A new ecosystem target to be placed within the Strategic Plan for Biodiversity 2050

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Summary: An ecosystem target, complementary to Aichi Target 12 on species extinctions, is an essential addition to the post-2020 Global Biodiversity Framework. An ecosystem target must provide a unifying aspiration for the conservation and restoration of ecosystems, applicable to all ecosystem types. We also note there is a good case to be made for outcomes at ecosystem level to be part of the possible overarching outcomes for the whole post-2020 Global Biodiversity Framework (again, analogous to potential overarching outcomes for species);

We propose a specific ecosystem target, over two timeframes:

By 2030, for all ecosystems, halt net loss of area and integrity, and prevent increases in risk of collapse.

By 2050, for all ecosystems, achieve gains in area and integrity, and reduce risk of collapse for at least 50% of ecosystems

Below, we suggest potential sub-targets to address the actions needed to achieve the target, including retention of intact areas and restoration, and discuss the option of biome-specific sub-targets to address key drivers and actions for ecosystems of concern.

Background

Ecosystems are a core part of the definition of biodiversity. Sustaining ecosystems is essential for safeguarding species, ecosystem processes, and the natural capital and ecosystem services people rely on. We propose that a new target that specifically addresses ecosystems is required in the post-2020 framework. This target should be based in ecosystem science, encompass all ecosystems (terrestrial, marine, freshwater), and build on rapidly expanding data and potential metrics of change. The new target should complement and be directly comparable with other targets on the status of species and genetic diversity under Strategic Goal C (*improve the status of biodiversity by safeguarding ecosystems, species, and genetic diversity*[1]).

Currently there is no explicit Aichi target on the status or integrity of ecosystems. Target 5 calls for a reduction in '*the rate of loss of all natural habitats, including forests'* and their degradation and fragmentation, while Target 15 calls for restoration of degraded ecosystems. Target 5 relates however to reducing pressures (under goal B) rather than improving the status of biodiversity (Goal C). The new ecosystem target should encompass all ecosystems; currently some ecosystem types are mentioned in various targets (e.g. forests in Target 5, coral reefs in Target 10, and other marine ecosystems in Target 6), with no cohesive aspiration for safeguarding them and the biodiversity they support.

The new target and associated indicators should be able to be disaggregated to countries or regions; we can also foresee specific ecosystem or biome targets being generated that align with (or are sub-targets of) the new target. The new target and associated sub-targets should also include actions needed to address ecosystem loss: both retaining intact ecosystems, and the recovery and restoration of degraded ecosystems, recognizing the UN Decade of Restoration. These actions can form sub-targets, specifically addressing how the target that should be achieved through retention of existing ecosystem extent and integrity, and the proportion that it is acceptable to achieve via restoration. Mathematically it could be argued that no net loss could be achieved by allowing losses in the extent and integrity of intact or primary ecosystems, whilst delivering compensatory gains in area and integrity through restoration. However, complete restoration of

intact ecosystems is highly unlikely, and such compensation is also unlikely to be a complete replacement for what is lost in all respects, and brings with it risks of delivery failure and long time-lags in delivery (and is far more expensive). Thus the emphasis should be on conservation of the original ecosystem wherever possible. The diagram below illustrates the relationships between the various targets and sub-targets that we believe to be needed.

Figure 1 Hierarchical relationship between potential ecosystem targets and sub-target.

Proposed elements of an ecosystem target, and potential target language

We recommend expanding the proposed IUCN target for ecosystems ("*Halt further net loss of ecosystems by 2030, towards restoration and recovery of ecosystems by 2050*") into a SMART target and associated sub-targets that must be met to achieve a global goal of no net loss[2] of biodiversity, to bend the curve towards net gains, to address the mission of the CBD and to improve the status of biodiversity specifically. We propose a new status target that reflects three aspects of change (ecosystem area, integrity and collapse), and actions needed for target achievement, over two timeframes.

By 2030, for all ecosystems, halt loss of area and integrity, and prevent increases in risk of collapse.

By 2050, for all ecosystems, achieve gains in area and integrity, and reduce risk of collapse, for at least 50% of ecosystems

Justification of target elements:

1. *Ecosystem definition*: Recent scientific advances have allowed the synthesis of ecological theory developed over the last century into practical and workable definitions of ecosystems[3]. Ecosystems include four essential elements: the living components, biotic complexes and assemblages of species; the abiotic environment or complex; the interactions within and between the biotic and abiotic; and the physical space in which these operate. Similar definitions are used for other, often synonymous terms, such as 'ecological communities', 'biotopes' and 'vegetation types' [3].
2. *Ecosystem area*: Larger ecosystems can support more biodiversity and ecosystem services, and are more resilient to environmental change than smaller ecosystems. Declines in ecosystem area reduce capacity to support biodiversity and ecological processes that underpin ecosystem services[3].

3. *Ecosystem integrity. We note that function, intactness, integrity* and *degradation* are all terms that are closely related and used somewhat interchangeably. Declines in integrity reduce habitat quality for native biota, disrupt ecological processes and functions, and diminish ecosystem resilience and capacity to sustain species and many ecosystem services[3]. More intact ecosystems support higher biodiversity and reduce extinction; conversely, more degraded ecosystems support lower biodiversity and have higher extinction risk[4,5].
4. *Risk of ecosystem collapse*: A collapsed ecosystem has lost its defining features (species, assemblages, processes and functions) and is replaced by a different ecosystem type. Measuring changes in collapse risk can reveal whether ecosystems are still imperiled, or whether management actions have reduced risk. Ecosystem collapse risk provides a complementary measure to species extinction risk.
5. *Retention of intact areas*: Retaining remaining intact areas is essential because they buffer against loss of species, ecosystem function and services globally[4,5]. Retention of intact areas is more cost-effective and less uncertain than recovery and restoration. Intact areas are those that have been minimally or not at all modified by human activity.
6. *Recovery and restoration:* Actions for recovery and restoration provide the only pathway for degraded ecosystems, particularly those that are most threatened. Thus they are an essential part of ensuring no net loss. However, restoration and recovery are riskier and more expensive than retaining more intact areas, due to uncertain outcomes and low success rates.
7. *Net loss and net gains:* Measuring net change acknowledges that some losses are inevitable as a result of anthropogenic pressures, but can be potentially counter-balanced by actions that lead to no net loss and ideally net gains[2]. The challenge is to ensure that such actions result in meaningful positive outcomes, rather than sanctioned further loss with uncertain future benefits[6]. We highlight that avoiding declines should be prioritized over restoration or creation of offsets wherever possible.

Potential indicators to support these targets

Mace et al. (2018)[7] identified three fundamental metrics or headline indicators for measuring change in species biodiversity: extinction risk, abundance and biotic health. Comparable ***headline indicators for ecosystems*** would address, respectively, collapse risk, ecosystem area, and ecosystem function. For each headline indicator, we suggest potential metrics with a brief summary of their suitability.

Risk of ecosystem collapse

1. *Red List Index (RLI) for Ecosystems*[8]: direct measure of ecosystem collapse risk, using risk status from the database of the IUCN Red List of Ecosystems, the global standard for ecosystem risk assessment; analogous to the Red List Index of Species Survival; currently available for a subset of countries/regions, with plans to complete all terrestrial ecosystems by 2023; applicable to all ecosystems types; scalable from single ecosystem to national and global.
2. *Number of collapsed ecosystems*: direct count of ecosystems listed as Collapsed in the IUCN Red List of Ecosystems; currently available for a subset of countries/regions, plans to complete all terrestrial ecosystems by 2023; applicable to all ecosystem types; scalable from national to global.
3. *Number of ecosystems that have improved in risk status*: direct count of ecosystems that were downlisted in the IUCN Red List of Ecosystems between assessments due to genuine recovery; available for a subset of countries; applicable to all ecosystem types; scalable from national to global.

Ecosystem area

1. *Ecosystem* Area Index[8]: uses IUCN Red List of Ecosystems data to measure changes in ecosystem area over standardized timeframes; currently available for a subset of countries/regions, all terrestrial ecosystems to be included by 2023; scalable from single ecosystem, to national to global; applicable to all ecosystem types.
2. *In* the interim, available datasets for a subset of ecosystem types include: *Forest cover*[9]*,* global gains/losses in forest extent (2000-2018) at 30m resolution; *Wetland Extent Trends Index*[10], change in wetland area (1970-2015), for a subset of natural and anthropogenic wetlands; *Mangrove watch*, global mangrove extent (1996-2010) at 30m resolution. Some global land-cover products, such as ESA-CCI, can be interim proxies for areas of all biome types

Ecosystem function, degradation, integrity and intactness
(note that metrics 3-5 model average assemblage/ecosystem responses to pressures, and 6-7 measure pressures, rather than directly measuring ecosystem status)

1. *Ecosystem Health Index*[8]: direct measure of ecosystem change using ecosystem-specific normalised variables over standardised timeframes, based on IUCN Red List of Ecosystems data; currently available for a subset of countries/regions, all terrestrial ecosystems to be completed by 2023; scalable from single ecosystem, to national to global; applicable to all ecosystem types.
2. *Living Planet Index*[11]: relative change in abundance of vertebrate species from terrestrial, freshwater and marine realms (1970-2018), based on opportunistic time-series data of variable length for >20,000 populations of >4,200 species; biased towards Europe and North America; disaggregation at fine scales challenging (similarly *Wild Bird Index*[12] in Europe and North America, and database *Biotime*[13]).
3. *Mean Species Abundance*[14]: change in mean local abundance of species relative to undisturbed levels in response to *pressures*, modelled using GLOBIO3; scales from individual cell to global.
4. *Biodiversity Intactness Index*[15]*:* change in local mean species richness or abundance relative to undisturbed levels in response to land use; modelled response to *pressures*, broken down into plants, vertebrates and invertebrates based on global averages; scales from individual cell to global.
5. *Forest Health Index* (unpublished): forest only; integrates maps of forest configuration and connectivity using data on damaging human pressures and modelled assessments of edge effects and hunting, to provide a globally consistent, continuous scale index of contemporary forest degradation (300m resolution). Initial release 2018, can readily be updated periodically. Analogous indices can potentially be generated for other ecosystem types within 1-3 years.
6. *Human Footprint Index*[16]: globally standardized measure of the cumulative human footprint on the terrestrial environment at 1 km^2 resolution (1993, 2009, 2013, can readily be updated periodically) based on eight major human pressures; thresholds have been identified for species extinction[17] to map intactness; recently combined with ecosystem area and connectivity maps at 1 km resolution[18].
7. *Marine Cumulative Human Impact indices*[19]: Marine only; vulnerability-weighted pressures (fishing, climate change, ocean- and land-based) on biodiversity.

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