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Marine Science Review – 210

Ecosystems and habitats

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In this review:

A. Recent articles with abstracts

Khripounoff, A., Caprais, J.C., Crassous, P., and Etoubleau, J. **Geochemical and biological recovery of the disturbed seafloor in polymetallic nodule fields of the Clipperton-Clarion Fracture Zone (CCFZ) at 5,000-m depth.** *Limnology and Oceanography* 51(5): 2033-2041, 2006.

Notes: Environmental data were obtained on the nodule fields of the Clipperton-Clarion Fracture Zone at 5,000-m depth in June 2004 during the Nodinaut cruise. The long-term effects of physical disturbance made by a dredge 26 yr ago on the sediment were investigated. We focused our study on its track, which is still visible on the bottom. The first major consequence of the passage of this equipment was to remove 4 cm ± 0.5 cm of superficial sediment. The physical and chemical properties of this disturbed sediment sampled in the track did not change significantly over time and has not shown any recovery since the disturbance. However, an exception was observed for depth variations of manganese concentration in the sediment, which were similar in the track to those in the surrounding undisturbed sediment and can be explained by the diffusion over time of oxygen from the sea water. On the other hand, the biological activity measured in the track with the respirometer RAP2 carried by the submersible Nautile did not differ from the unperturbed site, which suggests that the benthic fauna has completely recovered, as have nutrient fluxes at the water sediment interface

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Johannesson, K. and Andre, C. **Life on the margin: genetic isolation and diversity loss in a peripheral marine ecosystem, the Baltic Sea.** *Molecular Ecology* 15(8): 2013-2029, 2006.

Notes: Marginal populations are often isolated and under extreme selection pressures resulting in anomalous genetics. Consequently, ecosystems that are geographically and ecologically marginal might have a large share of genetically atypical populations, in need of particular concern in management of these ecosystems. To test this prediction, we analysed genetic data from 29 species inhabiting the low saline Baltic Sea, a geographically and ecologically marginal ecosystem. On average Baltic populations had lost genetic diversity compared to Atlantic populations: a pattern unrelated to dispersal capacity, generation time of species and taxonomic group of organism, but strongly related to type of genetic marker (mitochondrial DNA loci had lost c. 50% diversity, and nuclear loci 10%). Analyses of genetic isolation by geographic distance revealed clinal patterns of differentiation between Baltic and Atlantic regions. For a majority of species, clines were sigmoid with a sharp slope around the Baltic Sea entrance, indicating impeded gene flows between Baltic and Atlantic populations. Some species showed signs of allele frequencies being perturbed at the edge of their distribution inside the Baltic Sea. Despite the short geological history of the Baltic Sea (8000 years), populations inhabiting the Baltic have evolved substantially different from Atlantic populations, probably as a consequence of isolation and bottlenecks, as well as selection on adaptive traits. In addition, the Baltic Sea also acts a refuge for unique evolutionary lineages. This marginal ecosystem is thus vulnerable but also exceedingly valuable, housing unique genes, genotypes and populations that constitute an important genetic resource for management and conservation.

Meysman, F.J.R., Middelburg, J.J., and Heip, C.H.R. **Bioturbation: a fresh look at Darwin's last idea.** *Trends in Ecology and Evolution* 21(12): 688-695, 2006.

Notes: Bioturbation refers to the biological reworking of soils and sediments, and its importance for soil processes and geomorphology was first realised by Charles Darwin, who devoted his last scientific book to the subject. Here, we review some new insights into the evolutionary and ecological role of bioturbation that would have probably amazed Darwin. In modern ecological theory, bioturbation is now recognised as an archetypal example of ecosystem engineering, modifying geochemical gradients, redistributing food resources, viruses, bacteria, resting stages and eggs. From an evolutionary perspective, recent investigations provide evidence that bioturbation had a key role in the evolution of metazoan life at the end of the Precambrian Era.

Su, G.H., Huang, Y.L., Tan, F.X., Ni, X.W., Tang, T., and Shi, S.H. **Conservation genetics of *Lumnitzera littorea* (Combretaceae), an endangered mangrove, from the Indo-West Pacific.** *Marine Biology* 150(3): 321-328, 2007.

Notes: Mangrove forests, with their ecological significance and economic benefits, are vital inter-tidal wetland ecosystems. *Lumnitzera littorea* (Combreataceae) is a non-viviparous mangrove distributed in tropical Asia and North Australia. Due to natural and human impacts, populations of this species have been isolated, fragmented, and highly disturbed. In China, *L. littorea* is an endangered species, restricted to small regions of Hainan Island. The genetic composition of five populations of this species from the Indo-West Pacific (South China, Malay Peninsula, Sri Lanka, North Australia) was assessed using inter simple sequence repeat (ISSR) makers. At the species level, expected mean heterozygosity (He) was 0.240 with 75.6% of loci polymorphic (*P*). However, genetic variation was much lower at the population level (*P* = 37.1%, He = 0.118). A high coefficient of gene differentiation (Gst = 0.515) and low level of gene flow (Nm = 0.470) indicated significant genetic differentiation among populations. AMOVA also indicated that more than half the total variation (58.4%) was partitioned among populations. The high degree of differentiation observed among populations emphasizes the need for appropriate conservation measures that incorporate additional populations into protected areas, and achieve the restoration of separate, degraded populations.

Mermillod-Blondin, F. and Rosenberg, R. **Ecosystem engineering: the impact of bioturbation on biogeochemical processes in marine and freshwater benthic habitats.** *Aquatic Sciences* 68(4): 434-442, 2006.

Notes: In aquatic ecosystems, invertebrate bioturbation significantly influences microbial activities and bio-geochemical processes in sediments by modifying water and sediment fluxes at the water-sediment interface. We apply the concept of ecosystem engineering to develop a qualitative general understanding of the role of bioturbation on microbial processes in different benthic environments. We hypothesized that the effects of the bioturbation mode (sediment reworking, biogenic structure building, bioirrigation) on microbial processes vary between diffusion- and advection-dominated benthic environments because bioturbation does not have the same influences on hydrological exchanges (and the flux of resources for micro-organisms living in sediments) at the water-sediment interface of the two systems. To test this hypothesis, we experimentally compared the influence of three bioturbation modes (fine-sediment reworking, U-shaped structure burrowing, and gallery-network burrowing) in a diffusion-dominated system (fine sediments/low interstitial flow rates) and an advection-dominated system (coarse sediments/advection of water in sediments). Our analysis demonstrated that bioturbation modes in the two systems had different impacts on microbial activities. For instance, U-shaped tube burrowing by animals increased O_2 consumption in the diffusion-dominated system but produced the opposite effect in the advection-dominated system. The influence of bioturbation was also negatively related to interstitial flow rate, the bioturbation having a higher influence on O_2 consumption in the diffusion-dominated system than in the advection-dominated system. According to our hypothesis, bioturbation modified microbial processes in sediments depend on the hydrological characteristics of the system. In the diffusion-dominated system, invertebrate bioturbation can produce water fluxes at the water-sediment interface that may strongly influence microbial processes in sediments. In contrast, in the advection-dominated system, invertebrate bioturbation can only modify the water circulation patterns in sediments, moderately affecting microbial processes. Consequently, it is necessary to use a conceptual framework which takes into account the features of sediment habitats in order to allow a better prediction of bioturbation effects on sediment biogeochemistry. With this aim, the conceptual scheme of ecosystem engineers can be an organizing principle to integrate the complex relationships among physical habitat, bioturbation mode and microbial activity.

Hastings, A., Byers, J.E., Crooks, J.A., Cuddington, K., Jones, C.G., Lambrinos, J.G., Talley, T.S., and Wilson, W.G. **Ecosystem engineering in space and time.** *Ecology Letters* 10(2): 153-164, 2007.

Notes: The ecosystem engineering concept focuses on how organisms physically change the abiotic environment and how this feeds back to the biota. While the concept was formally introduced a little more than 10 years ago, the underpinning of the concept can be traced back to more than a century to the early work of Darwin. The formal application of the idea is yielding new insights into the role of species in ecosystems and many other areas of basic and applied ecology. Here we focus on how temporal, spatial and organizational scales usefully inform the roles played by ecosystem engineers and their incorporation into broader ecological contexts. Two particular, distinguishing features of ecosystem engineers are that they affect the physical space in which other species live and their direct effects can last longer than the lifetime of the organism - engineering can in essence outlive the engineer. Together, these factors identify critical considerations that need to be included in models, experimental and observational work. The ecosystem engineering concept holds particular promise in the area of ecological applications, where influence over abiotic variables and their consequent effects on biotic communities may facilitate ecological restoration and counterbalance anthropogenic influences.

Short, F.T., Koch, E.W., Creed, J.C., Magalhaes, K.M., Fernandez, E., and Gaeckle, J.L. **SeagrassNet monitoring across the Americas: case studies of seagrass decline.** *Marine Ecology: An Evolutionary Perspective* 27(4): 277-289, 2006.

Notes: Seagrasses are an important coastal habitat worldwide and are indicative of environmental health at the critical land-sea interface. In many parts of the world, seagrasses are not well known, although they provide crucial functions and values to the world's oceans and to human populations dwelling along the coast. Established in 2001, SeagrassNet, a monitoring program for seagrasses worldwide, uses a standardized protocol for detecting change in seagrass habitat to capture both seagrass parameters and environmental variables. SeagrassNet is designed to statistically detect change over a relatively short time frame (1-2 years) through quarterly monitoring of permanent plots. Currently, SeagrassNet operates in 18 countries at 48 sites; at each site, a permanent transect is established and a team of people from the area collects data which is sent to the SeagrassNet database for analysis. We present five case studies based on SeagrassNet data from across the Americas (two sites in the USA, one in Belize, and two in Brazil) which have a common theme of seagrass decline; the study represents a first latitudinal comparison across a hemisphere using a common methodology. In two cases, rapid loss of seagrass was related to eutrophication, in two cases losses related to climate change, and in one case, the loss is attributed to a complex trophic interaction resulting from the presence of a marine protected area. SeagrassNet results provide documentation of seagrass change over time and allow us to make scientifically supported statements about the status of seagrass habitat and the extent of need for management action.

Erftemeijer, P.L.A. and Lewis, R.R.R. **Environmental impacts of dredging on seagrasses: A review.** *Marine Pollution Bulletin* 52(12): 1553-1572, 2006.

Notes: Main potential impacts on seagrasses from dredging and sand mining include physical removal and/or burial of vegetation and effects of increased turbidity and sedimentation. For seagrasses, the critical threshold for turbidity and sedimentation, as well as the duration that seagrasses can survive periods of high turbidity or excessive sedimentation vary greatly among species. Larger, slow-growing climax species with substantial carbohydrate reserves show greater resilience to such events than smaller opportunistic species, but the latter display much faster post-dredging recovery when water quality conditions return to their original state. A review of 45 case studies worldwide, accounting for a total loss of 21,023 ha of seagrass vegetation due to dredging, is indicative of the scale of the impact of dredging on seagrasses. In recent years, tighter control in the form of strict regulations, proper enforcement and monitoring, and mitigating measures together with proper impact assessment and development of new environmental dredging techniques help to prevent or minimize adverse impacts on seagrasses. Costs of such measures are difficult to estimate, but seem negligible in comparison with costs of seagrass restoration programmes, which are typically small-scale in approach and often have limited success. Copying of dredging criteria used in one geographic area to a dredging operation in another may in some cases lead to exaggerated limitations resulting in unnecessary costs and delays in dredging operations, or in other cases could prove damaging to seagrass ecosystems. Meaningful criteria to limit the extent and turbidity of dredging plumes and their effects will always require site-specific evaluations and should take into account the natural variability of local background turbidity.

Shirley, L.J. and Battaglia, L.L. **Assessing vegetation change in coastal landscapes of the Northern Gulf of Mexico.** *Wetlands* 26(4): 1057-1070, 2006.

Notes: Multiple factors have caused rapid changes in coastal landscapes in the last half century. Coastal natural areas have been set aside to mitigate some of these changes for habitat preservation, among other goals. However, areas set aside for conservation are not exempt from these rapid changes. A major concern for coastal wetlands is the potential for habitat loss resulting from external land-use changes and sea-level rise, which essentially threaten these natural areas from all sides. In order to quantify these trends, we determined the types and rates of land-use/land-cover conversion in differing coastal sites in the U.S. along the northern Gulf of Mexico from the 1950s to the 1990s using existing National Wetlands Inventory (NWI) habitat data and Geographic Information Systems (GIS). All sites were located in protected areas and contained an intact marsh-to-forest transition. A buffer zone of ~ 2000 m around each site was also analyzed. Two sites, Mandalay National Wildlife Refuge (MNWR) and the Barataria Preserve Unit of the Jean Lafitte National Historical Park and Preserve (JLNHPP), were located on the Mississippi Deltaic Plain in Louisiana, while the other sites, Grand Bay National Estuarine Research Reserve (GBNERR) and Weeks Bay National Estuarine Research Reserve (WBNERR), were located on the Gulf Coastal Plain in Mississippi and Alabama, respectively. Results showed prevalent marsh loss across all sites in the study, although the rate and type of marsh conversion to other land-cover types varied between the Mississippi Delta sites and the Coastal Plain. In the Delta, marsh was converted to open water along shorelines and in internal patches, but the majority of marsh loss was attributed to scrub-shrub encroachment. In the Coastal Plain, marsh was lost more slowly overall, both along the shoreline and forest-marsh boundary. The main trend in the Coastal Plain was replacement of agricultural areas by forest. The buffers experienced an increase in anthropogenically-modified categories, except for a decrease in agricultural areas. Our study suggests that coastal transitions of the northern Gulf of Mexico have indeed experienced landward and seaward losses and that marsh areas are especially vulnerable. It appears that marshes are not keeping pace with the spatial shifts in the aquatic to terrestrial transition as sea level rises, although results in the Coastal Plain are less conclusive because major land-use changes dominate the trends.

Barth, J.A., Menge, B.A., Lubchenco, J., Chan, F., Bane, J.M., Kirincich, A.R., McManus, M.A., Nielsen, K.J., Pierce, S.D., and Washburn, L. **Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current.** *Proceedings of the National Academy of Sciences [USA]* 104(10): 3719-3724, 2007.

Notes: Wind-driven coastal ocean upwelling supplies nutrients to the euphotic zone near the coast. Nutrients fuel the growth of phytoplankton, the base of a very productive coastal marine ecosystem [Pauly D, Christensen V (1995) *Nature* 374:255-257]. Because nutrient supply and phytoplankton biomass in shelf waters are highly sensitive to variation in upwelling-driven circulation, shifts in the timing and strength of upwelling may alter basic nutrient and carbon fluxes through marine food webs. We show how a 1-month delay in the 2005 spring transition to upwelling-favorable wind stress in the northern California Current Large Marine Ecosystem resulted in numerous anomalies: warm water, low nutrient levels, low primary productivity, and an unprecedented low recruitment of rocky intertidal organisms. The delay was associated with 20- to 40-day wind oscillations accompanying a southward shift of the jet stream. Early in the upwelling season (May-July) off Oregon, the cumulative upwelling-favorable wind stress was the lowest in 20 years, nearshore surface waters averaged 2°C warmer than normal, surf-zone chlorophyll-*a* and nutrients were 50% and 30% less than normal, respectively, and densities of recruits of mussels and barnacles were reduced by 83% and 66%, respectively. Delayed early-season upwelling and stronger late-season upwelling are consistent with predictions of the influence of global warming on coastal upwelling regions.

Cabaco, S. and Santos, R. **Effects of burial and erosion on the seagrass *Zostera noltii*.** *Journal of Experimental Marine Biology and Ecology* 340(2): 204-212, 2007.

Notes: The effects of experimental burial and erosion on the seagrass *Zostera noltii* were assessed through in situ manipulation of the sediment level (-2 cm, 0 cm, +2 cm, +4 cm, +8 cm and +16 cm). Shoot density, leaf and sheath length, internode length, C and N content and carbohydrates of leaves and rhizomes were examined 1, 2, 4 and 8 weeks after disturbance. Both burial and erosion resulted in the decrease of shoot density for all the sediment levels. The threshold for total shoot loss was between 4 cm and 8 cm of burial, particularly during the 2nd week. A laboratory experiment confirmed that shoots did not survive more than 2 weeks under complete burial. There was no evidence of induced flowering by burial or erosion. As well, no clear evidence was found of sediment level effects on leaf and sheath length. Longer rhizome intemodes were observed as a

response to both burial and erosion, suggesting a plant attempt to relocate the leaf-producing meristems closer to sediment surface or in search of new sediment avoiding the eroded area. The C content of leaves and rhizomes, as well as the non-structural carbohydrates (mainly the starch in rhizomes), decreased significantly along the experimental period, indicating the internal mobilization of carbon to meet the plant demands as a consequence of light deprivation. The significant decrease of N content in leaves, and its simultaneous increase in rhizomes, suggests the internal translocation of nitrogen from leaves to rhizomes. About 50% of the N lost by the leaves was recovered by the rhizomes. Our results indicated that *Z. noltii* has a high sensitivity to burial and erosion disturbance, which should be considered in the management of coastal activities.

McGregor, H.V., Dima, M., Fischer, H.W., and Mulitza, S. **Rapid 20th-century increase in coastal upwelling off northwest Africa.** *Science* 315(5812): 637-639, 2007.

Notes: Near-shore waters along the northwest African margin are characterized by coastal upwelling and represent one of the world's major upwelling regions. Sea surface temperature (SST) records from Moroccan sediment cores, extending back 2500 years, reveal anomalous and unprecedented cooling during the 20th century, which is consistent with increased upwelling. Upwelling-driven SSTs also vary out of phase with millennial-scale changes in Northern Hemisphere temperature anomalies (NHTAs) and show relatively warm conditions during the Little Ice Age and relatively cool conditions during the Medieval Warm Period. Together, these results suggest that coastal upwelling varies with NHTAs and that upwelling off northwest Africa may continue to intensify as global warming and atmospheric CO_2 levels increase.

Altieri, A.H., Silliman, B.R., and Bertness, M.D. **Hierarchical organization via a facilitation cascade in intertidal cordgrass bed communities.** *American Naturalist* 169(2): 195-206, 2007.

Notes: It has recently been proposed that many communities are structured by a hierarchy of interactions in which facilitation by foundation species is of primary importance. We conducted the first explicit experimental test of this hypothesis by investigating the organization of positive interactions on New England cobblestone beaches. In this midintertidal community, wave-generated substrate instability and solar stress largely limit marine organisms to the shelter of cordgrass beds. Cordgrass, which can establish and persist without the aid of other foundation species, facilitates a dense assemblage of inhabitants (e.g., mussels, snails, seaweeds) with roots/rhizomes that stabilize substrate and a dense canopy that baffles waves and provides shade. Within the cordgrass bed community, ribbed mussels further enhance physical conditions and densities of other species (e.g., amphipods, barnacles) by providing crevice space and hard substrate. We conclude that cordgrass bed communities are hierarchically organized: secondary interactions (e.g., facilitation by ribbed mussels) play a key role within an assemblage dependent on primary facilitation by the independently successful foundation species cordgrass. Our results identify emergent indirect positive interactions in the form of facilitation cascades, have broad implications for conservation, and help unify existing models of community organization that were developed without considering the fundamental role of positive interactions.

Johst, K., Gutt, J., Wissel, C., and Grimm, V. **Diversity and disturbances in the Antarctic megabenthos: Feasible versus theoretical disturbance ranges.** *Ecosystems* 9(7): 1145-1155, 2006.

Notes: The intermediate disturbance hypothesis (IDH) predicts a hump-shaped relationship between regional diversity and the disturbance rate. We tested the IDH for the megabenthos inhabiting the Antarctic sea floor, which is disturbed by iceberg scouring. We used models based on the empirical knowledge of succession to calculate the IDH curve for this system and to extrapolate the presently observable range of the IDH curve to higher and lower disturbance rates. Although the hump-shaped relationship has been found for a purely theoretical (extremely large) disturbance range, within the feasible disturbance range (assumed as realistic in the Antarctic region under climate change), the regional diversity of successional stages due to iceberg scouring strongly decreases with lower disturbance rates but levels off only slowly with higher disturbance rates. The reason is the unevenness in the lifetimes of the successional stages, in that early stages are short-lived whereas late stages are long-lived. With such unevenness, increasing disturbances support the early stages without jeopardizing the later ones. Additionally, we converted this regional diversity of stages to the regional diversity of taxa using a transformation formula based on empirical knowledge of the number and mean abundance of taxa in the particular stages. Our results suggest that a decrease in iceberg scouring due to climate change would be more detrimental to the diversity of the Antarctic megabenthos than an increase.

Lluch-Cota, S.E. and et al. **The Gulf of California: Review of ecosystem status and sustainability challenges.** *Progress in Oceanography* 73(1): 1-26, 2007.

Notes: The Gulf of California is unique because of its geographical location and conformation. It hosts diverse ecosystems and important fisheries that support industry and provide livelihood to coastal settlements. It is also the site of interests and problems, and an intense interaction among managers, producers, and conservationists. In this report, we scrutinize the abiotic (hydrography, climate, ocean circulation, and chemistry) and biotic (phyto- and zooplankton, fish, invertebrates, marine mammals, birds, and turtles) components of the marine ecosystem, and some particular aspects of climate variability, endemisms, harmful algal blooms, oxygen minimum layer, and pollution. We also review the current conditions and conflicts around the main fisheries (shrimp, small and large pelagic fishes, squid, artisanal and sportfishing), the most important human activity in the Gulf of California. We cover some aspects of management and conservation of fisheries, especially the claimed overexploitation of fish resources and the ecosystems, and review proposals for creating networks of marine protected areas. We conclude by identifying main needs for information and research, particularly the integration of data bases, the implementation of models and paleoreconstructions, establishment of monitoring programs, and the evaluation of fishing impacts and management actions.

Alvarez-Castaneda, S.T., Cortes-Calva, P., Mendez, L., and Ortega-Rubio, A. **Development in the Sea of Cortes calls for mitigation.** *BioScience* 56(10): 825-829, 2006.

Notes: Islands in the seas of northwestern Mexico have the largest number of insular endemic species in North America. The islands have the greatest number of extinct mammalian taxa in Mexico, and many of the remaining taxa are rare, threatened, or endangered. Thus the Mexican government's plan to build 24 modern ports - the "Escalera Nautica" project - will place enormous pressure on island species, which are exceptionally vulnerable to human activities, including the introduction of alien species. The intensified port activities would most likely lead to an ecological disaster. Several mammal species inhabiting the islands are already close to the limit of their capacity to survive. For many endangered species, a small change in habitat can be the final push into extinction. In this article, we make some recommendations to try to prevent the extinction of species at risk.

Orth, R.J., Carruthers, T.J.B., Dennison, W.C., Duarte, C.M., Fourqurean, J.W., Heck, K.L., Hughes, A.R., Kendrick, G.A., Kenworthy, W.J., Olyarnik, S., Short, F.T., Waycott, M., and Williams, S.L. **A global crisis for seagrass ecosystems.** *BioScience* 56(12): 987-996, 2006.

Notes: Seagrasses, marine flowering plants, have a long evolutionary history but are now challenged with rapid environmental changes as a result of coastal human population pressures. Seagrasses provide key ecological services, including organic carbon production and export, nutrient cycling, sediment stabilization, enhanced biodiversity, and trophic transfers to adjacent habitats in tropical and temperate regions. They also serve as "coastal canaries," global biological sentinels of increasing anthropogenic influences in coastal ecosystems, with large-scale losses reported worldwide. Multiple stressors, including sediment and nutrient runoff, physical disturbance, invasive species, disease, commercial fishing practices, aquaculture, overgrazing, algal blooms, and global warming, cause seagrass declines at scales of square meters to hundreds of square kilometers. Reported seagrass losses have led to increased awareness of the need for seagrass protection, monitoring, management, and restoration. However, seagrass science, which has rapidly grown, is disconnected from public awareness of seagrasses, which has lagged behind awareness of other coastal ecosystems. There is a critical need for a targeted global conservation effort that includes a reduction of watershed nutrient and sediment inputs to seagrass habitats and a targeted educational program informing regulators and the public of the value of seagrass meadows.

Soomere, T. **Nonlinear ship wake waves as a model of rogue waves and a source of danger to the coastal environment: a review.** *Oceanologia* 48(S): 185-202, 2006.

Notes: A substantial part of the energy of wake waves from high-speed ships sailing in shallow water is concentrated in nonlinear components which at times have a solitonic nature. Recent results of investigations into solitonic wave interactions within the framework of the Kadomtsev-Petviashvili equation and their implications for rogue wave theory are reviewed. A surface elevation four times as high as the counterparts occurs if the properties of the interacting waves are specifically balanced. The slope of the water surface may increase eightfold. The resulting structure may persist for a long time. Nonlinear wake components may exert a considerable influence on the marine ecosystem in coastal areas.

Erm, A. and Soomere, T. **The impact of fast ferry traffic on underwater optics and sediment resuspension.** *Oceanologia* 48(S): 283-301, 2006.

Notes: Wake waves produced by fast ferries bring about significant changes in the optical parameters of sea water in the c. 1 m thick near-bottom layer of the coastal areas of Tallinn Bay. The greatest of these changes occur at relatively small depths, but the duration of the influence increases with increasing depth. Rough quantitative estimates suggest that the overall influence of fast ferry traffic in Tallinn Bay may result in an annual loss of the order of several hundred litres of fine sediments from each metre of the coastline.

Cravo, A., Madureira, M., Felicia, H., Rita, F., and Bebianno, M.J. **Impact of outflow from the Guadiana River on the distribution of suspended particulate matter and nutrients in the adjacent coastal zone.** *Estuarine, Coastal and Shelf Science* 70(1-2): 63-75, 2006.

Notes: In this study we collected surface water samples from the coastal area adjacent to the Guadiana estuary during winter for 3 consecutive years to assess the impact of the Guadiana outflow upon the concentration and spatial distribution of suspended particulate matter and nutrients (nitrate, phosphate, and silicate). Deeper water samples were also collected near the river mouth in water greater than 10 m in depth. Our results indicate that the maximal surface influence of the Guadiana outflow is close to the mouth of the Guadiana River, at the 10-m isobath, where the highest concentrations of suspended particulate matter (SPM) and nutrients were recorded, as well as the lowest salinity. SPM and nutrient concentrations decrease with increased water depth, while salinity increased. Beyond the 10-m isobath, toward the ocean, nutrient concentrations decreased gradually with increasing salinity. Nutrient concentrations showed a conservative behaviour only during the last of the three sampling periods. The impact of Guadiana outflow was especially low when river discharge was low, however, after periods of peak rainfall the river outflow increased enormously and the impact of SPM and nutrients (more than an order of magnitude higher than normal) was observed, particularly around the mouth of the estuary. This impact involved the development of a fingerprint plume that represents a net export of SPM and nutrients to the coastal area. This plume had a width of about 10-15 km, and despite being centred slightly east of the mouth of the Guadiana River, tended to migrate westward. The increase in N compounds was more significant than increases in P and Si, is reflected in high N:P and N:Si nutrient ratios. In water depths in excess of 10 m, the effect of the Guadiana outflow was most evident until 5 m depth. It is expected that with the completion of the biggest dam in Europe along the Guadiana River, the outflow of the river will be markedly reduced, especially during summer if climatic change continues to produce significant periods of dry weather. Under such conditions, nutrient concentrations will be reduced even further and impart a negative impact on nutrient biogeochemical cycles and productivity of the coastal zone.

Minh Thu, P. and Populus, J. **Status and changes of mangrove forest in Mekong Delta: Case study in Tra Vinh, Vietnam.** *Estuarine, Coastal and Shelf Science* 71(1-2): 98-109, 2007.

Notes: Because shrimp culture in the Mekong Delta develops rapidly, it has negatively impacted the environment, socio-economics and natural resources. In particular, mangrove forests have been altered by the shrimp culture. The area of mangrove forests in the region has been reduced and this is seen especially in Tra Vinh province. The results obtained from GIS (Geography Information System) and RS (Remote Sensing) show the status of mangrove forests in Tra Vinh province in 1965, 1995 (Northeastern part of Tra Vinh Province) and 2001. In 1965, the area of mangrove forests was 21,221 ha making up 56% of total land-use, while in 2001 it was 12,797 ha making up 37% of total land-use. Also based on GIS analysis, over the 36 years (1965-2001), the total coverage of mangrove forests have decreased by 50% since 1965. However, the speed of mangrove forest destruction in the period from 1965 to 1995 was much less than that in the period from 1995 to 2001. The

average annual reduction in mangrove forest coverage in the first period (1965-1995) was 0.2% whereas it was 13.1% in the later period (1995-2001). For the long time, mangrove deforestation has been caused by war, collection of firewood and clearing for agriculture, and recently, shrimp farming has significantly contributed rate of mangrove destruction.

Snedden, G.A., Cable, J.E., Swarzenski, C., and Swenson, E. **Sediment discharge into a subsiding Louisiana deltaic estuary through a Mississippi River diversion.** *Estuarine, Coastal and Shelf Science* 71(1-2): 181-193, 2007.

Notes: Wetlands of the Mississippi River deltaic plain in Southeast Louisiana have been hydrologically isolated from the Mississippi River by containment levees for nearly a century. The ensuing lack of fluvial sediment inputs, combined with natural submergence processes, has contributed to high coastal land loss rates. Controlled river diversions have since been constructed to reconnect the marshes of the deltaic plain with the river. This study examines the impact of a pulsed diversion management plan on sediment discharge into the Breton Sound estuary, in which duplicate 185 $m^3 s^{-1}$-diversions lasting two weeks each were conducted in the spring of 2002 and 2003. Sediment delivery during each pulse was highly variable (11,300-43,800 metric tons), and was greatest during rising limbs of Mississippi River flood events. Overland flow, a necessary transport port mechanism for river sediments to reach the subsiding backmarsh regions, was induced only when diversion discharge exceeded 100 $m^3 s^{-1}$. These results indicate that timing and magnitude of diversion events are both important factors governing marsh sediment deposition in the receiving basins of river diversions. Though the diversion serves as the primary source of river sediments to the estuary, the inputs observed here were several orders of magnitude less than historical sediment discharge through crevasses and uncontrolled diversions in the region, and are insufficient to offset present rates of relative sea level rise.

Pomeroy, L.R., DElia, C.F., and Schaffner, L.C. **Limits to top-down control of phytoplankton by oysters in Chesapeake Bay.** *Marine Ecology Progress Series* 325: 301-309, 2006.

Notes: Restoration of the oyster *Crassostrea virginica* population in Chesapeake Bay is often advocated as an easy solution for controlling phytoplankton blooms. Even at their pre-colonial densities, oysters are unlikely to have controlled blooms, despite the fact that sediment cores suggest that pre-colonial spring blooms were smaller than at present. Lack of access to all bay water and low springtime filtration rates would make it impossible for oysters to control the spring bloom and the resulting summer hypoxia. Previous studies have overestimated potential oyster filtration rates, because they extrapolated summer rates to spring conditions that are 20ºC cooler. Previous studies have also assumed that oysters have access to all phytoplankton, without considering the spatial separation. In Chesapeake Bay, oysters and the spring bloom are separated horizontally owing to the size of the bay and its small tidal amplitude. Indeed, a multi-species guild of suspension feeders now present in the bay should have a filtration capacity approaching that of pre-colonial oysters, but it does not control the bloom. Actual oyster filtration potential must be lower than many advocates of oyster restoration assume, and replenishing the bay with oysters is not the means of controlling blooms and hypoxia.

Seitz, R.D., Lipcius, R.N., Olmstead, N.H., Seebo, M.S., and Lambert, D.M. **Influence of shallow-water habitats and shoreline development on abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay.** *Marine Ecology Progress Series* 326: 11-27, 2006.

Notes: Within the coastal zone, waterfront development has caused severe loss of shallow-water habitats, such as salt marshes and seagrass beds. Although the effects of habitat degradation on community structure within intertidal marshes have been well studied, little is known about the impact of habitat degradation on, and the ecological value of, subtidal shallow-water habitats, despite the prevalence of these habitats in coastal ecosystems. In coastal habitats, bivalves are dominant benthic organisms that can comprise over 50% of benthic prey biomass and are indicative of benthic production. We quantified bivalve diversity, density, and biomass in deep and shallow (< 1.5 m MLW) unstructured subtidal habitats in 2 tributaries of lower Chesapeake Bay (Elizabeth-Lafayette River system and York River). We also examined the effects of shoreline alteration in shallow habitats by contrasting the benthos of the subtidal areas adjacent to natural marsh, bulkhead, and rip-rap shorelines. Bivalve diversity, density, and biomass were significantly higher in shallow than in deep benthic habitats in both systems. Benthic abundance and diversity were higher in subtidal habitats adjacent to natural marsh than those adjacent to bulkhead shorelines; abundance and diversity were intermediate in rip-rap shorelines, and appeared to depend on landscape features.

Predator density and diversity tended to be highest adjacent to natural marsh shorelines, and density of crabs was significantly higher in natural marsh than in bulkhead habitats. There is thus a crucial link between natural marshes, infaunal prey in subtidal habitats, and predator abundance. Consequently, the indirect effects of coastal habitat degradation upon secondary production in the shallow, subtidal habitats adjacent to salt marshes may be as great as or greater than direct habitat effects.

Reed, B.J. and Hovel, K.A. **Seagrass habitat disturbance: how loss and fragmentation of eelgrass *Zostera marina* influences epifaunal abundance and diversity.** *Marine Ecology Progress Series* 326: 133-143, 2006.

Notes: Seagrass habitats commonly display evidence of anthropogenic disturbances such as propeller scars, mooring and anchor damage, trampling, and plant harvesting. These physical disturbances may lead to habitat loss and fragmentation, yet effects of this habitat removal on seagrass epifaunal communities are not well understood. We investigated how the degree of eelgrass *Zostera marina* L. loss influenced the abundance, diversity, and community composition of epifauna within experimental seagrass plots in San Diego Bay, California, USA. We established replicate small (4 m^2) and large (16 m^2) plots within existing eelgrass habitat, and removed all aboveground and belowground plant material within randomly chosen cells to establish 4 to 6 levels of eelgrass clearing. We then sampled for epifauna up to 8 wk after eelgrass harvesting. We found no correlations between seagrass loss and epifaunal species richness, total epifaunal density or epifaunal diversity in small plots. In large plots, however, plots with 90% habitat removal had significantly lower epifaunal species richness and total epifaunal density than plots with 0, 10 or 50% habitat removal, suggesting that beyond a threshold level of eelgrass disturbance, species richness and abundance rapidly decline. Multivariate ordinations revealed that the 90% removal plots also had significantly different species composition than plots with less habitat loss. Our results support previous theoretical models predicting threshold levels of habitat loss for faunal communities and broaden our understanding of the response of marine epifauna to seagrass habitat degradation.

Heck, K.L., Valentine, J.F., Pennock, J.R., Chaplin, G., and Spitzer, P.M. **Effects of nutrient enrichment and grazing on shoalgrass *Halodule wrightii* and its epiphytes: results of a field experiment.** *Marine Ecology Progress Series* 326: 145-156, 2006.

Notes: We assessed the individual and combined effects of removing large predators and enriching water column nutrients on shoalgrass *Halodule wrightii* meadows in Big Lagoon, Florida, USA. To simulate the first-order effects of large predator reductions, we stocked 2.0 m^2 enclosures with elevated (~ 3 to 4x ambient) densities of the omnivorous pinfish *Lagodon rhomboides*, the dominant fish in local seagrass habitats, and we supplemented N and P in the water column to nearly 3x ambient levels. Monthly determinations of water column nutrients and chlorophyll *a* (chl *a*), coupled with bimonthly measurements of leaf epiphyte biomass, seagrass growth and biomass, and beginning and ending comparisons of mesograzer abundance, were used to evaluate the effects of increasing nutrient supply and changing food web structure. Results showed significant predator and nutrient effects, although there were fewer consumer effects and more negative nutrient effects on seagrasses than in our previous experiments, which had shown that mesograzers ameliorated the harmful effects of elevated nutrients on seagrasses. Epiphyte proliferation in enrichment treatments did not occur; thus, algal overgrowth could not explain the negative effects of nutrient loading on seagrass biomass. Instead, nutrient loading resulted in nitrogen-rich shoalgrass, and it appears that this high-quality food stimulated pinfish herbivory. Elevated pinfish consumption of the enriched shoalgrass then resulted in the decline of seagrass biomass in enrichment enclosures. These results add additional complexity to understanding and predicting the effects of eutrophication in coastal waters.

Barnes, D.K.A. and Conlan, K.E. **Disturbance, colonization and development of Antarctic benthic communities.** *Philosophical Transactions of the Royal Society of London [B]* 362(1477): 11-38, 2007.

Notes: A decade has yielded much progress in understanding polar disturbance and community recovery - mainly through quantifying ice scour rates, other disturbance levels, larval abundance and diversity, colonization rates and response of benthos to predicted climate change. The continental shelf around Antarctica is clearly subject to massive disturbance, but remarkably across so many scales. In summer, millions of icebergs from sizes smaller than cars to larger than countries ground out and gouge the sea floor and crush the benthic communities there, while the highest wind speeds create the highest waves to pound the coast. In winter, the calm associated with the sea surface freezing creates the clearest marine water in the world. But in

winter, an ice foot encases coastal life and anchor ice rips benthos from the sea floor. Over tens and hundreds of thousands of years, glaciations have done the same on continental scales-ice sheets have bulldozed the seabed and the zoobenthos to edge of shelves. We detail and rank modern disturbance levels (from most to least): ice; asteroid impacts; sediment instability; wind/wave action; pollution; UV irradiation; volcanism; trawling; non-indigenous species; freshwater inundation; and temperature stress. Benthic organisms have had to recolonize local scourings and continental shelves repeatedly, yet a decade of studies have demonstrated that they have (compared with lower latitudes) slow tempos of reproduction, colonization and growth. Despite massive disturbance levels and slow recolonization potential, the Antarctic shelf has a much richer fauna than would be expected for its area. Now, West Antarctica is among the fastest warming regions and its organisms face new rapid changes. In the next century, temperature stress and non-indigenous species will drastically rise to become dominant disturbances to the Antarctic life. Here, we describe the potential for benthic organisms to respond to disturbance, focusing particularly on what we know now that we did not a decade ago.

Brandt, A., De Broyer, C., DeMesel, I., Ellingsen, K.E., Gooday, A.J., Hilbig, B., Linse, K., Thomson, M.R.A., and Tyler, P.A. **The biodiversity of the deep Southern Ocean benthos.** *Philosophical Transactions of the Royal Society of London [B]* 362(1477): 39-66, 2007.

Notes: Our knowledge of the biodiversity of the Southern Ocean (SO) deep benthos is scarce. In this review, we describe the general biodiversity patterns of meio-, macro- and megafaunal taxa, based on historical and recent expeditions, and against the background of the geological events and phylogenetic relationships that have influenced the biodiversity and evolution of the investigated taxa. The relationship of the fauna to environmental parameters, such as water depth, sediment type, food availability and carbonate solubility, as well as species interrelationships, probably have shaped present-day biodiversity patterns as much as evolution. However, different taxa exhibit different large-scale biodiversity and biogeographic patterns. Moreover, there is rarely any clear relationship of biodiversity pattern with depth, latitude or environmental parameters, such as sediment composition or grain size. Similarities and differences between the SO biodiversity and biodiversity of global oceans are outlined. The high percentage (often more than 90%) of new species in almost all taxa, as well as the high degree of endemism of many groups, may reflect undersampling of the area, and it is likely to decrease as more information is gathered about SO deep-sea biodiversity by future expeditions. Indeed, among certain taxa such as the Foraminifera, close links at the species level are already apparent between deep Weddell Sea faunas and those from similar depths in the North Atlantic and Arctic. With regard to the vertical zonation from the shelf edge into deep water, biodiversity patterns among some taxa in the SO might differ from those in other deep-sea areas, due to the deep Antarctic shelf and the evolution of eurybathy in many species, as well as to deep-water production that can fuel the SO deep sea with freshly produced organic matter derived not only from phytoplankton, but also from ice algae.

Ducklow, H.W., Baker, K., Martinson, D.G., Quetin, L.B., Ross, R.M., Smith, R.C., Stammerjohn, S. E., Vernet, M., and Fraser, W. **Marine pelagic ecosystems: The West Antarctic Peninsula.** *Philosophical Transactions of the Royal Society of London [B]* 362(1477): 67-94, 2007.

Notes: The marine ecosystem of the West Antarctic Peninsula (WAP) extends from the Bellingshausen Sea to the northern tip of the peninsula and from the mostly glaciated coast across the continental shelf to the shelf break in the west. The glacially sculpted coastline along the peninsula is highly convoluted and characterized by deep embayments that are often interconnected by channels that facilitate transport of heat and nutrients into the shelf domain. The ecosystem is divided into three subregions, the continental slope, shelf and coastal regions, each with unique ocean dynamics, water mass and biological distributions. The WAP shelf lies within the Antarctic Sea Ice Zone (SIZ) and like other SIZs, the WAP system is very productive, supporting large stocks of marine mammals, birds and the Antarctic krill, *Euphausia superba*. Ecosystem dynamics is dominated by the seasonal and interannual variation in sea ice extent and retreat. The Antarctic Peninsula is one among the most rapidly warming regions on Earth, having experienced a 2ºC increase in the annual mean temperature and a 6ºC rise in the mean winter temperature since 1950. Delivery of heat from the Antarctic Circumpolar Current has increased significantly in the past decade, sufficient to drive to a 0.6ºC warming of the upper 300 m of shelf water. In the past 50 years and continuing in the twenty-first century, the warm, moist maritime climate of the northern WAP has been migrating south, displacing the once dominant cold, dry continental Antarctic climate and causing multi-level responses in the marine ecosystem. Ecosystem responses to the regional warming include increased heat transport, decreased sea ice extent and duration, local declines in ice-dependent Adelie penguins, increase in ice-tolerant gentoo and chinstrap penguins, alterations in phytoplankton and zooplankton community composition and changes in krill recruitment, abundance and availability to

predators. The climate/ecological gradients extending along the WAP and the presence of monitoring systems, field stations and long-term research programmes make the region an invaluable observatory of climate change and marine ecosystem response.

Smith, W.O., Ainley, D.G., and Cattaneovietti, R. **Trophic interactions within the Ross Sea continental shelf ecosystem.** *Philosophical Transactions of the Royal Society of London [B]* 362(1477): 95-111, 2007.

Notes: The continental shelf of the Ross Sea is one of the Antarctic's most intensively studied regions. We review the available data on the region's physical characteristics (currents and ice concentrations) and their spatial variations, as well as components of the neritic food web, including lower and middle levels (phytoplankton, zooplankton, krill, fishes), the upper trophic levels (seals, penguins, pelagic birds, whales) and benthic fauna. A hypothetical food web is presented. Biotic interactions, such as the role of *Euphausia crystallorophias* and *Pleuragramma antarcticum* as grazers of lower levels and food for higher trophic levels, are suggested as being critical. The neritic food web contrasts dramatically with others in the Antarctic that appear to be structured around the keystone species *Euphausia superba*. Similarly, we suggest that benthic-pelagic coupling is stronger in the Ross Sea than in most other Antarctic regions. We also highlight many of the unknowns within the food web, and discuss the impacts of a changing Ross Sea habitat on the ecosystem.

Murphy, E.J., Watkins, J.L., Trathan, P.N., Reid, K., Meredith, M.P., Thorpe, S.E., Johnston, N.M., Clarke, A., Tarling, G.A., Collins, M.A., Forcada, J., Shreeve, R.S., Atkinson, A., Korb, R., Whitehouse, M.J., Ward, P., Rodhouse, P.G., Enderlein, P., Hirst, A.G., Martin, A.R., Hill, S.L., Staniland, I.J., Pond, D.W., Briggs, D.R., Cunningham, N.J., and Fleming, A.H. **Spatial and temporal operation of the Scotia Sea ecosystem: a review of large-scale links in a krill centred food web.** *Philosophical Transactions of the Royal Society of London [B]* 362(1477): 113-148, 2007.

Notes: The Scotia Sea ecosystem is a major component of the circumpolar Southern Ocean system, where productivity and predator demand for prey are high. The eastward-flowing Antarctic Circumpolar Current (ACC) and waters from the Weddell-Scotia Confluence dominate the physics of the Scotia Sea, leading to a strong advective flow, intense eddy activity and mixing. There is also strong seasonality, manifest by the changing irradiance and sea ice cover, which leads to shorter summers in the south. Summer phytoplankton blooms, which at times can cover an area of more than 0.5 million km^2, probably result from the mixing of micronutrients into surface waters through the flow of the ACC over the Scotia Arc. This production is consumed by a range of species including Antarctic krill, which are the major prey item of large seabird and marine mammal populations. The flow of the ACC is steered north by the Scotia Arc, pushing polar water to lower latitudes, carrying with it krill during spring and summer, which subsidize food webs around South Georgia and the northern Scotia Arc. There is also marked interannual variability in winter sea ice distribution and sea surface temperatures that is linked to southern hemisphere-scale climate processes such as the El Nino-Southern Oscillation. This variation affects regional primary and secondary production and influences biogeochemical cycles. It also affects krill population dynamics and dispersal, which in turn impacts higher trophic level predator foraging, breeding performance and population dynamics. The ecosystem has also been highly perturbed as a result of harvesting over the last two centuries and significant ecological changes have also occurred in response to rapid regional warming during the second half of the twentieth century. This combination of historical perturbation and rapid regional change highlights that the Scotia Sea ecosystem is likely to show significant change over the next two to three decades, which may result in major ecological shifts.
