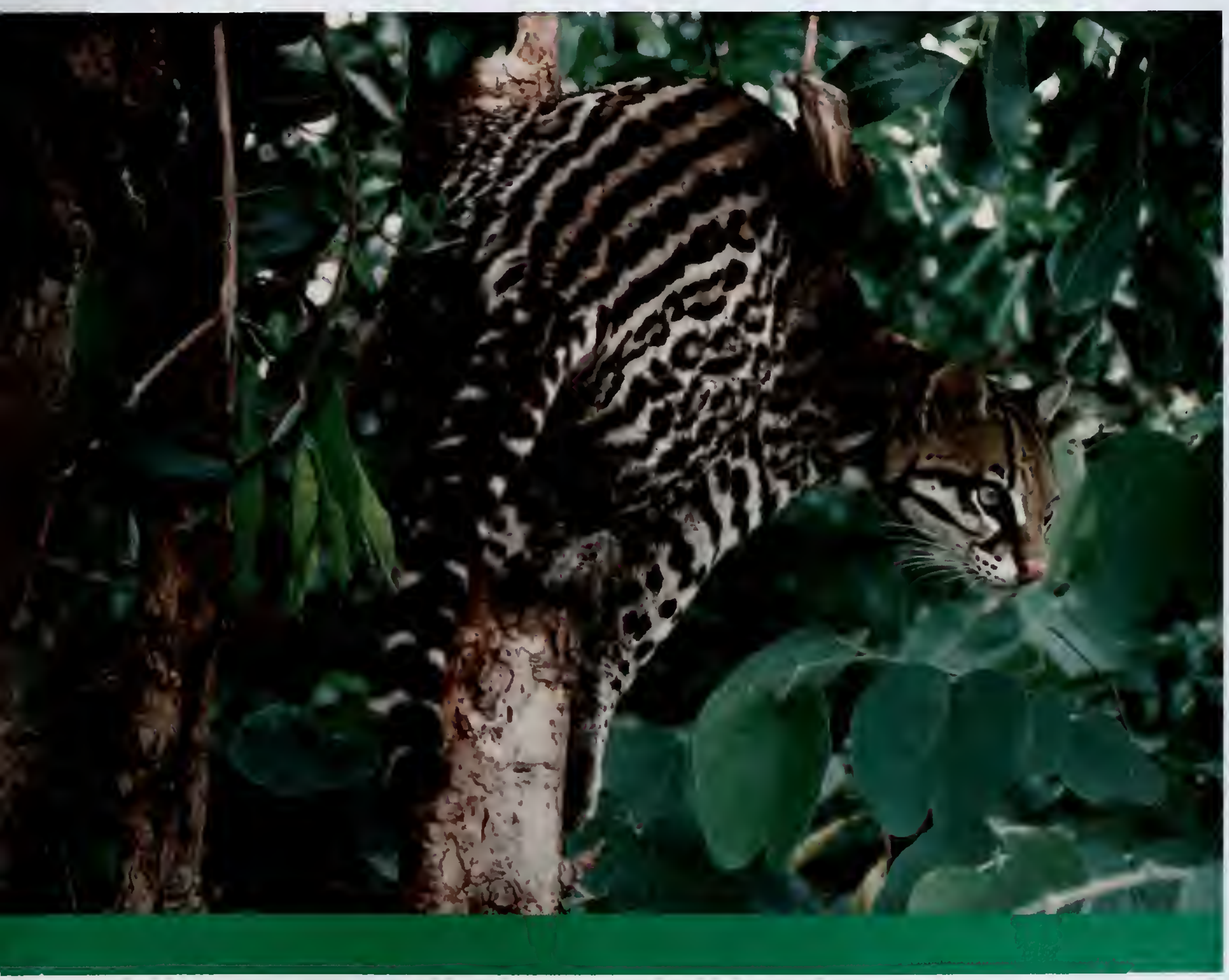
UNEP WCMC

Coverage of protected areas

Guidance for national and regional use

Version 1.2



2010 Biodiversity Indicators Partnership

This guidance document is one of a series produced with the support of the 2010 Biodiversity Indicators Partnership (2010 BIP) to assist Parties to the Convention on Biological Diversity (CBD) to track their progress towards the 2010 Biodiversity Target. Coverage of Protected Areas has been selected as one of the indicators suitable for assessing progress towards and communicating the 2010 Target at the global level. The aim of this document is to provide guidance to support the calculation and interpretation of the Coverage of Protected Areas indicator at the national and regional scales.

The 2010 Biodiversity Indicators Partnership (2010 BIP) intends this guidance to be a 'living document'. Updated versions will be produced based on users' feedback, and will include lessons learned and new examples of the indicators in use. Please send requests for advice and feedback on this guidance to: protectedareas@unep-wcmc.org

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For information on other indicator guidance documents and the 2010 BIP please see www.twentyten.net or contact info@twentyten.net

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Coverage of protected areas

PURPOSE

The Coverage of Protected Areas indicator represents the degree to which components of biodiversity are formally protected. It can show the changes in extent of protected areas, including marine protected areas, in relation to geographical and political units and to different measures of distribution of the components of biodiversity, such as priority areas, ecosystem or habitat maps and species distributions.

Overall, depending on the data, technical skills and equipment available, and the approach taken, this indicator can be used to:

- assess overall progress of total area protected as a measure of political will to protect biodiversity
- track changes in protection of key ecosystems and habitats;
- help assess the adequacy of protection of particular species or taxonomic groups of interest;
- track changes in the degree to which areas of key importance for biodiversity around the world are protected;
- help identify ecologically distinct priority areas for conservation.

However it cannot be used to:

- indicate how well managed these protected areas are;
- act as confirmation that the biodiversity within them is effectively protected;
- provide an indication of areas that are not formally protected but still may be important for conserving biodiversity.

PLACE IN THE 2010 BIODIVERSITY TARGET FRAMEWORK

Coverage of protected areas is both a headline indicator and an indicator adopted by the CBD for immediate testing, under the 2010 Target focal area *Status and trends of the components of biological diversity*. As a headline indicator it includes both the coverage of areas of key importance for biodiversity and management effectiveness of protected areas. These two indicators are complementary because formal designation of protected area status is not in itself sufficient to ensure conservation of that biodiversity contained within it.

Coverage of protected areas also directly complements several other headline indicators within this focal area:

1 trends in extent of selected biomes, ecosystems, and habitats;
2 trends in abundance and distribution of selected species;
3 change in the status of threatened species.

Protected areas may play a key role in retaining habitat cover and therefore in helping to maintain species populations. Protection also plays a role in the conservation status of species and is therefore closely linked to assessment of changes in that status.

In addition to the 2010 Target, Coverage of Protected Areas is relevant to a number of other CBD targets under specific programmes of work. These include the *Programme of Work on Protected Areas* and thematic programmes of work on: Marine and coastal biodiversity; Inland waters; Forest biodiversity; Mountains; Dry and sub-humid lands and Island biodiversity. It also addresses targets within the Global Strategy for Plant Conservation (GSPC).

Specific variants of protected areas coverage can be used to track progress under the Ramsar Convention and the Convention on Migratory Species (and its subsidiary agreements). At a regional scale it has also been adopted as an indicator within Europe under the SEBI-2010 process.

'Proportion of terrestrial and marine areas protected' is also Indicator 7.6 for reporting on progress towards the UN Millennium Development Goal 7 on environmental sustainability and its Target 7.B: 'Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss'.

KEY TERMS USED IN THIS DOCUMENT

Geographical Information System (GIS): a system of computer hardware and software used for storage, retrieval, mapping, and analysis of geographic data that is referenced to a map projection in an earth coordinate system.

Projection: a method of representing the surface of a sphere (globe) on a flat plane. All projections distort the surface in some fashion; therefore selection of the appropriate projection depends on the purpose of the map.

Equal area projection: quadrilaterals formed by meridians and parallels have an area on the map proportional to their area on the globe (real-world).

Attribute: a specification that defines a property of an object, feature or file. It usually consists of a name and a value.

Polygon: a feature used to represent areas. It is defined by lines that make up its boundary and have attributes that describe the feature they represent.

Point: GIS data that has no dimensions. A point represents the location of a feature but not its area and has attributes that describe the feature represented.

Protected Area: A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Designated: protected area site that is recognized, supported and declared by a national legislation and/or authority.

Establishment year: year that a protected area was formally established/designated.

Spatial coverage: total extent of protection referenced in geographical space and containing no overlaps in protection of sites. This is managed and analysed within a GIS.

Statistical coverage: total area of protection generated from tabular data. No spatial relationship is maintained between features, and is therefore unable to account for overlaps in protection of sites.

National and regional use

NATIONAL RELEVANCE

At national scale, coverage of protected areas is highly relevant for reporting progress towards international policy targets under the CBD, Ramsar, CMS and other relevant Conventions and processes. It also has been shown to support national policy and decision making in conservation and many other sectors affecting use of land and other natural resources. Furthermore CBD guidance suggests that a national gap analysis of protected areas coverage should form part of the NBSAP process, and national coverage analyses are also called for under the Programme of Work on Protected Areas. Most decisions with respect to protected area designation are taken at national level, and these decisions need to be informed by relevant information and analysis.

National implementation of a protected areas coverage indicator can take several approaches, depending on the components of biodiversity that are of interest and the data that are available. Measures of protected area coverage that might be of interest at this scale are:

- proportion protected nationally and by sub-national administrative unit of terrestrial or marine area or territorial area (terrestrial and marine combined);
- protected areas coverage of climatic zones or potential vegetation types;
- protected areas coverage of current vegetation, habitat or ecosystem cover;
- protected areas coverage of distributions and/or concentrations of key species (e.g. threatened species or endemics);
- protected areas coverage of priority areas.

Ideally, national coverage assessment should be developed from country-specific data sets but can potentially be disaggregated from a global assessment depending on the data quality.

IMPLEMENTATION

There are two main approaches to calculate the coverage of protected areas indicator, depending on the analysis required and the type of data, technical skills and equipment available. This section of the guidance document explains and illustrates these two approaches with examples from the global scale, as they have been developed by UNEP-WCMC. Subsequent sections discuss potential data sources suitable for national use and detail the methods for calculating the indicator.

The two main approaches to measurement of the coverage or extent of land and/or sea under formal protection are: (Table 1)

1. statistical, using tabular data of the cumulative number and area of protected sites per year;
2. spatial, using analysis of protected area site data in a GIS within a current year.

It is likely that at a minimum the statistical approach can be undertaken by the majority of national users, with the spatial approach being desirable if there is suitable technical capacity and spatial data. The spatial approach requires an IT/computer system capable of running GIS software (e.g. ESRI ArcGIS[1]) and a user with the technical understanding to run the analysis processes. The success of the spatial approach is also dependent on the availability of spatial (GIS) protected area boundary data (polygons). The main advantage of using spatial analysis is that you can remove any overlaps in protection of sites. This allows the production of an overall figure of 'spatial coverage protected' and a spatial GIS layer that can be used to calculate the level of protection of other biodiversity components, such as ecosystems, habitats, species or priority areas.

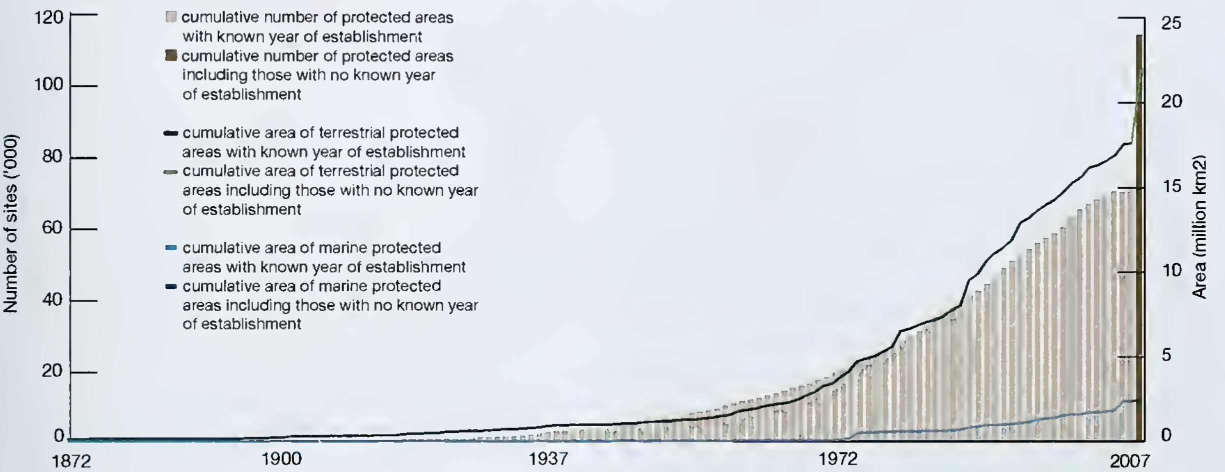
	Statistical	Spatial
Measurement	Trends in protection over time.	Spatially resolved coverage in current year.
Data	Tabular data of the cumulative number and area of protected sites per year (including overlaps in protection of sites).	Spatial layer of protected coverage in current year (with overlaps in protection of sites accounted for).
Definition	Total area of protection generated from tabular data. No spatial relationship is maintained between features, and is therefore unable to account for overlaps in protection of sites.	Total extent of protection referenced in geographical space and containing no overlaps in protection. This is managed and analysed within a GIS.
Analysis	Further analysis with other biodiversity components is not possible.	Further analysis with other spatial biodiversity components is possible.

Table 1: Two main approaches to producing the coverage of protected areas indicator

A basic requirement for both approaches is the availability of protected areas data with suitable attributes (information). The minimum attributes for the statistical approach are name of protected area, designation, legal status, total area, and year of establishment. The availability of geographic location (latitude/longitude), spatial boundary data, IUCN Protected Area Management category, and marine area, increases the likelihood of the user being able to carry out more advanced analysis, including possible breakdowns such as by IUCN management category.

1 ESRI ArcGIS software was used by UNEP-WCMC in developing and applying this method.

Figure 1: Growth of nationally designated protected areas, 1872-2007 (number and area)



Global application of the statistical approach

The statistical approach is used for reporting the growth in protected areas for the UN Millennium Development Goal Indicator 7.6, 'Proportion of terrestrial and marine areas protected'. As this approach is solely based on tabular data its success is dependent on good quality attribute data, especially total/marine area and establishment year. The UN MDG indicator requires summary tables to be produced of the cumulative number and area protected per establishment year at global, national, and MDG region level. An example of an output from this process is show in Figure 1: a graphical representation of the global growth in number and area of designated protected areas from 1872 – 2008. It is important to note that if an establishment year is unavailable for a designated protected area it cannot be included within the time series, but if it is known that a protected area had been designated by a certain year, it may be possible to include it within the time series (with qualification and caveats as necessary).

The UN MDG Goal 7 also calls for indicator 7.6 to be expressed as the proportion of surface area protected. This requires tabular data of protected areas, with an indication of whether the site is within the marine and/or terrestrial environment along with the equivalent area protected. In addition tabular data on the total land area and territorial waters (out to 12 nautical miles) per country are also required. Using the tabular information a simple statistic of the proportion protected (e.g. total terrestrial area protected divided by total terrestrial land) can be produced. By using the available tabular data it is possible to produce a time series analysis of proportion protected. However this is unable to account for overlaps in protection, such as multiple protection categories for the same site or overlaps in boundaries of neighbouring sites. Therefore, the proportion protected will always be inherently overestimated and is directly affected by the availability of up-to-date information.

Another significant limitation of the statistical approach is that it does not show how much biological diversity is protected, for which a spatial approach is required.

Global application of the spatial approach

The uneven distribution of biological diversity means there is not a straightforward relationship between the proportion of a territory that is protected and the proportion of biological diversity in that area. Therefore, it is more meaningful to consider area protected in relation to the distribution of components of biological diversity. An example of such a spatial approach is the work of UNEP-WCMC to analyse the proportion of biodiversity protected as represented by terrestrial ecoregions. This spatial approach can also be repeated with other spatial biodiversity datasets such as species, key biodiversity areas, habitats, etc. This approach accounts for overlaps in protection, but it is difficult to perform the analysis as a time series. This is due to the large amount of data processing required along with the limited availability of boundary data and establishment year or date of change information for protected areas. Consequently this type of spatial analysis is usually performed with a spatial layer of designated protected areas from the current year and displayed in mapped form, as shown in Figure 2.

In a few cases, it may be possible to draw meaningful conclusions

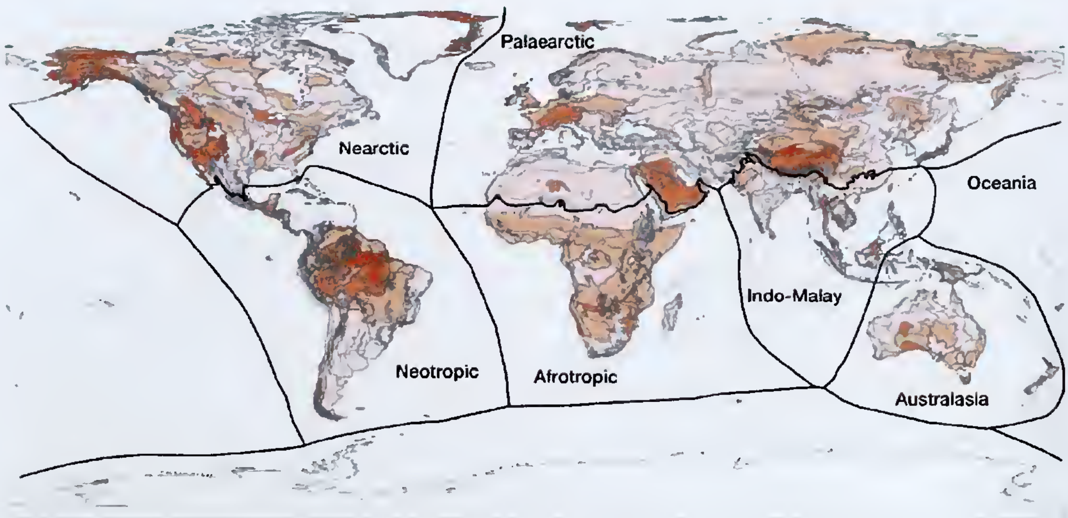


Figure 2: Percentage protection within terrestrial ecoregions. 2008.

about this protected areas coverage based purely on statistical data of the occurrence of key biodiversity elements within protected areas. However a further complication is that not all protected areas afford equal protection to the biodiversity within them. This variation is due both to differences in the type of management for which the area is designated, and the effectiveness with which the designated management is applied.

Protected areas are established under a huge range of legislative regimes and with many different purposes in mind. There may be no legislative or management requirement to maintain all the components of biological diversity that they hold and in some cases, particularly in IUCN management categories V and VI, maintenance of biological diversity may not be a major function of the protected area. For this reason, it may be useful to incorporate a breakdown of the indicator by IUCN category, where such data are available. In addition, a separate and complementary indicator under development within the 2010 Target framework is protected area management effectiveness.

Data sources

This section outlines potential sources of global spatial data on protected areas and biodiversity components that can be used with this indicator.

PROTECTED AREAS

In the majority of cases the most accurate and current data for determining protected areas coverage for a country will be available from the relevant protected areas agency or national equivalent. In some cases international non-governmental organizations may also have suitable data of value, including improved spatial (GIS) data on protected area boundaries.

In some circumstances the data available internationally may be the best source, as held by the World Database on Protected Areas (WDPA). The WDPA is a joint project of UNEP and IUCN, hosted and managed by UNEP-WCMC, with support from the IUCN World Commission on Protected Areas (IUCN-WCPA), and working with governments and collaborating NGOs.

The WDPA uses the IUCN definition of a Protected Area, which following its revision in October 2008 now closely reflects the CBD definition:

> *"A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values"* (Dudley, 2008).

The Convention on Biological Diversity defines protected areas as:

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

Information in the database is provided principally by ministries of the environment and other government agencies that are responsible for the designation and maintenance of protected areas. However information from NGOs and academic institutions, international environmental conventions, and others may also be included. Data are currently available for over 120,000 protected areas worldwide. The WDPA is updated as new information is made available. The WDPA, including spatial (GIS) and other attribute data on all the world's protected areas, is freely available for non-commercial use and is accessible via the internet at www.wdpa.org.

Ideally the areas included in the WDPA are assigned to one of the six protected area management categories defined by IUCN, opposite (Dudley, 2008).

In practice a substantial number of areas listed in the WDPA database have not as yet been assigned a specific category. In October 2008 new guidelines for applying IUCN Protected Areas Management Categories were published – see http://data.iucn.org/dbtw-wpd/edocs/PAPS-016.pdf.

IUCN MANAGEMENT CATEGORIES AND DEFINITIONS

Ia Strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areasfor scientific research and monitoring (i.e. Strict Nature Reserve)

Ib Protected areas that are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition (i.e. Wilderness Area)

II Protected areas that are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities (i.e. National Park).

III Protected areas that are set aside to protect a specific natural monument, which can be a landform, seamount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value (i.e. Natural Monument or Feature).

IV Protected areas that aim to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category (i.e. Habitat/ Species Management Area)A protected area where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values (i.e. Protected Landscape/Seascape).

VI Protected areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area (i.e. Protected area with sustainable use of natural resources).

DATA ON BIODIVERSITY DISTRIBUTION – ECOSYSTEMS AND ECOREGIONS

Data on biodiversity distribution may be drawn from internationally accepted ecoregional classifications as a useful first approximation, but many countries may have their own ecoregional classification systems or other measures of biodiversity distribution and priority that are more meaningful at national scale.

For global and regional scale reporting, the terrestrial ecoregions defined by World Wide Fund for Nature (WWF) are frequently employed. In this context an ecoregion is defined as a large area of land or water that contains a geographically distinct assemblage of natural communities that:

a share a large majority of their species and ecological dynamics;
b share similar environmental conditions, and;
c interact ecologically in ways that are critical for their long-term persistence.

The boundaries of an ecoregion approximate the original extent of natural communities prior to major land-use change. The database currently delineates 825 terrestrial ecoregions; in May 2008 WWF and TNC published a map of freshwater ecoregions of the world, with 426 units (FEOW, 2008). The ecological regions described in the recent Marine Ecoregionalization of the World (MEOW; Spalding, M. *et al*, 2006) or Large Marine Ecosystems (NOAA 2001) can be used to address marine systems.

The World Wide Fund for Nature (WWF) recognizes three caveats to its definition of ecoregions, which are appropriate for all bio-geographic mapping approaches:

- No single biogeographic framework is optimal for all taxonomic groups. Ecoregions reflect the best compromise for as many taxonomic groups as possible.
- Ecoregion boundaries rarely form abrupt edges; rather, ecotones and mosaic habitats form gradual transitions between habitat types.
- Most ecoregions contain habitats that differ from their assigned biome. For example, rainforest ecoregions in Amazonia often contain small edaphic savannas, and a recent analysis (Schmidt et al 2008) has shown that many ecoregions contain several distinct forest types.

Large Marine Ecosystems are not universally accepted to be biogeographical units and do not cover all of the worlds coastlines (countries in the south west Pacific and many oceanic islands are not included). However they are frequently used in many international processes and are useful in many respects. The Marine Ecoregions of the World (MEOW)utilise a tiered approach enabling analysis at progressively higher spatial resolutions (realms, provinces and ecoregions).

Many countries have their own national ecoregional or other ecological or vegetation classifications that can form the basis for protected area coverage analysis. These will often be far more detailed at country scale than the global ecoregion classifications. Examples of such national analyses include:

- an analysis of the protection of vegetation zones in Brazilian Amazonia by state based on a national vegetation map (Fearnside & Ferraz 1995);
- a protected areas coverage analysis of the Cape Floristic region in South Africa, which assessed protection of 88 broad habitat units defined based on topography, geology and vegetation (Rouget et al. 2003);
- national level ecoregional assessment in Mexico, which assessed 56 marine and 75 terrestrial ecoregions (CCA, In Press and CONABIO, 2006).

Increasingly it is becoming possible to base assessments of protection on remotely sensed data on current vegetation cover within ecoregions or other (bio)geographical units. This approach has the advantage of addressing the vegetation that is actually present within protected areas, rather than simply the zone in which they occur. However, results from these types of assessment need to be presented very carefully, so that protection is not falsely represented as increasing as a result of decreasing area of natural vegetation (see below on calculation and presentation). It also presents a number of challenges, including how to deal with the crude vegetation classifications usually produced by remote sensing and frequent changes in methods between remote sensing assessments, which reduce their comparability through time. Strand et al. (2007) cover many of the issues in using remote sensing data for biodiversity indicators, including protected area coverage.

DATA ON SPECIES DISTRIBUTION

Protected areas coverage of species can be assessed from detailed inventories of the protected areas themselves or from data on species distributions. The former approach is feasible only for some groups and gives information about representation of species within protected areas, but not about what fraction of their total extent of occurrence or population is protected. In the few cases where such inventory data are available across protected areas, they can be used to express the proportion of species in the inventoried group that are represented in the protected areas.

Only a few countries have detailed national data on the distribution of species within their borders. Where such data are available, however, they form a valuable basis for protected areas coverage analysis. Especially for large countries, global and regional data on species distributions can be valuable. Examples include the Global Amphibian Assessment (http://www.global amphibians.org/); Bird-Life International's data zone (http://www. birdlife.org/datazone/index.html); and the assessments of mammals and birds of the western hemisphere which can be obtained in digital form at: http://www.natureserve.org/get Data/animalData.jsp. In many cases it will be appropriate to focus on the distributions of only a few priority species or species of conservation concern. In one such example, Deguise and Kerr (2006) assessed the degree to which the distributions of threatened terrestrial species of Canada were covered by protected areas. In general, it is recommended that as many species as possible are included within the coverage analysis, excluding any species marginal to the region. Data collection efforts should be focused on better representation of endemic species, as these are the closest identified approximation to indicator species. As new species are added to the indicator, the analysis should be repeated for earlier points in time, so that coverage comparisons between years are possible.

DATA ON AREAS OF IMPORTANCE TO BIODIVERSITY

Areas of importance for biodiversity are often defined upon the basis of the vulnerability and uniqueness of the biodiversity contained within them (e.g. Eken et al. 2004a, b). Many countries have developed their own approaches for identifying biodiversity priority areas. Data sets on the distribution of such areas may be held by national authorities. They are also commonly developed and maintained by national and international conservation-focused non-governmental organizations. Countries, non-governmental organizations and international agreements all take different approaches to defining these key areas. However, there is some recent convergence.

Where national data sets of this type do not exist, it may be appropriate to make use of global or regional data on biodiversity areas, though these are often too coarse to be useful for small countries. Among these data sets, those at relatively fine resolution include:

- Important Bird Areas (IBAs) – Birdlife International's data zone (http://www.birdlife.org/datazone/index.html).
- Important Plant Areas (IPAs) – Plantlife International http://www.plantlife.org.uk/international/plantlife-ipas.html.

These areas are defined based on criteria encompassing issues of species rarity, threat status, endemicity and richness. Essential sites for migratory species are also included.

The selection methodology has been generalized to provide the concept of 'Key Biodiversity Areas' (Eken *et al.* 2004a, b). The intention is that these relatively small areas are nested within the larger scale definition of priority ecoregions or hotspots. Key Biodiversity Areas (KBAs) provide an important basis for protected areas coverage analysis. These are sites of global significance for biodiversity conservation, identified using globally standard criteria and thresholds, based on the occurrence of species requiring safeguards at site scale (Langhammer et al 2007). KBAs have so far been comprehensively identified in only a few countries (e.g. Turkey), but for other countries (e.g. Sri Lanka) preliminary identification of KBAs has been done. Many but not all KBAs correspond to IBAs or IPAs. Where they exist, they are an excellent basis for assessing protected areas coverage in relation to site scale priorities for species conservation; their species focus means that they may not be as effective a basis for assessing coverage in relation to ecosystems.

Calculating Protected Areas Coverage

This section outlines the key stages that comprise the statistical and spatial approaches to calculating protected areas coverage. For more information on preparing or calculating protected areas coverage using the methods outlined below please contact the UNEP-WCMC Protected Areas Programme at protectedareas@unep-wcmc.org.

STATISTICAL APPROACH

The simplest calculation of protected areas coverage is using the statistical approach to produce tables/graphs of the cumulative number and area of protected areas per year and the proportion of surface area protected. However this approach is completely dependent on the quality of protected areas information available, especially in the completeness of certain attributes such as designation, legal status, and total/marine area and establishment year. The main limitation of this approach is that it is unable to account for overlaps in protection as well the proportion protected of other biodiversity components such as ecoregions as it is based on non-spatial tabular data.

Below is a list of the main items required in order to carry out this analysis along with an overview and description of the stages/processes involved.

Items required:

- table of protected areas with required attributes in digital format (e.g. MS Excel or MS Access);
- computer capable of running a basic statistical programme (e.g. MS Excel and/or MS Access);
- table of total land area (including inland waters), territorial waters (out to 12 nautical miles), exclusive economic zone (out to 200 nautical miles).

Stage 1: Collation of tabular data on protected areas with required attribute information

Create a table of protected areas data that has the key information fields (attributes) of protected area name, designation, legal status, country (state/province), IUCN management category, total area, marine area and year of establishment. The minimum fields needed to perform this analysis are legal status, total/marine area and establishment year. Include a terrestrial area field in the table, the data for this may be approximated (if necessary) by subtracting the marine area from the total area. A field for country is necessary for a multi-national analysis, or a state/province field for a sub-national analysis.

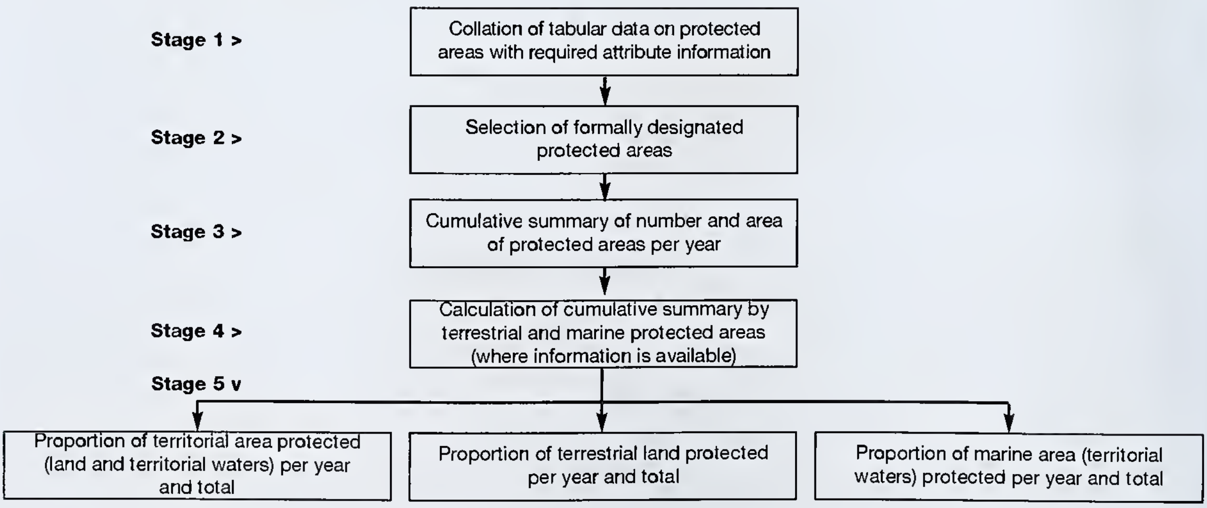
The table must be in a digital form, such as an MS Excel or MS Access (.dbf) file. It is important to ensure that area fields have the same units (e.g. hectares or square kilometres). One table row for every unique protected area is required. If the protected areas have a unique identification code (e.g. site_code in the WDPA) this should be included in the table, otherwise add a new field called 'ID' and add a unique number for every site (row).

If an analysis of the indicator by marine and terrestrial protected areas is desired then total area and marine area for each site is required. If there is a field that indicates whether the site is within marine and/or terrestrial environment this will aid the selection and calculation process.

Stage 2: Selection of formally designated protected areas

Make a copy of the table created in Stage 1. Using the copied table, select all protected areas that are formally or legally declared (i.e. designated) by the national legislation and/or authority, and remove all other sites.

Overview of the Spatial Approach:



Stage 3: Cumulative summary of number and area of protected areas per year

Using the designated protected areas table created in Stage 2 you will be able to produce some basic summary tables. UNEP-WCMC used MS Access to produce the summary tables and then MS Excel to produce the final cumulative tables and graphs. You can also use ESRI ArcGIS to produce the summary tables if required.

Summary table 1: number and area of protected areas per year

The first table to be produced is a summary of the number and area of protected areas per establishment year (see example A). This can be performed using MS Access, creating a query that groups the data by establishment year, sums the number of sites per year from the unique ID field, and sums the corresponding area and marine area fields. This may also result in sites being included without an establishment year, but the year in this field will remain blank (null).

Example A: Summary table of number and area of protected areas per year

Year	Total number of sites	Total area (sum) km²	Total marine area (sum) km²
1960	56	12,300	230
1975	2	60	0
1990	23	903	456
No year	45	1,500	560

Summary table 2: total number and area of protected areas

The second table to be produced is a summary of the total number and area of protected areas (see example B). In MS Access a simple query can count the number of sites from the unique ID field and sum the total area and marine area fields.

Example B: Summary table oftotal number and area of protected areas

Total number of sites	Total area (sum) km²	Total marine area (sum) km²
126	14,763	1,246

Summary table 3: breakdowns of main summary tables

If a more detailed analysis or breakdown of the indicator to a sub-national level is required, the procedure is to reproduce both tables as above with the addition of the state/province field into the query. Further breakdowns can be calculated with the addition of the appropriate field to the query. Depending on the level of breakdown required it may be necessary to further define the query to select only certain classes from the field being used to group the data (see example C). For example, to produce one output summary table per IUCN management category first group the data by IUCN category and then select or set the criteria for this field as 'Ia' to produce the table. This query can then be reused with the category changed to e.g. 'Ib' to produce a new table, and so on.

Example C: summary table of total number and area of protected areas per IUCN category

IUCN category	Total number of sites	Total area (sum) km²	Total marine area (sum) km²
1a	20	9,000	186
1b	50	1,056	23

Cumulative summary table 1: growth in number and area of protected areas per year

Export the summary table of number and area of protected areas per year (summary table 1) into MS Excel. Add three new number (double) fields called 'cumulative number of sites', 'cumulative total area' and 'cumulative marine area'. Ensure the row containing the totals for sites with no establishment year is located after the latest year (see example D). In cumulative number of sites field create a sum to add the previous year's total on to the subsequent year's total, once completed this field will show a cumulative increase in the number of protected areas per year. Repeat this process for the total area and marine area fields.

Example D: cumulative growth in number of number and area of protected areas per year

Year	Total number of sites	Total area (sum) km²	Cum. number of sites	Cum. total area km²
1960	56	12,300	56	12,300
1975	2	60	58	12,360
1990	23	903	81	13,263
No year	45	1,500	126	14,763
Total	126	14,763	126	14,763

A check can be made of whether the cumulative field totals are correct by comparing the cumulative total of the last row to the sum of total number of sites or area fields - they should match (see example D). This cumulative table can be used to produce graphs of the growth in protection (number and area) over time as shown in Figure 1 on page 5.

The same process as described above can be used on the breakdown tables to produce cumulative growth tables and graphs for certain classes or groups.

Year	Actual number of sites	Total number of marine sites	Total number of terrestrial sites	Total number of sites (marine+ terrestrial)	Number of marine and terrestrial protected areas
1960	56	35	27	62	62-56=6

Example E: Total number of sites disaggregated by marine and terrestrial protection

Stage 4: Calculation of cumulative summary by terrestrial and marine protected areas (where information is available)

A successful calculation of marine and terrestrial protected areas coverage depends on the availability of area information for both marine and terrestrial environments for each protected area, as well as its total area. Where terrestrial area is not available it is possible to calculate an approximation of terrestrial area by:

Total Area – Marine Area = Terrestrial Area (approx)

The process described in Stage 3 can be used to create summary tables of the number and area of protected areas disaggregated into marine and terrestrial protection. It is recommended that separate marine and terrestrial summary tables are created. Probably there will be protected areas that are both marine and terrestrial, and so they will be counted in the total number of sites in both tables. The number of these sites should be recorded in order to explain why the total number of marine and terrestrial sites is greater than the actual number of sites for that particular year (e.g. see Example E).

The total area of sites should be equal to the marine plus terrestrial area (e.g. see Example F). This approach has a number of limitations, including the assumption of a site being marine based upon the presence of a marine area. The presence or absence of a marine and total area has direct implications in the calculations performed in Stage 5.

Example F: total area of sites disaggregated by marine and terrestrial protection

Year	Total area km^2 (marine + terrestrial)	Total area km^2 marine	Total area km^2 terrestrial
1960	12,300	230	12,070

Stage 5: Proportion of surface area (territorial, marine and terrestrial) protected

Using the cumulative summary tables produced in Stages 3 and 4 it is possible to estimate the proportion of territorial, marine or terrestrial area protected at a national level by using the following calculations. Within the summary tables (Stage 3 – cumulative Summary table 1, Stage 4) add three additional number columns and populate with total land area and territorial waters. The total territorial area can be calculated by adding total land area to the area recorded for territorial waters. For countries that are landlocked or the territorial waters extent is unavailable, the territorial waters column will equal zero. Next add an additional number column that will contain the following calculations:

a to calculate total territorial area, the total land area (including inland waters) + territorial waters (out to 12 nm), that is protected:
(Total area protected/total territorial area) x 100;

b to calculate total marine area, the area from the high water line out to 12 nautical miles, that is protected:
(Total marine area protected/total area of territorial waters) x 100;

c to calculate total terrestrial area, the land area including inland waters, that is protected:
(Total terrestrial area protected/total land area) x 100.

These calculations can be performed for every year within the cumulative time series, providing a graphical estimation of the growth in protection in relation to total surface area. However this approach is dependent on the availability and quality of data on the total land area, territorial waters and protected areas. For example, you may find that the extent of territorial waters is unavailable but marine protected areas are present, or the total area under marine and/or terrestrial protection is greater than the terrestrial land area or waters recorded. Both of these issues, including overlaps in protection, cannot be easily resolved using non-spatial data.

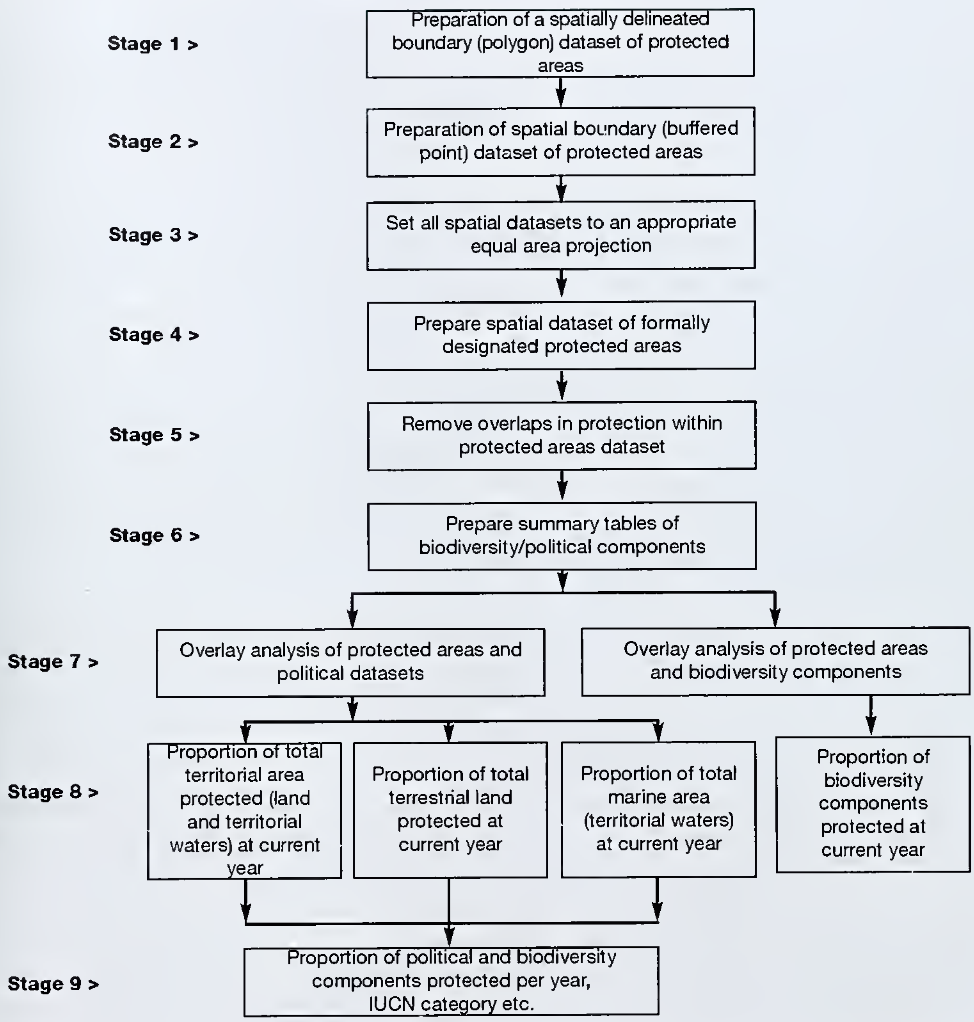
In addition an estimate of proportion protected of other biodiversity components such as ecoregions or species is not possible through this approach, as the relationship between protected areas and these components is not maintained.

SPATIAL APPROACH

A spatial approach for calculating protected areas coverage enables the user to estimate the degree to which particular components of biodiversity, or a nation's total surface area, are within designated protected areas.

This approach is completely dependent on the quality of spatial (GIS) protected areas boundary information available, especially in the completeness of certain attributes such as designation, legal status, and total/marine area and establishment year. Advantages of the spatial approach are that it is able to account for overlaps in protection of sites, as well as calculate the proportion protected of

Overview of the Spatial Approach:



other biodiversity components. However it is difficult to produce this analysis as a time series (per year) and it is reliant on staff with technical GIS skills and IT equipment capable of running GIS software.

Below is a list of main items required in order to carry out this analysis, along with an overview and description of the stages/ processes involved. Items required:

- Spatial (GIS) data of protected areas with required attributes (e.g. shapefile, E00, coverage, file/personal geodatabase)
- Computer capable of running GIS software (e.g. ArcGIS [ArcMap] v9.2 and above, ArcInfo Workstation)
- Spatial (GIS) data of terrestrial land area (including inland waters), territorial waters (out to 12 nautical miles), exclusive economic zone (out to 200 nautical miles) (e.g. shapefile, E00, coverage, file/personal geodatabase)
- Spatial (GIS) data of biodiversity components such as species, habitats, ecoregions, climate (e.g. shapefile, E00, coverage, file/personal geodatabase)

The spatial approach used by UNEP-WCMC involves nine stages to prepare the data for analysis. The GIS processes described were employed using ESRI ArcGIS (ArcMap) and ArcInfo Workstation (v9.2) software.

Stage 1: Preparation of a spatially delineated boundary (polygon) dataset of protected areas

This spatial boundary dataset should comprise of protected areas whose boundary/physical extent has been delineated or mapped in the real-world and represented digitally as a series of connected lines and nodes forming a feature. This feature will have been geo-referenced so its location and extent should match that sites' boundary in physical space (the 'real-world'). This digital representation of the protected area boundary will be held within a GIS and has an associated table that contains attributes/fields containing information specific to that site. A spatial dataset or layer can hold multiple protected area boundaries, with the attribute data being stored within subsequent rows in the associated table.

Ensure this attribute table includes key fields such as areaname, designation, status, country, IUCN category, total area, marine area and year of establishment. Add an additional text field called 'TYPE' and in this field enter 'poly' for every record.

Stage 2: Preparation of spatial boundary (buffered point) dataset of protected areas

Where no delineated spatial boundary (polygon) exists for a protected area but a geographic location (latitude and longitude) is recorded (point) along with total area and/or marine area it is possible to produce a polygon dataset through the 'buffer' process. This process also requires the point dataset to be projected to an equal area projection (such as Mollweide[2]) to define a numerical distance (meters or kilometres). Use the buffer process to produce a circular area to the numerical extent specified in the total area field around a central location (point). Ensure the attribute table includes key fields such as area name, designation, status, country, IUCN category, total area, marine area and year of establishment. Add an additional text field called 'TYPE', in this field enter 'buffpnt' for every record.

The advantage of this process is that this enables sites which would have normally been excluded from this analysis to be included. However the circular features do not truly reflect the 'delineated extent' of that site in the real-world, leading to potential over or under estimation of biodiversity components or surface area under protection.

Stage 3: Set all spatial datasets to an appropriate equal area projection

It is very important that all spatial datasets (protected areas, biodiversity components, land area, etc.) have the same geographical reference system/projection. Otherwise it is not possible to effectively calculate the degree of protection of the elements.

For global analysis UNEP-WCMC often uses the Mollweide projection to calculate the total area and coverage from the spatial (GIS) datasets in meters or kilometres squared. However this is often not suitable for analysis at a national scale. In ArcGIS (Arc-Map) the projection of the datasets from the original projection (where defined) can be changed using the 'PROJECT' command.

Stage 4: Prepare spatial dataset of formally designated protected areas

Using the spatial protected areas datasets from Stages 1-3, select out all protected areas that have a formally/legally declared (e.g. designated) in the legal status field. These are sites that have been formally recognized, supported, and designated by national legislation and/or authority. Remove all other sites that have NOT been formally/legally declared from the datasets.

Combine the 'buffered point' dataset (Stage 2) with the delineated spatial boundary dataset (Stage 1). In ArcMap datasets with the same attributes can be combined using the 'MERGE' command. Ensure the combined dataset has maintained the equal area projection chosen for the area country or region being analysed (Stage 3).

Stage 5: Remove overlaps in protection within protected areas dataset

In the protected areas dataset (Stage 4) there will be overlaps between the polygon features. To reduce these overlaps in protection (therefore reducing the over-estimation of protected area coverage figure) it will be necessary to perform a GIS process that aggregates all the overlapping features into a single continuous feature. In ArcGIS, this process is known as 'DISSOLVE'.

Add a new integer field called 'DISS' to the dataset and in this field enter 1 for every record. Run the dissolve process and ensure that the 'DISS' field is selected as the 'dissolve field'. If the protected areas dataset spans multiple countries, to calculate statistics at a national level another dissolve field (attribute) common to every record in each country, e.g. COUNTRY, must be used. Due to the size or complexity of the dataset it may not be possible to dissolve the whole layer in one process. You may need to dissolve subsets, then combine ('MERGE') the dissolved subsets and re-dissolve.

Stage 6: Prepare summary tables of biodiversity/political components

All spatial biodiversity and political datasets (land area, territorial waters) should have the same spatial projection as the protected areas dataset (Stage 3).

Where a country/region has a coastline it is necessary to have a spatial boundary dataset of the terrestrial (land) area and territorial waters (from coastline out to 12 nautical miles). Whilst ensuring that key attributes for both datasets are maintained, create a new dataset that combines territorial waters with terrestrial land dataset ('MERGE' command in ArcMap).

As all datasets share a common equal area projection it is possible to calculate the area of all features (polygons). Depending on the GIS software and map projection used it may be necessary to check that the map units are defined correctly, as these determine the units of the calculated area e.g. map units in meters equals calculated area

2: The Mollweide equal area projection is primarily used where accurate representation of area takes precedence over shape.

in square meters. In ArcMap set the map units to meters under the General Data Frame Properties.

Calculate the area of all features in the spatial biodiversity and political datasets. In ArcMap, this process is performed using the 'CALCULATE AREAS' command. The calculated area field will be automatically added for the datasets attribute table. Using the attribute table it is possible to group the data in common groups/classes and sum the total calculated area for all features in the common class. This process can be performed through MS Access, by exporting and importing the attribute table in DBF format, or within ArcMap by using the 'SUMMARY STATISTICS' command. These common summary tables will be needed for later stages.

Stage 7: Overlay analysis of protected areas and political/biodiversity component datasets

The overlay analysis is performed using the dissolved protected areas dataset (Stage 5) and the territorial (combined territorial waters and terrestrial land – Stage 6) dataset. The 'overlay analysis' results in a new output dataset that contains the protected areas (input) that have intersected/overlapped with the other layer. In ArcMap, this process is performed using the 'INTERSECT' command which allows only the parts of both datasets that overlap each other to be retained in the new output dataset. Alternatively, the 'IDENTITY' command can be used. This would enable calculation of the total area protected within terrestrial land and territorial waters as well as the area protected outside this zone. A thorough understanding of GIS spatial analysis techniques is required to use this command.

From this dataset it is possible to calculate the area of the protected area features that fall into territorial waters and/or terrestrial land. Using the attribute table and the attributes common to both protected areas and territorial waters, select all features where they have intersected ('overlapped'). Export these features to create a new dataset of protected areas within territorial waters. Repeat the selection process for where terrestrial land and protected areas features have intersected, export to a dataset. Ensure that the equal area projection and map units have been maintained in these new datasets.

Use the 'calculate areas' command (see Stage 6 for details) on the dataset of protected areas within territorial waters to calculate the total area protected within territorial waters. Repeat this process using the dataset of protected areas within terrestrial land. Finally, produce output summary tables on the total area protected area within territorial waters and/or terrestrial land (see Stage 6 for details).

This overlay process can be repeated with other biodiversity components, such as ecoregions, habitats, Important Bird Areas, etc. For each analysis process, create a new dataset that contains the protected areas within each biodiversity component, then use the 'calculate areas' command to find the total area protected. By using the attribute tables, summary statistics can be produced of the total area protected per group, class, species etc.

Stage 8: Proportion of political and biodiversity components protected

The output tables produced from the overlay analysis (Stage 7) and the calculated total area summaries (Stage 6) can be used to find the proportion of protection for a particular ecoregion, habitat class, terrestrial land or territorial waters.
For common classes/groups you will now have the total area protected (Stage 7) and the total calculated area for this class/group (Stage 6). Using these two figures you can calculate the proportion of protection per common class/group using the following calculations:

a to calculate total territorial area that is protected:
(Total area protected within territorial extent [terrestrial land + territorial waters]/ total calculated territorial area) x 100;

b to calculate total marine area that is protected:
(Total territorial waters protected/total calculated area of territorial waters) x 100;

c to calculate total terrestrial area that is protected:
(Total terrestrial land protected/total calculated terrestrial land area) x 100;

d to calculate the proportion of the biodiversity component (e.g. ecoregion, habitats, species) that is protected:
(Total area protected within biodiversity component/total calculated area of biodiversity component) x 100.

Although this approach accounts for overlaps in protection it is not without its limitations. It is dependent on the availability and quality of spatial data for protected areas and biodiversity/political component datasets. In addition the level of GIS processing required increases, if the user wishes to create a time series analysis, or a breakdown by IUCN category or biodiversity component type/class (see Stage 9). However the main advantage is that it enables estimation of the proportion protected of other biodiversity components, as the spatial relationship between protected areas and these components is maintained.

Stage 9: Proportion of political and biodiversity components protected per year, IUCN category etc

UNEP-WCMC has not yet performed an analysis of global spatial protected area coverage over time due to the level of computing power and processing time required as well as relatively low levels of delineated boundary (GIS) data for certain years, particularly where protected areas have themselves changed in extent over time. However we anticipate that in the near future the increase in availability of delineated boundary data and improvements in GIS software capabilities will enable this analysis to be performed.

For a country with a high proportion (>85%) of protected areas with delineated boundary data and an establishment year in their database, as well as the necessary capabilities (technical, time and IT), it may be desirable to generate a time series coverage analysis. For this analysis, first repeat Stage 5 to create a dissolved protected area layer per establishment year. Second, following the completion of Stage 6, perform an overlay analysis for every layer created in Stage 5 with their chosen political or biodiversity component layer (Stage 7). The results of each overlay analysis can then be summarized (Stage 7) and the proportion of protection calculated as in Stage 8. Using these summary tables of protected area coverage and proportion protected per year it is possible to create a graph showing the growth in coverage/proportion over time.

National users who wish to perform an analysis of global protected area coverage over time broken down by IUCN management category will need to ensure that a high proportion (>85%) of protected areas with delineated boundaries (GIS) and IUCN categories is available. They will then need to repeat the stages described above, creating a protected areas layer per IUCN category and repeating the overlay analysis with each layer.

THINGS TO CONSIDER WHEN CALCULATING PROPORTION OF BIODIVERSITY PROTECTED

If the results are to be expressed as a proportion or percentage, as is the case for addressing most existing policy targets, then it is important that (a) the coverage of a baseline quantity of the biodiversity units is being considered, rather than (b) the proportion of the current amount (Mulongoy & Chape 2004). Method (a) provides a constant unit for comparison, and avoids the potential issues that the target could be achieved through biodiversity loss rather than through increased representation, or that the indicator could be affected in either direction through taxonomic inflation (Isaac et al. 2004).

There is some interest in calculating absolute amounts of biodiversity protected, especially in the case of ecosystems that can be assessed from remotely sensed data, and which may not occupy the full area included in the baseline. For example, protected areas in forest zones may not be fully forested.

A further complication in the calculation of protected areas coverage is the limited availability of detailed boundary data for many protected areas. For example, for the WDPA in 2008 polygon information was absent for around 40% of sites. Whilst there are ongoing efforts to improve this situation, it is not expected to be resolved in the near future. In some cases, nationally available data may be more detailed. *In such cases it is important to try to ensure that these data are contributed to the WDPA so that the quality of global analyses is improved.* Otherwise, there is a need to make the best use of overlay analysis using the WDPA. Over 20% of sites without polygons do include geographic location with an associated area value. By generating a circular area to the numerical extent specified in the total area or marine area field around a central location ('buffering'), it is possible to include these additional sites in spatial overlays, thereby including about 80% of all protected areas in the analysis. These buffer-based coverage estimates are of lower certainty than estimates based upon delineated protected area boundaries, and the resulting indicators should be presented in a way that make this clear (see Use and Interpretation). A note of the number of protected areas that have been excluded as a result of missing locational data, non-designated protected areas, or lack of establishment year, should also accompany the indicator, to demonstrate the extent to which the indicator represents the full set of areas.

THINGS TO CONSIDER WHEN CALCULATING PROPORTION OF SPECIES PROTECTION

Where the indicator is to be based on species distributions, it will be necessary to make choices about which species are included. One option is to include every species known to occur in the region. Depending on the geographic unit that the indicator is employed within, this can lead to unwanted influence of individual species on the results (Rodrigues & Gaston 2002) – for example, the representation of globally common species marginal to the area would carry as strong an influence as the representation of rare endemics. A second option is to explicitly avoid inclusion of species that are marginal within the region but common outside it. It is also desirable to exclude unwanted non-natives. Another option is to include only species endemic to the region. At any given scale, this means that the indicator only considers species that can only be represented within that area. National analyses would usually consider national endemics. Assessing coverage of species classified as threatened under the IUCN Red List criteria is another useful approach, but there is complexity associated with tracking his type of assessment through time as the listings change. Finally, the analysis may focus on flagship, umbrella or indicator species as they relate to specific conservation targets.

Ideally, species maps would be filtered so that only viable populations were included in coverage analyses; but this is not yet possible for most species, and is subject to change through time. An ideal dataset would be regularly updated, and specify the date of observation of individual records, but this is in no way standard. There is therefore a risk of errors of commission (i.e. false inclusion of the species) in species coverage indicators, which is magnified when distribution maps include generalized polygons of the species' overall range, rather than of populations within its occupied range. If the extent of occurrence is used, the number of protected areas in which the species is assumed to occur may be many times greater than if only known populations are used. This is particularly problematic for widespread but sparsely distributed species. However, in a species-rich, under-recorded area like Latin America, it is unlikely that the species is absent from all the gaps in the recorded distribution. Assigning certainty levels to the occurrence of species in individual protected areas can help clarify the species coverage indicator, distinguishing polygons or points representing known occupancy (high certainty) from polygons representing the generalized extent of occurrence (medium to low certainty). Similarly, points or polygons could be categorized by estimated population viability, or by modelled probability of presence, where this information is available.

Presentation and interpretation

PRESENTATION

Protected areas coverage can be presented in mapped, graphical or statistical form. To track changes over time it is preferable to use the growth in number and area of protection in statistical form. This is due to frequent difficulties in obtaining the establishment year for protected areas together with equivalent spatial boundaries. Additionally, the amount of complex data processing that would be required to produce the statistics is another limiting factor. The main disadvantage of the statistical approach is that it does not account for overlaps in protection. Maps showing the overlay of protected areas with the biodiversity data of interest or political units can make it easier to visualize the degree of protection, and can make it possible for the user to understand the errors and uncertainties associated with the coverage estimates, Figure 3 shows the proportion of terrestrial protection per country produced using a spatial approach and displayed in map form.

It can also be useful to combine presentation of assessments of coverage of different subsets of biodiversity, so that for example protected area coverage of endemic birds and endemic mammals, or of several different biomes over time might be presented on a single graph. Consideration should also be given to separate presentation of coverage data for each protected area management category, whilst noting there may well be overlaps in protection and categories for some sites.

It is important to represent the uncertainty associated with the estimates in any presentation. Thus for example, when some protected areas are represented by buffered points, these should be shown on maps and the biodiversity coverage they comprise should be represented distinctly on maps (e.g. low certainty in Figure 4). Where possible, uncertainties associated with species or other biodiversity distributions should also be expressed in the presentation.

Figure 4: A hypothetical protected area coverage estimate, generated by overlay, and distinguishing spatial data sources of high certainty and low certainty

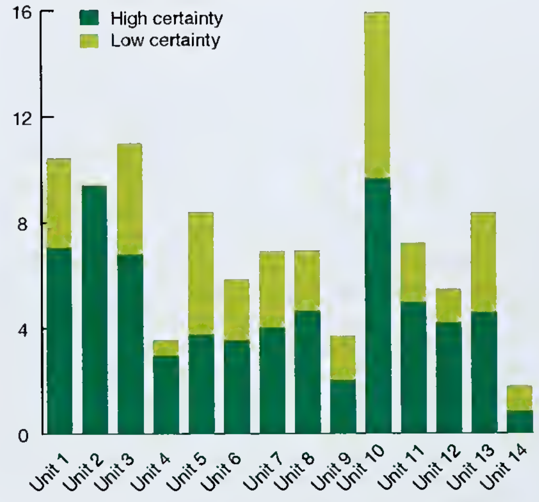
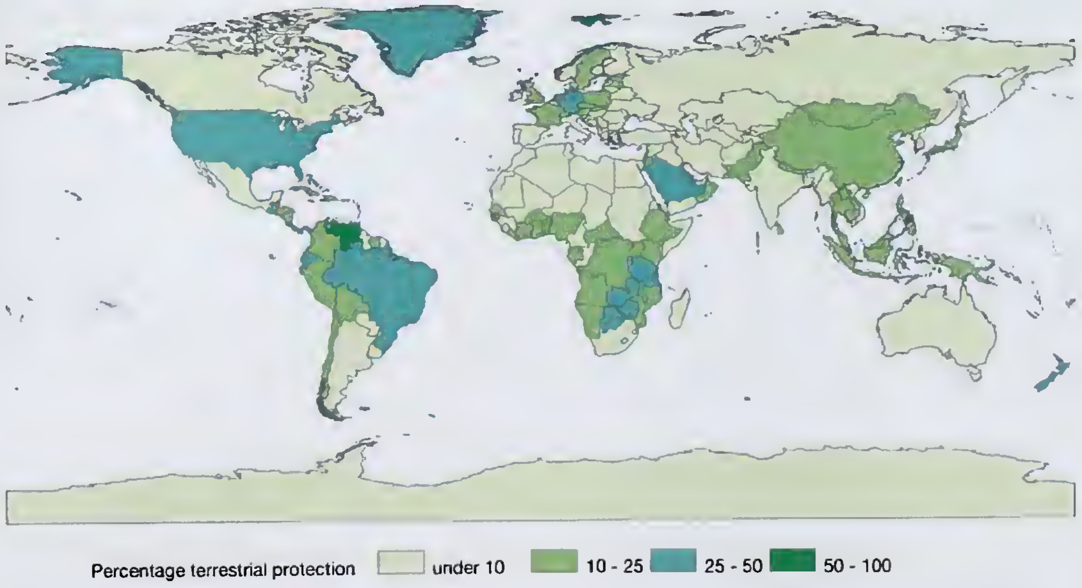


Figure 3: Percentage terrestrial protection by country



NARRATIVES (AND RELATION TO OTHER INDICATORS)

Presentation of national scale protected area coverage data should be part of a wider narrative examining trends in biodiversity according to several different measures or indicators. Changes in coverage should be related to observed trends in the extent of selected ecosystems and biomes and trends in species populations. Where the coverage indicator addresses threatened species it can also usefully be related to an appropriate IUCN Red List index or related measure of trends in threatened species. It is also important to relate this indicator to available information on the effectiveness with which protected areas are managed.

MEANING AND CAUSES OF TRENDS

It is important to present trends in protected areas coverage with sufficient contextual information to enable users to interpret them. This will of course include the relevant policy targets and recommendations regarding protected areas coverage, so that trends in the indicator can be used to track progress towards their achievement.

However, it is also important to recognize that increasing protected areas coverage in itself does not necessarily ensure the survival of those elements of biodiversity for which coverage has increased.

Increasing protection coverage of a baseline quantity of the biodiversity elements being considered is likely to mean that their future is more secure, as long as they actually persist within the protected areas. Therefore, wherever possible, protection coverage trends should be interpreted in the context of trends in abundance or extent of the biodiversity elements in the coverage indicator. It is especially useful to consider the extent of ecosystems actually remaining within the protected areas. Improvement in conservation of biodiversity is likely to be (but not necessarily) greater when the increase in proportion protected is due to added protected areas in higher management categories.

The degree to which improved protected area coverage ensures continued survival of the elements of biodiversity assessed also depends on the viability of the populations or extent of the ecosystem protected, and on the effectiveness of the management of the protected areas.

Implications for policy and management

Where protected areas targets already exist within national policy, the implications of trends in protected areas coverage are clear. Where national targets do not exist, there are still clear implications both for global and regional targets and for the development of an effective and representative system of protected areas as recommended under the CBD Programme of Work on Protected Areas.

Limitations

This indicator provides information only about the extent of protected areas and their relationship within the current understanding of the distribution of some elements of biodiversity. Because it does not include information on the effectiveness of the management of the protected areas, it provides only limited information on the likelihood that protection is helping to secure the elements of biodiversity under consideration.

Further limitations arise from the constraints on the accuracy and certainty of the data on distribution of protected areas and the biodiversity elements and the techniques employed in order to measure them. Errors also arise from mismatches between the resolutions of the datasets being compared (Rodrigues *et al.* 2004a).

Elements of good practice

Collaboration and engagement/building support and sustainability

It is important to engage fully with the national agencies responsible for protected areas designation and management to ensure that the protected areas data are as current as possible. Similarly, national and international non-governmental organizations are important stakeholders who may have key inputs to make regarding the distribution of elements of biodiversity or the definition of priority areas.

Data quality standards

Assessments of national or regional extinction risk should if at all possible be based on the IUCN Red List Categories and Criteria and meet the appropriate documentation standards (see www.iucnredlist.org). The guidelines on the application of IUCN Protected Area Management Categories (Dudley, 2008) and the revised IUCN definition of a protected area should be used by governmental and non-governmental agencies during data provision and in reviewing their PA systems.

Metadata

It is vital to document thoroughly the versions and sources of each data set used for the analysis and that a common standard of metadata is used to enable easy cross comparison and data management.

Methodological documentation and consistency (cross-calibration)

Full details should be documented of how the analysis is performed; including any proxy data such as buffered points in place of delineated protected area boundaries as well what data was excluded from or included in the analysis. It is critical to ensure that when improved data become available, previous assessments are updated to take account of them, thus ensuring that any trend line is accurate and consistent. Similarly, improvements to data on distribution of biodiversity elements will also need to be incorporated and for species-based indicators, the analysis should be repeated for earlier points in time as new species are added to the indicator, so that coverage comparisons between years are possible.

Frequency of updating

A primary constraint on updating estimates of protected areas coverage is the frequency of updating of the data on protected areas distribution. A new version of the WDPA is produced annually, incorporating updates based on the availability of improved data on protected areas boundaries, designation of new protected areas and changes to the management categories and other key attributes of existing ones. Whilst new on-line reporting mechanisms are reducing the time lags between such changes in a country and their incorporation into the WDPA, national sources should also be checked.

Data on biodiversity priority areas are updated infrequently, but the results of new surveys may lead to significant changes, especially with respect to species distributions, and these may eventually be incorporated into biodiversity priority area sets.

New survey efforts can improve knowledge about species presence in protected areas, and when this happens the historical values of the indicator must also be revised to take this into account. This entails determining whether the species' presence or absence in the protected area is a recent occurrence or long-term. Otherwise, the indicator would not distinguish change in knowledge about species distributions from change in the distributions themselves.

Finally, where coverage is based on land cover data, more frequent updates are likely to be available from remote sensing programmes.

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