Review

Assessing progress towards global marine protection targets: shortfalls in information and action

LOUISA J. WOOD, LUCY FISH, JOSH LAUGHREN and DANIEL PAULY

Abstract Current global marine protection targets aim to protect 10−30% of marine habitats within the next 3–5 years. However, these targets were adopted without prior assessment of their achievability. Moreover, ability to monitor progress towards such targets has been constrained by a lack of robust data on marine protected areas. Here we present the results of the first explicitly marine-focused, global assessment of protected areas in relation to global marine protection targets. Approximately 2.35 million km^2, 0.65% of the world's oceans and 1.6% of the total marine area within Exclusive Economic Zones, are currently protected. Only 0.08% of the world's oceans, and 0.2% of the total marine area under national jurisdiction is no-take. The global distribution of protected areas is both uneven and unrepresentative at multiple scales, and only half of the world's marine protected areas are part of a coherent network. Since 1984 the spatial extent of marine area protected globally has grown at an annual rate of 4.6%, at which even the most modest target is unlikely to be met for at least several decades rather than within the coming decade. These results validate concerns over the relevance and utility of broad conservation targets. However, given the low level of protection for marine ecosystems, a more immediate global concern is the need for a rapid increase in marine protected area coverage. In this case, the process of comparing targets to their expected achievement dates may help to mobilize support for the policy shifts and increased resources needed to improve the current level of marine protection.

Keywords Conservation target, international policy, marine protected area.

This paper contains supplementary material that can be found online at http://journals.cambridge.org

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Received 13 March 2007. Revision requested 26 June 2007.
Accepted 21 August 2007.

Introduction

Marine protected areas are increasingly viewed as an important management tool within a suite of policy alternatives to reduce, prevent and/or reverse, ongoing (and in some cases rapid) declines in marine biodiversity and fisheries (Agardy, 1994; Pauly *et al.*, 2002; Hoyt, 2005; Roberts *et al.*, 2005). This has led to their inclusion in three recent global marine protection targets. The 2002 Plan of Implementation of the World Summit on Sustainable Development committed to establishing a representative global network of marine protected areas by 2012 (United Nations, 2002, Section IV, paragraph 32(c)). At the Vth World Parks Congress in 2003 the recommendation was made to '[g]reatly increase the marine and coastal area managed in marine protected areas by 2012; these networks should include strictly protected areas that amount to at least 20–30% of each habitat'. Most recently, at the 8th Ordinary Conference of the Parties to the Convention on Biological Diversity (CBD) in 2006, a target that 'at least 10% of each of the world's ecological regions [including marine and coastal be] effectively conserved [by 2010]' was adopted (CBD, 2006). However, these targets were adopted with limited prior knowledge of the existing global marine protected area network (the most recent global assessment is > 10 years old and had data limitations; Kelleher *et al.*, 1995), and without any assessment of the feasibility of the targets.

The World Database on Protected Areas (WDPA; UNEP-WCMC, 2004) is a global data source that has been widely used for monitoring marine protected areas. However, its coverage of marine protected areas has significant limitations (CBD, 2003), permitting only relatively broad-scale analyses of the total number and area of protected areas (Chape *et al.*, 2005). More complete information on individual marine protected areas has been largely unavailable. Consequently, there have been formal calls for better information (CBD, 2004). In response, a collaboration was established between the *Sea Around Us* Project at the University of British Columbia, Canada, WWF, and the UN Environment Programme–World Conservation Monitoring Centre to revise and update the marine protected area data in the WDPA.

The objective of this study was to collect data to enable more effective monitoring of marine protected areas in relation to four stated requirements of the three global targets: (1) distribution and coverage, (2) network characteristics, as defined by available information on larval dispersal distances, (3) representativeness, and (4) growth of the network over time. Here we present a global review of the current status of the world's marine protected areas, with explicit reference to the three global targets, as well as a preliminary quantitative assessment of the feasibility of the targets. We discuss these results, their implications and their limitations, and the role of large-scale targets in advancing marine conservation.

Methods

Database

Spatial and descriptive data were extracted from the WDPA (Version 6.2; UNEP-WCMC, 2004) for all sites that were listed as marine. This includes protected areas that have been designated using statutory and non-statutory mechanisms operating at a range of scales, including individual protected area agreements, customary or traditional mechanisms, state/provincial legislation, national legislation, and international conventions. It also includes marine protected areas of variable designation status, including designated, proposed and degazetted. These data were restructured and used to create a new database, *MPA Global* (Wood, 2007). Some new fields were added, including marine area (portion of the total area that is below the mean high water mark), no-take area (portion of the marine area where extraction of resources, both living and non-living, is prohibited), and regulatory information. Registered users of the database can view, review and submit edits. Field-level referencing was built into the online editing process to increase the transparency of the database as well as document discrepancies between source materials.

The criterion used for inclusion of a protected area in *MPA Global* is based on the IUCN (1988) definition: 'Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment'. This definition was applied by reviewing the legal boundary of the site. If it extended seaward of the mean high water mark the site was left in, or added to, the database. For sites designated under non-statutory mechanisms, or for which the designating legislation did not specify the legal seaward boundary, eligibility for inclusion was assessed using multiple sources (see below). Protected areas in the Caspian Sea were not included. Sites whose only so-called marine area was lagoonal were included only if the lagoon has a permanent surface connection to the sea. A globally extensive (although not yet fully exhaustive), multi-pronged, site-level update and verification process was undertaken. Marine protected areas whose boundaries appeared to fall completely inland, using the 1:3,000,000 countries' coastline geographical information system (GIS) shapefile provided in the *ESRI Data and Maps Media Kit* 2003 (ESRI, Redlands, USA), were identified and individually assessed. Updates were made at regional, country and sub-country levels using multiple sources, including: a range of existing marine protected area databases, legislation, websites, peer reviewed and non-peer reviewed literature, and direct communications with regional and national experts. Finally, stratified sampling was undertaken to verify the data for the largest sites.

To date, over 1,100 sources have been used to perform over 200,000 edits, pertaining to all countries with marine protected areas. Almost 1,000 non-qualifying marine protected areas have been removed, 1,000 marine protected areas have been added from the WDPA that were not previously listed in the WDPA as marine, and almost 900 new sites have been added. These updates represent a *c.* 75% change to the original WDPA list of marine protected areas. New spatial data (protected area boundary polygons) have been obtained for 1,822 of 3,061 marine protected areas with spatial boundary data.

Protected area network coverage

Global marine protected area coverage was estimated for all areas designated up to 31 December 2006. Sites listed under international conventions (e.g. UNESCO World Heritage Convention 1972, RAMSAR Convention 1971) were excluded because of near-complete overlap with nationally designated sites. Sites whose status was not designated or informally designated were excluded. It was considered more accurate to estimate global marine protected area coverage by summing marine area estimates obtained through the editing process, rather than through spatial analysis, because of a lack of spatial boundary data for *c.* 31% of protected areas, and knowledge that some of the boundary data are out of date and substantially under- or oversized. Of the total marine protected area estimate, 92% was obtained from verified sources and 8% estimated. For protected areas with unknown marine area, their total area was prorated according to the median proportion of total area for protected areas with known marine area and matching broad habitat types (intertidal only, intertidal and subtidal, subtidal only). Double counting of area because of overlap between protected areas was eliminated by subtracting the area of sites identified through the verification process as overlapping. Some overlap may remain but this is negligible relative to the total area.

Information on no-take status was collected on two levels: a qualitative status (all/part/none of the protected area is no-take) and a quantitative areal estimate where available. No-take data are currently available for 65% of the total marine protected area. Total global no-take area was estimated by summing the areas stored in the attribute data; no overlap is known to exist between sites for which no-take data are available.

Protected area network characteristics

We assessed the connectedness of marine protected areas globally in terms of recommendations for protected area size and inter-protected area spacing based on known marine larval dispersal distances. A size-frequency distribution was produced using marine area data to identify the number and combined area of the world's marine protected areas that are large enough to be self-seeding for short-dispersing species. Sizes assessed were: > 3.14 km^2, 12.5–28.5 km^2 (Shanks *et al.*, 2003), and 10–100 km^2 (Halpern & Warner, 2003). Recommended inter-protected area distances were used to create buffers around protected areas in *ArcGIS v 9.2* (ESRI, Redlands, USA). Distances used were: 10–20 km (Shanks *et al.*, 2003) and 20–150 km (adapted from Palumbi, 2003, and Cowen *et al.*, 2006). Protected areas occurring within these bands were considered to be connected to at least one other protected area. These two analyses were combined to identify protected areas that meet both size and spacing requirements.

Global network representativeness

Four measures of protected area network representativeness were investigated. Firstly, the distance of the central point of each marine protected area from the coast was estimated in *ArcGIS*, enabling both the frequency and area to be plotted as a function of distance from shore. Secondly, the same procedure was used to measure distance of protected areas from the equator. The highly variable size and shape of individual protected area boundaries relative to the land mean that these distances may be an over-estimate in some cases and an underestimate in others but it represents a standard measure for all marine protected areas. Thirdly, the proportions of the following individual habitat types (for which a global distribution map is available) that are protected were estimated in *ArcGIS*: estuaries (Alder, 2003); mangroves (UNEP-WCMC data); seagrass (UNEP-WCMC data); coral reefs (UNEP-WCMC data); and seamounts (Kitchingman & Lai, 2004). Finally, the proportions of two large scale political and/or broad marine habitat classifications that are currently protected was estimated: Large Marine Ecosystem and Exclusive Economic Zone.

Global network growth and target attainment

Designation dates were available for marine protected areas constituting 98% of the total global area protected. The remaining 2% of the area was distributed across all years, prorated according to the proportion of the total global marine protected area (in sites of known marine area) designated in that year. Known chronological changes in the size of individual protected areas were incorporated into the cumulative growth data. Simple linear regression of the logged cumulative global protected area was used to estimate annual growth rate with which to predict target attainment dates.

Results

Global network of marine protected areas

Extent By 31 December 2006 *c.* 4,435 marine protected areas had been statutorily or non-statutorily designated at national or local levels, covering *c.* 2.35 million km^2, and occurring entirely within Exclusive Economic Zones. This represents 0.65% of the world's oceans, or 1.6% of the total global marine area within such Zones. Only 12.8% of those 2.35 million km^2, representing 0.08% of the world's oceans and 0.20% of the global marine area under national jurisdiction, is subject to no-take regulations (i.e. is 'strictly protected' in the wording of the World Parks Congress Recommendation; IUCN, 2003; Fig. 1). This is the first estimate of global no-take area that has been based directly on no-take data, and improves upon previous estimates that, because of a lack of such information, used IUCN management category as a proxy (Agardy *et al.*, 2003; Jones, 2006).

Characteristics The mean size of marine protected areas is *c.* 544 km^2, with a median size of 4.6 km^2. The substantial difference between mean and median size is largely attributable to 10 large protected areas that constitute 68% of global marine protected areas (Table 1). Following size range suggestions derived from larval dispersal distances (Halpern & Warner, 2003; Shanks *et al.*, 2003), 79% of marine protected areas, representing 98.6% of total marine area protected, appear to be either too small or too large (Fig. 2, Table 2), particularly the latter, because of the 10 largest areas. However, if the size recommendations are viewed as minima, 35–60% of marine protected areas, representing > 99% of the total area protected, are sufficiently large (Table 2).

A total of 2,496 marine protected areas (56.3% of the global total), covering 1.28 million km^2 (54.5% of the world's marine protected area) are connected within 10–20 km of at least one other marine protected area. The vast majority of these (85% by number and 98% by area) are connected to a maximum of 10 marine protected areas (Fig. 3a). Using the larger connectedness distance of 20–150 km, 3,487 marine protected areas (78.6% of the global total), covering 1.88 million km^2 (80.3% of the world's marine protected area) are connected to at least one other protected area, and are generally connected to more marine protected areas (Fig. 3b) than under the previous scenario. Combining the

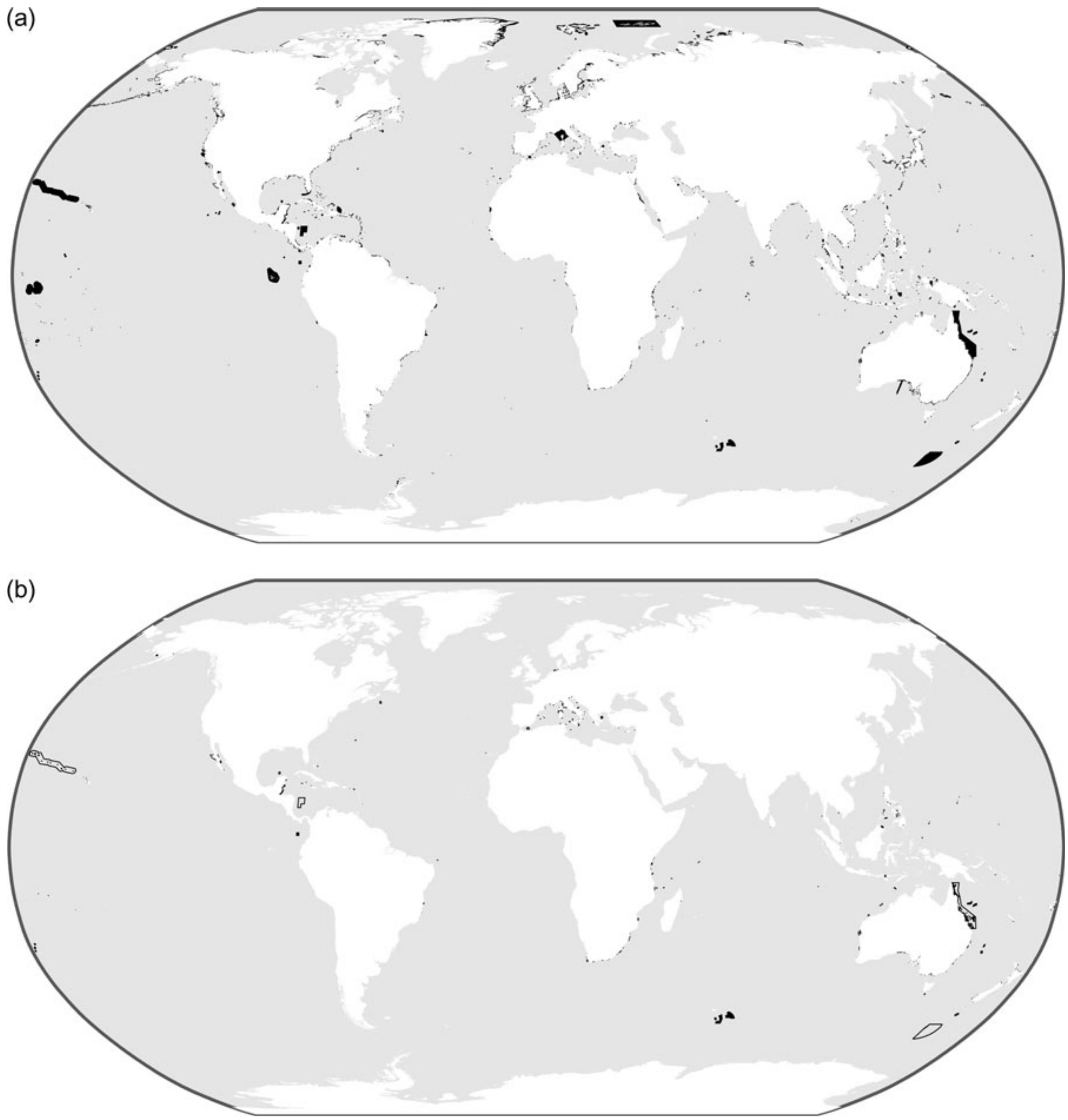

FIG. 1 The global distribution of (a) all and (b) no-take marine protected areas designated by 31 December 2006. In (b) shaded polygons show protected areas that are entirely no-take; unshaded polygons show protected areas that include one or more no-take zones.

minimum size and spacing requirements indicates that, at best, 49% of marine protected areas (80% by area) and at worst, only 18% (54% by area) could be considered as part of a connected network (Table 3).

Representativeness The distribution of the world's marine protected areas is distinctly non-uniform, being heavily biased towards both coastal waters and the 10 largest protected areas (Fig. 4, Table 1). The number of protected areas declines exponentially with distance from shore, as does the distribution of area protected with distance from shore, with the exception of some of the 10 largest protected areas. However, the boundaries of all of these large protected areas (Table 1) do abut the coast. As such, the measured distance of their centroid from shore is high simply by virtue of their large size (Fig. 4).

The majority of the global marine area protected (approximately 65%, representing 43% of all protected areas) is within the tropical latitude belt, between 30°N and 30°S, suggesting that tropical coastal habitats may be among the best protected of all marine habitat types, at least on paper (Fig. 5a). However, most of the remaining global marine area protected (31%, representing 26% of all marine protected areas and including five of the world's 10 largest marine protected areas) is in latitudes > 50°, two-thirds of which is located in the northern hemisphere. These northern areas protect by far the highest proportion of sea surface area by latitude (Fig. 5b). However, this may be

TABLE 1 Total and marine areas of the 10 largest marine protected areas globally.

Country	Name	Designation type	Year designated	Total area (10^3 km^2)	Marine area (10^3 km^2)
Australia	Great Barrier Reef	Marine Park	1979	344.4	344.4
USA	North-western Hawaiian Islands	Coral Reef Ecosystem Reserve[1]	2000	341.4	341.4
Republic of Kiribati	Phoenix Islands	Protected Area	2006	184.7	184.7
Australia	Macquarie Island	Marine Park	1999	162.0	162.0
Ecuador	Galapagos	Marine Reserve	1996	133.0	133.0
Denmark	Greenland	National Park	1974	972.0	110.6
Colombia	Seaflower	Marine Protected Area	2005	65.1	65.0
Australia	Heard Island and McDonald Islands	Marine Reserve	2002	64.6	64.6
Russia	Komandorsky[2]	Zapovednik (Strictly Protected Nature Reserve)	1993	58.3	55.8
Russia	Wrangel Island[2]	Zapovednik (Strictly Protected Nature Reserve)	1976	54.7	46.7
Total				2,380.2	1,508.2

[1]This site was redesignated as a Marine National Monument in June 2006.
[2]Total and marine areas include buffer zone areas.

largely attributable to the relatively small surface area of sea north of 50°N. Intermediate latitudes (30°–50°), and particularly southern temperate and polar latitudes, appear to be the least protected.

Laurel & Bradbury (2006) suggested that, based on larval dispersal distances, marine protected area size should increase with latitude. Using a subset of *MPA Global*, they concluded that this trend is not observed in the global network of marine protected areas. Using the complete dataset, we found a similar result. However, we also found that mean and median protected area size at latitudes > 50° is larger than the global values, and increases through the high latitude range (Fig. 5b, Table 4).

Proportional representation of habitat types within the global network is shown in Fig. 6. These are the only habitats for which global distributional data are known to be available, and mirrors the paucity of global data for terrestrial habitats (Balmford *et al.*, 2003). The accuracy of the proportions protected varies with habitat type because of variable (and largely unknown) accuracy of the habitat distributions themselves, both in terms of their precision as well as the confounding problems of habitat loss and change through time.

Fig. 7 shows the proportions of Large Marine Ecosystems and Exclusive Economic Zones that are currently protected. Large Marine Ecosystems are suggested by the CBD as an appropriate classification system for monitoring progress towards its target (CBD, 2005). However, this is problematic for Pacific Island countries and territories, none of which occur within a Large Marine Ecosystem but all of which (with the exception of US territories) are party to the Convention. Given this, and the largely national scale of implementation of the CBD target, we view the proportion of Exclusive Economic Zone as the best current assessment of the representativeness of the global marine protected area network (despite the political basis of the boundaries). It indicates that the current global network

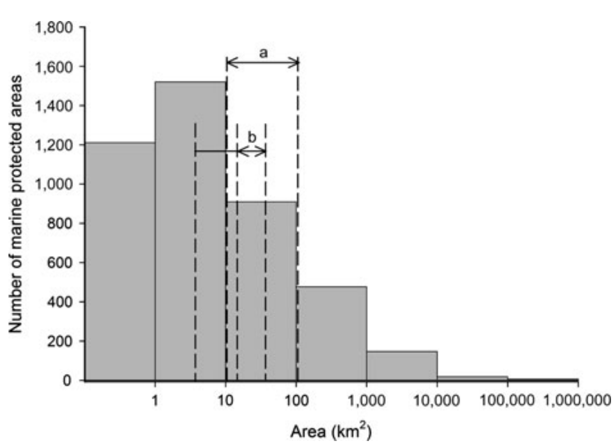

FIG. 2 Area-frequency distribution of the world's marine protected areas, showing recommended sizes using marine larval dispersal distances: a, 10–100 km^2 (Halpern & Warner, 2003); b, minimum 3.14 km^2, preferable 12.5–28.5 km^2 (Shanks *et al.*, 2003).

TABLE 2 Percentage of the world's marine protected areas by number and area that are within the area and minimum area recommendations made by (a) Halpern & Warner (2003) and (b) Shanks *et al.* (2003).

Size recommendation (km^2)	%	% of area
Area		
10–100[a]	21	1.4
12.5–28.5[b]	8	0.3
Minimum area		
>3.14[b]	58	99.7
>10[a]	35	99.4
>2.5[b]	33	99.4

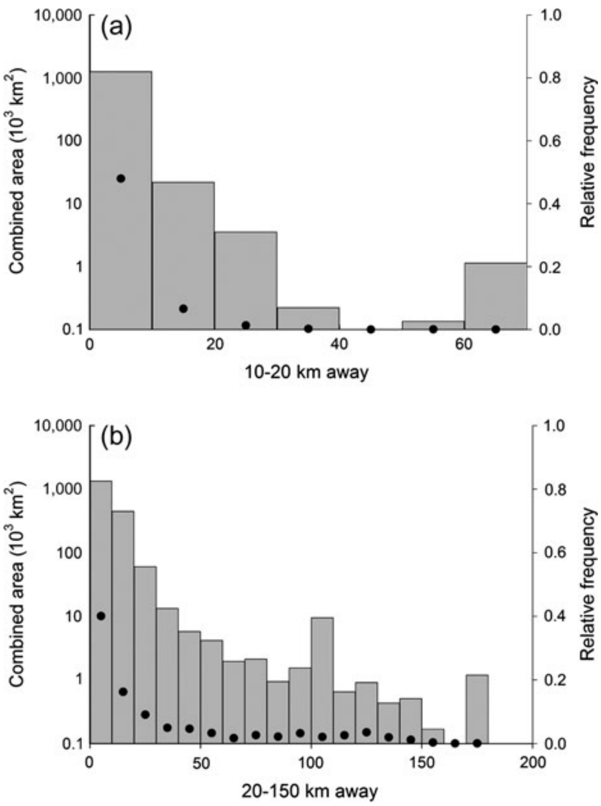

FIG. 3 Combined area (left axis, bars) and relative frequency (right axis, dots) of marine protected areas exhibiting variable individual levels of connectedness, as measured by the relative frequency occurring (a) 10–20 km, and (b) 20–150 km away from each protected area.

falls far short of target requirements. Over 87% of 226 coastal countries (including 69 overseas territories and the non-contiguous US states of Hawaii and Alaska, listed separately) have less than the global average of 1.6% of their Exclusive Economic Zones protected (Appendix). Of the nine countries that currently have > 10% of their Exclusive Economic Zones protected, four have relatively small maritime territories, rather than a high absolute area under protection. The remaining five are overseas territories (including the non-contiguous US state of Hawaii) that include four of the 10 largest marine protected areas.

TABLE 3 Percentage of the world's marine protected areas by number and area that meet both minimum size and inter-marine protected area distance recommendations made by (a) Halpern & Warner (2003) (b) Shanks *et al.* (2003) and (c) Palumbi (2003).

	Connected within 10–20 km[b]		Connected within 20–150 km[c]	
Minimum size (km^2)	%	% by area	%	% by area
>3.14[b]	34.1	54.6	49.1	80.3
>10[a]	19.9	54.4	29.9	80.1
>12.5[b]	18.4	54.4	27.6	80.0

Feasibility of attaining global targets

Growth of the network The cumulative global marine protected area has grown steadily since the mid 1970s, coincident with the coming into force of various international conservation conventions (UNESCO, 1970; Ramsar Convention, 1971; UNESCO World Heritage Convention, 1972), and with some irregularities because of the creation of a few large protected areas (Fig. 8, Table 1). Growth of no-take area has been slow until recently, when the rezoning of the Great Barrier Reef Marine Park in 2004 (GBRMPA, 2004) increased the global no-take area by > 50% and 100,000 km^2 (Fig. 8). On 15 July 2006 the North-western Hawaiian Islands Coral Reef Ecosystem Reserve (341,362 km^2, originally designated in 2000) was redesignated as a Marine National Monument. Although it is not yet completely no-take, various habitat-damaging activities and all fishing is required to have ceased within 5 years (Establishment of the North-western Hawaiian Islands Marine National Monument:

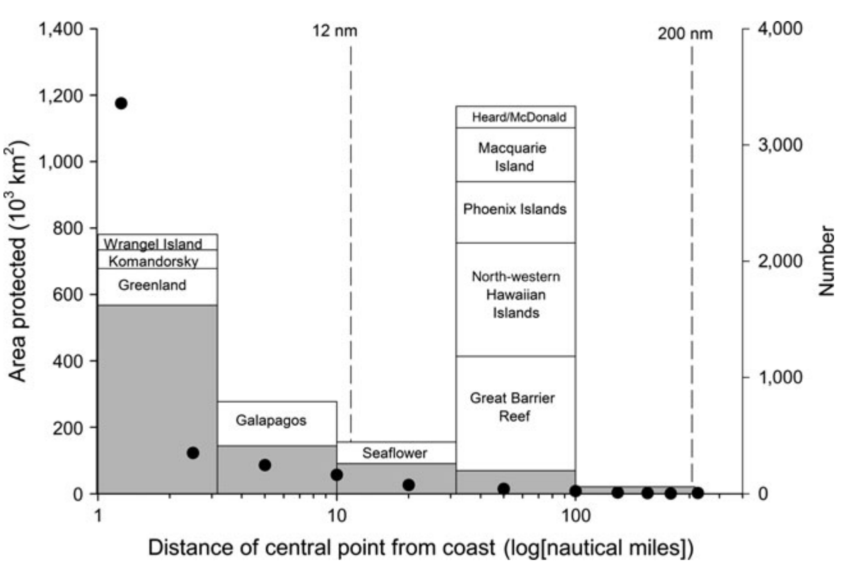

FIG. 4 Marine area protected as a function of distance from the coast, as area (bars) and number (dots). The world's 10 largest marine protected areas are shown separately (see Table 1). The limits for territorial sea (12 nm) and Exclusive Economic Zone (200 nm) are indicated for clarity.

https://doi.org/10.1017/S003060530800046X Published online by Cambridge University Press

TABLE 4 Summary statistics for marine protected areas (MPA) by number and area in high latitudes (> 50°).

Latitude	% of world ocean	% of world MPA area	Mean MPA size (km^2)	Median MPA size (km^2)	No. of MPAs	% of MPAs	No. of top 10 largest MPAs
World	100	100	544	5	4,435	100	10
>50°	33	31	699	4	1,169	26	5
>60°	21	17	1,521	7	263	6	2
>70°	11	14	7,629	398	43	1	2

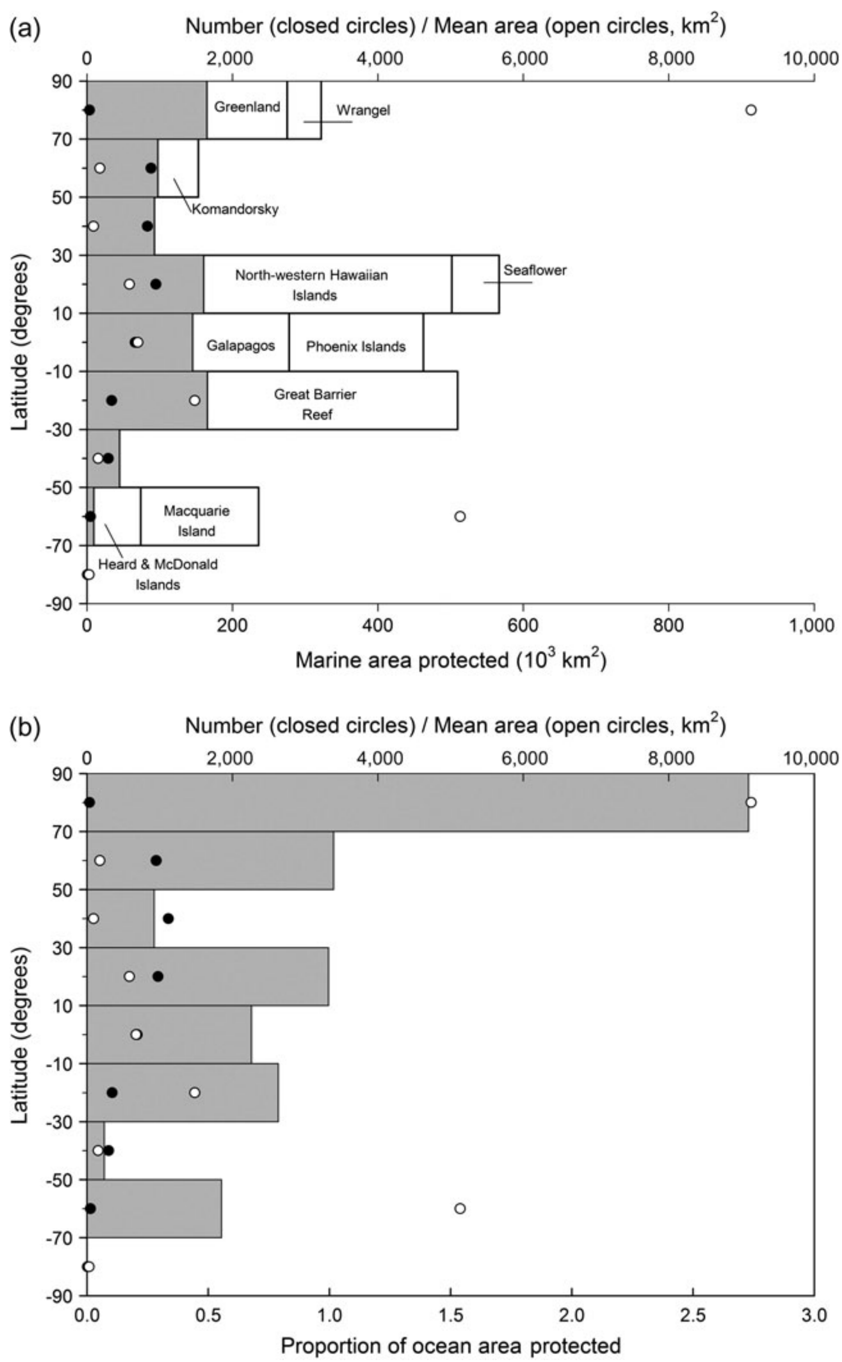

FIG. 5 Distribution of marine protected areas (by number and mean area) as a function of distance from the Equator. (a) Absolute area protected, with the world's 10 largest protected areas shown separately (see Table 1). (b) The proportion of ocean area that is protected.

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a Proclamation by the President of the United States of America, 2006).

Simple linear regression of the log-transformed cumulative marine protected area indicates a 4.6% annual increase over 1984–2006 (Fig. 9). This timespan was selected as it represents a time of steady growth and is representative of the recent political environment. As such it was considered an appropriate time frame on which to base projections for target attainment. Subsequent to the designation of the majority of the Great Barrier Reef Marine

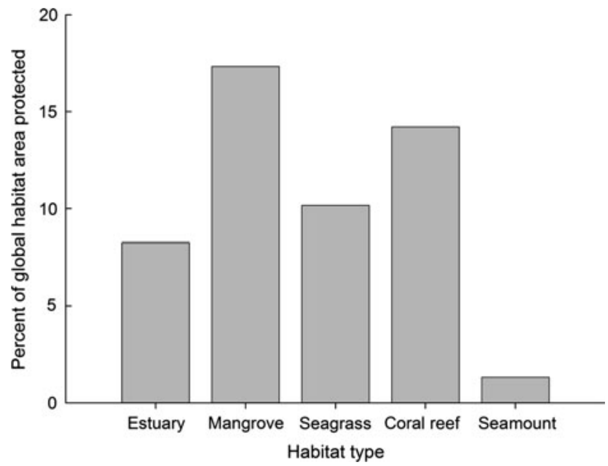

FIG. 6 Estimated proportion of marine habitats protected within the current global marine protected area network, for habitat types where global distribution data are available.

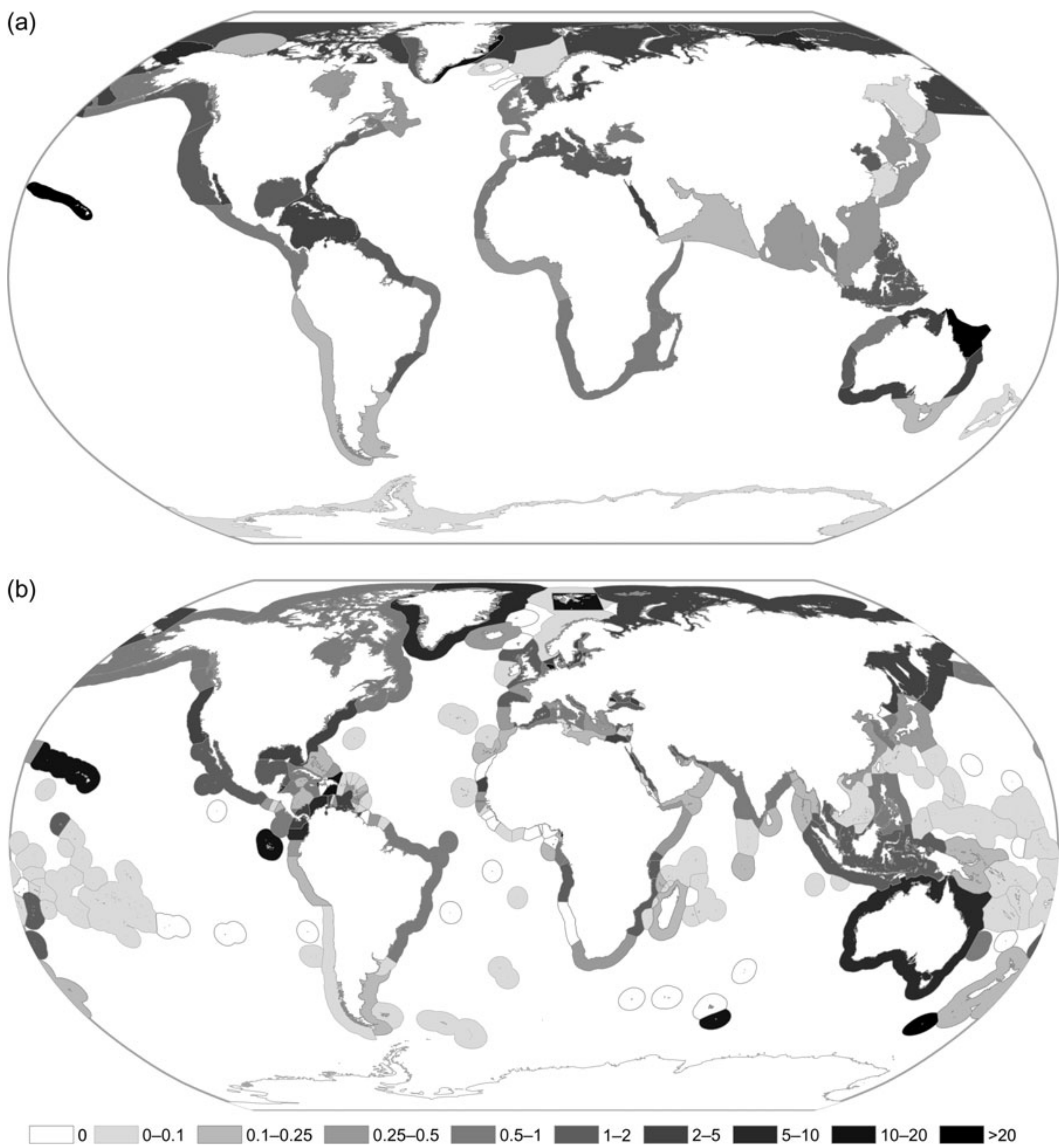

FIG. 7 Proportion of (a) Large Marine Ecosystem and (b) 200 nm Exclusive Economic Zones of maritime countries and territories that is protected.

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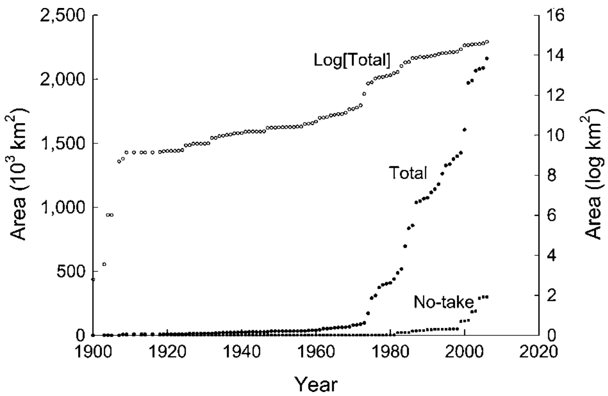

Fig. 8 Growth in cumulative global marine area protected for: total (solid circles), log(total) (open circles), and no-take (squares) area.

Park in 1984 (it was created through a series of extensions over 1978–1984; GBRMPA, 2007), seven of the 10 largest marine protected areas were designated, together covering 43% of the current global marine area protected and 67% of the combined area of the top 10 protected areas (Table 1). In spite of this substantial increase in area protected, the overall rate of global marine protected area growth has not shifted from what appears to be a stable, but slow, trajectory.

Projected attainment dates of targets We extrapolated the 4.6% growth into the future to assess the attainability of the World Parks Congress and CBD targets. It was not possible to assess attainability of the World Summit on Sustainable Development target using this method as it does not state quantitative areal targets. Results indicate that even the most modest targets will not be met for at least several decades (Fig. 9). Furthermore, the growth rates required to meet these targets on time are at least an order of magnitude greater than observed (Table 5). In other words, a marine area at least three times the combined size of the 10 largest marine protected areas (i.e. *c.* 4.5 million km^2) would have to be designated every year until and including 2010 for timely attainment of the CBD target. These projections do not impose any of the additional requirements stated in the targets, including strict protection, habitat representation, and management effectiveness.

Discussion

Our results indicate that the current extent, distribution, sizing and spacing of marine protected areas globally is vastly inadequate, particularly for no-take areas, and especially in light of past, ongoing, and expected future impacts on the oceans. The coastal bias of existing marine protected areas may not be too serious a disadvantage, because the coastal shelves contribute most to the world's primary production, known marine biodiversity and fisheries productivity (Pauly *et al.*, 2002). However, other attributes of the existing network may serve to reduce the effective area and extent of the network. Between 20 and 46% of the global area protected occurs in small and isolated areas, which may thus not be effective at ensuring persistence of marine populations or form part of a coherent global network. At the other extreme the majority of the total marine area protected globally is contained within a handful of extremely large protected areas. At least some large areas are needed to protect highly migratory species such as large pelagic fish and marine mammals, as well as to offset the concentration of fishing effort outside them (Walters, 2000), particularly if (as is the current situation) fishing effort is high and not reduced in conjunction with the creation of marine protected areas (Pauly *et al.*, 2002;

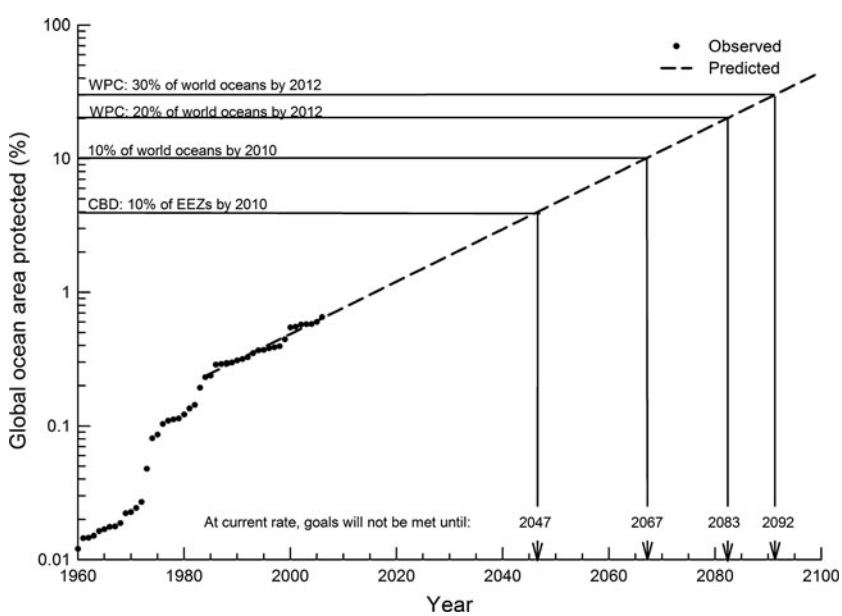

Fig. 9 Projection of the annual rate of increase (4.6%, $r^2 = 0.96$) of global marine area protected between 1984 and 2006 and into the future, in relation to attainment of marine protection targets adopted by the Convention on Biological Diversity (CBD) and the World Parks Congress (WPC).

TABLE 5 Summary of the annual rates of increase in global marine protected area (MPA) coverage required to meet various Convention on Biological Diversity (CBD) and World Parks Congress (WPC) marine protection targets on time, both at the time the targets were made and as of 31 December 2006.

			MPA area (10^3 km^2)			Annual rate of increase in global MPA coverage required to meet target	
Target	Target start	Target deadline	At target start	End 2006	Target	At target start	As of end 2006
CBD 10% of EEZs[1]	2006	2010	2,162	2,350	16,444	50.0	91.3
CBD 10% of world ocean[2]	2006	2010	2,162	2,350	36,106	75.6	148.6
WPC 20% of world ocean	2003	2012	2,086	2,350	72,212	48.3	98.4
WPC 30% of world ocean	2003	2012	2,086	2,350	108,318	55.1	115.1

[1]EEZ, Exclusive Economic Zone.
[2]The CBD target does not explicitly include the high seas but states that the high seas should be urgently protected using international cooperation. The data presented here are based on an extension of the CBD 10% target to include the high seas.

Worm *et al.*, 2003). However, the total marine area protected globally is currently so small that its concentration in a few marine protected areas means that much of the world's oceans are essentially unprotected. This configuration thus confers low levels of representation of many marine habitats, as well as of various biophysical, geographical and political regions. All of these factors may limit the resilience of the global network to many external threats, as well as anticipated spatial shifts in species, communities and hydrological features in response to climate change (Carr *et al.*, 2003; Perry *et al.*, 2005; Parmesan, 2006; Simmonds & Isaac, 2007).

In addition, the results presented here are best case scenarios, representing only the areas of the world's oceans that are protected on paper. It should not be assumed that (1) the process that created these marine protected areas also provided mechanisms for regulating human activities in the area, (2) where regulatory mechanisms are in place they are all being implemented, or (3) they are implemented effectively. In many, if not most, marine protected areas the biodiversity and fisheries benefits that may accrue through protection are eroded or undermined by inadequate management resources (financial and human), poor compliance with regulations, and little-managed or unmanaged external threats (Alder, 1996; McClanahan, 1999; Jameson *et al.*, 2002). The best available information on management effectiveness is currently from large-scale analyses that are either outdated or focused on a subset of the world's marine protected areas. These assessments indicate low rates of effective management (Kelleher *et al.*, 1995; Alder, 1996; Mora *et al.*, 2006).

Our results imply almost certain failure, at the very least in terms of attainment of global marine protection targets. Despite the designation in 2006 of the 184,700 km^2 Phoenix Islands Protected Area by the Government of Kiribati, a huge individual achievement, at least 76 more countries each need to create marine protected areas covering an area equivalent to this before 2010 for the CBD target to be met on time. Unfortunately, we suspect that the negative connotations of these predictions may undermine the benefits and successes of positive results at smaller scales, such as that of Kiribati. Our results do, however, demand that the question be asked, yet again: can large scale conservation targets do more harm than good?

The utility of broadscale conservation targets has been frequently questioned. Targets have historically been justified in terms of political expediency rather than ecological knowledge (Soulé & Sanjayan, 1998; Agardy *et al.*, 2003). Broadscale, uniform conservation targets may thus be inadequate for meeting biodiversity conservation objectives (Rodrigues *et al.*, 2004), and may ultimately weaken the political process to create protected areas if the expected benefits are not observed, particularly within the electoral time frame. However, the terrestrial protected area network has developed over more than a century, with at least half of the area designated (Chape *et al.*, 2005) before quantitative global targets were first established in the early 1980s (Soulé & Sanjayan, 1998). Similarly, the first explicitly marine, quantitative global protection target was made in 2003 (IUCN, 2003) when over 95% of the current marine area protected had already been created. Therefore, the location and design of both marine and terrestrial protected areas have, to date, been selected largely without explicit consideration of many of the recently formalized principles of marine protected area network design theory (Lubchenco *et al.*, 2003; Roberts *et al.*, 2003) or the application of systematic conservation planning tools (Kirkpatrick, 1983). Whereas it is important to understand the adequacy or otherwise of existing protected areas in meeting specific objectives to inform future conservation planning, it may be counter-productive, and perhaps irrelevant politically, to criticize the products of past processes in terms of current ones.

A more pressing question is how to garner the political will required to motivate a rapid increase in marine protection, particularly in the face of wider policy concerns such as food security, human welfare and health. In this regard, broadscale conservation targets can help mobilize support for, and schedule, conservation intervention in the face of limited resources, ongoing biodiversity losses, and inadequate protection (Margules & Pressey, 2000; Pressey *et al.*, 2003). In particular, the CBD target demonstrates a commitment of the parties to the Convention (presently 188; Appendix) to translate their general obligations under the Convention into concrete action for conservation and sustainable use (Pauly & Watson, 2005). Nevertheless, given the mismatch between the resources available and those required to implement and monitor a global network of marine protected areas, it seems likely that the network developed by the time of the target deadlines will almost certainly be a compromise, between quantity (i.e. how closely the targets are met) and quality (i.e. how appropriately designed and effectively implemented the protected areas thus created are). Broadscale conservation targets are thus, perhaps, necessary but not sufficient for effective marine resource conservation and management.

The work presented here has substantially improved knowledge of the global marine protected area baseline, and enhanced our ability to monitor various aspects of targets. While the value of a list of marine protected areas in terms of assessing the effective level of protection has been questioned (Roff, 2005), it remains a fundamental prerequisite to any assessment of status or progress. Our analysis has provided the first quantitative estimate of the rate of change needed for these targets to be met. While daunting, this new information arms decision makers and conservation planners with a greater understanding of the magnitude of the task ahead and the urgency with which they must tackle it.

Acknowledgements

This work was supported by WWF, the UN Environment Programme–World Conservation Monitoring Centre, and the *Sea Around Us* Project, an activity funded and initiated by the Pew Charitable Trusts. We thank Chris O'Grady for developing the *MPA Global* website, as well as numerous data contributors, and Jackie Alder, Dan Ogolla, Marjo Vierros, Colette Wabnitz and Dirk Zeller for comments.

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Appendix

The appendix for this article is available online at http://journals.cambridge.org

Biographical sketches

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