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 15.5.1: Red List Index

Institutional information

Organization(s):

International Union for Conservation of Nature (IUCN)

BirdLife International (BLI)

Concepts and definitions

Definition:

The Red List Index measures change in aggregate extinction risk across groups of species. It is based on genuine changes in the number of species in each category of extinction risk on The IUCN Red List of Threatened Species (IUCN 2015) is expressed as changes in an index ranging from 0 to 1.

Concepts:

Threatened species are those listed on The IUCN Red List of Threatened Species in the categories Vulnerable, Endangered, or Critically Endangered (i.e., species that are facing a high, very high, or extremely high risk of extinction in the wild in the medium-term future). Changes over time in the proportion of species threatened with extinction are largely driven by improvements in knowledge and changing taxonomy. The indicator excludes such changes to yield a more informative indicator than the simple proportion of threatened species. It therefore measures change in aggregate extinction risk across groups of species over time, resulting from genuine improvements or deteriorations in the status of individual species. It can be calculated for any representative set of species that have been assessed for The IUCN Red List of Threatened Species at least twice (Butchart et al. 2004, 2005, 2007).

Rationale:

The world's species are impacted by a number of threatening processes, including habitat destruction and degradation, overexploitation, invasive alien species, human disturbance, pollution and climate change. This indicator can be used to assess overall changes in the extinction risk of groups of species as a result of these threats and the extent to which threats are being mitigated.

The Red List Index value ranges from 1 (all species are categorized as 'Least Concern') to 0 (all species are categorized as 'Extinct'), and so indicates how far the set of species has moved overall towards extinction. Thus, the Red List Index allows comparisons between sets of species in both their overall level of extinction risk (i.e., how threatened they are on average), and in the rate at which this risk changes over time. A downward trend in the Red List Index over time means that the expected rate of future species extinctions is worsening (i.e., the rate of biodiversity loss is increasing). An upward trend means that the expected rate of species extinctions is abating (i.e., the rate of biodiversity loss is decreasing), and a horizontal line means that the expected rate of species extinctions is remaining the same, although in each of these cases it does not mean that biodiversity loss has stopped. An upward Red List Index trend would indicate that the SDG Target 15.5 of reducing the degradation of natural habitats and protecting threatened species is on track. A Red List Index value of 1 would indicate that biodiversity loss has been halted.

The name "Red List Index" should not be taken to imply that the indicator is produced as a composite indicator of a number of disparate metrics (in the same way that, e.g., the Multidimensional Poverty Index is compiled). The Red List Index provides an indicator of trends in species' extinction risk, as measured using the IUCN Red List Categories and Criteria (Mace et al. 2008, IUCN 2012a), and is compiled from data on changes over time in the Red List Category for each species, excluding any changes driven by improved knowledge or revised taxonomy.

The Red List Index is used as an indicator towards the 2011–2020 Strategic Plan for Biodiversity (CBD 2014, Tittensor et al. 2014), and was used as an indicator towards the Convention on Biological Diversity's 2010 Target (Butchart et al. 2010) and Millennium Development Goal 7. It can also be projected to assess future development scenarios (Visconti et al. 2015).

Comments and limitations:

There are four main sources of uncertainty associated with Red List Index values and trends.

1. Inadequate, incomplete or inaccurate knowledge of a species' status. This uncertainty is minimized by assigning estimates of extinction risk to categories that are broad in magnitude and timing.
2. Delays in knowledge about a species becoming available for assessment. Such delays apply to a small (and diminishing) proportion of status changes, and can be overcome in the Red List Index through back-casting.
3. Inconsistency between species assessments. These can be minimized by the requirement to provide supporting documentation detailing the best available data, with justifications, sources, and estimates of uncertainty and data quality, which are checked and standardized by IUCN through Red List Authorities, a Red List Technical Working Group and an independent Standards and Petitions Sub-committee. Further, detailed Guidelines on the Application of the Categories and Criteria are maintained (IUCN SPSC 2016), as is an online training course (in English, Spanish and French).
4. Species that are too poorly known for the Red List Criteria to be applied are assigned to the Data Deficient category, and excluded from the calculation of the Red List Index. For birds, only 0.8% of extant species are evaluated as Data Deficient, compared with 24% of amphibians. If Data Deficient species differ in the rate at which their extinction risk is changing, the Red List Index may give a biased picture of the changing extinction risk of the overall set of species. The degree of uncertainty this introduces is estimated through a bootstrapping procedure that randomly assigns each Data Deficient species a category based on the numbers of non-Data Deficient species in each Red List category for the set of species under consideration, and repeats this for 1,000 iterations, plotting the 2.5 and 97.5 percentiles as lower and upper confidence intervals for the median.

The main limitation of the Red List Index is related to the fact that the Red List Categories are relatively broad measures of status, and thus the Red List Index for any individual taxonomic group can practically be updated at intervals of at least four years. As the overall index is aggregated across multiple taxonomic groups, it can be updated typically annually. In addition, the Red List Index does not capture particularly well the deteriorating status of common species that remain abundant and widespread but are declining slowly.

Methodology

Computation method:

The Red List Index is calculated at a point in time by first multiplying the number of species in each Red List Category by a weight (ranging from 1 for 'Near Threatened' to 5 for 'Extinct' and 'Extinct in the Wild') and summing these values. This is then divided by a maximum threat score which is the total number of species multiplied by the weight assigned to the 'Extinct' category. This final value is subtracted from 1 to give the Red List Index value.

Mathematically this calculation is expressed as:

RLIt = 1 – [(Ss Wc(t,s) / (WEX * N)]

Where Wc(t,s) is the weight for category (c) at time (t) for species (s) (the weight for 'Critically Endangered' = 4, 'Endangered' = 3, 'Vulnerable' = 2, 'Near Threatened' = 1, 'Least Concern' = 0. 'Critically Endangered' species tagged as 'Possibly Extinct' or 'Possibly Extinct in the Wild' are assigned a weight of 5); WEX = 5, the weight assigned to 'Extinct' or 'Extinct in the Wild' species; and N is the total number of assessed species, excluding those assessed as Data Deficient in the current time period, and those considered to be 'Extinct' in the year the set of species was first assessed.

The formula requires that:

- Exactly the same set of species is included in all time periods, and
- The only Red List Category changes are those resulting from genuine improvement or deterioration in status (i.e., excluding changes resulting from improved knowledge or taxonomic revisions), and
- Data Deficient species are excluded.

In many cases, species lists will change slightly from one assessment to the next (e.g., owing to taxonomic revisions). The conditions can therefore be met by retrospectively adjusting earlier Red List categorizations using current information and taxonomy. This is achieved by assuming that the current Red List Categories for the taxa have applied since the set of species was first assessed for the Red List, unless there is information to the contrary that genuine status changes have occurred. Such information is often contextual (e.g., relating to the known history of habitat loss within the range of the species). If there is insufficient information available for a newly added species, it is not incorporated into the Red List Index until it is assessed for a second time, at which point earlier assessments are retrospectively corrected by extrapolating recent trends in population, range, habitat and threats, supported by additional information. To avoid spurious results from biased selection of species, Red List Indices are typically calculated only for taxonomic groups in which all species worldwide have been assessed for the Red List, or for samples of species that have been systematically or randomly selected.

The methods and scientific basis for the Red List Index were described by Butchart et al. (2004, 2005, 2007, 2010).

Butchart et al. (2010) also described the methods by which Red List Indices for different taxonomic groups are aggregated to produce a single multi-taxon Red List Index. Specifically, aggregated Red List Indices are calculated as the arithmetic mean of modelled Red List Indices. Red List Indices for each taxonomic group are interpolated linearly for years between data points and extrapolated linearly (with a slope equal to that between the two closest assessed points) to align them with years for which Red List Indices for other taxa are available. The Red List Indices for each taxonomic group for each year are modelled to take into account various sources of uncertainty:

1. Data Deficiency: Red List categories (from Least Concern to Extinct) are assigned to all Data Deficient species, with a probability proportional to the number of species in non-Data Deficient categories for that taxonomic group;
2. Extrapolation uncertainty: although RLIs were extrapolated linearly based on the slope of the closest two assessed point, there is uncertainty about how accurate this slope may be. To incorporate this uncertainty, rather than extrapolating deterministically, the slope used for extrapolation is selected from a normal distribution with a probability equal to the slope of the closest two assessed points, and standard deviation equal to 60% of this slope (i.e., the CV is 60%);
3. Temporal variability: the 'true' Red List Index likely changes from year to year, but because assessments are repeated only at multi-year intervals, the precise value for any particular year is uncertain.

To make this uncertainty explicit, the Red List Index value for a given taxonomic group in a given year is assigned from a moving window of five years, centred on the focal year (with the window set as 3-4 years for the first two and last two years in the series). Note that assessment uncertainty cannot yet be incorporated into the index. Practically, these uncertainties are incorporated into the aggregated Red List Indices as follows: Data Deficient species were allotted a category as described above, and a Red List Index for each taxonomic group was calculated interpolating and extrapolating as described above. A final Red List Index value was assigned to each taxonomic group for each year from a window of years as described above. Each such 'run' produced a Red List Index for the complete time period for each taxonomic group, incorporating the various sources of uncertainty. Ten thousand such runs are generated for each taxonomic group, and the mean is calculated.

Methods for generating national disaggregations of the Red List Index are described below.

Treatment of missing values:

- ***At country level:***

Red List Indices for each taxonomic group are interpolated linearly for years between data points and extrapolated linearly (with a slope equal to that between the two closest assessed points, except for corals) back to the earliest time point and forwards to the present for years for which estimates are not available. The start year of the aggregated index is set as ten years before the first assessment year for the taxonomic group with the latest starting point. Corals are not extrapolated linearly because declines are known to have been much steeper subsequent to 1996 (owing to extreme bleaching events) than before. Therefore the rate of decline prior to 1996 is set as the average of the rates for the other taxonomic groups.

- ***At regional and global levels:***

The Red List Index is calculated globally based on assessments of extinction risk of each species included, because many species have distributions which span many countries. Thus, while there is certainly uncertainty around the Red List Index, there are no missing values as such, and so no imputation is necessary.

Regional aggregates:

The Red List Categories and Criteria are applied for each species on The IUCN Red List of Threatened Species and are determined globally and provided principally by the Specialist Groups and stand-alone Red List Authorities of the IUCN Species Survival Commission, IUCN Secretariat-led initiatives, the BirdLife International partnership, and the other IUCN Red List partner organizations. The staff of the IUCN Global Species Programme compile, validate, and curate these data, and are responsible for publishing and communicating the results. Each individual species assessment is supported by the application of metadata and documentation standards (IUCN 2013), including classifications of, for example, threats and conservation actions (Salafsky et al. 2008).

Red List assessments are undertaken through either open workshops or through open-access web-based discussion fora. Assessments are reviewed by the appropriate Red List Authority (an individual or organization appointed by the IUCN Species Survival Commission to review assessments for specific species or groups of species) to ensure standardisation and consistency in the interpretation of information and application of the criteria. A Red List Technical Working Group and the IUCN Red List Unit work to ensure consistent categorization between species, groups and assessments. Finally, a Standards and Petitions Sub-committee monitors the process and resolves challenges and disputes over Red List assessments.

In addition, IUCN publishes guidelines on applying the IUCN Red List Categories and Criteria at regional or national scales (IUCN 2012b). Based on these, many countries have initiated programmes to assess the extinction risk of species occurring within their borders. These countries will be able to implement the Red List Index based on national extinction risk, once they have carried out at least two national Red Lists using the IUCN system in a consistent way (Bubb et al. 2009). An increasing number of countries have now completed national Red List Indices for a range of taxa (e.g., Gärdenfors 2010, Pihl & Flensted 2011).

While global Red List Indices can be disaggregated to show trends for species at smaller spatial scales, the reverse is not true. National or regional Red List Indices cannot be aggregated to produce Red List Indices showing global trends. This is because a taxon's global extinction risk has to be evaluated at the global scale and cannot be directly determined from multiple national scale assessments across its range (although the data from such assessments can be aggregated for inclusion in the global assessment).

Sources of discrepancies:

Some countries have assessed the national extinction risk of species occurring in the country, and have repeated such assessments, allowing a national Red List Index to be produced. This may differ from the indicator described here because (a) it considers national rather than global extinction risk, and (b) because it takes no account of the national responsibility for the conservation of each species, treating as equal both those species that occur nowhere outside the country (i.e. national endemics) and those with large ranges that occur in many other countries. Any such differences will be smaller for countries within which a high proportion of species are endemic (i.e., only found in that country), as in many island nations and mountainous countries, especially in the tropics. The differences will be larger for countries within which a high proportion of species have widespread distributions across many nations.

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

See existing metadata for the Red List Index SDG indicator 15.5.1, especially the section on "Methodology". In sum: the data underlying the Red List Index are compiled under the authority of the IUCN Red List Committee, through application of the IUCN Red List Categories & Criteria (https://portals.iucn.org/library/node/10315). This includes submissions of endemics from national red list processes, where these have been conducted following the "Guidelines for application of IUCN Red List Criteria at Regional and National Levels" (https://portals.iucn.org/library/node/10336) and following the "Required and Recommended Supporting Information for IUCN Red List Assessments" (http://goo.gl/O52euG). Assessments may be submitted in all three IUCN languages (English, French and Spanish) and Portuguese. All assessments are peer reviewed through the relevant Red List Authority for the species or species group in question, as documented in the Red List Rules of Procedure (https://cmsdocs.s3.amazonaws.com/keydocuments/Rules_of_Procedure_for_IUCN_Red_List_Assessments_2017-2020.pdf); see in particular Annex 3, the "Details of the Steps Involved in the IUCN Red List Process" (https://cmsdocs.s3.amazonaws.com/keydocuments/Details_of_the_Steps_Involved_in_the_IUCN_Red_List_Process.pdf).

See existing metadata for the Red List Index SDG indicator 15.5.1, especially the section on "Methodology". In sum: the key document providing international recommendations and guidelines to countries and all involved in application of the IUCN Red List Categories & Criteria (https://portals.iucn.org/library/node/10315) is the "Guidelines for Using the IUCN Red List Categories and Criteria" (in English - http://cmsdocs.s3.amazonaws.com/RedListGuidelines.pdf and in French - http://cmsdocs.s3.amazonaws.com/keydocuments/RedListGuidelines_FR.pdf) accompanied by the "Required and Recommended Supporting Information for IUCN Red List Assessments". For countries (and regions), this is supplemented by the "Guidelines for application of IUCN Red List Criteria at Regional and National Levels" (https://portals.iucn.org/library/node/10336). To support the calculation of Red List Indices for any given country (or region), "R code to calculate and plot national RLIs weighted by the proportion of each species' distribution within a country or region" is posted online (https://cmsdocs.s3.amazonaws.com/keydocuments/R_code_for_calculating_RLIs_weighted_by_proportion_of_each_species'_range_within_a_country_or_

Quality assurance:

See existing metadata for the Red List Index SDG indicator 15.5.1, especially the section on "Methodology", with full documentation in the Red List Rules of Procedure (https://cmsdocs.s3.amazonaws.com/keydocuments/Rules_of_Procedure_for_IUCN_Red_List_Assessments_2017-2020.pdf) in particular Annex 3, the "Details of the Steps Involved in the IUCN Red List Process" (https://cmsdocs.s3.amazonaws.com/keydocuments/Details_of_the_Steps_Involved_in_the_IUCN_Red_List_Process.pdf). In sum: all Red List assessments are peer reviewed through the relevant Red List Authority for the species or species group in question; and all Red List assessments undergo consistency checks (to ensure consistency with assessments submitted for other taxonomic groups, regions, processes, etc.) by the Red List Unit before publication on the Red List website (http://www.iucnredlist.org/). Finally, the Chair of the IUCN Species Survival Commission (elected each four years by the government and non-governmental Members of IUCN) appoints a Chair for a Standards and Petitions Sub-Committee (https://www.iucn.org/theme/species/about/species-survival-commission/ssc-leadership-and-steering-committee/sub-committees/standards-and-petitions-subcommittee), which is responsible for ensuring the quality and standards of the IUCN Red List and for ruling on petitions against the listings of species on the IUCN Red List.

In addition to dissemination via the Red List website (http://www.iucnredlist.org/), Red List data are disseminated through the Integrated Biodiversity Assessment Tool, available for research and conservation online (https://www.ibat-alliance.org/ibat-conservation/). This incorporates Country Profile documents for all of the world's countries, which includes documentation of the Red List Index indicator for the current year, starting from 2016. The first edition of each of these Country Profiles was sent for consultation to National Focal Points of the Convention on Biological Diversity (https://www.cbd.int/information/nfp.shtml), at the 13th meeting of the Conference of the Parties of the Convention on Biological Diversity; and this process will be repeated annually.

Data sources

Description:

National agencies producing relevant data include government, non-governmental organisations (NGOs), and academic institutions working jointly and separately. Data are gathered from published and unpublished sources, species experts, scientists, and conservationists through correspondence, workshops, and electronic fora. Data are submitted by national agencies to IUCN, or are gathered through initiatives of the Red List Partnership. From 2013–6, the Red List Partnership encompassed: BirdLife International; Botanic Gardens Conservation International; Conservation International; Microsoft; NatureServe; Royal Botanic Gardens, Kew; Sapienza University of Rome; Texas A&M University; Wildscreen; and Zoological Society of London.

Collection process:

See information under other categories.

Data availability

Description:

The Red List Index has been classified by the IAEG-SDGs as Tier 1. Current data are available for all countries in the world, and these are updated on a regular basis (approximately once every four years).

Time series:

Since 1980 (approximately 35 years).

Disaggregation:

The Red List Index can be downscaled to show national and regional Red List Indices, weighted by the fraction of each species' distribution occurring within the country or region, building on the method published by Rodrigues et al. (2014) PLoS ONE 9(11): e113934. These show an index of aggregate survival probability (the inverse of extinction risk) for all birds, mammals, amphibians, corals and cycads occurring within the country or region. The index shows how well species are conserved in a country or region to its potential contribution to global species conservation. The index is calculated as:

RLI(t,u) = 1 – [(Ss(W(t,s) * (rsu/Rs)) / (WEX * Ss (rsu/Rs))

where t is the year of comprehensive reassessment, u is the spatial unit (i.e. country), W_((t,s)) is the weight of the global Red List category for species s at time t (Least Concern =0, Near Threatened =1, Vulnerable =2, Endangered =3, Critically Endangered =4, Critically Endangered (Possibly Extinct) =5, Critically Endangered (Possibly Extinct in the Wild) =5, Extinct in the Wild =5 and Extinct =5), WEX = 5 is the weight for Extinct species, r_su is the fraction of the total range of species s in unit u, and R_s is the total range size of species s.

The index varies from 1 if the country has contributed the minimum it can to the global RLI (i.e., if the numerator is 0 because all species in the country are LC) to 0 if the country has contributed the maximum it can to the global RLI (i.e., if the numerator equals the denominator because all species in the country are Extinct or Possibly Extinct).

The taxonomic groups included are those in which all species have been assessed for the IUCN Red List more than once. Red List categories for years in which comprehensive assessments (i.e. those in which all species in the taxonomic group have been assessed) were carried out are determined following the approach of Butchart et al. 2007; PLoS ONE 2(1): e140, i.e. they match the current categories except for those taxa that have undergone genuine improvement or deterioration in extinction risk of sufficient magnitude to qualify for a higher or lower Red List category.

The indicator can also be disaggregated by ecosystems, habitats, and other political and geographic divisions (e.g., Han et al. 2014), by taxonomic subsets (e.g., Hoffmann et al. 2011), by suites of species relevant to particular international treaties or legislation (e.g., Croxall et al. 2012), by suites of species exposed to particular threatening processes (e.g., Butchart 2008), and by suites of species that deliver particular ecosystem services, or have particular biological or life-history traits (e.g., Regan et al. 2015). In each case, information can be obtained from The IUCN Red List of Threatened Species to determine which species are relevant to particular subsets (e.g. which occur in particular ecosystems, habitats, and geographic areas of interest).

Disaggregations of the Red List Index are also of particular relevance as indicators towards the following SDG targets (Brooks et al. 2015): SDG 2.4 Red List Index (species used for food and medicine); SDG 2.5 Red List Index (wild relatives and local breeds); SDG 12.2 Red List Index (impacts of utilisation) (Butchart 2008); SDG 12.4 Red List Index (impacts of pollution); SDG 13.1 Red List Index (impacts of climate change); SDG 14.1 Red List Index (impacts of pollution on marine species); SDG 14.2 Red List Index (marine species); SDG 14.3 Red List Index (reef-building coral species) (Carpenter et al. 2008); SDG 14.4 Red List Index (impacts of utilisation on marine species) – an ad hoc joint FAO-IUCN Technical Expert Group is currently working to develop agreed recommendations on the use and interpretation of this indicator; SDG 15.1 Red List Index (terrestrial & freshwater species); SDG 15.2 Red List Index (forest-specialist species); SDG 15.4 Red List Index (mountain species); SDG 15.7 Red List Index (impacts of utilisation) (Butchart 2008); and SDG 15.8 Red List Index (impacts of invasive alien species) (Butchart 2008, McGeoch et al. 2010).

Calendar

Data collection:

The IUCN Red List of Threatened Species is updated annually. Red List Indices for any sets of species that have been comprehensively reassessed in that year are usually released alongside the update of the IUCN Red List. Data are stored and managed in the Species Information Service database, and are made freely available for non-commercial use through the IUCN Red List website. Re-assessments of extinction risk are required for every species assessed on The IUCN Red List of Threatened Species once every ten years, and ideally undertaken once every four years. A Red List Strategic Plan details a calendar of upcoming re-assessments for each taxonomic group.

Data release:

New data typically become available for the Red List Index every year. For example, the first Red List Index for cycads was released in 2015, updates to the Red List Indices for birds and mammals will be released in 2016, and updates for conifers and sharks are anticipated in 2017.

Data providers

National agencies producing relevant data include government, non-governmental organisations (NGOs), and academic institutions working jointly and separately. Data are gathered from published and unpublished sources, species experts, scientists, and conservationists through correspondence, workshops, and electronic fora. Data are submitted by national agencies to IUCN, or are gathered through initiatives of the Red List Partnership.

Data compilers

Name:

IUCN

Description:

Compilation and reporting of the Red List Index at the global level is conducted by the International Union for Conservation of Nature (IUCN) and BirdLife International, on behalf of the Red List Partnership. Comprehensive syntheses of The IUCN Red List of Threatened Species have been published by, for example, Baillie et al. (2004) and Hoffmann et al. (2010).

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URL:

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