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Editorial

Super-sized MPAs and the marginalization of species conservation

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MARINE CONSERVATION IS OFTEN MODELLED ON TERRESTRIAL CONSERVATION

Marine species conservation died prematurely early in the new millennium before it had a chance to grow and flourish. The revolution happened; the world turned and moved on to managing higher-order ecological processes and services. The revolutionary conservation and research agenda of the new millennium has at least four interrelated themes: super-sized marine protected areas (MPAs; Wood *et al*., 2008; Pala, 2013), the ecosystem approach to fisheries management (ICES, 2005), ecosystem services and the economic valuation of nature and the poverty alleviation paradigm (Millennium Ecosystem Assessment, 2005; Sachs *et al*., 2009; Roe, 2013), plus the outlying game-changer of climate change (Hoegh-Guldberg and Bruno, 2010). These themes all involve higher-level aggregate attributes and values of biodiversity. Here, I pick one issue, MPAs, as a synecdoche – the part that may reflect the whole – of how conserving aggregate ecological attributes may dilute effective conservation.

Traditionally, marine conservation has followed the terrestrial template of population- and species-specific interventions by local government, in many cases prompted by the efforts of non-governmental organizations. Those species closest to extinction have been painstakingly nursed back to viability one newborn at a time in zoo-based captive breeding programmes, before being reintroduced into the wild, often into newly restored or protected habitats (Redford *et al*., 2011). Governments also employ species protection legislation to minimize threats through enforced spatial protection of critical habitat, usually by protected areas and parks.

On land, conservation has become increasingly strategic, especially with the advent of the mega-environmental non-governmental organizations (eNGOs, such as World Wildlife Fund, The Nature Conservancy, and Conservation International). An increasingly global-scale strategic approach to terrestrial conservation has been facilitated by in-house teams of conservation biologists who designed the most effective conservation outcomes, nationally and internationally.

This creative environment led to one of the most iconoclastic papers in conservation biology – 'Biodiversity hotspots for conservation priorities' (Myers *et al*., 2000) – in which, the authors revealed the 25 terrestrial hotspots of exceptional

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concentrations of threatened endemic species: almost half (44%) of vascular plants and a third (35%) of species in four main vertebrate clades could be secured by protecting only 1.4% of the Earth's land surface. We now know that these areas could be protected in perpetuity for an endowment of around only $500 million a year (Roman *et al*., 2009). While this may seem like a vast amount of money to us, it is a fraction of the budgets of governments and venture capitalists. As the authors point out, 'this is less than 0.1% of the funds allocated to the United States' Troubled Asset Relief Program (TARP) to bail out incompetent financial institutions'.

GLOBAL CONSERVATION PLANNING RELIES ON IUCN KNOWLEDGE PRODUCTS

This global strategic approach to conservation planning (Margules and Pressey, 2000) was made possible only through the development of species distribution maps and extinction risk assessments generated by the Species Specialist Groups of the International Union for Conservation of Nature Species Survival Commission (IUCN SSC) using their Red List Categories and Criteria (www.iucnredlist.org). The IUCN SSC has been evaluating the extinction risk of species since the 1950s, beginning with lists of those species believed to be at most risk of extinction, through to the first Red Data books for birds and mammals in the 1960s (Mace *et al*., 2008). Since then the process has grown and matured into a robust, objective and widely applicable classification scheme. The criteria are deceptively simple, yet are founded upon more than half a century of population dynamics theory (Mace and Lande, 1991). By the end of 2012, more than 65,518 species had been assessed across three kingdoms of life: animals, plants and fungi (http://www.iucnredlist.org/documents/summarystatistics/2012_2_RL_Stats_Table_1.pdf). The aide-memoir summary of the five criteria fits on a single page (http://www.iucnredlist.org/documents/2001CatsCrit_Summary_EN.pdf). The devil is in the details, and these are elaborated upon at length in a 38-page *Categories and Criteria* document (IUCN, 2001) and an 89-page set of guidelines (IUCN, 2004). In addition to enabling the delineation of hotspots, the Red List Assessments have provided the background information used to spur on national and regional species conservation, such as the US Endangered Species Act, Canada's Species at Risk Act, and the Barcelona and Berne conventions in Europe.

A DECADE OF PROGRESS IN MARINE RED LIST ASSESSMENT

Modelled on a decade of terrestrial geoconservation planning, a small team was convened in Washington DC in 2003 to plan the Global Marine Species Assessment (GMSA). The challenge was to prioritize the assessment of taxa that had a manageable number of species that could be tackled within a workshop by a small number of experts (there are more than 15 000 marine fishes). A decade on, the GMSA (http://sci.odu.edu/gmsa/), under the leadership of Professor Kent E. Carpenter, is over halfway to its goal of listing 20 000 marine fishes and invertebrates. It has assessed over 10 500 species, over half of which have passed through the review and quality control process and now appear in the IUCN Red List. Based on the work of the GMSA and associated Specialist Groups, we now know for the first time the status of some of the most economically and functionally important lineages, such as tunas and billfishes (Collette *et al*., 2011), parrotfishes and surgeonfishes (Comeros-Raynal *et al*., 2012), hagfishes (Knapp *et al*., 2011), as well as foundational species, including hard corals (Carpenter *et al*., 2008), seagrasses (Short *et al*., 2011), and mangroves (Polidoro *et al*., 2010). We now know the status of important biogeographic regions, such as the Mediterranean Sea (Cavanagh and Gibson, 2007; Malak *et al*., 2011), and Tropical Eastern Pacific (Polidoro *et al*., 2012), and we now have a thematic summary of the status of some of the most charismatic marine organisms (McClenachan *et al*., 2012), as well as a progress report on the status of marine species. So now we have the data why aren't we using it to conserve and manage populations and species?

THE RACE FOR SUPER-SIZED MARINE PROTECTED AREAS

The burgeoning primary literature and meta-analyses of the efficacy of marine protected areas has driven the quest for vast MPA networks (Molloy *et al.*, 2009; Gaines *et al.*, 2010). The message is simple - get what you can where you can annoy as few people as possible (Cressey, 2011; Trathan *et al.*, 2012). MPAs are often the conservation of a political opportunity rather than any unique biological feature and rarely has sufficient science come into the planning (Sale *et al.*, 2005). MPAs are alluring because there is no apparent need for science to guide their designation because the concept of ring-fencing or banking biodiversity is intuitive to anyone, hence easy to sell as the least-complicated 'magic bullet' solution (Trathan *et al.*, 2012). Even better, conservation eNGOs can sidestep the difficult challenges of fisheries management and work through the jurisdictions of the national environmental departments with which they may be more familiar. If implemented effectively MPAs can be extraordinarily successful, assuming it is clear what they were established to achieve in the first place (Lester *et al.*, 2009), however, there are surprisingly few clear examples of MPA success (Rife *et al.*, 2012).

The development of MPAs in the ocean has lagged far behind protected area designation on land (Pauly and Maclean, 2003). Until recently the rate of MPA designation was sluggish, and the median size of those MPAs was tiny – around 4.6 km^2 (Wood *et al.*, 2008). By the end of 2006, only 0.65% of the world's oceans (2.35 million km^2) had been designated through 4435 protected areas (Wood *et al.*, 2008). At this rate of designation it was estimated that the World Parks Congress target of protecting 30% of the world oceans by 2020 would not be reached until after 2090, and the then (2006) Convention on Biological Diversity target of 'at least 10% of each of the world's ecological regions [including marine and coastal] effectively conserved [by 2010] was adopted', by 2067 (Wood *et al.*, 2008). There are other stated goals for MPAs, however, this shortfall in the area protected has spurred on the development of super-sized MPAs and shark 'sanctuaries' – a heterogeneous class of spatial protections with the goal of protecting shark populations favoured and branded by the Pew Environment Group (Davidson, 2012; Pew Environmental Group, 2013). These super-sized MPAs and shark 'sanctuaries' may be the low-hanging fruit of marine conservation (Veitch *et al.*, 2012), and are mainly located in the sparsely populated Pacific Ocean often far from human settlements (Trathan *et al.*, 2012). The progress in the area acquisition goal of MPA designation up to 2006 was eclipsed last year, in 2012, when the global marine area protected doubled with the designation of the Coral Islands (503 000 km^2), Cook Islands (1 000 000 km^2), and New Caledonia (1 300 000 km^2) as reserves, albeit with varying levels of fisheries access (Pala, 2013). To date 5 300 000 km^2 or 1.6% of the world's oceans are designated as some form of marine protected area (Trathan *et al.*, 2012).

MPA PROGRESS, BUT IS IT CONSERVING BIODIVERSITY?

While we may now be back on track to meet the World Parks Congress target of 30% by 2020, but with respect to protecting species and improving fisheries yield are we missing the point? Many marine protected areas are not sanctuaries in the sense that the animals inside are safe from fishing (and other damaging activities). There are often varying levels of fisheries access and this important subtlety is often not readily apparent to the general public (Robbins *et al.*, 2006; Davidson, 2012; Sala *et al.*, 2012; DFO, 2013). Without effective enforcement enabled by sustainable financing, the aptly named 'paper parks' promise much hope but may deliver little more than a false sense of security or veneer of success (Cressey, 2011; Rife *et al.*, 2012).

There are many other MPA objectives, such as the protection of representative habitats and ecosystems, and science challenges (Sale *et al.*, 2005), but the successful enforcement of MPAs and most recently shark 'sanctuaries' (Davidson, 2012) is by far the greatest elephant in this room. For example, in Italian waters, only three out of 15 MPAs had effective enforcement, which resulted in significant improvements in predator density above that of control areas (Guidetti *et al.*, 2008). Similarly, the necessity of effective enforcement was underscored in the Great Barrier Reef Marine Park where only the most strictly protected no-entry zones (Preservation Zone, 'pink' reef) had the highest shark abundance; by comparison Marine National Park 'green' zoned reefs which allowed fishing boats to anchor but they are not legally allowed to fish were ineffective compared with control areas (Dulvy, 2006; Robbins *et al.*, 2006; Ayling and Choat, 2008). Traditional fisheries management measures such as landing size limits, tailored to the biology of the species of conservation interest, can be at least as effective as quite extensive and highly restrictive marine protected areas. Such fisheries measures have the advantage of being routinely used by fishers and within the competency of fisheries institutions, rather than an MPA which would involve multiple institutions and jurisdictions (Wiegand *et al.*, 2011). While the designation of an MPA is a necessary first step toward effective conservation, without sustained engagement and financing to ensure effective enforcement the hope generated by press releases and subsequent media uptake may be the only outcome. We assume that paper parks have no cost to conservation, is that true?

ARE PAPER PARKS ENABLING OVEREXPLOITATION AND DEGRADATION?

In an era of almost daily reports of biodiversity and climate change, hopeful stories are important motivators of societal change. But is there a risk that the hopeful designation of insufficiently enforced paper parks actually set conservation backwards? Is a paper park better than no park? Is a paper park better than using limited resources to tackle other conservation issues? One possible risk is that the paper park alone is perceived to be a conservation success, in terms of protecting species and sustaining fisheries (Rife *et al.*, 2012). After all why do we need more conservation when there is an MPA there already? Insufficiently enforced MPAs may be enabling ongoing environmental degradation. We can draw insights from the enabling behaviour of ecological restoration.

In the way that the friends and families of drug addicts support them and hence enable their continued addiction and destruction, ecological restoration can enable habitat degradation (Moore and Moore, 2013). Ecological restoration rarely returns habitats to their former diversity and function, and hence the availability of this tool allows industries to expand their footprint enabling environmental degradation while apparently compensating for it by 'repairing' another location (Moore and Moore, 2013). By analogy to the enabling behaviour of ecological restoration, I wonder whether unenforced MPAs may be enabling continued overfishing by precluding fund-raising for effective species management and conservation.

BUT WHATEVER HAPPENED TO EVIDENCE-BASED SPECIES CONSERVATION?

Last year Jonathan Baillie and Ellen Butcher worked with the Species Specialist Groups of the IUCN Species Survival Commission to compile lists of those species at most imminent risk of extinction. Along the way they realized that of the 100 species that are at most imminent risk of extinction, no more than half had any conservation in place. They were sufficiently astonished to rename the report, '*Priceless or worthless*?' (Baillie and Butcher, 2012). After a week of sessions dominated by higher order attribute conservation (marine protected areas, climate adaptation and ecosystem services) at the World Conservation Congress in Korea (www.iucnworldconservationcongress.org), the audience present at Baillie's launch of this report was stunned at this profound insight. His point was, if we are at risk of losing unique, irreplaceable and hence 'priceless' species within the next decade yet we are not moving to conserve them, does that not mean that they are worthless? The mood was captured perfectly by Dr Nicholas Pilcher, co-chair of the Marine Turtle Specialist Group, who stated, 'aren't species the building blocks of ecosystems and hence ecosystem services'. In our rush for super-sized MPAs and other higher-level conservation activities and values, are we missing the point? The point is that if we manage and conserve species effectively then the downstream benefits of ecosystem structure, function, and services will also be secured and resilient. I am not arguing against MPAs or any other form of conservation for higher-level attributes or values, but I raise the question as to whether in doing so we may be failing to effectively conserve species.

Protecting ocean area is just part of the solution; there are many ways the new IUCN data can be used to guide MPA designation priorities. But if ever there was a *Priceless or Worthless* species that might benefit from the protection of an effective MPA it is the Critically Endangered Angel shark (*Squatina squatina*) (Morey *et al*., 2006, Dulvy and Forrest, 2009, Baillie and Butcher, 2012). This species is now a conservation priority; but only because its perilous status became clear through the comprehensive IUCN Global Shark Red List Assessment. Conservation, whether through MPA or the range of fisheries management options is challenging, time consuming and expensive, so let's use the newly available data to get it right.

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REFERENCES

Ayling AM, Choat JH. 2008. *Abundance Patterns of Reef Sharks and Predatory Fishes on Differently Zoned Reefs in the Offshore Townsville Region: Final Report to the Great Barrier Reef Marine Park Authority*. Great Barrier Reef Marine Park Authority: Townsville.

Baillie JEM, Butcher ER. 2012. *Priceless or Worthless: The World's Most Threatened Species*. Zoological Society of London: London.

Carpenter KE, Abrar M, Aeby G, Aronson RB, Banks S, Bruckner A, Chiriboga A, Cortes J, Delbeek JC, DeVantier L, *et al.* 2008. One-third of reef-building corals face elevated extinction risk from climate change and local impacts. *Science* **321**: 560–563.

Cavanagh R, Gibson C. 2007. Overview of the conservation status of cartilaginous fishes (Chondrichthyans) in the Mediterranean Sea. *IUCN Species Survival Commission Shark Specialist Group*. Gland: Switzerland and Malaga, Spain.

Collette BB, Carpenter KE, Polidoro BA, Juan Jorda MJ, Boustany A, Die DJ, Elfes C, Fox W, Graves J, Harrison L, *et al.* 2011. High value and long-lived - double jeopardy for tunas and billfishes. *Science* **333**: 291–292.

Comeros-Raynal MT, Choat JH, Polidoro BA, Clements KD, Abesamis R, Craig MT, Lazuardi ME, McIlwain J, Muljadi A, Myers RF, *et al.* 2012. The likelihood of extinction of iconic and dominant herbivores and detritivores of coral reefs: the parrotfishes and surgeonfishes. *PLoS One* **7**: e39825.

Cressey D. 2011. Uncertain sanctuary. *Nature* **480**: 166–167.

Davidson LNK. 2012. Shark sanctuaries: substance or spin? *Science* **338**: 1538–1539.

DFO. 2013. Rockfish Conservation Areas. http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/rca-acs/index-eng.htm.

Dulvy NK. 2006. Conservation biology: strict marine protected areas prevent reef shark declines. *Current Biology* **16**: R989-R991.

Dulvy NK, Forrest RE. 2009. Life histories, population dynamics, and extinction risks in chondrichthyans. In *Sharks and Their Relatives II: Biodiversity, Adaptive Physiology, and Conservation*, Carrier JC, Musick JA, Heithaus MR (eds). CRC Press: Boca Raton; 635–676.

Gaines SD, White C, Carr MH, Palumbi SR. 2010. Designing marine reserve networks for both conservation and fisheries management. *Proceedings of the National Academy of Sciences of the United States of America* **107**: 18286–18293.

Guidetti P, Milazzo M, Bussotti S, Molinari A, Murenu M, Pais A, Spano N, Balzano R, Agardy T, Boero F, *et al.* 2008. Italian marine reserve effectiveness: does enforcement matter? *Biological Conservation* **141**: 699–709.

Hoegh-Guldberg O, Bruno JF. 2010. The impact of climate change on the world's marine ecosystems. *Science* **328**: 1523–1528.

ICES. 2005. *Guidance on the Application of the Ecosystem Approach to Management of Human Activities in the European Marine Environment*. ICES Cooperative Research Report: Copenhagen, Denmark.

IUCN. 2001. IUCN Red List Categories and Criteria: version 3.1. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

IUCN. 2004. *Guidelines for Using the IUCN Red List Categories and Criteria*. IUCN Species Survival Commission, Gland, Switzerland.

Knapp L, Mincarone MM, Harwell H, Polidoro B, Sanciangco J, Carpenter K. 2011. Conservation status of the world's hagfish species and the loss of phylogenetic diversity and ecosystem function. *Aquatic Conservation: Marine and Freshwater Ecosystems* **21**: 401–411.

Lester SE, Halpern BS, Grorud-Colvert K, Lubchenco J, Ruttenberg BI, Gaines SD, Airame S, Warner RR. 2009. Biological effects within no-take marine reserves: a global synthesis. *Marine Ecology Progress Series* **384**: 33–46.

Mace GM, Lande R. 1991. Assessing extinction threats: toward a reevaluation of IUCN threatened species categories. *Conservation Biology* **5**: 148–157.

Mace GM, Collar NJ, Gaston KJ, Hilton-Taylor C, Akcakaya HR, Leader-Williams N, Milner-Gulland EJ, Stuart SN. 2008. Quantification of extinction risk: IUCN's system for classifying threatened species. *Conservation Biology* **22**: 1424–1442.

Malak DA, Livingstone SR, Pollard D, Polidoro BA, Cuttlerod A, Bariche M, Bilecenoglu M, Carpenter KE, Collette BB, Francour P, *et al.* 2011. *Overview of the Conservation Status of the Marine Fishes of the Mediterranean Sea. International Union for the Conservation of Nature*. Gland: Switzerland and Malaga, Spain.

Margules CR, Pressey RL. 2000. Systematic conservation planning. *Nature* **405**: 243–253.

McClenachan L, Cooper AB, Carpenter KE, Dulvy NK. 2012. Extinction risk and bottlenecks in the conservation of charismatic marine species. *Conservation Letters* **5**: 73–80.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Biodiversity Synthesis*. World Resources Institute: Washington, DC.

Molloy PP, McLean IB, Côté IM. 2009. Effects of marine reserve age on fish populations: a global meta-analysis. *Journal of Applied Ecology* **46**: 743–751.

Moore KD, Moore JW. 2013. Ecological restoration and enabling behavior: a new metaphorical lens? *Conservation Letters* **6**: 1–5.

Morey, GSF, Mancusi C, Fowler SL, Dipper F, Ellis J. 2006. *Squatina squatina*. http://www.iucnredlist.org/details/39332/0.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **403**: 853–858.

Pala C 2013. Giant marine reserves pose vast challenges. *Science* **339**: 640–641.

Pauly D, Maclean J. 2003. *In a Perfect Ocean: Fisheries and Ecosystems in the North Atlantic*. Island Press: Washington.

Pew Environmental Group. 2013. Enforcing the laws of shark sanctuaries. http://www.pewenvironment.org/news-room/other-resources/enforcing-laws-of-the-worlds-shark-sanctuaries-85899447434.

Polidoro BA, Carpenter KE, Collins L, Duke NC, Ellison AM, Ellison JC, Farnsworth EJ, Fernando ES, Kathiresan K, Koedam NE, *et al.* 2010. The loss of species: mangrove extinction risk and geographic areas of global concern. *PLoS One* **5**: e10095.

Polidoro BA, Brooks T, Carpenter KE, Edgar GJ, Henderson S, Sanciangco J, Robertson DR. 2012. Patterns of extinction risk and threat for marine vertebrates and habitat-forming species in the Tropical Eastern Pacific. *Marine Ecology Progress Series* **448**: 93–104.

Redford KH, Amato G, Baillie J, Beldomenico P, Bennett EL, Clum N, Cook R, Fonseca G, Hedges S, Launay F, *et al.* 2011. What does it mean to successfully conserve a (vertebrate) species? *Bioscience* **61**: 39–48.

Rife AN, Erisman B, Sanchez A, Aburto-Oropeza O. 2012. When good intentions are not enough … Insights on networks of "paper park" marine protected areas. *Conservation Letters*. DOI: 10.1111/j.1755-263X.2012.00303.x

Robbins WD, Hisano M, Connolly SR, Choat JH. 2006. Ongoing collapse of coral reef shark populations. *Current Biology* **16**: 2314–2318.

Roe D 2013. Has biodiversity fallen off the development agenda? A case study of the UK Department for International Development. *Oryx* **47**: 113–121.

Roman J, Ehrlich PR, Pringle RM, Avise JC. 2009. Facing Extinction: Nine Steps to Save Biodiversity. *Solutions Journal* **1**: 50–66.

Sachs JD, Baillie JEM, Sutherland WJ, Armsworth PR, Ash N, Beddington J, Blackburn TM, Collen B, Gardiner B, Gaston KJ, *et al.* 2009. Biodiversity Conservation and the Millennium Development Goals. *Science* **325**: 1502–1503.

Sala E, Ballesteros E, Dendrinos P, Di Franco A, Ferretti F, Foley D, Fraschetti S, Friedlander A, Garrabou J, Güçlüsoy H, *et al.* 2012. The structure of Mediterranean rocky reef ecosystems across environmental and human gradients, and conservation implications. *PLoS One* **7**: e32742.

Sale PF, Cowen RK, Danilowicz BS, Jones GP, Kritzer JP, Lindeman KC, Planes S, Polunin NVC, Russ GR, Sadovy YJ, *et al.* 2005. Critical science gaps impede use of no-take fishery reserves. *Trends in Ecology & Evolution* **20**: 74–80.

Short FT, Polidoro B, Livingstone SR, Carpenter KE, Bandeira S, Bujang JS, Calumpong HP, Carruthers TJB, Coles RG, Dennison WC, *et al.* 2011. Extinction risk assessment of the world's seagrass species. *Biological Conservation* **144**: 1961–1971.

Trathan PN, Sala E, Merkl A, Beumer J, Spalding M. 2012. The MPA math: how to reach the 10% target for global MPA coverage. *MPA News* **13**: 1–4.

Veitch L, Dulvy NK, Koldewey H, Lieberman S, Pauly D, Roberts CM, Rogers AD, Baillie JEM. 2012. Avoiding empty ocean commitments at Rio +20. *Science* **336**: 1383–1385.

Wiegand J, Hunter E, Dulvy NK. 2011. Are spatial closures better than size limits for halting the decline of the North Sea thornback ray *Raja clavata*? *Marine and Freshwater Research* **62**: 722–733.

Wood LJ, Fish L, Laughren J, Pauly D. 2008. Assessing progress towards global marine protection targets: shortfalls in information and action. *Oryx* **42**: 340–351.

