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Marine Science Review – 237

Coral and coral reefs

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In this review:

O/A denotes an open access article or journal

A. Recent articles – no abstract available

Fine, M. and Tchernov, D. **Scleractinian coral species survive and recover from decalcification.** *Science* 315(5820): 1811, 2007.

Wallace, C.C., Muir, P.R., and Venkatesh, M. **Post-bleaching renewal of the dominant reef-building coral *Acropora abrotanoides* in the Lakshadweep islands of India.** *Coral Reefs* 26(1): 45, 2007.

Fabricius, K.E., Golbuu, Y., and Victor, S. **Selective mortality in coastal reef organisms from an acute sedimentation event.** *Coral Reefs* 26(1): 69, 2007.

Stone, R. **A world without corals?** *Science* 316(5825): 678-681, 2007.

Liao, M.H., Tang, S.L., Hsu, C.M., Wen, K.C., Wu, H., Chen, W.M., Wang, J.T., Meng, P.J., Twan, W.H., Lu, C.K., Dai, C.F., Soong, K., and Chen, C.A. **The "black disease" of reef-building corals at Green Island, Taiwan - Outbreak of a cyanobacteriosponge, *Terpios hoshinota* (Suberitidae; Hadromerida).** *Zoological Studies* 46(4): 520, 2007. O/A

Lapointe, B.E., Bedford, B.J., Littler, M.M., and Littler, D.S. **Shifts in coral overgrowth by sponges and algae.** *Coral Reefs* 26(3): 515, 2007.

Turley, C.M., Roberts, J.M., and Guinotte, J.M. **Corals in deep-water: will the unseen hand of ocean acidification destroy cold-water ecosystems?** *Coral Reefs* 26(3): 445-448, 2007.

B. Recent publications available online

Edinger, E., Baker, K., Devillers, R. and Wareham, V. 2007. ***Coldwater Corals off Newfoundland and Labrador: Distribution and Fisheries Impacts.*** WWF, Toronto, Canada. 41pp.

Available at: http://assets.panda.org/downloads/wwf_coral_report_final.pdf

Notes: This study assesses the impact of fishing on three fragile coldwater coral "hotspots" off the Canadian province of Newfoundland and Labrador, providing the scientific basis for Canadian and European governments to protect sensitive coral habitat in the Northwest Atlantic. Based on scientific surveys by Canadian researchers, the study illustrates the distribution of corals and assesses coral bycatch (where fishing gear becomes accidentally entangled in corals) in the six most common deep-water-fisheries off Newfoundland and Labrador.

C. Recent articles with abstracts

Vollmer, S.V. and Palumbi, S.R. **Restricted gene flow in the Caribbean staghorn coral *Acropora cervicornis*: Implications for the recovery of endangered reefs.** *Journal of Heredity* 98(1): 40-50, 2007.

Notes: Coral reef conservation requires information about the distance over which healthy reefs can rescue damaged reefs through input of coral larvae. This information is desperately needed in the Caribbean where the 2 dominant shallow water corals *Acropora cervicornis* and *Acropora palmata* have suffered unprecedented declines. Here we compare the population genetic structure in the staghorn coral *A. cervicornis* across the greater Caribbean using DNA sequence data from 1 mitochondrial and 3 nuclear genes. Data from 160 individuals from 22 populations and 9 regions show that *A. cervicornis* exhibits significant population genetic structure across the greater Caribbean in both the mitochondrial (f_{st} = 0.130) and nuclear data (f(st) = 0.067). The highest population structure was observed in the species' own, native mtDNA haplotypes (f_{st} = 0.235). Introgressed alleles from *A. palmata* tempered higher population structure in *A. cervicornis* over regional scales but in some cases generated highly localized "introgression hot spots" and fine-scale genetic structure among reefs separated by as few as 2 km. These data show that larval dispersal over moderate or long distances (> 500 km) is limited for this threatened species and in some cases locally limited as well. Thus, the endangered Caribbean staghorn corals require local source populations for their recovery and targeted conservation efforts over spatial scales much smaller than the hundreds to thousands of kilometers usually proposed for marine reserves.

Guzman, H.M. and Cortes, J. **Reef recovery 20 years after the 1982-1983 El Nino massive mortality.** *Marine Biology* 151(2): 401-411, 2007.

Notes: For over 20 years the El Nino-Southern Oscillation (ENSO) has caused damage to the coral reefs of the eastern Pacific and other regions. In the mid-1980s scientists estimated that coral cover was reduced by 50-100% in several countries across the region. Almost 20 years (2002) after the 1982-1983 event, we assessed the recovery of the virtually destroyed reefs at Cocos Island (Costa Rica), previously evaluated in 1987 and reported to have less than 4% live coral cover. We observed up to fivefold increase in live coral cover which varied among reefs surveyed in 1987 and 2002. Most new recruits and adults belonged to the main reef building species from pre-1982 ENSO, *Porites lobata*, suggesting that a disturbance as outstanding as El Nino was not sufficient to change the role or composition of the dominant species, contrary to phase shifts reported for the Caribbean. During the 1990s, new species were observed growing on the reefs. Notably, *Leptoseris scabra*, considered to be rare in the entire Pacific, was commonly found in the area. Recovery may have begun with the sexual and asexual recruits of the few surviving colonies of *P. lobata* and *Pavona* spp. and with long distance transport of larvae from remote reefs. We found an overall 23% live coral cover by 2002 and with one reef above 58% indicating that Cocos Island coral reefs are recovering.

Littler, M.M. and Littler, D.S. **Assessment of coral reefs using herbivory/nutrient assays and indicator groups of benthic primary producers: a critical synthesis, proposed protocols, and critique of management strategies.** *Aquatic Conservation: Marine and Freshwater Ecosystems* 17(2): 195-215, 2007.

Notes: 1. Rapid assessment protocols for determining and monitoring the status of any given coral reef are provided and include measuring: (a) standing stocks of functional indicator groups, (b) herbivore populations, (c) water-column nutrient levels, (d) tissue C:N:P ratios, (e) algal physiological-response assays, and (f) herbivory assays. These measurements can reveal quantitative tipping-point levels beyond which resilience to undesirable phase shifts begins to become critically reduced. Universal tipping-point approximations are reviewed for inorganic nutrients, and posited for the first time for herbivory. 2. The relative roles of top-down and bottom-up controls in determining benthic community structure and the health of coral reefs are especially important management concerns. This paper specifically addresses the top-down effects of herbivory and bottom-up effects of nutrient enrichment on critical indicator groups, i.e. reef-building corals, crustose coralline algae, dense turf algae and frondose macroalgae. 3. A predominance of (a) massive corals and calcareous coralline algae relative to frondose macroalgae and algal turfs indicates a healthy spatially heterogeneous condition reflecting low nutrients and high herbivory. An abundance of (b) frondose macroalgae illustrates the least desirable condition of elevated nutrient levels and reduced herbivory, possibly reflecting pollution in concert with destructive herbivore fishing practices. High coverage of (c) coralline algae suggests healthy high herbivory levels, but problems with elevated nutrients that are inhibitory to some corals.

Domination by (d) dense turf algae indicates desirably low nutrient levels, but an inadequate herbivory component. 4. The fast growth and turnover rates of fleshy algae compared to other reef organisms highlight their value as early warning indicators of reef degradation. 5. From a management perspective, levels of herbivory and nutrients rank among the most useful quantitative indicators of coral reef resilience; whereas, the degree of degradation and mortality are inferred from the above functional indicator groups of benthic primary producers.

Lapointe, B.E., Bedford, B.J., and Baumberger, R. **Hurricanes Frances and Jeanne remove blooms of the invasive green alga *Caulerpa brachypus* forma *parvifolia* (Harvey) Cribb from coral reefs off northern Palm Beach County, Florida.** *Estuaries and Coasts* 29(6A): 966-971, 2006.

Notes: Coral reefs worldwide are under stress from a variety of anthropogenic activities that can alter or inhibit recovery from catastrophic physical disturbances such as hurricanes. On coral reefs off southeast Florida, land-based nutrient pollution contributed to a successful invasion of *Caulerpa brachypus* forma *parvifolia* that dominated (up to 90% cover) reefs between January 2003 and August 2004. In September 2004, physical effects from Hurricanes Frances and Jeanne removed virtually all of the *C. brachypus* from the affected reefs. In July 2005, small patches of *C. bachypus* began to re-emerge and the area was affected again by Hurricane Wilma in October 2005. Although these hurricanes provided temporary relief from the *C. brachypus* invasion, the future of these reefs is uncertain because of competition with other opportunistic macroalgae and biota that may respond to the combination of newly created space and continued nutrient stress.

Haussermann, V. and Forsterra, G. **Extraordinary abundance of hydrocorals (Cnidaria, Hydrozoa, Stylasteridae) in shallow water of the Patagonian fjord region.** *Polar Biology* 30(4): 487-492, 2007.

Notes: During two scuba-diving expeditions in 2005 and 2006, stylasterids were documented and sampled from fjords and channels in the Central Patagonian Zone, Chile. At 15 of a total of 33 sampling sites we found colonies of *Errina antarctica*. We discuss the observed distribution patterns and the variability of colony shapes. In some regions we found *E. antarctica* to occur in extraordinary high densities on primary and secondary hard substratum below 10 m. In the archipelago Madre de Dios we discovered large colonies of *E. antarctica* covering areas of more than 10,000 m² with coverage exceeding 80%. The dense accumulations of *E. antarctica* have reef-like structure and form complex habitats. At one site we observed extensive mechanical damage to the corals that may result from coral extraction by divers and/or from boat anchors. Slow growth, fragility, scarceness and the lack of knowledge on their ecology make these spectacular and unique biocenoses very susceptible for damages and require protection and further studies.

Almany, G.R., Berumen, M.L., Thorrold, S.R., Planes, S., and Jones, G.P. **Local replenishment of coral reef fish populations in a marine reserve.** *Science* 316(5825): 742-744, 2007.

Notes: The scale of larval dispersal of marine organisms is important for the design of networks of marine protected areas. We examined the fate of coral reef fish larvae produced at a small island reserve, using a mass-marking method based on maternal transmission of stable isotopes to offspring. Approximately 60% of settled juveniles were spawned at the island, for species with both short (< 2 weeks) and long (> 1 month) pelagic larval durations. If natal homing of larvae is a common life-history strategy, the appropriate spatial scales for the management and conservation of coral reefs are likely to be much smaller than previously assumed.

Edmunds, P.J. and Elahi, R. **The demographics of a 15-year decline in cover of the Caribbean reef coral *Montastraea annularis*.** *Ecological Monographs* 77(1): 3-18, 2007.

Notes: On Caribbean reefs, a striking trend of the last 25 years has been the decline in cover of the framework-building coral *Montastraea annularis*, a species that has dominated reefs throughout the region for millennia. Clearly, such losses are important ecologically, but to evaluate their significance fully, they need to be placed in the context of the proximal causes and balanced against the potential for gains in cover through growth and recruitment. In this study, a population of *M. annularis* in St. John,

U.S. Virgin Islands, was censused annually from 1988 to 2003 to quantify coral cover and construct a size-based demographic model. The model was developed to explore the mechanisms of change in coral cover and to ascertain likely trajectories for future population growth. Over the study period, the cover of *M. annularis* declined from 41% in 1988, to; 12% by 1999 (a 72% decline) but remained unchanged statistically for the last five years of the study. Between 1988 and 2003, colony abundances declined by 57% (from 47 colonies/m^2 to 20 colonies/m^2), and the losses were driven mostly by the death and fission of medium to large colonies (i.e., ≥ 151 cm^2). By 2003, the population had proportionally more small colonies (70% were ≤ 50 cm^2) and fewer large colonies (3% were > 250 cm^2) than in 1988 (60% and 6%, respectively), and the changes in population structure had accelerated ≥ 14% in terms of the rate of change in population size and the time necessary to attain equilibrium of colony size structure. Importantly, this analysis revealed an ongoing and imminent population decline coincident with the recent period of apparently stable coral cover. Fifty-year projections indicate the strong likelihood of extirpation of *M. annularis* at this particular site in St. John (in contrast to a continuation of constant low cover) and suggest that the 1988 population structure cannot be restored by recruitment. It is unlikely that the population decline will reverse until there is an amelioration of the conditions that kill individual colonies.

Klaus, J.S., Janse, I., Heikoop, J.M., Sanford, R.A., and Fouke, B.W. **Coral microbial communities, zooxanthellae and mucus along gradients of seawater depth and coastal pollution.** *Environmental Microbiology* 9(5): 1291-1305, 2007.

Notes: The high incidence of coral disease in shallow coastal marine environments suggests seawater depth and coastal pollution have an impact on the microbial communities inhabiting healthy coral tissues. A study was undertaken to determine how bacterial communities inhabiting tissues of the coral *Montastraea annularis* change at 5 m, 10 m and 20 m water depth in varying proximity to the urban centre and seaport of Willemstad, Curacao, Netherlands Antilles. Analyses of terminal restriction fragment length polymorphisms (TRFLP) of 16S rRNA gene sequences show significant differences in bacterial communities of polluted and control localities only at the shallowest seawater depth. Furthermore, distinct differences in bacterial communities were found with increasing water depth. Comparisons of TRFLP peaks with sequenced clone libraries indicate the black band disease cyanobacterium clone CD1C11 is common and most abundant on healthy corals in less than 10 m water depth. Similarly, sequences belonging to a previously unrecognized group of likely phototrophic bacteria, herein referred to as CAB-1, were also more common in shallow water. To assess the influence of environmental and physiologic factors on bacterial community structure, canonical correspondence analysis was performed using explanatory variables associated with: (i) light availability; (ii) seawater pollution; (iii) coral mucus composition; (iv) the community structure of symbiotic algae; and (v) the photosynthetic activity of symbiotic algae. Eleven per cent of the variation in bacterial communities was accounted for by covariation with these variables; the most important being photosynthetically active radiation (sunlight) and the coral uptake of sewage-derived compounds as recorded by the $\delta^{15}N$ of coral tissue.

Frisch, A.J., Ulstrup, K.E., and Hobbs, J.P.A. **The effects of clove oil on coral: An experimental evaluation using *Pocillopora damicornis* (Linnaeus).** *Journal of Experimental Marine Biology and Ecology* 345(2): 101-109, 2007.

Notes: Clove oil solution (10% clove oil, 90% ethanol) is an anaesthetic that is widely used to catch demersal fish on coral reefs. This study assessed the effects of clove oil solution on colonies of *Pocillopora damicornis*, a cosmopolitan reef coral. In the laboratory, low concentrations (0.5 ppt) of clove oil solution had no effect on coral colour or photosynthetic efficiency, irrespective of exposure time (1- 60 min). Corals treated with high concentrations (50 ppt) of clove oil solution died immediately, including those that were exposed briefly (1 min). Intermediate concentrations (5 ppt) of clove oil solution produced variable results: a 1 min exposure had no effect, a 10 min exposure caused bleaching and reduced photosynthetic efficiency, and a 60 min exposure caused total mortality. To validate these observations, clove oil solution was applied to corals in situ. Sixty-three days after application, corals treated with 10 ml of clove oil solution appeared to be unaffected. It was concluded that (1) limited amounts of clove oil solution are unlikely to harm this coral, and (2) clove oil solution may represent an 'eco-friendly' alternative to cyanide for use in the live reef-fish trade.

Brander, L.M., Van Beukering, P., and Cesar, H.S.J. **The recreational value of coral reefs: A meta-analysis.** *Ecological Economics* 63(1): 209-218, 2007.

Notes: Coral reefs are highly productive ecosystems that provide a variety of valuable goods and services, including recreational opportunities. The open-access nature and public good characteristics of coral reefs often result in them being undervalued in decision making related to their use and conservation. In response to this, there now exists a substantial economic valuation literature on coral reefs. For the purposes of conducting a meta-analysis of this literature, we collected 166 coral reef valuation studies, 52 of which provided sufficient information for a statistical meta-analysis, yielding 100 separate value observations in total. Focusing on recreational values, we use US$ per visit as the dependent variable in our meta-analysis. The meta-regression results reveal a number of important factors in explaining variation in coral reef recreational values, notably the area of dive sites and the number of visitors. Different valuation methods are shown to produce widely different values, with the contingent valuation method producing significantly lower value estimates. Using a multilevel modelling approach we also control for authorship effects, which proves to be highly significant in explaining variation in value estimates. We assess the prospects for using this analysis for out-of-sample value transfer, and find average transfer errors of 186%. We conclude that there is a need for further high-quality valuation research on coral reefs.

Shafir, S., Van Rijn, J., and Rinkevich, B. **Short and long term toxicity of crude oil and oil dispersants to two representative coral species.** *Environmental Science and Technology* 41(15): 5571-5574, 2007.

Notes: Oil dispersants, the tool of choice for treating oil spills in tropical marine environments, is potentially harmful to marine life, including reef corals. In a previous study, we found that dispersed oil and oil dispersants are harmful to soft and hard coral species at early life stages. In this broader study, we employed a "nubbin assay" on more than 10 000 coral fragments to evaluate the short- and long-term impacts of dispersed oil fractions (DOFs) from six commercial dispersants, the dispersants and water-soluble-fractions (WSFs) of Egyptian crude oil, on two Indo Pacific branching coral species, *Stylophora pistillata* and *Pocillopora damicornis*. Survivorship and growth of nubbins were recorded for up to 50 days following a single, short (24 h) exposure to toxicants in various concentrations. Manufacturer-recommended dispersant concentrations proved to be highly toxic and resulted in mortality for all nubbins. The dispersed oil and the dispersants were significantly more toxic than crude oil WSFs. As corals are particularly susceptible to oil detergents and dispersed oil, the results of these assays rules out the use of any oil dispersant in coral reefs and in their vicinity. The ecotoxicological impacts of the various dispersants on the corals could be rated on a scale from the least to the most harmful agent, as follows: Slickgone > Petrotech > Inipol = Biorieco > Emulgal > Dispolen.

Haapkyla, J., Ramade, F., and Salvat, B. **Oil pollution on coral reefs: a review of the state of knowledge and management needs.** *Vie et Mileau* 57(1-2): 95-111, 2007. **O/A**

Notes: This paper reviews the current state of knowledge of the effects that oil pollution has on scleractinian corals. A review of results obtained in laboratory as well as in field conditions are given and suitable management tools are discussed. Studies made in the 1970s and 1980s presented conflicting results regarding the impacts of oil on coral physiology, but later results confirmed the detrimental effect of oil on corals. The world's coral reefs are severely threatened by an array of factors, one of which is oil pollution. More laboratory and field work with current oils and dispersants is urgently needed in order to update our knowledge in this field and reduce impacts in case of a major oil spill on coral reefs.

Feary, D.A., Almany, G.R., McCormick, M.I., and Jones, G.P. **Habitat choice, recruitment and the response of coral reef fishes to coral degradation.** *Oecologia* 153(3): 727-737, 2007.

Notes: The global degradation of coral reefs is having profound effects on the structure and species richness of associated reef fish assemblages. Historically, variation in the composition of fish communities has largely been attributed to factors affecting settlement of reef fish larvae. However, the mechanisms that determine how fish settlers respond to different stages of coral stress and the extent of coral loss on fish settlement are poorly understood. Here, we examined the effects of habitat degradation on fish settlement using a two-stage experimental approach. First, we employed laboratory choice experiments to test how settlers responded to early and terminal stages of coral degradation. We then quantified the settlement response of the whole reef fish assemblage in a field perturbation experiment. The laboratory choice experiments tested how juveniles from nine common Indo-Pacific fishes chose among live colonies, partially degraded colonies, and dead colonies with recent algal growth. Many species did not distinguish between live and partially degraded colonies, suggesting settlement patterns are

resilient to the early stages of declining coral health. Several species preferred live or degraded corals, and none preferred to associate with dead, algal-covered colonies. In the field experiment, fish recruitment to coral colonies was monitored before and after the introduction of a coral predator (the crown-of-thorns starfish) and compared with undisturbed control colonies. Starfish reduced live coral cover by 95-100%, causing persistent negative effects on the recruitment of coral-associated fishes. Rapid reductions in new recruit abundance, greater numbers of unoccupied colonies and a shift in the recruit community structure from one dominated by coral-associated fishes before degradation to one predominantly composed of algal-associated fish species were observed. Our results suggest that while resistant to coral stress, coral death alters the process of replenishment of coral reef fish communities.

Anthony, K.R.N., Connolly, S.R., and Hoegh-Guldberg, O. **Bleaching, energetics, and coral mortality risk: Effects of temperature, light, and sediment regime.** *Limnology and Oceanography* 52(2): 716-726, 2007. **O/A**

Notes: The most severe outcome of coral bleaching is colony mortality. However, the risk of mortality is one of the least understood consequences for reef corals under climate-change scenarios. Specifically, links among combinations of temperature anomalies, varying solar irradiance, reduced water quality, and mortality risks are unclear. Here, we analyze the effects of high temperature, irradiance, and sediment loading on coral survivorship in a controlled tank experiment using *Acropora intermedia* from the inner Great Barrier Reef lagoon. Survival analyses based on the fate of 1600 subcolonies revealed that temperature and sediment exerted strong effects on coral mortality risk. As expected, high temperature increased mortality risk at all light and sediment levels. However, high sediment reduced mortality under high temperature and/or high light, potentially by alleviating light pressure and by providing an alternative food source for bleached corals. A survivorship model using coral energy status (lipid stores) as a predictor variable provided an excellent fit to the data, suggesting that much of the variation in survivorship among treatments and over time can be explained by colony energetics. Our study provides a new framework for predicting coral mortality risk under complex bleaching scenarios in which multiple environmental variables are involved.

Tanaka, Y., Miyajima, T., Koike, I., Hayashibara, T., and Ogawa, H. **Imbalanced coral growth between organic tissue and carbonate skeleton caused by nutrient enrichment.** *Limnology and Oceanography* 52(3): 1139-1146, 2007. **O/A**

Notes: Effects of moderate nutrient enrichment (NO_3^- : < 5 μmol L^{-1}, PO_4^{3-} : < 0.3 μmol L^{-1}) on two carbon (C) fixation rates (photosynthesis and calcification) of the zooxanthellate coral *Acropora pulchra* were investigated under laboratory conditions. The coral branches were incubated in the nutrient condition for three different periods (0, 5, 10 d) to observe changes in tissue biomass and zooxanthellate chlorophyll *a* (Chl *a*) concentration. Next, the incubated corals were simultaneously transferred to nutrient-depleted seawater containing ^{13}C-labeled dissolved inorganic carbon to assay net photosynthesis and calcification rates. Chl *a* concentration per unit surface area increased 2.6-fold for the 10-d enrichment, and net photosynthetic rates were also stimulated up to a similar level (2.8-fold). Tissue biomass of the host coral and zooxanthellae was approximately doubled during the period. On the other hand, calcification rates only increased 1.3-fold, suggesting that even moderate nutrient loading resulted in one-sided enhancement of the algal photosynthetic activity. The measured C fixation ratios of organic C: skeletal C were higher than the structural ratios, and the inconsistency became greater as Chl *a* concentration increased. The increased photosynthetic products could be excessively stored in the organic tissue and/or released into the ambient seawater.

Donner, S.D., Knutson, T.R., and Oppenheimer, M. **Model-based assessment of the role of human-induced climate change in the 2005 Caribbean coral bleaching event.** *Proceedings of the National Academy of Sciences [USA]* 104(13): 5483-5488, 2007. **O/A**

Notes: Episodes of mass coral bleaching around the world in recent decades have been attributed to periods of anomalously warm ocean temperatures. In 2005, the sea surface temperature (SST) anomaly in the tropical North Atlantic that may have contributed to the strong hurricane season caused widespread coral bleaching in the Eastern Caribbean. Here, we use two global climate models to evaluate the contribution of natural climate variability and anthropogenic forcing to the thermal stress that caused the 2005 coral bleaching event. Historical temperature data and simulations for the 1870-2000 period show that the observed warming in the region is unlikely to be due to unforced climate variability alone. Simulation of background climate variability suggests that anthropogenic warming may have increased the probability of occurrence of significant

thermal stress events for corals in this region by an order of magnitude. Under scenarios of future greenhouse gas emissions, mass coral bleaching in the Eastern Caribbean may become a biannual event in 20-30 years. However, if corals and their symbionts can adapt by 1-1.5ºC, such mass bleaching events may not begin to recur at potentially harmful intervals until the latter half of the century. The delay could enable more time to alter the path of greenhouse gas emissions, although long-term "committed warming" even after stabilization of atmospheric CO_2 levels may still represent an additional long-term threat to corals.

Manzello, D.P., Brandt, M., Smith, T.B., Lirman, D., Hendee, J.C., and Nemeth, R.S. **Hurricanes benefit bleached corals.** *Proceedings of the National Academy of Sciences [USA]* 104(29): 12035-12039, 2007.

Notes: Recent, global mass-mortalities of reef corals due to record warm sea temperatures have led researchers to consider global warming as one of the most significant threats to the persistence of coral reef ecosystems. The passage of a hurricane can alleviate thermal stress on coral reefs, highlighting the potential for hurricane-associated cooling to mitigate climate change impacts. We provide evidence that hurricane-induced cooling was responsible for the documented differences in the extent and recovery time of coral bleaching between the Florida Reef Tract and the U.S. Virgin Islands during the Caribbean-wide 2005 bleaching event. These results are the only known scenario where the effects of a hurricane can benefit a stressed marine community.

Feary, D.A., Almany, G.R., Jones, G.P., and McCormick, M.I. **Coral degradation and the structure of tropical reef fish communities.** *Marine Ecology Progress Series* 333: 243-248, 2007.

Notes: Coral reefs can be degraded by a variety of perturbations, including bleaching and predation by crown-of-thorns starfish. The combination of these disturbances has contributed to a global decline of live coral cover on reefs. While the effects of bleaching and starfish predation on corals are relatively well known, their consequences for fish communities are less understood. We compared fish assemblages associated with 2 coral species, *Pocillopora damicornis* and *Seriatopora hystrix*, among 3 coral health categories: (1) live, (2) degraded and (3) dead colonies with recent algal growth. Categories 2 and 3 occur sequentially during the first few weeks following bleaching or crown-of-thorns starfish predation. The abundance of species with an obligate association with live coral differed among coral health categories. Average total abundance of all fish species was lowest in algal-covered colonies of both coral species and these assemblages were dominated by species that are not closely associated with live coral. Lower fish abundance on algal-covered colonies was largely due to the low number of small size classes (new recruits and juveniles). This study suggests that habitat health may play an important role in structuring coral-associated fish assemblages.

McClanahan, T.R., Ateweberhan, M., Graham, N.A.J., Wilson, S.K., Sebastian, C.R., Guillaume, M.M.M., and Bruggemann, J.H. **Western Indian Ocean coral communities: bleaching responses and susceptibility to extinction.** *Marine Ecology Progress Series* 337: 1-13, 2007.

Notes: A field study of coral bleaching and coral communities was undertaken spanning 8 countries and ~ 35 degrees of latitude in 2005. This was combined with studies in southern Kenya and northeast Madagascar in 1998 and Mauritius in 2004 to develop a synoptic analysis of coral community structure, bleaching response, susceptibility of the communities to bleaching, and the relative risk of extinctions in western Indian Ocean coral reefs. Cluster analysis identified 8 distinct coral communities among the 91 sites sampled, with 2 distinct communities in northern South Africa and central Mozambique, a third in the central atolls of the Maldives, and 5 less differentiated groups, in a swath from southern Kenya to Mauritius, including Tanzania, the granitic islands of the Seychelles, northeast Madagascar, and Reunion. Massive *Porites*, *Pavona*, and *Pociflopora* dominated the central and northern Indian Ocean sites and, from historical records, replaced dominance by *Acropora* and *Montipora*. From southern Kenya to Mauritius, coral communities were less disturbed, with *Acropora* and *Montipora* dominating, and a mix of subdominants including branching *Porites*, *Fungia*, *Galaxea*, massive *Porites*, *Pocillopora*, and *Synarea*. The survey identified an area from southernmost Kenya to Tanzania as having the least disturbed and highest diversity reefs, and as being a regional priority for management. Taxa vulnerable to future extinction based on their response to warm water, population density, and commonness include largely low-diversity genera with narrow environmental ranges, such as *Gyrosmilia interrupta*, *Plesiastrea versipora*, *Plerogyra sinuosa* and *Physogyra lichtensteini*.

Costantini, F., Fauvelot, C., and Abbiati, M. **Fine-scale genetic structuring in *Corallium rubrum*: evidence of inbreeding and limited effective larval dispersal.** *Marine Ecology Progress Series* 340: 109-119, 2007.

Notes: The red coral *Corallium rubrum* has a long history of intensive exploitation. As a consequence, most populations have been overharvested, which may be leading to reduced levels of genetic diversity. *C. rubrum* is a gorgonian distributed in the Mediterranean Sea and along the neighbouring Atlantic coasts, with brooding larvae which disperse only over short distances. Such limited dispersal of larvae suggests that gene flow is restricted in this species, but no experimental evidence is yet available. In the present study, small spatial scale genetic structuring was analysed in *C. rubrum* samples collected in the Ligurian Sea using a hierarchical sampling design, including scales from 10s to 100s of metres. The genetic variation of each colony was analysed using 4 microsatellite loci. Significant deviations from Hardy-Weinberg equilibrium due to elevated heterozygote deficiencies were detected in all samples and were consistent with the occurrence of inbreeding and a Wahlund effect. Significant levels of genetic differentiation were found both between locations (F_{ST} = 0.209 +/- 0.02) and among samples within each location (F_{ST} range = 0.025 to 0.082). Our results indicate the occurrence of significant genetic structuring at spatial scales of 10s of metres, supporting the hypothesis that planulae have a limited effective dispersal ability. The occurrence of structured breeding units and differences in genetic diversity among samples also suggest that strategies for sustainable management and conservation of red coral should be defined at a local scale,

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Stevenson, C., Katz, L.S., Micheli, F., Block, B., Heiman, K.W., Perle, C., Weng, K., Dunbar, R., and Witting, J. **High apex predator biomass on remote Pacific islands.** *Coral Reefs* 26(1): 47-51, 2007.

Notes: On coral reefs in Palmyra -- a central Pacific atoll with limited fishing pressure -- total fish biomass was 428 and 299% greater than on reefs in nearby Christmas and Fanning Islands. Large apex predators, groupers, sharks, snappers, and jacks larger than 50 cm in length, accounted for 56% of total fish biomass in Palmyra on average, but only 7 and 3% on Christmas and Fanning. These biomass proportions are remarkably similar to those previously reported for the remote and uninhabited Northwest Hawaiian Islands (NWHI) and densely populated Main Hawaiian Islands (MHI), although Palmyra's reefs are dominated in biomass by sharks (44% of the total), whereas the NWHI by jacks (39%). Herbivorous fish biomass was also greater on Palmyra than on Christmas and Fanning (343 and 207%, respectively). These results and previous findings indicate that remote, uninhabited islands support high levels of consumers, and highlight the importance of healthy coral reef ecosystems as reference points for assessment of human impacts and establishment of restoration goals.

Brown-Saracino, J., Peckol, P., Curran, H.A., and Robbart, M.L. **Spatial variation in sea urchins, fish predators, and bioerosion rates on coral reefs of Belize.** *Coral Reefs* 26(1): 71-78, 2007.

Notes: Although sea urchins are critical for controlling macroalgae on heavily fished coral reefs, high densities threaten reefs, as urchins are also prodigous bioeroders. This study examined urchin population characteristics, bioerosion rates, their fish predators (Labridae), and potential competitors (Scaridae) on unprotected reefs and a reef within a marine protected area (MPA) in the lagoonal regions off Belize. Urchin density (< 1 m^{-2}) and bioerosion rates (~ 0.2 kg $CaCO_3$ m^{-2} $year^{-1}$) were lowest and members of the Labridae were the highest (~ 20 fish 200 m^{-3}) within the MPA, while several unprotected reefs had higher (~ 18-40 m^{-2}) urchin densities, lower Labridae abundances (1-3 fish 200 m^{-3}), and bioerosion rates ranging from ~ 0.3-2.6 kg $CaCO_3$ m^{-2} $year^{-1}$. Urchin abundances were inversely related to Labridae (wrasses and hogfish) densities; however, on reef ridges, low algal cover (~ 15%), small urchin size (~ 14 mm), and low proportion of organic material in urchin guts suggested food limitation. Both top-down (predation) and bottom-up factors (food limitation) likely contribute to the control of urchins, predominantly *Echinometra viridis*, off Belize, thereby potentially diminishing the negative impacts of bioerosion activities by urchins.

Grober-Dunsmore, R., Frazer, T.K., Lindberg, W.J., and Beets, J. **Reef fish and habitat relationships in a Caribbean seascape: the importance of reef context.** *Coral Reefs* 26(1): 201-216, 2007.

Notes: Marine protected area (MPA) effectiveness is contingent on understanding key ecological patterns and processes at appropriate spatial scales and may depend upon maintaining critical linkages among essential habitat patches to conserve reef-fish communities. Hypotheses were tested to investigate the importance of habitat linkages in the US Virgin Islands. As expected, reef context (the spatial pattern of surrounding habitat patches) was a strong predictor of reef fish assemblage structure. Specific relationships were functionally consistent with the ecology of the fishes of interest. For example, reefs with large amounts of seagrass nearby harbored the greatest numerical abundance of fishes, particularly mobile invertebrate feeders and the exploited fish families of Haemulidae (grunts) and Lutjanidae (snappers). Species richness for the entire fish community and within these fish groups was also strongly associated with reef context. Furthermore, reef fish mobility influenced how fishes related to reef context. Fish-habitat relationships were detected as far as 1 km from study reefs, suggesting that fish movements result in habitat encounter rates that may influence their patterns of distribution. Consequently, functional habitat connectivity of habitat patches appears important in structuring reef-fish assemblages, and suggests that landscape-scale metrics may provide insights useful to managers in the design of MPAs.

Ledlie, M.H., Graham, N.A.J., Bythell, J.C., Wilson, S.K., Jennings, S., Polunin, N.V.C., and Hardcastle, J. **Phase shifts and the role of herbivory in the resilience of coral reefs.** *Coral Reefs* 26(3): 641-653, 2007.

Notes: Cousin Island marine reserve (Seychelles) has been an effectively protected no-take marine protected area (MPA) since 1968 and was shown in 1994 to support a healthy herbivorous fish assemblage. In 1998 Cousin Island reefs suffered extensive coral mortality following a coral bleaching event, and a phase shift from coral to algal dominance ensued. By 2005 mean coral cover was < 1%, structural complexity had fallen and there had been a substantial increase in macroalgal cover, up to 40% in some areas. No clear trends were apparent in the overall numerical abundance and biomass of herbivorous fishes between 1994 and 2005, although smaller individuals became relatively scarce, most likely due to the loss of reef structure. Analysis of the feeding habits of six abundant and representative herbivorous fish species around Cousin Island in 2006 demonstrated that epilithic algae were the preferred food resource of all species and that macroalgae were avoided. Given the current dominance of macroalgae and the apparent absence of macroalgal consumers, it is suggested that the increasing abundance of macroalgae is reducing the probability of the system reverting to a coral dominated state.

Whelan, K.R.T., Miller, J., Sanchez, O., and Patterson, M. **Impact of the 2005 coral bleaching event on *Porites porites* and *Colpophyllia natans* at Tektite Reef, US Virgin Islands.** *Coral Reefs* 26(3): 689-693, 2007.

Notes: A thermal stress anomaly in 2005 caused mass coral bleaching at a number of north-east Caribbean reefs. The impact of the thermal stress event and subsequent White-plague disease type II on *Porites porites* and *Colpophyllia natans* was monitored using a time series of photographs from Tektite Reef, Virgin Islands National Park, St. John. Over 92% of the *P. porites* and 96% of the *C. natans* experienced extensive bleaching (> 30% of colony bleached). During the study, 56% of *P. porites* and 42% of *C. natans* experienced whole-colony mortality within the sample plots. While all whole-colony mortality of *P. porites* was directly attributed to coral bleaching, the majority (82%) of the *C. natans* colonies that experienced total mortality initially showed signs of recovery from bleaching, before subsequently dying from White-plague disease type II.
