Reference metadata template for data reported on the Sustainable Development Goals (SDGs)

The purpose of this template is for international agencies to submit reference metadata on the agreed upon tier I and II global indicators and associated data for which they are responsible, in order to monitor the Sustainable Development Goals (SDGs) and targets in a consistent manner. In order to ensure coherence and consistency of the metadata that will be presented alongside the SDG indicator database, we are requesting uniform reference metadata on the global indicators and on associated data that you are reporting using this standard template.

While we realise this form is detailed, your willingness to provide this reference metadata in a standard format will be vital to users better understanding of the global indicators and associated data you have provided. We hope any metadata submitted previously can be copied and pasted into the relevant section of this form. Any metadata that was previously submitted to UNSD prior to July 2016 can be found at: http://unstats.un.org/sdgs/iaeg-sdgs/metadata-compilation/.

This form should be completed by the international agencies that provided their data for inclusion in the SDG progress report and associated database. Please replace the instruction text shaded in yellow with the appropriate text describing the reference metadata for that section (i.e. definition, rationale, etc.). Please try to make your responses as concise as possible while making sure to include all relevant information. For more detailed methodological information, a link can be included in the reference section (see page 4).

If there are any questions regarding SDG metadata or this form, please contact Zin Lin at lin@un.org.

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 15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species:
Indicator: Living Planet Index

Institutional information

Organization(s):
Zoological Society of London (ZSL)
WWF

Contact person(s):
Louise McRae
Robin Freeman

Email address (for internal use only)
louise.mcrae@ioz.ac.uk
robin.freeman@ioz.ac.uk

Concepts and definitions

Definition:

The Living Planet Index tracks changes in wild species abundance over time. The index is an aggregate of 25,000 population trends of vertebrate species globally. These building blocks are time-series of population sizes (or a proxy measure) from terrestrial, freshwater and marine habitats around the world.

The index starts in 1970 and the current global index has data up to 2016. The index is set to a value of 1 in the start year and index values are calculated for each subsequent year relative to the previous one. All subsequent values are expressed as percentage change in average population abundance from the baseline year. Data are collected and added to the database supporting the index on a continual basis. As such, the Living Planet Index can be updated as frequently as annually if needed.

Rationale:

Species population data are considered a sensitive metric of biodiversity change (Buckland et al 2011; Gregory et al 2010; Santini et al 2017). In this way, monitoring populations can provide an early warning signal of the impacts of threats on species. As an indicator of trends in species populations, the Living Planet Index can detect pressures on habitats and the consequent loss of biodiversity even if species have not yet been assessed as threatened with extinction.

The LPI uses time-series data that is of high temporal resolution and spatially explicit through being tied to a particular location. This allows for the recording of extensive metadata on local pressures or threats and conservation action, which could be specific to the assessment of national level biodiversity trends.

A decrease in the Living Planet Index represents an overall reduction in species population size, meaning that on average there has been a greater population decline among species than population increase. This implies that diversity will have reduced, even if none of those species populations has declined to extinction.

The Living Planet Index was initially developed as a global indicator to measure the state of the planet (Loh et al 2005), subsequently as one of the suite of indicators towards the Convention on Biological Diversity 2010 target (Collen et al 2009; Butchart et al 2010) and most recently to monitor progress for the Convention on Biological Diversity Strategic Plan for Biodiversity 2011-2020: Aichi targets 5,6,7 and 12 (Tittensor et al 2014; McRae et al 2017). Beyond the Convention on Biological Diversity, the global Living Planet Index has been used in the IPBES global assessment, IPBES regional assessments, Millenium Ecosystem Assessment, Global Environment Outlooks, Global Biodiversity Outlooks and the Global Wetlands Outlook.

The global Living Planet Index has been extrapolated to 2020 and 2030 (Tittensor et al 2014; LPR 2016) and can be used to project trends under different land use, climate change, management or policy scenarios (Visconti et al. 2015; Costelloe et al 2015; Nicholson et al; Spooner et al; LeClere et al).

The methodology has been adopted at a sub-global (Arctic Species Trend Index, Mediterranean wetlands) and national (Canada – part of the Canadian Environmental Sustainability Indicators, Netherlands, Uganda, Sweden, China, Belgium – in progress) level, as well as for selected groups of species and habitats (Arctic migratory birds, migratory fish, forest species). The method has been further adapted to monitor trends in habitat extent for wetlands (Dixon et al 2016; Darrah et al 2019) instead of species.

The Living Planet Index has recently been analysed alongside other SDG targets in developing countries (Ament et al, in press).

Concepts:

The Living Planet Index comprises population time-series which are repeated measures of population size (or a proxy) using the same method (or inconsistent method plus correction factor) for a minimum of two years, not necessarily consecutive. The term population refers to a collection of individuals of the same species that have been monitored in a defined location. The data sources are listed for each data sets and come primarily from scientific papers and national species monitoring schemes.

The index is an aggregation of species population trends using a geometric mean. This is an average which equates a doubling of a population size with a halving

Comments and limitations:

Data used is currently limited to vertebrate species, although efforts are underway to extend this to plants and invertebrates.

The taxonomic coverage of vertebrates is not comprehensive, and the data set is sometimes over-represented by well-studied species and regions. We take this into account by applying weighting when calculating the index as detailed in McRae et al, 2017.

Sufficient data are not currently in the LPI available to produce an index for all countries. This is being addressed methodologically by developing techniques for extrapolating species trends in countries where data are lacking. Additionally, targeted data collection is underway to fill gaps for countries where gaps exist.

Methodology

Computation Method:

The calculation of the Living Planet Index follows a robust and peer reviewed method (Loh *et al*, 2005 and Collen *et al*, 2009 for the unweighted version; McRae *et al*, 2017 for the diversity-weighted version). There is an R package for using the Living Planet Index method which is fully accessible and has examples of how the method can be applied. A tutorial manuscript, with a more detailed description of the many parameters and options that are available within the code is in progress.

```
For each species, estimate rates of change:

        For each population,

                Estimate population lambdas (rates of change):

        Average population lambdas for each species to obtain species trend

For each System (terrestrial, freshwater, marine):

        For each biogeographical realm (Palearctic, Indo-Pacific, etc):

                For each taxonomic group (birds, mammals, fish, herps):

                        Average species trends within group

                Average taxonomic trends, using taxonomic weightings, obtaining realm trend

        Average biogeographical realm trends, using realm weightings, obtaining system trend

Average system trends equally.

Convert average system rates of change to index values
```

Box1: Pseudocode outlining the algorithm for constructing the global Living Planet Index (McRae et al 2017).

Change in abundance is calculated between the baseline year and the end year using a two-stage modelling process, using mgcv 1.8-0 package in R (R Development Core Team 2018), to obtain annual time-series level trends. Long time-series are modelled through a Generalised Additive Modelling (GAM) framework. For short time series (less than 6 data points) and time series that fail the GAM the chain method (linear interpolation) is used. Annual time series are aggregated geometrically following a standardised method to produce the final index. Within the indices calculated using the unweighted approach, each population carries equal weight within each species and each species carries equal weight within the overall trend. Unless otherwise specified, all populations of a species are weighted equally, and an average value is calculated for a species with more than one population within the data set. This means that species represented by several populations within the data set will have the same influence on the trend as species with only one population within the data set.

$$\bar{d}_t = \frac{1}{n_t}\sum_{i=1}^{n_t} d_{it} \qquad (1)$$

where n_t is the number of populations, d_t is the annual rate of change for a population in a given year, given by

$$d_t = \log_{10}(\frac{N_t}{N_{t-1}}) \qquad (2)$$

where N is the population measure and t is the year.

Having constructed species, group, regional or global trends, these can be converted back to index values by:

$$I_t = I_{t-1} * 10^{\bar{d}_t}, \qquad I_0 = 1 \qquad (3)$$

In order to address unevenness in data from different taxonomic groups or regions, a weighted approach to the calculation of the Living Planet Index is used at the global level (McRae et al 2017) and can also be used for countries. The approach detailed here is the same for disaggregations of the global index.

Disaggregation:

The Living Planet Index can be disaggregated by any variable that can for attributed to a location or species. For example regionally (e.g. Arctic – McRae et al 2012, biogeographic realms – WWF 2018) and nationally (e.g. Canada – Marconi et al, Netherlands – van Strien et a; 2016, Uganda) level, for ecosystems (e.g. Mediterranean wetlands - Galewski et al 2011) as well as for selected groups of species and habitats (e.g. Reptiles – Saha et al 2018, Arctic migratory birds, migratory birds, forest species).

Treatment of missing values:

- At country level

Missing values are interpolated as described in the Computation Method section. No extrapolation of data occurs at time-series level before the start year or beyond the end year. Where insufficient data are available to calculate a Living Planet Index at the national level, techniques are in development (Spooner et al 2019; Leclère et al) to calculate spatially extrapolated values.

- At regional and global levels

Because the Living Planet Index does not rely on comprehensive coverage of taxonomic groups, there are no specific missing values. However, the weighted approach to the method is employed to compensate for disparity in taxonomic and geographic coverage, including gaps. A weighted value is assigned to a species group based on how diverse (how many species) it is. In addition, where insufficient data are available to calculate a Living Planet Index at the national level, techniques have been developed (Spooner et al 2019; Leclère et al) to calculate extrapolated values.

Regional aggregates:

The method of computation is the same as described above for global, regional and national aggregations. The outputs of regional aggregates would be provided to the custodian agency.

Sources of discrepancies:

There shouldn't be any discrepancy between country estimates as the underlying data will be the same and are a nested part of the global data set. Disaggregation will highlight differences in biodiversity trends in different areas of the globe (especially between temperate and tropical areas). However, these are genuine differences and do not represent a discrepancy as national-level data are a nested part of the global data set.

Methods and guidance available to countries for the compilation of the data at the national level:

Recently, the second version of guidelines for national applications of the Living Planet Index was produced (Marconi and McRae). This provides detailed steps to collecting and analysing data through to interpretation and diagnostics and is available from ZSL. A manuscript outlining the national application of the LPI using the example for Canada is being prepared for publication (Marconi et al).

Quality assurance

Supporting documents are available on the Living Planet Index website which outline the data collection protocols and standards
http://www.livingplanetindex.org/documents/data_standards.pdf and
http://www.livingplanetindex.org/documents/lpi_data_guide_data_input.pdf

All data provided to ZSL are added to the Living Planet Index Database and are therefore publicly available, unless they are provided to ZSL under the agreement that they should be kept confidential (in which case they are used as part of the calculation of global trends, but are never shown individually). In case of data sources providing large amounts of data, an MoU is usually signed between the parties.

Data Sources

Description:

Data are collated from scientific literature, government reports, NGO reports, national species monitoring schemes, conservation practitioners and scientists. Details of individual data sources are available for each record on the Living Planet Index Database website. Compiling the national data set and producing indices is done by either national agencies – government or non-governmental organisations or by ZSL, who maintain the global database.

Collection process:

Data Availability

Description:

Data are available for 195 countries and the amount of data varies for each country, which is why the Living Planet index is suitable for classification as a Tier 2 indicator. National indices are regularly produced for Canada, Netherlands, Uganda and have been proposed for a further three (Belgium, Indonesia and Sweden). Similar indices are regularly produced by the UK.

We estimate that sufficient data may be available for 63 countries. Where insufficient data are available to calculate a Living Planet Index at the national level, techniques are in development (Spooner et al 2019; Leclère et al) to calculate extrapolated values.

Time series:

The global Living Planet Index is currently available from 1970 to 2016.

Calendar

Data collection:

The data collection is an ongoing activity to capture data as soon as it is available. This includes the addition of new population time-series to the database and new annual data points to existing population time-series.

Data release:

The database is hosted and accessible online (www.livingplanetindex.org) and has a search interface that registered users can operate to access and download the data. As soon as new data are entered, they are available in the database. A global Living Planet Index and the accompanying data set is released every two years with the publication of WWF's Living Planet Report.

Data providers

Data are collated from scientific literature, government reports, NGO reports, national species monitoring schemes, conservation practitioners and scientists. Compiling the national data set and producing indices is done by either national agencies – government or non-governmental organisations or by ZSL, who maintain the global database.

Data compilers

ZSL are responsible for maintaining the database behind the Living Planet Index and for calculating regular updates to the global index. The results are published every two years in WWF's Living Planet Report and both organisations are responsible for providing regular updates to the Biodiversity Indicators Partnership.

References

URL: www.livingplanetindex.org

References:

Ament, J., Collen, B., Carbone, C., Mace, G., Freeman, R. (in press) Compatibility between agendas for improving human development and wildlife conservation outside protected areas: insights from 20 years of data. *BES People and Nature*

Buckland, S., Studeny, A., Magurran, A., Illian, J. & Newson, S. The geometric mean of relative abundance indices: a biodiversity measure with a difference. Ecosphere 2, doi:10.1890/ES11-00186.1 (2011).

Butchart SHM, Walpole M […], McRae, L et al. (2010) Did we meet the 2010 biodiversity target? A synthesis of global indicators. Science, 328: 1164-1168.

Costelloe B, Collen B, Milner-Gulland EJ, Craigie ID, McRae L, Rondinini C, & Nicholson E. (2015) Global biodiversity indicators reflect the modeled impacts of protected area policy change. Conservation Letters

Collen, B. et al. Monitoring Change in Vertebrate Abundance: the Living Planet Index. Conservation Biology 23, 317-327, doi:10.1111/j.1523-1739.2008.01117.x (2009).

Galewski T, Collen B, McRae L, et al (2011). Long term trends in the abundance of Mediterranean wetland vertebrates: from global recovery to localized declines. Biological Conservation, 144, 1392-1399

Geldmann, Coad…McRae et al Evidence of the role of capacity and resources in maintaining wildlife populations inside terrestrial protected areas. Conservation Letters

Gregory, R. & van Strien, A. Wild bird indicators: using composite population trends of birds as measures of environmental health. Ornithological Science 9, 3-22, doi:10.2326/osj.9.3 (2010).

Living Planet Index: Guidance for national and regional use. Version 1.1. (2010BIP, WWF & ZSL 2008)

Loh, J. et al. The Living Planet Index: using species population time series to track trends in biodiversity. Philosophical Transactions of the Royal Society B-Biological Sciences 360, 289-295, doi:10.1098/rstb.2004.1584 (2005)

Marconi V and McRae L Living Planet Index: Guidelines for National and Regional Use version 1.2.

Marconi, V., McRae, L. et al Developing a national indicator based on the Living Planet Index: an example of policy relevant conservation science

McRae L, Gill M, Bohm M, Deinet S, & Collen B. (2012) The Arctic Species Trend Index: using vertebrate population trends to monitor the health of this rapidly changing ecosystem. Circumpolar Biodiversity, 13: 144-156

McRae L, Deinet S, Freeman R (2017) The Diversity-Weighted Living Planet Index: Controlling for Taxonomic Bias in a Global Biodiversity Indicator. PLoS ONE 12(1): e0169156.

Nicholson E, Collen B […], McRae L, et al. (2012) Making Robust Policy Decisions Using Global Biodiversity Indicators. PLoS ONE, 7(7): e4112

Saha, Anwesha, et al. "Tracking global population trends: Population time-series data and a living planet index for reptiles." *Journal of herpetology* 52.3 (2018): 259-268.

Santini, L. et al. Assessing the suitability of diversity metrics to detect biodiversity change. Biological Conservation 213, 341-350, doi:10.1016/j.biocon.2016.08.024 (2017).

Tierney M, Almond R, McRae L, et al. (2014). Use it or lose it: measuring trends in wild species subject to substantial use . Oryx, 48, pp 420-429

van Strien, Arco J., et al. "Modest recovery of biodiversity in a western European country: The Living Planet Index for the Netherlands." *Biological Conservation* 200 (2016): 44-50

VISCONTI, P. et al. (2015) Projecting global biodiversity indicators under future development scenarios. Conservation Letters. doi: 10.1111/conl.12159

Related indicators

Based on the disaggregations possible with the Living Planet index, linkages can be made to the following goals and targets:

Target #	Target	Disaggregations of the Living Planet Index available
6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Freshwater species Forest species Montane species
14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	Marine species
14.4	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management	Species impacted by fishing practices

	plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	
15.1	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	Freshwater species Forest species Montane species Dryland species
15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	Forest generalist and specialists
15.4	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	Montane species
15.7	Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products	CITES species Non-CITES listed species regulated under forestry/fisheries management regimes and trafficked illegally
15.8	By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species	Species impacted by invasive species