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Marine Science Review – 214

Marine protected areas and reserves

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In this review:

A. Recent articles – no abstract available

Dulvy, N.K. **Strict marine protected areas prevent reef shark declines.** *Current Biology* 16(23): R989-R991, 2006.

B. Recent articles with abstracts

Garla, R.C., Chapman, D.D., Wetherbee, B.M., and Shivji, M. **Movement patterns of young Caribbean reef sharks, *Carcharhinus perezi*, at Fernando de Noronha Archipelago, Brazil: the potential of marine protected areas for conservation of a nursery ground.** *Marine Biology* 149(2): 189-199, 2006.

Notes: The movement patterns and long-term site-fidelity of primarily juvenile Caribbean reef sharks, *Carcharhinus perezi*, were investigated using tag-recapture and automated telemetry at an insular nursery area, the Fernando de Noronha Archipelago, Brazil. Of the 143 externally tagged juvenile sharks (< 110 cm), 22 (15.3%) were recaptured between 0 and 5 km from the site of tagging after 5-800 days at liberty, suggesting some site-fidelity in young individuals of this species. Site-fidelity and movement patterns of ten juvenile sharks ranging from 78 to 110 cm total length (TL) and one opportunistically captured adult female (224 cm TL) were also investigated for periods of up to 2 years with an array of automated telemetry receivers. Tagging and telemetry data from both inside and outside a marine protected area (MPA) show that shark abundance and activity is greatest along the part of the archipelago's coastline least disturbed by human activity. Telemetry tracking also showed that juvenile reef sharks demonstrated a high degree of site-fidelity and occupied specific locations along the coast throughout the year, with some evidence of an increase in activity space with ontogeny. Sharks appeared to range more widely at night and there were no seasonal variations in habitat use. Our results suggest that MPAs may be a useful conservation tool to protect young *C. perezi* and potentially other reef-dwelling carcharhinid sharks during their early life history.

Greenville, J. and MacAulay, T.G. **Protected areas in fisheries: a two-patch, two-species model.** *Australian Journal of Agriculture and Resource Economics* 50(2): 207-226, 2006.

Notes: The use of marine protected areas as a fishery management tool has been suggested as a hedge against management failures and variation in harvests. A stochastic bioeconomic model of a hypothetical predator-prey fishery is used to test the performance of protected areas in a fishery with heterogenous environments. Protected areas are analysed under density-dependent and sink-source dispersal relationships between the subpopulations that occur within the fishery. Differing management structures governing resource extraction are analysed. The focus of the study is placed on the biological and management characteristics that yield benefits to both fishers and society. It is shown that the establishment of a protected area improves fishery rent and lowers harvest variation. This result is sensitive to both current management controls and the correlation between species and patches.

Fryxell, J.M., Lynn, D.H., and Chris, P.J. **Harvest reserves reduce extinction risk in an experimental microcosm.** *Ecology Letters* 9(9): 1025-1031, 2006.

Notes: Overharvesting by humans threatens a substantial fraction of endangered species. Reserves have recently received enormous attention as a means of better conserving harvested resources, despite limited empirical evidence of their efficacy. We used manipulated microcosms to test whether reserves reduce extinction risk in mobile populations of harvested *Tetrahymena thermophila*, a ciliate. Here we show that patterns of population distribution inside and outside reserves can be accurately predicted on the basis of simple models of diffusion coupled with logistic controls on local population growth. No extinctions occurred in eight experimental trials with reserves, whereas extinction occurred in seven of eight trials without reserves, as predicted by population viability models based on stochastic population processes. These results suggest that marine reserves may be an effective means of improving long-term viability in heavily harvested fish species.

Alcala, A.C. and Russ, G.R. **No-take marine reserves and reef fisheries management in the Philippines: A new people power revolution.** *Ambio* 35(5): 245-254, 2006.

Notes: The marine-conservation and reef fisheries-management program that exists today in the Philippines had humble beginnings in the 1970s at Sumilon and Apo islands. These islands have produced some of the best evidence available that no-take reserves, protected and managed by local communities, can play a key role in biodiversity conservation and fisheries management. Perhaps more importantly, they served as models for an extraordinary expansion of no-take reserves nationally in the Philippines in the past 2 decades. This expansion contributed substantially to a major shift in national policy of management of marine resources. This policy shift partially devolved responsibility from a centralized government bureaucracy to local governments and local communities. Local governments now co-manage, along with the national government, marine resources out to 15 km from the coast. Giving some responsibility for management of marine resources to coastal people dependent upon those resources represents, in a very real sense, another "people power revolution" in the Philippines.

Field, J.C., Punt, A.E., Methot, R.D., and Thomson, C.J. **Does MPA mean 'major problem for assessments'? Considering the consequences of place-based management systems.** *Fish and Fisheries* 7(4): 284-302, 2006.

Notes: Marine protected areas (MPAs) have been increasingly proposed, evaluated and implemented as management tools for achieving both fisheries and conservation objectives in aquatic ecosystems. However, there is a challenge associated with the application of MPAs in marine resource management with respect to the consequences to traditional systems of monitoring and managing fisheries resources. The place-based paradigm of MPAs can complicate the population-based paradigm of most fisheries stock assessments. In this review, we identify the potential complications that could result from both existing and future MPAs to the science and management systems currently in place for meeting conventional fisheries management objectives. The intent is not to evaluate the effects of implementing MPAs on fisheries yields, or even to consider the extent to which MPAs may achieve conservation oriented objectives, but rather to evaluate the consequences of MPA implementation on the ability to monitor and assess fishery resources consistent with existing methods and legislative mandates. Although examples are drawn primarily from groundfish fisheries on the West Coast of the USA, the lessons are broadly applicable to management systems worldwide, particularly those in which there exists the institutional infrastructure for managing resources based on quantitative assessments of resource status and productivity.

Tuya, F., Garcia-Diez, C., Espino, F., and Haroun, R.J. **Assessment of the effectiveness of two marine reserves in the Canary Islands (Eastern Atlantic).** *Ciencias Marinas* 32(3): 505-522, 2006.

Notes: We assessed the effectiveness of two marine reserves (MRs) in the Canary Islands (eastern Atlantic), called "Punta La Restinga-Mar de Las Calmas" (El Hierro Island) and "Isla La Graciosa e islotes del norte de Lanzarote" (Chinijo Archipelago). Specifically, we evaluated the variability in the abundances and biomasses of four commercially-targeted fish species: the parrotfish (*Sparisoma cretense*), the island grouper (*Myeteroperca fusca*), the white sea- bream (*Diplodus sargus cadenati*) and the zebra sea-bream (*Diplodus cervinus cervinus*). Four fishing management categories were established within and around each MR: (1) a no-take or integral area (collection of all animals is not permitted), (2) a buffer area (fishing is permitted with traditional fishing

gears), (3) a neighbouring fishing area (< 20 km), and (4) a fishing area off a neighbouring island. Two randomly selected sites were sampled within each management category and MR in October and March 2004. Univariate tests provided evidence of a moderate "reserve effect" for both MRs consistent through time. Differences in abundances and biomasses of each species among management categories were clearly species-specific and inconsistent between both MRs. Species of the genus *Diplodus* showed greater abundances and biomasses within protected locations compared to unprotected locations at El Hierro Island. Moreover, the four selected species showed greater abundances and biomasses in the locations surveyed at El Hierro Island compared to unprotected locations at the neighbouring island. In contrast, *S. cretense* appeared to be the only species that benefited from protection in the Chinijo MR. Differences in the sizes of the MRs, the fishing effort around the MRs and the effectiveness of the enforcement within each MR, appeared to be possible explanations for the patterns observed.

Sanchirico, J.N., Malvadkar, U., Hastings, A., and Wilen, J.E. **When are no-take zones an economically optimal fishery management strategy?** *Ecological Applications* 16(5): 1643-1659, 2006.

Notes: Discussions on the use of marine reserves (no-take zones) and, more generally, spatial management of fisheries are, for the most part, devoid of analyses that consider the ecological and economic effects simultaneously. To fill this gap, we develop a two-patch ecological-economic model to investigate the effects of spatial management on fishery profits. Because the fishery effects of spatial management depend critically on the nature of the ecological connectivity, our model includes both juvenile and adult movement, with density dependence in settlement differentiating the two types of dispersal. Rather than imposing a reserve on our system and measuring its effect on profits, we ask: "When does setting catch levels to maximize system-wide profits imply that a reserve should be created?" Closing areas to fishing is an economically optimal solution when the value derived from spillover from the reserve outweighs the value of fishing in the patch. The condition, while simple to state in summary form, is complex to interpret because it depends on the settlement success of the dispersing organisms, the nature of the costs of the fishing, the economic and ecological heterogeneity of the system, the discount rate, and growth characteristics of the fish population. The condition is more likely to be satisfied when the closed area is a net exporter of biomass and has higher costs of fishing, and for fish populations with density-independent settlement ("adult movement") than with density-dependent settlement ("larval dispersal"). Rather surprisingly, there are circumstances whereby closing low biological productivity areas, and even sometimes low cost areas to fish, can result in greater fishing profits than when both areas are open to fishing.

Monaco, M.E., Friedlander, A.M., Caldow, C., Christensen, J.D., Rogers, C., Beets, J., Miller, J., and Boulon, R. **Characterising reef fish populations and habitats within and outside the US Virgin Islands Coral Reef National Monument: a lesson in marine protected area design.** *Fisheries Management and Ecology* 14(1): 33-40, 2007.

Notes: Marine protected areas are an important tool for management of marine ecosystems. Despite their utility, ecological design criteria are often not considered or feasible to implement when establishing protected areas. In 2001, the Virgin Islands Coral Reef National Monument (VICRNM) in St John, US Virgin Islands was established by Executive Order. The VICRNM prohibits almost all extractive uses. Surveys of habitat and fishes inside and outside of the VICRNM were conducted in 2002-2004. Areas outside the VICRNM had significantly more hard corals, greater habitat complexity, and greater richness, abundance and biomass of reef fishes than areas within the VICRNM. The administrative process used to delineate the boundaries of the VICRNM did not include a robust ecological characterisation of the area. Because of reduced habitat complexity within the VICRNM, the enhancement of the marine ecosystem may not be fully realised or increases in economically important reef fishes may take longer to detect.

Stefansson, G. and Rosenberg, A.A. **Designing marine protected areas for migrating fish stocks.** *Journal of Fish Biology* 69: 66-78, 2006.

Notes: This paper extends an earlier analysis and presents an investigation of how migration rates affect the performance of various types of management regimes with respect to economic yield and conservation benefits. Particular emphasis is placed on evaluating the geometric design of marine protected areas (MPAs). Earlier results have shown that MPAs are only likely to provide significant benefits when they are used in conjunction with direct catch or effort controls, unless they are quite large and cover most of the resource in question. Conversely, catch and effort controls are far more effective when protected areas

are included in the management regime as a buffer against uncertainty. Dispersal of reproduction (recruitment) to other areas is an important expected benefit of protected areas, but such dispersal increases the variability of the effects of the area protection. If fishing mortality rates outside of the protected area are not controlled then dispersal can result in nullifying some of the benefits of the protected area. Similarly, adult migration increases the variability in the results when an area is protected and critically depends upon an overall control of fishing mortality outside the area. For both dispersal and migration separately or in combination, however, there are clear benefits to using MPAs in conjunction with catch or effort controls. These benefits are expressed in terms of long-term yield and recovery probabilities. In addition, short-term yield declines relatively slowly with increasing area protected. Design of the protected areas is seen to be important since using contiguous areas provide greater protection against overfishing than protected areas in isolation.

Gladstone, W. **Requirements for marine protected areas to conserve the biodiversity of rocky reef fishes.** *Aquatic Conservation: Marine and Freshwater Ecosystems* 17(1): 71-87, 2007.

Notes: 1. This study describes spatial patterns in the biodiversity (species, assemblages) of rocky reef fishes at a spatial scale relevant to management, and compared the outcomes for this biodiversity from alternative procedures for selecting marine protected areas (MPAs) and from the selection of MPAs for fisheries-related objectives. 2. The study area included 104 species in two assemblage types; 36 species and 14 species occurred only in one or two locations respectively. 3. MPAs selected by hotspot richness, greedy richness complementarity, and summed irreplaceability included similar percentages of species and significantly more species than randomly selected MPAs. A combined species-assemblage selection ensured representation of assemblage diversity. Representation of all species and assemblage types required 92% of locations. 4. MPAs chosen using density of all fishes or density of exploitable fishes as selection criteria included fewer species (than MPAs selected using species identity) and the percentage of species accumulated did not differ from a random selection. 5. Use of an established MPA as the seed for an expanded network was inefficient, leading to additional locations being required and an accumulation of species that did not differ front a random selection. 6. The smallest MPA network that fulfilled multiple management objectives (representation of assemblage diversity and majority of species, population viability, support for fisheries, connectivity) required 30% of the surveyed locations. 7. This study concluded that: MPAs selected without the benefit of data on intra-habitat variation in species assemblages will be unrepresentative; the upper range of currently promoted targets for MPA establishment (i.e. 30%) should be regarded as a minimum for biodiversity conservation; MPAs selected for fisheries-related reasons may not provide expected benefits for the remainder of the fish assemblage.

Hughes, T.P., Bellwood, D.R., Folke, C.S., McCook, L.J., and Pandolfi, J.M. **No-take areas, herbivory and coral reef resilience.** *Trends in Ecology and Evolution* 22(1): 1-3, 2007.

Notes: Coral reefs worldwide are under threat from various anthropogenic factors, including overfishing and pollution. A new study by Mumby *et al.* highlights the trophic relationships between humans, carnivorous and herbivorous fishes, and the potential role of no-take areas in maintaining vulnerable coral reef ecosystems. No-take areas, where fishing is prohibited, are vital tools for managing food webs, ecosystem function and the resilience of reefs, in a seascape setting that extends far beyond the boundaries of the reefs themselves.

Wagner, L.D., Ross, J.V., and Possingham, H.P. **Catastrophe management and inter-reserve distance for marine reserve networks.** *Ecological Modelling* 201(1): 82-88, 2007.

Notes: We consider the optimal spacing between marine reserves for maximising the viability of a species occupying a reserve network. The closer the networks are placed together, the higher the probability of colonisation of an empty reserve by an occupied reserve, thus increasing population viability. However, the closer the networks are placed together, the higher the probability that a catastrophe will cause extinction of the species in both reserves, thus decreasing population viability. Using a simple discrete-time Markov chain model for the presence or absence of the species in each reserve we determine the distance between the two reserves which provides the optimal trade-off between these processes, resulting in maximum viability of the species.

Hart, D.R. **When do marine reserves increase fishery yield?** *Canadian Journal of Fisheries and Aquatic Sciences* 63(7): 1445-1449, 2006.

Notes: An age-structured model is developed for analyzing the effects of marine reserves and other long-term closures on fishery yield, assuming larvae are well-mixed and that exchange of adults between the open and closed areas is negligible. A number of analytic results are derived, including a formula for the gradient of yield with respect to fishing mortality and closure fraction. Increasing the closure fraction at equilibrium spawning stock biomass (SSB), B, will increase yield if and only if $s'(B) > 1/b_0(0)$, where $s'(B)$ is the slope of the stock-recruitment curve at B and $b_0(0)$ is SSB per recruit at zero fishing mortality. Conditions for the level of closure required to prevent stock collapse are also derived. Applications of the theory to canary rockfish (*Sebastes pinniger*) and Georges Bank sea scallop (*Placopecten magellanicus*) illustrate that long-term closures increase yield only at low SSB associated with fishing mortalities greater than F_{MSY} and with low closure fractions. The theory presented here gives simple analytic and graphical techniques for predicting the effects of long-term closures on yield and stock persistence.

Laurel, B.J. and Bradbury, I.R. **"Big" concerns with high latitude marine protected areas (MPAs): trends in connectivity and MPA size.** *Canadian Journal of Fisheries and Aquatic Sciences* 63(12): 2603-2607, 2006.

Notes: The success of marine protected areas (MPAs) as fisheries management tools in tropical latitudes has generated interest in their applicability and potential elsewhere. Here we suggest that dispersal and gene flow in marine fish populations (a primary biological consideration for marine reserve design) increases with latitude. For example, north temperate fish species at latitudes between 40º and 45º had about three times greater dispersal potential (planktonic larval duration (PLD), n = 96 species) and genetic homogeneity (F_{ST}, n = 100 species) than fish species near equatorial regions. Using the PLD and FST relationships, dispersal increases at a rate of ~ 8% per degree of latitude north or south of the equator. Therefore tropical MPAs should not serve as direct scalar templates in other regions, but rather should be used as a basis against which higher-latitude MPAs should be scaled. However, a review of 429 existing MPAs indicates that no such changes in reserve size have been implemented with respect to latitude. Fisheries managers must be prepared and willing to implement MPAs at large scales in high latitudes, either as single reserves or in a network, or else we lose the legitimacy of a new and promising management tool for conserving marine biodiversity in cold ocean regions.

Kaplan, D.M., Botsford, L.W., and Jorgensen, S. **Dispersal per recruit: An efficient method for assessing sustainability in marine reserve networks.** *Ecological Applications* 16(6): 2248-2263, 2006.

Notes: Marine reserves are an increasingly important tool for the management of marine ecosystems around the world. However, the effects of proposed marine reserve configurations on sustainability and yield of populations are typically not estimated because of the computational intensity of direct simulation and uncertainty in larval dispersal and density-dependent recruitment. Here we develop a method for efficiently assessing a marine reserve configuration for persistence and yield of a population with sedentary adults and dispersing larvae. The method extends the familiar sustainability criteria of individual replacement for single populations based on eggs-per-recruit (EPR) to spatially distributed populations with sedentary adults, a dispersing larval phase, and limited carrying capacity in the settlement-recruit relationship. We refer to this approach as dispersal-per-recruit (DPR). In some cases, a single DPR calculation, based on the assumption that post-settlement habitat is saturated (i.e., at maximum recruitment), is sufficient to determine population persistence, while in other cases further iterative calculations are required. These additional calculations reach an equilibrium more rapidly than a full simulation of age- or size-structured populations. From the DPR result, fishery yield can be computed from yield-per-recruit (YPR) at each point. We assess the utility of DPR calculations by applying them to single reserves, uniformly distributed systems of reserves, and randomly sized and spaced systems of reserves on a linear coast line. We find that for low levels of EPR in fished areas (e.g., 10% or less of the natural, unfished EPR when post-settlement habitats are saturated by 35% of natural settlement), a single DPR calculation is sufficient to determine persistence of the population. We also show that, in uniform systems of reserves with finite reserve size, maximal fisheries yield occurs when the density of reserves is such that all post-settlement habitat is nearly saturated with settlers. Finally, we demonstrate the application of this approach to a realistic proposed marine reserve configuration.

Richardson, E.A., Kaiser, M.J., Edwards-Jones, G., and Possingham, H.P. **Sensitivity of marine-reserve design to the spatial resolution of socioeconomic data.** *Conservation Biology* 20(4): 1191-1202, 2006.

Notes: Socioeconomic considerations should have an important place in reserve design. Systematic reserve-selection tools allow simultaneous optimization for ecological objectives while minimizing costs but are seldom used to incorporate socioeconomic costs in the reserve-design process. The sensitivity of this process to biodiversity data resolution has been studied widely but the issue of socioeconomic data resolution has not previously been considered. We therefore designed marine reserves for biodiversity conservation with the constraint of minimizing commercial fishing revenue losses and investigated how economic data resolution affected the results. Incorporating coarse-resolution economic data from official statistics generated reserves that were only marginally less costly to the fishery than those designed with no attempt to minimize economic impacts. An intensive survey yielded fine-resolution data that, when incorporated in the design process, substantially reduced predicted fishery losses. Such an approach could help minimize fisher displacement because the least profitable grounds are selected for the reserve. Other work has shown that low-resolution biodiversity data can lead to underestimation of the conservation value of some sites, and a risk of overlooking the most valuable areas, and we have similarly shown that low-resolution economic data can cause underestimation of the profitability of some sites and a risk of inadvertently including these in the reserve. Detailed socioeconomic data are therefore an essential input for the design of cost-effective reserve networks.

Lynch, T.P. **Incorporation of recreational fishing effort into design of marine protected areas.** *Conservation Biology* 20(5): 1466-1476, 2006.

Notes: Theoretical models of marine protected areas (MPAs) that explore benefits to fisheries or biodiversity conservation often assume a dynamic pool of fishing effort. For instance, effort is homogenously distributed over areas from which subsets of reserves are chosen. I tested this and other model assumptions with a case study of the multiple-use Jervis Bay Marine Park. Prior to zoning of the park I conducted 166 surveys of the park's recreational fisheries, plotting the location of 16,009 anglers. I converted these plots into diagrams of fishing effort and analyzed correlates between fishing and habitat and the effect of two reserve designs - the draft and final zoning plans of the park - on the 15 fisheries observed. Fisheries were strongly correlated with particular habitats and had negatively skewed and often bimodal spatial distribution. The second mode of intensely fished habitat could be 6 SD greater than the fishery's mean allocation of effort by area. In the draft-zoning plan, sanctuary zone (no-take) area and potential subduction of fishing effort were similar. In the final plan, which was altered in response to public comment, the area of sanctuary zone increased, and the impact on fishing effort decreased. In only one case was a fishery's most intensely targeted location closed to fishing. Because of the discriminating manner with which fishers target habitats, if simple percentage targets are used for planning, sanctuary location can be adjusted to avoid existing fishing effort. According to modeled outcomes, the implication of this may be diminished reserve effectiveness. To address this, reserve area should be implicitly linked to subducted fishing effort when promoting or modeling MPAs.

Perez-Ruzafa, A., Gonzalez-Wanguemert, M., Lenfant, P., Marcos, C., and Garcia-Charton, J.A. **Effects of fishing protection on the genetic structure of fish populations.** *Biological Conservation* 129(2): 244-255, 2006.

Notes: Marine reserves have been identified as an important tool in the management of fishery resources and their number is increasing rapidly, most of them being on islands. However, knowledge on the real effect of protection from fishing on the genetic structure of populations, the spatial scales involved, or the suitability of islands as reserves in terms of connectivity, is scarce. This paper analyses the effects of fishery protection on the genetic structure of populations of *Diplodus sargus*, a target species, in protected and non-protected areas of the western Mediterranean. Populations studied showed high genetic variability at spatial scales from 10^1 to 10^3 km. Protected areas have significantly higher allelic richness. The lower levels of heterozygosis and higher heterozygote deficit showed by islands compared with coastal areas makes clear the importance of considering the connectivity processes when designing a MPA.

Shears, N.T., Grace, R.V., Usmar, N.R., Kerr, V., and Babcock, R.C. **Long-term trends in lobster populations in a partially protected vs. no-take Marine Park.** *Biological Conservation* 132(2): 222-231, 2006.

Notes: Increasing the level of protection afforded to the marine environment requires assessment of the efficacy of existing marine protected areas (MPAs) in protecting exploited species. Long-term data from before and after the establishment of MPAs provide a rare but valuable opportunity to assess these effects. In this study we present long-term data (1977-2005) from before and after park establishment, on the abundance of spiny lobster *Jasus edwardsii* from fixed sites in a no-take marine park and a recreationally fished marine park, to assess the efficacy of no-take vs. partial protection. Lobster densities were comparable between both marine parks prior to park establishment, but the response of lobster populations differed markedly following protection. On average, legal-sized lobster were eleven times more abundant and biomass 25 times higher in the no-take marine park following park establishment, while in the partially protected marine park there has been no significant change in lobster numbers. Furthermore, no difference was found in densities of legal-sized lobster between the partially protected marine park and nearby fully-fished sites (< 1 per 500 m^2). Long-term data from fully fished and partially protected sites suggest long-term declines in lobster populations and reflect regional patterns in catch per unit effort estimates for the fishery. The long-term patterns presented provide an unequivocal example of the recovery of lobster populations in no-take MPAs, but clearly demonstrate that allowing recreational fishing in MPAs has little benefit to populations of exploited species such as *J. edwardsii*.

Kareiva, P. **Beyond marine protected areas.** *Current Biology* 16(14): R533-R535, 2006.

Notes: Socioeconomic and ecological analyses of eleven coral reef conservation efforts make clear that marine protected areas are not the answer, and that in fact support of local communities is far more important than some government mandated 'fishing closure'. Apparently there are marine 'paper parks' just as there are terrestrial 'paper parks'.

McClanahan, T.R., Marnane, M.J., Cinner, J.E., and Kiene, W.E. **A comparison of marine protected areas and alternative approaches to coral-reef management.** *Current Biology* 16(14): 1408-1413, 2006.

Notes: Marine protected areas (MPAs) have been widely adopted as the leading tool for coral-reef conservation, but resource users seldom accept them and, and many have failed to produce tangible conservation benefits. Few studies have objectively and simultaneously examined the types of MPAs that are most effective in conserving reef resources and the socioeconomic factors responsible for effective conservation. We simultaneously explored measures of reef and socioeconomic conservation success at four national parks, four comanaged reserves, and three traditionally managed areas in Indonesia and Papua New Guinea. Underwater visual censuses of key ecological indicators and revealed that the average size and biomass of fishes were higher in all areas under traditional management and at one comanaged reserve when compared to nearby unmanaged areas. Socioeconomic assessments revealed that this "effective conservation" was positively related to compliance, visibility of the reserve, and length of time the management had been in place but negatively related to market integration, wealth, and village population size. We suggest that in cases where the resources for enforcement are lacking, management regimes that are designed to meet community goals can achieve greater compliance and subsequent conservation success than regimes designed primarily for biodiversity conservation.

Robbins, W.D., Hisano, M., Connolly, S.R., and Choat, J.H. **Ongoing collapse of coral-reef shark populations.** *Current Biology* 16(23): 2314-2319, 2006.

Notes: Marine ecosystems are suffering severe depletion of apex predators worldwide; shark declines are principally due to conservative life-histories and fisheries overexploitation. On coral reefs, sharks are strongly interacting apex predators and play a key role in maintaining healthy reef ecosystems. Despite increasing fishing pressure, reef shark catches are rarely subject to specific limits, with management approaches typically depending upon no-take marine reserves to maintain populations. Here, we reveal that this approach is failing by documenting an ongoing collapse in two of the most abundant reef shark species on the Great Barrier Reef (Australia). We find an order of magnitude fewer sharks on fished reefs compared to no-entry management zones that encompass only 1% of reefs. No-take zones, which are more difficult to enforce than no-entry zones, offer almost no protection for shark populations. Population viability models of whitetip and gray reef sharks project ongoing

steep declines in abundance of 7% and 17% per annum, respectively. These findings indicate that current management of no-take areas is inadequate for protecting reef sharks, even in one of the world's most-well-managed reef ecosystems. Further steps are urgently required for protecting this critical functional group from ecological extinction.

Carson, H.S. and Hentschel, B.T. **Estimating the dispersal potential of polychaete species in the Southern California Bight: implications for designing marine reserves.** *Marine Ecology Progress Series* 316: 105-113, 2006.

Notes: Using known and inferred life-history information, we estimated the dispersal potential of 501 polychaete species sampled during a 1998 monitoring study in the Southern California Bight. We tested the hypothesis that species having life-history traits that suggest long-distance dispersal will be encountered more frequently throughout the region than will species having life histories that suggest limited dispersal. When all 501 species and all 200 sampling sites were analyzed, occurrence frequency (percentage of sites at which a species was collected) was not significantly related to dispersal potential. When data from 53 shelf sites in the Channel Islands were analyzed separately from collections at 147 mainland-shelf sites, there was a significant positive relationship between dispersal potential and occurrence frequency at the island sites but not at the mainland sites. Of the 501 species, 119 were collected only at island sites, 98 were found only at mainland sites, and 284 were found at both island and mainland sites. The majority of the 'island only' species had life-history traits indicating low dispersal potential. In contrast, only 13% of the 'mainland only' species were categorized as having low dispersal potential. The 'cosmopolitan' species had a broad range of dispersal potential. Models indicate that efforts to conserve biodiversity by establishing Marine Protected Areas (MPAs) must consider species' dispersal. In the shelf communities of the Southern California Bight, networks of small reserves that are located in existing areas of high diversity should succeed in the Channel Islands, where the majority of polychaete species tend to have limited dispersal potential. On the mainland shelf, however, designing effective MPAs will be more challenging due to the prevalence of species that have a greater potential for long-distance dispersal to or from unprotected sites.

Mace, A.J. and Morgan, S.G. **Larval accumulation in the lee of a small headland: implications for the design of marine reserves.** *Marine Ecology Progress Series* 318: 19-29, 2006.

Notes: Oceanic currents and larval accumulation potentially have large impacts on the choice of locations for marine reserves. Larval settlement of benthic invertebrates was greater in the lee than on the windward side of a small headland during the height of upwelling in central California during 2001 and 2002. Strong upwelling during the study was indicated by mean seasonal Bakun indices of 149 to 176 $m^3 s^{-1}$ per 100 m of coastline in 2001-2002. Weekly sampling of near-surface and near-bottom settlement in the lee of Bodega Head from August 2000 to September 2001 revealed that most larvae of 7 crab taxa settled during spring and summer, which coincides with the upwelling season. Comparison of sites in the protected (lee) and exposed (windward) sides of the headland (2 sites each) during the peak settlement season in 2001 showed that most larvae settled in the lee of the headland, including 91% of crabs, 89% of barnacles, and 80% of mussels in weekly samples. During 2002, weekly sampling at 1 protected and 1 exposed site also demonstrated that most settlement occurred in the lee of the headland, including 74% of crabs, 82% of barnacles, and 65% of mussels. Crabs settled mostly at the surface, whereas barnacles and mussels primarily settled near the bottom, indicating that postlarvae in both surface and bottom waters accumulate in the lee of the headland. Larval accumulation zones should be included in networks of marine reserves to supply adult populations with propagules in recruitment-limited upwelling regions.

Lambert, D.M., Lipcius, R.N., and Hoenig, J.M. **Assessing effectiveness of the blue crab spawning stock sanctuary in Chesapeake Bay using tag-return methodology.** *Marine Ecology Progress Series* 321: 215-225, 2006.

Notes: The blue crab spawning stock in Chesapeake Bay sustained a severe and persistent decline beginning in 1992. As part of the effort to enhance the spawning stock, the spawning sanctuary in lower Chesapeake Bay was enlarged to over 240 000 ha. This marine reserve and corridor prohibits exploitation of mature females en route to or in the spawning grounds during the summer spawning season (1 June to 15 September). To assess the effectiveness of the sanctuary, we tagged terminally melted, mature females inside and outside the sanctuary during 3 sanctuary seasons (2002 to 2004). Crabs were captured throughout the bay and its tributaries, measured, tagged, and released on site. Recaptures of tagged crabs were reported by commercial and recreational fishers. Probability of recapture for crabs released outside the sanctuary was 6.3, 5.2, and 2.8

times the probability of recapture for crabs tagged inside the sanctuary in 2002, 2003 and 2004, respectively. Consequently, a significant proportion of adult female blue crabs remains in the sanctuary to spawn and is not captured by the fishery. Hence, the marine reserve and corridor for the blue crab spawning stock in Chesapeake Bay is an effective means of protecting females migrating to or residing in the spawning grounds. This investigation serves as one of the few empirical tests to date of the effectiveness of a marine reserve designed to protect spawning stock.
