks. They offer a low environmental impact method of comparing biodiversity among sites and regions in a standardized way (same area and type of substrate in each collector), and can be used in areas where diver surveys are not feasible as they are deployed and retrieved from a boat. We will describe the tool and present data from one year of deployment to illustrate the effect of level of resolution of sorting (size of organisms examined), sample size, and the spatial scale at which patterns can be detected. Preliminary results indicate that the spatial pattern detected did not differ substantially with the size resolution of organisms examined, but that the number of species found increased by an order of magnitude. The current project in which these collectors are being used to examine larger-scale patterns of biodiversity, and the processes that control them, will also be discussed.

The Darwin Mounds revisited: status of cold-water coral reefs after 8 years of protection

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The Darwin Mounds, discovered in 1998 in the northern Rockall Trough, were the first well-documented cold-water coral mounds in UK deep waters (Masson et al., 2003). Initial sidescan sonar maps revealed over 300 mounds of 50-75 m across and up to 5 m high. They also revealed that several mounds had been badly damaged by deep-sea trawling (Wheeler et al., 2005). Those observations eventually resulted in the closure of the area to bottom trawling, first under EU emergency legislation (August 2003, based on the Common Fisheries Policy), later under a permanent measure (March 2004). The UK government is currently converting these regulations into UK legislation, and has submitted the Darwin Mounds as one of the first candidate UK deep-water Special Areas of Conservation (SACs) to the EU (Habitats Directive). However, there are indications of increased trawling activity in the area shortly before the closure (Davies et al., 2007) and as of March 2011, the status of the coral mounds was unknown. In this contribution, we present preliminary results from cruise JC060 (May/June 2011), aimed at the study of deep-sea benthic ecosystems and their response to human impacts in the Rockall area, NW of Scotland. The assessment of the current status of the Darwin Mounds is based on a combination of multibeam and sidescan sonar maps acquired with the Autosub6000 Automated Underwater Vehicle (AUV), video data and carefully collected samples. The results may give an insight into the effectiveness of the protection measures, and into the potential recolonisation of the reefs.

Spatial and temporal variability of macroalgal assemblages along the Istrian rocky coast (northern Adriatic, Croatia)

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Few studies in the past have found a decline and changes of flora association for the northern Adriatic due to anthropogenic disturbances. In addition, the quantitative data on the abundances of the most common algal species at different spatial and temporal scales for this region are scant. In this research differences in composition and abundances of macroalgal assemblages along a gradient of urbanisation were tested. Destructive sampling was repeated during a period of one year to investigate the distribution of macroalgal assemblages within 3 different areas: (i) within a radius of 50 m; (ii) 1 to 3 km and (iii) more than 10 km with respect to the direct sewage outfall in the town of Rovinj. Differences among canopy forming species at the scale of sites and areas were identified. In spring there was no evidence of biomass differences of *Cystoseira compressa* among the 3 investigated areas, despite the prediction that its abundance would be greater in pristine areas. The abundances of *Cystoseira barbata* and *Cystoseira crinita* were significantly greater in putatively pristine areas and their abundances did not differ during the investigated period. Biomass of leathery macroalgae groups was greater at pristine sites in the winter-spring period while that of the sheet groups was greater in polluted areas in the same period. These results form the background for future research related to understanding ecological processes responsible for distribution and dynamics of macroalgal assemblages in natural and urbanised environments.

The influence of environmental design features for marine life inhabiting coastal engineering structures

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Artificial sea defence against potentially devastating flood and erosion is likely to increase with the anticipated changes in the frequency and intensity of storms, and as a consequence of sea level rise. Marine conservation is a priority for sensitive coastal areas and is an important consideration when planning the construction of coastal structures. This research will provide operating authorities and engineers with practical guidance for the design and maintenance plans of coastal defence structures, to influence the positive environmental impact of artificial structures. The specific influential factors include: increased surface complexity; slope; the presence of water retaining pools, and the presence of crevices. These structural features are investigated for their influence on community development, such as habitat diversity, species abundance and species diversity. Preliminary observations on Plymouth breakwater show that existing pools and crevices influence species abundance and diversity by creating habitats that encourage different assemblages of species. There were differences between species assemblages found on structures with pools; with crevices and structures of an even surface. As a consequence we are now modifying wave breaker blocks to demonstrate the influence of design features on the diversity and abundance of marine epibiota. Manipulations include: casting holes to increase the surface diversity; adding features to retain water, and; adding habitat retreats. Preliminary observations indicate that modifications are influencing the species present.

Ecosystem rebuilding to manage climate-driven incursion of sea urchins

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Incursion of sea urchins (*Centrostephanus rodgersii*) as a result of climate-driven change, coincident with ecological overfishing of large lobsters (*Jasus edwardsii*) as the key predator of urchins in their new range, has realized extensive overgrazing in eastern Tasmania. In this region, the phenomenon represents the single largest threat to the integrity of shallow rocky reef systems and the important biodiversity and fisheries they support. We report on a large scale translocation of large lobsters to extensive sea urchin barrens and to incipient barrens (existing as a patchwork of barrens patches in otherwise intact seaweed beds) in an attempt to rebuild important functional interactions evident in MPAs. We will summarise (1) effects on the lobster and sea urchin populations, (2) lobster behaviour, (3) results of 'forensic ecology' using molecular analyses of lobster faecal material to detect predation events on sea urchins, (4) patterns of the seaweed community, and (5) results of modelling to estimate lobster-sea urchin dynamics and projected recovery of community structure. Our overall conclusion is that the challenge to manage *C. rodgersii*, including rebuilding of ecosystem resilience, is best met by a range of different responses at different scales, but that rebuilding of populations of large rock lobsters at a whole-of-coast scale is fundamental to maintaining the integrity and productivity of this important ecosystem. This is achievable while maintaining a viable rock lobster fishery.

Positive Interactions Along an Exposure Gradient: a look at the effects of spatial and temporal variability of the kelp canopy on community structure

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Environmental gradients are common ecological phenomena that profoundly influence habitat structure and community assemblages in the marine realm. I combined observations and experiments to determine the influence of the environmental gradient of oceanic swell on habitat structure and invertebrate community assemblages in the canopy of *Macrocystis* forests. Specifically, I examined the relative strengths of two exposure gradients as sources of variation in the canopy habitat (among forests along a gradient of exposure to ocean swell, and within forests along a gradient of exposure from the outer section to the more protected inshore sections). I found strong differences in physical structure of the canopy habitat and invertebrate communities among forests along the gradient of oceanic swell but not within forests. The kelp forests that are most exposed supported the greatest total abundance, species richness, and markedly different invertebrate communities in comparison to kelp forests more protected from oceanic swell. Experimental manipulations of canopy habitat structure (number, size and dispersion of sporophytes) demonstrated that the interaction between the dispersion and the size of individual sporophytes contributed to variation of invertebrate community composition. Effects of increased physical stress along the gradient of oceanic swell were ameliorated by the increasing abundance of an epiphytic bryozoan (*Membranipora* spp.). This association occurs disproportionately more in the kelp forests with the greatest exposure to oceanic waves. In turn, in absence of oceanic swell, presence of *Membranipora* significantly increase total abundance, species richness, species evenness and diversity of invertebrates.

Disturbance and recovery of kelp beds in a dynamic environment: pulse experiments in non-equilibrium systems

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The major inference made when applying pulse disturbance experiments to marine communities is that there is an equilibrium state for the community that will be returned to once the pulse disturbance is removed. Benthic temperate communities dominated by the kelp *Ecklonia radiata* are released from competition for space or other limiting resources after a disturbance removes the kelp canopy. This results in co-existence of multiple species until the competitively dominant kelp canopy, perceived as the equilibrium state, is re-established. It could be argued that kelp beds of the small kelp *E. radiata* are non-equilibrium systems where disturbance is more frequent than development of an adult stand, although the disturbance is stochastic in both time and space. What emergent property of these non-equilibrium systems results in persistence of a kelp bed that is a mosaic of different stages in the recovery of kelps from disturbance (sensu Toohey et al. 2007). Here we describe the trajectories of recovery of a species rich foliose macroalgal assemblage over many years post-disturbance to investigate 1. Whether in time and space there is an equilibrium kelp state in *E. radiata* beds 2. Whether there is a generalizable trajectory of recovery, and 3. What processes keep macroalgal assemblages from an equilibrium state. We conclude with discussing the nature and emergent properties of non-equilibrium states and a framework for interpreting such states using pulse experiments.

Post-settlement density-dependent mortality and predation overrides flow-mediated supply

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Complex interactions between a species and its environment can decouple dispersal from recruitment. Habitat fragmentation, biological invasions and disturbance arising from climate change impacts contribute to climbing global extinction rates making evaluation of mechanisms of spread an urgent priority. Despite few physical barriers to dispersal, propagule dispersal distances are relatively short creating an evolutionary trade-off between finding new areas to colonise and being carried away from the favourable conditions. Several factors including flow, post-settlement mortality and predation are important recruitment drivers. While much is known about the individual roles of supply, mortality and predation in determining population structure, relatively little is known about their combined effects on population establishment and growth or how the response might change when rates of supply vary. Here, we simultaneously evaluate their role in the development of an important foundation species, the eastern oyster *Crassostrea virginica*. Using field-based manipulative experiments, rates of predation by two crab species and post-settlement mortality under varying rates of supply were evaluated. Recruitment was estimated at three locations throughout South Carolina, USA. Higher flow velocities enhanced settlement, but a combination of post-settlement mortality and crab predation by the blue crab, *Callinectes sapidus*, mitigated any initial differences in settlement rate. These post-settlement processes likely determine the structure and functioning of marine communities by reducing recruitment densities below minimum thresholds required for population establishment, development and persistence.

Experimental warming reduces invertebrate density and community diversity on rocky shores

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The importance of temperature is currently being addressed with renewed vigor as anthropogenic climate change begins to drive global temperatures beyond historical bounds. Climate change scenarios suggest the earth will warm by 1.7-4.4 °C by the end of the century, which constitutes extremes in both the maximum temperatures reached and the rate at which interannual change is occurring. The broad-brush effects of warming are already observable across a wide variety of systems and taxa, however specific responses of species or ecosystems of interest are more difficult to predict. To determine how thermal stress affects population and community patterns in situ, temperature was manipulated by deploying black and white tiles in The Strait of Georgia rocky intertidal. Barnacle body size appeared to be smaller in experimentally warmed treatments. Additionally, barnacle populations were smaller and declined more rapidly through time on heated tiles. Green algal populations were affected by thermal treatments, but depended on intertidal zone and time. Finally, community diversity was lower in heated treatments and exhibited similar patterns over time within each zone.

The effects of suspended particulate matter and burial on the behaviour and survival of *Sabellaria spinulosa* and *Mytilus edulis*

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Seabed disturbances from many anthropogenic activities result in increased suspended particulate matter (SPM) and the burial of habitats. Although much is known of the ecological effects of burial at the population level, little is known about the effects of burial at the behavioural level and less still of the species responses to elevated SPM. Here we detail the experimental apparatus developed to conduct burial and elevated SPM experiments with a focus on two biogenic reef forming organisms, *Mytilus edulis* and *Sabellaria spinulosa*. *M. edulis* is relatively tolerant of short term (≤ 32 days) burial events, with less than 15 % mortality of all buried specimens. Animals showed a limited ability to re-emerge from a shallow (2 cm) burial depth and mortality increased with progressively finer sediment fractions. *M. edulis* displays an overt nocturnal shell gape cycle, the strength of which is significantly reduced under high SPM conditions. *S. spinulosa* is highly tolerant of short term burial in fine sand with no effect of burial depth. We describe 'emergence tube' construction which occurs under sediment burial, the exact function of which is still unknown. Finally individual *S. spinulosa* showed increasing tube growth rates under increasing SPM load. From the data generated it is possible to make some species specific predictions on burial tolerance and behavioural change under conditions of elevated SPM. Such predictions may be used to inform environmental impact models for the benefit of offshore industries and regulators.

The space-time continuum of biodiversity following non-random species loss in intertidal algal communities

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Loss of biodiversity has pervasive impacts on the world's ecosystems, yet there is still considerable debate about how to quantify aspects of diversity and how it varies over space and time. Beta-diversity has several spatial components and interpretations, but its temporal component is far less tractable because it can only be gauged painstakingly through time. Our work compares the spatial and temporal components of diversity. Here we show that temporal diversity, βt, in rocky intertidal algal communities comprises a large portion of total diversity, that it can take several years to become evident, varies by tidal zone, and depends on impacts to canopy species. Furthermore, our experiments show that short-term impacts to these habitat-forming species can have long-term consequences on community structure, diversity and primary production.

Worldwide analysis of three decades of high-resolution coastal sea temperatures reveals more than warming

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Coastal marine ecosystems are expected to be affected as the Earth warms, with important consequences for biodiversity, economy, and for the global supply of ecosystem goods and services. A better understanding of the warming process requires finer resolution temperature data, which has been hindered by the lack of global, accurate, high-resolution observations obtained by means of standardized methods. Recently, however, NOAA has released a cloud-free product offering unparalleled temporal and spatial resolution (Optimum Interpolation 1/4 Degree Daily SST Analysis data). Here we show that the rate of coastal warming has been highly heterogeneous worldwide, and that warming trends have varied not only regionally but also seasonally. We demonstrate that, in most of the world's coastlines, the frequency of extremely cold events has significantly decreased while the frequency of extremely hot days has increased. Also, we show that the onset of the warm season is significantly advancing earlier in the year in most temperate coastal regions. In Europe, higher coastal warming rates were observed in the Baltic Sea, North Sea, English Channel and British Isles. For the first time, it is possible to analyse local patterns within the global context, which is extremely important for a broad array of scientific fields, policy makers and even for the general public.

Pursuing predator-driven habitat recovery on a warming coast: residency of large lobsters reintroduced to sea urchin barrens ground

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Recent climate warming in eastern Tasmania has driven pole-ward range extension of the long-spined sea urchin (*Centrostephanus rodgersii*) which has effected catastrophic overgrazing of productive Tasmanian kelp beds. The documented role of large lobsters as predators of *C. rodgersii* provides managers the opportunity to (1) increase resilience of seaweed beds against further phase-shifts, and (2) potentially rehabilitate widespread sea urchin barrens. This talk addresses the 'chicken or egg' question: "Are there few lobsters on barrens because they have been fished down, or because sea urchin barrens represent undesirable habitat?" For predator-driven habitat recovery to be a viable management option, predators must inhabit sea urchin barrens over the longer term or at very least undergo foraging excursions from adjacent kelp habitat. We will address results of a large-scale reintroduction of large predatory-capable lobsters to a newly reserved reef in north eastern Tasmania supporting a widespread *C. rodgersii* barren. Extensive trap sampling spanning ~ 3 years and two 3-month acoustic telemetry deployments were used to examine dispersal and patterns of habitat utilisation by large lobsters. Importantly, this work shows that large lobsters persist and become resident on the widespread barrens indicating that predation, in the longer term, may allow widespread kelp recovery. Notably, patterns of kelp recovery are predicted to vary spatially as experiments show that predation risk for urchins will vary depending on rocky reef substratum type. Finally, a new method for detecting change in benthic habitat plus change in the urchins' abundance across deep reef-scapes is introduced.

Climate-induced changes in variability of extreme events and loss of habitat formers: compounded effects on marine coastal assemblages

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Predicting the response of natural systems to global climate change scenarios is key for maintaining their functioning and, hence, services to humans. Along with variations in the mean intensity of extreme environmental and meteorological events, climate changes are expected to generate a substantial increase in their temporal variability, the impact of which has been largely overlooked. In the marine environment, these changes have the potential to alter natural regimes of disturbance, thus interacting with current declines in ecological key species in influencing the resistance or resilience of natural systems. The aim of this study was to experimentally investigate the compounded effects of changes in the mean intensity and temporal variability of storms and loss of canopy-forming macroalgae on the abundance and diversity of benthic assemblages in rockpools, on temperate coasts. Results showed that increases in variability of storm events and loss of a canopy have the potential to accelerate the shift of assemblages towards a less productive system, even if not significantly less diverse. In particular, the aggregation of intense storm events within narrow temporal windows could lead to a drastic decrease in covers of sessile invertebrates, turf-forming and encrusting algae. More generally, our results suggest that preserving habitat-formers could be key to minimize biodiversity losses in the face of global climate changes.

Exploitation of keystone species: population and community-level effects

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Experimental work has shown the importance of grazing by patellid limpets in structuring intertidal assemblages suggesting that limpet over-exploitation would result in dramatic changes to the structure and functioning of intertidal ecosystems. Arguably, the largest anthropogenic impact on Azorean shores has been the over-exploitation of limpets but little is known about the effects of such large-scale and chronic impact. Here, we provide a general overview of studies done over a 3-year period. Generally, patterns of limpet distribution were variable at different spatial scales. At the larger spatial scale, inter-island variation in harvesting intensity affected the abundance and size structure of limpet populations as well as the balance between grazers, algae and barnacles. Stocks of limpets showed clear signs of over-exploitation and there was evidence that current legislation, including limpet protected zones, have been largely ineffective in protecting these populations. Experimental work showed that current dominance by algal turfs at mid shore levels is not a stable state and is result of chronic limpet removal. Hence, cessation of limpet harvesting should allow a return to the pre-exploited community structure. At smaller spatial scales, substratum microtopography affected limpet distribution and here we show how the experimental provision of microhabitats could be used as a measure to mitigate the effects of coastal urbanisation while enhancing the stocks of exploited species.

Processes affecting the re-establishment of the habitat-forming alga *Phyllospora comosa* in Sydney

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Degradation of natural habitats as a result of increasing urbanization is a substantial cause of loss of biodiversity. Macro-algae provide habitat and food to many organisms. These habitats are, however, amongst the most sensitive to environmental change. The loss of habitat-forming algae along urbanized coastlines is a global issue. To develop successful restoration and conservation strategies, it is necessary first to determine which ecological processes are being affected. The habitat-forming macro-alga *Phyllospora comosa* is distributed along the east coast of Australia from Port Macquarie in NSW to Tasmania, but it is absent from the Sydney metropolitan region. Evidence suggests, however, that *Phyllospora* was common and abundant on shallow subtidal rocky reefs in this region until the 1970's. Its absence may be related to heavy outfall discharges along the Sydney metropolitan coast. Despite the significant improvement in water-quality in the last 20 years, *Phyllospora* has not re-established in this region. This could be due to lower or no supply or availability of propagules or settlement. Alternatively, it could be due to smaller or no post-settlement survival of recruits and/or adults. We experimentally transplanted *Phyllospora* recruits and adults from the 2 closest populations on the periphery of Sydney to rocky reefs in the Sydney metropolitan region to test these latter models. The results of this manipulative experiment to determine which processes regulate patterns of distribution of *Phyllospora* in urbanized habitats will be discussed and how these relate to conservation and restoration will be identified.

Effects of changes in relative abundances of rare and common species of benthic assemblages

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Many assemblages contain numerous rare species, yet little is known about roles of rare species in assemblages. To analyse consequences of rarity, we experimentally tested competitive interactions of rare and common species of gastropods known to compete when at large densities. We changed densities of combinations of naturally rare gastropods to match those of common species to examine growth and mortality in response to combinations of inter- and intra- specific densities in combinations of rare and common species. Rarity per se did not cause rare species to differ from common species. Rare species did not respond to the abundances of other rare species, nor show consistently different responses from those of common species. Instead, individual species responded differently to different densities, regardless of whether they are naturally rare or abundant. Such experimental studies contribute to understanding of the roles of rare as opposed to abundant species and therefore, ultimately, on the structure of diverse assemblages.

Larval supply and recruitment of barnacles in Brazilian Upwelling System: a result of the influence of two oceanographic contrasting conditions

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Supply side ecology is a proved relevant tool when understanding coastal invertebrate communities. Larval supply and recruitment of barnacles can be associated with singular oceanographic features. The objective of our study was to investigate the effect of contrasting oceanographic conditions over larval supply and recruitment of Cirripedia, experimentally assessing spatial and temporal variability in a local scale. Sampling was realized at Arraial do Cabo, Brazil, a tropical environment direct influenced by two contrasting time-alternated oceanographic phenomena: Northeast Wind-Upwelling System (NWU) and Cold Front-Relaxation System (CFR). Experiments were designed to test the influence of the following factors: 'oceanographic condition'; 'event'; 'depth'; 'horizontal gradient'. Recruits and both barnacle larval stages were used as models, cypris and nauplius. Measurements were obtained by passive traps in two temporal windows: 6-day, comprehending an entire meteorological event; and 1-day. A significant effect of oceanographic condition over larval supply and recruitment was detected. The greatest cypris supply occurred during CFR. Nauplius supply was not different between oceanographic conditions, just for 1-day sampling. We observed differences in magnitude of larval supply among events of the same oceanographic conditions. Depth was a relevant factor to explain supply variability, but no significant horizontal gradient was detected. Recruitment followed the tendencies found for cypris supply, except for depth. Barnacle larval processes in the study area fit the Upwelling-Relaxation Model. Thus, our results are another evidence that ocean processes are capable of influencing barnacle larval dynamics, specially in Upwelling Systems.

A detailed survey of Haig Fras

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In 2010, JNCC and Cefas formed a partnership agreement to work together to support national obligations to achieve challenging objectives for marine nature conservation and biodiversity protection. One of the objectives of the first research cruises under the partnership agreement was to survey Haig Fras Site of Community Importance (SCI). Haig Fras SCI was one of the first UK sites to be submitted to Europe as an offshore Special Area of Conservation (SAC) for its reef features. Haig Fras is a granite exposure situated in the Celtic Sea measuring about 45 km by 15 km and protrudes in patches above the surrounding sediment as a rock platform. The rock is mostly smooth with occasional fissures and faultlines, some containing patchy overlying sediment. In one area it rises to a peak which lies just 40 m beneath the sea surface. The surrounding seabed is approximately 100 m deep. High resolution multibeam data was collected for the area during two surveys in 2011. An adaptive survey technique was used to maximise the seabed coverage with the aim of obtaining a full coverage high resolution bathymetric map of the area. Backscatter information from the multibeam system was used to inform different seabed substrata. Drop down video and still images were used to ground-truth the acoustic data. Preliminary results indicated that coralline algae and *Corynactis viridis* were found in shallower parts of the reef while *Caryophyllia smithii* appeared dominant in deeper waters. The ross coral *Pentapora* was found to occur in deep rocky areas.

Physical forcing and generality in benthic systems

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Ecology attempts to explain the distribution and abundances of organisms. Because it is impossible to make all measurements at all places, this requires us to seek generality, in other words, 'laws' or patterns to which 'all' organisms conform. In effect such laws do not exist and I believe probably cannot exist. Ecosystems vary in time and in space and a common approach is a reductionist one based on the premise that if we can make sufficient measurements of enough factors at all appropriate scales, then we can make accurate predictions. I believe this is incorrect and that we should instead take a synthetic approach. Ultimately ecosystems respond in the first instance to the interaction of multiple drivers that are themselves set by physical conditions that vary across space and alter in time. Consequently, the patterns we observe in nature reflect the physical and temporal scales at which environmental gradients are strong or show clear variability. Generally predictability diminishes with physical scale, partially as a result of the blurring or disappearance of environmental gradients. Using examples from work done by postgraduate students and post-doctoral researchers at Rhodes University, I illustrate: that ecosystems can show dramatic and unpredictable variability in time; that while we can observe large scale generality in space, this generality is not perfect; that at small-scales we can improve predictability through the creation of small-scale gradients in physical factors; that natural systems can show small-scale spatial determinism and that interactions are key to understanding ecosystem structure and function.

Potential impact of climate-related changes is buffered by differential responses to species interactions

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Detection of ecosystem responsiveness to climatic perturbations can provide insight into climate change consequences. Recent analyses linking phytoplankton abundance and mussel recruitment to the North Pacific Gyre Oscillation revealed a paradox. Despite large increases in mussel recruitment beginning in 2000, adult mussel responses were idiosyncratic by site and intertidal zone, with no response at one site, and slight changes at the other. What are the mechanisms underlying these differential changes? Species interactions such as facilitation by barnacles and predation are potential determinants of successful mussel colonization. We analyzed patterns of barnacle recruitment, predation rate, and tested facilitation interactions between mussels and barnacles. Barnacle recruitment changed little from the 1990s to the 2000s, and relationships between local-scale patterns of barnacle recruitment and climate indices were weak. Despite differences in rates of prey recruitment and abundance of sea stars in 1990-91, 1999-2000, and 2007-2008, predation rates were nearly invariant through time. The facilitation experiment showed that mussels *M. trossulus* only became abundant when barnacle recruitment was allowed, when barnacles reached high abundance, and when mussel recruitment was sufficiently high. Thus, despite sharply-increased recruitment, minimal changes in mussel abundance are consistent with the hypothesis that change was buffered by the insensitivity of barnacle recruitment to climatic fluctuations, and a resultant lack of change in facilitation strength. Although rocky intertidal ecosystems may be sensitive to major climatic perturbations, predicting community responses will be difficult due to complex individualistic responses of key taxa during the recruitment stage and their influences on subsequent species interactions.

Intertidal biodiversity in New Zealand: current status and future concerns

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Macroecology and biogeography are traditional disciplines receiving renewed interest in light of their importance in assessing and predicting anthropogenic impacts in marine ecosystems. Rocky intertidal systems are amenable to such studies across a range of spatio-temporal scales and are sensitive to many anthropogenic pressures, e.g. exhibiting some of the fastest climate-induced range shifts globally. New Zealand is an isolated archipelago extending across 30° latitude, straddling two major marine biogeographic provinces and eleven biogeographic regions. Complex local to basin-scale hydrography, strong gradients in temperature and wave exposure, habitat type, high rates of erosion and volcanic activity can all shape regional variation in coastal flora and fauna. Distributions of intertidal species were qualitatively described several decades ago but little quantitative data has been collected across large geographic areas. To track future change and predict responses of biodiversity to large-scale drivers such as climate change, sea level rise and ocean acidification a current, quantitative national baseline with good local and regional coverage has been established. The distributions and abundances of macroalgae and invertebrates and local biodiversity have been recorded on 125 rocky shores around the New Zealand coastline using standard international protocols developed from the MarClim project. The data show patterns in community structure across biogeographical regions, but little evidence of structure within some guilds or assemblages. New Zealand supports an estimated 65,000 marine species with a high degree (44%) of endemism. Many endemic intertidal species with fragmented or restricted distributions were recorded, along with several non-native species. These are important from an ecosystem structure and functioning perspective and also from a conservation viewpoint, given current concerns regarding climate-driven extinctions and invasions.

Scared to austereness - Risk effects on prey (*Littorina littorea*) reproduction depend on predator (*Carcinus maenas*) diet and origin

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This study addressed effects of predation risk on prey mating behaviour and reproductive output. In one field and four 10 day long laboratory experiments, effects of presence of nocturnal predatory crabs (*Carcinus maenas*) on mating frequency, number of released eggs, and seaweed consumption of the periwinkle *Littorina littorea* were assessed. As risk cues we used predators from two NE Atlantic islands (Helgoland and Sylt) or their faeces, after feeding them with periwinkles, mussels or plaice. Neighbouring consumption activity of crabs from Helgoland and Sylt significantly reduced number of released eggs in Helgoland but not in Sylt periwinkles by ≤ 50 % in the laboratory. This effect was found in light and in darkness. Presence of male and female Helgoland crabs feeding on mussels had similar negative effects on periwinkle reproductive output. Faeces of Helgoland crabs fed with mussels or periwinkles, but not of plaice fed crabs significantly lowered number of released eggs by, on average, 40 %. Effects of periwinkle fed crabs found in the laboratory were confirmed in a field experiment. A significant reduction in frequency of mating periwinkles when risk cues were present was apparent in most experiments, while seaweed consumption by snails was rarely affected by risk treatments. Our results suggest that neighbouring consumption activity of crabs can reduce reproductive output of prey throughout the reproductive season by changing mating behaviour rather than by reduced energy intake of prey. Risk cues seem to derive from digestion of mollusks, yet, their efficacy depends on prey but not on predator origin.

A global imprint of climate change on marine biological systems

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Our understanding of global marine climate change impacts lags behind that of terrestrial systems. Here, we present the first comprehensive synthesis of the evidence for biological impacts of climate change in the world's oceans. We compiled a database of 4300+ observations of climate change impacts on marine biology from 300+ studies from the peer-reviewed and grey literature (including responses both consistent and inconsistent with climate change). Observations included impacts on distribution, phenology, and abundance. We show marine biological responses are widespread and have been reported from every ocean, although the majority of observations come from higher latitudes and coastal waters and this likely reflects the intensity of global research effort. The broad impacts of climate change are observed across taxa with the majority of observations of shifts in phenology coming from seabirds, fish and plankton and distribution changes from fish, molluscs and macroalgae (seaweeds). Warming temperatures and loss of sea ice are reported as drivers of change in many of the observations. Our global meta-analysis reveals that rates of change in phenology and distribution of marine animals and plants are comparable to those reported for land animals and plants, despite the slower warming of the oceans. An understanding of the consequences of these marine biological responses for ecosystem structure and functioning is vital to inform adaptive management responses.

Respiratory carbon fluxes in mussel: Intertidal and subtidal beds compared

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Mytilids have a world-wide distribution and mussel beds are prominent features in intertidal and subtidal systems. Brittany (France) is a hybrid zone between two species (*Mytilus edulis* and *Mytilus galloprovincialis*), here after called mussels. Their limited locomotory potential prevents the organisms to escape from short-term disturbances (e.g. desiccation, irradiation, temperature variations). This study evaluates respiratory carbon fluxes for small (shell length 24-26 mm) and large (shell length 43-66 mm) mussels collected from intertidal mid-shore and subtidal beds. Both aerial and underwater metabolisms were measured seasonally. Aerial respiration was directly measured during short-time incubations in airtight chambers using an infrared gas analyzer. Underwater respiration carbon fluxes were calculated from dissolved inorganic carbon, at the beginning and at the end of 1h incubation in close chambers. Mussels' aerial respiration fluxes were directly correlated with temperature. In contrast, underwater carbon fluxes seem to be influenced by other factors as food availability and reproduction period. Maximum fluxes during immersion were observed in April and minimum fluxes in November. While underwater metabolism was similar for small and large individuals, aerial respiration showed different adaptations. Intertidal and subtidal small mussels had similar respiration in air. Large intertidal individuals showed higher carbon fluxes in air than subtidal individuals. These data suggest that adult intertidal mussels are better adapted to aerial respiration than subtidal ones.

Impact of an introduced species on the functioning of a native ecosystem

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Worldwide biodiversity loss owning to climate changes and anthropogenic activities can alter ecosystem functioning. As a consequence, large macroalgal zone losses (mainly canopy species) have been reported worldwide. Canopy species are often replaced by more simple morphological or introduced species. Using a combination of *in situ* observations and experimental manipulations, the impact of a well established invasive species, *Sargassum muticum*, was investigated on a native intertidal rocky shore biodiversity and ecosystem functioning. Demography of this introduced species was compared to one of its native competitor: *Fucus serratus*. A detailed study of *S. muticum* fecundity was also carried out. Differences in their life history may allow coexistence of both species in the same ecosystem. Productivity of these two species was estimated in the laboratory. A much lower productivity of *S. muticum* was observed. In addition, a field removal experiment of *S. muticum* was undertaken to assess its effect on the native biodiversity and ecosystem functioning using production as a proxy. Early results of this long term experiment will be presented.

The mutual mucus ingestion hypothesis. Evidence of convergent resource use in intertidal grazing gastropods within experimental microcosms

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According to traditional ecological theory niche differentiation and complementary resource use are mechanisms by which species are able to coexist by reducing competition for available resources. In this study a manipulative experimental approach was used to examine whether species coexistence induces dietary niche differentiation and partitioning of available food resources when three species of grazing gastropod found on temperate rocky reefs (*Littorina littorea, Patella vulgata* and *Patella depressa*) were held under differing conditions in experimental cages. Several hypotheses were evaluated: 1.) The diet of caged animals, forced to forage only on biofilms, differs from that of uncaged conspecifics free to forage naturally. 2.) The diet of animals caged with interspecific competitors shows dietary divergence, differing from that of animals in single-species treatments. 3). Food availability influences diet in grazing gastropods and that interspecific competition further affects food choice. Animals were held in experimental cages for six months. Species number and food availability were manipulated to test the articulated hypotheses. Stable carbon and nitrogen isotope analyses were used to quantify grazer diets. The results showed that food availability and species identity were important factors controlling diet choice in intertidal grazing gastropods but no evidence for niche differentiation or divergent resource use was observed. In fact, *L. littorea* and *P. vulgata* caged together on bare rock exhibited dietary convergence: the diets of the two species were more similar when caged together than when caged separately. A number of possible explanations for this interesting phenomenon were proposed including the ‘mutual mucus ingestion hypothesis’.

The effects of loss of species on ecosystem functioning are determined by environmental conditions in a temperate reef system.

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Despite extensive research into biodiversity-ecosystem function relationships, little is known about how they vary under different environmental conditions. Empirical studies in aquatic systems have been criticized for failure to take account of variation in environmental conditions and for their short duration. This study examined the effects of loss of species of grazers on primary productivity, algal assemblage structure and biomass accumulation, at both ambient and nutrient enriched conditions. Using a series of purpose-built rock pools in southeast Ireland, the presence of three common gastropod grazers was manipulated. Experimental treatments included assemblages with all three species present, removal of each species individually and removal of all three species simultaneously. Manipulation of water column nutrient concentrations also allowed us to test for interactions between the loss of grazer species and nutrient enrichment. After 13 months, primary productivity rates were greater in pools with enhanced nutrient concentration but there was no effect of loss of grazers on primary productivity. This was surprising because although loss of grazers did not affect total algal biomass at enhanced nutrient concentrations, the loss of certain grazer species (*Patella ulyssiponensis, Littorina littorea*) at ambient conditions led to an increase in total accumulated algal biomass. Moreover, algal assemblage structure was affected by nutrient concentration and not by loss of grazers. Our findings suggest that the effects of eutrophication on total algal biomass are stronger than the effects of loss of key species and show clearly that the effects of loss of species on ecosystem functioning vary with environmental context.

Body mass-abundance relationships are robust to cascading effects in marine food webs

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Body mass has been shown to scale negatively with abundance in a wide range of habitats and ecosystems. It is believed that this relationship has important consequences for the distribution and maintenance of energy in natural communities. The relationship between body mass and abundance may be robust to major food web perturbations, fuelling the belief that natural processes may preserve the slope of this relationship and the associated cycling of energy and nutrients. Here, we use data from a long-term experimental food web manipulation to examine this issue. Similar benthic communities were developed in large experimental mesocosms over a six month period. Some of the mesocosms were then subjected to species removals, based on the mean strength of their trophic interactions in the communities. In treatments where the strongest interactors were removed, a community-level trophic cascade occurred. The biomass density of benthic invertebrates increased in these communities, which led to a suppression of primary production. In spite of these widespread changes in ecosystem functioning, the slope of the relationship between body mass and abundance remained unchanged. This was the case whether average species body mass and abundance or individual organism size spectra were considered. An examination of changes in species composition before and after the experimental manipulations revealed an important mechanism for maintaining the body mass-abundance relationship. The manipulated communities had a higher species turnover than the intact communities, with the highest turnover in communities that experienced cascading effects. As some species increased in body mass and abundance, new species filled the optimal size-abundance niches that were created thus providing a stabilising structure to the communities.

Evaluating the integrity of fish communities in temperate reefs

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Due to the requirements of the Water Framework Directive, fish assemblages from streams and transitional waters have been used thoroughly as quality indicators, but little is known on using marine fish assemblages for the assessment of the state of a system. However, the increasing over-exploitation of fishing stocks encouraged a broader approach to understand how coastal communities can support the integrity of offshore populations of commercially important species. This encouraged the establishment of coastal marine protected areas in rocky reefs and led to fish communities being a recent requirement of the Marine Strategy Framework Directive for the assessment of marine waters. The authors propose a multimetric index approach to fish assemblage assessment in temperate reefs, the Marine Fish Community Index (MFCI), and test the influence of both anthropogenic and natural variation on community metrics in a marine protected area on the west coast of Portugal. The proposed method assesses the structural and functional integrity of fish communities and can be a very useful tool for management and conservation of the marine environment.

Introducing statistical rigour into ecological ordination plots

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The high-dimensional nature of ecological data requires ordination techniques to reduce the data cloud down to just two or three dimensions that can be plotted in order to visualise patterns. Non-metric multi-dimensional scaling (MDS) has become the most popular ordination technique for ecological community data due to its lack of assumptions and its ability to represent high-dimensional structures well in a reduced space. Despite its widespread use, there is currently no statistically rigorous method of making inferences about the regions observed in an MDS plot. Typically, researchers just present the sample units as a configuration of points, but in what region(s) of the plot might new samples from a population be expected to lie? Traditional techniques of inference for classical ordination methods (PCA, CVA) draw circles or ellipses (ellipsoids if the ordination is plotted in 3-D) to show confidence regions, which rely on the assumption of multivariate normality, which is unrealistic in ecology and inappropriate for non-parametric MDS ordination. Using examples from the marine environment, we will present (using a simple intuitive framework) the development of data-driven (non-parametric) methods for drawing empirical regions for valid statistical inference directly in ordination plots such as PCA, PCO or MDS.

Invertebrate Diversity Associated with *Sabellaria spinulosa* Reefs in the UK

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The polychaete worm *Sabellaria spinulosa* can have a huge impact on the physical nature of the seabed, turning large quantities of sand into intricate, though often disorderly, reef structures. Like other factors known to increase habitat complexity, the presence of these reefs has often been linked with an increase in biodiversity. Detailed studies carried out to test this assumption have demonstrated that *S. spinulosa* reefs can consolidate benthic communities, enhancing their abundance, biomass and alpha diversity. The variation in species composition, or beta diversity, within these reef communities is however lower than surrounding sediment deposits such that a species discovery curve reaches its asymptote with relatively little sampling effort. This has important implications for both the conservation value of *S. spinulosa* reefs and their function in the wider marine ecosystem. Macrobenthic species which are found only sporadically in sedimentary environments are effectively condensed by *S. spinulosa* reefs so that the preservation of such structures would safeguard a large proportion of macrobenthic species in a relatively small area. The concentration of faunal biomass also provides an easily accessible source of prey for demersal fish and large invertebrates. The influence of *S. spinulosa* on the feeding behaviour and diet of demersal fish is investigated using samples from the southern North Sea and Eastern English Channel. A number of fish species have been found to feed on *S. spinulosa* directly and others make adaptations to their feeding behaviour in order to take-advantage of the abundant crustaceans associated with these reef features.

Prezygotic barriers to hybridization in marine broadcast spawners: reproductive timing and mating system variation in sibling species.

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Sympatric broadcast spawning species with incomplete reproductive barriers can reveal how reproductive isolation arises, and the interplay between ecological and non- ecological factors. Interspecific asynchrony in gamete release and gametic incompatibility are the main presumptive prezygotic barriers to hybridization, while the role of mating system variation has been emphasized in plants. The sibling brown algal species *Fucus spiralis* and *Fucus vesiculosus* were used as a model because 1) they form hybrids in parapatry in the rocky intertidal zone, 2) maintain species integrity over a broad geographic range, and 3) have contrasting mating systems (*F. spiralis* is a selfing hermaphrodite and *F. vesiculosus* is a dioecious outcrosser). Reproductive synchrony (egg release) was coincident at yearly/seasonal and semilunar/tidal temporal scales, and was controlled by semidiurnal tidal and daily light-dark cues, rather than semilunar cycles. Importantly, interspecific shifts in timing detected at hourly scales during single tides were consistent with a partial ecological prezygotic hybridization barrier. Gamete release in both species followed a power law-like distribution, indicating strong reproductive synchrony. However, relaxed constraints on synchrony hypothesized for selfing species was confirmed by the broader range of tidal phases for spawning in *F. spiralis*. Synchronous gamete release is critical for fertilization success, and reproductive opportunities are limited in high-energy intertidal environments. Despite these constraints, subtle variations in reproductive timing have evolved that potentially provide an ecological barrier to hybridization between congeners. The evolution of selfing, by relaxing constraints on synchrony, may have facilitated the divergence between sibling species.

Hydrodynamic conditions and particle behaviour within two artificial reefs in different water depth of the south-western Baltic Sea: first results

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Artificial reefs were built in the past to enhance fish aggregation and production, and to protect coastal erosion as well. Less is known about the resulting influences on the vicinity of fresh deployed artificial reef. The two artificial reefs are located northwest and north east of Rostock Warnemuende. The "Artificial reef - Nienhagen" is located in the Southwestern part of a fishery protected zone at a water depth of 11 to 12m, 1.5 km offshore. It comprises of about 1,400 concrete elements and about 2500 t of natural stone and covers a surface of about 50,000 m². The „Artificial reef- Rosenort“ is also located in a fishery protected zone 2 km offshore. It is much smaller than the Reef Nienhagen, comprises of 56 concrete elements and 180 t natural stone, and is built in 6-7 m water depth. Both reefs were surveyed with two different acoustic doppler current profiler (ADCP) systems, CTD-casts and sediment sampling. Measured parameters were particulate organic Carbon (POC), particulate organic Nitrogene (PON), Chlorophyll-a, total particulate matter (TPM) and ^{234}Thorium for the water column. Sediments were analyzed for C, N, Chl-*a*, grain size and water content. Here we present first results of high resolution measurements of hydrodynamic conditions and particulate matter behavior.

Using the past to predict the future as a test for alternative states

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It has been suggested that rockweed stands and mussel beds are alternative states on sheltered intertidal shores in the Gulf of Maine USA, and in 1996, we created 48 clearings in rockweed stands (ranging from 1 to 8 m in diameter) at 12 sites in Maine to test this idea. By 2009, 33 % of the clearings had become mussel beds; an outcome that is consistent with the idea of alternative states. In 2010, half of the clearings were re-scraped as an additional test of the hypothesis. We will discuss the prediction that the past (i.e. patterns of recruitment, mortality and percentage cover from 1997 to 2009) will not predict the future if mussels and rockweeds are alternative states. In addition, hourly temperatures in groups of tethered mussels were monitored for 51 days after completion of the re-scraping. First three PCA axes described 58 % of the variation in temperature (total number of axes = 1280). Temperatures varied among sites more than between re-scraped and not re-scraped plots. During low tides, 2.5 % of the temperature readings were above 30 degrees Celsius, which is close to the thermal limits for mussels. These findings suggest temperature may have a large, but idiosyncratic, impact on recruitment and survival of mussels and may explain why the development of mussel beds in some clearings but not others appears to be unpredictable.

Possible effects of gorgonian forest loss on Mediterranean coralligenous assemblages

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Mediterranean gorgonian forests are threatened by several human activities and are affected by climatic anomalies, which promote the development of mucilaginous aggregates and increase the susceptibility to pathogens and epibionts. In the last decade, these phenomena led to several gorgonian mass mortality events in the north-western Mediterranean Sea. Although these phenomena have been largely investigated, little is known of the possible impact of gorgonian habitat loss on coralligenous assemblages. The effects of *Eunicella cavolinii* and *Paramuricea clavata* on the settlement and recruitment of epibenthic organism were investigated by a field experiment carried out from June to October, 2010. Gorgonian forests were simulated by transplanting three apical branches (~20 cm) on plastic recruitment panels. Panels with and without gorgonians were arranged in plots of four panels each. For each gorgonian species, four forested and four non-forested plots were deployed, interspersed, in two randomly selected sites (Tavolara Island, Sardinia, and Portofino promontory, Liguria) at 24 and 40 m in depth, for *E. cavolinii* and *P. clavata* respectively. Recruited assemblages revealed site and species specific effects. Overall, both gorgonians lowered the growth of not calcareous algae and the recruitment of some serpulid polychaetes. *P. clavata* favoured some hydroids and bryozoans, while *E. cavolinii* promoted coralline algae at one site. Both gorgonians reduced species diversity and evenness. Gorgonians could affect recruited assemblages by modifying microscale hydrodynamism and sedimentation rate, intercepting the larvae before their settlement, creating shading that reduces photosynthesis and providing dim light conditions, competing for food with the filter-feeders and/or producing allelochemicals.

Reef-building ecosystem engineers in shallow temperate soft-bottom environments: Challenges and conflicts for management

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The presence of ecosystem engineers is known to have important effects in many coastal sediments. It is necessary to value the function of ecosystem engineers in their environment and to recognize the consequences of their anthropogenically induced degradation. Persistent emergent structures in aquatic environments are often referred to as 'biogenic reefs'. *Lanice conchilega* is a well-known marine ecosystem engineer of shallow soft bottom ecosystems, exhibiting reef like features by shaping the biological, physical and biogeochemical environment locally. The effect of *L. conchilega* as ecosystem engineer is in the subsurface similar to endobenthic ecosystem engineers like *Arenicola marina* and *Echinocardium cordatum* while the effect of protruding part is comparable to what is found for tube building polychaetes such as *Sabellaria spinulosa*. This combined ecosystem engineering effect is unique for *L. conchilega*. When this tube builder occurs in high densities, structures originate which are referred to as reefs. The 'label' of temperate reef for this habitat is interesting when it comes to management. Our study discusses the use of the term 'reef' when important ecosystem engineers that create biogenic habitats are used in the implementation of the ecosystem approach to management. We use *L. conchilega* as a specific case study to discuss the topic in a broader context.

Disturbance to conserved bacterial communities in *Eunicella verrucosa*: environmental factors and monitoring for susceptibility to disease

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Bacterial populations associated with corals are of great interest due to growing incidences of coral disease and the hypothesis that bacteria play an integral role in coral health, and disease. While studies have detailed bacterial communities associated with tropical and sub-tropical corals, there is little information on the stability of bacterial communities associated with temperate gorgonians. In this study, the microbial community associated with both healthy and diseased colonies of *Eunicella verrucosa* located off SW England was investigated. Microbial communities were assessed at three sites, chosen for differences in sediment load and depth, in June and September 2007 using 16S rRNA clone libraries and denaturing gradient gel electrophoresis (DGGE). Clone libraries demonstrated the presence of a conserved bacterial community associated with healthy colonies, suggesting the presence of a specific microbial community which is consistent with previous studies in tropical corals. In addition, sequences included a high proportion of affiliations to *Spongiobacter* sequences, previously found in a number of invertebrates and suggested to play a role in coral health. Clones libraries from visually diseased colonies showed a decrease in affiliated clones and an increase in diversity of clones related to potentially harmful/ transient microbes. DGGE banding patterns confirmed these results. Site differences in the level of disturbance to bacterial communities were apparent, correlating most significantly with increasing sediment loads. Further, data shows changes to bacterial communities occurring prior to visual signs of stress, suggesting the potential use of bacterial fingerprinting as a way of identifying susceptible colonies.

The effects of inbreeding on the metapopulation dynamics of the giant kelp

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The commonly held belief that ecological factors manifested in random environmental and demographic events are the primary causes of local population reduction and eventual extinction is being challenged by recent studies that have found evidence for local extinction from inbreeding. We are examining the role of inbreeding in the metapopulation dynamics of giant kelp, *Macrocystis pyrifera*, which occurs in discrete patches off southern California that undergo frequent local extinctions and recolonizations on time scales of a few years. Our findings thus far show that smaller and more isolated patches were more likely to go extinct and were less likely to be recolonized following local extinction. That extinction was more strongly linked to the degree of isolation of a patch than to its area is consistent with the hypothesis that genetic factors such as inbreeding depression play a role in the metapopulation dynamics of giant kelp. Dispersal characteristics and self-compatibility lead to a high likelihood of inbreeding in giant kelp. Results from inbreeding experiments showed that self-fertilization resulted in severe detrimental consequences to adult reproduction, thus providing a viable mechanism by which inbreeding can affect the probability of extinction in isolated populations. Our ongoing research examining the effects of inbreeding depression on the metapopulation dynamics of giant kelp is being facilitated by our recent development of: (1) highly polymorphic microsatellite markers for characterizing the population genetics of giant kelp, (2) a high resolution oceanographic model for estimating connectivity among local populations of giant kelp, and (3) the use of satellite imagery to estimate effective population size for all discrete patches of giant kelp.

Biodiversity patterns on Eastern Mediterranean vermetid reefs: an endangered ecosystem

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The Levant Basin is a distinctive ecoregion because (1) of its extreme biophysical conditions, having the hottest, saltiest and most nutrient-poor waters the Mediterranean; (2) it is the eastern edge of distribution of multiple Atlanto-Mediterranean species, some may be near at the edge of their physiological comfort zone; (3) it is a major bioinvasion hotspot; and (4) it hosts a unique habitat: the biogenically-structured rocky intertidal reefs known as “vermetid platforms”. Preliminary data from the 1990s suggested that this poorly-studied rocky-shore ecosystem is going through major community transformations. A new comprehensive biodiversity monitoring program (11 sites) is quantifying for the first time the diverse communities and biophysical conditions along the coast and how they change seasonally/annually. It indeed reviled considerable alterations of this ecosystem. The most disturbing change is the extinction of *Dendropoma petraeum*, the vermetid gastropod that used to build a rim at the platform’s edge and by that alter the physical conditions on the flats and protect the rocky substrate from abrasion, rendering it an ecosystem engineer. Today the rims in many sites appear considerably eroded with possible ramifications to the communities on the platform flats. Furthermore, many platforms are dominated by an invasive mussel, and many species that used to inhabit the platforms in the 1960s are rare or absent. What are the drivers of these profound changes is unclear but climate change is one possibility. Water temperatures and sea level are rising regionally, and both can have extensive impacts on biodiversity patterns along the coast.

Population dynamics of the World's smallest viviparous sea star, on temperate intertidal platforms in Southern Australia.

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Marine invertebrates that reproduce via direct development have long been thought to have more stable populations than species with life-histories that include a pelagic larval phase. Recent evidence suggests that species with pelagic larval phases may actually have more stable populations than species that have no larval period, but a lack of data on the population dynamics of species with direct development, currently limits our ability to understand these relationships. We examined seasonal and inter-annual changes in the distribution and abundance of three populations of the direct developing, viviparous sea star *Parvulastra parvivipara*. This species inhabits tide pools on seven isolated intertidal rock platforms on the west coast of the Eyre Peninsula, South Australia. Our data suggest that the abundance of *P. parvivipara* is stable at the population level, but highly variable among tide pools within each population. While the presence and abundance of *P. parvivipara* could generally be predicted by the structural complexity of tide pools, their depth, temperature and the degree of wave exposure they experience, the sea stars disappeared sporadically from some tide pools that were ostensibly suitable for them. These tide pools were subsequently recolonised, but there was no periodicity to disappearance and recolonisation events. Although *P. parvivipara* does not have a dispersive larval stage, they appear to be able to re-colonise tide pools. We suggest that despite the highly dynamic fluctuations in the abundance of the sea stars within tide pools, overall population stability is maintained by small-scale metapopulation relationships.

Resistance against phase-shifts from kelp forests to algal turfs: grazers fail to eat their share under future conditions.

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There is increasing evidence that future [CO_2] and temperatures will cause the expansion of algal turfs and promote the loss of kelp forests. Yet the metabolic theory of ecology suggests that the molluscs which consume these turfs, being ecotherms, should consume greater quantities under elevated temperatures, potentially countering the spread of turfs. In contrast, ocean acidification is predicted to be detrimental to grazers, potentially decreasing their ability to consume turfs. To tease these potentially opposing effects apart, we exposed subtidal molluscs (*Austrocochlea rudis*) to combined increases in CO_2 and temperature and quantified both their metabolic rate (O_2 consumption) and the amount of algal turf that they consumed. In contrast to predictions, elevated temperatures caused a decrease in the amount of algae consumed by grazers, which was reduced even further when concurrently exposed to elevated CO_2. Importantly, the mechanism for this decrease in consumption was likely to be metabolic depression, even though grazers were well below their thermal limits. In regions where the dominant grazers are molluscs, this result suggests that systems will have little inherent resistance against phase-shifts which are facilitated by the expansion of fast growing algal species.

A species of herbivorous, territorial damselfish in temperate Australia has the potential to impact algal assemblages at greater spatial scales than its tropical counterparts.

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The herbivorous, territorial damselfish *Parma mccullochi* is abundant on rocky reef throughout temperate Western Australia, with its peak densities at Perth (32o S). Over its geographical range *P. mccullochi* is strongly associated with turfing algae habitat, in an environment that is generally dominated by canopy forming algae. Behavioural observations revealed that *P. mccullochi* feed over large areas (8.8m2) in comparison to many well studied tropical 'gardening' damselfish. These areas consist of mixed epilithic turfing algae, and epiphytic algae. Territories are defended against herbivorous fishes including confamiliars, kyphosids and scarids. *P. mccullochi* structure the levels of fish herbivory within territories through territorial exclusion of herbivorous competitors, and maintain a constant low level of herbivory within the territory. It was hypothesised that with the exclusion of resident *Parma mccullochi*, early successional filamentous and small foliose algal forms, which are typical of feeding areas, might be replaced by an increase in biomass of later successional forms. However, in contrast to this hypothesis a series of six week experiments uncovered no effect of the exclusion of resident *P. mccullochi* on the composition or biomass of the functional groups of algae that make up the feeding area. In summary, as temperate Parma defend larger feeding areas they have the behavioural potential to impact benthic communities over larger spatial scales than their tropical 'gardening' counterparts. However, at the temporal and spatial scales manipulated through these experiments no impact of the fish was detected upon algal assemblages at the functional group level.

Fractured connectivity in a changing wave environment: consequences for algal settlement following diffuse and local impacts

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Connectivity across increasingly fragmented populations is critical in maintaining community structure along coastlines, yet models rarely account adequately for how this works in ecological time for most species. At site scales, there is a broad correlation between wave climate and community structure of intertidal communities but the mechanisms that underlie this can involve processes from sub-millimetre (e.g., benthic boundary conditions) to kilometres (e.g., currents) and involve both attachment and detachment processes. Using intertidal fucoid algae as models, simple diffusion models describe dispersal curves reasonably well and show there is a low probability of long range dispersal via propagules. However, they do not capture the high variability of long distance dispersal or the fact that LDD clearly occurs in these species. A range of mechanisms, including stratification processes that may clump propagules as they disperse, dispersal via drifting reproductive adults, and particular conditions of wind and tide may render effective LDD much more probable than expected (although still exceedingly rare). Furthermore, successful attachment of propagules depends on the wave climate, and effective recruitment on settling density. These are discussed in the context of recent decadal increases in significant wave height along coastal New Zealand.

Reef Nienhagen – the largest artificial reef in the Baltic Sea

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In 2003 an artificial reef was installed 1.5 nm off the coast of Mecklenburg-Vorpommern (south-western Baltic Sea). The area of the artificial reef extends over approximately 4 hectare, equipped with several thousand reef structures and was placed into the subtidal part of Mecklenburg Bight in approximately 12 m depth on sandy-gravelly bottom. Different designs and forms of artificial reef elements, made from three diverse concrete compounds, additional rocky and boulders deposits and a large number of natural substratum such as stones, boulders and granite blocks were used to design the artificial reef area. The reef was designed as a test area for studying the effects of artificial hard substrate for fish recruitment. An important question in this context was the influence of secondary structures as formed by macroalgae and sessile animals, on fish communities and their recruitment. Accordingly, the achievement of a highly structured fouling community, preferably consisting of filter feeders and perennial algal species in a stable hard bottom community, was one of the targets of the reef experiment. In this regard, it was essential to compare the species colonisation strategies and patterns as well as the community formation and succession on above mentioned different artificial substrates in short- and long-term investigations. In general, the investigated reef structures were rapidly colonised directly after their submersion and showed dense and diverse benthic communities. Productive hard bottom habitats like this attract fishes, and provide food for them and protection of juveniles. In this context, a successful colonisation by fishes, especially by commercial ones, for example the Atlantic cod can be evidenced within the artificial reef project.

Environmental determinants of the regional distribution of NW Atlantic rocky intertidal invertebrates

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We present the first results of a program investigating the biogeography of NW Atlantic rocky shores, focusing on the most abundant filter feeders (barnacles and mussels) and their predators (dogwhelks). Barnacle (*Semibalanus balanoides*) recruit density was regionally related to nearshore phytoplankton abundance on Canadian and American shores, suggesting that recruitment responds to bottom-up regulation by pelagic food supply. To a lesser degree, recruitment rates were regionally related to the density of adult organisms, suggesting a reproductive effect. Ultimately, however, recruitment has a limited influence on regional population structure, as the occurrence of scouring by winter sea ice overrides recruitment effects and largely determines regional adult abundance. Additionally, we tested the abundant-centre model by surveying mussels (*Mytilus edulis* and *M. trossulus*, identified genetically) and dogwhelks (*Nucella lapillus*) between Newfoundland and New York. *Mytilus edulis* and *Nucella lapillus* occurred everywhere but were most abundant at a relatively southern location (Maine), while *M. trossulus* was absent at the southernmost location (New York) and peaked in abundance towards its southern limit (southern Nova Scotia and Maine), with all species showing a trough in Cape Breton. Abrupt changes in habitat conditions (lack of rocky substrate and heat stress south of New York, and ice scour in Cape Breton) explain the departure from an abundant-centre pattern. Mussel abundance was negatively related to critical aerial exposure time (stressful aerial exposures during the coldest winter hours and warmest summer hours) along the coast, thus partially supporting the model. Regional predator abundance appears to respond positively to prey abundance.

Limpets inside and outside tidepools along the SW Portuguese coast: a multi-scale study

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Limpets are keystone species within rocky-shore communities and have been mostly studied in open-rock habitats. Comparatively little is known about their ecology within tidepools and in the interface between tidepools and neighbouring environments. *Patella depressa*, *Patella ulyssiponensis* and *Siphonaria pectinata* are the most common species of intertidal limpets in SW Portugal. We have studied diversity, distribution, abundance and size of limpet populations inside and outside tidepools in seven shores along the South-West Portuguese coast. Furthermore, we have related these dependent variables to physical variability of tidepools and shores. In each shore, two coastal stretches of 10 meters long were considered. In each stretch, 25 tidepools were sampled randomly within the intertidal zone by identifying, counting and allocating to 1 cm size-classes (maximum shell length) limpets found in 3 environments: i) bottom of each tidepool (Pool); ii) tidepool edge (Edge); and iii) open-rock areas surrounding each tidepool (Near). Additionally, at the mid-shore level, open-rock areas at least 25 centimeters away from any tidepool were sampled (Far). Abundance and size of the three species within Pool, Edge and Near environments were compared, and related to characteristics of individual tidepools (e.g. shore height, depth, surface area, distance to the nearest tidepool) and of each shore stretch (e.g. topographical complexity and proportion of tidepools / other habitats). Comparisons among the four environments were done at the mid-shore level. Results will be discussed in view of the main patterns of limpet populational traits within different environments and the environmental variability at several spatial scales.

How hot is hot? Characterization of induced thermal stress levels in Patella spp.

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Temperature has long been recognized as one of the most effective terrestrial stressors in intertidal environments. Nevertheless, the scales at which thermal stress gradients emerge remain poorly understood. In fact, recent research has revealed that even at the lowest, sun-exposed, zones of the shores remarkably high temperatures are an unexpectedly common feature. As networks for the measurement of intertidal temperatures grow in number and size, it is vital to understand the relations between body temperatures and the thermal stress that is actually experienced by organisms, which is still largely unclear. In the present work we submitted limpets of the Patella genus to a series of temperature profiles under laboratorial conditions and quantified (1) mortality and (2) sub-lethal thermal stress by measuring the levels of HSP induction and heartbeat rate. Temperature trajectories replicated those experienced by the animals in the field. We tested for differences arising from both acute (i.e. short periods of very high temperatures) and chronic (i.e. long periods of moderately high temperatures) stresses induced by temperatures as actually experienced across a variety of microhabitats from several locations along the European Atlantic coast. This work provides new insights for the prediction on how a changing environment may impact the distribution of intertidal organisms.

Fractal analysis of foraging behaviour reveals optimal food concentrations and food-sex trades-offs in the intertidal gastropod *Littorina littorea*

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All animals constantly face the challenge of finding food and mates, while avoiding predators in spatially structured, complex environments. A few theoretical studies have predicted the emergence of fractal patterns and associated power-law distributions to specific optimisation processes. This is consistent with theoretical works suggesting fractal Lévy walks as an adaptive behavioural response to foraging in highly unpredictable and resource-poor environments. However, the potential phenomenological link between habitat and animal behaviour fractal properties remains an open issue, in particular in intertidal ecology. In this context, we focused on the foraging behaviour of the intertidal prosobranch *Littorina littorea* to quantify the interplay between the distribution of microalgal biomass, the presence of a conspecific (from the same or the opposite sex) and individual motion behaviour. This question has been addressed on an intertidal flat characterized by a strong submetre-scale heterogeneity in microphytobenthos biomass distribution and a high abundance of *L. littorea*. The overall complexity of *L. littorea* males and females movement pathways was assessed using fractal analysis and shown to belong to a specific class of fractal motion. They were further compared to the spatial patterns of microphytobenthos biomass over foraged areas, and we consistently identified microphytobenthos concentrations with fractal properties specifically matching those of *L. littorea* males and females movement pathways, suggesting the existence of sex-specific optimal food concentrations in *L. littorea*. Finally, the fractal properties of movement pathways of individuals that trail-followed a conspecific significantly differ from the fractal properties of food-foragers, suggesting a trade-offs between mate-seeking and food-seeking individuals.

Recovery of temperate reef fauna from the effects of towed fishing gear

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Lyme bay reefs were subject to scallop dredging and demersal trawling, which damaged the fragile mudstone habitat and the associated reef faunal assemblages. In 2008, 206 km^2 of Lyme Bay was granted protection from bottom towed fishing gear. This Marine Protected Area was the first in the UK to be established to protect marine biodiversity with no fisheries agenda. It was therefore important to monitor the damaged reef to determine if, when and how the associated fauna recovered. We undertook a 3 year study examining changes in benthic species assemblages resulting from the closure. A suite of indicator species were selected a priori for univariate analyses to represent the range of Lyme bay species' life history traits, susceptibility to damage, and recoverability. We developed a new, cost-effective and relatively non destructive method which employed High definition video, mounted on a towed, flying array to remotely sample the benthic assemblages. Video transects were taken in the newly closed area and at control locations. To quantify changes in the reef nekton and mobile cryptic species, we deployed the high definition gear on a baited static frame, at sites established for the main survey. Due to the long lived nature of many of the characteristic sessile species of Lyme bay, such as pink sea fans *Eunicella verrucosa*, from the offset we anticipated that the time-scale of the project was insufficient to fully determine 'recovery. However, we suggest that we have detected early stages of recovery of the reef faunal assemblages.

Barnacle lotteries and competitive equivalence: the roles of variable recruitment and interference on species coexistence

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Among sessile organisms, hierarchical competition for space can be a pervasive process structuring rocky shore communities. The maintenance of species dominance or coexistence may involve both local and regional processes, but few studies have simultaneously examined both. We investigated the roles of local interference variable recruitment, and the interplay between them in structuring patterns of coexistence of two co-occurring chthamalid barnacles along the central Chilean coast, *Jehlius cirratus* and *Notochthamalus scabrosus*. These species occupy slightly different portions of the upper intertidal shore, but inter-specific mixing occurs at scales of few centimeters and over 60-80% of the entire barnacle zone. We monitored recruitment rates at three tidal elevations at four sites (separated by 100s km) and manipulated barnacle density to quantify the effect and direction of local interference on individual growth and mortality rates for approximately 20 months. Results revealed: 1) intra- and inter-specific interactions among barnacles were generally positive, 2) Jehlius and *Notochthamalus* are competitively equivalent, with no hierarchical domination of space by one species over the other, 3) patterns of recruitment between *Jehlius* and *Notochthamalus* vary among tidal elevations and are strongly correlated to patterns of adult dominance, 4) patterns of adult barnacle abundance across sites and tidal elevations are positively correlated to species-specific abundance within the newly-settled juvenile spat, and 5) patterns and mechanisms of species dominance vary little among sites. We conclude that lottery type interactions and species-specific post-settlement mortality rather than an inter-specific competitive hierarchy determine patterns of coexistence of *Jehlius* and *Notochthamalus* in central Chile.

Hot hard bottoms: a novel technique for examining the effect of seawater warming on benthic communities.

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Significant warming has been observed in every ocean, yet our ability to predict the consequences of oceanic warming on marine biodiversity remains poor. Field experiments on the effects of seawater warming on marine communities have been severely limited, because it has not been possible to manipulate temperature in a consistent manner across a range of marine habitats. We constructed a 'hot-plate' system to directly examine ecological responses to elevated seawater temperature in a subtidal marine system. In the first experiment, the substratum available for colonisation and overlying seawater boundary layer were warmed for 36 days, which resulted in greater biomass of marine organisms and a doubling of space coverage by the dominant species; a community-altering ascidian. In subsequent deployments, significant changes in community structure on warmed plates were also observed. The 'hot plates' can be manipulated in similar ways to traditional settlement panels, so that experiments of multiple stressors (i.e. warming and nutrients/disturbance/grazing pressure) can be conducted under realistic conditions. Although the technique has some limitations, it should compliment other approaches (e.g. modelling or tank/mesocosm experiments) in advancing knowledge of how marine communities will respond to continued warming in coastal habitats.

The effect of marine reserves on snapper in northern New Zealand: an analysis using Bayesian hierarchical mixed models

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In order to assess the utility of marine reserves as tools for conservation and fisheries management, it is important to monitor their effects on local biological communities. This is particularly true for species that are targeted by fishing because they are expected to show the fastest and strongest response to protection, they are of most concern to humans, and changes in their abundance can produce indirect effects in other parts of the ecosystem. Data from monitoring studies typically present some challenges when it comes to their analysis. The complex hierarchical designs that are usually employed require mixed models that contain both random and fixed effects. In addition, the tendency of fish to group together can cause counts to be overdispersed, violating the assumption of mean-variance equality that is implicit in the standard Poisson error distribution that is usually applied to count data. We present data from baited underwater video (BUV) surveys of snapper (*Pagrus auratus*) from in and around reserves in northern New Zealand. A Bayesian hierarchical mixed modelling approach was used, yielding robust estimates of parameters while quantifying uncertainty explicitly in the form of posterior distributions. Variance components were estimated so that the magnitude of the reserve effect can be directly compared with those of annual, seasonal and spatial factors. In addition, this method allowed the negative binomial error distribution to be implemented relatively easily, thus allowing for overdispersion.

Identifying coherent groups of species responding to spatio-temporal environmental gradients: a statistical method

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Multivariate analysis is routinely applied for the analysis and description of complex ecological datasets, such as are generated in studies of biota along gradients in time or space. The main focus of analyses tends to be the description and analysis of patterns among samples. Early applications of multivariate analyses to ecological data also recognised the importance of, and gave equal weight to, understanding how variables (species or taxa, in biotic datasets) varied among samples, but such analyses have inherent difficulties. Among these are the facts that species do not vary independently of each other, responses of species to gradients may not be monotonic, and that abundances vary widely within and among species. Although some methods are routinely applied to explore species responses to environmental gradients, none explicitly recognises that species do not vary independently. Within a very widely-used framework for the nonparametric multivariate analysis of ecological data we demonstrate how new and old approaches may be combined in a novel way to detect statistically distinct subsets of species which respond to gradients in a coherent manner. We show how the method discriminates groups of species which respond differently to a single gradient, or respond coherently to different gradients.

Impacts on diversity of intertidal algal communities: why is it common to be rare?

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Measuring biodiversity through time is a complex business because it depends on numerous spatial and temporal factors involving the appearance and disappearance of many species. There are few ways to be "common" but many ways to be "rare" in communities. Our experimental studies in rocky intertidal communities of New Zealand show that the great majority of species are rare, cryptic or ephemeral in space or time. Unfortunately, the functional roles of most of these species are difficult to ascertain and usually overlooked. We therefore know little about the ecological or functional roles of the bulk of species that comprise communities. Here, we consider what it means to be common and rare in the marine environment, categorising species according to known functional roles, obligate associations or "neutral" species which, individually, appear to have little "function". These are discussed in the context of a variety of long-term disturbance experiments done in algal assemblages at different tidal heights.

Simple simulations of marine organisms can predict complex spatial and temporal patterns

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Simple agent-based simulations of organisms have been conducted on social insects for the last few decades, often giving unique insights into collective, self-organising behaviours of populations. More recently, these techniques have been applied to rocky shore snails, and other reef organisms. In general, by simulating simple, individual-level, behaviours, complex, group-level dynamics emerge. The technique has proved successful in predicting real aggregation patterns of rocky shore snails in space and time and similar techniques have also been applied to predict locations of aggregation in fish such as the Nassau grouper (*Epinephelus striatus*). Here I give an overview of the methods and results obtained so far from such simulations, as well as giving insights into new work. This new work, like recent work conducted on social insects, focuses on differences in individual-level behaviours and the resultant changes in group or population patterns that arise from these differences. In general, population-level patterns, such as rocky shore snail aggregations, are stable with changes in individual behaviour. However, it is possible to affect aggregation patterns by manipulating behaviours of many individuals, or the overall composition of species within an assemblage. These simulations, combined with the potential of real experimental manipulations, indicate the possible use of reefs and rocky shores as model sites for evolutionary ecology experiments into study areas such as cooperation and cheating.

Detecting change in Marine Protected Areas: a comparison of in-situ monitoring regimes of subtidal reefs in Wales

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Following the UK implementation of the EC Habitats Directive, the Countryside Council for Wales has been undertaking systematic subtidal monitoring of temperate reefs in three of the marine Special Areas of Conservation (SACs) that contain reef features around the coast of Wales, since 2004. We present results of seven years of sub-tidal dive monitoring that has been undertaken using two regime themes: (i) SAC-feature based monitoring of the SACs in North Wales and (ii) community-based monitoring in West Wales. The rationale for method selection, quality assurance and results will be presented, together with interpretation and analyses. With the imminent initial assessment (in 2012) required by Member States for the implementation of the European-wide Marine Strategy Framework Directive; we will also present lessons learned from the strengths and challenges of differing monitoring regimes, and how effective each has been in identifying anthropogenic versus natural change.

Investigation of deep-sea echinoid feeding ecology on the Irish continental margin: Implications for deep-sea coral ecosystems

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In shallow water habitats, echinoids play an important role in nutrient redistribution and tropical coral reef stability through bioerosion, yet in deep-sea habitats their role remains obscure. Stable isotope analysis (SIA) was used to study echinoid feeding strategies in deep-sea habitats on the Irish continental margin. Six species (*Gracilechinus elegans, Echinus affinis, Cidaris cidaris, Tromikosoma uranus, Phormosoma placenta* and unidentified *Echinothuriidae*) were collected with a remotely operated vehicle. Gut content analyses were performed in conjunction with SIA. The maximum range of $\delta^{15}N$ measurements was 17.6‰ (*C.cidaris*) - 8.0‰ (*G.elegans*) and 19.2‰ (*C.cidaris*) - 8.1‰ (*G.elegans*) for gonads and echinoderma, respectively. *G.elegans* had coral filled guts and all other echinoids had sediment filled guts. No overlap was detected for isotopic signatures among tissues of deposit feeding echinoids within canyon. $\delta^{15}N$ signatures between tissues were similar, but a large shift (3-5‰) was observed between $\delta^{13}C$ signatures. Results show two distinct diets: (1) Deposit feeding echinoids primarily displayed selective feeding behaviours by partitioning food sources in the sediment. While maintaining resource partitioning, they also show signs of seasonal shifts in diet as well as occasional opportunistic feeding. (2) Evidence of previously unreported bioerosion of cold-water coral (CWC) by a deep-sea echinoid, *G.elegans*, showing that it actively predates on the reef building coral *Lophelia pertusa* in the NE Atlantic. This particular finding may have important consequences for the stability of CWC reef systems as well as on current understanding of processes sustaining the high biodiversity observed in CWC reefs.

Bacterial quorum sensing signal molecules induce settlement of *Balanus improvisus* cyprids

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Bacteria utilise N-acylhomoserine lactones (AHLs) to modulate behaviour on a population level. This 'Quorum Sensing' process is widespread amongst bacteria and modulates the expression of multiple genes. AHLs also enhance the settlement of zoospores of the green seaweed *Ulva*. Many reports have described enhanced settlement of invertebrate larvae on bacterial biofilms, yet few have demonstrated the nature of the cue responsible. Using cyprids of the barnacle *Balanus improvisus*, the hypothesis that these organisms utilise AHLs as a cue in surface selection was tested. Biofilms of the bacteria *Vibrio anguillarum*, *Aeromonas hydrophila* and *Sulfitobacter* sp. attracted cyprids. However, when AHL production was inactivated, either by mutation of the AHL synthetic genes or by expression of an AHL-degrading gene (aiiA), the ability of the bacteria to attract was abolished. In addition, cyprids were attracted to biofilms of *E. coli* expressing recombinant AHL synthase genes, but not to *E. coli* that did not produce AHLs. Finally, synthetic AHLs resulted in increased cyprid settlement. Thus, similar to *Ulva*, the ecological success of a barnacle is also dependent on a bacterial signalling process. This strengthens the theory that AHLs are a universal cue for surface selection, influencing the development and functioning of hard substrate communities.

Ecosystem function in macroalgal assemblages: why canopy layering and assemblage structure matters

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Natural communities usually have vertical structuring of canopy levels that greatly affects the light environment to understory species. In shallow-coast marine communities dominated by large brown algae, light is delivered variably through canopies swaying in wave-driven conditions which produce a constantly fluctuating light environment to understory species. However, few studies have considered the light environment in functional responses of primary producers that occupy different canopy layers in naturally structured, intact marine communities and how these may change when community components are lost. Here we show that a key ecosystem function, primary productivity, is significantly greater in whole algal communities than in communities missing structural components of understory species, but only at high light intensities. For algal communities in New Zealand and Oregon, there is a previously undescribed upsurge in primary productivity at irradiance levels beyond c.1500 µmol m^{-2} s^{-1}. This is the level at which light penetrating the canopy exceeds the compensation points for sub-canopy species, resulting in a significant increase in community productivity by buffering against photo-inhibition and saturation of component taxa and thereby augmenting overall assemblage production. This enhancement of primary productivity provides a mechanism of how complementary light use operates across autotrophic assemblages. Our results highlight the importance of understanding real-world consequences of changes in naturally structured communities, as multiple coastal impacts affect the light environment, species, and functional layering of communities.

Patterns of algal turf following disturbance of canopy assemblages: the interactive effects of multiple processes varying in spatial autocorrelation.

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Understanding how natural assemblages respond to multiple disturbance processes and evaluating the onset of interactive effects may help to unravel the mechanisms driving shifts in dominance. We focused on the spatial pattern of environmental processes on algal dominated rocky shores, testing the general prediction that disturbances that are randomly distributed in space can amplify the effect of spatially autocorrelated disturbances, similarly to what observed in other biological systems (a phenomenon known as stochastic resonance). We experimentally simulateding two physical disturbances that differ naturally with respect to the level of spatial autocorrelation. Gradual variability was introduced by removing clipping fronds of *Cystoseira amentacea*, while understorey organisms were dislodged from small gaps in a random sequence along replicated transects of 32m on rocky reefs in the northwest Mediterranean. Beside the factorial combination of the two processes, we also removed canopy fronds using random sequences, aiming at discriminating between effects due to the spatial distribution or to the identity of disturbance. We examined the effects of these treatments on the establishment of algal turfs. The experiment evidenced the importance of both the identity and spatial autocorrelation of disturbances on turf distribution. While the removal of fronds locally promoted turf proliferation independently of spatial autocorrelation of disturbances, domination of understorey patches by turf seems to be favoured by casual aggregation of disturbance gaps, occasionally merging into larger, colonisable areas. Results also revealed interactive effects of disturbances characterized by different levels of autocorrelation, indicating that effects of environmental processes cannot be predicted by examining each driver in isolation. Contrary to our expectation, interactions were antagonistic, underlying a tendency of natural assemblages to mitigate disturbance effects, thus hindering the shift from canopy to turf-dominated assemblages.

California's Gold: Using ecological and collaborative research to inform fisheries management strategies for the red sea urchin, *Strongylocentrotus franciscanus*

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When considering fisheries management in general, sustainable populations of marketable-sized individuals must be available to support a profitable fishery. However, in contrast to most of the world's fisheries, harvested urchins must have marketable quality as well. For the past decade the red sea urchin fishery has been the fifth largest in the state of California; fishermen dive to collect urchins by hand, and two-thirds are harvested from the northern Channel Islands. For this roe-based fishery, the gonads of harvested individuals must be the proper size, texture, color and freshness in order to be profitable in the competitive international market. Fishermen are more likely to yield greater profits during the time of year when gonads are larger and firmer, which varies over time and space. In order to properly manage this fishery for optimal profits and sustainability, researchers must examine not only temporal and spatial variability in sea urchin density and size frequency across the management area but also gonad quality. Using data from subtidal monitoring and collaborative port-sampling, we find that gonadosomatic index varies across the islands and peaks in winter months in accordance with the annual spawning cycle. Given the temporal and spatial dynamics of gonad quality, a varying management regime where urchins are extracted during the optimal quality specific to a particular location may both increase fisheries profits and ensure a sustainable fishery.

Habitat heterogeneity and patchiness on man-made structures

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Habitat heterogeneity is known to increase species diversity and the abundance of individuals. Compared to natural habitats most man-made structures are relatively homogonous and offer limited diversity of habitats. There is a growing body of evidence that adding heterogeneity to man-made structures as part of engineering design could increase species diversity and the abundance of individuals, including those from exploited populations. Here we examine how the distribution and extent of artificially introduced habitat influences the utilisation of this resource by intertidal grazers. At locations where grazer density was naturally low the introduction of aggregated patches of habitat resulted in a greater increase in the abundance of individuals than introduction of evenly spaced habitat. While at locations where grazer density was naturally high introduction of evenly spaced habitat resulted in a greater increase in the abundance of individuals. These outcomes indicate that consideration of the configuration, as well as the extent, of introduced habitat is important for the management and conservation.

Rocky intertidal communities: past environmental changes, present status and predictions for the next 25 years

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In 2002 we prepared a synthesis of anthropogenic threats to rocky intertidal habitats. These were considered in relation to natural variability, historical evidence of impacts / trends and our predictions for the future. Almost 10 years on we re-examine the evidence base, consider trends for the last decade and predictions for the 2020s and 2030s. Audience participation essential!

Table 1) Past perspectives and evidence of impacts on rocky shores from the 1960s, 1980s and (2000s), predictions for trends in severity by the 2020s, plus an estimate of our ability to make predictions based on existing evidence (from Thompson et al. 2002).

		1960s evidence	1980s evidence	2000s evidence	2020s severity	2020s predictability
Pollution	Endocrine disrupters	-	*	***	↑	●●
	Oil spills	***	**	***	↓	●●●
	Eutrophication	-	*	***	-	●●
	Toxic algal blooms	-	**	***	↑	●●
Living resources & recreation	Gathering food & bait	*	**	***	↑	●●●
	Recreation Research & Education	-	-	*	↑	●●
	Introduced species	*	**	***	↑	●
	Genetically modified organisms	-	-	-	↑	●
Global change	Warming	-	*	**	↑	●●
	Ultra violet radiation	-	-	*	↑	●
	Sea level rise	-	-	*	↑	●●
	Storms & extreme weather	-	*	**	↑	●●
	ENSO	-	*	**	↑	●●
Modification of coastal processes	Sea defences	-	*	**	↑	●●
	Sedimentation	*	**	**	↑	●
	Renewable Energy	*	*	**	↑	●

Evidence of impacts: negligible evidence (-), evidence of isolated incidents/occurrence (*), Concerns and some evidence of impacts (**), evidence of major impacts (***). Expected trends in severity: little overall change (-), increasing severity (↑), decreasing severity (↓). Ability to predict impacts based on current evidence: low (●), moderate (●●), good (●●●).

Long-term (30-year) tests of hypotheses about structure of intertidal assemblages

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Long-term studies that span decades using consistent designs of sampling are still quite rare in marine ecology. Apart from insights that cannot be gained from shorter-term studies, longer-term observations are often necessary to test specific hypotheses. Here, I describe outcomes of sampling at 5-year intervals over a total of 76 intertidal sites from 1974 to 2004, at Cape Banks (Botany Bay, New South Wales, Australia). Sites were chosen to represent different tidal heights and regimes of exposure to wave-action, which are associated with generally different assemblages of intertidal invertebrates (dominated by grazing gastropods, small barnacles, larger barnacles – from the most sheltered to the most wave-exposed sites). Experiments in the 1970s and 1980s identified processes maintaining or changing the general structure of these assemblages. These led to predictions about change or lack of change in assemblages and different habitats. Sampling over 30 years allowed several "turns-over" of populations, ensuring natural changes or persistences of the existing assemblages. As a result, the predictions from short-term experiments could be tested. The results will be discussed to show the relevant ecological processes and their consequences for assemblages. Results also showed that integration of short-term experiments and longer-term tests of predictions is very imformative, but only by suitably designed long-term studies.

Environmental heterogeneity affects mechanisms contributing to stability in rocky shore ecosystems

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Ecological theory predicts that biodiversity begets ecosystem stability; functional compensation between competing species with differing responses to the environment maintains a constant level in ecosystem properties. However, the effect of environmental heterogeneity on the strength of stabilising mechanisms is still unclear. We tested the model that functional compensation among species abundances is stronger in heterogeneous than in homogeneous environments. Our model system was the north-central coast of Chile (~30°S), where a strong and extended upwelling centre south of Punta Lengua de Vaca (PLV) maintains more stable sea surface temperatures relative to northern areas. We explored the temporal variability in %-cover of sessile macrobenthic species in replicated 18-mo time series of intertidal hard-bottom communities. The variance ratio (VR), which describes the temporal variance of individual species abundances relative to that of the summed total, was used as measure of compensatory dynamics. Results showed that VR was significantly lower at environmentally more variable sites, indicating increased compensatory dynamics at those sites. In addition, manipulative experiments showed that species responses to a pulse thermal stress tended to be more asynchronous at environmentally more variable sites. The mean-variance scaling in species' abundances differed between regions, with a significantly larger slope, and thus individual species variability, at environmentally more variable sites. Community variability, however, did not vary across sites of differing environmental variability. Our results suggest that the destabilising effects of increases in individual species variability may be counteracted by the stabilising effects of compensatory dynamics in natural communities confronted to environmental changes.

Global patterns in marine herbivory: are there any latitudinal effects?

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Biogeographic theory predicts that plant-herbivore interactions are more intense at lower latitudes, and that higher levels of herbivory in the tropics have selected for increased defences. However, recent empirical evidence from terrestrial systems indicates that latitudinal trends are more equivocal than currently assumed. In this study, we compared marine plant-herbivore interactions across a tropical-temperate range spanning 13º of latitude in Western Australia. The brown alga *Sargassum decurrens* was used as a bioassay to compare relative broad rates of algal consumption across a range of habitats at three latitudes, and a reciprocal feeding preference experiment was set up in the field to compare the palatability of tropical and temperate specimens. Specific rates of leaf herbivory and leaf production were measured in situ for the seagrass *A. antarctica*. Carbon, nitrogen, phosphorus and total phenolic content of both macrophytes were also measured. Herbivore consumption was greater in the tropics for both the alga and the seagrass, but we found no effect of latitude on the proportion of seagrass primary production consumed, since both leaf production and consumption were greater in the tropics. Seagrass phenolic content was relatively high and decreased with latitude, suggesting that that tropical plants are better defended, but algal phenolic content was lower and significantly increased with latitude. Nitrogen and N:P increased with latitude in both macrophytes, while C:N decreased. These findings provide new insights with important consequences for our understanding of the mechanisms that may be driving latitudinal gradients in plant-animal interactions.

Don’t forget the bait! Subsidies of organic matter to wild capture fisheries.

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Organic inputs to wild capture fisheries in the form of bait have to date been largely unrecognised. In contrast, organic input to aquaculture is one of the major challenges facing the aquaculture industry with concerted efforts made to reduce the industry’s reliance on fish meal and fish oil. The addition of organic matter to wild capture fisheries in the form of bait potentially evokes similar concerns as it raises the question of whether bait is an efficient use of increasingly overexploited fish stocks. Bait may also represent an external source of organic matter to these ecosystems when imported from outside the area where the fishery operates. We undertook a review of the potential contribution of bait as a source of organic matter to global marine ecosystems, concentrating on trap and line fisheries. Bait addition was assessed using fish:fish out (FIFO) ratios, facilitating comparison across fisheries and with other industries. Over 740,000 tonnes of bait is added to marine ecosystems globally, with a FI:FO ratio of 0.36. Lobster trap fisheries were the least efficient in terms of bait usage, with a FIFO ratio of 1.11 while demersal longline fisheries were the most efficient with a FIFO ratio of 0.07. Spatially, bait input was highest in temperate reef systems due to the prevalence of lobster fisheries in these areas. FIFO ratios observed amongst many wild capture fisheries are comparable to organic matter addition from the aquaculture sector and discards from trawl fisheries.

Pre-selection in marginal habitats – juvenile barnacles (*Amphibalanus improvisus*) tolerate high levels of ocean acidification.

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World's oceans are warming and becoming more acidic. Both stressors have the potential to impact marine species with particular effects on calcareous organisms. In the Baltic Sea, summer stratification can lead to hypoxic conditions in bottom waters. Occasional upwelling causes strong pH (and temperature) fluctuations in shallow marine habitats. Organisms naturally exposed to extremely variable conditions might consequently be pre-adapted to future changes. We investigated the effects of ocean acidification (OA) and warming on the barnacle *Amphibalanus improvisus*. Juveniles were treated under mean pCO2 of 700, 1000 and 2140 µatm in 20 and 25 °C for 8 weeks. In a second experiment, barnacles were treated under mean pCO_2 of 620, 1030, 1930 and 2870 µatm in 20 °C for 12 weeks in a flow through water system. Warmer water increased mean length of barnacles by 8 % after 2 weeks. This effect vanished with time and was absent at the end of the experiment. Surprisingly, after 2 weeks, OA (2140 µatm) increased barnacle mean length significantly by 9 %. This effect was, however, absent thereafter. In the second experiment, OA (1930 and 2870 µatm) decreased barnacle mean length significantly after 10 and 12 weeks by 5-9 %. Results highlight on the importance of the duration of ecological experiments and problems in interpreting them. In contrast to other studies on OA, both experiments show a strong overall tolerance of *A. improvisus* towards OA. We conclude that variable and extreme marginal habitats may harbor species, which are able to cope better with climate change than species from more stable environments.

Are invaders tougher?

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The frequency of bioinvasions as well as of extreme environmental conditions due to climate change is predicted to increase in coastal ecosystems. While the first may have far reaching consequences for the composition of ecological communities and ecosystem functioning, the second will lead to pronounced short-term fluctuations in environmental parameters such as temperature, oxygen content, salinity, or sedimentation. If invasives are more resistant to environmental stress than residents, these two aspects of global change may act in synergy. In a series of modular experiments run in 11 different biogeographic regions around the world we compared stress resistance among invasive and resident species and among invasive and resident populations of single species. Invasive species were significantly more stress tolerant than functionally equivalent and closely related resident species. Similarly, invasive populations were significantly more stress tolerant than resident populations of the same species. We discuss that a higher stress tolerance of invasive populations and species could be both cause for and consequence of their invasion, and that this property could contribute to a future enhancement of bioinvasions.

Is *Sabella pavonina* (Polychaeta, Sabellidae) a biogenic reef-forming species?

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Sabella pavonina (Savigny) is a sedentary mucus tube-dwelling polychaete found intertidally and subtidally throughout Europe which can form dense aggregations (approximately 800 m-2) in some locations. A three year study using a population located on an intertidal sand bank in the Solent investigated if aggregations of this species constitute a biogenic reef in the context of its physical, biological and temporal attributes. Density quadrats and sediment and macrofaunal cores were used to characterise spatial and temporal distributions at the site and assess biodiversity in the sediment and associated with the tubes. Highest mean population densities (30.58 m-2 ± 8.05) were recorded with proximity to ELWST, although these densities did change significantly over time. The population was also "clumped" at different spatial scales (e.g. 188 per 0.25 m2, 23 individuals per 100 cm2 sub-section). SIMPER analysis revealed that macrofaunal diversity within the sediment was greatest where densities of *S. pavonina* were at a maximum. The enhancement of secondary space for epibionts provided by the vertical tube structures also added to this diversity. Particle size analysis and dGPS measurements will reveal the effect of this species on the sediment and if it meets the physical features (elevation and distinctiveness from surrounding sediment) to qualify for reef status. If *S. pavonina* does meet the criteria to be considered a biogenic reef-forming species this would have major implications for its conservation and management.

Latitude and aptitude: linking biogeography, physiology and genetics to reduced ecological function of seaweeds in a marginal climate

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Ecological impacts of global climate change have been extensively documented in terrestrial ecosystems, but substantially fewer examples exist from the marine biome – not because it has not been affected, but because of limited time series and broad-scale data sets. An analysis of ~100,000 Australian herbarium records document the profound influence of ocean climate on the distribution of seaweeds, and suggests that changes have occurred over the past ~50 years. Forecasting further changes will require a mechanistic understanding of the underlying drivers of change, which can best be achieved through experiments. A review of marine climate change experiments reveal an under-representation of studies on macrophytes and a lack of field studies. This is worrying given the ecological importance of seaweeds as food, habitat and ecosystem engineers, and because laboratory and mesocosm experiments are constrained by both spatial and temporal scale. Australian kelp beds show a strong positive relationship between the genetic diversity of populations, the functional versatility of individuals and the ecological resilience of kelp habitats along a latitudinal gradient in ocean temperature. This documents the importance of genetic diversity to ecosystem function, and how the selective forces of adverse climates might degrade the foundation which underpins the capacity for species to respond to perturbations.

Underestimating SE Asia's intertidal biodiversity: implications for climate change predictions

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Attempts to predict the possible impacts of climate change on marine organisms requires fundamental knowledge of species' phylogeographic patterns and physiological tolerances. Researchers in temperate areas have been able to achieve this, and track shifts in species ranges to predict changes in coastal communities. Although the Census of Marine Life recognized SE Asia as global marine biodiversity hot spot, many common 'species' remain poorly described and identified in this region. Even identifying species' distribution patterns is problematic due to a lack of taxonomic research and difficulties in cross-country collaborations. As a result, the mis-identification of species and their associated distribution ranges can lead to poor predictions of which species may be affected by climate change, and subsequent community changes. To attempt to address this knowledge gap regional collaborations on common intertidal taxa (barnacles, limpets and littorinids) has revealed that many widely distributed ‘species’ are in fact cryptic species complexes with taxa having very different tolerances to thermal stress. Identifying these species, and incorporating this knowledge into recognized databases, will help us to better predict potential shifts in species distribution patterns, and possible impacts on regional biodiversity.

Habitat complexity and biodiversity: bryozoan patch-reef size, and polychaete biodiversity on the New Zealand continental shelf

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Large, heavily-calcified bryozoans dominate an area of continental shelf of south-eastern New Zealand (Otago shelf, 46°S), about 500 km^2, in water depths of 80–150 m. The cyclostome *Cinctipora elegans* dominates small patch reefs which grow to about 15 cm tall and <1 m^2 in area. Reefs are interspersed with heterogeneous muddy gravels in which biogenic material (molluscan and bryozoan) is an important constituent. Diverse in- and epifauna are associated with these biogenic habitats. We examine the relationship between habitat complexity generated by bryozoans as live colonies and as constituents of sediment, and the biodiversity of associated polychaetes, using the naturally varying quantities of bryozoan material in each sample. Thirty large grab samples were collected from 80 m water depth, and each was divided into a small sediment sample, epifauna including bryozoans, and infauna. Faunal samples were washed on 5 mm, 1 mm and 0.5 mm sieves and sediment samples analysed using standard procedures. Polychaetes were identified to the lowest possible taxonomic unit, and multivariate analyses were used to examine the relationship between polychaete species and trophic diversity, and the habitat generated by bryozoans as epifauna and as sediment. Here we present data on habitat and associated fauna from the 5 mm sample fractions. Our findings may have important implications for management of these fragile shelf habitats, which are threatened by commercial fishing.

Posters

In alphabetical order by lead author

Structure of fish larval assemblages sampled with light traps near rocky reefs at the Arrábida Marine Park, Portugal

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Fluctuations in fish larval supply can strongly affect recruitment patterns of reef fish species. Most studies that have investigated these relationships have been conducted in tropical systems and little is known on the dynamics of fish larval assemblages near temperate reefs. We investigate the inter-annual (2007-2008) and small scale vertical patterns in the structure of fish larval assemblages, sampled with light traps at the very nearshore environment of the Arrábida Marine Park. A total of 6,601 larvae corresponding to 28 species of 8 families were collected. Larval diversity was similar between years, but the structure of the assemblages differed significantly inter-annually. We also detected vertical differences within the same year: gobies dominated the bottom assemblages while *Tripterygion delaisi* was clearly the most abundant species at the surface. Ontogenetic patterns in the distribution of larvae could also be found for some species (*Gobius xanthocephalus* and *Pomatoschistus pictus*) indicating possible larval retention near the reefs. The larvae collected on the bottom were usually larger and more developed than those from the surface with the exception of *Tripterygion delaisi*. For other species like *Parablennius pilicornis* and *Parablennius gattorugine* only undeveloped larvae (pre-flexion) were caught, revealing the probable dispersal of more developed stages. We show that light-traps are an effective method to sample large numbers of fish larvae in temperate nearshore reefs and to improve the understanding of the factors regulating reef fish populations.

Edge effects on temperate reefs: a real concern?

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Intertidal rocky-reefs are affected by both terrestrial and marine impacts and threatened by multiple stressors. Disturbance-recovery dynamics often play a key role in the functioning of rocky intertidal ecosystems and how we might predict the response of these systems to environmental change. Fundamental issues in designing manipulative experiments aimed at assessing effects of stressors on recovery rates are the choice of sampling units and size of experimental plots in order to avoid “edge effects”. The potential for edge effects emphasizes the use of larger plot sizes, but this creates logistical and sampling difficulties in setting up experiments. Although concerns over edge-effects have been addressed in terrestrial ecosystems and are recognised on temperate reefs, edge effects have not been properly evaluated and tested. In this study, we experimentally cleared 1m2 plots (5 replicate plots at each site) in the microtidal upper infralittoral at 5 sites along the Ligurian rocky coast (North-western Mediterranean) to assess recovery dynamics over one year, using continuous fixed transects (1m length), sampled six times in a year. We compared equal length patches (5, 10, 20 cm) at edges (left and right) and in the middle of the experimental plots. Our results show that there are no-significant differences in recolonisation between edges and middle even at the smallest scale of the sampling area (5 cm), suggesting that recovery is not driven by lateral encroachment and big experimental areas are not needed in this kind of study along microtidal environments in temperate reefs dominated by coralline and turf-forming algae.

Effects of ocean acidification on *Mytilus galloprovincialis* and *Patella caerulea* at natural CO2 vents.

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Increasing anthropogenic atmospheric CO2 is altering the chemistry of surface seawater worldwide, resulting in ocean acidification. Current research into ocean acidification is mainly based in aquaria or mesocosms and whilst this has been invaluable in determining effects on a range of biological and physical processes it is nevertheless difficult to extrapolate the findings to predict effects on whole marine ecosystems. Here we show the effect of CO2 on shell thickness, strength and mineralogy of two widespread Mediterranean molluscs, *Mytilus galloprovincialis* and *Patella caerulea*, were investigated using CO2 vents (Ischia, Italy) as a natural laboratory. Mussels were transplanted and maintained up to 7 months along a gradient of pHT (7.2-8.1) whereas *P. caerulea* already lived intertidally near the vents, where CO2 levels were higher than those expected for the next 300 years. Their shells were analysed using SEM; shell strength and periostracum integrity were also measured for *M. galloprovincialis*. Mussels transplanted to mean pHT 7.2 had larger areas of damaged periostracum (due to adjacent mussels rubbing together) than those transplanted to mean pHT 8.1 (6.4 ± 3.1 % and 0.4 ± 0.9%, respectively), suggesting a decreased ability to repair periostracum at low pH. There was significant thinning of the aragonitic layer and reduced shell strength near the umbo. *P. caerulea* living at mean pHT 6.5 had significantly thinner shells than those at pHT 8.04, but only in the old part of the shell, likely due to higher dissolution rates. Our results show that these common rocky shore molluscs can calcify at pH levels lower than those predicted for 2100 but that their shell dissolve and the mineralogy is altered as CO2 levels increase.

The wonderful world of coralligenous sponges

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The biogenic construction known as coralligenous has a key role in the coastal Mediterranean environment, hosting the highest diversity known for hard bottom assemblages. One of the main problems to face studying coralligenous biodiversity, is the high heterogeneity of the habitat. Porifera taxon represents the most diverse group living in the coralligenous but only massive and encrusting species are sufficiently known, very poor is the knowledge regarding boring and insinuating species, respectively destroying and stabilizing the conglomerate. According to the available literature, 285 species have been hitherto recorded from the Mediterranean coralligenous concretions. The massive species are the most abundant (52 %), encrusting species represent 38 %, the boring sponge 9 %, and insinuating sponges only 1 %. The present paper analysed the whole sponge assemblage in four areas of the Ligurian Sea. We recorded in total 133 sponge species. The encrusting sponges represent 54 % of the total identified sponges, the insinuating ones, living in the internal crevices of the rocky structures, count up to 27 %, massive specimens represent 11 %, and boring species are 9 %. It is evident that the cryptic fraction is important but strongly underestimated, confirming this habitat as an extraordinary reservoir of biodiversity still largely unexplored, not only taxonomically, but also as specific adaptations and life histories. In tropical reef cryptic sponges have a fundamental ecological role regarding the benthic-pelagic coupling, suggesting that also in the coralligenous habitat, these organisms may affect epibenthic trophic webs.

Combined effects of multiple contaminants on coastal ecosystems: the importance of concentration and timing

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Humans exert many pressures on coastal ecosystems that alter their biodiversity and ability to function. Natural habitats are replaced with infrastructure and degraded through addition of chemicals used to manage pests in cities, farmlands and in aquaculture. Climatic change is expected to increase rainfall and storminess, which is likely to increase the number and concentration of pollutants washed into coastal ecosystems and to modify temporal patterns of influx. Metals and organophosphates are routinely used as biocides and are important classes of pollutants found in marine habitats. A novel system has been developed for delivering specified concentrations of these pollutants at controlled intervals to mimic scenarios of run-off anticipated through climatic change. Field experiments with epifaunal assemblages are examining whether climatic change will alter the impacts of pollutants on marine ecosystems. We aim to test whether multiple stressors (copper and chlorpyrifos) act independently or interactively and whether their effects on biodiversity and its functions vary depending on their respective concentrations and the timing of their arrival. Through this, our work offers an example of how ecology can assist the sustainable management of coastal ecosystems in a changing world.

Biomimetic Desiccation Loggers for Intertidal Mollusks

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Intertidal organisms regularly experience both marine and terrestrial habitats and can be affected by extreme conditions in either habitat. In particular, sessile organisms or those with limited mobility, cannot actively escape or avoid stressful conditions and are potential indicators of the effects of climate change on species distribution in the intertidal zone. Microclimate choice in a variable environment is a key factor to the survival of these organisms. Biomimetic data loggers can measure physical stresses experienced by intertidal organisms in the field, across the range of potential habitat variability, to examine their effects on species distribution or zonation in the intertidal. Previous biomimetics have only measured parameters such as wave force and body temperature, ignoring the prevalent stress of desiccation. We discuss the application and limitations of a newly developed biomimetic data logger intended to measure the desiccation potential of any microclimate as experienced by intertidal limpets. We show that the zonation of some limpet species is strongly influenced by desiccation potential.

Biotic and abiotic relationships in shallow rocky substrata

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A large (150 Km) rocky shallow subtidal area was sampled using 31 transects systematically distributed along the Basque coast (northern Spain). Macrofaunal assemblages distribution patterns and the environmental factors contributing to observed patterns were investigated. For this purpose, environmental natural variables recorded were those that described the physical properties of the substrate (depth, substratum topography and sediment) as well as the complexity of the vertical layering of the vegetation (crustose, basal and cup) from which the faunal inventories were obtained. Five distinct macrofaunal assemblages were identified with differences mostly due to the relative dominance of detritivores, epiphytic forms and specific taxa (particularly, some species of gastropods, bryozoans and hydroids). Significant correlation was found between faunal species composition and the environmental variables measured. The subset of environmental variables that showed the highest overall correlation with the invertebrate structure of assemblages were the slope of the substrata together with the basal and cup vegetation layers. These three features condition to a great extent the variety of invertebrate assemblages capable of developing on shallow rocky substrata. These results also highlight the importance of seaweeds offering a major biological resource for animals.

Coralligenous assessment: video surveys in the North – Western Mediterranean Sea

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The study of bio-constructions such as coralligenous accretions in the Mediterranean Sea provided up today general knowledge concerning compositions of benthic communities, but lacks in cartographic data of their distribution and monitoring protocol, an important gap for environmental protection programs. Habitats defence, threatened by anthropic activities and climate changes, requires an urgent finding of adequate assessments methods. Tools to join this target are thorough analysis of populations and the creation of a solid baseline for efficient monitoring. We examined 13 sites in protected areas along Italian coasts of Mediterranean Sea. Video-transects recorded during the dives allowed us with non-invasive methods to collect covering data by images of video-transects. A list of categories was checked during their "reading", verifying the presence and abundance of 28 vegetal taxa and 97 animal one. We estimated also the entity of injury or necrosis, the nature of substrata, epibiosis and marks of anthropic damage as the presence fishing-lines. The analysis evidenced that Algae and Cnidaria are the most important categories to be considered for coralligenous characterization, in particular Phaeophyceae, Chlorophyceae, Plexauridae and Scleractinia. Tavolara island was found to be the most rich in species and the most diverse. Portofino Promontory, portrayed by substratum, Scleractinia, Plexauridae and Rhodophyceae, was evidenced as the site with more equitability, while the upper side of S Stefano shoal, characterized by substratum, algal felt and Phaeophyceae was evidenced as the less rich, less diverse and the most monotonous site.

The coralligenous biocenosis in the European Community Interest Site of Capo Berta (Liguria, Italy).

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According to European Habitats Directive (Dir. N. 92/ 43/ CEE), Sites of Community Interest (SCIs) contribute significantly to the maintenance or restoration of natural habitats biological diversity and conservation status. Aim of this work is to describe the biodiversity of Capo Berta SCI (codex: IT1315670) (Ligurian Sea, Italy) focusing on coralligenous constructions between 40 and 60 m depth. These accretions developed on 2-3 m high vertical walls on a seabed of organogenous sediments. Data were collected by photo sampling, video transects and direct observations. A total of 150 taxa were listed. Biodiversity, in terms of species richness, varied with depth (PERMANOVA $F = 13.8174$; $P > 0.000$). The deepest site (60 m) was the richest one, showing rich gorgonian facies (15 ± 5 %) (es. *Paramuricea clavata* and *Eunicella singularis*) and erected Bryozoans (6 ± 1 %). At 50 m depth, encrusting Bryozoans were the most frequent category (14 ± 5 %) with massive sponges (11 ± 4 %), in particular *Sarcotragus spinosulus*. At 40 m depth diversity was low with erect sponges (8 ± 3 %), Cnidarians (7 ± 2 %) (es. *Parazoanthus axinellae*), and sessile Polychaetes (1%) among the commonest categories. Species listed in the II SPAMI Annex were often recorded at all depths and high density of rare species such as *Peltaster placenta* and *Stylocidaris affinis* were documented in two of the deep sites. Unfortunately, fishing nets and garbage were frequently recorded, individuating trawling as one of the biggest threats for the vulnerability of these sites. Data highlight the importance and urgency of amplifying knowledge regarding Ligurian sea deep biocenosis, in order to develop appropriate conservation plans.

Does *Caulerpa racemosa* compromise *Eunicella singularis* population recovery after mortality events?

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Caulerpa racemosa (Forsskål) is an opportunistic invasive green alga, widely distributed in tropical seas and currently also in the Mediterranean Sea. Negative impacts of *C. racemosa* overgrowing on benthic native macrophytes and soft-bottom animal assemblages are documented. Aim of this study is to define possible interactions between *C. racemosa* and *Eunicella singularis* (Esper, 1791) population dynamics inside the Marine Protected Area of Portofino (Italy), where the alga was recorded for the first time in 2007. At that time the population of *E. singularis* showed a homogeneous density of about 8 colonies/m^2 down to 30 m depth. From 2009 to 2010, after and during gorgonian mortality episodes, the gorgonian population density and *C. racemosa* percentage of seabed coverage were seasonally recorded at 10, 20 and 30 m depth. Surveys showed minimum values of *E. singularis* density corresponding to maximum values of C. racemosa coverage (Pearson coefficient=-0.469; P = 0.05). At 10 m depth *C. racemosa* average coverage was 32 ± 12 % and *E. singularis* density was 3.76 ± 0.91 col/m². At 20m depth C. racemosa coverage was maximum (45.6 ± 13 %) *and E. singularis* density minimum (0.95 ± 0.5 col/m²). At 30 m depth, *C. racemosa* showed the lowest values of coverage (15 ± 6 %) and *E. singularis* the highest density values (7.91 ± 1.61 col/m²). *C. racemosa* modifies the sea-bed features, increasing areas rich in sediments. These modifications limit the availability of settlement areas for *E. singularis* larvae, leading to a gradual gorgonian rarefaction and loss of habitat complexity.

What's the size of a site?

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One of the largest issues in reef ecology is the assessment of relevant scales of variation in community structure and functioning. The choice of appropriate sample sizes and definition of the grain, lag and extent of sampling has fundamental implications in highlighting relevant scales of variation. Herein we focus on the implications of the size of sites or stations and how this can influence interpretation of patterns and processes. The use of hierarchical designs, although highly replicated at each spatial scale unit, may fail and confuse variability across replicates and across investigated spatial scales if the site extent is too small and sites are too close together. In order to address the relevant site extent, we performed a biodiversity survey in the upper infralittoral at 10 sites along the Ligurian rocky coast (North-western Mediterranean). At each site, visual sampling (400 cm^2 quadrats) was performed along a 140 m long stretch of coast. A total of 30 replicate samples were collected at fixed distances from each other: odd and even samples being 1m apart and odds being 10 m apart. Such sampling strategy allowed assessment of species alpha- and beta- diversity across multiple distance scales. Our sampling strategy allowed partitioning of the percentage of variation explained over scales from 1 to 80 m. Consistently, across investigated sites most of the variation was explained in a stretch of coast of around 40-50 m, implying that this is the most effective site extent. These results have implications in structuring sampling and manipulative designs in microtidal temperate reefs.

Distribution, abundance and size of the barnacle *Austrominius modestus* in its southern limit in continental Europe (Portugal)

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The barnacle *Austrominius modestus* (= *Elminius modestus*) is an Australasian species. It was first observed in Europe (UK) during the 40's. Its actual distribution in continental Europe ranges from Germany to Portugal. In France, Spain and Portugal, its distribution is described as being restricted to estuaries and ports. Several surveys of its distribution and abundance were made during the late 50's and early 60's. At that time, the most southerly location where *A. modestus* was recorded in mainland Europe was São Martinho (Portugal). In 1998, a survey along the Portuguese coast south of São Martinho noted that its southern limit has moved about 300 km south (Faro, Portugal). In the present study, 24 sites were revisited or surveyed for the first time along Portugal during spring/summer of 2010 and 2011. Observations on the distribution, abundance and size of *A. modestus* were made in ports, estuaries and open coast. Abundance was measured using a semi-quantitative scale comparable with what was used in previous studies. The size structure of *A. modestus* was compared among sites where it was frequent, common or abundant. It was observed for the first time in a port in the open coast of SW Portugal (Sines), but was rare. In Faro, where in 1998 it was considered to be occasional, was now considered frequent (attached to rocks) or occasional (attached to mussels). In general, when mussels were present, the abundance of *A. modestus* attached to mussels was higher. Its occurrence still remains mostly associated with ports and estuaries.

Salmon farming in Chilean Patagonia: A growing threat for cold water corals?

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Chilean Patagonia´s coastal ecosystems support unique populations like shallow, cold water corals. At the same time Chile is the second largest producer of farmed salmon in the world and its aquaculture is intensifying. Three geographic areas can be distinguished based on the level of exploitation: the northern fjords heavily used for aquaculture, the southern coast currently under development, and central Patagonia not exploited yet. Three species of scleractinians and one stylasterid coral have been discovered in shallow depths. Scleractinians are more abundant in Northern Patagonia while Stylasteridea occur mainly in the south. Corals and salmon farms distributions overlap in the north and will overlap in the south as aquaculture expands. Sedimentation and eutrophication caused by fish farming have potential impacts on corals, but investigations are needed to confirm this. The potential threats need to be addressed through regulations, development of Marine Protected Areas and enhancing research capacity before irreversible damages manifest.

Artificial coastal defences: enhancing biodiversity using sensitive design

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Global climate change is one of the greatest threats facing society, the predicted effects of which include rising global temperatures, rising sea levels and changes in weather patterns. The predicted effects of climate change will be increased flooding and erosion prompting the need for building and upgrading of coastal defences to protect property and infrastructures. These structures provide hard-substrate habitat in areas that typically comprise soft sediments, acting as stepping stones, facilitating the range extension of rocky shore species. Coastal defences can also alter local hydrodynamic processes which can in turn affect benthic infaunal communities. By building coastal defences using ecologically sensitive design principles, it is possible to increase habitat-availability and enhance biodiversity. Bangor University is involved in two consortium projects (THESEUS & URBANE) relating to the ecology and design of coastal defences. Here, we introduce the two projects, giving information on the background and objectives of both. The projects have 3 main objectives: (i) assess the biodiversity of both natural rocky shore and coastal defences; (ii) test the effects of defences on community structure of benthic assemblages and; (iii) examine the effect of different structure designs on colonizing biodiversity. We outline plans for objectives relating to the ecologically sensitive design of coastal defences.

Temporal variation of an algal assemblage at the Arrábida Marine Park – algal tufts as recruitment habitat for coastal fish

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The spatial and temporal patterns of a macroalgae assemblage and the importance of tuft forming algae on fish recruitment were studied on a temperate reef at the Arrábida Marine Park (Portugal). Data were collected monthly, using Scuba diving at two different sites, during 2007 and early 2008. A random stratified sampling scheme was established considering two depth strata (0-4 m and 4-8 m). Algal tufts higher than 20 cm were covered with plastic bags and collected along with the fish associated with each tuft. To investigate the seasonality in the algal assemblage we monitored the percentage cover of benthic algae monthly employing ten replicate quadrats of 50 x 50 cm (49 intercepts), in generated random points, at three fixed transepts perpendicular to the coast line. In order to determine interannual variation in macroalgae and juvenile fish composition sampling surveys were performed twice during juvenile peak season in 2008 and 2009. PERMANOVA and MDS analysis was performed revealing seasonal differences in the overall structure of macroalgae and juvenile assemblages. Abundance of each species at each depth strata varied with significant differences for some macroalgae and juvenile species. Associations between algal and fish species were revealed by CA. Variations in diversity indices were also analyzed and the possible ecological impacts of the invasive macroalgae *Asparagopsis armata* on fish recruitment are discussed.The results of the present study provide evidence that some macroalgae species have particular importance in settlement and initial recruitment processes for some coastal fish species, namely labrids and gobiesocids.

The establishment of reference values in a multimetric approach to the assessment of temperate reef fish assemblages

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Recently there has been an acute effort in order to assess the state of biological communities due to increasing human pressure. One of the greatest challenges of assessing anthropogenic impacts is the need to define reference sites or theoretical values that ideally correspond to an unimpacted community. The ideal method is to select reference values from the same site and season with comparable methods in the absence of disturbance, but often there are no data meeting this assumption. Alternatively, the most common approaches used are based on the selection of least impacted sites or the combined use of biological and physicochemical datasets. The authors applied an approach to define reference values by calculating a human pressure index and comparing it to the response of a fish-based multimetric tool, the Marine Fish Community Index (MFCI). In order to choose the reference values that optimise this relation, we tested different methods (e.g. simple linear regression, multivariate analysis, principal response curves) to estimate the boundary between an excellent and a good status for the various MFCI metrics. The results show that the information provided by the combination of these two indices is very useful, not only in the estimation of reference values, but also to facilitate the detection of anthropogenic impact sources. The latter is essential as a support to international policies such as the Marine Strategy Framework Directive, by allowing the development of plans of measures in order to achieve “good environmental status” of marine waters.

Predicting *Pollicipes pollicipes* (Crustacea: Cirripedia) abundance in intertidal rocky shores of SW Portugal: a multi-scale approach based on wave exposure indices

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The stalked barnacle *Pollicipes pollicipes* is an important shellfish resource in Portugal, and is intensively harvested in intertidal and shallow subtidal rocky shores. *P. pollicipes* occurs in wave exposed locations such as capes and headlands, but within such locations its abundance varies at small spatial scales (meters apart) depending on the orientation of the site to the prevailing income wave direction. The aim of this study was to model the abundance of *P. pollicipes* as a function of wave exposure. Available wave climate and meteorological data, sattelite imagery (Google Earth) and open-source GIS software (QGIS, Wave Fetch Model) were used to estimate wave exposure indices along a stretch of coast (~50km) in SW Portugal. *P. pollicipes* percent cover in mid-intertidal rocky shores along the study area (several sites, 10's of kilometers to 10's of meters apart) was estimated by digital analysis of photo-quadrats taken in the Summer of 2010. We modeled *P. pollicipes* percent cover as a function of wave exposure indices, and predicted its occurrence in SW Portugal. Model validation was done by comparing predicted results with data from a new set of photo-quadrats. We discuss the fit of the model and its potential use in the management of the stalked barnacle exploitation. This model can be used as a tool to predict *P. pollicipes* abundance, providing information that stakeholders and resource managers may use for the assessment of standing stocks, definition of harvesting areas and implementation of monitoring and surveillance plans.

It’s not always about air temperature: Predicting patterns of physiological stress in intertidal organisms

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In the marine intertidal zone, a complex interplay of factors, including air temperature, water temperature, wind speed, and solar radiation, drive the body temperatures, and thus the levels of physiological stress of the organisms that live there. And yet, the most common approach for estimating temporal and spatial patterns in stress, mortality, and shifts in species distributions is the use of single environmental variables, such as air temperature, as proxies. Using seven years of temperature data collected by biomimetic sensors designed to mimic the thermal characteristics of the intertidal mussel *M. californianus* at Hopkins station, California, as well as weather station data collected immediately adjacent to this site, we analyzed the strength of the relationship between aerial (low tide) body temperature and air and water temperature at daily and monthly intervals. Results indicate a very weak relationship (R^2 0.00-0.60) between all metrics of body and air temperature, with the strongest correlations observed between measurements of minimum body temperature and minimum air temperature. These results strongly suggest that studies relating measurements conducted at “habitat” level, such as air or water temperature, are not always good indicators of physiological stress, even in relative terms.

Performance of mussels *Perna perna* exposed to single and combined cues from two predators with different attack strategies

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Mussels are important components in intertidal rocky shore food webs and exhibit a wide array of plastic traits in response to predation risk. As a means to avoid being noticed by predators, mussels may decrease filtration rate at the expense of lower performance. We compared the condition index, feeding and growth rates of mussels exposed to risk cues of two natural predators, the crab *Eriphia gonagra* and the whelk *Stramonita haemastoma*, both separately and combined, and also to cues from injured conspecifics. Our results showed that mussel growth and clearance rate of microalgal suspensions were both negatively and equally affected by the presence, separately or joint, of these two predators, and much lower (over 100 %) compared to individuals exposed to damaged conspecifics and a control treatment. In contrast, the condition index did not differ among treatments. These results suggest that (i) the presence of crabs or whelks in the natural habitats would equally impact mussel performance, decreasing reproductive output of these consumers and their role in transferring energy to higher trophic levels, (ii) the strength of predator-prey interactions for these two carnivores are similar, and (iii) eventual alarm cues released by other mussels do not accurately signal predation risk.

Predation risk affects feeding rate, not prey size selection, of the intermediate consumer in a subtropical crab-whelk-mussel trophic chain

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Recent research has documented the importance of trait-mediated indirect interactions (TMIIs) as a mechanism driving trophic cascades. There is growing interest in studying the consistency of these interactions in different habitats, but such has not been attempted at intertidal Brazilian coastlines. We examined the putative role of TMII in a simplified tri-trophic food chain, with the predatory crab *Eriphia gonagra* as the initiating species, the whelk *Stramonita haemastoma* as the propagating species and the mussel *Perna perna* as the basal resource. These species are common components of rocky intertidal communities along the south-eastern Brazilian coast. In laboratory experiments, we tested whether predation rate or prey-size selection (small: <10mm and medium mussels: 15-20mm) by the intermediate consumer is affected by water-borne predation cues, delivered by damaged conspecifics or from the top predator *E. gonagra* fed with different diets (whelks vs fishes). In the presence of crab cues, *S. haemastoma* reduced five times the bivalve consumption regardless of crab diet. Cues from damaged conspecifics have no effect on whelk foraging behaviour. We did not detect significant changes in mussel-size selection by whelks exposed to different chemical cues. As demonstrated on other rocky shores, our results indicate that TMIIs can play an important role in energy flow and dynamics in this subtropical assemblage. Mussel survival could be enhanced at sites with higher crab abundance, although future studies on the effect of *E. gonagra* predation upon *P. perna* are necessary to understand the relative importance of TMIIs compared to direct interactions in this system.

Nearshore satellite data as relative indicators of intertidal organism physiological stress

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The physiological performance of intertidal and shallow subtidal invertebrates and algae is significantly affected by water temperature, and so the ability to measure and model onshore water temperatures is critical for ecological and biogeographic studies. Because of the localized influences of processes such as upwelling, mixing, and surface heating from solar radiation, nearshore water temperatures can differ from those measured directly offshore by buoys and satellites. It remains an open question what the magnitude of the differences in these temperatures are, and whether “large pixel” measurements can serve as an effective proxy for onshore processes, particularly when extrapolating from laboratory physiological studies to field conditions. We compared 9 years of nearshore (~10 km) MODIS (Terra and Aqua overpasses) SST data against in situ measurements of water temperature conducted at two intertidal sites in central Oregon- Boiler Bay and Strawberry Hill. We collapsed data into increasingly longer temporal averages to address the correlation and absolute differences between onshore and nearshore temperatures over daily, weekly and monthly timescales. Results indicate that nearshore SST is a reasonable proxy for onshore water temperature, and that the strength of the correlation increases with decreasing temporal resolution. Correlations between differences in averages are highest, followed by maxima and minima, and were lower at a site with regular upwelling. The average magnitude of differences were ~0.1-0.3°C, and were highest for cold temperatures. The results suggest that, at least at these two sites, SST can be used as an effective proxy for general trends, especially over longer time scales.

Seaweed or biofilm? Experimental approaches to examine the diet of *Patella vulgata* using stable isotopes.

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The intertidal limpet, *Patella vulgata*, has a profound effect on the structure of rocky shore communities on the temperate rocky reefs of the northeast Atlantic. This keystone grazer has long been considered to feed predominantly on epilithic biofilms which coat intertidal rock surfaces. However, stable isotope analyses showed that δ13C values of limpet muscle tissues were 3 to 4 ‰ higher than δ13C values of biofilms, and were more consistent with those obtained for intertidal macroalgae. These results required validation, so a series of experiments were proposed. Firstly, a manipulative experiment tested the hypothesis that individual limpets, caged and restricted to a diet of epilithic biofilm, would have lower carbon isotope values than those free to forage naturally. After six months, significantly lower δ13C values were indeed recorded in caged animals, compared with animals free to forage on biofilm and macroalgal materials. A second, mensurative experiment examined whether the diet of *P. vulgata* was affected by food availability. Limpets were sampled from naturally contrasting habitat types and their isotope ratios compared. Animals from bare, rocky habitats had low δ13C values, similar to those of epilithic films; whereas animals from macroalgal habitats had higher δ13C values, indicating macroalgal consumption. These findings are of great interest to temperate reef biologists and have wide-reaching implications in studies of trophic ecology. My results demonstrate that the diet of intertidal grazing gastropods, such as *P. vulgata* is strongly influenced by food availability and that seaweeds are a more important dietary component than was previously appreciated.

Seasonal variation and monitoring designs in quality assessment of temperate reef fish assemblages

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The increasing anthropogenic pressure on the marine environment has led to an increasing concern to establish international goals for the conservation and recovery of marine habitats. Despite their important ecological and socioeconomic role, marine fish communities are a recent requirement for the assessment of marine environmental status in the context of the Marine Strategy Framework Directive. Most of the proposed assessment tools for rivers and estuaries in the context of the Water Framework Directive often lack spatial and temporal context and also do not provide information on the minimum detectable alterations to the community structure, an aspect that can greatly affect monitoring effectiveness. The authors propose a multimetric tool, the Marine Fish Community Index (MFCI) and test the response of fish community metrics on two study sites in the West coast of Portugal, when facing two types of confounding variability: seasonal variation and errors induced by sampling design. The results indicate that both factors can greatly influence monitoring results, which can have devastating ecological and/or socioeconomic consequences if they are not accounted for and clearly stated when designing assessment tools and monitoring plans. It is only by distinguishing natural from anthropogenic variability that a tool can be usable in management and conservation contexts.

Influence of an artificial reef on particle dynamics in the south-western Baltic Sea: Evidence from the particulate-matter Tracer ^{234}Thorium.

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Artificial reefs were built in the past to enhance fish aggregation and production, and to protect coastal erosion as well. Less is known about the resulting influences on the vicinity of fresh deployed artificial reef. Therefore a deep understanding of hydrodynamic processes within artificial reefs is necessary, to get insights into import and export processes to and from the reef. The "Artificial reef - Nienhagen" is located in the Southwestern part of a fishery-protected zone at a water depth of 11 to 12m, 1.5 km offshore and 7 km west of Rostock-Warnemuende. It comprises of about 1,400 concrete elements and about 2500 t of natural stone and covers a surface of about 50,000 m². A down looking acoustic doppler current profiler system (ADCP) was used to get the spatial pattern of hydrodynamics above the reef, and a stationary up looking ADCP for temporal hydrodynamic conditions as well. Water column was sampled with a pump-CTD at 8 Stations in June 2010 for Carbon (C), Nitrogen (N), Chlorophyll-*a*, total particulate matter (TPM) and ^{234}Thorium. The particle reactive, radioactive, naturally occurring Thorium-234 was used to evaluate the temporal behavior of particulate matter in the water column above and in the surrounding of the reef. Here we present first results of changed particle behavior through an artificial reef.

Reef Check: involvement of SCUBA diver volunteers in the Coastal Environment Monitoring Protocol for the Mediterranean Sea

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Science has neither the work force nor the financial resources to meet the demands that are being placed upon it. However, much of the research that is needed to fulfil biodiversity action plans is labour intensive but technically straightforward. Volunteer-based monitoring is a potential solution to this problem. The use of macrodescriptors, easily recordable even by non-specialists, allows the involvement of laypeople, in order to add further data to those provided by the scientific community. Volunteers have already made significant contributions to scientific knowledge through their participation in a range of studies. The potential of this workforce is well illustrated in the tropical programme 'Reef Check'. Recreational divers surveyed over 300 reefs in 31 countries in a global survey that was certainly beyond the resources of conventional scientific projects. In northern Europe, NELOS (www.biologie.nelos.be) in Belgium and The Netherlands, and SEASEARCH (www.seasearch.org.uk) in the UK, are well-established projects that have developed observation protocols appropriate for their target areas and objectives. Since 2006, the Mediterranean network, coordinated by Reef Check Italia onlus, involves more than 600 trained recreational divers that conduct around 2.000 surveys. They apply a standardised visual census method concerning up to 39 easily identifiable target species. All the data are stored in an online database (www.reefcheckitalia.it). Citizen science allows all those who are interested in the marine resource to contribute to its understanding. Beyond providing valuable data, the increased awareness that comes from participation in the surveys is vital to the protection of coastal marine resources.

Multidisciplinary Approach to Marine Ecosystem Functioning: MEABRs

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Management and Exploitation Areas for Benthic Resources (MEABRs) have been described as an effective tool for biological conservation. MEABRs originate from the need to protect specific taxonomic groups (e.g. molluscs, sea-urchins, fishes) and it geographical location are usually associated with zones of high productivity, such as upwelling areas. These attributes make MEABRs a natural experiment that allows to quantify how multi-species assemblages respond to different types of disturbances; biotic (anthropogenic) and abiotic (upwelling). The objective of our work was first to assess the temporal and spatial variation in diversity in one of the oldest MEABRs existing in Central Chile. Secondly, a morphological and molecular approach was used to characterize the responses of intertidal herbivorous fishes to nutrients availability (coastal upwelling). These responses mediate the abundance of major taxonomic groups of macroalgae and ultimately determinate coastal community dynamics.

Effects on rockpool ecosystems of nutrient stress combined with changes in richness, evenness and functional density of macroalgae tested using a simplex approach

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Marine ecosystems are simultaneously being affected by anthropogenic stressors and changes in biodiversity. In many cases, species are not lost, but their overall abundance is reduced and the structure of communities is altered by changes in the relative abundance (evenness) of their consituent species. These aspects of biodiversity have received much less attention than species richness and we have little evidence to predict how biodiversity-ecosystem functioning relationships may be affected by environmental stressors. Based on a simplex design, artificial assemblages composed of varying relative densities of three species of macroalgae were replicated at two levels of total functional density (estimated as thallus surface area) and at two levels of nutrient addition in rock pools on the west coast of Ireland. Productivity and community respiration were derived from measurements of oxygen fluxes under light and dark conditions. Data were analysed using diversity-interaction modelling approach (Kirwan 2009, Ecology 90: 2032-2038), which quantifies the contributions of species identity (weighted by initial functional density), evenness and species interactions to ecosystem function. In this system, the BEF relationship was based on identity effects, rather than richness, evenness or functional density. It was not modified by nutrient stress.

Spatial and temporal variability of subtidal macroalgae assemblages in relation to environmental factors

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Macroalgae are important components of shallow-water ecosystems and their distribution and abundance respond to a great extent to physical and chemical factors. Sublittoral marine phytobenthic communities of the Abra de Bilbao and adjacent coast (N Spain) were surveyed five times over the period 2000-2008 at 3 bathymetric levels (2, 4 y 6 m below lowest astronomical tide) in eigth locations. Species cover was visually estimated on five replicated quadrats at each bathimetric level. Several abiotic measures were also recorded at each location. The three assemblages identified on the basis of the PCO ordination analysis were discriminated according to the SIMPER routine by the following species: (i) *Antithamnionella* spp., *Dictyota dichotoma* and *Spirulina subsalsa* in sheltered to exposed sites with low light penetration levels (ii) *Mesophyllum lichenoides*, *Falkenbergia rufolanosa*, *Corallina elongata* and *Gelidium pusillum* in sheltered to semi-exposed sites with high light levels (iii) *Mesophyllum lichenoides*, *Zanardinia typus*, *Falkenbergia rufolanosa*, and *Acrosorium ciliolatum* in exposed to very exposed sites with moderate to high light. Distance-based linear models (DISTLM routine) were used for modelling the relationships between biological and environmental variables in order to build a parsimonius model. Water movement, light, salinity and turbidity showed significant relationships with species data, explaining the combination of the first two variables 42.3 % of the community structure variation.

Biogenic patch reefs of the south-eastern New Zealand shelf — a review of the environment and associated fauna

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Bryozoan thickets are a globally unusual biogenic reef habitat that occur on the continental shelf of New Zealand. We review the environmental and biological characteristics of the Otago shelf thickets (46°S), where 16 species of large, heavily-calcified bryozoans occur over an area of 500 km^2, providing three-dimensional structure on the seafloor, from the mid shelf to the shelf break (80–150 m). Two bryozoan assemblages are separated by water depth and sediment type, one occurs on relict gravel sediments of the mid shelf, and is dominated by the cyclostome *Cinctipora elegans*, the other on gravelly sand of the outer shelf, and comprises *Cellaria immersa*, *Celleporina grandis*, *Hippomenella vellicata* and others. Bryozoan fragments contribute significantly to the heterogeneous shelf sediments. Diverse in- and epifaunal assemblages, detected at the shelf scale, are associated with the thickets. Bryozoan colony form is species-specific, and the various structures provide habitat for different macroinvertebrate assemblages at the centimetre scale. Epibionts occur in particular zones on the bryozoan colonies. For example hydroids grow on distal colony parts, whilst soft-tested ascidians grow in more sheltered positions. We summarise the nested distribution of organisms, describe the range of environmental conditions that contribute to habitat heterogeneity, and briefly relate the history of commercial fishing in the area, which presents a threat to this fragile habitat.

Monitoring fish communities on a shallow-water methane derived carbonate reef in a Welsh SAC

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Holden's Reef, is a unique shallow-water (<20m) methanogenic carbonate reef (MCR) and a habitat feature of Cardigan Bay and the Sarns Special Area of Conservation (SAC), North Wales (UK). As part of the monitoring requirements for this site, fish assemblages were comparatively assessed both temporally (2004 – 2010), and spatially (with one other methanogenic and two non-methanogenic rocky reefs) in the same geographic area. There were significant differences between the fish communities on all sites in 2010 although all were dominated by species of the family Labridae, both in terms of diversity (27%) and abundance (81%). Total mean abundances of fish were significantly lower on Holden's Big, compared to Holden's Reef, Bedrock Ridge and Lucy's Boulders. The same trend can be seen with diversity of species, although Shannon-diversity (H') and Simpson's index are significantly greater on Bedrock Ridge and Lucy's boulders, compared to Holden's Reef indicating lower equitability and a patchy distribution dominated by few prominent species in the latter. Habitat complexity on Holden's reef was higher than on any other reef with significantly higher values for rugosity and number of fissures (holes) compared to Bedrock Ridge. A possible explanation for this variability includes physical factors such as reef height, and the influence of recent low and prolonged sea bottom winter temperatures that may help to explain the high annual variation in fish community structure on Holden's Reef revealed by the time-series data 2004 – 2010. To date, there have been no published scientific reports concerning the composition of the reef fish assemblages on temperate shallow water MCRs. The results help to contribute to the wider Across-Wales Monitoring Project and represent potential conservation implications associated with specific marine management strategy in Wales such as the allocation of Marine Conservation Zones (MCZs) and Marine Spatial Planning (MSP).

Integrating Impacts on the Environment and Visitors: An Interdisciplinary Analysis of Activities on Rocky Shores

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In the conference pack there is a short survey for delegates to complete during any spare time they have during the week. This survey is part of an ongoing interdisciplinary project, which looks at the interaction between visitors and the environment. This survey in particular is exploring expert's views on the frequency and impact of human activities on rocky shore environments. It also looks at people's perceptions of the effect those activities have on the visitor's human well-being (feeling happy and healthy) and the potential impact visiting this environment has on knowledge on marine issues. This is an important and rather novel approach, as the impact on visitors and on the environment is rarely studied together. Therefore this research allows us to identify activities that are highly beneficial to humans but have little harmful impact on the environment.

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