The Sustainable Development Goals adopted by all United Nations Member States, and the 20 Aichi Biodiversity Targets of the Strategic Plan for Biodiversity set through the Convention on Biological Diversity, provide a framework to address associated challenges and track progress towards the 2020 deadline. Two of the most well-established CBD Biodiversity Indicators are presented here.

Living Planet Index (LPI) and Global Shark Trend Database

The LPI[1] measures global trends in the size of populations relative to 1970. The LPI is calculated using abundance time-series from the Global Shark Trend Database, an open source research initiative to make all published population trends (and their metadata) on sharks, rays, and chimaeras accessible to everyone. This database consists of 650 time-series from ~200 species with fishery-dependent and independent data (stock-assessment, standardized CPUE, nominal CPUE). The LPI is a quantitative mean index of year-to-year rate of change taken across species time-series in the same region, then aggregated to a global scale. It can also be decomposed into regions, species or by ecological traits. The annual rates of change d_t for a time series is the logarithm of the growth rate of the time-series in a given year (t):

$$d_t = \log_{10}\left(\frac{I_t}{I_{t-1}}\right)$$

where I_t denotes the posteriors of the estimated abundance trend in a given year (t) obtained from the Bayesian state-space model[2] outputs. The state process is an exponential growth population model linked to true expected population via the observation equation from ref. [3]. For each time-series, it is also possible to project model estimates from the last data point of the time-series to the future to be able to estimate trajectories for the LPI up to the final year of assessment for progress towards Biodiversity goals. Then, the log values are back-transformed to the linear scale to generate index values for the range of scales:

$$LPI_t = LPI_{t-1} \times 10^{\bar{d}_t}$$

where LPI_t is the Living Planet Index at a given year (t), with $LPI_{t=1} = 1$. Although the overall extent of change in the LPI is an indicator of status and trends in biodiversity, it might be sensitive to the species with available data. The sensitivity of the LPI to the subset of species can be evaluated using a jackknife procedure in which we sequentially dropped individual, or group of, species and recalculated the index.

Red List Index (RLI)

The RLI[4] shows changes in the aggregate extinction risk of sets of species over time. It is an index based on the proportion of species in each category on the IUCN Red List (Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct), published on the IUCN website, or retrospectively assessed by IUCN Species Survival Commission's Shark Specialist Group. The RLI value of a particular year (*t*) is calculated by multiplying the number of species (*s*) in each Red List category by the category weight (*W*) (0 for LC, 1 for NT, 2 for VU, 3 for EN, 4 for CR and 5 for EX), then summing the product and dividing by the maximum possible product (number of species (*N*) multiplied by the maximum weight 5), and subtracted from 1 to have an index between 0 (all species are EX) and 1 (all species are LC):

$$RLI_t = 1 - \frac{\sum_s W_{c(t,s)}}{W_{EX} * N}$$

[1] Loh, J. *et al.* The Living Planet Index: using species population time series to track trends in biodiversity. *Philos. Trans. R. Soc. B Biol. Sci.* **360**, 289–295 (2005).

[2] Sherley, R. B. *et al.* Estimating IUCN Red List population reduction: JARA—A decision-support tool applied to pelagic sharks. *Conserv. Lett.* (2019).

[3] Winker, H., Carvalho, F. & Kapur, M. JABBA: Just Another Bayesian Biomass Assessment. *Fish. Res.* **204**, 275–288 (2018).

[4] Butchart, S. H. *et al.* Improvements to the red list index. *PloS One* **2**, e140 (2007).

Country-specific RLI and National Conservation Responsibilities

It is useful to disaggregate global RLI down to the country-level because species are not equally distributed across different countries. The RLI calculation is adapted such that Red List threat categories are further weighted by the proportional area (***W_p*** signified in **bold**) of each species' (*s*) distribution, to calculate a RLI specific to the unique set of species found in any one nation's Exclusive Economic Zone (EEZ), accounting for the proportional area of each species' distribution that overlaps with the EEZ[5]:

$$RLI_t = 1 - \frac{\sum_s W_{c(t,s)} * \boldsymbol{W_{p(s)}}}{W_{EX} * N}$$

A measure of overall National Conservation Responsibility (NCR) for each country can be derived from the country-level RLI calculations. This measure collectively reflects, across any group of species found within one country, the assessed Red List threat category (W_c) for each species (s) at time (t), weighted by the area of each species' distribution found within the country's EEZ, as a proportion of their total distribution ($W_{p(s)}$):

$$NCR_t = \sum_s W_{c(t,s)} * W_{p(s)}$$

Systematic Conservation Planning (SCP)

Conservation actions are applied to address the accelerating declines in global biodiversity. A key feature of SCP are spatial prioritization analyses, which identify and design areas and/or actions that maximise conservation benefits at the lowest 'cost'[6]. These costs can be the direct costs of setting up a protected area, or the cost of lost economic 'opportunity' due to protection of a resource -- but these cost data can be hard to get[7]. Instead, proxies are often used for true costs, such as Gross Domestic Product, distance to population centres, or fishing pressure. SCP provides a robust and transparent approach to spatially identify conservation priorities, given a particular conservation problem. This is achieved by spatial optimization software that adopt one of two typical paradigms in solving conservation problems[8]:

1. **Minimum set problem:** protect or manage specific targets of conservation features, at the lowest cost (e.g. "30% of all species' distributions conserved within protected areas")
2. **Maximum cover problem:** protected as much as possible within a fixed budget (e.g. "conserve 30% of as many species' distributions as possible within a $5 million budget")

Basic data requirements for running spatial prioritizations are: (1) clearly defined planning area and planning problem, (2) spatially consistent data of species probability distributions, and (3) the type of cost considered in the prioritization. The Global Shark Trends project is updating species maps and their Red List status, which are key data inputs for the spatial prioritization analyses that will be conducted at both global and regional (e.g. Western Indian Ocean) scales. Importantly, spatial prioritizations enable the generation and comparison hundreds of thousands of spatial options for effective conservation actions. The outputs of spatial priorities are intended to provide objective starting points for discussions and refinement with relevant stakeholders and policymakers[9], making prioritization software central *decision-support* tools for conservation.

[5] Kyne, P. M. *et al.* The thin edge of the wedge: extremely high extinction risk in wedgefishes and giant guitarfishes. *bioRxiv* 595462 (2019). doi:10.1101/595462.
[6] Margules, C. R. & Pressey, R. L. Systematic conservation planning. *Nature* **405**, 243–253 (2000).
[7] Ban, N. C. & Klein, C. J. Spatial socioeconomic data as a cost in systematic marine conservation planning. *Conserv. Lett.* **2**, 206–215 (2009).
[8] Delavenne, J. *et al.* Systematic conservation planning in the eastern English Channel: comparing the Marxan and Zonation decision-support tools. *ICES J. Mar. Sci.* **69**, 75–83 (2012).
[9] Pressey, R. L. & Bottrill, M. C. Opportunism, threats, and the evolution of systematic conservation planning. *Conserv. Biol.* **22**, 1340–1345 (2008).