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Marine Science Review – 200

Ecosystems and habitats

SeaWeb
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In this review:

A. Recent articles – no abstract available

Sheaves, M., Baker, R., and Johnston, R. **Marine nurseries and effective juvenile habitats: an alternative view.** *Marine Ecology Progress Series* 318: 303-306, 2006.

B. Recent publications available online

Nellemann, C. and Corcoran, E. (eds). 2006. **Our Precious Coasts – Marine Pollution, Cimate Change and the Resilience of Coastal Ecosystems**. United Nations Environment Programme, GRID-Arendal, Norway. 38pp.

Available at: http://www.grida.no/

Notes: At the current rate of growth, coastal development may impact up to 90% of tropical and temperate coastlines by 2032 if development continues unchecked. While progress has been made to reduce the discharge and impacts of oil spills and persistent organic pollutants (POPs), there now needs to be a focus on the largest current threats to the coastal marine environment : untreated sewage and piecemeal coastal development. Over 90% of all the world's coral reefs are found in the Indo-Pacific region of Asia, but also found here are some of the largest increases and levels of emissions of untreated sewage discharge and coastal marine pollution and development. A drastic increase in the appropriate integrated management of coastlines particularly near marine protected areas is urgently needed. Furthermore, an increase in enforcement and extent of protected coastlines is urgently needed to secure the future diversity and recovery of coral reefs from climate change. Such combined joint protected areas may form source-"islands" or coral "treasure vaults" for re-colonization of damaged areas. Furthermore, the combined cumulative effects of coastal overfishing, marine pollution and coastal development may impact the long-term productivity of the coastal zone. This, in turn, may lower the capacity of these systems to support human livelihoods in the long-term. This challenge requires effective integrated land-use planning including fisheries, tourism and costal infrastructure development, as well as proper watershed management further inland.

De Groot, R.S., Stuip, M.A.M., Finlayson, C.M. and Davidson, N. 2006. **Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services.** Ramsar Technical Report No. 3/CBD Technical Series No. 27. Ramsar Convention Secretariat, Gland, Switzerland & Secretariat of the Convention on Biological Diversity, Montreal, Canada. 45pp.

Available at: http://www.biodiv.org/doc/publications/cbd-ts-27.pdf

Notes: This report outlines a framework which should assist readers to conduct an integrated assessment of wetland ecosystem services, and it sets out five key steps in undertaking a wetland valuation assessment. These are: Step 1: Analysis of policy processes and management objectives *(why undertake the valuation?)*. Step 2: Stakeholder analysis and involvement *(who should do the valuation, and for whom?)*. Step 3: Function analysis (identification & quantification of services) *(what should be valued?)*.

Step 4: Valuation of services *(how to undertake the valuation?)*. Step 5: Communicating wetland values *(to whom to provide the assessment results?)*. Subsequent sections provide more detailed guidance on undertaking each of these steps and the available methods for their application. This guidance is supplemented by case studies from around the world of where different aspects of wetland valuation have supported decision-making, and by sources of further information on wetland valuation. More and better information on the socio-cultural and economic benefits of ecosystem services is needed to:

i) demonstrate the contribution of wetlands to the local, national and global economy (and thus build local and political support for their conservation and sustainable use);
ii) convince decision-makers that the benefits of conservation and sustainable use of wetlands usually outweigh the costs and explain the need to better factor wetlands into development planning (through more balanced cost-benefit analysis);
iii) identify the users and beneficiaries of wetland services to attract investments and secure sustainable financial streams and incentives for the maintenance, or restoration, of these services (i.e., make users pay and ensure that local people receive a proper share of the benefits); and
iv) increase awareness about the many benefits of wetlands to human well-being and ensure that wetlands are better taken into account in economic welfare indicators (e.g., in Gross National Product (GNP) calculations) and pricing mechanisms (through internalization of externalities).

C. Recent articles with abstracts

Laegdsgaard, P. **Ecology, disturbance and restoration of coastal saltmarsh in Australia: a review.** *Wetlands Ecology and Management* 14(5): 379-399, 2006.

Notes: It is clear that saltmarshes are a unique and important component of the coastal biosphere of Australia. Their contribution ranges from stabilisation of fine sediments and providing an excellent protective buffer between land and sea, to their diverse blend of terrestrial and marine fauna. Further, saltmarsh plants are highly specialised and adapted to fill a harsh niche allowing them to act in roles that other vegetation types cannot. Saltmarsh habitats are recognised for their importance to migratory waders under the Ramsar convention, but it is becoming increasingly evident that they are also important to a variety of commercially valuable fish and native mammal species. Activities that are detrimental to saltmarshes continue and need to be addressed in order to conserve remaining saltmarsh areas. In general, urbanisation of the catchment has lead to filling of saltmarshes, tidal restriction, use by recreational vehicles, grazing, trampling and increased sedimentation and nutrient runnoff allowing colonisation and invasion of mangroves. These disturbances have a number of ecological consequences ranging from weed infestation to complete changes in the species composition and ecology. Reversing the disturbance is not always simple and can require extensive groundwork to be successful. Rehabilitation of existing saltmarsh areas has been a successful means to enhance this habitat. In general, it requires relatively little effort to remove weeds and fence off areas to regenerate naturally. Saltmarsh areas have been shown to respond well to this type of manipulation. Restoration and creation require substantial effort and planning to ensure a successful outcome. However, given the right environmental combinations of elevation, tide and salinity, saltmarsh will establish and grow. To speed the process transplantation of saltmarsh plants can be considered either from donor sites or plants propagated in green houses.

Törnqvist, T.E., Bick, S.J., van der Borg, K., and de Jong, A.F.M. **How stable is the Mississippi Delta?** *Geology* 34(8): 697-700, 2006.

Notes: Large deltas are commonly believed to exhibit rapid rates of tectonic subsidence, largely due to sediment loading of the lithosphere. As a result, deltaic plains are prone to accelerated relative sea-level rise, coastal erosion, and wetland loss. Hurricane Katrina's devastation testifies to the severe threat that these processes pose to the Mississippi Delta, but the relative role of tectonics versus other mechanisms causing land subsidence remains elusive. Relative sea-level records derived from basal peat have the potential to quantify differential crustal movements over Holocene time scales with exceptionally high accuracy and precision. Here we present new sea-level index points from two study areas in the southwestern Mississippi Delta that essentially coincide with a recently published detailed relative sea-level record from the eastern part of the delta. Our results show that differential vertical movements among the three study areas have been only 0.1 mm yr-1. We compare our evidence with a recent sea-level compilation from the Caribbean, to a large extent based on data from areas that are tectonically stable. Our sea-level index points nearly coincide with the Caribbean data, showing surprising tectonic stability for considerable sections of the Mississippi Delta. However, the well-documented high subsidence rates in and near the birdfoot

of the Mississippi Delta indicate that different conditions prevail there. The rapid wetland loss in coastal Louisiana is likely due, to a considerable extent, to the compaction of Holocene strata.

Greenberg, R., Maldonado, J.E., Droege, S., and McDonald, M.V. **Tidal marshes: A global perspective on the evolution and conservation of their terrestrial vertebrates.** *BioScience* 56(8): 675-685, 2006.

Notes: Globally, tidal marshes are found in small pockets or narrow bands totaling only approximately 45,000 square kilometers. The combination of salinity, low floristic and structural complexity, and regular tidal inundation, as well as unpredictable catastrophic flooding, provides a unique selective environment that shapes local adaptations, including those that are morphological, physiological, demographic, and behavioral. Although tidal marshes support a low diversity of nonaquatic vertebrate species, a high proportion of these inhabitants, at least along North American coastlines, are restricted to or have subspecies restricted to tidal marshes. Tidal marshes and their endemic fauna face broad threats from a variety of human-caused environmental changes. Future research should focus on global inventories, intercontinental comparative work, and investigation to determine why almost all presently described endemic taxa appear to be found in North America.

Vermaat, J.E. and Thampanya, U. **Mangroves mitigate tsunami damage: A further response.** *Estuarine, Coastal and Shelf Science* 69(1-2): 1-3, 2006.

Notes: This is a contribution to the discussion on the potential mitigating effect of mangroves to tsunami damage. Kathiresan and Rajendran (2005) were criticised by Kerr et al. (2006). We re-analysed of the original data with an ANOVA-model with covariates. We conclude: (a) the original conclusion of Kathiresan and Rajendran (2005) holds, mortality and property loss were less behind mangroves, and literature suggests that this can be generalised beyond the investigated area; (b) relocation of human settlements 1 km inland is not practical, instead a combination of societal preparedness with early warning and disaster response systems is to be preferred. Furthermore, we deduce that mortality was most strongly, and significantly reduced with increasing elevation above mean sea level, whereas property loss was governed by distance to the shore. This could improve coastal risk assessments.

Lee, S.Y., Dunn, R.J.K., Young, R.A., Connolly, R.M., Dale, P.E.R., Dehayr, R., Lemckert, C.J., McKinnon, S., Powell, B., Teasdale, P.R., and Welsh, D.T. **Impact of urbanization on coastal wetland structure and function.** *Austral Ecology* 31(2): 149-163, 2006.

Notes: Urbanization is a major cause of loss of coastal wetlands. Urbanization also exerts significant influences on the structure and function of coastal wetlands, mainly through modifying the hydrological and sedimentation regimes, and the dynamics of nutrients and chemical pollutants. Natural coastal wetlands are characterized by a hydrological regime comprising concentrated flow to estuarine and coastal areas during flood events, and diffused discharge into groundwater and waterways during the non-flood periods. Urbanization, through increasing the amount of impervious areas in the catchment, results in a replacement of this regime by concentrating rain run-off. Quality of run-off is also modified in urban areas, as loadings of sediment, nutrients and pollutants are increased in urban areas. While the effects of such modifications on the biota and the physical environment have been relatively well studied, there is to date little information on their impact at the ecosystem level. Methodological issues, such as a lack of sufficient replication at the whole-habitat level, the lack of suitable indices of urbanization and tools for assessing hydrological connectivity, have to be overcome to allow the effects of urbanization to be assessed at the ecosystem level. A functional model is presented to demonstrate the impact of urbanization on coastal wetland structure and function.

Hilton, M.J. **The loss of New Zealand's active dunes and the spread of marram grass (*Ammophila arenaria*).** *New Zealand Geographer* 62(2): 105-120, 2006.

Notes: This article examines the decline of New Zealand's active dunes in relation to the introduction of marram grass (*Ammophila arenaria*). The area of active dunes in New Zealand declined from 129 000 ha in the early 1900s to about 39 000 ha

in 2000; a reduction of 70%. The extent of active dunes has declined since the 1950s in all regions, particularly in Northland, Auckland and the Manawatu. The loss of active dunes on the west coast of the North Island resulted primarily from the introduction of marram grass, followed by the establishment of *Pinus radiata* plantations and extensive pastoral farming. Between 1985 and 2005 marram grass extended its range to the detriment of the indigenous foredune flora. Conservation and resource management agencies should urgently identify dune systems for conservation management and marram grass eradication.

Byers, J.E., Cuddington, K., Jones, C.G., Talley, T.S., Hastings, A., Lambrinos, J.G., Crooks, J.A., and Wilson, W.G. **Using ecosystem engineers to restore ecological systems.** *Trends in Ecology and Evolution* 21(9): 493-500, 2006.

Notes: Ecosystem engineers affect other organisms by creating, modifying, maintaining or destroying habitats. Despite widespread recognition of these often important effects, the ecosystem engineering concept has yet to be widely used in ecological applications. Here, we present a conceptual framework that shows how consideration of ecosystem engineers can be used to assess the likelihood of restoration of a system to a desired state, the type of changes necessary for successful restoration and how restoration efforts can be most effectively partitioned between direct human intervention and natural ecosystem engineers.

Hayek, L.A.C. and Buzas, M.A. **The martyrdom of St. Lucie: Decimation of a meiofauna.** *Bulletin of Marine Science* 79(2): 341-352, 2006.

Notes: St. Lucie, the southernmost inlet of the Indian River Lagoon, Florida, is affected by a variety of stresses including dumping from Lake Okeechobee, the second-largest freshwater lake in the U.S., through a system of canals. Foraminifera, a major component of the meiofauna, are utilized as a source of nutrition by a large assortment of deposit feeders in this area. Just as pollutants, spills, and organic enrichment are obvious sublethal effects of estuarine health, so too is the disappearance of organisms constituting essential links in the food web. Because the meiofauna is at the base of the food web, the consequences of major declines and local extinctions clearly are indicators of serious damage to the health of the entire ecosystem. To establish a baseline, foraminiferal density, species richness, evenness, and community structure were examined in 1975/1976. Thirty years later in 2005, the same area was re-sampled. In 1975/1976 the mean density was 280 per 20 ml of sediment. In 2005, we observed a mean of 46 per 20 ml, a decline of 83%. In 1975/1976, we observed 62 species while in 2005 we observed 13, a decline of 79%. The most abundant species constituted 42% of the fauna in 1975/1976; by 2005 it had risen to 76%, a dramatic increase in dominance. Based upon our newly-developed three-stage evaluation system of ecosystem decline over time, we find that the St. Lucie area is nearing, if not at, the beginning of Stage 3 (local extinction).

Gopal, B. and Chauhan, M. **Biodiversity and its conservation in the Sundarban Mangrove Ecosystem.** *Aquatic Sciences* 68(3): 338-354, 2006.

Notes: The Sundarban, covering about one million ha in the delta of the rivers Ganga, Brahmaputra and Meghna is shared between Bangladesh (~60%) and India (~40%), and is the world's largest coastal wetland. The area experiences a subtropical monsoonal climate with an annual rainfall of 1,600-1,800 mm and severe cyclonic storms. Enormous amounts of sediments carried by the rivers contribute to its expansion and dynamics. Salinity gradients change over a wide range of spatial and temporal scales. The biodiversity includes about 350 species of vascular plants, 250 fishes and 300 birds, besides numerous species of phytoplankton, fungi, bacteria, zooplankton, benthic invertebrates, molluscs, reptiles, amphibians and mammals. Species composition and community structure vary east to west, and along the hydrological and salinity gradients. Sundarban is the habitat of many rare and endangered animals (*Batagur baska*, *Pelochelys bibroni*, *Chelonia mydas*), especially the Royal Bengal tiger (*Panthera tigris*). Javan rhino, wild buffalo, hog deer, and barking deer are now extinct from the area. Large areas of the Sundarban mangroves have been converted into paddy fields over the past two centuries, and more recently into shrimp farms. The Sundarban has been extensively exploited for timber, fish, prawns and fodder. The regulation of river flows by a series of dams, barrages and embankments for diverting water upstream for various human needs and for flood control has caused large reduction in freshwater inflow and seriously affected the biodiversity because of an increase in salinity and changes in sedimentation. *Heritiera fomes* (locally called Sundari, from which Sundarban derives its name), *Nypa fruticans* and *Phoenix paludosa* are declining rapidly. During the past three decades, large parts of the remaining Sundarban have been

protected for wildlife, particularly tiger, through the creation of several sanctuaries and a biosphere reserve. Parts of the Sundarban in both India and Bangladesh have been declared World Heritage sites. However, its biodiversity continues to be threatened by a growing human population that not only places pressure on its biological resources, but also impacts on the freshwater inflows from upstream areas. Oil exploration in coastal areas is also emerging as a new threat. Further threats arise from global climate change, especially sea level rise. The future of the Sundarban will depend upon the management of freshwater resources as much as on the conservation of its biological resources.

Canals, M., Puig, P., de Madron, X.D., Heussner, S., Palanques, A., and Fabres, J. **Flushing submarine canyons.** *Nature* 444(7117): 354-357, 2006.

Notes: The continental slope is a steep, narrow fringe separating the coastal zone from the deep ocean. During low sea-level stands, slides and dense, sediment-laden flows erode the outer continental shelf and the continental slope, leading to the formation of submarine canyons that funnel large volumes of sediment and organic matter from shallow regions to the deep ocean. During high sea-level stands, such as at present, these canyons still experience occasional sediment gravity flows, which are usually thought to be triggered by sediment failure or river flooding. Here we present observations from a submarine canyon on the Gulf of Lions margin, in the northwest Mediterranean Sea, that demonstrate that these flows can also be triggered by dense shelf water cascading (DSWC) - a type of current that is driven solely by seawater density contrast. Our results show that DSWC can transport large amounts of water and sediment, reshape submarine canyon floors and rapidly affect the deep-sea environment. This cascading is seasonal, resulting from the formation of dense water by cooling and/or evaporation, and occurs on both high- and low-latitude continental margins. DSWC may therefore transport large amounts of sediment and organic matter to the deep ocean. Furthermore, changes in the frequency and intensity of DSWC driven by future climate change may have a significant impact on the supply of organic matter to deep-sea ecosystems and on the amount of carbon stored on continental margins and in ocean basins.

Kraufvelin, P., Moy, F.E., Christie, H., and Bokn, T.L. **Nutrient addition to experimental rocky shore communities revisited: Delayed responses, rapid recovery.** *Ecosystems* 9(7): 1076-1093, 2006.

Notes: Coastal eutrophication may alter the dominance patterns of marine macroalgae, with potential consequences for the associated fauna and the entire ecosystem. Benthic macroalgae and animals in control and nutrient-enriched mesocosms were monitored to investigate eutrophication-induced changes in rocky shore communities. During a 3-year project, nutrient addition had only minor effects on the community structure, such as increased cover and biomass of green *Ulva* spp. and increased abundance of certain animal species at high nutrient levels. This study is a 4-year extension of a previously reported project, with 2 extra years of effect studies (altogether 5 years) and a subsequent 2 years for recovery. During the 4th year of nutrient enrichment, the cover of *Fucus vesiculosus* and *Fucus serratus* started to decline. In the 5th year, these canopy species crashed and there was an evident take-over by green algae at high nutrient addition levels. The previously observed abundance stimulation for fauna disappeared later in the time series, probably due to the loss of the macroalgal canopy. After less than 2 years on regular seawater, the algal and animal communities had returned to within the range of normal variability. The results indicate that established rocky shore communities of perennial algae with associated fauna are able to persist for several years, even at very high nutrient levels, but that community shifts may suddenly occur if eutrophication continues. They also indicate that rocky shore communities have the ability to return rapidly to natural undisturbed conditions after the termination of nutrient enhancement.

Costanza, R., Mitsch, W.J., and Day, J.W. **A new vision for New Orleans and the Mississippi delta: applying ecological economics and ecological engineering.** *Frontiers in Ecology and Environment* 4(9): 465-472, 2006.

Notes: The restoration of New Orleans and the rest of the Mississippi delta after Hurricane Katrina can become another disaster waiting to happen, or it can become a model of sustainable development. Sea level is rising, precipitation patterns are changing, hurricane intensity is increasing, energy costs are predicted to soar, and the city is continuing to sink. Most of New Orleans is currently from 0.6 to 5 m (2-15 feet) below sea level. The conventional approach of simply rebuilding the levees and the city behind them will only delay the inevitable. If New Orleans, and the delta in which it is located, can develop and pursue a new paradigm, it could be a truly unique, sustainable, and desirable city, and an inspiration to people around the world. This

paper discusses the underlying causes and implications of the Katrina disaster, basic goals for a sustainable redevelopment initiative, and seven principles necessary for a sustainable vision for the future of New Orleans and the Mississippi delta.

Breitburg, D.L. and Fulford, R.S. **Oyster-sea nettle interdependence and altered control within the Chesapeake Bay ecosystem.** *Estuaries and Coasts* 29(5): 776-784, 2006.

Notes: Research on the effects of declining abundances of the Eastern oyster (*Crassostrea virginica*) in Chesapeake Bay and other estuaries has primarily focused on the role of oysters in filtration and nutrient dynamics, and as habitat for fish or fish prey. Oysters also play a key role in providing substrate for the overwintering polyp stage of the scyphomedusa sea nettle, *Chrysaora quinquecirrha*, which is an important consumer of zooplankton, ctenophores, and icthyoplankton. Temporal trends in sea nettle abundances in visual counts from the dock at Chesapeake Biological Laboratory, trawls conducted in the mesohaline portion of the Patuxent River, and published data from the mainstem Chesapeake Bay indicate that sea nettles declined in the mid 1980s when overfishing and increased disease mortality led to sharp decreases in oyster landings and abundance. Climate trends, previously associated with interannual variation in sea nettle abundances, do not explain the sharp decline. A potentially important consequence of declining sea nettle abundances may be an increase in their ctenophore prey (*Mnemiopsis leidyi*), and a resultant increase in predation on icthyoplankton and oyster larvae. Increased predation on oyster larvae by ctenophores may inhibit recovery of oyster populations and reinforce the current low abundance of oysters in Chesapeake Bay.

Ricketts, P. and Harrison, P. **Coastal and ocean management in Canada: Moving into the 21st century.** *Coastal Management* 35(1): 5-22, 2007.

Notes: In the years since the first Canadian Special Issue of the then Coastal Zone Management Journal in 1983, the development of Integrated Coastal and Ocean Management in Canada has moved at speeds ranging from glacial to hectic. This article presents an overview of this development, and attempts to tie together the various articles in this Special Issue of the Coastal Management Journal. With the passage of the Canada Oceans Act in 1997, the initiation of an Oceans Strategy in 2002, and the development of Phase I of the Oceans Action Plan in 2005, Canada has finally begun to move into the 21st century with a coherent plan for Integrated Coastal and Ocean Management. Furthermore, with its ocean-to-shore perspective on Integrated Management for Large Ocean Management Areas, Canada has an opportunity to take a leading global role in the implementation of a truly integrated, multistakeholder management strategy.

Billett, D.S.M., Bett, B.J., Jacobs, C.L., Rouse, I.P., and Wigham, B.D. **Mass deposition of jellyfish in the deep Arabian Sea.** *Limnology and Oceanography* 51(5): 2077-2083, 2006.

Notes: In December 2002, large numbers of dead jellyfish, *Crambionella orsini*, were observed on the seabed over a wide area of the Arabian Sea off the coast of Oman at depths between 300 m and 3,300 m. Moribund jellyfish were seen tumbling down the continental slope. Large aggregations of dead jellyfish were evident within canyons and on the continental rise. At the deepest stations, patches of rotting, coagulated jellyfish occurred. The patches were several meters in diameter, at least 7-cm thick, and covered about 17% of the sediment surface. At other locations on the continental rise the seafloor was covered in a thin, almost continuous, layer of jelly "slime" a few millimeters thick or was littered with individual jellyfish corpses. Photographic transects were used to estimate the amount of carbon associated with the jelly detritus. The standing stock of carbon (C) varied between 1.5 g C m^{-2} and 78 g C m^{-2}, the higher figure exceeding the annual downward flux of organic carbon, as measured by sediment traps, by more than an order of magnitude. The episodic nature of jellyfish blooms, which may be modulated by global change phenomena, provides a hitherto unknown mechanism for large-scale spatial and temporal patchiness in deep-sea benthic ecosystems.

Schiel, D.R., Wood, S.A., Dunmore, R.A., and Taylor, D.I. **Sediment on rocky intertidal reefs: Effects on early post-settlement stages of habitat-forming seaweeds.** *Journal of Experimental Marine Biology and Ecology* 331(2): 158-172, 2006.

Notes: Modification of the coastal environment by human activities often leads to an increase in sedimentation of nearshore waters, with potential impacts on benthic marine assemblages. Here we assess the relationships between the levels of sedimentation, wave exposure and benthic organisms on rocky intertidal platforms around the Kaikoura Peninsula in southern New Zealand. We designed and tested five sediment traps to provide a tool for measuring the relative abundance of sediment across sites. Using field- and laboratory-based experiments, we tested hypotheses concerning whether different levels of sedimentation affected algal germling survival and algal zygote attachment, and whether the interactions of grazers and sediments affected germling survival. Levels of sediment and exposure were inversely related across seven sites. The fucoid alga *Hormosira banksii* characterized the more sedimented wave-sheltered and intermediately wave-exposed sites, with up to 80% cover in the lower mid-tidal zone, while the bull kelp *Durvillaea antarctica* characterized the three most wave-exposed sites. Grazing molluscs were found across all sites but species abundances varied by sediment and exposure levels. We did two 11-day trials testing the effects of different levels of sediment and different species of molluscan grazers on the survival of 1-week-old *Hormosira* germlings. Generally, there was no significant treatment effect of grazers, but mortality varied considerably among sites. In particular, one site had very high levels of sediment, which resulted in 100% mortality of germlings across all grazer treatments. Removing sediment at 1-week, 2-week and 4-week intervals made no difference to the survival of *Hormosira* germlings. In laboratory-based experiments, a light dusting of sediment reduced the percentage of zygotes of *Hormosira* by 34% and *Durvillaea* by 71% that attached to primary substratum, and a complete cover of sediment prevented attachment altogether. Overall, the effects of sediments and its interaction with molluscan grazing were highly variable but often large, particularly on the attachment of zygotes to primary substratum.

Schiel, D.R. **Rivets or bolts? When single species count in the function of temperate rocky reef communities.** *Journal of Experimental Marine Biology and Ecology* 338(2): 233-252, 2006.

Notes: There is considerable controversy about the role of individual species in ecosystem functioning. Most models stress the role of species richness and diversity in ecosystem function, but it is also recognised that individual species or functionally similar species can play prominent roles in assessments of function. There have been relatively few tests of functional replacement by similar species in the marine environment. On intertidal reef platforms in southern New Zealand, six species of fucoid algae co-occur. Two of these, *Cystophora torulosa* and *Hormosira banksii*, have extensive cover in the mid-tidal zone. These species were removed from their areas of dominance in the mid-tidal zone at two sites and followed for several years to determine how resilient they are to disturbance, what processes determine functional recovery, the role of the dominant grazer, the gastropod *Turbo smaragdus*, in the recovery process, and whether there is functional replacement of species. In the *C. torulosa* removal experiment, *H. banksii* recruited rapidly into removal treatments within the first year at one site, but this took a year longer at the other site. A press removal of *C. torulosa* developed almost 100% cover of *H. banksii* after 3 years, but only at one site. In the pulse treatment, there was a mixed stand of the two species after 3-4 years. In the *H. banksii* removal experiment, there was no functional replacement by other species. The rate of recovery for *H. banksii* was variable. Bare space increased following canopy removal, particularly on the higher shore treatment at one site, because of the burn-off of newly exposed turfing coralline algae, which had not fully recovered by the end of the experiment. After 10 months, there were 20-40% fewer species in the removal plots in both experiments than in controls. *T. smaragdus* grazing had great effects on ephemeral algae, but not on the fucoids. The conclusion is that these fucoid species have no functional equivalents in their areas of dominance. They are the autogenic engineers or foundation species on which most other species in their communities rely. There is little buffering overall in these mid-shore zones should these species be lost or severely reduced in abundance. They are, therefore, key species in the function of the intertidal system and must be understood if the functioning of these areas is to be managed effectively. These results are discussed in the spirit of this festschrift for AJ Underwood.

Palacios, D.M., Bograd, S.J., Foley, D.G., and Schwing, F.B. **Oceanographic characteristics of biological hot spots in the North Pacific: A remote sensing perspective.** *Deep Sea Research Part II, Topical Studies in Oceanography* 53(3-4): 250-269, 2006.

Notes: Biological hot spots in the ocean are likely created by physical processes and have distinct oceanographic signatures. Marine predators, including large pelagic fish, marine mammals, seabirds, and fishing vessels, recognize that prey organisms congregate at ocean fronts, eddies, and other physical features. Here we use remote sensing observations from multiple satellite platforms to characterize physical oceanographic processes in four regions of the North Pacific Ocean that are recognized as biological hot spots. We use data from the central North Pacific, the northeastern tropical Pacific, the California Current System, and the Galapagos Islands to identify and quantify dynamic features in terms of spatial scale, degree of persistence or recurrence, forcing mechanism, and biological impact. The dominant timescales of these processes vary from

interannual (Rossby wave interactions in the central North Pacific) to annual (spring-summer intensification of alongshore winds in the California Current System; winter wind outflow events through mountain gaps into the northeastern tropical Pacific), to intraseasonal (high-frequency equatorial waves at the Galapagos). Satellite oceanographic monitoring, combined with data from large-scale electronic tagging experiments, can be used to conduct a census of biological hot spots, to understand behavioral changes and species interactions within hot spots, and to differentiate the preferred pelagic habitats of different species. The identification and monitoring of biological hot spots could constitute an effective approach to marine conservation and resource management.

Reese, D.C. and Brodeur, R.D. **Identifying and characterizing biological hotspots in the northern California Current.** *Deep Sea Research Part II, Topical Studies in Oceanography* 53(3-4): 291-314, 2006.

Notes: Understanding how marine animals utilize their environment and identifying important habitats are crucial for understanding how marine ecosystems function. The goal of the present study is to identify biologically rich areas within the northern California Current and to determine the environmental characteristics occurring within these areas. We analyzed how surface nekton are distributed in the northern California Current, not only in space and time but also with reference to species assemblages, habitat characteristics, and environmental factors. Sampling was conducted during June and August of 2000 and 2002 as part of the US GLOBEC mesoscale surveys from Newport, Oregon, in the north to Crescent City, California, in the south. A geostatistical approach was used to create surfaces to be used in a GIS to determine the presence or absence of biological hotspots throughout the region. Two biological hotspots were identified and determined to persist in space and time, yet differed with respect to biological and physical features and in the amount of area covered. We used indicator species analyses (ISA) and non-metric multidimensional scaling (NMS) to explore patterns in community structure. Results indicate that although the locations of the biological hotspots persisted over the course of the study, the habitat characteristics and nekton community composition within each hotspot varied over time. The most consistent environmental parameters explaining the distributions were sea-surface temperature, salinity, and density, indicating the likely structuring mechanism of the hotspots is related to the flow through the region and differing patterns of circulation.

Gende, S.M. and Sigler, M.F. **Persistence of forage fish 'hot spots' and its association with foraging Steller sea lions (*Eumetopias jubatus*) southeast Alaska.** *Deep Sea Research Part II, Topical Studies in Oceanography* 53(3-4): 432-441, 2006.

Notes: Whereas primary and secondary productivity at oceanic 'hotspots' may be a function of upwelling and temperature fronts, the aggregation of higher-order vertebrates is a function of their ability to search for and locate these areas. Thus, understanding how predators aggregate at these productive foraging areas is germane to the study of oceanic hot spots. We examined the spatial distribution of forage fish in southeast Alaska for three years to better understand Steller sea lion (*Eumetopias jubatus*) aggregations and foraging behavior. Energy densities (millions KJ/km^2) of forage fish were orders of magnitude greater during the winter months (November-February), due to the presence of schools of overwintering Pacific herring (*Clupea pallasi*). Within the winter months, herring consistently aggregated at a few areas, and these areas persisted throughout the season and among years. Thus, our study area was characterized by seasonally variable, highly abundant but highly patchily distributed forage fish hot spots. More importantly, the persistence of these forage fish hot spots was an important characteristic in determining whether foraging sea lions utilized them. Over 40% of the variation in the distribution of sea lions on our surveys was explained by the persistence of forage fish hot spots. Using a simple spatial model, we demonstrate that when the density of these hot spots is low, effort necessary to locate these spots is minimized when those spots persist through time. In contrast, under similar prey densities but lower persistence, effort increases dramatically. Thus an important characteristic of pelagic hot spots is their persistence, allowing predators to predict their locations and concentrate search efforts accordingly.

Lohrer, A.M., Hewitt, J.E., and Thrush, S.F. **Assessing far-field effects of terrigenous sediment loading in the coastal marine environment.** *Marine Ecology Progress Series* 315: 13-18, 2006.

Notes: Major rain events erode coastal catchments, and muddy plumes of terrigenous sediment can extend far offshore. Surface waters gradually clear as terrigenous sediments sink, although nearbed turbidity may remain high due to resuspension by waves and tides. This may adversely affect large suspension-feeding benthic epifauna, structurally and functionally

important organisms in coastal marine systems, by clogging their filtration structures and decreasing their feeding efficiency. While terrigenous sediment concentrations likely decrease with distance from the coast, sensitivities of suspension feeders to this stressor may increase. We tested this hypothesis using controlled additions of terrigenous sediment at estuarine and coastal sites in northern New Zealand. None of the large, solitary suspension feeders (pirmid bivalves *Atrina zelandica*, sponges *Aaptos* spp., and ascidians *Styela plicata*) were completely buried or killed by experimental deposition of terrigenous sediment. However, after living in the deposits for 3 wk, the condition of all 3 taxa declined relative to controls, and clearance rates of *A. zelandica* and *Aaptos* spp. were reduced (averaging about 40% less). *A. zelandica* outside the estuary (Site MI, coarse ambient sediment) were more sensitive to terrigenous material than *A. zelandica* inside the harbour (Site TK, fine ambient sediment), which was probably related to the greater background suspended sediment concentrations at TK to which the *A. zelandica* were accustomed. Impacts to large, structure-forming species such as *A. zelandica*, *Aaptos* spp., and *S. plicata* may eventually affect ecosystem structure and function, particularly if the frequency or magnitude of terrigenous sediment loading and resuspension increases.

Adams, A.J., Dahlgren, C.P., Kellison, G.T., Kendall, M.S., Layman, C.A., Ley, J.A., Nagelkerken, I., and Serafy, J.E. **Nursery function of tropical back-reef systems.** *Marine Ecology Progress Series* 318: 287-301, 2006.

Notes: Similar to nearshore systems in temperate latitudes, the nursery paradigm for tropical back-reef systems is that they provide a habitat for juveniles of species that subsequently make ontogenetic shifts to adult populations on coral reefs (we refer to this as the nursery function of back-reef systems). Nevertheless, we lack a full understanding of the importance of the nursery function of back-reef systems to the maintenance of coral reef fishes and invertebrate populations; the few studies that have examined the nursery function of multiple habitats indicate that the relationship between juvenile production in back-reef habitats and their subsequent contribution to adult populations on reefs remain poorly understood. In this synopsis we (1) synthesize current knowledge of life history, ecological and habitat influences on juvenile distribution patterns and nursery function within back-reef systems; (2) outline a research strategy for assessing the nursery function of various habitat types in back- reef systems; and (3) discuss management recommendations, particularly in regard to how improved knowledge of the nursery function of back-reef systems can be used in fisheries and ecosystem management, including habitat conservation and restoration decisions. The research strategy builds on research recommendations for assessing the nursery function of temperate habitats and includes 4 levels of research: (1) building conceptual models to guide research and management; (2) identifying juvenile habitat use patterns; (3) measuring connectivity of juvenile and adult populations between habitats; and (4) examining ecological processes that may influence patterns assessed in Level 2 and Level 3 research. Research and modeling output from Levels 1 to 4 will provide an improved ecological understanding of the degree and importance of interconnections between coral reef and adjacent back-reef systems, and will provide information to managers that will facilitate wise decisions pertaining to habitat conservation, habitat restoration, and ecosystem-based management, and the maintenance of sustainable fisheries.

Faunce, C.H. and Serafy, J.E. **Mangroves as fish habitat: 50 years of field studies.** *Marine Ecology Progress Series* 318: 1-18, 2006.

Notes: Mangroves dominate undisturbed natural shorelines of many sub-tropical and tropical regions, yet their utilization by fishes is poorly understood. To provide the first comprehensive list of empirical field studies for comparative and reference purposes, we assembled and quantified aspects of 111 mangrove-fish surveys published between 1955 and 2005. Differences in the location, purpose, methodology, data gathered, and analyses performed among studies have resulted in a fragmented literature making cross-study comparisons difficult, at best. Although the number of published studies has increased over time, a geographical bias in the literature has persisted towards studies performed in the USA and Australia, and against studies performed in Southeast Asia and West Africa. The typical survey design has examined < 10 fixed locations on a monthly or bimonthly basis for a period of less than 2 yr. Water temperature and salinity measurements have been the most reported habitat variables; others, such as structural and landscape measures, continue to be rare. Moreover, the focus to date has been on identifying assemblage-level patterns of fish use, with very few studies providing species-specific estimates of abundance, growth, mortality, and secondary production. Unless future studies strive towards obtaining such estimates, gauging the importance of mangroves as fish habitat and their broader contribution to ecosystem diversity and production will remain elusive.

Cattrijsse, A. and Hampel, H. **European intertidal marshes: a review of their habitat functioning and value for aquatic organisms.** *Marine Ecology Progress Series* 324: 293-307, 2006.

Notes: Salt marshes form true ecotones between land and sea fauna and flora that have adapted to an environment that is both aquatic and terrestrial in nature. Despite the extreme and sharp gradients that exist in salt marshes, they form the temporary or permanent home for many animals and plants and they fulfil many important roles in marine and estuarine ecosystems. While research on the terrestrial component of European marshes has helped in their management, knowledge of the aquatic component has largely been ignored in safeguarding the existence and ecological importance of tidal marshes. This situation is in sharp contrast with studies of coastal marshes along the eastern and southeastern coasts of North America. The typical European salt marsh differs in several physical aspects from the typical American salt marsh, but recent investigations have indicated parallels regarding nekton habitat usage. The present paper reviews the current state of European studies on the habitat role that tidal marshes play for fish and crustacean fauna. Mirrored against the more extensive American literature, we discuss where functional similarities and differences exist between both types of tidal marshes and where further knowledge is still needed for European marshes. Management of European tidal marshes would benefit from extending the current knowledge, and this paper identifies potential topics of interest.
