Beyond Extinction Rates: Monitoring Wild Nature for the 2010 Targets
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Summary

There are now over 100,000 protected areas world-wide, covering over 12% of the Earth's land surface. Consequently they represent one of the most significant human resource use allocations on the planet. The importance of protected areas is reflected in their widely accepted role as an indicator for global targets and environmental assessments.

However, measuring the number and extent of protected areas only provides a unidimensional indicator of political commitment to biodiversity conservation. Data on the geographic location and spatial extent of protected areas will not provide information on a key determinant for meeting global biodiversity targets: *effectiveness* in conserving biodiversity. Although tools are being devised to assess management effectiveness, there is no globally accepted metric.

Nevertheless, the numerical, spatial and geographic attributes of protected areas can be further enhanced by investigation into the biodiversity coverage of these protected areas, using species, habitats or biogeographic classifications.

This paper reviews the current global extent of protected areas in terms of geopolitical and habitat coverage, and considers their value as a global indicator of conservation action or response. The paper discusses the role of the World Database on Protected Areas, collection and quality control issues and identifies areas for improvement, including how conservation

effectiveness indicators may be included in the database to improve the value of protected areas data as an indicator for meeting global biodiversity targets.

Key words: *protected areas, biodiversity indicators, measurement, effectiveness*

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1. Introduction

Protected areas are recognised as the most important core "units" for *in situ* conservation and information about the numerical and spatial attributes for over 100,000 sites covering more than 12 percent of the Earth's land area provides a basis for assessing the extent of formal protection of global biodiversity and a measure of conservation commitment at the global scale. Protected area coverage was endorsed by the 7th Conference of the Parties (CoP7) of the Convention on Biological Diversity (CBD) as an indicator for immediate testing in relation to the adopted target of significantly reducing the rate of biodiversity loss by 2010. Additionally, CoP7 set a target that "at least 10% of each of the world's ecological regions [should be] effectively conserved" (SCBD 2004: 383). Protected areas are also indicators for success in achieving Millennium Development Goal 7: Ensuring Environmental Sustainability[1]. In both cases the indicator is defined in terms of areal extent: "coverage" and "land area protected" respectively. Provision of data to measure this indicator, it can be argued, is both essential and straightforward and therefore we can maintain the current set of measurable parameters (numerical, spatial and geographic data). However, neither the indicator of areal extent, nor the current global protected area dataset, tells us if protected areas are *achieving* their conservation objectives. Therefore, it is proposed, two inter-related types of measurement are needed to assess real progress in meeting the 2010 targets:

1. Effectiveness of coverage: how much and what biodiversity is included within protected areas?

2. Effectiveness in achieving conservation objectives: are protected areas being managed effectively?

In reviewing these two issues, this paper will discuss the role and value of using protected areas as indicators for meeting global biodiversity targets. It will also:

- review current global protected area numbers and extent;
- describe and review the current state of knowledge of the global extent of protected areas in relation to biomes and habitat types;
- discuss current protected area management effectiveness initiatives that can contribute to the role of protected areas as indicators for achieving global biodiversity targets;
- evaluate shortcomings in current data and evaluation methods, and propose improvements to ensure that protected areas are an effective indicator for achieving global biodiversity targets.

2. What Do We Mean by Protected Areas?

Setting aside natural areas to maintain their intrinsic values is not a recent phenomenon in human history. It has been part of human endeavour for millennia, occurring in all regions of the planet where humans have settled. Historically, reasons for protecting natural areas have ranged from religious purposes to resource or species management, including initiatives such as sacred groves, and limited or prohibited species exploitation areas. For example, those areas set aside by Pacific islanders, European hunting reserves and the forest, elephant, fish and wildlife reserves established by the Mauryan kings of India in the second to third

centuries BC (Grove 1995). As McNeely (1998) has noted, "protected areas are a cultural response to perceived threats to nature. Because society is constantly changing, so too are social perspectives on protected areas and the values that they are established to conserve". By the nineteenth century, human impact on the planet's natural ecosystems, especially through European colonial expansion and commercial enterprise in the Americas, Australasia, Asia and Africa, led to the establishment of the first modern national parks and reserves, as understood in the initial Western paradigm of protected areas. However, since the establishment of Yellowstone National Park in the United States in 1872, often quoted as the start of the modern era of protected areas, the global loss of natural habitats and species has continued unabated. In the face of this ongoing loss, our "cultural response" has been to establish more and more protected areas to conserve the Earth's vanishing biological diversity. Protected areas now represent one of the most significant forms of human land use on the planet - although the commitment to marine protection, at 0.5 percent of the Earth's oceans, remains completely inadequate.

Since the 1960s, conservation science and principles for establishing and managing protected areas have developed enormously. International conservation organisations and academic institutions have helped this development, but primarily the growth of protected area knowledge has resulted from the work commenced by IUCN and the original National Parks Commission in the late 1950s (now the World Commission on Protected Areas) and strengthened over the past four decades. In particular, the early 1960s were a benchmark period in the global approach to protected areas. The First World Conference on National Parks was convened by IUCN, the NPC and other partners in 1962, and in the same year the UN General Assembly endorsed the importance of periodically reviewing the number and extent of the world's 'national parks and reserves' by establishing the 'UN List'[2] reporting process. The thirteenth edition of the UN List of Protected Areas was released in 2003

(Chape *et al.*), one of the world's longest running environmental reporting processes. Over the past 40 years there has also been a paradigm shift (Phillips 2003) in the role of protected areas - in fact the term "protected areas" was a relatively recent addition to the conservation lexicon in the latter half of the 20th century. We have moved from the 19th to mid-20th century 'national parks and reserves' paradigm to a broader conceptual and practical approach that includes:

- the formulation of specific protected area management categories that recognise the scope and values of different management objectives in the conservation of natural areas;
- "mainstreaming" of conservation concerns into development agendas, rethinking the role of protected areas *vis-à-vis* conservation and sustainable human use (for example, see Dudley and Stolton 2003, Pierce *et al.* 2002);
- the recognition of the importance of cultural and social values; and
- recognition of the role of protected areas as key indicators for assessing achievement of global biodiversity and sustainable development objectives.

IUCN and the World Commission on Protected Areas (WCPA) have been instrumental in guiding this paradigm shift, and have defined (IUCN 1994) a protected area as:

> An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

The IUCN definition is widely adopted and is used, for example, by the UNEP World Conservation Monitoring Centre as a basis for recording protected area information in the World Database on Protected Areas (WDPA). Also adopted at the global level - at least by the 188 countries currently party to the Convention - is the protected area definition of the Convention on Biological Diversity (CBD):

> A geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

Other international conventions and agreements have definitions of specific types of protected areas, and some definitions have been developed for particular regions. For example: World Heritage Sites, Ramsar Sites, Biosphere Reserves, ASEAN Heritage Sites, the European Natura 2000 network, and the Ministerial Conference on the Protection of Forests in Europe (see Box 1).

Despite the growth in global agreements on nature conservation and establishment of protected areas, protected area designations used by countries are not necessarily directly comparable across countries because of potentially different legislative regimes. Over 1,000 different terms are known to be used around the world to designate protected areas. These terms are often defined within national legislation in relation to objectives and legal protection for individual areas. The need for internationally standardised protected area nomenclature and definitions was raised at the First World Conference on National Parks in 1962 (Adams 1964). It was noted that "an effort should be made to standardise the nomenclature for various types of specifically reserved areas or…to properly relate these terms so that similar objectives of differently designated areas will be readily recognisable" (Brockman and Curry-Lindahl 1964:366).

Box 1: Internationally Recognised Sites

Given the perceived importance of protected areas as a conservation tool, it is not surprising that they are actively promoted in a wide range of international conventions and programmes going back more than 70 years to the 1933 London Convention that called on Contracting Parties to establish "national parks" and "strict natural reserves" (the purpose of which was defined in the text of the Convention). Since then a range of international agreements and programmes have come into effect which designate or recognise specific sites nominated by national governments or some other appropriate body at the national level. These include:

- **Site-based initiatives that recognise excellence** including the *World Heritage Convention* and the *European Diploma*. In both cases sites must meet certain criteria, and each nominated site is assessed to ensure that these criteria are met. A major part of the purpose of such initiatives is to ensure the continued viability of some of the most significant natural areas.

- **Systematic development of networks of sites** including the *Ramsar Convention*, and the European *Natura 2000* and *Bern Convention*. These initiatives are specifically aimed at the systematic development of networks of sites for the protection of identified species and/or habitats, and ensuring the protection of key features.

- **Site networks that promote research, training and education** including the *UNESCO-MAB network of Biosphere Reserves*. Again part of the intention is to develop a systematic network of sites covering the full range geographical and biogeographical regions.

In each case, assessments are regularly made on the coverage of these networks, at least in terms of biogeography, and in some cases in terms of individual species and other key features. Also information on these sites and their management is generally good. They therefore provide a basis for delivering a more detailed and complete set of indicators on smaller subsets of protected areas. Growth of these networks over time also demonstrates the increasing attention given to protected areas internationally.

Following the recommendations of the 1962 conference to seek a better approach to protected area terminology, a debate ensued for the next 30 years on the best way to address this issue. Finally, in 1994, agreement was reached on a six management objective-based category system (see Box 2). A number of countries have now formally adopted the IUCN Management Categories as the basis for planning and managing their national protected area systems, and in July 2003 the system was formally adopted in the revised African Convention on the Conservation of Nature and Natural Resources approved by the Assembly of the African Union. The international credibility of the categories was further strengthened by the endorsement of the category approach at the CBD CoP7:

> [the CoP] "*recognizes* the value of a single international classification system for protected areas and the benefit of providing information that is comparable across countries and regions and therefore *welcomes* the ongoing efforts of the IUCN World Commission on Protected Areas to refine the IUCN system of categories and *encourages* Parties, other Governments and relevant organizations to assign protected-area management categories to their protected areas, providing information consistent with the refined IUCN categories for reporting purposes" (VII/28.31)

Box 2: Definitions of the IUCN Protected Area Management Categories

(IUCN 1994)

CATEGORY Ia
Strict Nature Reserve: protected area managed mainly for science
Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

CATEGORY Ib
Wilderness Area: protected area managed mainly for wilderness protection
Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

CATEGORY II
National Park: protected area managed mainly for ecosystem protection and recreation
Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

CATEGORY III
Natural Monument: protected area managed mainly for conservation of specific natural features
Area containing one or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

CATEGORY IV
Habitat/Species Management Area: protected area managed mainly for conservation through management intervention
Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

CATEGORY V
Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation
Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

CATEGORY VI
Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems
Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

3. The World Database on Protected Areas and its Role in Measuring the Extent of the Global Protected Areas Estate

The World Database on Protected Areas provides the only comprehensive global inventory of the world's protected areas. First established in 1981 and managed since that time by the IUCN Conservation Monitoring Centre[3], now UNEP-WCMC, this database represents a unique and important resource. Since 2002, protected areas information from the WDPA has provided regular statistical and analytical information for the MDG, Millennium Ecosystem Assessment and CBD processes. For example, the WDPA provided global data for the preparation of technical reports to the ninth meeting of the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) in 2003 (SCBD 2003) and CBD CoP7 in 2004 (Mulongoy and Chape 2004), thereby contributing to the key decisions of CoP7 on protected areas.

The data-holdings within the WDPA have been gathered from a broad range of sources, with major updates undertaken every 3-5 years in preparation for the publication of the *United Nations List of Protected Areas*. Critical sources have included government agencies with direct responsibility for protected areas. However, other sources have generally included NGOs and published materials, particularly for those areas where formal government responses were unobtainable. In 2002 the WDPA was considerably strengthened through the establishment of a Consortium of international conservation organisations[4]. WDPA Consortium members are pooling their information resources for inclusion in the WDPA and collaborating on the improvement of the structure of the WDPA, as well as the quality and quantity of the core data that it contains.

A broad range of data are held within the WDPA, including the following core information fields for sites within each country:

- Site name
- National designation
- Location (co-ordinates)
- Size
- IUCN management category
- Date of designation
- Marine/Coastal
- Biogeographic code (Udvardy 1976)

Further fields allow for the tracking of a site's designation history (proposed, gazetted and changes in boundaries), the annotation of habitat fields, relationship to other sites (adjacent, overlapping, etc), ownership and administration. There remain fields available for annotation of management information, staffing, budgets and visitor statistics; however, these are largely unused at the present time.

Integral to the database is a geographical information system (GIS). This includes polygon boundary information for sites. As with the aspatial data, GIS data is derived from a broad range of sources, including official government systems and reliable secondary sources, including NGOs working on sites or in particular countries. The scale, resolution and reliability of the source material varies considerably.

The WDPA provides a unique tool to investigate progress in the development of the global network of protected areas. Using both the database and the GIS it is possible to provide summary information at global, regional and national levels, while the GIS gives a further possibility to undertake spatial assessments, combining the protected areas information with other data layers, such as species or habitats. In this way it is possible to summarise the "effectiveness" of the protected areas network in covering particular places, habitats or species. IUCN management categories have been applied to about 60 percent of sites and

these provide some indication of the expected level of management intervention and human influence within sites.

4. Analysis of the Global Network of Protected Areas in 2004

For the present discussion we present a summary of the current holdings of the WDPA from a geopolitical perspective, and also a new analysis looking at the habitat coverage of the protected areas network. These represent part of a larger synthesis of protected areas information currently under development (Spalding *et al.* in prep).

4.1 Methodology

- **Aspatial Attribute Information**

The WDPA contains information on some 104,791 protected areas worldwide[5], with information on all countries. However, not all data-fields are complete for all of these sites and so subsequent analyses have to take these deficiencies into account.

Size: Information is available for 86% of the sites in the database. The largest protected areas tend to be the best documented and so, although it cannot be shown definitively, it is likely that those sites for which no size has been provided are small.

IUCN protected area management categories: Historically this information was completed, where possible, by national agencies. However, if such information was not forthcoming it was assigned by other expert bodies including the World Commission on Protected Areas or by staff at UNEP-WCMC, using legislative or other sources wherever possible. In 2002 a decision was made to only assign IUCN categories when these were supplied by the relevant national agency and otherwise to leave this information blank. The result is that at the present time the IUCN category information includes both nationally "approved"

information and non-official interpretations. Sites listed as "no category" meet the IUCN definition of a protected area.

Date of designation: Available for 66,573 sites (64% of the total).

- **Geographic and boundary information**

Boundary information is held in the GIS for some 39,194 sites (37%). For a further 36,550 (35%) information is available describing the geographic co-ordinates of the central point, and there is also information on the size of the site. With this information it is possible to create buffered points (circles of the correct size centred on the known central point). The combined layer of polygons and buffered points therefore represents 72% of the total sites in the database. However, these include most of the largest sites and account for 95% of the total known area of protected areas. In addition, it is known in which country every protected area lies.

In many countries there may be overlaps between protected areas, with strict nature reserves lying within the boundaries of national parks or other categories. A simple summation of the area statistics would thus produce an inflated estimate of total coverage. Using a GIS based approach it is possible, within the limitations of the accuracy of the source polygon information, to reduce this error and limit double counting[6]. For the statistics presented in the following analysis GIS figures were calculated for all sites with available locational information, while sites without such geographic pointers were simply added to the totals so derived.

The sources for the information within the database are highly varied, and it must be assumed that the spatial accuracy of the information contains similar variation. Errors are likely to arise both from inaccuracy (points are simply wrong, with errors potentially varying

from tens of metres to tens of kilometres), to issues of resolution (with effectively the same results – maps prepared for low resolution use may show increasing levels of spatial misplacement associated with "pushing" them beyond their true resolution). At the present time it is not possible to provide an assessment of the level of these errors within the database.

- **Habitat analysis**

Four broad sources of information were used in separate analyses to look at the habitat coverage of the global protected areas network:

Land versus sea area: The Digital Chart of the World (DCW) (rasterised to 1km resolution grid) was used to determine the proportion of the global protected areas estate which was terrestrial versus marine.

Terrestrial habitats: The Global Land Cover 2000 (GLC2000) dataset was taken as a starting point. Unlike earlier global land cover assessments, considerable regional expertise was used in the development of this map layer. It uses a globally consistent legend based on the FAO Land Cover Classification System (FAO 2000), and is based on 1km resolution SPOT imagery, although information from other sensors has been used to refine particular elements (Barolome *et al.*, 2002).

Various alterations were made in this base-map, notably subdividing a number of classes on broadly latitudinal bands, enabling the discernment of major forest and desert classes (tropical, temperate and boreal for forests, warm, cold and polar for deserts). Further refinements were made to fill some gaps in the GLC2000 coverage, notably for the far

northern parts of Eurasia and also some of the island groups, using data of the 1km Land Cover Classification Derived from AVHRR (Hansen *et al.* 2000, 1998).

Mountains: In 2000 UNEP-WCMC developed the global mountains map, with data improved in 2002 (Blyth *et al.* 2002). This layer was analysed separately from the land cover information described above.

Marine and coastal habitats: Two further habitat layers developed at UNEP-WCMC were also used for a separate analysis of coral reefs and mangrove forests (Spalding *et al.*, 1997; Spalding *et al.*, 2001).

■

It should be noted that each of these layers will include inaccuracies, which may be compounded where information is also out of date. For example, in the GLC2000 there are problems of interpretation, with some areas simply being mis-identified. The resolution of the source data may compound such error as boundary areas and patchwork landscapes are summarised into single square kilometre pixels. There may also be errors of spatial location, which will be particularly noticeable when any single layer is combined with another, and when buffered point and point only data is used. This can result in errors of "omission", when habitats are *incorrectly not included* in a protected area; and "commission", when habitats are *incorrectly included* within a protected area (see Figure 1).

Insert
Figure 1: How Omission and Commission Errors Occur in Habitat Data Analysis

In the present study the mis-match between the GLC2000 and the higher resolution ocean layer held at UNEP-WCMC led to the occurrence of a considerable area of "no-data" along

the coastline in many areas. The relatively low resolution of the GLC2000 data-layer means that fine-scale habitats, such as riparian and coastal habitats are generally missed or under-represented – for example, although it includes a mangrove class (No. 23) it missed information for particular areas and it was necessary to incorporate additional data from the UNEP-WCMC data set. Similarly, there is still no accurate or commonly agreed layer of wetlands (GLC2000 No. 22) worldwide, partly due to the fine-scale nature of many of these, but also because many wetlands are seasonal or sporadic, and the vegetation present in many wetlands may lead to their being classed into other forest, grassland or shrub categories.

In combining any two spatial layers, further inaccuracies may accrue due to mismatch between the layers. These inaccuracies may affect precision of habitat extent or protection estimates for habitats that are naturally fragmented and narrow (such as coastal features) and does not allow precise assessment of habitat distribution within separate sites. However, at the regional or global scale these problems do not distort statistical outputs and the methods applied provide the best currently achievable estimates.

4.2 Results

- **Numbers and Extent of Protected Areas**

The 104,791 protected areas in the WDPA cover a total surface of over 20 million square kilometres. The majority of this represents terrestrial surfaces, and they cover a total of 12.2% of the world land surface. By contrast less than 2 million square kilometres of ocean are protected, a figure representing about 0.5% of the total ocean surface or about 1.4% of the coastal shelf areas.

Table 1 provides a summary of the protected areas of the world based on geopolitical regions as defined by the World Commission on Protected Areas[7]. From this it can be seen that there is considerable variation in the total area protected between regions. In fact the very low

level of protection provided for the Antarctic region is somewhat misleading as the entire continent is given a considerable level of protection by the Antarctic Treaty and its Protocol on Environmental Protection (Anon 1991) and is considered by some to be a protected area in its entirety. If Antarctic is excluded the some 13.5% of the world's land surface is protected.

Table 1: Distribution of Protected Areas by WCPA Region

Region	Total sites	Total protected area	Total protected land area (ha or km²)?	Total no marine sites	Total protected marine area	Total land area	Percentage land area protected
Central America	677	151,058	133,731	103	17,327	521,600	25.6%
South America	1,507	2,217,725	2,056,559	114	161,166	9,306,560	22.1%
North America*	13,414	4,450,119	4,231,839	754	218,280	23,724,226	17.8%
East Asia	3,265	1,930,651	1,904,342	285	26,309	11,799,212	16.1%
South East Asia	2,674	791,681	715,218	390	76,463	4,480,990	16.0%
Eastern and Southern Africa	4,117	1,838,144	1,825,918	155	12,226	11,487,920	15.9%
Caribbean	973	80,770	36,469	370	44,301	234,840	15.5%
South America (Brazil)	1,280	1,321,751	1,305,864	88	15,887	8,547,400	15.3%
Europe	43,837	699,761	634,248	829	65,513	5,119,172	12.4%
Australia/New Zealand	9,550	1,400,292	831,420	422	568,872	8,011,930	10.4%
Western and Central Africa	2,583	1,302,812	1,293,206	43	9,606	12,804,860	10.1%
Pacific	404	418,641	54,949	240	363,692	553,058	9.9%
North Africa and Middle East	1,247	1,251,034	1,226,928	136	24,106	12,954,170	9.5%
North Eurasia	17,719	2,006,914	1,789,006	82	217,908	22,110,050	8.1%
South Asia	1,478	344,248	339,058	184	5,190	4,487,510	7.6%
Antarctic	66	70,233	3,470	59	66,763	14,024,832	0.0%
	104,791	**20,275,834**	**18,382,225**	**4,254**	**1,893,609**	**150,168,330**	**12.2%**

*North America here includes Greenland, but excludes the US state of Hawaii

+ Only Brazil?

As might be expected, there is considerable variance in both the average size and the total number of protected areas declared under each of the IUCN management categories, as shown in Figure 2. Category Ia and Ib sites are generally few in number and of average size,

LAC = 151,058 + 2,217,725 + 80,770 + 1,321,751 Ha

Category III sites are numerous, but make up only 1% of the total protected areas coverage while both Category II and VI cover very large areas, but make up only 4% of the total number of sites each. These figures become more instructive at the level of individual regions, as shown in Table 2. For example, in many regions it is one category that dominates the regional statistics, such as Category II inNorth America , Category IV in South Asia and North Eurasia, Category V in Europe and Category VI in North Africa-Middle East and Australia-New Zealand. In some cases the regional dominance of particular categories is explained by single large protected areas, such as the Category VI Ar-Rub'al-Khali Wildlife Management Area (640,000 km^2) in Saudi Arabia.

Table 2: Distribution of Protected Areas by IUCN Protected Area Management Category in WCPA Regions

Region		Ia	Ib	II	III	IV	V	VI	No category
North America	Area	80,469	478,492	1,681,824	73,688	647,266	144,212	1,131,604	670,609
	No. sites	845	701	1,362	595	1,338	2,082	1,287	5,204
Caribbean	Area	168	90	24,087	460	31,221	3,711	24,005	4,666
	No. sites	11	18	164	38	284	38	192	228
Central America	Area	9,180	165	31,180	5,475	13,628	1,462	43,532	48,293
	No. sites	16	1	95	49	198	5	100	213
South America (Brazil)	Area	82,769	-	159,742	2,809	5,091	134,233	183,251	866,172
	No. sites	180	-	177	5	259	115	67	477
South America (Hispanic)	Area	11,833	1,925	520,550	110,389	89,661	113,405	536,993	1,020,111
	No. sites	58	28	222	80	154	164	254	691
Europe	Area	56,331	37,146	101,043	4,344	74,994	293,411	21,924	148,673
	No. sites	1,465	508	265	3,444	15,310	3,010	203	19,453
Western and Central Africa	Area	17,801	11,384	342,195	4,393	379,902	214	106,705	489,254
	No. sites	19	7	90	5	124	1	46	2,291
Eastern and Southern Africa	Area	2,946	1,260	509,651	155	272,038	15,558	530,362	620,976
	No. sites	22	7	218	24	481	29	224	3,087
North Africa and Middle East	Area	6,652	48	229,808	12,448	101,624	108,881	776,049	67,537
	No. sites	29	2	72	50	274	157	28	635
North Eurasia	Area	350,676	24	95,471	29,028	1,056,633	15,054	95,724	391,712
	No. sites	195	-	66	11,324	5,267	407	54	406
South Asia	Area	2,672	201	72,294	-	179,368	4,608	24,244	73,924
	No. sites	31	1	139	-	658	11	11	627
East Asia	Area	63,908	46,449	105,900	20,323	5,938	1,631,329	58,660	30,643
	No. sites	43	34	78	34	121	2,146	77	732
South East Asia	Area	25,072	25,343	205,195	4,035	138,877	26,806	197,908	203,584
	No. sites	287	12	254	68	199	169	830	833
Australia/New Zealand	Area	216,679	39,383	309,644	33,152	251,100	21,662	593,162	2,864
	No. sites	2,137	38	681	3,948	1,653	216	489	388
Pacific	Area	3,524	576	6,837	723	4,368	11,089	346,600	45,553
	No. sites	27	-	31	24	77	20	54	193
Antarctic	Area	67,735	-	599	-	365	-	-	1,534
	No. sites	88	-	3	2	23	5	1	4

Insert
Figure 2: Global Distribution of Protected Areas by IUCN Protected Area Management Category

The extensive global coverage of protected areas is a relatively recent phenomenon and Figure 3 provides an illustration of the growth of the protected areas network over time.

Insert
Figure 3: Growth of Global Protected Areas over Time

- **Biome and Habitat coverage**

Earlier studies of this nature looked at biogeographic provinces developed by Udvardy (1976) and, while this is still a valid and interesting approach, it is important to point out that this is a biogeographic analysis. Due to the extent of environmental change and widespread biodiversity loss, the boundaries of most biomes or ecological regions now define hypothetical zones of applicability, and their usefulness as biodiversity indicators is limited. However, biome and ecoregion-based analyses do provide a theoretical framework that can function as a baseline for determining the extent of global change. We therefore present here a current analysis of the Udvardy biomes, supplemented with additional biome-level data derived by UNEP-WCMC for the Caspian Sea and the world's oceans (Table 3 and Figure 4 – except for oceans due to the large area relative to other biomes).

The global coverage of different habitat types, total areas and percentages protected are shown in Table 4 (in all sites including IUCN categories I-VI and those with no category assigned) and in Figure 5. The numbered habitats are those derived from the GLC2000 data layer, although it should be noted that not all of these are presented here as some were considered to be too unreliable for further investigation (including 22 wetlands and 23 mangroves), as noted above. The findings from the separate studies on mountains,

mangroves and coral reefs are also presented in Table 4. However, these have not been included in Figure 5 due to the relatively small total area coverage of the marine habitats and the very large area coverage by mountains. These results clearly show a marked variation in the level of protection being offered to different habitats. However, by looking at actual habitat cover it is particularly important to note that such statistics no longer represent original vegetation cover – percentage protection may appear elevated as a result of widespread habitat loss and these figures should be read as "percentage of remaining habitat protected".

The differences between the theoretical biome approach and actual habitat/land cover mapping is not directly comparable for all classes due to the different criteria used. However, it is illustrated, for example, by the difference between the Udvardy biome analysis of Temperate Grassland (5.95% protected) and that of the GLC2000 analysis (16%). This is based on a total theoretically available biome area of just over 9 million km^2, compared to an estimated actual remaining habitat area of around 6.4 million km^2 - as well as differences in the resolution of the two methods of analysis.

Table 3: Protected Area Extent by Udvardy Biome

Udvardy Biomes	Biome (km^2)	Extent of PAs (km^2)	% Biome Protected
Tropical humid forests	10,553,490	1,991,052	18.87
Sub-tropical/Temperate rain forests/ Woodlands	3,961,627	539,155	13.61
Temperate needle-leaf forests/Woodlands	17,032,915	1,424,311	8.36
Tropical dry forests/Woodlands	17,316,029	2,302,192	13.30
Temperate broad-leaf forests	11,278,456	1,159,314	10.28
Evergreen Sclerophyllous forests	3,720,843	327,696	8.81
Warm deserts/semi-deserts	24,247,134	2,681,875	11.06
Cold-winter deserts	9,282,478	1,340,329	14.44
Tundra communities	9,479,571	2,093,468	22.08
Tropical grasslands/Savannas	4,265,293	564,061	13.22
Temperate grasslands	9,009,157	536,405	5.95
Mixed mountain systems	10,631,877	1,721,892	16.20
Mixed island systems	3,292,175	402,432	12.22
Mixed island systems (additional terr.2004)	10,533	391	3.71
Lake systems	537,961	14,270	2.65
Antarctic glaciers/tundra	12,440,785	795	0.01
Caspian Sea (added 2004)	373,248	3,934	1.05
Ocean (added 2004)	362,630,384	2,099,456	0.58

Insert
Figure 4: Area Protected by Biome (%)

Table 4: Major Habitat Types - Global Coverage and the Area Protected

Habitat name	Total habitat area (1000 km^2)	Total area protected (1000 km^2)	Proportion protected
1 Tropical Moist Forest	9,306	2,798	23%
2 Tropical Dry Broadleaf Forest	2,830	342	11%
3 Tropical and Subtropical Needle-leaf Forest	2,044	304	13%
4 Temperate and Boreal Broadleaf Forest	3,965	577	13%
5 Temperate and Boreal Mixed Forest	3,057	376	11%
6 Temperate and Boreal Needle-leaf Forest	9,210	1,539	14%
7 Temperate and Boreal Sparse forest	1,359	219	14%
8 Savannah, Tree Cover Mosaic	1,850	386	17%
9 Savannah, Tropical Shrubland	5,562	890	14%
10 Tropical Grassland, Savannahs	5,795	763	12%
11 Shrubland, Subtropical	2,480	254	9%
12 Temperate Grassland	6,376	1,175	16%
13 Shrubland, Subboreal	1,276	301	19%
14 Warm Semidesert	6,274	617	9%
15 Warm Desert	10,769	1,458	12%
16 Cold Semidesert	5,676	304	5%
17 Cold Desert	3,259	309	9%
18 Shrubland, Boreal and Sub-polar	2,299	359	14%
19 Tundra	3,972	710	15%
20 Polar and High-Altitude Desert	739	161	18%
21 Snow and Ice	14,275	1,130	7%
24 Cropland and Natural Vegetation Mosaic	6,388	535	8%
25 Cropland	16,523	866	5%
26 Urban and built-up	257	12	5%
29 No data	338	91	21%
Mountains	39,433,364	5,996,622	15%
Mangrove	233,588	44,002	19%
Coral reefs	255,339	53,632	21%

Insert
Figure 5: Major Habitat Types - Global Coverage and the Area Protected

5. Can We Use Protected Areas as Indicators for Biodiversity Targets?

All types of protected areas have a role in global *in-situ* biodiversity conservation to a greater or lesser extent, whether they are managed as strict nature reserves, national parks, community conserved areas or managed resource areas. In the face of increasing human pressure on the planet's resources an effective global protected area system is the best hope for conserving viable, representative areas of natural ecosystems and their habitats and species. Therefore, protected areas are a valid measurable indicator of progress in conserving the world's remaining biodiversity or at least slowing the rate of loss. That, at least, is the theory. However, we need to be clear that measurements of the number and extent of protected areas, at least at the formal governmental level, may only provide a superficial indication of the political commitment to conserving biodiversity. Based on a comprehensive global gap analysis undertaken by Conservation International in 2003, Rodrigues *et al.* (2004: 641) have concluded that "the degree to which biodiversity is represented within the existing network of protected areas is unknown". Two factors are fundamental to understanding the issues associated with using protected areas as global biodiversity indicators:

1. protected area locations and design issues; and

2. effectiveness of protected areas in achieving conservation objectives.

- **Protected Area Location and Design Issues**

Although a number of countries have designed and implemented protected area system plans (Davey 1998), studies have confirmed (for example, Rodrigues *et al.* 2003, Pressey *et al.*

2002, Margules and Pressey 2000) that protected area establishment frequently does not correlate with identified conservation priorities. One of the most apparent observations from the current global statistical analysis is the considerable mismatch between the levels of protection between terrestrial and marine areas. The task of setting aside areas of ocean has barely begun, while the price already being paid for this shortfall is one of collapsing fish stocks and growing levels of pollution. Aside from the gross difference between the level of protection for terrestrial and marine realms, we know that even terrestrial protected area systems are inadequate, confirmed by the Conservation International study that concluded that "at least 1,310 species (831 at risk of extinction) are not protected in any part of their ranges" (Rodrigues *et al.* 2003:7).

Protected area data, in combination with habitat and species information, can provide a basis for determining gaps in the extent of biodiversity protection, and thereby inform decision-makers and stakeholders about priorities for conservation action (see Figure 6). However, the quality and relevance of the analysis clearly depends on the accuracy and resolution of the protected area boundary, habitat and species data and, as we have noted, there is considerable variation in the currently available data. On a related issue, the setting of minimum percentage targets for conservation of biomes or ecological regions (for example, the 10% target agreed by Contracting Parties at CoP7) may create political comfort but does not provide a basis for realistic assessments, as discussed above. However, it is important that consistent indicators are set that are useful at sub-national, national, regional and global levels (Reid *et al.* 1993) and biomes/ecological regions continue to provide the baseline framework in which more detailed habitat, community and species level monitoring can occur.

Insert
Figure 6: Example of Determining Habitat Conservation Priorities in Southern Chile

- **Effectiveness of Protected Areas** in Achieving Conservation Objectives

Throughout the world, but especially in the tropics, established protected areas are under severe threat (MacKinnon in press, Bruner *et al.* 2001, Carey *et al.* 2000, Oates 1999, Brandon *et al.* 1998). Carey *et al.* (2000:18) have summarised significant threats to protected areas, in increasing order of importance, as:

- "Individual elements removed from the protected area without alteration to the overall structure (e.g. animal species used as bushmeat, exotic plants or over-fishing of specific species).

- Overall impoverishment of the ecology of the protected area (e.g. through encroachment, long-term air pollution damage or persistent poaching pressure).

- Major conversion and degradation (e.g. through removal of vegetation cover, driving roads through the protected area, major settlements or mining).

- Isolation of protected areas (e.g. through major conversion of surrounding land)."

In the face of widespread threats to protected areas, and their conservation values, it is essential that we understand and measure the dimensions of the problem. That is, to bring together information about protected area numbers, extent and ecological representivity with assessments of conservation effectiveness of the existing network. By doing so we can develop a set of sound indicators that can provide meaningful assessments of whether or not biodiversity targets are met. Unfortunately, existing protected area data held in the WDPA does not indicate if protected areas (as individual sites, national systems and global networks) are actually effective in *achieving* identified biodiversity conservation objectives.

Existing numerical, spatial and geographic data therefore needs to be supplemented with relevant information that enables an assessment of conservation effectiveness.

Achievement of conservation objectives is part of the assessment of overall management effectiveness of protected areas. Considerable work is being undertaken globally in this regard, notably by IUCN (Hockings et al. 2000), and The Nature Conservancy (TNC 2003). Based on the IUCN framework (see Box 2), several other tools have been developed for assessing management effectiveness at individual protected areas and at the level of the protected area system. These include the WWF Rapid Assessment and Prioritization of Protected Areas Management (RAPPAM) methodology (Ervin 2003), recently used to assess 200 forest protected areas (Dudley *et al.* 2004). Since 2001, assessments have also been completed in a number of countries including Russia (Tyrlyshkin *et al.* 2003), China (Li 2003) and Bhutan (Tshering 2003).. In KwaZulu Natal in South Africa (Goodman 2003) the RAPPAM methodology was used to prioritise allocations of budgets across the protected area system, based on management needs.

However, there is as yet no globally accepted measure for assessing management effectiveness and the sheer number of protected areas means that a full assessment of management effectiveness for all sites worldwide remains unlikely in the short-term. Even so, the CBD CoP7 endorsed a protected areas programme of work, which included under Goal 4.2 the following ambitious activities by States Parties:

Box 2: Measuring the Effectiveness of Protected Area Management

There is a growing concern amongst protected area professionals that many protected areas around the world are not achieving the objectives for which they were established. One response to this concern has been an emphasis on the need to increase the effectiveness of protected area management, and to help this process a number of assessment tools have been developed to assess management practices. It is clear that the existence of a wide range of situations and needs require different methods of assessment. The World Commission on Protected Areas (WCPA) therefore developed a 'framework' for assessment. The WCPA framework aimed both to provide some overall guidance in the development of assessment systems and to encourage standards for assessment and reporting. The WCPA Framework is based on the idea that good protected area management follows a process that has six distinct stages, or elements:

- it begins with understanding the **context** of existing values and threats,
- progresses through **planning**, and
- allocation of resources (**inputs**), and
- as a result of management actions (**processes**),
- eventually produces products and services (**outputs**),
- that result in impacts or **outcomes**.

In order to monitor the progress towards meeting its effectiveness target, the World Bank/WWF Alliance for Forest Conservation and Sustainable Use has published (Stolton *et al.* 2003) a simple site-level tracking tool to facilitate reporting on management effectiveness of protected areas within WWF and World Bank projects. The tracking tool has been built around the WCPA framework and has been adopted by the GEF and other agencies. The methodology can be modified to fit local needs to :

- Identify the strengths and weaknesses of a protected area system.
- Analyse and compare a variety of pressures and threats across all protected areas within a system.
- Identify areas with high ecological and social importance, and determine conservation priorities.
- Develop and prioritize policy interventions and follow-up steps.
- Complement more detailed, site-level assessments.

WWF International is setting up a database to compile the results of interventions at WWF and Bank-assisted sites, although the primary beneficiaries and users of the results are protected area staff. The tool has been translated into French and Spanish as well as Chinese, Lao, Khmer, Vietnamese, Mongolian and Indonesian and tested at more than 200 sites worldwide.

The original tracking tool was developed for forested protected areas but has also been adapted for use in marine protected areas, where it is currently being field–tested (Staub and Hatziolos 2004).

"4.2.1 Develop and adopt, by 2006, appropriate methods, standards, criteria and indicators for evaluating the effectiveness of protected area management and governance, and set up a related database, taking into account the IUCN-WCPA framework for evaluating management effectiveness, and other relevant methodologies, which should be adapted to local conditions.

4.2.2 Implement management effectiveness evaluations of at least 30 percent of each Party's protected areas by 2010 and of national protected area systems and, as appropriate, ecological networks." (SCBD 2004)

Both IUCN and WWF approaches to evaluating management effectiveness include achievement of protected area conservation objectives and assessment of threats and vulnerability. However, for the purposes of assessing achievement of biodiversity targets it may be more efficacious to adopt a separate set of simple measures that can be applied at national levels and collated at regional and global levels within the WDPA. Parks Canada (2004), for example, has successfully adopted a process of measuring ecological integrity (Box 3) of its protected area system to:

- assess the effectiveness of management actions;
- increase understanding of ecosystem change;
- find areas where further research is needed; and
- serve as an 'ecological baseline' to which non-protected landscapes can be compared.

Box 2: Parks Canada Ecological Integrity Monitoring Framework
(Parks Canada 2004)

Biodiversity (characteristic of region)	Ecosystem Functions (resilient, evolutionary potential)	Stressors (unimpaired system)
Species richness ▪ change in species richness ▪ numbers and extent of exotics	**Succession/ retrogression** ▪ disturbance frequencies and size (fire. insects, flooding) ▪ vegetation age class distributions	**Human land-use patterns** ▪ land use maps, road densities, population densities
Population dynamics ▪ mortality/natality rates of indicator species ▪ immigration/ emigration of indicator species ▪ population viability of indicator species	**Productivity** ▪ Remote or by site	**Habitat fragmentation** ▪ patch size, inter-patch distance, forest interior
	Decomposition ▪ by site	**Pollutants** ▪ sewage, petrochemicals etc. ▪ long-range transport of toxics
Trophic structure ▪ size class distribution of all taxa ▪ predation levels	**Nutrient retention** ▪ Ca, N par site	**Climate** ▪ weather data ▪ frequency of extreme events
		Other ▪ park specific issues

Another national example of protected area monitoring is being applied in the Philippines for improving the conservation and management of coral reef protected areas (CCEF/CRMP 2002). Measured indicators include:

- human activities and natural disturbances: fishing, tourism, population and land use impacts, climatic factors (typhoons, coral bleaching);
- condition of habitat and causes of coral damage;
- status of fish and other species; and
- community perceptions of the marine protected area.

6. Delivering Accurate and Meaningful Protected Area Indicators for Assessing Global Biodiversity Targets

There are two fundamental streams of action, with associated information needs, required to achieve the 2010 biodiversity target, and the 2012 target for establishing an effective, globally representative marine protected areas system: completing protected area systems and ensuring the biodiversity effectiveness of protected areas.

6.1 Completing Protected Area Systems

There is a need to improve the accuracy of data on the spatial distribution of protected areas within a time-based framework to enable equally accurate, and comprehensive, assessment of the conservation status of ecosystems/habitats and species. This requires:

1. *Database:* Improvements to the structure, content quality and access of the WDPA, continuing the global collaboration with international conservation organisations and improving interaction with national agencies and regional bodies responsible for protected area data collection. Relay of high quality protected areas numerical, areal and geographic data from countries to the WDPA on a regular basis – especially accurate polygon boundary information, linking to effective quality control mechanisms.

2. *Analyses:* Regular habitat and species gap analyses relative to protected area networks at national, regional and global level.

3. *Communicating results:* Publication and wide dissemination of annual analytical status reports on protected areas data – including reports on the conservation effectiveness issues discussed below.

6.2 Ensuring the Biodiversity Conservation Effectiveness of Protected Areas

Conservation effectiveness is the key to achieving and *sustaining* global biodiversity targets and appropriate measures need to be incorporated into monitoring and reporting processes as soon as possible. Although work still needs to be done to improve the accuracy of measurements of the extent of protected areas, there is a level of urgency in the need to measure conservation effectiveness within the short time frame available before 2010. As we have seen, the tools have been developed – it is a question of agreeing on an appropriate standard set of indicators that can be recorded and compared for global analyses. Action needs to be taken to:

- *Ensure a global approach to assessment:* Develop a global approach to the design and application of conservation effectiveness indicators. The necessary design work could be undertaken by the Ongoing Ad Hoc Technical Working Group on Protected Areas established at the CBD CoP7, and the international specialist organisations assigned as partners in the implementation of the CBD Programme of Work on Protected Areas (IUCN WCPA, UNEP-WCMC, WWF, etc).

- *Measure biodiversity conservation effectiveness:* Develop and implement a global protected areas monitoring project to measure baseline and ongoing conservation effectiveness over a 5-10 year period - potentially expressed through measures of ecological integrity. Ideally, such a project should include every country, but would at least need to include a representative sample of protected areas (600-1,000) in all biomes/ecoregions.

- *Incorporate new data layers:* Improve the capacity of the WDPA to incorporate relevant data on habitats, and also other factors that contribute to an understanding of key

management effectiveness issues: for example, budgets (as a proportion of GDP), staffing, or visitor numbers. As management effectiveness measures become more widely available they will improve the resolution of the WDPA to act as an indicator of progress towards targets. It is possible that an 'indicator subset' of the WDPA could be created specifically to assist the indicator biodiversity reporting process.

- *More effective application of IUCN protected area management categories:* IUCN management categories also have a potentially important role in regional and global analyses by providing a common language and enabling the comparison and summary of protected areas on the basis of management objectives. If uniformly adopted and properly applied, the categories provide another layer of useful information that can be used in the evaluation of management and conservation effectiveness and action needs to be taken at all levels to improve their use.

6.3 Use of Remote Sensing Technology

More widespread and better use needs to be made of remote sensing technology. The relatively recent ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) remote sensing system was launched in 1999 with an expected life of more than six years and clearly has great potential to support protected areas monitoring from national to global scales. ASTER is recording 600 high-resolution images a day, each one covering an area of 60 km^2, with a pixel size of 15 metres. NASA is using the system to compile a prototype 'protected areas archive' with a simple set of effective tools available for field level use by protected area managers (NASA 2004). The system is being constructed with the following capabilities:

- read and display user-supplied overlay shape files;

- image annotation - adding text, lines, arrows, shapes;
- distance and area measurement;
- inclusion of historic Landsat data to support change analysis; and
- creation of new shapefiles;
- support for ASTER, Landsat, and MODIS data;
- simple classification functions;
- topographic layer, with draping capability and perspective roaming;
- simulated true colour;
- ability to create custom CD-ROMs where the user selects scenes/protected areas;
- access to information through both CD-ROMs and the Internet;
- integration with specialised documentation for PA managers; and
- links to external sources of information (for example, WDPA and species databases).

Linkages with high-resolution remote sensing data could assist in developing more complex GIS models to look at a range of measures of "conservation effectiveness". It would be possible, for example to investigate critical issues such as connectivity and potential for ecological networks, boundary length, and threats (such as population densities within threshold distances from park boundaries and adjacent land/resource uses).

7. Conclusion

This paper has stressed the importance of a comprehensive approach to the use of protected areas as an indicator for meeting global biodiversity targets. Measurements of numbers and extent *must* be combined with assessments of conservation effectiveness to achieve meaningful results. Monitoring methodologies are being applied by different organisations

and national agencies in a number of the world's protected areas that have the potential for use in measuring the status of protected areas at the global level. The challenge is to define a standard methodology and apply it consistently in countries so that meaningful results can be derived to determine if global biodiversity targets are met. As indicated in this review, there are significant inaccuracies in the current spatial data on the world's protected areas, which in turn means imprecision in identifying conservation gaps and defining priorities. Yet these inaccuracies can be addressed in a relatively straightforward manner, given sufficient technical and financial resources and concerted action.

Above all, national governments need to progress the protected areas agenda adopted at the CBD CoP7 – including the endorsed outcomes of the 5th World Parks Congress held in 2004 – to provide effective protection regimes to conserve the world's remaining biodiversity. The application of such effectiveness is the test of real political will, expressed through good governance, enforcement of legal protection and provision of resources necessary for protected area management.

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[1] Goal 7 - Ensure environmental sustainability; Target 9: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources; Indicator 26: Land area protected to maintain biological diversity.

[2] XVII UN General Assemby: Economic development and the conservation of nature, 18 December, 1962.

[3] Which became the World Conservation Monitoring Centre in 1988 and the UNEP World Conservation Monitoring Centre in 2000.

[4] Founding members are: American Museum of Natural History, BirdLife International, Conservation International, Fauna & Flora International, IUCN – The World Conservation Union, The Nature Conservancy, UNEP World Conservation Monitoring Centre, Wildlife Conservation Society, World Resources Institute, WWF

[5] This figure represents only those sites which are known to have been designated – there is further information on the WDPA regarding degazetted, proposed and recommended sites which is not considered further in this study.

[6] In fact this approach introduced a secondary error for those sites where buffered points have been used. In these cases it is possible that adjacent sites could be falsely presented as overlapping. In the current study this error was assumed to be smaller than the potential error of double counting, although further work may be needed to address the scale of this problem.

[7] **Antarctica:** Antarctica, Bouvet Island (Norway); French Southern Territories (France) Heard and McDonald Islands (Australia); Falkland Islands, St. Helena, South Georgia and South Sandwich Islands (UK); **Australia** (Christmas Island, Cocos/Keeling, Norfolk Island) **and New Zealand**; **Caribbean:** Anguilla, Bermuda, Cayman Islands, Montserrat, Turks and Caicos Islands, British Virgin Islands (UK); Anitgua and Barbuda; Aruba, Netherlands Antilles (Netherlands); Bahamas; Barbados; Cuba; Dominica; Dominican Republic; Grenada; Guadeloupe, Martinique (France); Haiti; Jamaica; Puerto Rico; US Virgin Islands (US); Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Trinidad and Tobago; **Central America:** Belize; Costa Rica; Él Salvador; Honduras; Guatemala; Nicaragua; Panamá; **Eastern and Southern Africa:** Botswana; Eritrea; Ethiopia; Kenya; Lesotho; Malawi; Mayotte, Réunion (France); Mozambique; Namibia; Seychelles; Somalia; South Africa; Sudan; Swaziland; United Republic of Tanzania; Uganda; Zambia; Zimbabwe; **East Asia:** China; Japan; Hong Kong (SAR, China); DPR Korea; Republic of Korea; Macau (SAR China); Mongolia; Taiwan, Province of China; **Europe:** Albania; Andorra; Austria; Belgium; Bosnia and

Herzegovina; Bulgaria; Croatia; Czech Republic; Denmark (incl. Faroe Islands); Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Liechtenstein; Lithuania; Luxembourg; FYR Macedonia; Malta; Monaco; Netherlands; Norway (incl. Svalbard and Jan Mayen Islands); Poland; Serbia and Montenegro; Slovenia; Spain; Sweden; Switzerland; UK (incl. Gibraltar); Vatican City State; **North Africa and Middle East:** Afghanistan; Algeria; Bahrain; Cyprus; Egypt; Islamic Republic of Iran; Iraq; Israel; Jordan; Kuwait; Lebanon; Libyan Arab Jamahiriya; Morocco; Oman; Qatar; Saudi Arabia; Syrian Arab Republic; Tunisia; Turkey; United Arab Emirates; Republic of Yemen; **North America:** Canada; Greenland (Denmark); Mexico; St. Pierre and Miquelon (France); United States; **North Eurasia:** Armenia; Azerbaijan; Belarus; Georgia; Kazakhstan; Kyrgyzstan; Republic of Moldova; Russian Federation; Tajikistan; Turkmenistan; Ukraine; Uzbekistan; **Pacific:** American Samoa, Guam, Hawaii, United States Minor Outlying Islands (US); Cook Islands, Niue, Tokelau (New Zealand); Fiji; French Polynesia, New Caledonia, Wallis and Futuna Islands (France); Kiribati; Marshall Islands; Micronesia; Nauru; Northern Mariana Islands; Palau; Papua New Guinea; Pitcairn, Henderson (UK); Samoa; Solomon Islands; Tonga; Tuvalu; Vanuatu; **South America:** Argentina; Bolivia; Chile; Colombia; Ecuador; French Guiana (France); Guyana; Paraguay; Peru; Suriname; Uruguay; Venezuela; **South Asia:** Bangladesh; Bhutan; British Indian Ocean Territory (UK); India; Maldives; Nepal; Pakistan; Sri Lanka; **Southeast Asia:** Brunei Darussalam; Cambodia; Indonesia; Lao PDR; Malaysia; Myanmar; Philippines; Singapore; Thailand; Timor Leste; Viet Nam; **Western and Central Africa:** Angola; Benin; Burkina Faso; Burundi; Cameroon; Cape Verde; Central African Republic; Chad; Comoros; Congo; DR Congo; Côte d'Ivoire; Djibouti; Equatorial Guinea; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Liberia; MadagSascar; Mali; Mauritania; Mauritius; Niger; Nigeria; Rwanda; Sao Tome and Principe; Senegal; Sierra Leone; Togo.

Measuring the Extent and Effectiveness of Protected Areas as an Indicator for Meeting Global Biodiversity Targets

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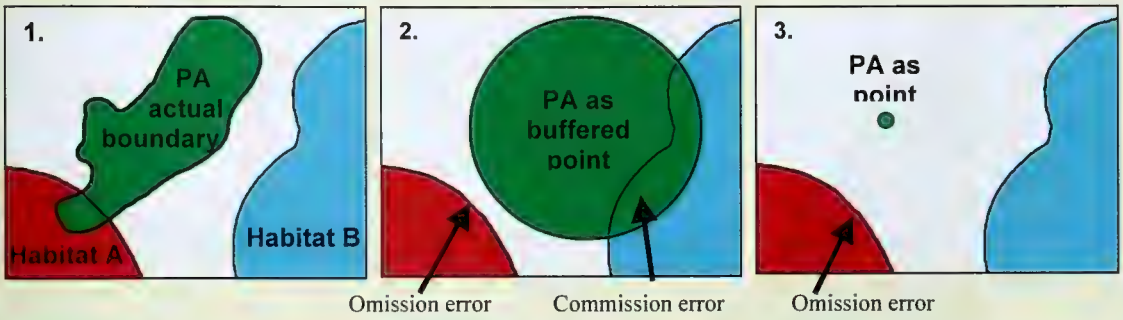
FIGURES

Figure 1: How Omission and Commission Errors Occur in Habitat Data Analysis
(Adapted from Rodrigues et al. 2003)



1. *True shape of PA reflected in accurate polygon boundary*
2. *Buffered points of PA (known area and centre point) can result in errors of omission (Habitat A) and commission (Habitat B)*
3. *Point only data of PA can result in errors of omission (Habitat A)*

Figure 2: Global Distribution of Protected Areas by IUCN Protected Area Management Category

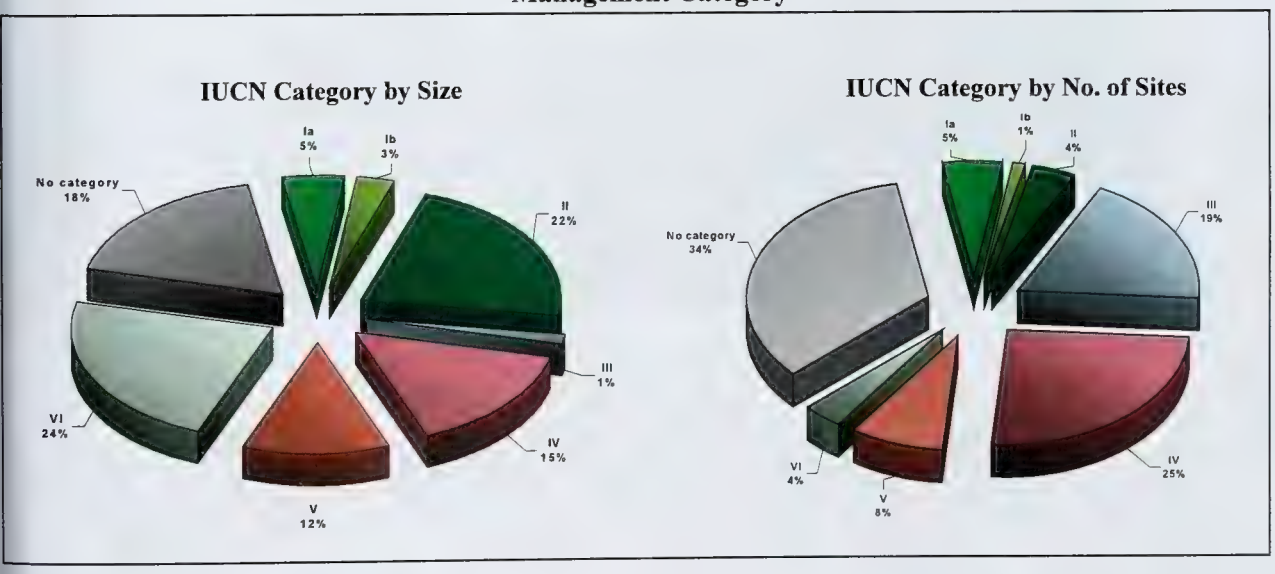


Figure 3: Growth of Global Protected Areas over Time

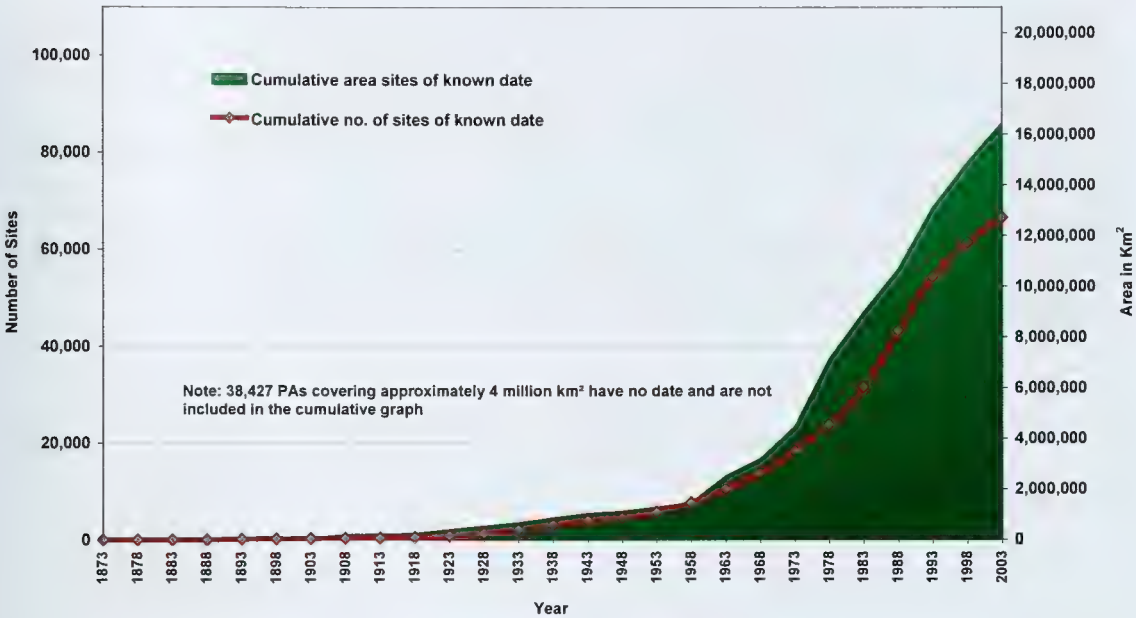


Figure 4: Area Protected by Biome (%)

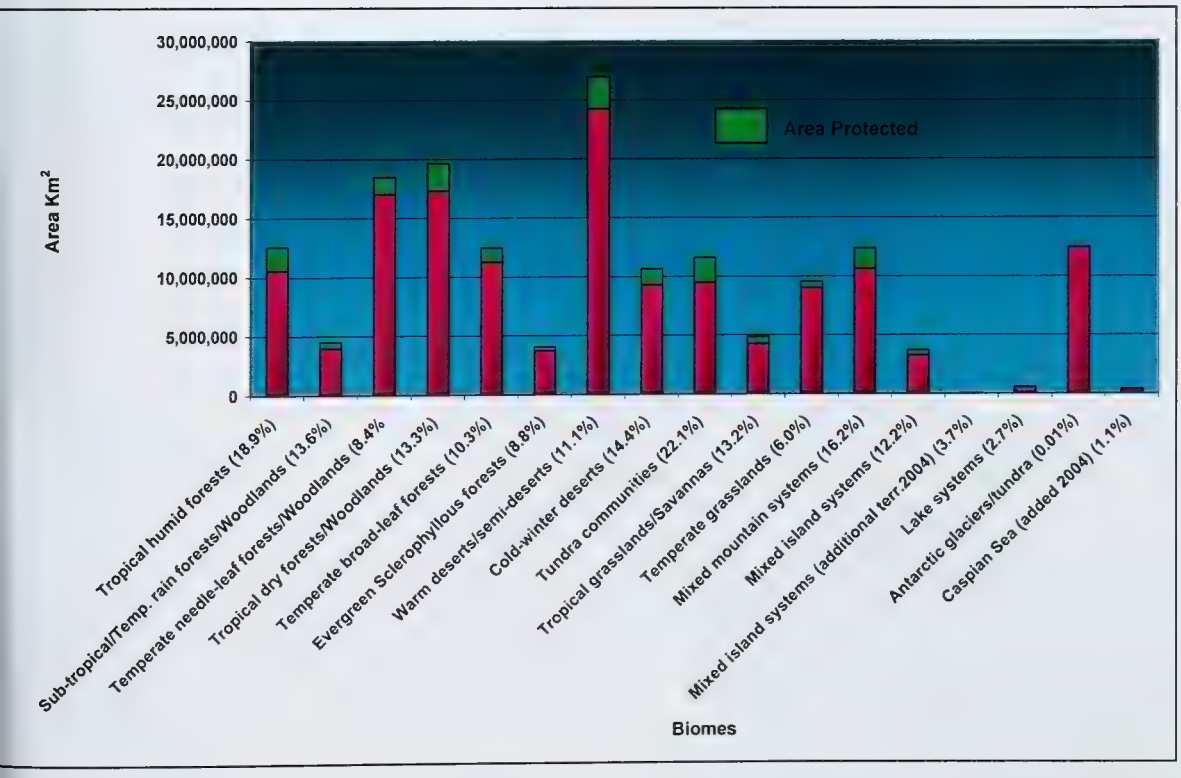


Figure 5: Major Habitat Types - Global Coverage and the Area Protected

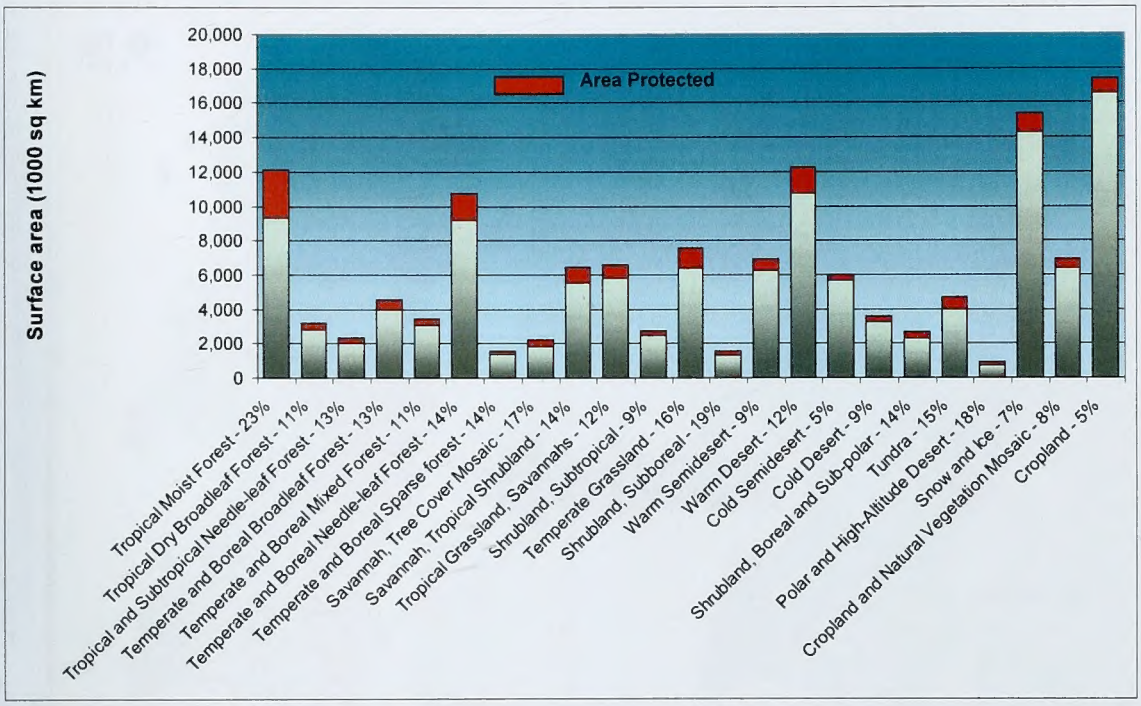


Figure 6: Example of Determining Habitat Conservation Priorities in Southern Chile

(Adapted from Lysenko and Bubb 2003)