

**Eco-Region Protection Indicator  
for the Natural Resource Management Index of the  
Millennium Challenge Corporation**

**Data and Methodology**

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*Note: An earlier version of this data and methodology note incorrectly stated that we used the 2008 version of the World Database on Protected Areas (WDPA). The version was in fact the 2007 version, completed in December 2007.*

*Also, in 2009 we will no longer include those protected areas included in the World Database on Protected Areas (WDPA) that are listed under the designation “international”. The vast majority of such internationally designated protected areas, which include World Heritage, Ramsar, and Biosphere Reserve sites, are contained in either the IUCN I-VI or the “no category” national protected area databases of the WDPA, meaning that they have some national legal status. Where they have no national legal status, such protected areas cannot be considered to be adequately protected. This decision is supported by the common practice of many studies that utilize the WDPA to assess the protected status of a nation's territory.*

**What it measures**

This indicator measures the degree to which a country achieves the target of protecting at least 10% of each terrestrial biome within its borders. We adopted a target of 10% of each biome protected because that is the target most faithful to the existing international consensus. The Convention on Biological Diversity (CBD), at its 7th Conference of the Parties, set the following target: “At least 10% of each of the world’s ecological regions effectively conserved.” (<http://www.biodiv.org/doc/decisions/COP-07-dec-en.doc>, page 385). We treat protected status as a necessary but not sufficient condition for an ecological region to be “effectively conserved.” How well protected areas are managed, the strength of the legal protections extended to them, and the actual outcomes on the ground, are all vital elements of a comprehensive assessment of effective conservation. Such measures are not available on a widespread basis, though there are efforts underway to fill critical gaps (Chape et al, 2005, 452).

There are some nuances that need to be made clear about this target.

First, the target as expressed by the CBD and the conservation community more generally refers to “ecological regions.” In the 2006 Environmental Performance Index (EPI) we abbreviated this as “ecoregion” (Esty et al 2006). To make this metric concrete we had to choose a specific data set accepted in both scientific and policy-making circles. We used

the Olson et al (2001) delineation of “biomes” for this purpose. Biomes are broad terrestrial ecological regions. Nested within the biomes are what the authors call “ecoregions,” which are finer-scale areas sensitive to more specific ecological patterns. These “ecoregions” are probably more appropriate as policy targets, because they identify areas based on factors that affect biodiversity on the ground more precisely than biomes. However, given the scale of the present analysis (global 1-km grids) and the processing time requirements, it was determined that using ecoregions as the unit of analysis would not be possible (see Caveats section below).

Second, the target of 10% is clearly the result of many political considerations. Based purely on the scientific merits, some ecological regions should probably be protected to a greater extent. One systematic review of the literature concluded that most ecological regions probably require more than 10% protection (Svancara et al 2005). We feel it is incumbent on us to point out that the 10% target probably represents more of a floor than a ceiling, and that over time it is likely that either a) the scientific community will come to a more precise consensus on more ambitious targets, perhaps differentiated by ecoregion, or b) the policy-community will endorse a more ambitious target, also possibly differentiated, or both. Certainly, it would not be prudent to make any assumption about the 10% target being fixed into the future.

### **Data Set Preparation**

We utilized the 2007 World Database of Protected Areas (WDPA) maintained by UNEP’s World Conservation Monitoring Centre (WDPA 2007). As with prior versions of the WDPA, the 2007 version includes both points and polygon layers. The protected areas represented by polygons, which provide the actual boundaries, are a subset of the protected areas represented by points.

We excluded protected areas that were listed as historical, archaeological, or cultural sites, or that were listed as proposed but not yet designated. For protected areas that had point and area information but not an explicit polygon identified, we created a circular buffer around the point with a total area equivalent to the area listed in the database.<sup>1</sup> Marine Protected Areas whose points were located offshore were excluded from this step. To avoid over-counting overlapping protected areas, the dissolve command in ArcMap was used to create a consolidated set of polygons that distinguished areas that were under protected status from those that were not.

The biome data were obtained from WWF’s Terrestrial Ecoregions of the World (Olson *et al.* 2001). Rather than utilize the 200 ecoregions, many of which are quite small, we utilized 14 terrestrial biomes identified in the data set. Because we are measuring the extent of terrestrial protected areas, biome 98 (water) was excluded.

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<sup>1</sup> Note that for points that are located near a country’s land border, in some cases the buffered points cover territory in the neighboring countries. This is a case in which it would be important for the country to provide accurate boundary files to the WCMC for incorporation in the next iteration of the WDPA. For more information visit <http://www.unep-wcmc.org> or contact [protectedareas@unep-wcmc.org](mailto:protectedareas@unep-wcmc.org).

## Methods

In order to compute what proportion of each biome in a country is protected, we first created a composite layer consisting of country boundaries (CIESIN 2005), WWF's terrestrial biomes layer and the consolidated global protected area polygon layer. The combined country boundary-biome-protected area map was projected using Mollweide equal area projection and the area for each unique polygon was computed. The attribute table of the projected layer was exported into tabular data for import into statistical packages.

The tabular data set quantifies, for each country, the total area of each biome and the total protected area of each biome. The percentage of each biome that is protected was calculated. The percentage was capped at 10%, so that additional "credit" does not accrue where protection exceeds 10%. The countries overall score is a weighted average of the protection score for each biome. The weights are derived by calculating the biome area as a fraction of a country's overall land area. Greater weights are applied to larger biomes.

## Caveats

Spatial errors are always a possibility when combining multiple global, 1:1m scale data sets for analytical purposes. For some very small island nations, we found that certain biomes fall outside the country border of our country boundary file (derived from various national administrative boundary datasets), which underestimates the biome area for that country. To correct for that, we assigned the resulting polygons a code of biome 0 (undefined), and added those areas to the country's biomes in proportion to the size of each biome in the country or based on a visual inspection of adjacent biomes. For most island nations there is only one biome, and hence the assignment was relatively easy. Uncertainty about the exact location of boundaries of some protected areas, especially those represented by creating circles around points, and the potential spatial mismatch between the protected areas layer and the biome-country layer represent other potential sources of error. Furthermore, comparative analyses have found some differences between park boundaries in the WDPA and other national databases of protected areas (Wilson 2005).

## Citations and Related Readings

Chape, S., J. Harrison, M. Spalding and I. Lysenko, 2005. "Measuring the Extent and Effectiveness of Protected Areas as an Indicator for Meeting Global Biodiversity Targets," *Philosophical Transactions of the Royal Society* 360: 443-455.

Center for International Earth Science Information Network (CIESIN), Columbia University; and Centro Internacional de Agricultura Tropical (CIAT). 2005. Gridded Population of the World Version 3 (GPWv3): National Boundaries. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at <http://sedac.ciesin.columbia.edu/gpw>.

Esty, D. C., M. A. Levy, T. Srebotnjak, A. de Sherbinin, C. H. Kim and B. Anderson. 2006. *Pilot 2006 Environmental Performance Index*. New Haven: Yale Center for Environmental Law & Policy.

Ferrier, Simon and others, 2004. "Mapping More of Terrestrial Biodiversity for Global Conservation Assessment," *BioScience* 54,12: 1101-1109.

Hoekstra, Jonathan M., Timothy M. Boucher, Taylor H. Ricketts, Carter Roberts 2005. "Confronting a Biome Crisis: Global Disparities of Habitat Loss and Protection," *Ecology Letters* 8: 23-29.

Olson, D.M., E. Dinerstein, E.D. Wikramanayake, *et al.* 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth, *Bioscience* 51(11): 933-938.

Rodrigues, A.S.L., et al. 2004. "Effectiveness of the Global Protected Area Network in Representing Species Diversity, *Nature* 428, 640-643.

Svancara, Leona K., Ree Brannon, J. Michael Scout, Craig R. Groves, Reed F. Noss, Robert L. Pressey. 2005. "Policy-Driven Versus Evidence-Based Conservation: A Review of Policy Targets and Biological Needs" *BioScience* 55,11: 989-995.

Wilson, C. 2005. *Personal Communication*.

World Database on Protected Areas (WDPA) Annual Release 2007 (web-download version), December 2007. The WDPA is a joint product of UNEP and IUCN, prepared by UNEP-WCMC, supported by IUCN WCPA and working with Governments, the Secretariats of MEAs and collaborating NGOs. For further information: [protectedareas@unep-wcmc.org](mailto:protectedareas@unep-wcmc.org) or [www.wdpa.org](http://www.wdpa.org)