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14

EXTINCTION RISK INDICES FOR MEASURING AND PROMOTING PLANETARY WELL-BEING

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Introduction

The impact of human actions on Earth system and ecosystem processes has increased to a level that threatens the existence of diverse life-forms on the planet and harms human well-being. The leading direct drivers of ecosystem degradation and biodiversity loss are conversion of natural ecosystems for agricultural, urban, and other uses (*e.g.*, forestry), direct exploitation of populations on both land and sea, climate change, pollution, and transport of species outside their natural ranges (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019).

Scientists widely agree that halting, and ultimately reversing, the negative trends in ecosystem degradation will require transformative changes across economic, social, political, and technological structures within and across nations (*ibid.*; Leclere *et al.*, 2020; Leadley *et al.*, 2022). However, navigating such transformative changes involves setting common goals and targets as well as managing the competing interests of different stakeholders (Harrop, 2011). In this chapter, we use existing biodiversity goals and targets as a point of departure and focus on one family of indices whose qualities we find particularly effective in guiding action and tracking progress towards planetary well-being.

To date, global efforts to halt ecosystem degradation and biodiversity loss have been unsuccessful. Nonetheless, most world governments have agreed to pursue the conservation of biological diversity by signing the 1992 UN Convention on Biological Diversity (CBD). In 2002, governments further agreed “to achieve by 2010 a significant reduction of the current rate of biodiversity loss”, but this goal was not achieved (Morgera and Tsioumani, 2010). After failing to meet the 2010 target, governments across the globe approved the Strategic Plan for Biodiversity

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2011–2020. The plan included 20 Aichi Biodiversity Targets and aimed to "take effective and urgent action to halt the loss of biodiversity" (CBD, 2010). Again, not one of the Aichi Biodiversity targets has been met in full (CBD, 2020).

The repeated failures in global biodiversity conservation have given rise to a debate on how the goals and targets of multilateral environmental agreements should be formulated to allow national implementation and monitoring of progress. For example, Butchart, Di Marco, and Watson (2016) found that the above-mentioned 20 Aichi targets in general suffer from ambiguity, lack of quantifiable elements, complexity, and redundancy, which together makes it difficult to stimulate and quantify progress. Green *et al.* (2019) found that more progress was made towards Aichi targets with elements that were measurable, realistic, unambiguous, and scalable, suggesting that such target qualities may make it easier for governments to interpret and translate into policies and actions. In December 2022, after four years of negotiations over the implementation intricacies of biodiversity goals and targets (Leadley *et al.*, 2022), governments adopted the Kunming-Montreal Global Biodiversity Framework and 23 action-oriented global targets to facilitate urgent action over the decade ending 2030 (CBD, 2022a). During the negotiations, particular attention was paid to the specificity and measurability of the targets.

Regardless of the above-mentioned associations between target qualities and ease of implementation, it is good to note that measurable targets in and of themselves do not guarantee success. A fitting example of this is Aichi target 12 from the 2010 CBD agreement: "By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained". Despite the relative ease of quantifying species extinctions and conservation status, these targets were not met, and the conservation status of species actually worsened between 2010 and 2020 (CBD, 2020). The successor of Aichi target 12 is the combination of Kunming-Montreal target 4 and goal A, which together produce a similar albeit slightly more ambitious and measurable version of the Aichi target: By 2030 we should "halt human induced extinction of known threatened species" and "by 2050, extinction rate and risk of all species are reduced tenfold" (CBD, 2022a).

The key problem in multilateral environmental agreements seems to be the difficulty of getting countries to commit to clearly defined targets with assigned responsibilities for necessary actions. While the 2015 Paris Agreement to hold the increase in global average temperature to well below 2°C above pre-industrial levels has fostered climate action, the action has not, at least to date, been sufficient to reach the target (Boehm *et al.*, 2022). One reason for this is that the agreement does not specify who should do what and how much; instead, countries independently decide their nationally determined contributions towards achieving the global target.

Lack of assignability or responsibility is also prevalent in the target and goal setting of the Convention on Biological Diversity. Concerning the Aichi targets, it states that "[p]arties are invited to set their own targets within this flexible framework, taking into account national needs and priorities, while also bearing in mind national contributions to the achievement of the global targets". Almost the same escape clauses are embedded in the text of the Kunming-Montreal targets: "Actions to reach these targets should be implemented … taking into account national circumstances, priorities and socioeconomic conditions". Thus, the agreements do not bind each and every party to take action, but the responsibility is diluted among all signatories.

Agreeing on clear responsibilities is obviously difficult in multilateral agreements. Yet without clear responsibilities the chances of achieving the targets are low. Maxwell *et al.* (2015) pointed out that in contentious issues with diverging stakeholder interests—like the protection of biodiversity—signatories find it easier to agree on targets that are worded ambiguously, are difficult to measure, or are so ambitious that they are clearly unachievable. Even though the signatories of the Convention on Biological Diversity are obliged to develop, implement, and report national biodiversity strategies and action plans that significantly contribute towards the global biodiversity agenda, it has simply proven to be too easy for the parties to wriggle out of the obligations due to the ambiguous goals and targets for which there are no quantifiable indicators.

In this chapter, we suggest that eliminating the human-induced extinction risk of all species is the ultimate goal of promoting planetary well-being, and argue that Red List Indices, which are based on the International Union for Conservation of Nature (IUCN) methodology for assessing species extinction risk, provide good indicators for monitoring and quantifying progress towards this goal. We first explain the links between planetary well-being and species extinction risk, then describe the relevant methodologies for extinction risk assessment and the Red List Index, and close by elucidating the benefits of the Red List Index as an indicator for monitoring success of global biodiversity policy and progress towards planetary well-being.

Linking planetary well-being and extinction risk

The relationship between planetary well-being and extinction risk of species and populations originates from the very definition of planetary well-being as

> a state in which the integrity of Earth system and ecosystem processes remains unimpaired to a degree that lineages can persist to the future as parts of ecosystems, and organisms (human and nonhuman) can realize their typical characteristics and capacities.
>
> *(Kortetmäki* et al.*, 2021)*

Thus, the essence and aim of planetary well-being is securing the integrity of ecosystem processes and the persistence of lineages (*i.e.*, groups of organisms with a shared genetic ancestry, distinct from other such groups). In the case of sexually reproducing organisms, species and populations constitute lineages at global and local scales, respectively. Before going into the details on how the persistence of lineages into the future can be quantified, let us explain why it is incorporated into the definition of planetary well-being in the first place.

The inclusion of the persistence of lineages in the definition of planetary well-being arises from three dimensions: Normative, systemic, and practical. First, the concept of planetary well-being is normative: It considers the well-being of both humans and nonhumans as intrinsically valuable and extends the scope of moral considerability to lineages and even to ecosystems. The survival of lineages is seen as a goal in itself (Chapter 2). Wiping out the outcomes of eons of evolutionary history and their future potential, that is, driving lineages to extinction, is considered immoral.

Second, the concept of planetary well-being is systemic: It is understood that life on Earth is a set of interlinked, interdependent systems, where the well-being of any system (*i.e.*, the functional integrity of the system) is dependent on the functioning of many other systems (Kortetmäki *et al.*, 2021). Lineages of living organisms are integral parts of the larger system of life on Earth. Hence, even if we may have difficulties in cataloguing and measuring the integrity of all Earth system and ecosystem processes, we can be confident that safeguarding lineages also serves to safeguard Earth system and ecosystem processes. The logic also works in reverse: If we see that lineages are at risk of disappearing from ecosystems, we have good reasons to believe that some ecosystem processes are failing to provide for the needs of those lineages. Lineages are thus essential parts of larger systems, and the risk of loss of lineages can be seen as an indication of larger system failure.

Third, planetary well-being is meant to be a practical concept for facilitating action and transformative change. This means that we should be able to assess the state of planetary well-being, identify the necessary actions to improve it, and quantify the progress towards planetary well-being. We suggest that assessments of extinction risks for species and populations—which are estimates of lineage persistence and thus directly relevant for planetary well-being—offer just that: An ideal database for derivation of indicators with which we can monitor the development of extinction risk of species. In addition to indicating the risk of extinction, these assessments also include information about the main direct threats that must be mitigated to actively reduce and eliminate the risk of extinction.

The IUCN Red List of Threatened Species

The IUCN Red List of Threatened Species (hereafter Red List) is a methodology for assessing the extinction risk of species with clearly defined science-based criteria. The methodology has been developed since the 1960s in numerous different expert groups, and it is the most objective, comprehensive, and commonly used approach for evaluating the risk of extinction at global, regional, and national levels (Mace *et al.*, 2008; IUCN, 2012a,b).

The IUCN Red List classification utilizes data of past, current, and projected population sizes and geographic ranges to assign species to extinction risk categories (see Figure 14.1). By 2023, the global extinction risk of more than 150,000 species has been assessed.[1] Because extinction risk assessment requires a considerable amount of work and adequate data regarding the ecology, distribution, and population size of species, assessments have been carried out mainly for well-studied species, especially vertebrates.

The IUCN Red List employs five categories of extinction risk, corresponding to increasing risk of impending extinction, ranging from Least Concern (LC) to Critically Endangered (CR). In addition, species that have disappeared from their past natural range, either regionally or globally, are placed in one of the appropriate Extinct categories: Regionally Extinct (RE), Extinct in the Wild (EW), or Extinct (EX). For instance, if a species has less than 50 mature individuals left, or its population has reduced by ≥80% over ten years or three generations (whichever is longer), the species is classified as Critically Endangered. This corresponds

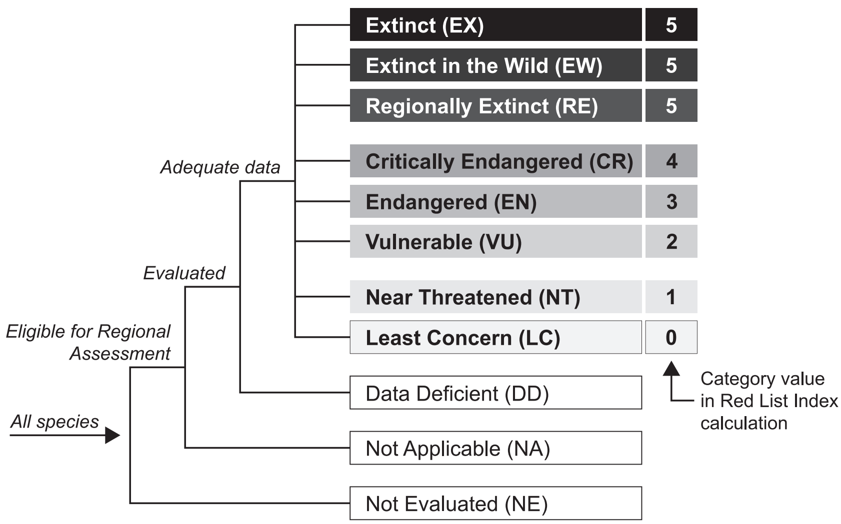

FIGURE 14.1 IUCN Red List assessments assign evaluated species to extinction risk categories (or to the Data Deficient category when there is insufficient data to assess extinction risk). The regional Red Lists have two categories that are not present in the global Red List: Not Applicable (NA) and Regionally Extinct (RE). A species is listed as Not Applicable if it occurs in the focal region but has been excluded from the regional Red List for a specific reason, and is listed as Regionally Extinct if it is now extinct in the region but still occurs in its natural range outside the region. The Red List Index (RLI) is a summary statistic portraying the mean risk of extinction for a species utilizing the category weight portrayed in the figure (see main text for further details).

roughly to at least a 50% chance of extinction in the following ten years or three generations, whichever is longer (IUCN, 2012b).

In addition to classifying species according to their risk of extinction, the Red List includes data on direct threats to species survival, following a comprehensive standard lexicon (*i.e.*, systematic classification) (Salafsky *et al.*, 2008). Direct threats are those proximate human activities or processes (*e.g.*, livestock farming and ranching, urban sprawl, or logging) that currently have, have had or will have an impact on species endangerment. The data on direct threats allows general comparisons of threat types with respect to biodiversity loss (*e.g.*, IPBES, 2019, p. 253). For each threat, the Red List assessment identifies whether it is past, current, or likely to occur in the future ("timing"); the proportion of the total population affected ("scope"); as well as the overall declines caused by the threat ("severity") (https://www.iucnredlist.org/resources/threat-classification-scheme). Altogether, this information can be used to identify actions that can help to mitigate threats to species survival (see *e.g.*, Kyrkjeeide *et al.*, 2021).

The IUCN Red List evaluates the global status of species, but exclusive focus on global extinction risk does not give sufficient attention to protection of biodiversity outside global biodiversity hotspots (Purvis, 2020). Therefore, the IUCN system for assessing extinction risk has been developed for regional and national levels, with appropriate modifications for dealing with non-native species and species that do not regularly breed in the focal area (IUCN, 2012a). Indeed, regional and national Red Lists offer valuable information for conservation at the relevant level of jurisdiction, which in the implementation phase of global biodiversity policies is generally countries (Kyrkjeeide *et al.*, 2021). While "region" and "regional" can refer to geographic units above or below the national level, in what follows we refer, for brevity, to national and regional Red Lists as national Red Lists and to regions as countries.

National Red List assessments are especially valuable for countries that cover only a small part of a species' range and have few endemic species, that is, species that occur only in that country (*e.g.*, Finland, see Raimondo *et al.*, 2022). Within their borders such countries can do relatively little direct conservation work, such as protection, management, and restoration, to influence the global risk of extinction (however, the impacts of transborder effects via for instance pollution or damming of rivers should not be dismissed). Nonetheless, such countries are responsible for the survival of populations within their own borders. National Red Lists are developed in particular to assess the likelihood of survival of populations within the borders of countries. Of specific importance in national Red Lists is the Regionally Extinct category, which is used for species that are now extinct from the country but still occur in their natural range outside the country. National Red Lists thus manifest the disappearance of populations from a country that often would not be evident in the global Red List. However, it is also possible for a species to be stable within a country yet declining in other parts of its range. In this case, the status of the species may be better in the national Red List than in the global Red List. Such species should be given particular attention at the national level because of their significance for the species' global status (IUCN, 2012a). To facilitate such consideration, it might be worthwhile in the national Red List assessments to always report the global Red List status alongside the national one.

While the global and national Red Lists are arguably the most objective and thorough sources for data on extinction risk, they are not all-encompassing. The assessed species are biased towards terrestrial ecosystems and vertebrates, while for instance insects, plants, and fungi are underrepresented. Also, coverage is poorer in the global South, where biodiversity is richer, reflecting the state of ecological knowledge in general (Bachman *et al.*, 2019). However, there are ongoing efforts to fill in the data gaps.

Red List Index (RLI)

To gain an overall idea of the state of biodiversity, the wealth of data in the Red Lists can be compiled into an index. The Red List Index (RLI_t) is a statistic that indicates the mean risk of extinction for a group of species (s) at any given time (t). It is calculated as:

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

where the category weights (W_c) of all included species (s) at time (t) are summed and then divided by the product of the number of included species (N) and the maximum category weight ($W_{max} = 5$) (see Figure 14.1) (Butchart *et al.*, 2007).

The RLI takes values between zero and one: Zero means that all included species are extinct, one means that all included species are in the Least Concern category. The Red List Index thus gives a simple and intuitive measure of the risk of extinction for the group of included species.

If eliminating the human-induced extinction risk of all species is considered the ultimate goal of promoting planetary well-being, the deviation of RLI values from one would serve as a specific and quantifiable indicator of how far we are from achieving that goal. Moreover, RLI values calculated for the same set of species diachronically are ideal for monitoring progress over time because changes can be interpreted as signifying improving or deteriorating planetary well-being. Perhaps it is worth mentioning here that for the purpose of monitoring progress, only those changes in extinction risk category where the reason for the change is genuine (*i.e.*, threats, distribution or population size have changed) should be included; non-genuine category changes (*e.g.*, due to improved knowledge, revised taxonomy, or changes to classification criteria) should not be included (IUCN, 2023c).

The global RLI is calculated from the global Red List and currently includes only mammals, birds, amphibians, corals, and cycads (IUCN, 2023a). However, even if it were comprehensive across taxa, the global Red List Index alone would not be a very good indicator of planetary well-being. This is because most of the world's biodiversity is located in the tropics, and a comprehensive global RLI would thus effectively be a description of the state of tropical biodiversity. In other words, degradation of ecosystems in less biodiverse regions, like boreal forests, would not be detected in the global RLI. This is an undesirable feature, as planetary well-being is about integrity of ecosystem processes and persistence of lineages irrespective of the species richness of the region. However, Red List Indices compiled at the national level can be good indicators of planetary well-being, as we will argue below.

There are two ways to calculate country-specific RLIs, and they produce results that can be interpreted differently. The first way, "disaggregated global RLI", uses global Red List assessments to derive global extinction risk and adjusts each species' contribution to the country-specific index by weighting it by the fraction of the species' distribution occurring within the country (Rodrigues *et al.*, 2014; Raimondo *et al.*, 2022). Disaggregated global RLIs for each country are available on the IUCN Red List website (see IUCN, 2023b). However, as was discussed above in the context of national and global Red Lists, the disaggregated global RLI as an indicator of planetary well-being suffers from the characteristic that it is a poor biodiversity indicator for countries that cover only a small part of the species' ranges and have few endemic species.

The second way to calculate country-specific RLI is to conduct national Red List assessments (see above) and compile a "national RLI" for the assessed species. Investment in national RLI is worthwhile as it is a better indicator of species conservation status in any given country compared to global or disaggregated global RLI. Conducting national species assessments also builds capacities and knowledge for designing appropriate conservation actions and provides the needed opportunity to monitor the impacts of conservation measures taken nationally (Raimondo *et al.*, 2022). For biodiverse countries in particular, another option is to conduct assessments on a sample of a few hundred or more species per taxonomic group. When conducted correctly, such "sampled RLI" method has been shown to be able to detect trends that can be extrapolated beyond the conservation status of the sampled species (Baillie *et al.*, 2008; Henriques *et al.*, 2020). Perhaps it is worth mentioning here that despite its usefulness, national RLIs cannot be mathematically compiled into a global RLI. Specifically, it would not be appropriate to take an average of national RLIs to track global progress towards planetary well-being: Such calculation could mask biodiversity loss in megadiverse countries under the better performance of countries that are less biodiverse but more numerous. Instead, global progress could be tracked by nations showing improvement in their country-specific RLI.

Conclusions

In order to improve planetary well-being it is critical to be able to measure it (see Chapter 15). Above, we have explained why species extinction risk is a good indicator of planetary well-being, and how this risk can be estimated in practice with the IUCN Red List assessments and associated Red List Indices. The Red List can also be used to identify the direct threats that need to be mitigated in order to move towards planetary well-being.

Our arguments in the chapter provide support for the Red List Index to be maintained as a headline indicator in the monitoring framework of the Kunming-Montreal Global Biodiversity Framework (CBD, 2022b). Headline indicators of the monitoring framework are explained to be the minimum set of indicators that capture the overall scope of the goals and targets of the Kunming-Montreal global biodiversity framework.

We believe that disaggregating the current Kunming-Montreal Global Biodiversity Framework target (*i.e.*, halting human-induced extinction of known threatened species by 2030 and reducing the extinction rate and risk of extinction of all species tenfold by 2050) to the national level would provide the much-needed assignment of responsibility to the agreement. In line with the argument presented by the IPBES in its assessment report on land degradation and restoration (Kohler *et al.*, 2018, pp. 61–65), such disaggregation could be considered fair in the sense that it sets the same baseline for all countries: The aim for each country would be to ensure that all native species, including those that are currently Regionally Extinct, reach the status of Least Concern. This would share the burden of conservation and restoration more evenly between the higher-income countries, which have degraded ecosystems and have lost species more in the past, and the lower-income countries, where biodiversity and ecosystems may be less degraded relative to their natural state.

The disaggregation of targets to the level (national, subnational, or supranational) where policy is designed, implemented, and monitored does not diminish our common responsibility for planetary well-being at the global level. Efforts to improve national RLI should not be designed in such a way as to undermine planetary well-being in other countries (*e.g.*, by sourcing natural resources from other countries in a way that harms biodiversity there). In contrast, trade policies could be adjusted to make use of national or disaggregated global RLIs to favour countries that are showing improvement. While the current global trade laws do not allow origin-specific discrimination, trade agreements allow room for encouraging and rewarding production processes that help improve RLI values, and non-state actors could also use the RLI information in procurement and subcontracting agreements. Moreover, we contend that the current trade system needs to be changed to stop subjugating planetary well-being to free trade.

A popular mnemonic from management theory suggests that goals and targets should be SMART: specific, measurable, assignable, realistic, and time-related (Doran, 1981). Interestingly, the original Meaning of "A" as "assignable—specify who will do it" has changed in biodiversity literature either to "ambitious" (Maxwell *et al.*, 2015; Green *et al.*, 2019; Hughes, Qiao and Orr, 2021), "achievable" (Wood, 2011), or "agreed" (Burgass *et al.*, 2021). Whether the meaning of "A" has been changed intentionally or by accident in literature is not clear, but this surely has been a misstep. Even though assignable targets may be challenging to agree on, they have a much higher chance of delivering than ambitious targets without a responsible actor. National RLIs, by reintroducing assignability to multilateral agreements, could function as the foundation for genuinely SMART targets for improving planetary well-being.

Note

1 There are approximately 1.2 million identified species in the world, and perhaps around 7 million unidentified species, of which the great majority are insects.

References

Bachman, S.P. *et al.* (2019) 'Progress, challenges and opportunities for Red Listing', *Biological Conservation,* 234, pp. 45–55. https://doi.org/10.1016/j.biocon.2019.03.002

Baillie, J.E.M. *et al.* (2008) 'Toward monitoring global biodiversity', *Conservation Letters,* 1(1), pp. 18–26. https://doi.org/10.1111/j.1755-263X.2008.00009.x

Boehm, S. *et al.* (2022) *State of Climate Action 2022*. Berlin, Cologne, San Francisco, CA, and Washington, DC: Bezos Earth Fund, Climate Action Tracker, Climate Analytics, ClimateWorks Foundation, NewClimate Institute, the United Nations Climate Change High-Level Champions, and World Resources Institute. https://doi.org/10.46830/wrirpt.22.00028.

Burgass, M.J. *et al.* (2021) 'Three key considerations for biodiversity conservation in multilateral agreements', *Conservation Letters,* 14(2), e12764. https://doi.org/10.1111/conl.12764

Butchart, S.H.M., Di Marco, M. and Watson, J.E. (2016) 'Formulating smart commitments on biodiversity: Lessons from the Aichi Targets', *Conservation Letters,* 9(6), pp. 457–468. https://doi.org/10.1111/conl.12278

Butchart, S.H.M. *et al.* (2007) 'Improvements to the Red List Index', *PLoS One,* 2(1), e140. https://doi.org/10.1371/journal.pone.0000140

CBD (2010) *The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets*. UNEP/CBD/COP/DEC/X/2. Available at: https://www.cbd.int/decision/cop/?id=12268 (Accessed: 1 January 2023).

CBD (2020) *Global Biodiversity Outlook 5*. Montreal: Secretariat of the Convention on Biological Diversity. Available at: https://www.cbd.int/gbo5 (Accessed: 1 January 2023).

CBD (2022a) *Kunming-Montreal Global Biodiversity Framework*. CBD/COP/DEC/15/4. Available at: https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf (Accessed: 1 January 2023).

CBD (2022b) *Monitoring Framework for the Kunming-Montreal Global Biodiversity Framework.* CBD/COP/DEC/15/5. Available at: *https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-05-en.pdf* (Accessed: 1 January 2023).

Doran, G.T. (1981) 'There's a SMART way to write management's goals and objectives', *Management Review,* 70(11), pp. 35–36.

Green, E.J. *et al.* (2019) 'Relating characteristics of global biodiversity targets to reported progress', *Conservation Biology,* 33(6), pp. 1360–1369. https://doi.org/10.1111/cobi.13322

Harrop, S.R. (2011) ''Living In Harmony With Nature'? Outcomes of the 2010 Nagoya Conference of the Convention on Biological Diversity', *Journal of Environmental Law,* 23(1), pp. 117–128. https://doi.org/10.1093/jel/eqq032

Henriques, S. *et al.* (2020) 'Accelerating the monitoring of global biodiversity: Revisiting the sampled approach to generating Red List Indices', *Conservation Letters,* 13(3), e12703. https://doi.org/10.1111/conl.12703

Hughes, A.C., Qiao, H. and Orr, M.C. (2021) 'Extinction targets are not SMART (specific, measurable, ambitious, realistic, and time bound)', *BioScience,* 71(2), pp. 115–118. https://doi.org/10.1093/biosci/biaa148

IPBES (2019) *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn: IPBES Secretariat. https://doi.org/10.5281/zenodo.3831673

IUCN (2012a) *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels.* Version 4.0. Gland: IUCN. Available at: https://portals.iucn.org/library/node/10336 (Accessed: 1 January 2023).

IUCN (2012b) *IUCN Red List Categories and Criteria: Version 3.1.* 2nd edn. Gland and Cambridge: IUCN. Available at: https://portals.iucn.org/library/node/10315 (Accessed: 1 January 2023).

IUCN (2023a) *Red List Index*. Available at: https://www.iucnredlist.org/assessment/red-list-index (Accessed: 1 January 2023).

IUCN (2023b) *IUCN Red List. Advanced Search*. Available at: https://www.iucnredlist.org/search (Accessed: 1 January 2023).

IUCN (2023c) *Reasons for Changing Category*. Available at: https://www.iucnredlist.org/assessment/reasons-changing-category (Accessed: 1 January 2023).

Kohler, F. *et al.* (2018) 'Chapter 2: Concepts and perceptions of land degradation and restoration', in Montanarella, L., Scholes, R. and Brainich, A. (eds.) *The IPBES Assessment Report on Land Degradation and Restoration*. Bonn: Secretariat of the IPBES, pp. 53–134. https://doi.org/10.5281/zenodo.3237392

Kortetmäki, T. *et al.* (2021) 'Planetary well-being', *Humanities and Social Sciences Communications,* 8(1), 258. https://doi.org/10.1057/s41599-021-00899-3

Kyrkjeeide, M.O. *et al.* (2021) 'Bending the curve: Operationalizing national Red Lists to customize conservation actions to reduce extinction risk', *Biological Conservation,* 261, 109227. https://doi.org/10.1016/j.biocon.2021.109227

Leadley, P. *et al.* (2022) 'Achieving global biodiversity goals by 2050 requires urgent and integrated actions', *One Earth,* 5(6), pp. 597–603. https://doi.org/10.1016/j.oneear.2022.05.009

Leclere, D. *et al.* (2020) 'Bending the curve of terrestrial biodiversity needs an integrated strategy', *Nature,* 585(7826), pp. 551–556. https://doi.org/10.1038/s41586-020-2705-y

Mace, G.M. *et al.* (2008) 'Quantification of extinction risk: IUCN's system for classifying threatened species', *Conservation Biology,* 22(6), pp. 1424–1442. https://doi.org/10.1111/j.1523-1739.2008.01044.x

Maxwell, S.L. *et al.* (2015) 'Being smart about SMART environmental targets', *Science,* 347(6226), pp. 1075–1076. https://doi.org/10.1126/science.aaa1451

Morgera, E. and Tsioumani, E. (2010) 'Yesterday, today, and tomorrow: Looking afresh at the convention on biological diversity', *Yearbook of International Environmental Law,* 21(1), pp. 3–40. http://dx.doi.org/10.2139/ssrn.1914378

Purvis, A. (2020) 'A single apex target for biodiversity would be bad news for both nature and people', *Nature Ecology & Evolution,* 4(6), pp. 768–769. https://doi.org/10.1038/s41559-020-1181-y

Raimondo, D. *et al.* (2022) 'Using Red List Indices to monitor extinction risk at national scales', *Conservation Science and Practice,* 5(1), e12854. https://doi.org/10.1111/csp2.12854

Rodrigues, A.S.L. *et al.* (2014) 'Spatially explicit trends in the global conservation status of vertebrates', *PLoS One,* 9(11), e113934. https://doi.org/10.1371/journal.pone.0113934

Salafsky, N. *et al.* (2008) 'A standard lexicon for biodiversity conservation: Unified classifications of threats and actions', *Conservation Biology,* 22(4), pp. 897–911. https://doi.org/10.1111/j.1523-1739.2008.00937.x

Wood, L. (2011) 'Global marine protection targets: how SMART are they?', *Environmental Management,* 47(4), pp. 525–535. https://doi.org/10.1007/s00267-011-9668-6