Protected Area Representativeness Index (PARC-Representativeness)
### Key indicator facts

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<th>Indicator type</th>
<th>Last update</th>
<th>Coverage</th>
<th>Availability</th>
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<td>Operational and included in the CBD's list of indicators</td>
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### Partners

**Commonwealth Scientific and Industrial Research Organisation (CSIRO)**

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### Contact point

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### Key resources

**Publications and reports**


### Indicator description

This indicator is one of a new suite of Protected Area Representativeness and [Connectedness](#) (PARC) indices developed by CSIRO (Australia's national science agency), working in partnership with GEO BON, GBIF and Map of Life. The indicator assesses an important element of Aichi Target 11 – i.e. the extent to which terrestrial protected areas are "ecologically representative". This assessment is performed at a much finer ecological and spatial resolution than that typically employed in other assessments of protected-area representativeness. The PARC-representativeness indicator is therefore intended to complement existing indicators of ecological representativeness such as [Protected Area Coverage of Ecoregions](#).

PARC-representativeness is generated using a fine-scaled grid covering the entire terrestrial surface of the planet. For each cell in this grid an estimate is derived of the proportional protection of all cells that are ecologically similar to this cell of interest. Ecological similarity between cells is predicted as a function of abiotic environmental surfaces (describing climate, terrain, and soils), scaled using generalised dissimilarity modelling to reflect observed patterns of spatial turnover in species composition, based on best-available occurrence records for plants, vertebrates and invertebrates globally. PARC-representativeness for any given spatial reporting unit (e.g. IPBES region, country) is then derived as a weighted geometric mean of the scores obtained for all cells within that unit, with the contribution of each cell weighted according to its ecological uniqueness.
**Related Aichi Targets**

**Primary target**

**Target 11:**
By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

**Related SDGs**

GOAL 15 - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

**Target 15.1 | Relevant indicator**
By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

**Target 15.4 | Relevant indicator**
By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

**Other related MEAs and processes**

**IPBES Regional Assessment Chapters**

**Chapter 4 | Official indicator**
Direct and indirect drivers of change in the context of different perspectives of quality of life

**Chapter 6 | Official indicator**
Options for governance, institutional arrangements and private and public decision-making across scales and sectors

**Themes**

**Policy & conservation actions**
View related indicators >

**Terrestrial habitats**
View related indicators >

**Graphs / Diagrams**
Figure. Change in global PARC-representativeness between 1970 and 2016 (averaged across plants, vertebrates and invertebrates).

Current storyline

The global trend in PARC-representativeness (see Graphs and diagrams) indicates a continual improvement, from 1970 onwards, in the extent to which terrestrial protected areas are “ecologically representative” – i.e. how well these areas, in combination, sample the full range of environmental, and therefore biological, variation occurring on the planet. Overall the trend in improvement is close to linear from 1970 to 2000, but then slows slightly from 2000 onwards, and most noticeably after 2012. The value of the indicator in 2016 was still less than 0.1, suggesting that a sizeable proportion of the world’s relatively unique environments, and their associated biotas, have less than 10% of their extent included in protected areas.

Indicator relationship to Aichi Target 11

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

The PARC-representativeness indicator assesses the extent to which terrestrial protected areas are “ecologically representative”, based on modelling and mapping of relationships between spatial turnover in biodiversity composition and fine-scaled environmental variation globally.

Data and methodology

Coverage: Global/sub-global/Regional/National. The indicator is derived from data and models covering the entire terrestrial surface of the planet at 30-arcsecond (approximately 1km) grid resolution.
Scale: Global data. As above, the indicator covers the entire terrestrial surface of the planet at 1km grid resolution.


Possible disaggregations: The indicator can potentially be reported at any desired level of spatial disaggregation including individual 1km grid-cells, countries, any defined regional classification (e.g. IPBES regions), or the entire planet. It can also be reported separately for each of three biological groups - plants, invertebrates, vertebrates - or as a combined average across the groups.

Metadata used: The models of ecological similarity used to derive this indicator were fitted using the following input data:

- Global occurrence records for all terrestrial species within the following taxa: vascular plants, amphibians, reptiles, birds, mammals, ants, bees, beetles, bugs, butterflies, centipedes, dragonflies, flies, grasshoppers, millipedes, snails, moths, spiders, termites, wasps. The records for amphibians, birds and mammals were extracted from data accessible through the Map of Life (https://mol.org/) while records for all other taxa were extracted from data accessible through the Global Biodiversity Information Facility (GBIF http://www.gbif.org/). Records from GBIF underwent basic filtering (for spatial precision) and cleaning (name-matching etc.). The resulting dataset used for model fitting consisted of: 52,489,096 records of 254,145 species of vascular plants; 33,549,534 records of 24,442 species of vertebrates; and 13,244,784 records of 132,761 species of invertebrates.

For each year of interest, a 30-arcsecond grid of protected-area coverage is derived from all protected-area boundaries included in the World Database on Protected Areas (https://www.protectedplanet.net/). This grid records the proportion of each grid-cell included within protected areas – i.e. 0 if none of the cell is protected, 1 if all of the cell is protected, and a proportion between 0 and 1 if only part of the cell is protected. Any protected area for which only a centroid and areal extent are provided (rather than an explicit boundary) is assumed to be circular in shape.

Methodology:

Underpinning models of ecological similarity

Generalised dissimilarity modelling (GDM; Ferrier et al 2007) was used to develop a set of statistical models predicting ecological similarity between any pair of 30-arcsecond (approximately 1km) grid-cells, as a function of the abiotic environmental attributes and geographical locations of these cells.

A total of 183 separate GDMs were fitted, one for each possible combination of three broad biological groups – plants, vertebrates and invertebrates – and 61 bio-realms (unique combinations of biomes and biogeographic realms, as per WWF’s ecoregionalisation; http://www.worldwildlife.org/biomes). In a few cases, data from neighbouring or ecologically-related bio-realms were used to supplement the dataset employed in fitting GDMs for more poorly sampled combinations of bio-realm and biological group. To accommodate the 'presence-only' nature of much of the assembled biological data, and the diversity of sub-groups encompassed by each of the three broad biological groups, GDMs were fitted to observed matches and mismatches in species identity between pairs of individual occurrence records (drawn from within the same sub-group). The fitted GDMs model spatial turnover in species composition as a function of the environmental variables listed above, the geographical distance between records, and the identity of WWF ecoregions within which they occur.

“Ecological similarity”, as referred to below, equals the predicted proportional overlap in species composition between any given pair of locations (grid cells) – i.e. the mean proportion of species occurring at one of the locations that would be
expected to also occur at the other location (in the absence of habitat degradation at both locations). Values for ecological similarity range from 0 (for a pair of cells predicted to have no species in common) through to 1 (for a pair of cells predicted to contain exactly the same species).

Derivation of the indicator

PARC-representativeness is derived by combining the above models of ecological similarity with the 30-arcsecond grid delineating the global coverage of protected areas for the year of interest. For each and every terrestrial cell on the planet (not just those falling within protected areas) an estimate is derived of the proportional protection of all cells that are ecologically similar to this cell of interest. This is undertaken using the general approach described by Ferrier et al (2004) and Allnutt et al (2008), incorporating enhancements described by Williams et al (2016). This approach is underpinned by the same basic principle as that widely employed in approaches assessing representativeness in terms of the proportional protection of discrete ecological classes, such as ecoregions. When ecoregions are used to assess representativeness, each location (cell) on the planet is viewed as belonging to a single region, and the proportional protection of that entire region is assigned to every cell within the region, regardless of whether that particular cell is itself protected or unprotected. In other words, all cells within a given ecoregion are mapped in the same colour, indicating the region’s overall level of protection. However, in the approach adopted here, each cell is viewed not as belonging to a homogeneous set of cells forming a discrete region, but rather as sitting within a continuum of ecological variation. The PARC-representativeness score assigned to a given ‘focal cell’ is therefore calculated as the proportional protection of all ecologically-similar cells, with the contribution any other cell makes to this calculation weighted according to its predicted level of similarity with the focal cell.

PARC-representativeness for any given spatial reporting unit (e.g. IPBES region, country) is then derived as a weighted geometric mean (Buckland et al 2005) of the scores obtained for all cells within that unit, with the contribution of each cell weighted according to its ecological uniqueness – i.e. the inverse of the summed ecological similarity of this cell to all other cells (for further details see Ferrier et al 2004, Allnutt et al 2008, Williams et al 2016). This aggregate score therefore indicates the extent to which protected areas sample (represent) the full range of ecological, and therefore biological, diversity occurring within a given reporting unit.

References


National use of indicator

Producing this indicator nationally: The PARC-representativeness indicator is derived using data and models covering the entire terrestrial surface of the planet at 30-arcsecond (approximately 1km) grid resolution. This relatively fine spatial
resolution allows the indicator to be disaggregated, and reported, reliably at national level.

**Use of the global method and data at the national level:** CSIRO has calculated the PARC-representativeness indicator for all individual countries, using national subsets of the global 30-arcsecond-resolution data and models. National-level results have been generated for the same years reported globally – i.e. 1970, 1980, 1990, 2000, 2010, 2012, 2014, and 2016. CSIRO is currently collaborating with NatureServe to make these results freely accessible via their Biodiversity Indicators Dashboard in the near future.

The methodology used to derive PARC-representativeness can potentially be applied to in-country biological, environmental and protected-area data in place of, or in combination with, the data employed globally. However this would require expert involvement of CSIRO to undertake additional model-fitting and analysis.

**Examples of national use:** For an example of the application of this approach using finer-scaled (250m grid-resolution) national data for Australia see:


**Further resources**

**Publications and reports**

**GEO BON (2015) Global Biodiversity Change Indicators. Version 1.2**