CHAPTER 20

MARINE PROTECTED AREA MANAGEMENT

Principal authors:
Jon C. Day, Dan Laffoley and Katherine Zischka

Supporting authors:
Paul Gilliland, Kristina Gjerde, Peter J. S. Jones, John Knott, Laurence McCook, Amy Milam, Peter J. Mumby and Aulani Wilhelm

CONTENTS

IUCN
WCPA World Commission on Protected Areas
Convention on Biological Diversity

PRINCIPAL AUTHORS

JON DAY was previously Director of Heritage Conservation at the Great Barrier Reef Marine Park Authority, and is now a PhD student at the Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Australia.

DAN LAFFOLEY is Senior Advisor, Marine Science and Conservation, International Union for Conservation of Nature (IUCN) Global Marine and Polar Program and Marine Vice-Chair of the IUCN World Commission on Protected Areas (WCPA), United Kingdom.

KATHERINE ZISCHKA is a marine research consultant, a member of the IUCN WCPA, and has worked in marine research, conservation, advocacy and management.

SUPPORTING AUTHORS

PAUL GILLILAND is Head of Marine Planning at the Marine Management Organisation, Cambridge, United Kingdom.

KRISTINA GJERDE is Senior High Seas Advisor to the IUCN Global Marine and Polar Program, USA.

PETER J. S. JONES is Senior Lecturer in the Department of Geography, University College London, United Kingdom.

JOHN KNOTT is Director of Knott and Associates, Hall, ACT, Australia.

LAURENCE McCOOK is Manager of Ecosystem Conservation and Resilience, Great Barrier Reef Marine Park Authority, Australia.

AMY MILAM is Protected Areas Program Officer with the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) in Cambridge, UK.

PETER J. MUMBY is Professor in the Marine Spatial Ecology Lab, University of Queensland, Australia.

AULANI WILHELM is Superintendent of the Papahānaumokuākea Marine National Monument, National Oceans Atmospheric Administration, USA.

ACKNOWLEDGMENTS

Our thanks go to all the supporting authors listed above and the case study and box authors (Michael Coyle, Fanny Douvere, Charles Ehler, Erich Hoyt, Paul Marshall, Giuseppe Notarbartolo di Sciara, David Obura, John Roff and Rod Salm) for their assistance, and to John Baxter and Graeme Worboys for comments on earlier manuscript drafts.

CITATION

Day, J. C., Laffoley, D. and Zischka, K. (2015) 'Marine protected area management', in G. L. Worboys, M. Lockwood, A. Kothari, S. Feary and I. Pulsford (eds) *Protected Area Governance and Management*, pp. 609–650, ANU Press, Canberra.

TITLE PAGE PHOTO

Aerial view of the Great Barrier Reef Marine Park, Australia
Source: © Great Barrier Reef Marine Park Authority

Introduction

Globally, the protection of marine areas has been a comparatively recent initiative compared with the use of protected areas for terrestrial conservation and resource management. Oceans cover 70 per cent of the Earth's surface and contain 97 per cent of the Earth's water. They drive climate and weather, regulate temperature, generate much of the oxygen in the atmosphere, absorb much of the carbon dioxide, and replenish freshwater to both land and sea through the formation of clouds. Oceans make up more than 90 per cent of the planet's biologically useful habitat and contain most of the life on Earth, including nearly all of the major groups of animals, plants and microbes. This watery living system is critical to how our world works. Oceans supply food, provide leisure opportunities and generate billions of dollars for national economies.

In recent decades, considerable efforts have been directed worldwide to establishing marine protected areas (MPAs). There has been a growing understanding that far more needs to be done to adequately manage our use of coasts, seas and oceans in order to ensure environmental and economic sustainability. There is an emerging realisation that effective marine protection requires us to identify and protect representative examples of marine habitats, rather than trying to protect specific threatened species or special or scenic areas (Day and Roff 2000). To be effective in protecting marine biodiversity, this approach needs to be applied in offshore waters and the open sea, as well as in near-shore and coastal areas.

In this chapter, we outline the progress in establishing marine protected areas across the world's oceans, consider the various types of marine protected areas and their benefits, and describe key aspects of their governance and management.

Progress in establishing marine protected areas

For the oceans, little progress in protection was made until a little more than 100 years ago when the world's first MPAs were declared in Australia. The earliest of these—Royal National Park, part of which includes a large tidal inlet—is located on the southern outskirts of Sydney and was designated in 1879. Most of these early MPAs focused on the protection of iconic species or special habitats rather than taking an ecosystem-based approach. What some refer to as the world's first 'proper' MPA for ecosystems was the Fort Jefferson National Monument in Florida, USA, a coastal marine site designated in 1935.

Coral Reef, Ha'apai Multi/Multiple Use Conservation Area, Kingdom of Tonga

Source: Katherine Zischka

The main impetus for MPAs, however, came much later with the World Parks Congress on National Parks in 1962, and a follow-up meeting in 1982 calling for the incorporation of marine, coastal and freshwater sites into the worldwide network of protected areas. The movement for MPAs grew in strength from that point, in the recognition that demand was outstripping supply of goods and services from the ocean to fuel an ever-increasing global population. The 1982 UN Convention on the Law of the Sea (UNCLOS), the fundamental framework for marine governance globally, further obliged all states to protect and preserve the marine environment.

In 1995, a four-volume series recommended a globally representative network of MPAs (GBRMPA et al. 1995); this was the first real global focus on marine protection through MPAs, and was followed by a guide for MPA planners and managers in 2000 (Salm et al. 2000). The World Summit on Sustainable Development (WSSD) in 2002 called for the establishment of MPA networks by 2012 (UN 2002). Further supporting this goal, four years later, the UN Convention on Biological Diversity (CBD) reinforced the WSSD decision by setting a global target for at least 10 per cent of each of the world's marine ecological regions to be effectively conserved by 2012 (CBD 2004). In 2003, the recommendations of the fifth International Union for Conservation of Nature (IUCN) World Parks Congress broadened this—to 'establish by 2012 a global system of effectively managed, representative networks of marine

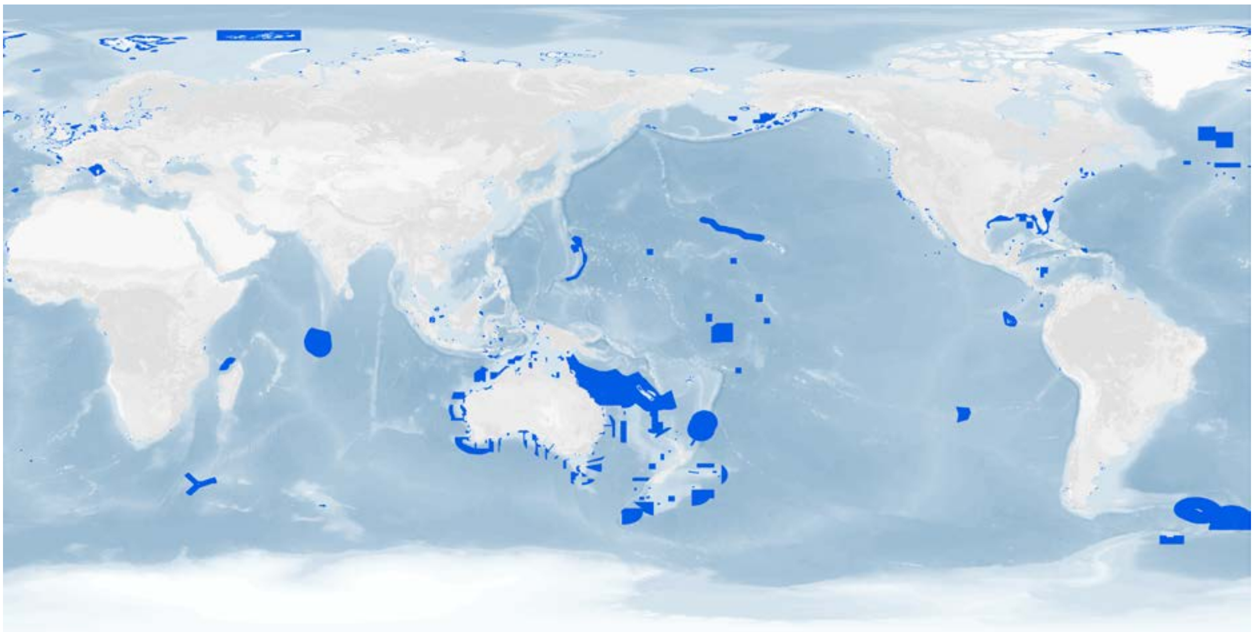

Figure 20.1 Global extent of Marine Protected Areas (MPAs). MPAs cover approximately 3.4% of Earth's oceans. For national jurisdiction (0–12 nautical miles), 8.4% is covered, for the Exclusive Economic Zone (12–200 nautical miles), 8.0% is covered (UNEP-WCMC 2014).

Source: IUCN and UNEP-WCMC (2014)

and coastal protected areas' (IUCN WCPA 2003b:191), which was maintained in the CBD 2011–20 strategic plan (CBD 2011).

While the time scales may have changed more recently, these remain the principal global targets for MPAs. After setting the initial global target to effectively conserve at least 10 per cent of each of the world's marine ecological regions by 2012, the world acknowledged a decade later that the 10 per cent target was not going to be achieved and the deadline was extended to 2020, with a revised text:

> By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes. (CBD 2011)

By including ecosystem services and stating that area-based protection must be effectively and equitably managed as well as ecologically representative, Aichi Target 11 has become a much more meaningful target for the world to achieve (Figure 20.1). The target is not only more meaningful for the ocean but also more attainable. It implies a scientifically driven, culturally inclusive and well-balanced effort by countries; however, there is still no guidance for countries to ensure their conservation efforts contribute to the newly revised targets that now include 10 per cent of marine areas. This lack of clarity effectively leaves each member country to decipher what it means within respective political contexts.

Despite evident growth in the MPA network, we are still far below the 10 per cent target for the global ocean. The reason is that growth in marine protection has occurred primarily in near-shore coastal zones (Spalding et al. 2014). Of the 3.4 per cent of the global ocean that is currently protected, the largest proportion is still concentrated in the territorial seas (within 12 nautical miles of shore). Beyond this point, protection drops sharply in exclusive economic zones (EEZs) (up to 200 nautical miles) and is further reduced in the high seas beyond national jurisdiction (Toropova et al. 2010). Based on these statistics, to meet the 10 per cent marine target in areas under national jurisdiction alone (0–200 nautical miles), it is estimated that an additional 6.5 million square kilometres of marine and coastal areas will need to be protected by 2020.

Despite ongoing concerns about how and when the Aichi Target for MPAs will be met, the world continues to make significant progress in achieving increasingly higher levels of marine protection. Toropova et al. (2010) showed that the MPA network had grown by 150 per cent in seven years. In terms of ecological representativeness, recent estimates indicate that 59 per cent of the 232 marine ecoregions still have less than 1 per cent of their area protected (Bertzky et al. 2012).

There are signs that the currently skewed level of marine protection could be starting to balance out as the number and extent of MPAs, including very large offshore MPAs and community-supported MPAs, have increased rapidly in recent years, and an additional 3.6 million square kilometres of marine reserves are planned for establishment over the next few years (Pala 2013).

Types of marine protected areas

IUCN categories and marine protected areas

So what counts as an MPA? As set out earlier in this book, a protected area as defined by the IUCN must have nature conservation as the primary objective. This definition forms the basis for defining MPAs, just as it does for terrestrial protected areas. Other existing values may be of similar importance, but in the event of a conflict between values, nature conservation must be considered the most important. Therefore, a site may be considered an MPA provided it: 1) has defined boundaries that can be mapped; 2) is recognised by legal or other effective means; and 3) has distinct and unambiguous management aims that can be assigned to a particular protected area category. The six management category types and four governance types are set out in Dudley (2008) (see Chapters 2 and 7).

In the sea, as on land, there are many managed areas that protect biodiversity indirectly, incidentally or fortuitously. It is indeed a principle of the CBD's ecosystem approach that all land and water management should contribute to conservation, and as a result the distinction between what is and what is not a protected area is sometimes unclear; however, such areas do not necessarily fulfil the IUCN definition of a protected area.

This is particularly the case in the marine environment, where spatial planning and management of activities often have no stated aim or interest in nature conservation; they are just an incidental link. While some areas may be relatively easy to classify, others may be harder to determine and the following types of area-based measures are not necessarily MPAs:

- fishery management areas (temporary or permanent) with no wider stated conservation aims
- community areas managed primarily for sustainable extraction of marine products (such as coral, fish and shells)
- marine and coastal management systems managed primarily for tourism, which also include areas of conservation interest
- wind farms and oil platforms that incidentally help to build up biodiversity around underwater structures and by excluding fishing and other vessels.

Given the challenges in interpreting Dudley (2008) for MPAs, supplementary guidelines were issued in 2012 to ensure the IUCN categories can be effectively applied to all types of MPAs, as well as to any marine components of adjoining terrestrial protected areas (Day et al. 2012). The guidelines are intended primarily for policymakers but are also useful to help MPA managers understand the management objectives for the category to which an MPA has been assigned and thus guide planning and implementation.

Marine Indigenous Peoples' and Community Conserved Territories and Areas

Indigenous Peoples' and Community Conserved Territories and Areas (ICCAs) are defined by the IUCN as 'natural and/or modified ecosystems containing significant biodiversity values, ecological functions and benefits, and cultural values voluntarily conserved by indigenous peoples and local communities both sedentary and mobile—through customary laws or other effective means' (Corrigan and Granziera 2010:1).

As with other governance types, community areas managed primarily for sustainable extraction of marine products would not be considered MPAs according to the IUCN definition unless nature conservation is the primary stated objective of the management regime.

Many ICCAs have been established by coastal communities in marine ecosystems (Box 20.1). The ICCA Registry is an online information portal and secure database developed by the UN Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC) with support from the UN Development Programme's Global Environment Fund Small Grants Program, which documents indigenous and community conservation areas including in the marine environment (Day et al. 2012a). The ICCA Registry aims to increase awareness of the biodiversity values of areas managed by communities, and provides a wide range of information. It is hoped that further guidance on implementing the IUCN categories in marine ICCAs will be developed. Additional information is available through the ICCA Consortium and a primary reference is Dudley (2008) (see Chapter 8).

Box 20.1 Examples of community conserved marine areas

In many parts of the world, indigenous peoples and local communities manage marine and coastal areas in ways that help ensure conservation. Such ICCAs include:

- in Fiji, 149 locally managed marine areas (LMMAs) governed by communities and recognised by law make up all of Fiji's MPAs, covering 1.77 million hectares (more than 50 per cent of the country's inshore marine area)
- in Madagascar, 16 LMMAs of varying size cover 394 000 hectares
- in Kenya, several inshore reef areas are managed by fisher communities under the *Fisheries Act*, which allows for the creation of Beach Management Units to develop and enforce rules governing their fisheries, including demarcating boundaries and excluding non-members from outside the area
- in Japan, more than 1000 community protected or conserved marine areas have been documented, including 387 self-imposed no-catch community MPAs
- in Costa Rica, there are an increasing number of 'marine areas for responsible fishing' where fisher communities are authorised to make local rules and enforce them
- in Spain, marine ICCAs are governed by about 230 *Cofradías*, ancient local governance bodies that manage the common use of all coastal professional fisheries in the country
- in Australia, Canada, the Philippines and some other countries, several indigenous territories recognised or in the process of recognition cover marine areas crucial for biodiversity conservation
- communities protect marine turtle nesting sites in Chile, Costa Rica, Suriname and several countries of South Asia; in Suriname, several other marine species including the West Indian manatee (*Trichechus manatus*) also benefit from such protection.

Source: Kothari et al. (2012)

Locally managed marine area at Laitoko Village, Solomon Islands

Source: Hugh Govan

Private marine protected areas

Alongside traditional types of MPAs, there are a small but growing number of privately run MPAs, which like other protected areas must still meet the established IUCN criteria to count as an MPA. A good example is Chumbe Island Coral Park Limited (CHICOP). This is an award-winning private nature reserve, first developed in 1991 for the conservation and sustainable management of uninhabited Chumbe Island off Zanzibar, one of the last pristine coral islands in the region. The company's objectives are non-commercial, while operations follow commercial principles. The overall aim of CHICOP is to create a model of financially and ecologically sustainable park management, where ecotourism supports conservation, research and comprehensive environmental education programs for local schools, as well as other benefits for local people (Kloiber 2013).

High seas

Until recently, most attention has focused on inshore areas within the national 200 nautical mile EEZ and the 12 nautical mile territorial sea, where countries have established policy and legal frameworks to provide for area-based measures such as MPAs. Significant attention, however, has been directed for some time towards Antarctic (Southern Ocean) waters and to other areas beyond EEZs, where relevant countries have agreed on cooperative actions (for example, the Mediterranean Sea and North-East Atlantic Ocean; see below).

Ramsar sites

Some coastal and estuarine MPAs have also been recognised as wetlands of international importance (that is, Ramsar sites; see Chapters 2, 19), including Shoalwater Bay and Moreton Bay (Australia), Delaware Bay Estuary and San Francisco Bay (USA) and Røstøyan Archipelago (Norway).

Corals and reef life, Great Barrier Reef Marine Park, Australia

Source: © Great Barrier Reef Marine Park Authority

World Heritage

As of 2014, 46 MPAs have been inscribed on the World Heritage List. They include three of the world's 10 largest MPAs. One of the best-known is the Great Barrier Reef (Australia) and others include the Galápagos Islands (Ecuador), Tubbataha (Philippines) and the west Norwegian fjords.

The recent move towards large-scale marine protected areas

The past decade has seen a global trend towards the establishment of large-scale (very large) MPAs. The creation of the Northwestern Hawai'ian Islands Coral Reef Ecosystem Reserve (now Papahānaumokuākea Marine National Monument) in 2000 has been followed by a number of other countries declaring large MPAs within their national jurisdictions. Between 2000 and 2012, five sites of similar size were established—all but one in the Pacific Ocean (Table 20.1). Several other sizeable ocean areas have been or are in the process of being established, with further areas proposed by both governments and non-governmental organisations (NGOs) (Wood et al. 2008; Leenhardt et al. 2013). These are largely located in remote areas with low or no human numbers, where anthropogenic impacts have been less severe. The areas contain some of the most intact and least impacted ecosystems left on the planet (Halpern et al. 2008).

The drivers towards protecting these recently designated ocean areas are varied. Some have been designated for their intrinsic natural or cultural value, others to advance global targets to increase the proportion of the ocean set aside for protection (Toonen et al. 2013), while others are to strike a balance between economic growth and biodiversity conservation. With the variation in goals follows a variation in management approaches. Some sites are complete no-take areas, while others allow for commercial fishing and other human use in defined areas, often by necessity. By a 2013 estimate, the pioneer large-scale sites (Table 20.1) accounted for 80 per cent of the area contained within all MPAs in the world (Toonen et al. 2013), thus evolving the definition and concept of MPA design and management.

Large-scale MPAs are not, however, a panacea. They are one of many tools to achieve ocean conservation. The most prevalent criticism of large-scale MPAs is that they are difficult to enforce. Given the high measures of biomass, these areas can be attractive to illegal, unreported and unregulated fishing, heightening the need for effective surveillance and enforcement. Enforcement is an obvious and costly challenge requiring remote surveillance and other technological capabilities to effectively monitor large areas. Fortunately, legal and technological advances may soon allow such monitoring and enforcement to become far more cost effective and feasible.

Table 20.1 Pioneer large-scale marine protected areas

Name	Country	Founded	Size (sq km)	Proportion of site that is no-take (%)	Comments
Great Barrier Reef Marine Park	Australia	1975	344 000	33	UN World Heritage property since 1981
Papahānaumokuākea Marine National Monument	United States of America	2000	362 074	100	Created as Northwestern Hawai'ian Islands Ecosystem Reserve in 2000 and became a Marine National Monument in 2006; UN World Heritage property since 2010
Phoenix Islands Protected Area	Republic of Kiribati	2008	408 250	4	Declared in 2006 and established in 2008; UN World Heritage property since 2010
Mariana Trench Marine National Monument	Commonwealth of Northern Mariana Islands, USA	2009	246 609	~95	Only protected deep-sea trench in the world, but surface waters remain open to fishing
British Indian Ocean Territory Marine Protected Area	UK Overseas Territory	2010	640 000	100	British Indian Ocean Territory consists entirely of the Chagos Archipelago and surrounding waters, with the exception of Diego Garcia Atoll out to 3 nm.
Motu Motiro Hiva Marine Park	Chile	2010	150 000 (with planned expansion to 411 000)	100	Isolated reefs north-east of Rapa Nui (Easter Island), explicitly created to protect one of the last pristine ecosystems in the Pacific Ocean and advance the 10 per cent goal of the Aichi Biodiversity Targets
Cook Islands Marine Park	Cook Islands	2012	1 065 000	TBD	Remote atolls and high volcanic islands surrounded by fringing reefs and unsoiled fauna associated with underwater mountains—management planning process is still under way; will likely contain a variety of zones with different levels of protection

Source: Adapted from Toonen et al. (2013)

Benefits of marine protected areas

MPAs provide a range of benefits to both natural ecosystems and human communities inhabiting marine and coastal areas. These include ecological benefits such as maintaining and increasing biological diversity and enhancing fish stocks; social benefits of nature appreciation and engagement; and economic benefits of facilitating sustainability in fisheries and tourism as well as recreational use of the marine environment. The importance of ocean health in relation to the world's climate is fundamental, since oceans absorb carbon dioxide and generate most of the world's oxygen.

MPAs provide many benefits when implemented through a rigorous science-based approach, but they must not be considered as the sole management approach for conserving all marine biodiversity. Properly established MPAs are the best tool for protecting ocean biodiversity, but they in turn cannot protect themselves from external stressors such as pollution, land-based run-off and climate change. Consequently, MPAs should be considered in conjunction with other broad ecosystem-based management approaches.

The biodiversity-related benefits of MPAs include:

- maintaining or restoring ecosystem structure, function and integrity by:
    1. protecting habitats from physical damage of fishing and other human activities
    2. avoiding biodiversity loss and productivity loss by maintaining genetic integrity, and restoring population size, age structure and community composition
    3. protecting key ecological functions and processes that are driving forces of many marine systems—for example, maintaining food webs and trophic structure including avoiding trophic cascades and threshold effects, and maintaining the abundance of important keystone species
    4. contributing to holistic ecosystem-based management and enhancing broad-scale ecosystem resilience to pressures.
- providing 'insurance' to mitigate any detrimental effects, especially in adjacent areas (for example, by overfishing)
- protecting areas that can provide reproductive 'seedbanks' from which eggs and larvae of marine species may be distributed to other areas (Day 2006).

Ecosystem connectivity

A 2014 study on global priorities for marine biodiversity conservation highlighted that 'protecting biodiversity and the essential ecosystem services it supports has become a priority for the scientific community, resource managers, and national and international policy agreements' (Selig et al. 2014).

Individual marine species exist as part of larger, connected and interdependent networks of ecosystems such as coral reefs, coastal mangrove habitats or deep-sea hydrothermal vent communities. The connectivity of these ecosystems provides marine organisms with important ecological services such as the provision of food, breeding and nursery grounds, or shelter from predators during vulnerable planktonic development stages. The importance of marine connectivity can be seen in examples of cross-continental shelf connectivity (Box 20.2), where larval dispersal has the potential to occur over thousands of kilometres.

Anse Mais, Aldabra Atoll World Heritage Property, Seychelles
Source: Carl Gustaf Lundin, IUCN

The interconnectivity of marine systems requires management that is broad and ecosystem based. MPA networks provide a key tool for protecting marine biodiversity on a broader, integrated and interconnected scale where the maintenance of holistic ecosystems results in greater overall ecological, economic and social benefits. The success of effective MPA zoning and how it contributes to protecting broader marine biodiversity are described further below.

Ecosystem function

Where MPAs have strong beneficial effects on ecosystem 'engineers', such as corals or kelps (Ling and Johnson 2012), the benefits may extend to important ecosystem functions and services. For example, services such as productive fisheries, tourism appeal and coastal protection from storms are all founded on the existence of a healthy reef with a complex structure (Done et al. 1996). Processes that kill corals and accelerate the erosion of reef structures could, however, shift the reef towards a negative carbonate budget, which means the reef will gradually erode over time. Reefs that experience

Box 20.2 Ecosystem connectivity: Habitats utilised during the life cycle of the red emperor

Cross-shelf connectivity on a reef system is critical to maintaining habitats for recreationally and commercially important reef fish such as the red emperor (*Lutjanus sebae*) on Australia's Great Barrier Reef. The red emperor utilises a much wider range of interconnected habitats during various life-cycle stages than was initially believed, ranging from inshore estuaries to coral and deep-water seagrass communities (Figure 20.2).

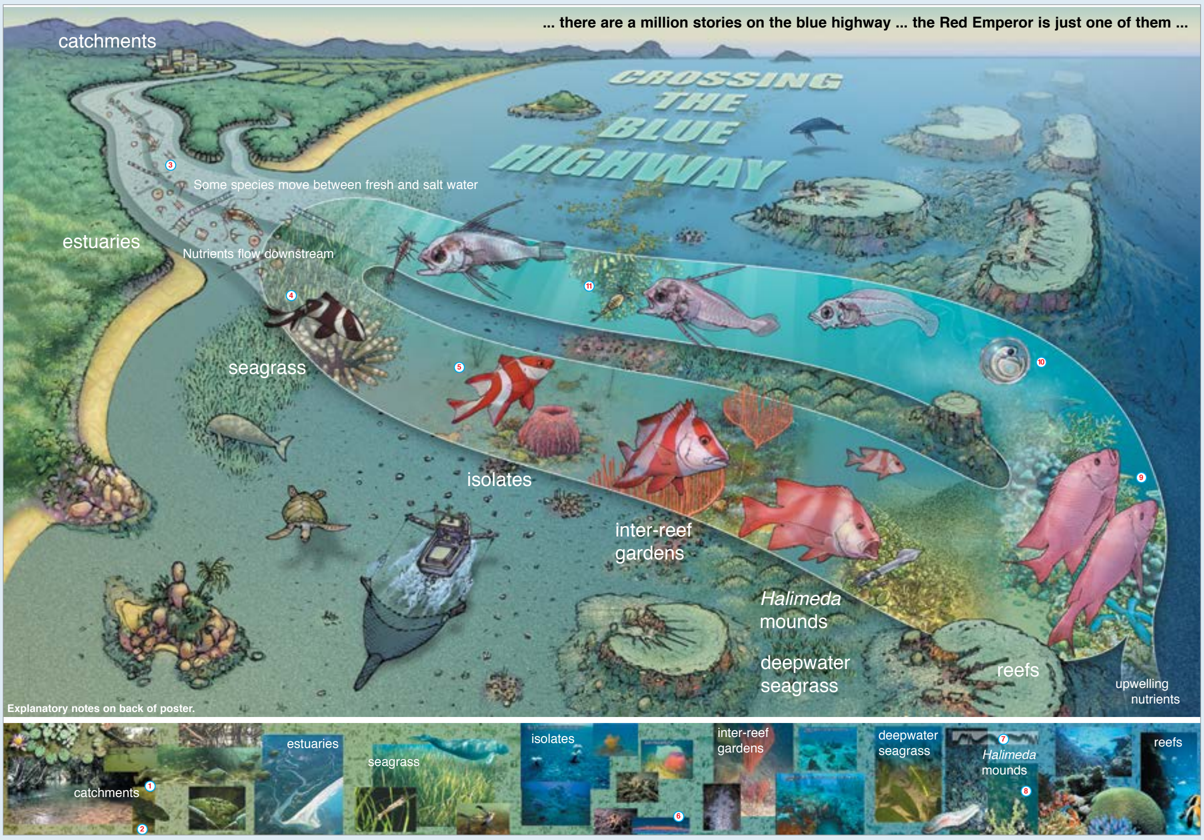

Figure 20.2 Ecosystem Connectivity

Source: Based on a concept developed by Russell Kelley and illustrated by Gavin Ryan; © Cappo and Kelley (2001); reproduced with permission

net erosion will lose their complexity, biodiversity and function. In 2013, a model was developed that accounted for the impacts of global change on coral reefs including rising sea temperatures and ocean acidification (Kennedy et al. 2013). It found that positive carbonate budgets were still possible towards the end of the century but they required MPA-level local protection of the watershed and fishing, and aggressive action to reduce greenhouse gas emissions.

Enhancing fish stocks inside and outside marine protected areas

In addition to maintaining biodiversity, MPAs can play an important role in enhancing biological productivity, particularly of fish stocks—both inside and outside MPAs. The establishment of MPAs provides a protective refuge for fish during critical life-cycle stages such as spawning or juvenile growth. By protecting spawning and nursery ground habitats such as mangroves, seagrass meadows and reef systems, MPAs provide a safe refuge for juvenile fish as they develop and grow into adulthood, as well as protecting breeding fish such as in spawning aggregations.

Coral reefs, Great Southern Lagoon, part of the marine World Heritage property, New Caledonia
Source: Dan Laffoley

Safe havens are particularly important as recovery areas for species experiencing high-intensity fishing pressures. No-take MPAs or zones within large MPAs provide safe areas for fish stocks to increase, rebuild and expand in the absence of fishing pressure. As fish stocks increase within MPAs, a positive flow-on effect is created for adjacent areas when excess fish from healthy, flourishing stocks inside MPAs 'spillover' into adjacent non-protected areas. Termed the 'spillover effect', this leads to an overall increase in fish abundance in adjoining areas where fishing is allowed, ultimately facilitating broad-scale positive changes for various commercial, recreational or indigenous fishing.

The positive impact of MPAs on fish stocks has been widely documented (Box 20.3). Studies demonstrate that fish in no-take zones and other protected areas produce more offspring (that is, have higher fecundity) and are greater in size and abundance than fish outside such areas. Halpern (2003) reported that the average fish biomass across 89 marine reserves was nearly triple that of fish in unprotected areas, with a 20 to 30 per cent increase in average size. In 2009, a global analysis of almost 150 peer-reviewed studies of fully protected no-take marine reserves from 29 countries reported an overall increase in both fish size and biomass within the reserves (Lester et al. 2009).

Box 20.3 The spillover effect: Examples from around the world

One of the more well-studied benefits of reserves—the spillover of adults into neighbouring fished areas (Kellner et al. 2007)—has been revisited for fishing communities in the Philippines. Trap and gillnet catches near the Sumilon Island reserve increased 27 per cent within six years of the reserve being established, and catch increases of 41 per cent were found near Apo Island reserve after 20 years (Alcala et al. 2005).

The major outcomes of ceasing fishing are the increased size and abundance of fishes within a protected area (Halpern 2003). In a comparison of fish abundance among Kenyan marine parks of different age, McClanahan et al. (2007) found that some groups of reef fish, such as parrotfish, recovered within 10 years of protection whereas others, such as large-bodied acanthurids (surgeonfish, tangs and unicorn fish), still showed no sign of reaching a plateau after 30 years. Data from the Philippines reveal that significant increases in fish biomass can be found within five years of reserve creation, but the biomass of large predators continued to increase after 19 years—the maximum duration of protection at the time of the census (Russ et al. 2005). Rapid increases of coral trout (*Plectropomus* spp.), however, entailing a rise in fish density of approximately 65 per cent, were observed within just two years of the formation of new no-take areas of the Great Barrier Reef Marine Park in 2004 (Russ et al. 2008). Reef shark abundance was also considerably higher in no-take zones of the Great Barrier Reef, but higher still in long-term 'no entry' zones (McCook et al. 2010).

Rapid recovery of fish populations is feasible, in part, because the dispersal of reef fish larvae appears to be fairly local. At one extreme, two-thirds of sea anemone-dwelling clownfish (*Amphiprion polymnus*) were found to settle within 100 metres of their parents despite spending up to 12 days in the plankton (Jones et al. 2005). Dispersal is greater in larger reef fish, such as the squaretail coral grouper (*Plectropomus areolatus*), but even here evidence suggests that about 50 per cent of juveniles recruit within 14 kilometres of an adult spawning aggregation site and 95 per cent recruit within 33 kilometres of the spawning site (Almany et al. 2013). Indeed, new genetic studies have now confirmed that larval export of commercially important reef fish from reserves is significantly greater than that from fished areas, and can help replenish exploited fish stocks and form networks of larvae among reserves. In this case, reserves lay within 20 kilometres of one another (Harrison et al. 2012).

— Peter J. Mumby

Black grouper (*Mycteroperca bonaci*), Bahamas
Source: Craig Dahlgran

Wider indirect benefits of marine protected areas

In many tropical areas, no-take reserves have become the *de facto* means of addressing multiple management objectives. There has been burgeoning interest in using no-take areas to improve reef health, particularly given the rising tide of threats to corals including bleaching and disease (Weil and Rogers 2011). The idea is simple: if food webs can be somewhat restored by preventing fishing, could trophic interactions cascade and benefit corals?

Indeed, positive impacts of reserves can also be observed in the health of coral reef communities more broadly. Since disease caused the Caribbean-wide die-off of the long-spined sea urchin (*Diadema antillarum*) in 1983–84, recovery has been limited. Diadema was an important herbivore on Caribbean reefs and its loss resulted in phase shifts towards higher seaweed biomass (Steneck and Dethier 1994). In a study of the Exuma Cays Land and Sea Park in the central Bahamas, it was found that Diadema populations remained virtually non-existent within the reserve, but at measurable levels in neighbouring fished areas (Harborne et al. 2009). The higher densities of urchin predators within the reserve likely accounted for the failure of urchin recovery. Fortunately, densities of herbivorous parrotfish doubled inside the Exuma Cays Land and Sea Park in response to a cessation of fishing, which appears to have set off an important trophic cascade that began by causing a fourfold reduction in the cover of seaweeds (Mumby et al. 2006), which benefits corals.

The ability of reserves to create such trophic cascades will vary according to the strength of the reserve impact—the difference in the biomass of harvested species across reserve boundaries and hence the effectiveness of management—and the degree to which harvested species influence others. In the case of Caribbean reefs where seaweed growth is rapid (Roff and Mumby 2012), there is a strong trophic link between herbivorous fish biomass and seaweed cover (Williams and Polunin 2000).

Social benefits of marine protected areas

MPAs also provide important social benefits to local communities and visitors, including recreational enjoyment and appreciation of the environment, as well as cultural connectivity to ocean areas.

MPA networks can demonstrate important social benefits when established through community involvement, collaborative management and incorporation of culture into MPA management strategies. The Arnavons Marine Conservation Area of the Solomon Islands is co-managed by the national and Provincial governments, an NGO and three local communities. This co-management approach has resulted in closer social cohesion and security between isolated communities, as well as facilitating communication between different cultural groups. In the Apo Islands of the Philippines and the Bunaken MPA in Indonesia, collaborative management arrangements have been established that involve local community representatives in management, community-wide involvement in MPA management, and respect for traditional use and access rights. This has led to increased employment, greater empowerment of women and improved health and public sanitation (Mulongoy and Gidda 2008).

An important social benefit of effectively managed MPAs is the maintenance of local human culture. This is particularly important across areas of the Pacific Islands such as Fiji, the Solomon Islands and Hawai‘i, or indigenous communities of North America or Australia, where local culture is closely connected to the marine environment. For example, the Papahānaumokuākea Marine National Monument (covering the north-western Hawai‘ian Islands) has deep traditional significance for living native Hawai‘ian culture, as an ancestral environment, as an embodiment of the Hawai‘ian concept of kinship between people and the

natural world, and as the place from which it is believed life originates and to which the spirits return after death. On two of the islands there are archaeological remains relating to pre-European settlement and use.

Economic benefits of marine protected areas

The ecological resources of the world's oceans provide humans with a variety of economic benefits. Since 2007, 'The Economics of Ecosystems and Biodiversity' (TEEB) initiative has drawn attention to the economic benefits of biodiversity and the growing cost of biodiversity loss and ecosystem degradation, and provides tools to support effective decision-making. While it is difficult to quantify the value of the many services, especially non-monetary, that ecosystems provide, economic benefits resulting directly from a healthy marine environment are measurable in areas such as sustainable marine tourism and fisheries. In 2004, for example, the 166 000 hectares of reef system off the main Hawai'ian Islands were estimated at a value of US$360 million per year (TEEB 2010). In Australia's Great Barrier Reef, the total combined economic contribution in 2012 to the Australian economy of tourism, recreation, commercial fishing and scientific research from the Great Barrier Reef catchment and World Heritage property was estimated at US$5.7 billion (Deloitte Access Economics 2013)—greatly exceeding the amount spent on protection (McCook et al. 2010).

Sustainable tourism

Globally, the appreciation of marine environments through commercial tourism activities such as scuba diving, snorkelling or whale watching is well established. In 2012, tourism in the Great Barrier Reef and adjoining catchment generated a profit of approximately US$4.9 billion (or 90 per cent of the total economic contribution of the marine park to the national economy), and provided an equivalent of 64 000 full-time jobs. Tourism also contributes US$6.5 million annually to reef management (see 'Fees and charges' subsection below).

Species-specific ecotourism for marine megafauna protected by MPAs (for example, whales and sharks) is creating sustainable long-term economic benefits for local communities. A 2008 whale-watching study estimated the global industry generated more than US$2.1 billion (O'Connor et al. 2009), and 2013 estimates for the global shark diving industry were US$314 million annually (Cisneros-Montemayor et al. 2013). Whale-shark ecotourism is well established

Shark and other fish, Great Barrier Reef Marine Park, Australia

Source: © Great Barrier Reef Marine Park Authority

in Western Australia (Ningaloo Reef), Mexico, the Seychelles and the Philippines—and is expanding around the world. The industry has been estimated to generate more than US$47.5 million worldwide (Graham 2004). Shark-diving tourism in the recently established shark sanctuary of Palau was estimated to be worth US$200 million over a shark's lifetime, based on the long-term value of 100 sharks (Vianna et al. 2012).

Sustainable recreation

The economic benefits of MPAs also include sustainable recreational (that is, non-commercial) use of protected areas such as surfing, snorkelling, fishing or boating. In 2008, more than 14 million recreational visitors were estimated to visit the Great Barrier Reef Marine Park from surrounding areas every year. Recreational activities ranked as the second-largest direct use of the Great Barrier Reef in 2012, generating US$310 million and the equivalent of 2724 full-time jobs (GBRMPA 2013).

Sustainable fisheries

Fisheries provide significant economic support to coastal communities (particularly subsistence communities), with positive impacts from MPAs including increased fish abundance and size, protective habitats for fish growth and reproduction, and provision of sanctuaries for recovery from overexploitation. Many commercially valuable fish stocks are overexploited as a result of

Indigenous Ranger at Mapoon, Queensland, Australia assisting a marine turtle

Source: Craig Wheeler

increased pressure from highly subsidised industrial fishing fleets, poor regulation and weak enforcement of rules (World Bank and FAO 2009). Across the 53 countries that contribute 95 per cent of global fisheries catch, MPAs have been estimated to provide US$870 million worth of subsidies to fisheries (Cullis-Suzuki and Pauly 2008).

Governance of marine protected areas

> The ecological, economic and social benefits of protected areas can only be enhanced and sustained when they are effectively managed through good governance. (Mulongoy and Gidda 2008:28)

Governance can be defined as 'the involvement of a wide range of institutions and actors in the production of policy outcomes … involving coordination through networks and partnerships' (Johnston et al. 2000: 317). Historically, marine governance has been developed sporadically and in a fragmented way to suit individual management needs where they have arisen, and less in a holistic, long-term and ecosystem-based way.

The governance of protected area networks can be framed within various arrangements including international environmental conventions at the global level, coordination between neighbouring countries at the regional level, government legislation at the national level, and community and NGO-driven governance at the local level. The various types of governance and how these contribute to effective MPA management are covered in greater detail below (see also Chapter 7).

International context

The majority of coastal (and many non-coastal) countries around the world are signatories to international marine agreements or conventions. These provide legal frameworks to establish mechanisms for governing and managing marine areas under their national jurisdictions, or more simply, within their national waters. International environmental laws have been established to address a wide range of marine issues, from the basic designation of national maritime boundaries to navigation, fisheries management, international trade in endangered species, biodiversity conservation and the establishment of MPAs. Such international laws can include both hard (legally binding) and soft (non-binding) laws.

The UN Convention on the Law of the Sea (UNCLOS) is widely recognised as the overarching framework for marine governance. In force since 1994, it provides nations with the legal capacity to delineate national maritime boundaries (such as the EEZ), to regulate extractive activities such as fishing within those boundaries, and to establish protected areas within both the 200 nautical mile EEZ and the 12 nautical mile territorial sea of a national coastline consistent with the rights of international shipping. This convention is supported widely, with more than 160 signatory nations worldwide in 2014 (UN 2014).

Where UNCLOS provides an overarching legal framework for states to protect the marine environment, the CBD provides targets and action plans for implementation, particularly for the conservation of biological diversity, including providing the legally binding governance mechanism to frame the Aichi Targets discussed previously. Other conventions such as the International Whaling Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora and the Convention on the Conservation of Migratory Species of Wild Animals also indirectly facilitate the establishment of MPAs—for example, by facilitating the establishment of whale sanctuaries as protection for individual endangered species (see Chapter 8).

Regional context

Regional approaches, such as the UNEP's Regional Seas Program, have been established around the world to improve marine management, and information and benefit sharing, at the regional level. Established in 1974, it includes 18 regions around the world with separately established regional programs. Fourteen of these have now adopted legally binding conventions that provide a foundation for management programs further implemented through action.

National context

The majority of the world's MPAs are governed by laws and regulatory mechanisms established at a national or sub-national government level. In most coastal countries, the marine environment is not governed under a single law but is addressed through an often fragmented set of laws and mechanisms established to manage different aspects of the marine environment such as conservation, tourism, pollution or fisheries. Consequently, it is common for laws to be administered under separate jurisdictions and managed by a variety of stakeholders including national, regional Provincial/State/Territory or local government agencies, councils, NGOs or local communities. Jurisdictional overlap, gaps and lack of integration between multiple organisations can often lead to challenging MPA governance. Functional, holistic and cross-jurisdictional governance systems for MPAs are critical.

Local context

The local context is becoming increasingly important in MPA governance and management. Local governance, where coastal communities are responsible for governing and managing their own local marine resources, is often referred to as 'customary marine tenure'. This is common in regions such as the Pacific, where it has led to the establishment of LMMAs in several countries including Fiji, Papua New Guinea and the Solomon Islands. LMMAs are becoming increasingly important as a marine governance approach (Box 20.1).

In both Papua New Guinea and the Solomon Islands, inshore marine ecosystems are owned not by the national government, but by clans or tribes who claim customary ownership, and where ownership has varying degrees of recognition under national law. The Kimbe Bay region in Papua New Guinea contains an MPA network including nine LMMAs and represents an interesting case study of local governance by coastal communities (White et al. 2014; Case Study 20.1).

No matter whether MPAs are governed under national, regional or locally managed systems, for governance regimes to be most effective, clear international, regional, national and/or local regulatory obligations requiring effective management and law enforcement must be established (Jones 2014). A well-integrated and comprehensive management model that is widely regarded as effective by marine and coastal managers globally is the Great Barrier Reef Marine Park in Australia. This represents integrated and comprehensive collaboration between national and State management authorities, and these in turn with traditional owners, local councils and communities, industry and scientific research groups, in order to provide an effective ecosystem-based approach to marine management.

Types of marine governance

Governance systems can be broadly separated into three general approaches: top down, bottom up and governance based on market incentives. The top-down approach emphasises government-led governance from 'above', through the establishment of laws and other regulatory mechanisms that enforce biodiversity conservation. The bottom-up approach focuses on decentralising decision-making processes from national government to incorporate local community-based approaches, often with a focus on harnessing local or traditional knowledge bases. A system that integrates top-down and bottom-up governance has been shown to be the most effective. The market incentives approach focuses on the economic or monetary incentives that come from valuing nature and the services that ecosystems provide, such as supporting alternative livelihoods for communities through a shift from non-renewable extractive resource use to renewable ecotourism (Jones 2014).

The analysis of MPA governance by Jones (2014) using the 'MPA Governance Framework' has identified five broad governance approaches, each containing varying degrees of government, community and private sector involvement (Table 20.2). It is widely accepted that no one approach can provide a perfect governance system, and a collaborative co-management approach may maximise the effective governance of MPAs; this was highlighted in the Durban Accord from the fifth IUCN World Parks Congress in 2003.

Case Study 20.1 Locally managed marine areas of Kimbe Bay, Papua New Guinea

Kimbe Bay is in Papua New Guinea within the world's most biodiverse marine area: the Coral Triangle (Weeks et al. 2014; Figure 20.3). Approximately 100 000 people live in coastal communities in the bay, relying on both land and marine resources for their livelihoods. The bay comprises a high diversity of both shallow and deep-water marine habitats of high conservation value, where land and sea ownership is clan-based and communities make decisions regarding local conservation and resource management (Green et al. 2009).

In 2006, The Nature Conservancy led the design of a resilient and science-based MPA network for Kimbe Bay—the first of its kind in the Coral Triangle—by assessing biodiversity and socioeconomic values to identify 14 'areas of interest' (AOIs) (Green et al. 2009). Since then, the Conservancy and partners have supported a community-based planning process, which has led to 14 communities establishing nine LMMAs within seven of the AOIs, including co-management arrangements between some communities (Weeks et al. 2014). The LMMA design process involved: 1) community engagement; 2) community visioning; 3) participatory conservation planning; 4) community development of an LMMA plan; 5) preparation of a draft plan and agreement; and 6) stakeholder consultation and finalisation of the plan and agreement by the community (Green et al. 2009).

Substantial progress has also been made towards establishing a governance and management framework for Kimbe Bay, with marine management and protection laws (created for the three local governments with marine areas) providing a legal foundation for community-developed LMMA management plans. Further governance progress includes the establishment of the 'PNG Learning and Training Network', which aims to identify and share good practice tools and methods for community conservation and resource management; a memorandum of understanding between The Nature Conservancy and the Provincial government to develop a governance system for the Kimbe Bay Marine Management Area, which includes establishing a governing secretariat; and a steering committee comprising members from NGOs, government and private sectors, which has now taken ownership of the implementation process (Weeks et al. 2014).

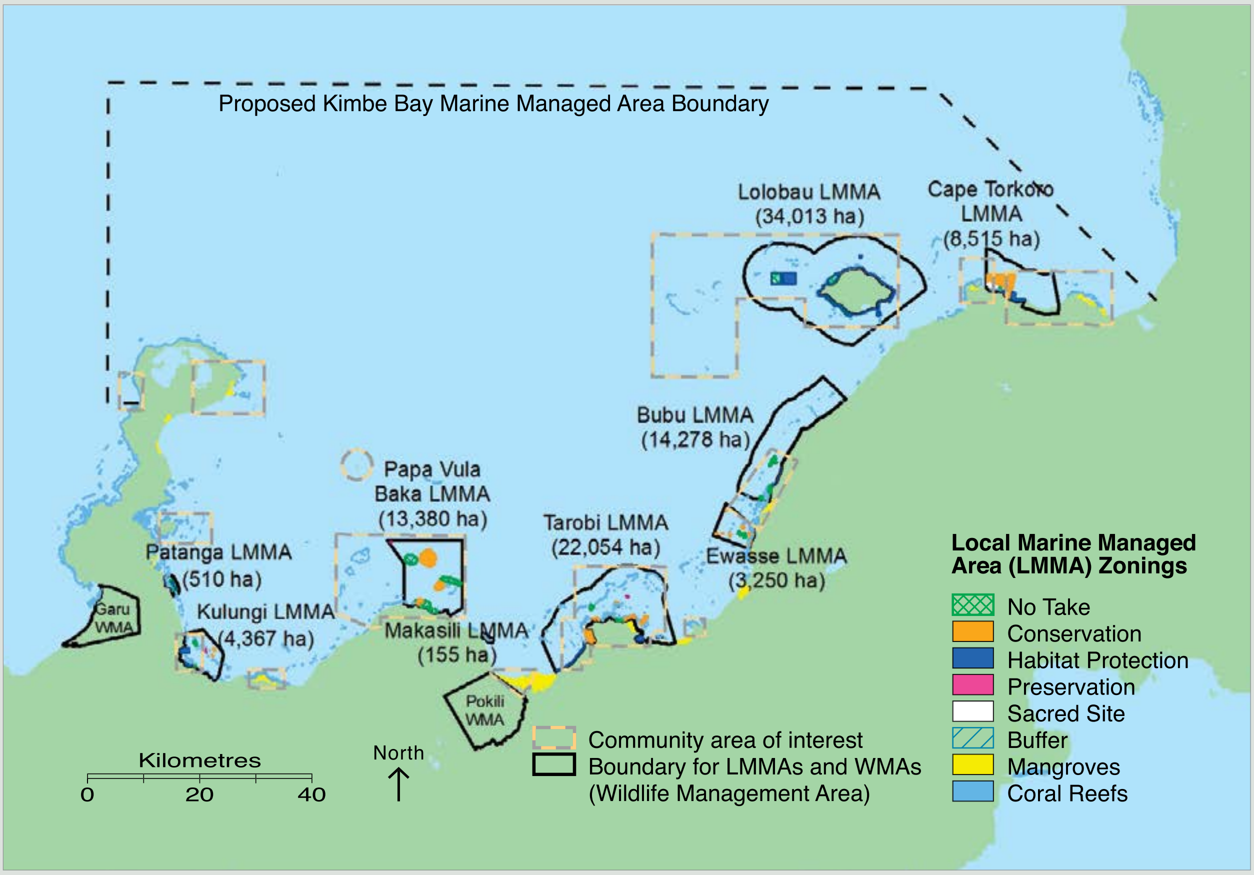

Figure 20.3 The Kimbe Bay Marine Management Area, including Locally Managed Marine Areas (LMMAs) established within areas of interest

Source: Modified from Weeks et al. (2014)

Table 20.2 Five marine protected area governance approaches with examples

Governance approach	Details of the approach	Examples of MPAs in which the approach is adopted
Government-led	Managed primarily by the government under a clear legal framework	Great Barrier Reef Marine Park (Australia) Darwin Mounds candidate Special Area of Conservation (United Kingdom) North East Kent European Marine Site (United Kingdom) Wash and North Norfolk Coast European Marine Site (United Kingdom) *California Marine Life Protection Act* (USA) United States National Marine Sanctuary System (USA)
Decentralised	Managed in a shared approach by the government with significant decentralisation and/or influences from the private sector	Sanya Coral Reef National Marine Nature Reserve (China) Seaflower MPA (Colombia) Galápagos Marine Reserve (Ecuador) Karimunjawa Marine National Park (Indonesia) Wakatobi National Park (Indonesia) Tubbataha Reefs Natural Park (Philippines) Ha Long Bay Natural World Heritage Property (Vietnam)
Community-led	Managed primarily by local communities under collective management arrangements	Isla Natividad (Mexico) Os Miñarzos Marine Reserve of Fishing Interest (Spain)
Private-led	Managed primarily by the private sector and/or NGOs granted property/management rights	Chumbe Island Coral Park (Tanzania) Great South Bay Marine Conservation Area (USA)
No clear governance framework	No clear effective governance framework in place	Baleia Franca Environmental Protected Area (Brazil) Pirajubaé Marine Extractive Reserve (Brazil) Cres-Lošinj Special Marine Reserve (Croatia)

Source: Jones (2014)

Marine protected area governance incentives

Positive governance outcomes can be promoted through the use of incentives that 'provide for certain strategic policy outcomes, particularly biodiversity conservation objectives' (Jones et al. 2011:13). A global analysis of 20 MPA case studies by Jones (2014) identified five categories of incentives (Table 20.3).

Legal frameworks and incentives implemented through the top-down leadership of states play an important role in framing effective MPA governance. They provide the framework for enforcing compliance and can promote local community stewardship via legally enforced community property rights, which help to protect areas from external resource exploitation. It is important for states to enable and support local stewardship, or community ownership, if an MPA initiative is attempting to engage and gain the support of local communities as part of its governance approach.

In addition to state-driven legal incentives, economic incentives are identified as the most frequently used governance tool. The economic benefits of renewable long-term shark diving ecotourism in the recently established shark sanctuary of Palau, for example, were shown to greatly outweigh the income from non-renewable shark-finning practices (Vianna et al. 2012).

Additionally, the bottom-up roles of traditional and local knowledge and participation, as well as the expert guidance of individuals or organisations such as environmental NGOs are important in driving and implementing MPA governance. Achieving an equitable balance between a healthy and thriving local community that has controlled access to local resources and ensuring appropriate protection to avoid resource over exploitation within MPAs is critical.

It is the combination of legal and economic incentives with other interpretative, knowledge and participatory incentives that are important for effective governance. Twenty global case studies identified that no single governance approach is likely to be most appropriate, and that a combined approach with a diversity of appropriate

Table 20.3 Five categories of incentives

Incentive category	Definition (number of incentives in this category employed in MPA Governance Framework)
Economic	Using economic and property rights approaches to promote the fulfilment of MPA objectives (10)
Interpretative	Promoting awareness of the conservation features of the MPA, the related objectives for conserving them and the approaches for achieving these objectives, and promoting support for related measures (3)
Knowledge	Respecting and promoting the use of different sources of knowledge (local-traditional and expert-scientific) to better inform MPA decisions (3)
Legal	Establishment and enforcement of relevant laws, regulations, and so on, as a source of 'state steering' to promote compliance with decisions and thereby the achievement of MPA obligations (10)
Participative	Providing for users, communities and other interest groups to participate in and influence MPA decision-making that could potentially affect them, in order to promote their 'ownership' of the MPA and thereby their potential to cooperate in the implementation of decisions (10)

Source: Jones (2014)

incentives from different incentive categories increases the resilience of governance systems and maximises marine governance effectiveness. Just as diversity is the key to resilience for species and ecosystems, a diverse governance approach with multiple incentives combining the role of people, markets and the state is the key to best-practice governance.

Governance challenges

Limits of marine governance: Maritime boundaries and high seas governance

Among the main challenges to marine governance are the legal differences between terrestrial and marine ecosystems. Sixty-four per cent of the world's ocean—and nearly half the surface of the Earth—is outside the legal powers of traditional national governance systems. Despite their vastness, marine ecosystems and species in the high seas and international seabed areas beyond national jurisdiction are threatened on multiple fronts, making efforts to address areas both within and beyond national jurisdiction vital to achieving international goals for marine conservation.

Establishing governance across the whole ocean is essential. Near-shore and offshore systems are linked in many ways: ocean currents move water masses, pollution and marine debris; marine animals such as cetaceans, sea turtles, sea birds and tuna undertake extensive migrations; many coastal marine species are found in the open ocean for large proportions of their life history (Ban et al. 2014). Fish stocks and seabed features such as seamounts, hydrothermal vents and cold-water coral reefs may straddle national and international boundaries. Spawning sites, breeding grounds and other habitats necessary for critical life-cycle stages of rare, threatened or endangered species as well as commercially important species may occur on either side of legal boundaries (Ban et al. 2014).

There is accordingly a critical governance gap for a large proportion of the global marine environment. A broad framework for cooperation to protect and preserve the marine environment, including in areas beyond national jurisdiction is set out under UNCLOS, under which all countries have a duty to protect and preserve the marine environment including rare and fragile ecosystems and the habitats of depleted, threatened or endangered species (Article 194.5), and to conserve high seas living resources (Article 117). There is, however, no specific legal framework for integrated and ecosystem-based management and no specific mandate for the establishment of MPAs for those bodies with the authority to regulate specific human activities. Progress in establishing representative networks of high seas MPAs to 2014 has thus been very slow (Gjerde and Rulska-Domino 2012).

Despite this, high seas MPAs have been established. The first high seas MPA was designated in the Mediterranean in 1999, partly on the high seas. The world's first MPA located entirely in high seas, the South Orkney Islands–Southern Shelf MPA, was established in the Southern Ocean in 2010. The same year, a network of high seas MPAs began to be established in the North-East Atlantic Ocean under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR).

By December 2012, seven areas of the North-East Atlantic had been designated as MPAs in areas beyond national jurisdiction and in high seas. Approximately

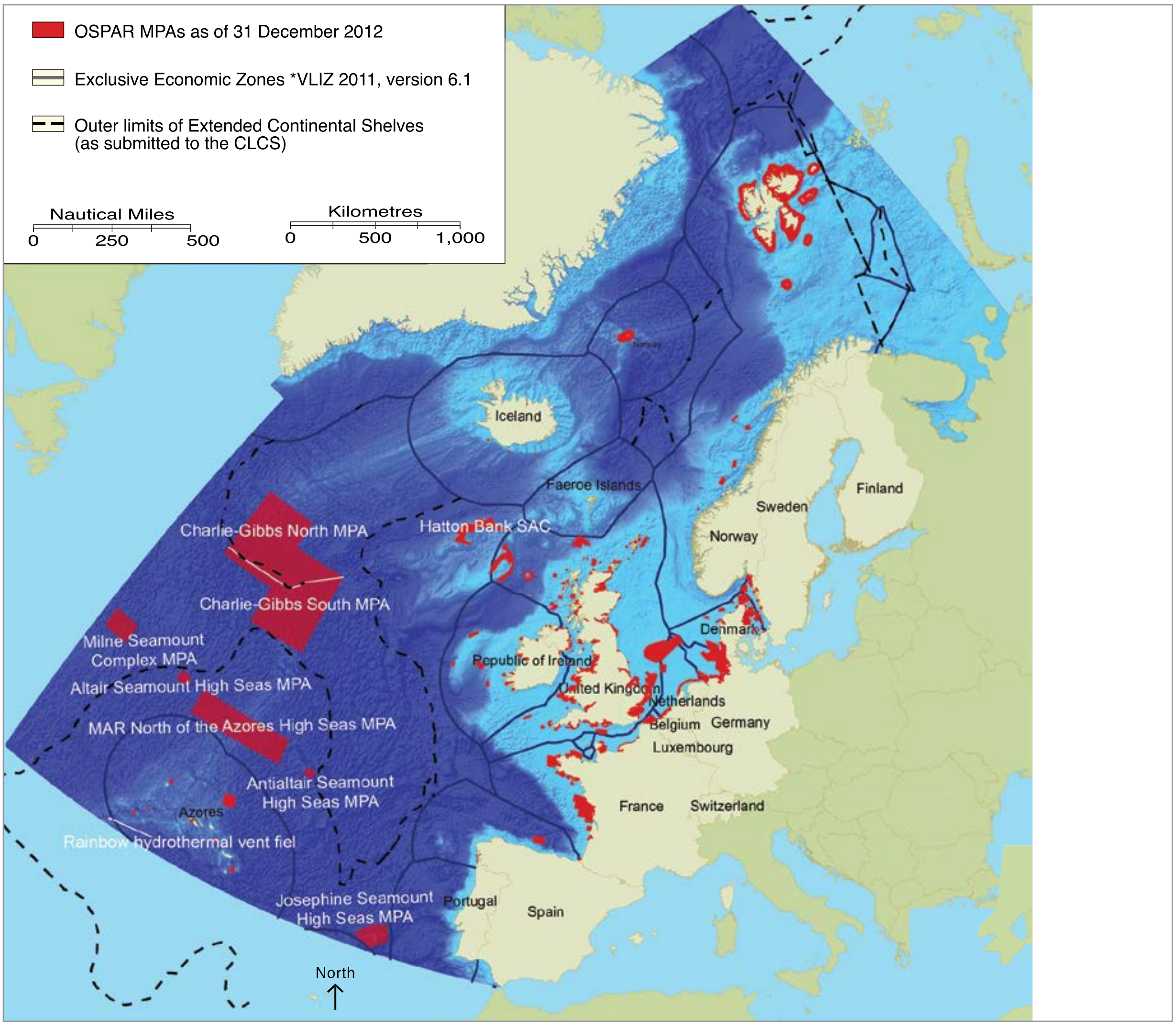

Figure 20.4 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) network of MPAs, as of December 2012

Source: Modified from OSPAR Commission (2013), reproduced with permission from the OSPAR Commission, London

40 per cent of the OSPAR maritime area lies outside the national jurisdiction of coastal states (OSPAR Commission 2013; Figure 20.4). States in the Southern Ocean have committed to following this action by developing a full network of MPAs in this area (Gjerde and Rulska-Domino 2012). The establishment of high seas MPA networks represents early progress in high seas MPA governance, but highlights the fact that progress remains slow.

Alongside these specific actions, activity-based organisations can also apply area-based management tools that may have conservation benefits. Regional fisheries management organisations can adopt spatial or temporal closed areas or gear modifications. The International Maritime Organisation has criteria and guidelines for designating 'Particularly Sensitive Sea Areas', which provide an umbrella for the adoption of routeing, reporting, discharge or other protective measures within its competence. With respect to seabed mining, the International Seabed Authority has adopted a representative system of 'Areas of Particular Environmental Interest' in the Clarion-Clipperton Zone in the Pacific Ocean that could be replicated in other areas where seabed mining may occur. To date, however, these measures are not being applied as part of a systematic approach to develop a representative network of MPAs.

As noted above, some ocean regions benefit from pre-existing regional seas conventions that provide a forum for cooperation to, among other things, identify and designate MPAs and manage specific activities. It is also possible to spur cooperation without a regional seas framework; the Sargasso Sea in the central Atlantic is a prime example (Freestone et al. 2014). To spur global cooperation and coordination, however, states at the United Nations have been discussing a possible new implementation agreement under UNCLOS for the

Case Study 20.2 Indigenous sea country governance in Australia: Traditional-use marine resource agreements

In the Great Barrier Reef, local Aboriginal and Torres Strait Islander people have fostered connections to 'sea country' for tens of thousands of years. Today approximately 70 clan groups are recognised as having sea country ties to areas within the marine park. The Great Barrier Reef Marine Park Authority (GBRMPA) acknowledges the ongoing social, cultural, economic and spiritual connections of the Traditional Owners to the region and has established governance structures that aim to ensure effective partnerships including Indigenous land-use agreements and traditional-use marine resource agreements (Figure 20.5). These provide a collaborative working relationship between the Australian (Federal) and Queensland (State) governments and local traditional user groups.

In 2005, the Girringun Traditional Owners, comprising nine tribal sea country groups, were the first Traditional Owners in the Great Barrier Reef to establish a traditional use of marine resource agreement; this addressed the management of traditional take of turtle and dugong.

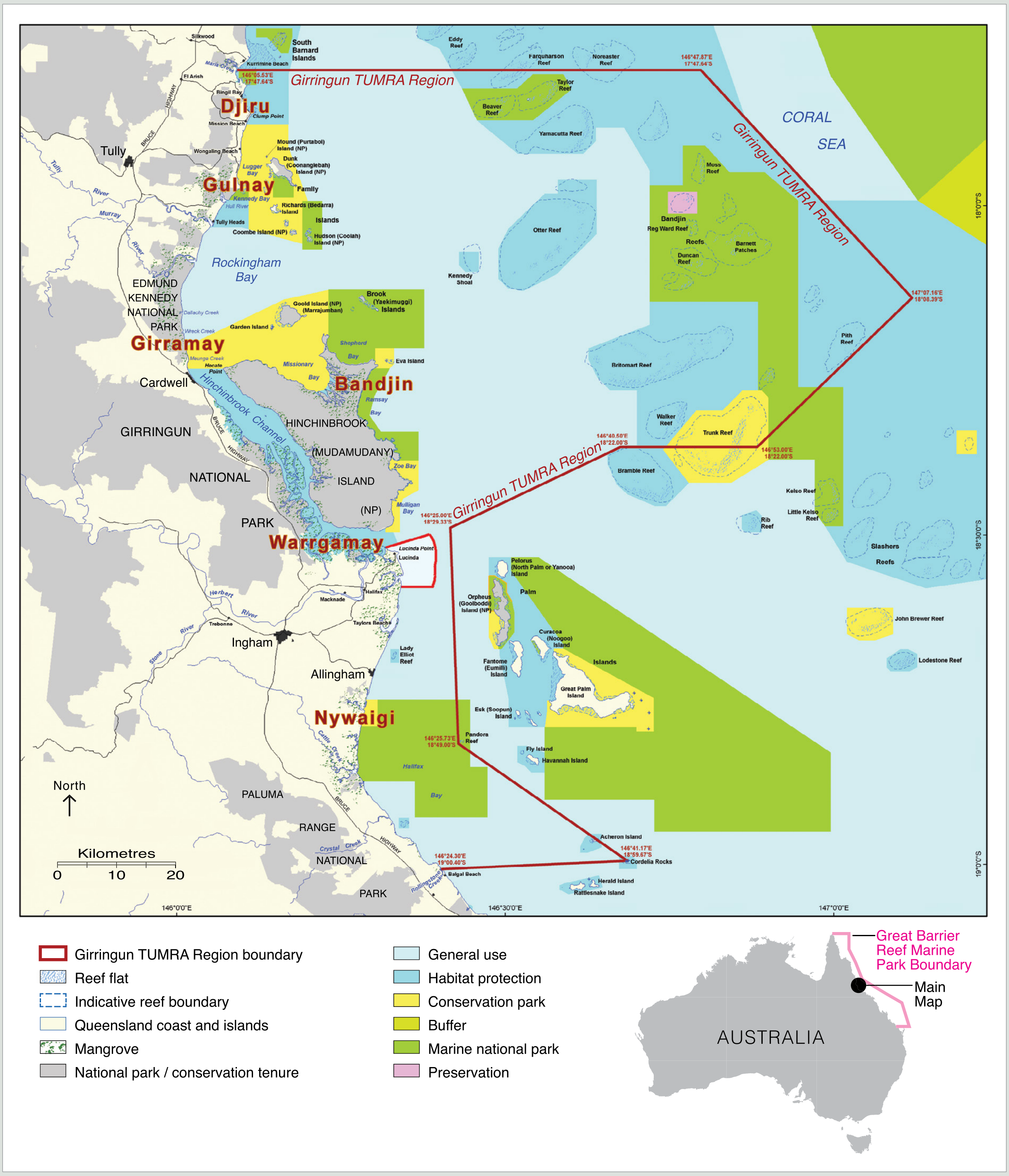

Figure 20.5 Traditional-use marine resource agreement area (TUMRA)

Source: Modified from Great Barrier Reef Marine Park Authority (2014)

Case Study 20.3 Inuit MPA governance in Canada: Ninginganiq, Akpait and Qaqulluit National Wildlife Areas

In the Nunavut Settlement Area of far north-eastern Canada, a collaborative government–traditional owner relationship has been established between the Canadian Government and Inuit of Nunavut, through the Inuit Impact and Benefit Agreement. Under this agreement, the three Ninginganiq, Akpait and Qaqulluit National Wildlife Areas, covering 4534 square kilometres of the north-eastern coast of Baffin Island, are co-managed by the local Inuit community and the Canadian Wildlife Service. This co-management 'ensures that both the traditional knowledge and expertise of the Inuit and the best scientific data are combined effectively in all decision-making processes' (Department of Oceans and Fisheries Canada 2014).

conservation and sustainable use of marine biodiversity beyond national jurisdiction. Such an agreement could provide a legal framework for the establishment of high seas MPAs, set standards for environmental impact assessment and accelerate progress towards integrated ecosystem-based management and governance (Gjerde and Rulska-Domino 2012). To build a scientific basis to assist nations and international organisations, in 2008 the CBD adopted the 'Ecologically and Biologically Significant Areas' criteria (CBD 2008) and in 2010 commenced a series of workshops to facilitate their description across all ocean basins (Dunn et al. 2014). Three-quarters of the total estimated ocean area—265.7 million square kilometres—has since been surveyed (CBD SBSTTA 2014).

Traditional use of marine protected areas: Co-management in governance

The importance of a diverse collaborative co-management approach to governance was highlighted at the fifth IUCN World Parks Congress in 2003, where the Durban Accord urged 'commitment to innovation in protected area management, including adaptive, collaborative and co-management strategies' (IUCN WCPA 2003a:223).

Co-management has the potential to incorporate a diverse range of stakeholders and knowledge in decision-making processes to improve effective MPA governance:

> The diversity of co-management approaches makes them capable of fitting different contexts. If properly understood and adopted, co-management can lead towards more effective and transparent sharing of decision-making powers, a more active, conservation-friendly and central role for indigenous, mobile and local communities in protected area management, and better synergy of the conservation capacities of different stakeholders. (IUCN WCPA 2003b:201)

Effective MPA governance requires a balanced approach that maintains and incorporates the cultural values, customs and knowledge of traditional communities living within and adjacent to marine areas. Around the world, governance arrangements have been established that integrate traditional communities with national governance through co-management arrangements. Traditional use and co-management arrangements from Australia and Canada are discussed in Case Studies 20.2 and 20.3.

Management of marine protected areas

MPA managers rarely manage natural systems or specific marine species *per se*; what they generally do is manage the human impacts within or on their MPA (Day 2006). MPA management typically relies on using a combination of management tools (including spatial tools like zoning plans or plans of management; temporal tools like seasonal closures for nesting birds or key spawning periods; legislative tools like regulations; and/or permits), along with various management approaches (such as education, impact assessment, monitoring, partnerships and enforcement). Such approaches are used to regulate access, and to control and/or mitigate impacts associated with activities (such as recreation, tourism, fisheries or shipping) or to address pressures (such as declining water quality or climate change). Many of these key management tools and approaches are discussed in more detail below.

Management is usually considered to be a continuous, interactive, adaptive and participatory process, comprising a set of related tasks that all need to be undertaken to achieve a desired set of goals and objectives. It is important that these goals and objectives are clearly established early in the life of an MPA, that they are widely known and are able to provide the benchmark against which the effectiveness of management is evaluated.

Box 20.4 Marine spatial planning and MPAs: From theory to implementation

Marine spatial planning is:

> [A] public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that are usually specified through a political process. (Ehler and Douvere 2009:18)

Marine spatial planning provides a process for a strategic and integrated plan-based approach to marine management that makes it possible to look at the 'bigger picture' and to identify and manage current and potential conflicting uses, as well as the cumulative effects of human activities. It provides contextual information for the planning and management of MPAs. Processes become more transparent, and it provides greater certainty in the provision of permits, and for other planning and allocation processes for both developers and environmental managers. It is ideally conducted as a continuous, iterative and adaptive process and consists of at least three ongoing phases.

1. **Planning and analysis:** Generating and adopting one or more integrated, comprehensive spatial plans for the protection, enhancement and sustainable use and development of the sea and its resources. The planning and analysis phase will be based on a set of research initiatives (including mapping) that addresses both environmental and human processes.
2. **Implementation:** Implementing the plan through the execution of programs of work or investments, enabling change, encouraging improvement and through regulation and incentives, and enforcement of proposed changes and ongoing activities in, on, over and under the sea, in accordance with the plans.
3. **Monitoring and evaluation:** Assessing the effectiveness of the plans, their time scales and implementation mechanisms, considering ways in which they need to be improved and establishing review and adaptation procedures. Results of evaluation are fed back into the planning and analysis element of management, and the process begins again.

The ultimate decision on what space will be allocated for what use (or non-use) is a matter of societal and political choice. People are central to the decision-making process and relevant stakeholders, including the wider public, need to be effectively involved throughout the marine strategic planning process. All steps of this process need financing on a continuing basis to achieve management goals and objectives.

— Charles Ehler and Fanny Douvere

Patterns of use and technological approaches are constantly changing, so MPA management also needs to be flexible, adaptive and responsive. The marine environment itself is similarly dynamic and subject to both natural changes and differing patterns of use. Consequently, an adaptive management approach (Chapter 8) is essential for effective MPA management. Particularly in large MPAs, this is best achieved through regular interaction between agencies, across all levels of government and with local communities and interest groups.

Marine spatial planning and management planning

Planning an MPA frequently requires consideration of a range of national and/or State or Provincial legislation, especially to ensure that planning accords with the legal mandate(s) for the area. Planning may also be guided by specific obligations under relevant international conventions, and for ICCAs there may also be community requirements.

Planning in the marine environment includes numerous challenges, many of which are not faced when planning terrestrial protected areas—for example:

- the interdependency on neighbouring ecological communities and the interconnectedness of the coastal and marine environments
- the impacts from adjacent land or sea areas that could threaten the integrity of even the best-managed MPA
- the three-dimensional (water column) aspects of an area requiring management (few MPAs are well known, easily viewed or easily 'delineated' for management purposes)
- the problem that most parts of the marine environment are not easily viewed or understood ('out of sight, out of mind')
- ownership issues—for most marine areas worldwide, open-access resources are poorly or insufficiently regulated (Day 2006) and jurisdiction at the coastal land–sea interface may be unclear.

Effective marine spatial planning should be both strategic and integrated (see Box 20.4). How a systematic planning process can be applied through the concept of 'ecoregions' is discussed in Case Study 20.4. Broad-area integrated management that has zoning within a large MPA is considered more effective than a series of small, isolated highly protected areas within a broader unmanaged area because:

Case Study 20.4 Systematic planning and management of MPAs: Applying the concept of ecoregions in practice

The overall objectives of marine conservation should be to protect as many of the components of marine biodiversity as possible, while allowing for sustainable use such as fisheries. In order to accomplish this objective, the areas chosen for conservation—as MPAs—should include both 'representative' areas and 'distinctive' areas. Ecoregions provide a natural framework within which to deliver such an approach. For effective marine conservation, the designation of MPAs within an ecoregion should be based on the best available biogeographical and ecological information that has been assembled into a coherent framework.

An overall target for conserving at least 10 per cent of marine ecoregions (CBD 2011) is still rather arbitrarily defined. While this target is provisionally accepted in this example, some authors, such as Roff and Zacharias (2011), have suggested methods of defining a framework for regional MPAs that is non-arbitrary in total proportion of the area to be protected. The process of selecting MPAs based on a target of conserving all recognised components of biodiversity is a complex one, best accomplished by computer analysis of the array of options.

Using computer analysis, candidate sets of MPAs can be selected and presented to decision-makers, with additional political and socioeconomic factors then incorporated into decision-making processes. At the same stage of the planning process, an evaluation should be made to determine whether any chosen coherent set of MPAs could also form a true network of MPAs.

Planning a true MPA network involves knowledge of several additional factors including: local and regional oceanographic and atmospheric circulation patterns (tides, currents, wind stress, and so on), and development times of vertebrate and invertebrate larval forms (and/or other propagule types). With such information, the patterns of connectivity among the candidate MPAs of a region can be modelled or calculated, based on estimates of larval duration of important or representative species (usually fish larvae), and appropriate distances between MPAs can be decided.

— John Roff

- *ecologically:* it recognises temporal/spatial scales at which ecological systems operate and ensures the entire MPA remains viable as a functioning ecosystem
- *practically:* it is easier to manage; it buffers and dilutes the impacts of activities in areas adjacent to highly protected 'core' areas
- *socially:* it can help to resolve and separate conflicting uses and ensure all reasonable uses can occur with minimal conflict, as well as minimising confusion by a single management agency having responsibility rather than a multitude of differing agencies
- *economically:* integration within a larger area will generally have lower management costs per spatial area than a series of small MPAs managed separately (Day 2002).

A common misconception in MPA planning is the expectation that all activities and impacts can be effectively addressed in a single two-dimensional planning approach like zoning. In the Great Barrier Reef Marine Park, for example, zoning is only one of many management tools used, and many other spatial and temporal management tools or strategies are applied on top of the underlying zoning. These include:

- permits (often tied to specific zones or smaller areas within zones, and providing a detailed level of management arrangement not possible by zoning alone)
- plans of management for areas requiring more specific statutory management arrangements such as limiting numbers or applying approved policies
- site plans and special management areas for specific high-use areas or where special local arrangements might be applied
- other spatial restrictions (such as for defence training areas, shipping areas and agreements with traditional owners).

Zoning is not always the most effective way to manage all activities or impacts on the MPA and many management challenges, such as pollution from the land, increasing coastal development and even some impacts within an MPA, may be better managed using other spatial and temporal management tools.

A fully integrated approach to planning is the only way to achieve effective marine conservation, as well as long-term social and economic sustainability for communities and industries that are dependent on the marine environment. To be effective, integrated planning needs to consider and wherever possible involve:

- all relevant levels of government (national, provincial and/or local) that have a role within the MPA or any role with uses/activities that impact on the MPA
- all relevant sectoral/user/industry groups
- relevant social, economic and cultural aspects as well as the more obvious ecological aspects

- the need to 'think outside the MPA square' (especially across the coastal–marine interface, as integration across this land–water boundary is essential for effective MPA management)
- taking into account 'shifting environmental baselines' (successive generations comparing changes against already altered baselines).

Marine connectivity in conservation planning

Given the high levels of connectivity both within and between marine ecosystems, MPA planning should aim to consider connectivity in the following ways:

- explicitly aim to protect representative examples of all habitat and community types (such as reefs, Halimeda macro-algae and seagrass meadows) and physical environment types (such as cays, channels, differing levels of exposure to environmental stressors such as ultraviolet radiation, wind, waves, and so on), utilising bioregionalisation planning and the application of the key biophysical planning principles (Fernandes et al. 2005)
- deliberately ensure cross-shelf, depth-range and latitudinal diversity are included in the MPA network to encompass potential connections within networks
- aim to ensure reserve networks incorporate a range of dispersal distances, but especially distances of less than 30 kilometres
- specifically design the MPA to maximise as many as possible of the known ecological processes and connectivity patterns (spatial and/or temporal), such as ocean upwelling, turtle and seabird nesting sites, fish spawning areas; and known 'sink' or 'source' reefs
- aim for replication of no-take areas by protecting multiple examples within each bioregion if possible in order to spread the risk of likely impacts (McCook et al. 2009).

A well-structured, systematic approach to the design and implementation of MPA networks can have broad, and sometimes unplanned, benefits. For example, McCook et al. (2010) discuss the expected and unexpected benefits of a systematic design approach for the Great Barrier Reef Marine Park.

Site management arrangements

Site management arrangements are localised plans for the use of a particular site. They identify significant values of the specific site and describe current management arrangements, concentrating on specific use issues and cumulative impacts at the site. For example, the Whitsundays Plan of Management in the Great Barrier Reef assigns most reefs, bays and coastal areas to a 'setting', ranging from intensively used (Setting 1) to protected (Setting 5), and prescribes the maximum limits for each setting (Table 20.4).

Recreational users are able to access all settings provided they adhere to the limits, whereas only a limited number of tourism operators who have relevant permit endorsements are able to access Setting 5 areas.

Marine risk management and resilience

A risk is the effect of uncertainty on the outcomes being sought, in terms of: a) the consequences of the risk, which can be either beneficial or detrimental; and b) the likelihood of the risk occurring (Standards Australia 2013). 'Effect' is a deviation from the expected (positive and/or negative), and 'uncertainty' is the level of certainty about information relating to an understanding or knowledge of an event, its consequences or its likelihood.

Risk management involves undertaking a risk assessment of the likelihood and consequences of impacts, such as human-caused pollution, on key species or habitats and/or localities such as bays, islands or reefs. An effective risk assessment helps to make an informed management decision and should also consider the social, cultural, economic and reputational risks to the MPA.

Table 20.4 Limits for planning settings

Setting	Vessel length	Group size
1. Developed	max. 70 metres	no limit
2. High use	max. 35 metres	no limit
3. Moderate use	max. 35 metres	max. 40 people
4. Natural	max. 35 metres	max. 15 people
5. Protected	max. 20 metres	max. 15 people

Box 20.5 Building resilience through effective management

Operationalising resilience concepts in management has been the target of a number of key programs, requiring actions and policies from the level of grassroots/field agents, through protected area managers to agency decision-makers. Key aspects of resilience-based management include the following.

- Design and site selection issues, including decisions about the siting of MPA core zones, their size and number, and representation and replication of key habitats across the seascape (Grimsditch and Salm 2006; Salm et al. 2006; McLeod et al. 2009). An important question that is yet to be answered conclusively is whether it is more effective to establish fewer large no-take MPAs, multiple small no-take MPAs of equivalent area or larger still multiple-use MPAs with small no-take areas embedded in them. A desirable feature is the ability to adjust the zoning of MPAs in response to future threats and the condition of protected systems. Selecting critical areas in a seascape is an essential component of maintaining resilience, as some key sites (such as spawning aggregations or source areas for reseeding impacted areas) have unique importance in maintaining resilience over larger geographic areas.
- Reducing threats that undermine healthy ecosystems is the first line of defence against any disturbance, whether minor or catastrophic, temporary or long-term. Corals that are exposed to stressors such as pollution, siltation, damaging activities or overfishing, for example, are at greater risk of succumbing to further stress brought on by storms, elevated seawater temperatures and ocean acidification. Consequently, MPA managers need to prioritise the abatement of manageable stresses to the extent possible.
- Connectivity in marine ecosystems is a key determinant of larval replenishment and this is important for resilience after any major disturbance, as is retaining ecological processes such as productivity and the life cycles of many marine organisms. As outlined earlier, connectivity is now being considered more in MPA planning and management, with recent research demonstrating a greater degree of replenishment than previously thought (Harrison et al. 2012). Maintaining a connected network of healthy sites inside and outside MPAs will become an increasingly important management goal in coming decades, supported by improvements in connectivity science.

While the above factors focus on biological elements of resilience, the effectiveness of management (Salm et al. 2006; Chapter 28) remains a key determinant of success in using resilience concepts, applying to design aspects, threat abatement and managing people's behaviour. In many parts of the world, the effectiveness of management programs is dependent on the willingness of adjacent communities, especially resource harvesters, to abide by the regulations and support management efforts. To achieve such collaboration, managers need clear communication materials and measures, and to nurture community engagement in management planning and actions. Co-management of marine resources is increasingly being used at the grassroots level—for example, in fisheries management.

Management governance structures will need to make management practices and institutions more adaptive in the future, mirroring the concepts of ecological and social resilience (in promoting adaptive capacity). Currently, most management programs and governance structures for MPAs are too rigid to cope with change. Ideally, part and parcel of the process for review and revision of management plans and policies should include adjustment of MPA zones and boundaries to cope with emerging threats or opportunities. Ecosystem-based management, integrated coastal management, marine spatial planning and other area-based management approaches can be used to improve the application and adaptability of resilience-based approaches to management. One compelling example is the work by Harrison et al. (2012) demonstrating that well-planned and adequately protected marine reserve networks can make a significant contribution to the replenishment of fish populations in both no-take areas and fished areas within 30 kilometres of the protected area.

— David Obura and Rod Salm

Ecosystem resilience refers to the capacity of a marine ecosystem to withstand or recover from natural disturbances such as cyclones or disease, or from human-related impacts, and to maintain key functions without collapsing or changing to a different state. Resilient ecosystems are able to withstand or recover from impacts that would otherwise damage components of the system if they were to continue to occur over sufficient time.

In parallel with exponential growth in the study of ecological (and social) resilience in shallow marine ecosystems, the past decade has seen rapid expansion and innovation in the use of resilience concepts in managing MPAs (see Chapter 10). Effective management helps to build reef resilience (as outlined in Box 20.5), and has been facilitated in recent years through the development of a practical 'Reef Resilience Toolkit' for MPA practitioners (Box 20.6). An example of how marine mammal protected areas are providing connectivity and increasing resilience can be seen in Case Study 20.5.

Box 20.6 The Reef Resilience Toolkit

The Reef Resilience Toolkit was developed as part of the Reef Resilience Program, a partnership led by The Nature Conservancy, which builds the capacity of reef managers and practitioners around the world to better address the local impacts on coral reefs from climate change and other stressors. Through resources such as networking, online training seminars and the dissemination of resilience science, the toolkit provides useful management actions to enhance survival prospects for coral reef communities. These include to:

- protect multiple samples of a full range of reef types, representing the likely complement of biodiversity, to spread among them the risk of any one being completely lost as a consequence of a stress event such as heat-related bleaching
- identify and fully protect coral communities that are at low risk of succumbing to events such as heat stress and coral bleaching, as these will survive to reproduce and seed susceptible areas, aiding in their recovery (West and Salm 2003)
- fully protect other critical habitats such as spawning aggregation and nursery sites and aim to include the full complement of critical life-stage habitats in no-take areas
- restore functionality to degraded habitats, such as after bleaching events, managing and monitoring resilient areas to enable their recovery, as a basis for reproduction and effective reseeding of less-resilient sites
- manage susceptible sites to facilitate recovery—including, for example: removing coral predators, prohibiting or reducing fishing of herbivores, preventing destructive fishing practices, controlling tourism impacts and temporarily closing reef fisheries on and around bleached or otherwise damaged reefs
- nest MPAs into broader management frameworks such as large multiple-use reserves, integrated coastal management regimes or both, to enable effective control of threats originating upstream and in surrounding areas and to maintain high water quality (Salm et al. 2006)
- monitor MPAs against baseline data and compare with control reefs outside MPAs to determine the effectiveness of management strategies
- regulate developments upstream or in adjacent linked areas that could compromise the health of coral communities, such as beachfront developments that would cause run-off or discharge of sediments, fresh water or pollutants
- facilitate and foster scientific studies and research at the sites through partnerships with local universities and research scientists who can provide hard science data and third-party advice and generate agency credibility and political support for management actions to build resilience
- obtain and share information, through research, learning networks, education, interpretative programs and volunteer programs such as 'bleach watch'
- implement a management effectiveness evaluation system for the MPA, which allows for improvements in reef management, to maintain them as healthy as possible, and therefore better able to survive or recover rapidly from a stress event.

— Rod Salm, Paul Marshall and David Obura

Cumulative effects

A key aspect of resilience is the cumulative interaction between impacts: different impacts may combine or exacerbate each other so that the cumulative impacts may be far greater than any individual impact. They may interact simply (for example, additive, as in '1 + 1 = 2') or in a more complex way (for example, synergistic, as in '1 + 1 = 3 … or 4').

This has important consequences for MPA management including the need to manage as many impacts as possible so as to reduce cumulative effects, and the recognition that reductions in one impact may reduce the effects of other impacts, thus increasing the 'resilience' of the ecosystem to cope with other less manageable impacts such as those caused by climate change. While there is widespread recognition of the need to manage cumulative effects and there are a number of guidance documents on approaches and methodologies, it is proving difficult to make practical progress, even in well-established and well-researched MPAs.

It is important to consider the scale at which cumulative effects are occurring. Halpern et al. (2008) considered cumulative effects at the global scale, but, depending on the size of a site or the source of a pressure, the effects may be more readily addressed at the scale of an individual MPA. There appear to be few cases, however, where specific evidence has been shown of evaluating the effectiveness of managing cumulative effects. This is probably because it is too soon to draw conclusions from those examples where such intervention has occurred.

Cumulative effects may arise from multiple pressures, such as a bay receiving nutrient enrichment from both direct point-source discharges (for example, sewage) and diffuse agricultural run-off. Alternatively, it may be

Case Study 20.5 Examples of marine mammal protected areas delivering connectivity and increased resilience

For marine mammals, resilience is partly created through replication of effectively managed MPAs. If animals in one area decline in number or disappear, other areas will be able to help protect that species. With marine mammals being long-lived, it may take many decades before the benefits of increased resilience result in improved conservation outcomes. While it is difficult to isolate the conditions responsible for success, there are many other benefits that accrue, such as greater public involvement and appreciation of these wide-ranging animals. The following are examples of success.

- Great Barrier Reef Marine Park in Australia: Has afforded improved protection for dugongs, reducing bycatch and other pressures as a result of rezoning and higher protection levels (Grech and Marsh 2008).
- Nine marine mammal sanctuaries in the Pacific Ocean: Covering the EEZs of Pacific Island countries, these have been able to afford greater protection and potential resilience for dugongs through the replication of good protected habitats. The connectivity at this scale is partly delivered by the shared approach to marine mammal conservation through the Secretariat of the Pacific Regional Environment Program.
- Critically endangered Mediterranean monk seals (*Monachus monachus*) in Madeira: Effectively protected on the Desertas Islands. These animals have flourished and have now begun to move to the main island of Madeira (Pires et al. 2008).
- Atlantic Ocean Sister Sanctuaries: The first sister sanctuary was established between the Stellwagen Bank National Marine Sanctuary in the Gulf of Maine, USA, and the Marine Mammal Sanctuary in the Dominican Republic in recognition of the two key seasonal areas in the North Atlantic Ocean favoured by humpback whales (*Megaptera novaeangliae*)—the northern site for feeding and the Caribbean site for breeding. In 2009, the two sites joined with the newly created Agoa Sanctuary of Martinique, Guadeloupe, St-Martin and St-Barthélemy in the eastern Caribbean, to cooperate on humpback and other marine mammal conservation efforts (Hoyt 2012).
- Eastern North Pacific: The former intensive grey whaling grounds of Scammon's Lagoon (Laguna Ojo de Liebre) in Baja California became the first cetacean protected area in 1972. Later, Mexico protected a second lagoon, at San Ignacio, followed by Magdalena Bay and then an umbrella biosphere reserve called El Vizcaíno. With these actions, the breeding grounds of this species were effectively protected with increased resilience offered through the replication of protection in the various lagoons and different management levels that could offer the chance to compare outcomes (Hoyt 2011). Grey whales (*Eschrichtius robustus*) are considered a conservation success story and have been the first (and so far only) whale to return to estimated pre-whaling levels.

— Erich Hoyt and Giuseppe Notarbartolo di Sciara

the same pressure that is repeatedly affecting a feature over time, such as seabed features exposed to episodic fishing (such as trawling with bottom-towed gear), or different pressures arising from the same development acting cumulatively on the one feature—for example, development of infrastructure on intertidal mudflats leading to habitat loss (footprint) and disturbance (through increased use of vessels).

Ideally, when assessing cumulative effects there is an understanding of the degree of pressure or impact that is sustainable and will allow the achievement of conservation objectives for an MPA. While there are cases where quantitative thresholds are widely used (for example, water-quality standards), deriving ecological thresholds is difficult and assessment techniques will often involve either some form of predictive modelling or expert judgment. Practical tips on assessing and managing cumulative impacts on MPAs are provided in Box 20.7.

Community engagement

Rarely does a single MPA agency or community have jurisdictional control over all the activities occurring within an MPA, so there is usually a need to integrate effective MPA management across a range of agencies, industries and stakeholders. Since the early days of MPAs, there has been strong recognition of the importance of engaging local communities to help protect natural and cultural values. Early in the 21st century, this commitment to maintaining effective and meaningful partnerships with indigenous people, local communities and users is even stronger in order to conserve the values of an MPA as well as to enhance the resilience of the marine environment to cope with inevitable pressures. Community engagement is usually an ongoing requirement for effectively implementing an MPA and can occur in a number of ways:

- **Establishing local marine advisory committees:** These voluntary community-based committees can provide advice on management issues at a local level. Members may be independent or represent

Box 20.7 Practical tips on assessing and managing cumulative impacts on MPAs

There are a number of practical issues to consider in using cumulative effects assessment as a systematic procedure for identifying and evaluating the significance of effects from multiple pressures and/or activities.

1. Be clear on what you are trying to achieve. Is the scope of assessment or decisions on cumulative effects work defined in legislation or specified in objectives, such as for management of an individual MPA? Whereas many assessments focus on activities or projects of the same type—like oil developments—those for MPAs will focus on the receptor(s) such as the habitat or species for which an MPA is designated and therefore could encompass the range of activities/projects that interacts with those receptors.
2. Cumulative effects can occur over time, requiring caution in viewing a snapshot of ongoing activities. It is more than likely that cumulative effects had already occurred when a baseline was established—that is, when the MPA was designated. While it might be desirable to 'hindcast' to describe or quantify a prior un-impacted state, it may be better to focus resources, where limited, on avoiding further decline and promoting recovery of some kind.
3. Given the complexity of the subject, more will be achieved by narrowing the scope of cumulative effects work to as few receptors as possible. There is then a greater chance to gain a sufficiently deep enough understanding of the issues to justify management intervention. In MPAs this may be readily achieved where certain habitats or species are the main reason for designation.
4. Often a complex picture of multiple pressures can be made simpler by identifying the few 'dominant' pressures. For example, for the European Marine Strategy Framework Directive initial assessment, it was considered that for many characteristics of the ecosystem the cumulative effects of human pressures are dominated by one or a small number of pressures. Therefore, dominant pressures should be screened out to make assessments efficient and targeted.
5. To prioritise further it may be necessary to identify 'hotspots' with both a high diversity of conservation interest and high cumulative effects (see Halpern et al. 2008).
6. Management intervention to avoid or reduce identified cumulative effects will be more readily achieved if there is a clear mandate, such as provided by the legislation and objectives underpinning the MPA. Even where that is the case, action may require coordination amongst several agencies or bodies if more than one activity or more than one jurisdiction (such as national and State or local government) is involved. When in doubt, attempt to keep the approach as simple as possible. To simply map and then manage the impact of just three activities causing one pressure on one habitat or species are challenging enough.

— Paul Gilliland and Michael Coyle

a community or industry group from which they coordinate feedback. The aim is to have a balanced representation of local people who are involved in the management or use of the MPA. Major benefits of committees include an opportunity for the two-way flow of information between the local community and managing agencies.

- **Establishing expertise-based advisory committees:** These may be established to provide advice to the managing agencies for specific issues—for example, a tourism or indigenous advisory committee. While they usually comprise nominated experts, such committees may include other community members to ensure any advice is balanced.
- **Undertaking regular communication:** Communication with the community is conducted through a variety of means including email, Facebook posts or an electronic newsletter (see Chapter 15).
- **Implementing 'Friends of XXX MPA' programs:** These often incorporate volunteers as a key part of the program. The Reef Guardians Schools and Reef Guardian Councils programs as set up in the Great Barrier Reef are good examples of community engagement and partnerships, with 10 per cent of the entire population adjoining the reef now involved in these programs.

One example where additional resources were channelled into specific intense periods of community engagement in order to achieve important and specific outcomes is the participatory activities during the major rezoning of the Great Barrier Reef Marine Park in the late 1990s (Box 20.8) (see Day et al. 2012b).

Establishing effective and meaningful partnerships with indigenous peoples, local communities, the private sector and users is essential to protect cultural and heritage values and conserve biodiversity in an MPA. Partnerships are distinguished from other types of community involvement by the sharing of power and responsibility for its use among participants. Successful engagement is dependent on the willingness of the partners to engage in matters that are important to them, and on the level of commitment of managers to also get it right in how they engage. Informed and involved partners are essential if an MPA is to be used and managed in a way that recognises the close relationship between sustainable community livelihoods, recognition of community values and traditions, and the effective protection and management of the MPA. Some principles behind effective partnerships include:

- shared power and responsibility among participants with no partner being made responsible for the decisions or actions of others
- realistic expectations, shared intent and relationship values
- partnership coordinators who have appropriate tenure to develop long-term personal relationships among, and between, participants (Oliver 2004).

Compliance management

Compliance management is a planned approach to ensuring that individuals and entities interacting with the MPA, for the purpose of deriving value from it, do so in accordance with legislation, regulations, permit conditions or lawful instructions. Compliance management involves a much wider consideration, however, than just enforcement. Human activity may include recreation, tourism, commercial fishing, extractive processes and/or shipping. Coastal MPAs may in addition be concerned about land-based activities that impact on water quality such as farming practices, community expansion and coastal development.

The effective management of compliance is therefore key to achieving the strategic goal of MPA management, balancing protection with sustainable use. Ideally, compliance is included as a key performance indicator and a key element of any external assessment of the MPA and its certification. When properly integrated into the MPA management cycle, compliance management supports the achievement of outcomes including conservation, use management, sustainability, industry, business and public involvement and indigenous engagement.

With a focus on monitoring, measurement and evaluation, an effective approach to compliance management will also indicate trends that may necessitate adjustments being made to the MPA management plan and permitted use.

The foundation of compliance management is grounded in a number of disciplines including law, law enforcement, human behaviour, risk management, data management, stakeholder management, measurement and evaluation, intelligence analysis and public relations. A structured approach begins with a detailed demographic analysis of the regulated community, analysing and categorising the behaviours, assessing the impacts of the behaviours, identifying and assessing threat and risk, and determining appropriate treatments to mitigate the risks. Enforcement and prosecution may be treatments of last resort, and other treatments may be more appropriate given the threat, human behaviour and environmental impact. These include information, education, surveillance and monitoring, audit, caution, warning letters or infringement notices. The objective is to achieve informed self-regulation with the majority of users, focusing limited resources on high-impact non-compliant behaviours.

Box 20.8 Lessons learned about effectively involving the public during a planning program for an MPA

- **There is no simple way of creating a conflict-free consultative mechanism for many MPAs:** While many decision-makers would like to have consensus-based decision-making, ‘consensus is not an achievable goal for stakeholder processes dealing with issues of this magnitude’ (Day et al. 2004:258 quoting Helms 2002).
- **People need to understand there is a problem before accepting that a solution is required:** It is usually necessary to inform stakeholders that an MPA is under pressure and that the level of protection of the biodiversity is insufficient before stakeholders are willing to accept that a new approach to management is part of the solution.
- **Many stakeholders have little understanding of the key issues:** Many people do not know what ‘biodiversity’ means, nor do they understand its importance for the future of marine waters, so there is a need to use simple language to communicate in laypersons’ terms to the majority of stakeholders.
- **Different messages for different target audiences:** Different stakeholder groups have interests in different aspects of marine planning so communication needs to be appropriately tailored.
- **Some elements of community engagement are more successful than others:** Community information sessions in regional and local centres proved to be far more successful than public meetings for the Great Barrier Reef. While these sessions required considerable organisation and a large commitment in terms of resources and staff, the results were well worth the effort.
- **There are those who support the proposed increase in the level of protection but who will not overtly state their views:** The silent majority can often be ‘drowned out’ by the vocal minority who are highly motivated to voice their concerns. There is a need to encourage supporters to make the effort to voice their approval for increased protection.

Source: Adapted from Day et al. (2004)

Coral (*Echinopora lamellosa*) with pink crustose coralline algae and fish (probably snapper, *Lutjanus kasmira*), Seychelles outer islands, Republic of Seychelles

Source: James Tamelander

Compliance management can involve a wide range of interests, and other regulatory and law enforcement agencies, whose primary responsibility may be shipping, fishing, tourism or communication, and who may be assisted by the MPA compliance team to deliver compliance outcomes relevant to their specialist areas.

This requires an effective approach to compliance management, beginning with a strategic plan with typically a three-year outlook. The first year of the rolling three-year plan, refined in more detail, identifies operations and resource requirements for the coming 12 months. This facilitates a thorough approach to targeting resources and the delivery and reporting of compliance outcomes. Failure to pay attention to a range of sensitivities around managing compliance could compromise the key objectives of the MPA.

In order to make decisions on threat, risk and the application of compliance management strategies, it is necessary to routinely gather, manage and analyse data. Apart from reporting the efficacy of the compliance management effort, data analysis indicates trends that enable better targeting of management effort. The requirement to justify resources by proving positive impact on both user behaviour and ecosystem outcomes requires input from marine specialists. Such collaboration helps focus on planning and implementing strategies that address protection and sustainable use. Reporting is regular and comprehensive in order to disseminate results throughout the organisation and to enhance accountability at all levels.

The development of a compliance management capability requires good planning, adequate resources and support from higher levels in the agency. Capability will mature over time as experience, lessons learned and staff competence grow and the value of captured data increases. The organisational structure of a compliance unit should aim to provide all of the key functions including intelligence, planning, operations, stakeholder management, measurement and evaluation, investigation and surveillance. Legal advice located within the unit is a distinct advantage. Audit expertise may be sourced externally. Given the diversity of functions, the range of stakeholders and the importance of compliance management to the delivery of strategic MPA objectives, strong leadership and a strategy for promoting its services and conveying them to others are important.

Systems are required to support surveillance, monitoring, data analysis and information management, ideally housed in a restricted-access room where data management and electronic monitoring equipment can be confidentially located.

Staff must be skilled to an appropriate level in compliance management against defined competency standards. There are enough range and diversity of activity in a compliance management unit to provide staff with a long-term career. Currently, there are few professional compliance managers so there is a requirement to support a comprehensive training program to provide specialist qualifications; the Great Barrier Reef Marine Park Authority has developed such a framework.

Marine management issues

Climate change

Of all the emerging issues facing MPAs and marine environments worldwide, climate change remains one of the most challenging. Increasing ocean acidity, warming sea temperatures, leading to shifts in circulation patterns and changed rainfall patterns, and increasing sea-levels are real, serious and long-term threats to marine ecosystems and the communities which live in the coastal zone.

The latest Intergovernmental Panel on Climate Change report (IPCC 2013) shows that a number of climate change variables are already changing, and based on a combination of global climate projections and regional observations and models, they are projected to change substantially more over the next 50 years (see Chapter 17). For example, coral reef scientists are concerned that coral bleaching is likely to become more frequent and more severe, even under optimistic climate scenarios produced by the IPCC.

Coal loader aground on the Great Barrier Reef, Australia
Source: © Great Barrier Reef Marine Park Authority

Management activities in MPAs have a critical role to play in influencing how serious these consequences are, but ultimately, the rate and extent of changes to the global climate system will determine the long-term fate of susceptible marine ecosystems. MPAs can provide a buffer against the effects of climate change and an aid to the natural resilience of marine ecosystems.

Pollution

Marine pollution can occur when harmful, or potentially harmful, effects result from the entry into the ocean of chemicals, particles, industrial, agricultural and residential waste, noise or the spread of invasive organisms. Poor water quality and sediment quality are the most serious known pollution issues affecting many nations' coastal and marine environments. Pollution from land contributes up to 80 per cent of all marine pollution (NOAA National Ocean Service 2014) and is a major threat to the long-term health of near-shore marine systems, affecting ecological processes, public health and social and commercial uses of marine resources.

The pollution often comes from non-point sources such as agricultural run-off, windblown debris and dust. Excessive inputs of nutrients (usually nitrogen or phosphorus) are a primary cause of eutrophication of surface waters, which stimulates algal growth. When pesticides are incorporated into the marine ecosystem, they quickly become absorbed into marine food webs. Once in the food web, pesticides can cause mutations and diseases, which can be harmful to humans as well as to the entire food web.

Point sources for pollutants include urban run-off, sewage discharge, industrial pollution and unregulated coastal developments. Toxic metals can also be introduced into marine food webs. These can cause a change to tissue matter, biochemistry, behaviour and reproduction, and suppress growth in marine life. Marine toxins can be transferred to land animals via fishmeal in feed supplements, and may appear later in meat and dairy products.

Dredging and port development

Dredging and subsequent dumping at sea of dredge spoil can have major impacts, especially changing the hydrographical conditions within an MPA or in areas adjacent to an MPA. The extent of the effects depends on a wide range of factors, including the location of the dredged area and the disposal area, the method and rate of extraction, and the type of machinery, as well as the nature of the surface of the sea bottom, the sediments, the coastal processes and the sensitivity of habitats and species.

Unless appropriate controls are imposed, the impacts of dredging or the construction of port facilities can cause seabed disturbance, transport or re-suspension of contaminants, alteration of sediment movement and changes in coastal processes. These impacts can be significant, and unless precautionary and preventive actions are taken during the construction and operational phases, a port may cause significant short-term and long-term negative impacts on local communities (both ecological and social) in adjacent areas.

Mineral and sand extraction

Marine sand and gravel, as well as minerals of interest found on or in the seabed, are non-renewable resources. The quantities of sand and gravel currently being exploited are very large. For example, in the North-East Atlantic Ocean alone, the extraction of sand and gravel was estimated to be an average of 40 million cubic metres per annum during the 1990s. Accordingly, pressure may come about to allow their extraction in MPAs, but the possible impacts are similar to those outlined for dredging (see above).

Oil and gas

Offshore oil and gas operations have increased dramatically and are expanding from shallow coastal waters to deeper offshore areas. Some activities associated with oil and gas operations, including surveys, drilling and production activities, may, if adjacent to MPAs, impact on the MPA in a variety of ways. The Deepwater Horizon oil spill in the Gulf of Mexico in 2010 was the largest accidental marine oil spill in the history of the petroleum industry and had a devastating effect on marine life in the gulf.

Shipping impacts

Shipping can potentially damage an MPA by collisions, groundings, the introduction of invasive marine pests, oil and chemical spills, the introduction of antifouling paints, waste disposal and anchor damage. Even a minor oil spill can cause local impacts to coastal species including mangroves, crabs and sediment-dwelling species. The potential for shipping activity to introduce non-native species into marine ecosystems is always present, and ballast water is a major source of introduced marine pests.

Unsustainable fishing

Fishing, whether commercial or recreational, can affect target species, non-target species and their habitats, and consequently has the potential to produce ecological effects in both fished areas and the marine environment as a whole. Ecosystem effects and the cumulative impacts of fishing are poorly understood. Scientific studies have shown that as well as affecting the abundance and characteristics of targeted species in fishing zones, fishing may also affect prey species and food webs more broadly. It is therefore important to develop a strategic approach to managing commercial, recreational and indigenous fishing in order to achieve ecological sustainability.

Many fishing techniques (for example, line, net and pot) may have little impact on habitats. Trawling, however, can cause habitat damage if not appropriately managed. Some fisheries management tools, such as bag and size limits, can help to protect the sustainability of a fishery, but do not fully address the impact of extractive activities on the ecosystem including on other non-target species. A good example of a comprehensive ecological risk assessment of a commercial fishery that looks at target species but also non-target species (bycatch), habitats and ecological processes is Pears et al. (2012).

Unsustainable tourism

If not regulated or limited, particularly in high-use areas, tourism can lead to impacts on both the marine environment and adjacent islands. For example, repeated anchoring of tourist vessels in the same locality has the potential to damage coral and seagrass habitats. A range of mandatory and voluntary arrangements can be used to minimise the impact of tourist operations.

Anchor damage can be reduced by the installation of public and private moorings in high-use areas, designated anchoring and no-anchoring areas, reef protection markers and by introducing best-practice guidelines. Sewage discharge by all users, including tourism operations, may be necessary if there are insufficient land-based facilities to service the pump-out requirements of the area. Planning for tourism should consider forecasts of the growth in tourism numbers as well as predictions of increasing impacts of use.

Mariculture

Unless appropriately managed, mariculture can modify, degrade or destroy marine habitat, disrupt trophic systems, deplete natural seed stock, transmit diseases and reduce genetic variability. The expansion of mariculture in coastal areas can not only lead to significant physical alteration of coastal environments, but can also reduce coastal protection and other functions of the ecosystem. Other impacts include pollution from nutrients, antibiotics and antifouling agents.

Staff, assets, fees and licences

The delivery of MPA management relies on the skills and commitment of staff (both field staff and office staff) and on the support they are given to perform their roles (see Chapter 8). Managers need to ensure access to:

- an appropriately sized and skilled workforce
- management infrastructure that is operational and appropriately located

Safety during marine operations, National Parks and Wildlife Service vessel *Shearwater II*, South Coast of New South Wales, Australia

Source: Graeme L. Worboys

Management vessel, Great Barrier Reef Marine Park, Australia

Source: © Great Barrier Reef Marine Park Authority

- a vessel fleet that is suitable for the task(s), well maintained and operational
- systems and technology able to assist in the delivery of tasks in an informed, contemporary and timely way.

Effective and efficient delivery of MPA management requires an appropriately sized and skilled workforce with the skills and the resources they need to perform their roles (see Chapter 9). When determining the appropriate staffing levels and skills, one focus should be on securing staff with skills that cannot be readily obtained elsewhere (for example, from other government agencies, industry or the community). The commitment of staff and effective leadership are two of the most important elements for the success of an MPA organisation (see Chapter 12).

Training, equipment needs and operating capacity need to be periodically reviewed and should be important parts of an agency's annual business plan. The safety and wellbeing of those who deliver field management operations in an MPA and/or island environment are critical, particularly if the field-based tasks are undertaken in remote localities. This requires that safe workplaces, equipment and training are provided and that staff are competent to ensure all necessary tasks are performed safely.

Assets management

Managing physical MPA assets (such as vessels or an operational base) should have the objective of providing the required level of service in the most cost-effective manner. Physical asset management should consider the 'whole life cycle' of an asset, including design, construction, commissioning, operation, maintenance, repair, modification, replacement and decommissioning or disposal (see Chapter 24).

The obvious preference is to have a reliable, safe, fit-for-purpose vessel(s), which is/are well maintained and operational, but sometimes vessel patrols for some tasks can be shared (such as with other governmental agencies or with the private sector). If vessels are owned by the MPA agency, a prioritised vessel replacement schedule should be part of the regularly reviewed business strategy (for example, replacement of outboard motors every four to five years or replacement of larger vessels every 10–15 years).

Beyond a physical presence on the water, MPA managers should seek to augment their field capacity with the adoption of technology and advanced systems (such as satellite monitoring), particularly where they help to capture and retain observations, heighten intelligence gathering and assist the efficient deployment of the MPA's physical assets. Such technology is likely to be most applicable for enhancing compliance and natural

resource monitoring capabilities in an informed, contemporary and timely way at both remote and high-risk locations.

Fees and charges

While many protected areas, such as national parks and historic sites, have successfully implemented visitor entry fees (see Chapter 23), it is rarely so easy in an MPA, especially if there is a multitude of access points or no effective way to collect the fees. Where an MPA attracts a large number of tourists and a fee or charge can be effectively levied, significant income can be derived. There can, however, be drawbacks.

One major obstacle faced by government departments in implementing revenue-generating mechanisms like user fees, public donations or gift shop sales is that it is generally difficult to segregate such revenue for the MPA, where government income is expected to be paid into a consolidated fund and allocated according to national priorities (Geoghegan 1998). NGOs may not have adequate systems for financial accountability and their authority as revenue collectors may be questioned by users or management partners. In addition, the process for collecting fees may be so complex or unworkable that it may cost more to collect or enforce than the funds that are generated.

There are, however, some good examples around the world—such as the 'Environmental Management Charge' in the Great Barrier Reef, which generates more than US$6.5 million annually (most of it from tourism). These funds are used for Great Barrier Reef management and research; however, other government funding appropriations for the Great Barrier Reef are influenced by the amount of Environmental Management Charge fees that are generated.

There are also good examples of successful fee processes in much smaller MPAs in the Caribbean: in Bonaire (Saba) and the British Virgin Islands, fees are levied on users of the marine resources, including scuba divers, and in the British Virgin Islands on yacht charterers as well. The user-fee systems are implemented in close collaboration with the commercial dive and charter boat operators, who collect the fees from clients, keep records of use and perform basic interpretative information and surveillance functions on behalf of the protected areas (Geoghegan 1998). In some MPAs, visitor fees are supplemented with other funding sources such as souvenirs, gift shop sales or visitor donations (such as those generated by the 'Friends of the Saba Marine Park').

When developing revenue generation strategies for an MPA, Geoghegan (1998) recommends starting by developing a desired budget for the MPA, creating a fundraising strategy through a consultative approach with all major stakeholders, ensuring that resilience is achieved through a diverse funding base with a year-on-year reduction of dependence on direct government support, and optimising partnerships and co-management agreements throughout to increase management efficiency and reduce costs.

Licences and permits

In some MPAs certain activities require a permit. For example, the following activities require a Marine Parks permit to operate in the Great Barrier Reef:

- conducting most commercial activities, including virtually all tourist operations
- installation and operation of structures such as jetties, marinas, pontoons and aquaculture facilities
- any works such as repairs to structures, dredging and dumping of spoil, and placement and operation of moorings
- anchoring or mooring for an extended period
- waste discharge from a fixed structure
- research (except for limited-impact research).

Complementary arrangements under both the national and the State MPA legislation mean only a single permit is required in the Great Barrier Reef and a permit is not required for any recreational activities. The information necessary to apply for a permit and the assessment process are both set out in the legislation; and experience over many decades has shown the need for a clear permit process, including unambiguous definitions, clear assessment criteria, and the benefits of an effectively implemented permit system. If a proposal might restrict reasonable use of part of the marine park by the public, one of the requirements before a permit is issued is public notification of the proposal, inviting comments.

Management effectiveness

Evaluating the effectiveness of managing an MPA is a challenge facing the managers of most MPAs worldwide. Increasingly, there are expectations that management should be able to demonstrate that it is achieving its goals and objectives, but also that management is cost-effective, efficient and proactive. Consequently, management effectiveness needs to be assessed and demonstrated in a systematic way that will allow useful comparisons over time (Day et al. 2002). The IUCN

Scientist undertaking monitoring work, Great Barrier Reef Marine Park, Australia

Source: © Great Barrier Reef Marine Park Authority

Reef visitors, Great Barrier Reef Marine Park, Australia

Source: © Great Barrier Reef Marine Park Authority

World Commission on Protected Areas (WCPA) framework for management effectiveness evaluation (Hockings et al. 2006) suggests that a comprehensive assessment of management effectiveness should assess six management elements (see Chapter 28):

1. an understanding of the 'context' of the MPA including its values, the threats it faces and opportunities available, its stakeholders, and the management and political environments
2. 'planning' that establishes the vision, goals, objectives and strategies to conserve values and reduce threats
3. the 'inputs' (resources) of staff, money and equipment needed to achieve the objectives
4. implementation of management actions according to accepted 'processes'
5. production of 'outputs' (goods and/or services, which should usually be outlined in management and work plans)
6. many outputs and actions that result in impacts or 'outcomes' that achieve defined goals and objectives.

A comprehensive assessment of MPA management needs to assess all six elements. Such an evaluation can have many benefits including:

- improving decision-making and ongoing management in a changing environment
- reviewing MPA policies and programs
- providing feedback on management to decision-makers and interest groups
- helping account for existing management expenditure
- justifying the need for additional resources.

Monitoring

Monitoring is a fundamental management tool to provide information for analysis and documenting environmental impacts, both natural and anthropogenic, and for assessing the effectiveness of marine management actions. Monitoring management performance is an important task in order to know if an MPA is efficient and effective (Day et al. 2002), where changes in the marine environment over time are compared with a baseline condition.

Monitoring of marine environments has evolved as management requirements have changed. Most monitoring programs have been directed towards biological, biophysical or social aspects and have generally been undertaken as 'stand-alone' monitoring or research tasks. Some of these programs assess the effectiveness of specific management actions, but few provide an integrated assessment of the overall effectiveness of a marine managed area, or specifically monitor against the objectives for which such an area was initially declared. A number of lessons learned from conducting marine monitoring programs include starting with a modest monitoring program, understanding that a

combination of monitoring methods may provide a more reliable assessment than just a single method, and exploring opportunities for encouraging stakeholder participation or local input in the overall monitoring process (Day et al. 2002). Do not wait for all the answers or perfect science before taking appropriate adaptive management action arising from monitoring information.

Conclusion

The ocean makes up 70 per cent of our planet's surface and nearly 98 per cent of its viable living space. While the ocean is the ecological engine that powers our survival, multiple pressures—including unsustainable fishing, global climate change, habitat destruction, invasive species and pollution—have led to a decline in ocean health.

With the growing number of MPAs, we are now more likely to reach 10 per cent protection by 2020 than we were just a few years ago. The question 'is 10 per cent enough?' continues to raise concern, however, with some estimates of adequate ocean protection in the range of 20–30 per cent (or even higher) to ensure sustained ocean health (IUCN 2003). Further debate looms among stakeholders in the marine conservation community over what type of conservation strategies should be counted towards Aichi Target 11 as well as how to measure the effectiveness of MPAs.

Rapid expansion of marine protection, especially the establishment of mega MPAs, also comes with the challenge of implementing effective management. Furthermore, to successfully achieve the target, the MPA network will need to be ecologically representative, equitably and effectively managed and of particular importance for ecosystem services, as alluded to in the text of Aichi Target 11; but without clear guidance it will remain a lofty goal and the world will struggle to maintain a globally consistent pace. In conclusion, achieving the 10 per cent quantitative target will be a significant first step, but only a first step.

If the very feat of MPA designation were not enough, two major issues continue to burden the system: one is a longstanding issue—the notion of 'paper parks'; the other is a more recent creation—the notion of 'regression' in progress. Paper parks are areas that are designated by name but not protected by management actions. A key step in moving the MPA agenda forwards involves addressing the widespread concern that many MPAs around the world are mostly legislative exercises and do not provide the levels of protection needed (World Bank 2006).

Globally, few hard data exist to truly quantify and categorise the level of management effectiveness at local or larger scales. Most management effectiveness evaluations have taken place in terrestrial protected areas, but there is growing international recognition of the need to evaluate and understand the degree to which MPA management efforts are effective and meeting their objectives, and how best to improve their effectiveness (Hockings et al. 2000, 2006; Toropova et al. 2010).

Regression—or 'backsliding'—is the reversal of progress and actions by governments on MPA commitments. Often blamed on the global financial slowdown in 2008, this situation has now been used by governments as an opportunity to reduce their commitments to ocean protection, and in the worst cases, to unpick existing designations and conservation agreements. Many countries including the United Kingdom and Australia have been accused by some of dramatically scaling back plans for MPAs, alongside reducing or removing areas from network plans that contain high levels of protection for marine species and ecosystems. Such backsliding is highlighted by the World Wide Fund for Nature Protected Area Downgrading, Downsizing, and Degazettement (PADDD) program (WWF 2014).

Effective planning and management of MPAs will help address many of the challenges facing our oceans; but MPAs alone are not the sole answer to countering such complex challenges as climate change. More effective management of all our oceans and our catchments is also required. We cannot wait, however, until we have all the answers or even all the information; we must act now and be prepared to adaptively manage as we learn more.

References

Recommended reading

Alcala, A. C., Russ, G. R., Maypa, A. P. and Calumpong, H. P. (2005) 'A long-term, spatially replicated experimental test of the effect of marine reserves on local fish yields', *Canadian Journal of Fisheries and Aquatic Sciences* 62: 98–108.

Almany, G. R., Hamilton, R. J., Bode, M., Matawai, M., Potuku, T., Saenz-Agudelo, P., Planes, S., Berumen, M. L., Rhodes, K. L., Thorrold, S. R., Russ, G. R. and Jones, G. P. (2013) 'Dispersal of grouper larvae drives local resource sharing in a coral reef fishery', *Current Biology* 23(7): 626–30.

Ban, N. C., Bax, N. J., Gjerde, K. M., Devillers, R., Dunn, D. C., Dunstan, P. K., Hobday, A. J., Maxwell, S. M., Kaplan, D. M., Pressey, R. L., Ardron, J. A., Game, E. T. and Halpin, P. N. (2014) 'Systematic conservation planning: a better recipe for managing the high seas for biodiversity conservation and sustainable use', *Conservation Letters* 7: 41–54. <doi:10.1111/conl.12010>

Bertzky, B., Corrigan, C., Kemsey, J., Kenney, S., Ravilious, C., Besançon, C. and Burgess, N. D. (2012) *Protected Planet Report: Tracking progress towards global targets for protected areas*, IUCN and UNEP-WCMC, Gland and Cambridge.

Cappo, M. and Kelley, R. A. (2001) 'Connectivity in the Great Barrier Reef World Heritage Area—an overview of pathways and processes', in E. Wolanski (ed.) *Oceanographic Processes of Coral Reefs: Physical and biological links in the Great Barrier Reef*, pp. 161–87, CRC Press, Boca Raton, FL.

Cisneros-Montemayor, A. M., Barnes, M., Al-Abdulrazzak, D., Navarro-Holm, E. and Sumaila, U. R. (2013) 'Global economic value of shark ecotourism: implications for conservation', *Oryx* 47(3): 381–8.

Convention on Biological Diversity (CBD) (2004) COP 7 Decision VII/28, Seventh Meeting of the Conference of the Parties to the Convention on Biological Diversity, Kuala Lumpur, Malaysia, 9–20 February.

Convention on Biological Diversity (CBD) (2008) COP IX Decision VIII/20, Eighth Meeting of the Conference of the Parties to the Convention on Biological Diversity, Bonn, Germany, 19–30 May.

Convention on Biological Diversity (CBD) (2011) *Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets*, Secretariat of the Convention on Biological Diversity, Montreal. <www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf>

Convention on Biological Diversity Subsidiary Body on Scientific, Technical and Technological Advice (CBD SBSTTA) (2014) *Progress report on describing areas meeting the criteria for ecologically and biologically significant marine areas*, Submitted to the 18th meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, Montreal, 23–28 June.

Corrigan, C. and Granziera, A. (2010) *A Handbook for the Indigenous and Community Conserved Areas Registry*, UNEP-WCMC, Cambridge.

Cullis-Suzuki, S. and Pauly, D. (2008) 'MPA costs as "beneficial" fisheries subsidies: a global evaluation', *Coastal Management* 38: 113–21.

Day, J. C. (2002) 'Zoning—lessons from the Great Barrier Reef Marine Park', *Ocean & Coastal Management* 45: 139–56.

Day, J. C. (2006) 'Marine protected areas', in M. Lockwood, G. L. Worboys and A. Kothari (eds) *Managing Protected Areas: A global guide*, pp. 497–527, Earthscan, London.

Day, J. C. and Roff, J. C. (2000) *Planning for Representative Marine Protected Areas: A framework for Canada's oceans*, WWF Canada, Toronto.

Day, J. C., Dudley, N., Hockings, M., Holmes, G., Laffoley, D., Stolton, S. and Wells, S. (2012) *Guidelines for Applying the IUCN Protected Area Management Categories to MPAs*, IUCN, Gland.

Day, J. C., Fernandes, L., Lewis, A. and Innes, J. (2004) 'RAP—an ecosystem level approach to biodiversity protection planning', in *Proceedings of the Second International Tropical Marine Ecosystems Management Symposium*, pp. 251–65, ICRI, Manila.

Day, J. C., Hockings, M. and Jones, G. (2002) 'Measuring effectiveness in marine protected areas—principles and practice', in *Proceedings World Congress on Aquatic Protected Areas*, Cairns, Queensland. <www.researchgate.net/publication/43465429>

Day, J. C., Wren, E. and Vohland, K. (2012b) 'Community engagement in safeguarding the world's largest reef: Great Barrier Reef, Australia', in A. Galla (ed.) *World Heritage: Benefits beyond borders*, pp. 18–29, UNESCO, Paris, and Cambridge University Press, Cambridge.

Deloitte Access Economics (2013) *Economic Contribution of the Great Barrier Reef 2011–2012*, Great Barrier Reef Marine Park Authority, Townsville, Queensland.

Department of Oceans and Fisheries Canada (2014) *Spotlight on Marine Protected Areas in Canada*, Department of Oceans and Fisheries Canada, Ottawa. <www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/spotlight-pleinsfeux/index-eng.htm>

Done, T. J., Ogden, J. C., Wiebe, W. J. and Rosen, B. R. (1996) 'Biodiversity and ecosystem function of coral reefs', in H. A. Mooney, J. H. Cushman, E. Medina, O. E. Sala and E. D. Schulze (eds) *Functional Roles of Biodiversity: A global perspective*, pp. 393–429, Wiley, Chichester, UK.

Dudley, N. (ed.) (2008) *Guidelines for Applying Protected Area Management Categories*, IUCN, Gland.

Dunn, D. C., Ardron, J., Bax, N., Bernal, P., Cleary, J., Cresswell, I., Donnelly, B., Dunstan, P., Gjerde, K., Johnson, D., Kaschner, K., Lascelles, B., Rice, J., von Nordheim, H., Wood, L. and Halpin, P. N. (2014) 'The Convention on Biological Diversity's ecologically or biologically significant areas: origins, development, and current status', *Marine Policy* 49: 137–45.

Ehler, C. and Douvere, F. (2007) *Visions for a sea change. Report of the First International Workshop on Marine Spatial Planning*, IOC Manual and Guides No. 48, IOCAM Dossier No. 4, Intergovernmental Oceanographic Commission and Man and the Biosphere Programme, UNESCO, Paris.

Ehler, C. and Douvere, F. (2009) *Marine spatial planning: a step-by-step approach toward ecosystem-based management*, IOC Manual and Guides No. 53, ICAM Dossier No. 6, Intergovernmental Oceanographic Commission and Man and the Biosphere Programme, UNESCO, Paris.

Fernandes, L., Day, J. C., Lewis, A., Slegers, S., Kerrigan, B., Breen, D., Cameron, D., Jago, B., Hall, J., Lowe, D., Innes, J., Tanzer, J., Chadwick, V., Thompson, L., Gorman, K., Simmons, M., Barnett, B., Sampson, K., De'ath, G., Mapstone, B., Marsh, M., Possingham, H., Ball, I., Ward, T., Dobbs, K., Aumend, J., Slater, D. and Stapleton, K. (2005) 'Establishing representative no-take areas in the Great Barrier Reef: large-scale implementation of theory on marine protected areas', *Conservation Biology* 19(6): 1733–44.

Freestone, D., Johnson, D., Ardron, J., Killerlain Morrison, K. and Unger, S. (2014) 'Can existing institutions protect biodiversity in areas beyond national jurisdiction? Experiences from two on-going processes', *Marine Policy* 49: 167–75.

Geoghegan, T. (1998) *Financing Protected Area Management: Experiences from the Caribbean*, Caribbean Natural Resources Institute, Port of Spain, Trinidad. <www.canari.org/finance.pdf>

Gjerde, K .M. and Rulska-Domino, A. (2012) 'MPAs beyond national jurisdiction: some practical perspectives for moving ahead', *International Journal of Marine and Coastal Law* 27: 351–73.

Graham, R. T. (2004) 'Global whale shark tourism: a "golden goose" of sustainable and lucrative income', *Shark News* 16: 8–9.

Great Barrier Reef Marine Park Authority (GBRMPA) (2013) *Great Barrier Reef Region Strategic Assessment: Strategic assessment report—Draft for public comment*, Great Barrier Reef Marine Park Authority, Commonwealth of Australia, Canberra.

Great Barrier Reef Marine Park Authority (GBRMPA) (2014) *Traditional Use of Marine Resources Agreements*, Great Barrier Reef Marine Park Authority, Townsville, Queensland. <www.gbrmpa.gov.au/our-partners/traditional-owners/traditional-use-of-marine-resources-agreements>

Great Barrier Reef Marine Park Authority (GBRMPA), World Bank and International Union for Conservation of Nature (IUCN) (1995) *A Global Representative System of Marine Protected Areas. Volumes I–IV*, eds G. Kelleher, C. Bleakley and S. Wells, The World Bank, Washington, DC.

Grech, A. and Marsh, H. (2008) 'Rapid assessment of risks to a mobile marine mammal in an ecosystem-scale marine protected area', *Conservation Biology* 22(3): 711–20.

Green, A., Smith, S. E., Lipsett-Moore, G., Groves, C., Peterson, N., Sheppard, S., Lokani, P., Hamilton, R., Almany, J., Aitsi, J. and Bualia, L. (2009) 'Designing a resilient network of MPAs for Kimbe Bay, Papua New Guinea', *Oryx* 43(04): 488–98.

Grimsditch, G. D. and Salm, R. V. (2006) *Coral Reef Resilience and Resistance to Bleaching*, IUCN, Gland.

Halpern, B. S. (2003) 'The impact of marine reserves: do reserves work and does reserve size matter?', *Ecological Applications* 13: 117–37.

Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C., Bruno, J. F., Casey, K. S., Ebert, C., Fox, H. E., Fujita, R., Heinemann, D., Lenihan, H. S., Madin, E. M. P., Perry, M. T., Selig, E. R., Spalding, M., Steneck, R. and Watson, R. (2008) 'A global map of human impact on marine ecosystems', *Science* 319(5865): 948–52.

Harborne, A. R., Renaud, P. G., Tyler, E. H. M. and Mumby, P. J. (2009) 'Reduced density of the herbivorous urchin *Diadema antillarum* inside a Caribbean marine reserve linked to increased predation pressure by fishes', *Coral Reefs* 28(3): 783–91.

Harrison, H. B., Williamson, D. H., Evans, R. D., Almany, G. R., Thorrold, S. R., Russ, G. R., Feldheim, K. A., van Herwerden, L., Planes, S., Srinivasan, M., Berumen, M. L. and Jones, G. P. (2012) 'Larval export from marine reserves and the recruitment benefit for fish and fisheries', *Current Biology* 22(11): 1023–8.

Helms, G. (2002) Quoted in an article titled 'Balancing ecology and economics: lessons learned from the planning of a marine reserve network in the Channel Islands (US)', *MPA News* 4(6), December 2002. <depts..washington.edu/mpanews/MPA37.htm>.

Hockings, M., Stolton, S. and Dudley, N. (2000) *Evaluating Effectiveness: A framework for assessing the management of protected areas*, IUCN WCPA, Gland.

Hockings, M., Stolton, S., Leverington, F., Dudley, N. and Courrau, J. (2006) *Evaluating Effectiveness: A framework for assessing management effectiveness of protected areas*, 2nd edn, IUCN, Gland.

Hoyt, E. (2011) *Marine Protected Areas for Whales, Dolphins and Porpoises. A world handbook for cetacean habitat conservation and planning*, 2nd edn, Earthscan, London and New York.

Hoyt, E. (ed.) (2012) *Proceedings of the Second International Conference on Marine Mammal Protected Areas (ICMMPA 2)*, Fort-de-France, Martinique, 7–11 November 2011.

Intergovernmental Panel on Climate Change (IPCC) (2013) 'Summary for policymakers', in T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P. M. Midgley (eds) *Climate Change 2013*: *The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, pp. 1–35, Cambridge University Press, Cambridge.

International Union for Conservation of Nature World Commission on Protected Areas (IUCN WCPA) (2003) *The Durban Accord*, Fifth IUCN World Parks Congress, Durban.

International Union for Conservation of Nature World Commission on Protected Areas (IUCN WCPA) (2003b) *Fifth IUCN World Parks Congress Recommendations*, IUCN WCPA, Gland.

International Union for Conservation of Nature (IUCN) and United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) (2014) *Global Statistics from The World Database on Protected Areas: August 2014*, UNEP-WCMC, Cambridge.

Johnston, R. J., Gregory, D., Pratt, G. and Watts, M. (2000) *The Dictionary of Human Geography*, 4th edn, Wiley-Blackwell, Oxford.

Jones, G. P., Planes, S. and Thorrold, S. R. (2005) 'Coral reef fish larvae settle close to home', *Current Biology* 15(14): 1314–18.

Jones, P. J. S. (2014) *Governing Marine Protected Areas: Resilience through diversity*, Earthscan, London.

Jones, P. J. S., Qiu, W. and de Santo, E. M. (2011) *Governing marine protected areas: getting the balance right*, Technical Report, United Nations Environment Programme, Nairobi.

Kellner, J. B., Tetreault, I., Gaines, S. D. and Nisbet, R. M. (2007) 'Fishing the line near marine reserves in single and multispecies fisheries', *Ecological Applications* 17(4): 1039–54.

Kennedy, E. V., Perry, C. T., Halloran, P. R., Iglesias-Prieto, R., Schönberg, C. H. L., Wisshak, M., Form, A. U., Carricart-Ganivet, J. P., Fine, M., Eakin, C. M. and Mumby, P. J. (2013) 'Avoiding coral reef functional collapse requires local and global action', *Current Biology* 23(10): 912–18.

Kloiber, U. (2013) *Chumbe Island Coral Park—Conservation and education, status report 2013*, Zanzibar, Tanzania.

Kothari, A., Corrigan, C., Jonas, H., Neumann, A. and Shrumm, H. (eds) (2012) *Recognising and Supporting Territories and Areas Conserved by Indigenous Peoples and Local Communities: Global overview and national case studies*, Technical Series No. 64, Secretariat of the Convention on Biological Diversity, ICCA Consortium, Kalpavriksh and Natural Justice, Montreal.

Leenhardt, P., Cazalet, B., Salvat, B., Claudet, J. and Feral, F. (2013) 'The rise of large-scale marine protected areas: conservation or geopolitics?', *Ocean & Coastal Management* 85(Part A): 112–18.

Lester, S. E., Halpern, B. S., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B. I., Gaines, S. D., Airamé, S. and Warner, R. R. (2009) 'Biological effects within no-take marine reserves: a global synthesis', *Marine Ecology Progress Series* 384: 33–46.

Ling, S. D. and Johnson, C. R. (2012) 'Marine reserves reduce risk of climate-driven phase shift by reinstating size- and habitat-specific trophic interactions', *Ecological Applications* 22(4): 1232–45.

McClanahan, T. R., Graham, N. A. J., Calnan, J. M. and MacNeil, M. A. (2007) 'Toward pristine biomass: reef fish recovery in coral reef marine protected areas in Kenya', *Ecological Applications* 17: 1055–67.

McCook, L. J., Almany, G. R., Berumen, M. L., Day, J. C., Green, A. L., Jones, G. P., Leis, J. M., Planes, P., Russ, G. R., Sale, P. F. and Thorrold, S. R. (2009) 'Management under uncertainty: guidelines for incorporating connectivity into the protection of coral reefs', *Coral Reefs* 28: 353–66.

McCook, L. J., Ayling, T., Cappo, M., Choat, J. H., Evans, R. D., de Freitas, D. M., Heupel, M., Hughes, T. P., Jones, G. P., Mapstone, B., Marsh, H., Mills, M., Molloy, F. J., Pitcher, C. R., Pressey, R. L., Russ, G. R., Sutton, S., Sweatman, H., Tobin, R., Wachenfeld, D. R. and Williamson, D. H. (2010) 'Adaptive management of the Great Barrier Reef: a globally significant demonstration of the benefits of networks of marine reserves', *Proceedings of the National Academy of Sciences* 107(43): 18 278–85.

McLeod, E., Salm, R., Green, A. and Almany, J. (2009) 'Designing marine protected area networks to address the impacts of climate change', *Frontiers in Ecology and the Environment* 7: 362–70.

Mulongoy, K. J. and Gidda, S. B. (2008) *The Value of Nature: Ecological, economic, cultural and social benefits of protected areas*, Secretariat of the Convention on Biological Diversity, Montreal.

Mumby, P. J., Dahlgren, C. P., Harborne, A. R., Kappel, C. V., Micheli, F., Brumbaugh, D. R., Holmes, K. E., Mendes, J. M., Broad, K., Sanchirico, J. N., Buch, K., Box, S., Stoffle, R. W. and Gill, A. B. (2006) 'Fishing, trophic cascades, and the process of grazing on coral reefs', *Science* 311: 98–101.

National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (2014) *What is the Biggest Source of Pollution in the Ocean?*, National Oceanic and Atmospheric Administration National Ocean Service, Silver Spring, MD. <oceanservice.noaa.gov/facts/pollution.html>

O'Connor, S., Campbell, R., Cortez, H. and Knowles, T. (2009) *Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare*, International Fund for Animal Welfare, Yarmouth Port, MA.

Oliver, P. (2004) 'Developing effective partnerships in natural resource management', in C. Richards and L. Aitken (eds) *Social Innovations in Natural Resource Management: A handbook of social research in natural resource management in Queensland*, pp. 58–60, Department of Natural Resources and Mines, Brisbane.

OSPAR Commission (2013) *2012 Status Report on the OSPAR Network of MPAs*, OSPAR Commission, London.

Pala, C. (2013) 'Giant marine reserves pose vast challenges', *Science* 339: 640–1.

Pears, R. J., Morison, A. K., Jebreen, E. J., Dunning, M. C., Pitcher, C. R., Courtney, A. J., Houlden, B. and Jacobsen, I. P. (2012) *Ecological Risk Assessment of the East Coast Otter Trawl Fishery in the Great Barrier Reef Marine Park: Summary report*, Great Barrier Reef Marine Park Authority, Townsville, Queensland.

Pires, R., Costa Neves, H. and Karamanlidis, A. A. (2008) 'The critically endangered Mediterranean monk seal *Monachus monachus* in the archipelago of Madeira: priorities for conservation', *Oryx* 42(2): 278–85.

Roff, G. and Mumby, P. J. (2012) 'Global disparity in the resilience of coral reefs', *Trends in Ecology and Evolution* 27(7): 404–13.

Roff, J. C. and Zacharias, M. A. (2011) *Marine Conservation Ecology*, Earthscan, London.

Russ, G. R., Cheal, A. J., Dolman, A. M., Emslie, M. J., Evans, R. D., Miller, I., Sweatman, H. and Williamson, D. H. (2008) 'Rapid increase in fish numbers follows creation of world's largest marine reserve network', *Current Biology* 18: 514–15.

Russ, G. R., Stockwell, B. and Alcala, A. C. (2005) 'Inferring versus measuring rates of recovery in no-take marine reserves', *Marine Ecology Progress Series* 292: 1–12.

Salm, R. V., Clark, J. and Siirila, E. (2000) *Marine and Coastal Protected Areas. A guide for planners and managers*, 3rd edn, IUCN, Gland.

Salm, R. V., Done, T. and McLeod, E. (2006) 'Marine protected area planning in a changing climate', in *Coral Reefs and Climate Change: Science and management*, pp. 207–21, American Geophysical Union, Washington, DC.

Selig, E. R., Turner, W. R., Tröeng, S., Wallace, B. P., Halpern, B. S., Kaschner, K., Lascelles, B. G., Carpenter, K. E. and Mittermeier R. A. (2014) 'Global priorities for marine biodiversity conservation', *PLoS ONE* 9(1).

Spalding, M. D., McIvor, A. L., Beck, M. W., Koch, E. W., Möller, I., Reed, D. J., Rubinoff, P., Spencer, T., Tolhurst, T. J., Wamsley, T. V., van Wesenbeeck, B. K., Wolanski, E. and Woodroffe, C. D. (2014) 'Coastal ecosystems: a critical element of risk reduction', *Conservation Letters* 7(3): 293–301.

Standards Australia (2013) *Risk Management Guidelines—Companion to AS/NZS ISO 31000:2009*, Standards Australia, Sydney.

Steneck, R. S. and Dethier, M. N. (1994) 'A functional group approach to the structure of algal-dominated communities', *Oikos* 69: 476–98.

The Economics of Ecosystems and Biodiversity (TEEB) (2010) *The Economics of Ecosystems and Biodiversity: Mainstreaming the economics of nature—A synthesis of the approach, conclusions and recommendations of TEEB*, TEEB, Nairobi.

Toonen, R. J., Wilhelm, T. A., Maxwell, S. M., Wagner, D., Bowen, B. W., Sheppard, C. R., Taei, S. M., Teroroko, T., Moffitt, R., Gaymer, C. F., Morgan, L., Lewis, N., Sheppard, A. L. S., Parks, J. and Friedlander, A. M. (2013) 'One size does not fit all: the emerging frontier in large-scale marine conservation', *Marine Pollution Bulletin* 77(1): 7–10.

Toropova, C., Meliane, I., Laffoley, D., Matthews, E. and Spalding, M. (eds) (2010) *Global Ocean Protection: Present status and future possibilities*, Agence des aires marines protégées, Brest, France; IUCN WCPA, Gland; UNEP-WCMC, Cambridge; The Nature Conservancy, Arlington, VA; and UNU, Tokyo.

United Nations (UN) (2002) *Plan of Implementation of the World Summit on Sustainable Development, A/CONF.199/20, Chapter 1, Resolution 2*, September, Johannesburg.

United Nations (UN) (2014) *Chronological Lists of Ratifications of, Accessions and Successions to the Convention and the Related Agreements as at 29 October 2013*, Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations, New York. <www.un.org/depts/los/reference_files/chronological_lists_of_ratifications.htm>

Vianna, G. M. S., Meekan, M. G., Pannell, D. J., Marsh, S. P. and Meeuwig, J. J. (2012) 'Socio-economic value and community benefits from shark-diving tourism in Palau: a sustainable use of reef shark populations', *Biological Conservation* 145: 267–77.

Weeks, R., Aliño, P. M., Atkinson, S., Beldia, P., Binson, A., Campos, W. L., Djohani, R., Green, A. L., Hamilton, R., Horigue, V., Jumin, R., Kalim, K., Kasasiah, A., Kereseka, J., Klein, C., Laroya, L., Magupin, S., Masike, B., Mohan, C., da Silva Pinto, R. M., Vave-Karamui, A., Villanoy, C., Welly, M. and White, A. T. (2014) 'Developing marine protected area networks in the Coral Triangle: good practices for expanding the Coral Triangle Marine Protected Area System', *Coastal Management* 42(2): 183–205.

Weil, E. and Rogers, C. S. (2011) 'Coral reef diseases in the Atlantic–Caribbean', in *Coral Reefs: An ecosystem in transition*, pp. 465–91, Springer, Netherlands.

West, J. M. and Salm, R. V. (2003) 'Resistance and resilience to coral bleaching: implications for coral reef conservation and management', *Conservation Biology* 17(4): 956–67.

White, A. T., Aliño, P. M., Cros, A., Fatan, N. A., Green, A. L., Teoh, S. J., Laroya, L., Peterson, N., Tan, S., Tighe, S., Li, R. V., Walton, A. and Wen, W. (2014) 'MPAs in the Coral Triangle: progress, issues, and options', *Coastal Management* 42(2): 87–106.

Williams, I. D. and Polunin, N. V. C. (2000) 'Differences between protected and unprotected reefs of the western Caribbean in attributes preferred by dive tourists', *Environmental Conservation* 4: 382–91.

Wood, L. J., Fish, L., Laughren, J. and Pauly, D. (2008) 'Assessing progress towards global marine protection targets: shortfalls in information and action', *Oryx* 42(3): 340–51.

World Bank (2006) *Scaling up marine management: the role of marine protected areas*, Report No. 36635, The World Bank, Washington, DC. <siteresources.worldbank.org/ENVIRONMENT/Resources/Scaling_Up_MPA_ESW-May2011.pdf>

World Bank and Food and Agriculture Organisation (FAO) (2009) *The Sunken Billions: The economic justification for fisheries reform*, The International Bank for Reconstruction and Development and The World Bank, Washington, DC, and FAO, Rome.

World Wide Fund for Nature (WWF) (2014) *PADDDtracker: Tracking protected area downgrading, downsizing, and degazettement*, [Beta version]. <www.PADDDtracker.org>

This text taken from *Protected Area Governance and Management*,
edited by Graeme L. Worboys, Michael Lockwood, Ashish Kothari, Sue Feary and Ian Pulsford,
published 2015 by ANU Press, The Australian National University, Canberra, Australia.