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Science Brief for the Ecosystem Objectives of the Post-2020 Global Biodiversity Framework

ECOSYSTEM AREA AND INTEGRITY

SCIENCE BRIEFS ON TARGETS, GOALS AND MONITORING IN SUPPORT OF THE POST-2020 GLOBAL BIODIVERSITY FRAMEWORK NEGOTIATIONS

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ECOSYSTEM AREA AND INTEGRITY OBJECTIVES OF THE POST-2020 GLOBAL BIODIVERSITY FRAMEWORK

Background on the science briefs

The bioDISCOVERY programme of Future Earth and the Secretariat of the Group on Earth Observations Biodiversity Observation Network (GEO BON), convened a group of experts to prepare six briefs to provide scientific support for the negotiations of the post-2020 global biodiversity framework (GBF) at the fourth meeting of the Working Group on the Post-2020 Global Biodiversity Framework in Nairobi, from 21 to 26 June 2022. This includes four briefs on individual Targets 3, 7, 8 and 10, a brief on the GBF monitoring framework, and a brief on the ecosystem area and integrity objectives of the GBF that also addresses Targets 1 and 2 in detail.

The analysis in this brief focuses on the quantitative and qualitive relationships of ecosystem level objectives of the GBF. In particular it focuses on the relationship between the ecosystem elements of Goal A and the action targets, in particular Target 1- Spatial Planning and Target 2 - Restoration. Note that connectivity is not treated as a separate topic in this brief: it is important and should be retained in Goal A.

This analysis is based on the text of the first draft of the post-2020 global biodiversity framework, CBD/WG2020/3/3 and subsequent negotiations of this text.

Structure of this brief

1) Background

- 1.a) Overview
- 1.b) Analysis of the area of natural ecosystems objective in Goal A and relationships to targets, focusing on Targets 1, 2 and 3
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- 1.d) Analysis of the spatial planning objectives of Target 1
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2) Quantitative and qualitative analysis of ecosystem area objectives

- 2.a) Overview of natural ecosystem area in goals and targets
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KEY MESSAGES CONCERNING THE ECOSYSTEM AREA AND INTEGRITY OBJECTIVES OF THE POST-2020 GLOBAL BIODIVERSITY FRAMEWORK

- Achieving net gains in the integrity of all ecosystems and in the area and integrity of natural ecosystems by 2030 and 2050 depends on concerted actions across all targets, and requires transformative change including considerable strengthening of conservation measures, systemic changes to increase the sustainability of production and consumption, and mobilisation of all sectors of society.
- "No net loss" and "net gain" policies for nature have generally been successful only when they set clear limits on losses, and have clear objectives for restoration such as strict like-for-like compensation of losses. Spatial planning and area-based conservation are critical elements of the GBF, but could be worded in a way that provides clearer objectives for reducing losses that build on Aichi Target 5. Similarly, the restoration target could include clearer qualitative and quantitative objectives for contributions to ecosystem area and integrity.
- Net gains in the area of natural ecosystems occur when the restoration of transformed to natural ecosystems is greater than losses of natural ecosystems. For example, net gains of 5% in the global area of natural terrestrial ecosystems by 2030 could be achieved with greatly reduced rates of loss of natural ecosystems and very ambitious restoration of transformed to natural ecosystems on the order of 350-400 Mha over the period 2021-2030. Global scale scenarios and other evidence indicate these reductions in losses and increases through restoration to achieve a 5% net gain in the <u>area</u> of natural terrestrial ecosystems are very ambitious but feasible.
- There is potential for quickly slowing and in some cases reversing losses the integrity of existing natural and managed ecosystems by reducing pressures leading to degradation. Gains in integrity can also be achieved through widespread restoration and rehabilitation actions. However, continued losses of natural ecosystems will have large negative impacts on ecosystem integrity; and some direct drivers of degradation, such as climate change, will inevitably intensify over the coming decade. In addition, newly created natural areas will have low integrity at first, and may take decades or even centuries to reach high integrity and so will make only modest contributions to integrity before 2030. The feasibility of net gains in ecosystem integrity is more difficult to evaluate than for the area of natural ecosystems, but several lines of evidence suggest that a 5% net increase in the <u>integrity</u> of natural terrestrial ecosystems by 2030 is near the upper limit of what is feasible.
- Directly translating global objectives, especially quantitative objectives, to national and local levels will likely result in sub-optimal use of resources and outcomes for biodiversity, as well as setting levels of ambition that are too low in some areas, and unrealistically high in others. Translation to national and local levels is more likely to succeed if it is developed inclusively with all actors, in particular indigenous peoples and local communities, considers past and present states and drivers of biodiversity, is resourced adequately, and incorporates strong, transparent governance. One way of assessing implementation and progress towards global goals would be to develop plans that take into account national contexts, conduct regular review of collective national contributions to global goals and then revisit national plans if needed. To facilitate this, indicators should be scalable so that national ambitions and contributions can be summed to assess their collective contributions and appropriate burden-sharing.
- One of the biggest challenges of the GBF is to meet objectives for biodiversity conservation and sustainable use at the same time, and ecosystem objectives are at the heart of this challenge. Spatial planning can play a major role in helping to reconcile these objectives and in finding synergies, and this could be more clearly reflected in the wording of Target 1.
- Clear definitions and consistent wording across goals and targets is essential for the implementation, monitoring and coherence of the GBF: this is lacking in the current draft. This brief provides advice on definitions and relatively modest changes in wording that would help clarify the levels of ambition, translation to national levels and overall coherence of the GBF.

BACKGROUND ON ECOSYSTEM AREA AND INTEGRITY

1.a) Overview

1.a.i) Area and integrity are complementary and not equivalent measures of the status of biodiversity, ecosystem functioning and nature's contributions to people (NCP)

Increasing the area of natural ecosystems and increasing integrity of natural and managed ecosystems are complementary but not mutually substitutable, so both are essential for protecting and restoring biodiversity, ecosystem functions and nature's contributions to people (Díaz et al. 2020). In addition, "...different actions are required in ecosystems that are predominantly 'natural' compared to those that are predominantly 'managed'. A goal of net gain of both area and integrity should only apply to 'natural' ecosystems because gain in their area will by definition have to come from 'managed' ecosystems. The increase in area and integrity of 'natural' ecosystems can be achieved both through restoration of 'managed' ecosystems back into a 'natural' state (increases in area first and then, over a longer time frame, also integrity) and by the restoration of degraded 'natural' ecosystems to a higher level of integrity (but no increase in area)." Díaz et al. (2020, Supplement 5). This brief, therefore, analyses separately the quantitative and qualitative relationships between area and integrity in Goal A and the action targets.

1.a.ii) Text of the first draft of the Post-2020 Global Biodiversity Framework for Goal A, Target 1 and Target 2.

The text of Goal A, Target 1 and Target 2 from the first draft of the GBF (CBD/WG2020/3/3) are provided below because they are the focus of much of the discussion in later sections. Negotiated text from the WG2020-3 in Geneva, March 2022 was not used as the basis of suggestions for rewording because the negotiated texts of Goal A, Target 1 and Target 2 are exceptionally difficult to interpret and comment upon (see CBD/WG2020/4/INF/1, including comments by the co-chairs).

> ***2050 Goal A: (ecosystem component) The integrity of all ecosystems is enhanced, with an increase of at least 15 per cent in the area, connectivity and integrity of natural ecosystems… 2030 Milestone A.1: (by 2030) Net gain in the area, connectivity and integrity of natural systems of at least 5 per cent.***
>
> ***Target 1. Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning addressing land- and sea-use change, retaining existing intact and wilderness areas.***
>
> ***Target 2. Ensure that at least 20 per cent of degraded freshwater, marine and terrestrial ecosystems are under restoration, ensuring connectivity among them and focusing on priority ecosystems.***

1.b) Area of Natural Ecosystems

1.b.i) What is a 'natural' ecosystem and why is a clear definition important for the GBF?

The term 'natural ecosystem' broadly refers to ecosystems where the impact of humans on ecosystem composition, structure and function are low compared to natural factors. There is a wide range of estimates of the area of natural ecosystems because the criteria of 'low human influence' used in most definitions is ambiguous. This ambiguity arises from different value judgements and because there is a gradient between very low human influence (clearly natural) and very high influence (clearly not natural) with no clear dividing line in-between (Díaz et al. 2020, see Glossary Appendix-Box 2). Definitions of 'natural' generally centre around "low human influence" either measured by ecosystem integrity or by the degree of artificialisation (Riggio et al. 2020). Using this definition, about 50% of global land area is natural (range 48-56%, Riggio et al. 2020). Global scale impacts of humans like climate change are generally not accounted for in the definition of 'natural'.

'Natural' is less well defined for marine and freshwater, as human impacts may diffuse more broadly in water and be detectable farther afield, but with low impact, but the concept still applies (see Halpern et al. 2012, 2015, Jones et al. 2018). For rivers, a binary attribution of naturalness ('natural' vs. 'non-natural') is generally not used but there are several continuous indices which rate individual river reaches using criteria based on major pressures. One such index is the Connectivity Status Index (CSI; Grill et al. 2019). The index uses five major pressure types to score individual river reaches. Then entire river networks that score above 95 % for CSI for all reaches are defined as “free flowing rivers”. Based on this the world’s rivers have been assessed as “free flowing“ or “not free flowing”. For some this binary attribution is equivalent to natural vs. managed but this view is not universally adopted and there are major conceptual challenges in treating a river network as a single entity.

A clear definition of 'natural' is critical for the GBF for several reasons. First, too strict a definition of 'natural', for example restricted to 'wilderness', would mean that many countries would currently be classified as having little or no natural ecosystems. There are many ecosystems that have low human impact that make large contributions to biodiversity, but don’t meet the strict criteria of very low human influence and very large area used to define wilderness (Wintle et al. 2019, Riva & Fahrig 2022). Too broad a definition of 'natural' makes it possible to count low integrity ecosystems (e.g., low levels of biodiversity compared to relatively undisturbed ecosystems) towards conservation goals. Second, ‘natural’ is only used in Goal A (and Milestone A.1) and not other parts of the GBF, so a definition that clearly relates ‘natural’ ecosystems to other terminology in the GBF such as 'high integrity', ‘intact’ ecosystems and ‘wilderness’ would greatly facilitate the understanding of how actions across multiple targets contribute to the outcome in Goal A. Finally, net gains in natural ecosystem area and integrity (Goal A) cannot be calculated without a clear definition.

Suggestion:

- *A clear definition of ‘natural ecosystems’ in the GBF glossary including a more in-depth treatment of the gradient from highly natural to highly managed ecosystems could help avoid misunderstandings about the scope of Goal A and its relationship to targets, as well as greatly improve the ability to evaluate progress on the ecosystem area and integrity objectives of Goal A (see Glossary).*

1.b.ii) How are net gains in ‘natural’ ecosystem area calculated?

Net gains or losses in natural ecosystem area result from the balance between increases due to restoration of ‘transformed’ ecosystems to natural states and losses of existing natural ecosystems. 'Transformed’ ecosystems are defined as having been converted from natural areas to agricultural and other uses (IPBES 2018, see Glossary Appendix-Box 3). The definition of ‘transformed’ is similar, but not identical to the definitions of 'converted' (Strassburg et al. 2020) and ‘managed’ ecosystems (Díaz et al. 2020, see Glossary for extended discussion of terms). Increases in natural ecosystem area could also come from the restoration of natural ecosystems that are so badly degraded that they are no longer considered intact enough to be natural: in this brief we use the term ‘transformed’ broadly to include this case. It is important to note that many restoration actions do not create new area of natural ecosystems (see 1.b.iv).

Net change in natural ecosystem area in the context of the GBF can be written as follows (all increases and losses are expressed as ‘since 2020’ assuming that the reference reporting period is 2020):

Net change in natural ecosystem area =

Restoration of transformed to natural ecosystems

- Losses of natural ecosystems

Percent net gains or losses are then calculated based on the net gains in area divided by the total area of 'natural' ecosystems at the 'reference time period' and can be written as follows:

% Net change in natural ecosystem area =

100 x Net change in natural ecosystem area / Area of natural ecosystems in 2020

Examples of calculations of net change in global natural terrestrial ecosystem area are discussed in Section 2.b) for two scenarios: business-as-usual and a scenario that meets the objectives of 5% net gain by 2030 and 15% by 2050.

Suggestions:

- *Providing a clearer definition of 'net change in natural ecosystem area' in the GBF glossary, including its mathematical formulation, would help avoid confusion and make it possible to properly assess progress on Goal A.*
- *The relationship between Target 2 and the ecosystem area component of Goal A would be much clearer if Target 2 made explicit reference to the restoration of 'transformed' (or some other similar terminology such as 'converted') to 'natural' ecosystems.*

1.b.iii) Why is it important to have clear quantitative objectives for reducing loss of natural ecosystems?

No net loss and net gain goals often fail to conserve biodiversity when objectives for reducing losses are not explicit, and the lack of explicit objectives to halt losses of natural ecosystems is a major weakness of the wording of the first draft of the GBF (Díaz et al. 2020, Maron et al. 2021). First, it is important to prioritise slowing losses of existing, in part because newly restored 'natural' ecosystems often take decades or centuries to reach high levels of integrity if ever (Maron et al. 2021, Milner-Gulland et al. 2021, Atkinson et al. 2022, Leadley et al. 2022, CBD/WG2020/3/INF/11). The priorities for protecting and restoring biodiversity should be 1) avoid losses, 2) minimise losses, 3) restore and 4) offset losses in other places (Milner-Gulland et al. 2021). Second, some loss of natural ecosystems over the coming decades is inevitable. But there are ecosystems that are so rare, unique or threatened that halting losses is essential: these have been termed 'critical' and 'irreplaceable' (Díaz et al. 2020, Maron et al. 2021, Milner-Gulland et al. 2021). Third, Target 1 only refers to 'retaining existing intact and wilderness areas'. It is not clear what 'retaining' means in terms of reducing losses. And reducing losses in 'intact and wilderness areas' is very important, but by most definitions of these terms only covers a fraction of losses in natural ecosystems.

Target 2, as worded in the first draft of the GBF, has a number of serious weaknesses because it: i) does not refer to retaining natural ecosystems other than 'intact ecosystems' and 'wilderness', ii) is unclear what 'retaining' implies in terms of reducing losses, and iii) does not address the need to halt losses of 'critical' ecosystems.

Suggestions:

- *Setting a clear objective for halting losses in critical ecosystems and significantly reducing losses in natural ecosystems (as was the case for Aichi Target 5) in Target 1 or in Goal A could help avoid the pitfalls of 'net gain' framing of Goal A.*

1.b.iv) How does restoration contribute to increasing natural ecosystem area?

Restoration is often used quite broadly to refer to actions that aim to enhance composition or structure or nature's contributions to people (NCP) components of ecosystem condition in terrestrial, freshwater or marine ecosystems (IPBES 2018, Duarte et al. 2020, UNCCD 2022, Glossary Appendix-Box 3). Many actions referred to as 'restoration' use this very broad definition, for example many forest restoration actions in the Bonn Challenge, do not increase the area of natural ecosystems and in some cases do little to increase ecosystem integrity. Indeed, substantially less than half of the Bonn Challenge commitments should probably be counted towards restoring natural ecosystem area (IPBES 2018, Gann et al. 2019, Secretariat of the Convention on Biological Diversity 2020, UNCCD 2022).

Restoration increases natural ecosystem area only when 'converted' or 'transformed' ecosystems are restored to states that are similar in integrity to 'natural' reference ecosystems—which is an ecosystem in a similar environment that has low human impacts (IPBES 2018, Gann et al. 2019, Glossary Appendix-Box 3). Examples of restoration outcomes that do not increase natural ecosystem area include: 1) Restoration that increases the biodiversity and NCP of agricultural ecosystems (sometimes referred to as 'regeneration' or 'rehabilitation', IPBES 2018, Gann et al. 2019); 2) restoration that creates systems that don't have sufficient integrity to be considered natural, such as forest plantations, especially monospecific stands with alien species (these actions are sometimes referred to as 'regeneration' and can contribute little to ecosystem integrity, Chazdon 2008, Gann et al. 2019, Löf et al. 2019); and 3) restoration to new systems that may have high diversity and NCP value, but are not like a 'natural' reference system (UNCCD 2022). Examples that do increase the area of natural ecosystems include restoration of abandoned cropland to a forest that is similar to surrounding 'natural forests' (Glossary Appendix-Box 3, IPBES 2018, Gann et al. 2019).

To be successful in compensating for losses in natural ecosystem area, restoration should focus on replacing destroyed or badly degraded natural ecosystems with a similar ecosystem type, using a relatively fine level of definition of ecosystem type. For example, simply compensating 'forest' loss with 'forest' restoration provides little guarantee that deforestation of high integrity forests is compensated by anything other than low integrity tree monocultures. These principals are often collectively referred to as like-for-like compensation (Díaz et al. 2020, Maron et al. 2021).

Because Target 2 in the first order draft of the GBF does not specify the objective of restoration actions, it provides no guidance on how Target 2 should be implemented, nor how it contributes to gains in natural ecosystem area. Implemented without sufficient guidelines Target 2 could potentially make little contribution to increasing natural ecosystem area and only modest contributions to ecosystem integrity.

Suggestions:

- *Target 2 would be clearer and easier to relate to Goal A if it had separate objectives for restoration of degraded ecosystems to increase integrity (which may or may not ecosystem area, see Section 1.c.iv) and restoration of <u>transformed</u> to <u>natural</u> ecosystems which increases the area of natural ecosystems.*
- *Including clear wording on strict like-for-like compensation in Target 2 could also help avoid the pitfalls of 'net gain' framing of Goal A.*
- *Expressing restoration of transformed to natural terrestrial ecosystem objectives in terms of global area (millions of hectares, Mha) would avoid known issues with defining the current extent of 'transformed' or 'converted' area. This would make it much easier to quantify objectives and progress for terrestrial ecosystems. Area-based objectives for restoration would need to be different for freshwater and marine ecosystems, and are poorly adapted to freshwater and marine ecosystems where area is not a good measure of restoration objectives.*

1.b.v) How do 'intact and wilderness areas' referred to in Target 1 relate to 'natural ecosystems' in Goal A? How could Target 1 and Goal A be reworded to improve coherence?

Intact ecosystems and wilderness areas are very closely associated terms and are to a large extent redundant, and often used as synonyms of ecosystems with very high integrity (see Glossary). These are generally defined with stricter limits on low human influence and minimal area requirements than for 'natural' ecosystems, such that only half or less of 'natural' ecosystems are generally considered 'wilderness' (see Glossary). As such, Target 1 only refers to retaining a subset of 'natural' ecosystems, creating a disconnect between wording of Target 1 and Goal A. Many ecosystems that are not wilderness should be high priority for halting losses and should therefore be explicitly addressed in Target 1 (Díaz et al. 2020 used 'critical' ecosystems, and Maron et al. 2021 used 'irreplaceable' to refer to these systems).

Suggestions:

- *Rewording Target 1 to be more inclusive than 'intact and wilderness areas' would make it clearer that Target 1 has the objective of reducing losses in the area of all natural ecosystems. This would clarify links with Goal A.*
- *It is important to distinguish between ecosystems, typically referred to as 'critical' or 'irreplaceable' where it is essential to halt losses immediately, and other 'natural' ecosystems where losses should be greatly reduced, but cannot realistically be brought to zero by 2030.*

1.b.vi) What are the roles of protected areas and other effective area-based conservation measures (OECM) in Target 3 in contributing to net gains in natural ecosystem area?

Protected areas, when properly resourced and managed, and OECMs reduce losses of natural ecosystem area (see Target 3 brief). As such, protected areas are one of the keystones of biodiversity-inclusive spatial planning (see Section 1.d).

1.b.vii) What is an ambitious and feasible quantitative global objective for net gain in natural ecosystem area? How do global quantitative objectives translate to national levels?

For land, about 350-400 Mha of restoration of transformed to natural ecosystems globally along with substantial reductions in losses of natural ecosystems are very ambitious objectives, but are needed to attain a 5% increase in natural ecosystem area by 2030 (see Section 2b). This might seem coherent with the Bonn Challenge of 350 Mha of forest restoration by 2030, but it is much more ambitious because about half of Bonn Challenge is low diversity forest plantations and should not be counted as natural (Secretariat of the Convention on Biological Diversity 2020, UNCCD 2022). The means of achieving this in terms of the transformative changes required is addressed in Section 2b of this brief based on a synthesis of global 'bending the curve'' scenarios. Clarifying this will help countries plan and implement their restoration efforts. Similar calculations are not available for marine and freshwater ecosystems, but it should be possible to do these same calculations for marine and freshwater ecosystems where natural ecosystem area is an appropriate measure of biodiversity conservation and restoration objectives. Global objectives, especially quantitative objectives should not be translated directly to national levels because this would result in sub-optimal use of resources and outcomes for nature and people. While quantitative objectives expressed as percent might appear to be easier to translate from global to national levels than global area, we illustrate in Section 2c why this is not the case. Section 2c addresses this in depth and illustrates how area-based objectives could be interpreted and implemented at national levels.

1.c) Integrity of all ecosystems, including the integrity of natural ecosystems

1.c.i) What does ecosystem integrity mean? Why is it important to the GBF?

Ecosystem integrity is a measure of ecosystem structure, function and composition relative to the reference state of these components, typically an intact ecosystem in a similar environment (Noss 1990, Teixeira et al. 2016, Nicholson et al. 2021, Karr et al. 2022, see Glossary). Ecosystem integrity is a highly relevant measure of the progress resulting from actions in targets (Karr et al. 2022), and in particular for Target 1 in which the objective of retention of remaining ecosystems focuses on those with high integrity; Target 2 for which it is an important measure of the need for restoration and success in restoration; Target 3 for which it indicates if protected areas are effectively managed and Target 10 for which it indicates if agriculture, aquaculture and forestry are managed sustainably (Garibaldi et al. 2020). It should be noted that the term 'integrity' is not widely applied to managed ecosystems other than forests; for example 'ecosystem health' and 'ecosystem condition' are more commonly used and widely accepted for agricultural ecosystems (Roche & Campagne 2017) and in marine ecosystems (Halpern 2020). Ecosystem integrity is, however, used at landscape levels that include a wide range of agricultural and other transformed ecosystems and achieving 100% of the composition, structure and function of intact natural ecosystems is typically not the reference used to assess high levels of integrity (McGarigal et al. 2018, Walston & Hartmann 2018, DeClerck et al. 2021, Zelený et al. 2021).

Suggestion:

- *Maintaining 'integrity' in the wording of GBF is important because it is much more inclusive than wording focusing on less than all three components of integrity: composition, structure and ecosystem function.*

1.c.ii) How do you measure ecosystem integrity?

There is general agreement that ecosystem integrity includes components of ecosystem structure, function and composition (Díaz et al. 2020, Hansen et al. 2021, Nicholson et al. 2021). There is, however, no common agreement on the individual indicators for each of these components, nor their respective weights. This situation is evolving rapidly, and the concept, means of monitoring, and demonstrated applications of ecosystem integrity are well developed for some types of ecosystems such as forests (Hansen et al. 2021, Nicholson et al. 2021, Background Appendix-Figure 1). Indicators of the components of ecosystem integrity are now available for application for many ecosystems and can be applied for the GBF (Hansen et al. 2021, Background Appendix-Table 1). These can be combined into an overall ecosystem integrity index and used as a headline indicator for some ecosystems (Hansen et al. 2021, Background Appendix-Table 1).

Commonly used indices that measure biodiversity intactness compared to reference intact ecosystems such as mean species abundance (MSA, Schipper et al. 2020) and biodiversity intactness indexes (BII, e.g., Newbold et al. 2015) are often used as proxies of integrity, but these indicators only measure part of the compositional component of integrity, and are not necessarily good indicators of ecosystem integrity / condition / health of managed ecosystems because they are based on reference states of natural ecosystems (Roche & Campagne 2017, DeClerck et al. 2021).

Suggestions:

- *Reach agreement on the definition of ecological integrity for GBF Glossary and monitoring framework.*
- *Think about how to express 'integrity' of managed ecosystems and landscapes, especially for semi-natural ecosystems.*
- *Think through how to measure and express 'integrity' in the most meaningful way in marine and freshwater ecosystems.*
- *Apply multiple indicators that are adapted to ecosystem types.*

1.c.iii) How are net gains in natural ecosystem integrity calculated?

Net change in natural ecosystem integrity can be written as follows (all increases and losses expressed as 'since 2020' assuming that the reference reporting period is 2020):

Net change in natural ecosystem integrity =

Increases in integrity from restoration of existing natural ecosystems

+/- Increases/losses in integrity resulting from restoration of transformed to natural

+/- Increases/losses in integrity from alleviation of / increases in pressures in natural

- Losses of integrity due to transformation of natural ecosystems

This formula is more complex when including managed landscapes or seascapes, but there are attempts underway to do this calculation for global terrestrial ecosystems (DeClerck et al. 2021). Percent net gains or losses are then calculated based on the net gains in area divided by the total area of 'natural' ecosystems at the 'reference time period' and can be written as follows:

% Net change in natural ecosystem integrity =

100 x Net change in natural ecosystem integrity /

Integrity of natural ecosystems in 2020

Suggestions:

- *Providing a clearer definition of 'net change in natural ecosystem integrity' in the GBF glossary, including its mathematical formulation, would help avoid confusion and make it possible to properly assess progress on Goal A.*

1.c.iv) How does restoration of 'degraded' ecosystems contribute to ecosystem integrity? Should restoration be explicitly qualified in Target 2 wording to specify an objective of increased integrity?

Expressing restoration as a percentage of 'degraded' ecosystems is very problematic. In part, this is because degradation can be a continuous process and there is no consensus on when a threshold is passed to constitute "a degraded ecosystem". In addition, the notion of what is degraded is highly value laden and a very wide range of indicators is used to measure degradation (IPBES 2018, IPCC 2019, UNCCD 2022). For example, the Global Land Outlook 2 (UNCCD 2022) gives a range of 20-40% of global land that is degraded, where the upper bound includes nearly all agricultural land. This makes assessment of objectives based on percent restoration of degraded lands exceptionally problematic. For example, percent restoration of degraded ecosystems was not used for assessment of progress towards Aichi Target 15 in the Global Biodiversity Outlook 4 (Leadley et al. 2014), nor in the Global Biodiversity Outlook 5 (Secretariat of the Convention on Biological Diversity 2020). There is no simple solution to this, since decades of research and international negotiations have not reached agreement on a definition of degraded that would allow Target 2 to be clearly quantified as it is currently worded. International assessments and reports such as the IPBES Land Degradation and Restoration Assessment (IPBES 2018), the Global Biodiversity Outlook 5 (Secretariat of the Convention on Biological Diversity 2020) and the Global Land Outlook 2 (UNCCD 2022) have typically evaluated global restoration actions and commitments in numbers and types of projects, or area rather than percent restoration of degraded area. The most ambitious international commitment for restoration, the Bonn Challenge, is expressed as a global area of 350 Mha of forest to be restored. The UNCCD has set objectives of land degradation neutrality and Zero Net Land Degradation. These are problematic in terms of evaluation of progress, in part because of issues related to like-for-like compensation.

Marine restoration attempts have had varied and unpredictable success (Fraschetti et al. 2021), with poorer outcomes in offshore and open ocean areas (Elliott et al. 2007). Prioritisation of sites according to human use and conservation status will achieve greater biodiversity benefits (Fraschetti et al. 2021) and direction of effort into alleviation of pressures on offshore marine ecosystems is likely to be more beneficial to marine biodiversity than restoration efforts in these areas (Elliott et al. 2007) much recent emphasis is being placed on undertaking Integrated Ecosystem Assessments (Levin et al. 2014) to assist in identification of mitigation measures along most impactful sector-pressure-ecological pathways.

Suggestions:

- *Providing a typology of restoration actions in GBF glossary and explaining how they are related to goals and targets would help clarify the objectives of restoration in the GBF, their implementation, monitoring and assessment of progress.*
- *Explicitly stating in Target 2 that it focuses on restoration that aims to increase ecosystem integrity would highlight the importance of restoration actions that contribute to Goal A and discount restoration actions that contribute little to Goal A.*

1.c.v) What are ambitious and feasible quantitative global objectives for net gain in ecosystem integrity? How do global quantitative objectives translate to national levels?

Global ecosystem integrity is much more difficult to calculate than ecosystem area because of the additional complexity in its formulation (see 1.c.iii) and the lack of integrity indicators for many ecosystems (see 1.c.ii). Therefore, all analyses of changes in future global scale integrity should be viewed with considerable caution. In the analysis of global scenarios in CBD/WG2020/3/INF/11 we wrote concerning the 'bending-the-curve' scenarios analysed by Leclère et al. (2020) that “Taken together, these actions are projected to contribute substantially to achieving a global net gain in the area of ecosystems by 2030 (area component of Milestone A.1), and a stabilisation (but not reversal) of species distribution, population and extinction rate (so making progress towards but not fully attaining Milestone A.2 objectives of early 'bending-the-curve'; Figure 1.3). Time lags involved in biodiversity recovery (see Message 2 and Technical Section 2) reduce the likelihood of achieving ambitious outcomes for species and ecosystem integrity (as compared to ecosystem area outcomes) in 2030 milestones A.1 and A.2 and parts of the 2050 Goal A (implying strong recovery, beyond ecosystem extent).”

Other scenarios analysed in CBD/WG2020/3/INF/1 are in agreement with this analysis of Leclère et al. (2020). Based on these analyses of integrated assessment models (IAMs), a no net loss of ecosystem integrity objective by 2030 would seem ambitious and a 5% gain exceptionally difficult (see also Díaz et al. 2020). However, the IAMs used for these scenarios overlook many important aspects of integrity that may make them overly pessimistic. First, the analyses were based entirely on the composition component of integrity, and some structural and functional components may recover more quickly than compositional components. Second, the ability of IAMs to account for restoration actions is limited and focus on restoration of transformed to natural ecosystems (CBD/WG2020/3/INF/1): other restoration actions could also make major contributions to integrity (see 1.c.iii).

1.d) Spatial planning

1.d.i) What is ‘biodiversity-inclusive’ spatial planning? Why is it important for the GBF?

Biodiversity-inclusive spatial planning everywhere is important because it addresses loss and degradation of biodiversity both outside and inside protected areas. Areas outside protected areas are critical for the conservation of biodiversity—and for nature's contributions to people—because a large fraction of the world's biodiversity will only be found there even with 30% protected area coverage (Locke et al. 2019, Riva & Fahrig 2022). The situation is likely more extreme in the case of marine ecosystems, given that 75% of Exclusive Economic Zones have less than 10% of their geomorphic features and benthic habitats protected (Fischer et al. 2019).

For the GBF, Target 1 provides a spatial context for integrating all the other targets—particularly the area or ecosystem-based Targets 1, 2, 3 and 10 (Background Appendix-Figure 2), but also the targets/goal relating to the integrity of biodiversity (Background Appendix-Figure 2), sustainable use (targets 9-13), spatial aspects of tools and solutions (Targets 14-20) and, very importantly, the rights and responsibilities of IPLC and other stakeholders (Target 21). For example, integrated spatial planning is necessary to ensure that two components of Target 3 are met, specifically ''ecologically representative, well-connected systems of protected areas [...] integrated into the wider landscapes and seascapes''. Indeed, integrated spatial planning is the mechanism through which authorities can maintain or restore sufficient connectivity within and across protected areas, and mitigate pressures to biodiversity in the wider landscapes and seascapes, while representation is one of the core principles of spatial conservation planning theory and tools (Margules & Pressey 2000, Wilson & Piper 2010, Kukkala & Moilanen 2013). Similarly, opportunities for habitat restoration are increased by reducing pressures on land through integrated planning (Leclère et al. 2020, Williams et al. 2020), and restoration success is improved by mitigating pressures outside restoration areas.

1.d.ii) How does spatial planning contribute to reducing the loss of biodiversity?

Evidence of the benefits of integrated land use planning in promoting synergies between multiple development goals abound and include the social, environmental and economic benefit of integrated coastal management in Belize (Arkema et al. 2015) and Australia (Ban et al. 2015), integrated forest management in Europe (Sotirov & Arts 2018). Local, empirical evidence has also been used to parameterize models to estimate the maximum potential of integrated planning in the oceans (Sala et al. 2021) and on land (Fastré et al. 2021).

Without Target 1, goal A will be missed even if Targets 2 (on ecosystem restoration) and 3 (on protected areas) are met. Critical ecosystems, their unique biodiversity, and their contributions to people will be irrevocably lost due to ongoing land-/sea-use change (Díaz et al. 2020). The loss and degradation of natural habitats outside protected and restored areas will reduce biodiversity and many classes of NCP across most of the world (Brauman et al. 2020). Even within protected areas, biodiversity will decline as the surroundings become less nature-friendly (Laurance et al. 2012, Díaz et al. 2020, Leclère et al. 2020, Maxwell et al. 2020, Fastré et al. 2021, Leadley et al. 2022).

Spatial planning does not, however, guarantee positive outcomes for biodiversity per se, for two reasons. First, other factors may override biodiversity, such that all the feasible expected outcomes involve some overall loss of biodiversity (CBD/WG2020/3/INF/11). Second, plans may fail to deliver their expected outcome. Plans are more likely to succeed if they are developed inclusively with local actors and stakeholders, consider biodiversity processes as well as patterns, are resourced adequately, and have strong and transparent governance (OECD 2017, CBD/WG2020/3/INF/11). There are many examples of failures as well as successes that should be learned from OECD (2017).

1.d.iii) How does spatial planning contribute to meeting a wide range of SDG objectives?

Target 1 requires inclusion of biodiversity in spatial planning everywhere, while recognizing that biodiversity is not the only factor to be considered when making decisions. Including biodiversity in spatial planning can improve outcomes for both nature and livelihoods. Planning that considers multiple dimensions can find solutions that, while not optimal for any single dimension, score highly on them all (Strassburg et al. 2020, Jung et al. 2021).

1.d.iv) Is it feasible to do spatial planning everywhere by 2030?

Most places have some form of spatial planning (Metternicht 2018). But the fraction that could be considered biodiversity-inclusive is not well known, in many places being limited or non-existent in many places (Metternicht 2018). The feasibility of achieving biodiversity-inclusive spatial planning in 100% of all land and sea areas is not well known. Many countries currently lack the capacity to include biodiversity in spatial planning by 2030, so substantial resources would have to be rapidly mobilised, and new partnerships facilitated, to build human and technical capacity. Many countries indicated they lack the capacity to do this (CBD/WG2020/4/INF/1), but all countries have planning processes that cover nearly all of their terrestrial land and freshwater. Marine spatial planning is underway in over 100 countries around the world (UNESCO-IOC/FAO 2022), estimated to account for at least 44% of nations with marine waters (Frazão Santos et al. 2019), but it is a strong aspiration and science-based target for full coverage to be achieved in the near future.

1.d.v) How can progress on spatial planning be measured?

The current list of indicators in the GBF monitoring framework focus on the extent to which spatial planning considers biodiversity, but not the quality of the spatial planning, in other words, whether these plans are effectively designed to i) abate the threat of land/sea-use change, and ii) contribute to the achievement of goals A, B, C within the respective jurisdictions. A state variable indicator, such as the expected changes in the STAR metric (Mair et al. 2021) or the Red List of Ecosystems (Bland et al. 2018, Rowland et al. 2020) attributable to area-based conservation would be best placed to complement the current list of response variable indicators. There are multiple indicators that quantify land/sea-use change (e.g., Human Footprint), and its predicted/modelled impacts on biodiversity (e.g., Biodiversity Intactness Index, Biodiversity Habitat Index), as well as forest loss/cover change (Curtis & Larson 2020, Global Forest Watch, Global Mangrove Watch).

1.d.vi) Why is it important to take into consideration the IPLC roles, rights, and equity in Target 1?

A key concern for many countries and stakeholders is that spatial planning is conducted with full acknowledgement of the rights and participation of Indigenous People and Local Communities (IPLC), and of other stakeholders. Lands managed by IPLC have, on average, better biodiversity status and trends than other land (IPBES 2019). Almost half of the text proposals from Geneva addresses these issues: [and the places most important for delivering ecosystem services/nature's contributions to people]], [sustaining ecosystem services, …]/[and taking into account [and respecting] [, in the context of sustainable development and poverty eradication,] the customary rights of Indigenous Peoples and local communities.].

1.e) Suggestions for rewording of Goal A, Target 1 and Target 2

The considerations in sections 1.b-d above support the rewording of Goal A, Target 1 and Target 2. An example shows how the wording and quantitative objectives could be improved to explicitly link Goal A, Target 1 and Target 2, without intending to be prescriptive. For terrestrial ecosystem area in particular this brief shows how Target 1 and Target 2 quantitative objectives can be aligned to match objectives for Goal A and vice versa. Changes in text compared to the first draft of the GBF are indicated in underlined text.

Goal A (Ecosystem objectives): The integrity of all ecosystems is enhanced, with an increase in the area, connectivity and integrity of natural ecosystems by *X% by 2030* and *X%* by 2050.

Suggestions:

- *Few changes compared with the GBF first draft wording: the only change is that the 2030 Milestone A.1 has been incorporated in the wording of Goal A.*
- *The analyses in sections 1a-d suggest that 5% net gain in area by 2030 and integrity of natural terrestrial ecosystems and 15% by 2050 is feasible—but these are very ambitious and would require deep, systemic changes in production and consumption.*
- *It would be helpful to clarify in the glossary than 'natural' = 'high integrity' ecosystems*

Target 1 (option 1): Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning that includes the objectives of halting the loss and degradation of critical ecosystems, substantially reducing the loss and degradation of wilderness and other natural ecosystems, and reconciling competing demands for land and marine resources.

Target 1 (option 2): Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning that includes the objectives of bringing the rate of loss and degradation of high integrity ecosystems as close to zero as possible, and reconciling competing demands for land and marine resources.

Suggestions:

- *Clarifies the dual objectives of spatial planning which are to greatly reduce losses of biodiversity and reconcile this with other uses of land and sea*
- *Employs terminology that makes it easier to make direct links with Goal A by including an objective (albeit non-quantitative) for reducing losses of wilderness and all natural ecosystems (or high integrity ecosystems)*
- *Clearly states the objective of halting the loss of critical ecosystems (option 1), but could perhaps be specified elsewhere.*
- *The second option uses fewer words and has a clearer loss reduction ambition than option 1 by: i) Using 'high integrity ecosystems' or similar wording in place of 'wilderness and other natural ecosystems'. This would simplify wording and help avoid terminology that is contested. ii) Setting an aspirational goal of bringing losses as close to zero as possible by 2030 (similar to Aichi Target 5). This is the scenario presented in Section 2b that achieves 5% net gain of ecosystem area by 2030.*

Target 2: Ensure that a substantial fraction of degraded freshwater, marine and terrestrial ecosystems are under restoration actions to increase ecosystem integrity, ensuring connectivity, like-for-like compensation of losses of natural ecosystems, and at least *X* Mha of restoration of transformed to natural terrestrial ecosystems globally.

Suggestions:

- *Includes a non-quantitative objective for overall restoration efforts for degraded ecosystems because i) there is no commonly agreed upon quantitative value for degraded systems in any of the three realms and ii) that any quantitative value would likely differ between freshwater, marine and terrestrial ecosystems.*
- *Analyses in Section 2 of this brief suggest that 350-400 Mha of restoration of transformed to natural terrestrial ecosystems is feasible and needed to meet the objective of 5% net gain of natural ecosystem area by 2030.*
- *This wording adds the important condition of like-for-like compensation and specifies the total amount of land area to be restored from converted to natural areas in order to achieve the natural ecosystem areas objectives of Goal A. This is wording highly desirable, but could perhaps be specified outside of target wording.*
- *Note that the restoration of converted land objective is probably better expressed as a global area objective, since the extent of converted land is not well bounded.*

2) Quantitative and qualitative analysis of ecosystem area objectives

2.a) Overview of natural ecosystem area in goals and targets

The change in the area of natural ecosystems (Goal A) represents a balance between reducing losses of natural ecosystems (Target 1b) and restoring transformed ecosystems and badly degraded natural ecosystems to a more natural state (Target 2).

2.b) Global analysis of natural ecosystem area objectives

Figure 1 presents calculations for terrestrial ecosystem area for two scenarios: 1) the first scenario meets the objectives of 5% net gain by 2030 and 15% net gain by 2050 set in the first draft of the GBF and 2) the second scenario represents a continuation of current rates of losses of natural ecosystems combined with ambitious, but not exceptionally ambitious restoration. These scenarios are intended to give a sense of the ambition that is needed to meet the 2030 and 2050 objectives for net gain in area of natural terrestrial ecosystems and provide an illustration of how, with judicious rewording, the objectives in Goal A can be quantitatively related to Target 1 (and by extension Target 3) and Target 2. The feasibility and means of achieving these goals and targets are then discussed in the context of much more sophisticated global scale "bending-the-curve" scenarios and other evidence. The need for clearer definitions and greater coherence in the wording in Goal A and Targets 1 and 2 is also discussed. Finally, we suggest ways in which the same methods could be applied to marine ecosystems.

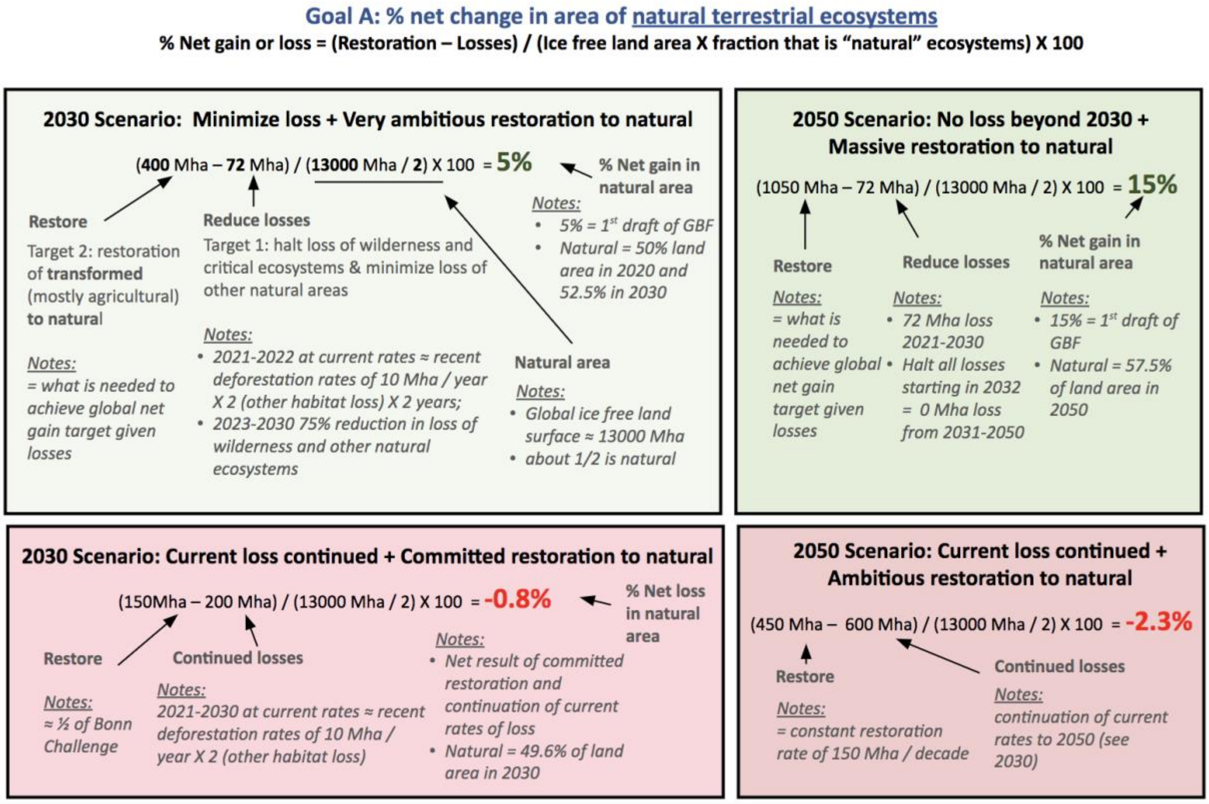

Figure 1. Simple global scale calculations of net change in the area of natural terrestrial ecosystems. *The upper panels are scenarios that meet numerical targets for 2030 and 2050 set in Goal A of the GBF. The lower panels are "business-as-usual" scenarios. These scenarios are based on simple assumptions concerning current natural area, rates of losses of natural areas (Target 1 and by extension Target 3) and restoration of transformed lands to natural ecosystems (Target 2). A 75% average reduction in losses over the period 2023-2030 is the equivalent of ramping up to a 100% reduction (i.e., halting losses) by 2027. Key assumptions are noted in the figure; justification for these assumptions can be found in Background Appendix-Box 1. Note that wording for Targets 1 and 2 reflect suggested modifications of wording compared to the first draft of the GBF (see text). For an idea of scale, the area of China is about 960 Mha and Kenya 58 Mha. 1 Mha = 10 000 km^2. The reference year for calculating net gain or loss is 2020.*

<u>Main messages from the simple scenarios in Figure 1</u>

- It appears feasible to meet the quantitative objectives set for net gain in natural terrestrial ecosystem area in Goal A, but these calculations highlight the importance of very high ambition: actions that greatly reduce losses of natural ecosystems and exceptionally ambitious restoration of transformed to natural ecosystems are required to meet the 2030 and 2050 objectives.
- Business-as-usual losses, even with ambitious restoration of transformed to natural ecosystems, result in net loss of natural ecosystem area by 2030 and 2050.
- By 2030 (and even by 2050) areas under restoration will be in early stages of restoration far from a "natural" status that often takes decades or centuries to reach. So this increase in area does not mean that the integrity components of Goal A will be met (CBD/WG2020/3/INF/11, Leadley et al. 2022).

This also means that reductions of losses play a relatively smaller role in net changes in area than they do for integrity.

- Achieving the numerical objectives of net gain proposed in the first draft of the GBF is dominated by very ambitious restoration; reductions in losses play a relatively smaller role. This could lead to perverse incentives to focus on restoration rather than slowing losses as has occurred in the majority of cases of net gain/loss targets. This argues in favour of a clear numerical objective for reducing losses in Target 1 or in Goal A (Díaz et al. 2020). Restoration does not have the opportunity to compensate for the loss of integrity of old ecosystems that are lost, which is a compelling reason to focus on reducing losses.
- Natural area is the denominator of the calculation of net change in natural area, so choosing a very low natural area (e.g., just wilderness area) makes it much easier to achieve the objective of large net gains, but fails to address large areas that are natural. This could lead to perverse incentives to use overly strict definitions of "natural" ecosystems when assessing progress towards this goal.
- Restoration of transformed ecosystems to natural ecosystems takes land out of agricultural production. While many of these lands might be marginally productive, the loss of agricultural production would need to be compensated for by increased production elsewhere and/or more sustainable diets and reductions in food waste.

<u>Feasibility, relationship to SDGs, and means of achieving net gains in natural ecosystem area</u>

Comparisons of these simple scenarios with those made with more sophisticated scenario analyses with Integrated Assessment Models (IAMs) helps to provide insight into the feasibility, relationship to SDGs, and means of achieving the ambitious objectives in Figure 1. We summarise the analysis of 'bending-the-curve' for biodiversity scenarios from the "Expert Input" information document prepared in support of the negotiations of the GBF in Geneva, March 2022 (see CBD/WG2020/3/INF/11 for details, tables and figures numbers prefixed by "EI" in the summary below are references to this "Expert Input" information document, see also Leadley et al. 2022).

- Holding losses to only 72 Mha in the 15% net gain scenario for 2050 is very ambitious compared to losses in 'bending-the-curve' scenarios. Estimates of losses from global scenarios vary widely: the lower end estimates of gross conversions natural ecosystems to agriculture and forestry between 2020 and 2050 are about 400-550 Mha in 'business-as-usual' (Kok et al. 2020, Leclère et al. 2020, EI Table A1.3.1-Appendix 1.3), ranging up to over 1200 Mha (Strassburg et al. 2020, Fastré et al. 2021). In the best scenarios, losses are estimated to be around 200 Mha over this same period (EI Table A1.3.1-Appendix 1.3). The 72 Mha loss by 2030 is also low (EI Table A1.3.1-Appendix 1.3). Using these best case losses from 'bending-the-curve' scenarios would require substantially more ambitious restoration: about 1200 Mha. Strassburg et al. (2020) tested a scenario 55% restoration of transformed to natural ecosystems (=1580 Mha). Such large scale restoration may only be possible through transformative changes in our food system, reducing over-consumption, food waste and changes in dietary composition, and necessitate strong safeguards to avoid risks for livelihoods and food security. The 2050 restoration assumption (1050 Mha) is roughly equivalent to the highest values used by Leclère et al. (2020) and Kok et al. (2021) in terms of absolute area (around 1000 Mha, see Table A.1.3.1 in info doc).
- Overall, 'bending-the-curve' scenarios project a net gain in natural ecosystems generally fall below the 15% net gain in natural terrestrial ecosystems from 2020 to 2050, with middle ground of about 10% a range of -1% to 20% (assuming land is currently about one-half natural ecosystems), but well above the "business-as-usual" scenario (EI Appendix 1.3-Table A1.3.1). This suggests that 15% is exceptionally ambitious based on what is assumed in these scenarios, but appears to be feasible under certain conditions in a context of achieving multiple SDGs simultaneously.
- All of the analyses with integrated assessment models (IAMs) used in the analyses in CBD/WG2020/3/INF/11 (see also Leadley et al. 2022), include considerable improvements in most aspects of NCP and human well-being. One of the most recent of these analyses shows that achieving a wide range of SDGs related to human well-being and those related to the environment have very strong synergies (Soergel et al. 2021). One clear example of this is related to food systems. Greatly reducing food waste and overconsumption improves food security (assuming equitable

sharing of the benefits of these actions), makes a substantial contribution to climate mitigation, reduces pollution and greatly diminishes pressures on biodiversity.

Reducing loss of natural area is extremely important, it requires transformative changes to our food system and limiting reliance on biofuels for achieving the energy transition in order to decrease pressure of expansion of agricultural lands (IPBES 2018, 2019). At the same time, there are many areas where progress can be made to closing yield gaps through sustainable intensification, again lowering demands and thus reducing losses (IPBES 2019, FAO & INRAE 2020).

Restoration may be difficult and face trade-offs in areas transformed to highly productive agricultural and residential land systems. Most potential for restoration of transformed to natural ecosystems is found in areas that have been converted from natural areas, but have marginal yields or have faced degradation through previous use (UNCCD 2022). Such areas include agricultural abandonment areas that provide considerable potential for re-wilding, but also include areas transformed for extensive cultivation or grazing, with low productivity, but sometimes harmful impacts on fragile ecosystems (IPBES 2018, UNCCD 2022). In restoring those areas care should be taken of the reliance of local communities on these lands and the land rights they hold. Spatial planning and sustainable intensification in these systems may free up a lot of land in these areas, creating shared landscapes in which both nature and people benefit from the restoration activities (Obura et al. 2021).

Implications for the wording of Goal A, Target 1 and Target 2

- Goal A - provide a much clearer definition of natural in GBF glossary.
- Target 1 - set specific objectives concerning reducing losses of critical ecosystems, as well as other natural ecosystems.
- Target 2 - set specific objectives for restoration of transformed to natural ecosystems which should not be conflated with general wording concerning restoration of degraded ecosystems. We suggest using a global area (millions of hectares) target for this rather than a percent because of large ranges in the estimates of transformed land available for restoration to natural ecosystems.

Application to marine and freshwater ecosystems

We have not applied these calculations to marine and freshwater ecosystems, because their dynamics are somewhat different, but also because datasets on 'natural area' are less well established. For some specific freshwater and marine systems this could be relatively easily done, because the data is available to make at least rough calculations (e.g., wetlands, UNESCO-IOC/FAO 2022). The overall principles may be similar, though practical application of actions to achieve target levels may be very different.

2.c) Translating global objectives for net gain in natural ecosystem area to national levels

Translation to national levels of the global scale numerical elements of Goal A and Targets 1, 2, 3 and 10 (to address the overall transitions between natural, managed (used broadly to include transformed and converted areas, see glossary) and restored areas requires taking into account national contexts. We show visual illustrations of hypothetical countries with varying proportions of land categories in the GBF, to illustrate the global calculations above. The global average illustrates the near 50/50 split between managed and natural/semi-natural landscapes, protected/conserved areas at 17% (Aichi Target 11 in 2020), and the proportion of degraded lands (15.8%) across semi-natural and managed lands (Figure 2). In 2030 (right panel) restoration actions (3.2%) and protected and conserved areas (30%) are spread across natural and managed lands, while all managed lands are managed for sustainability. The importance and scope of fully national spatial planning across 100% of territory that blends biodiversity considerations with the goals of other sectors is clear.

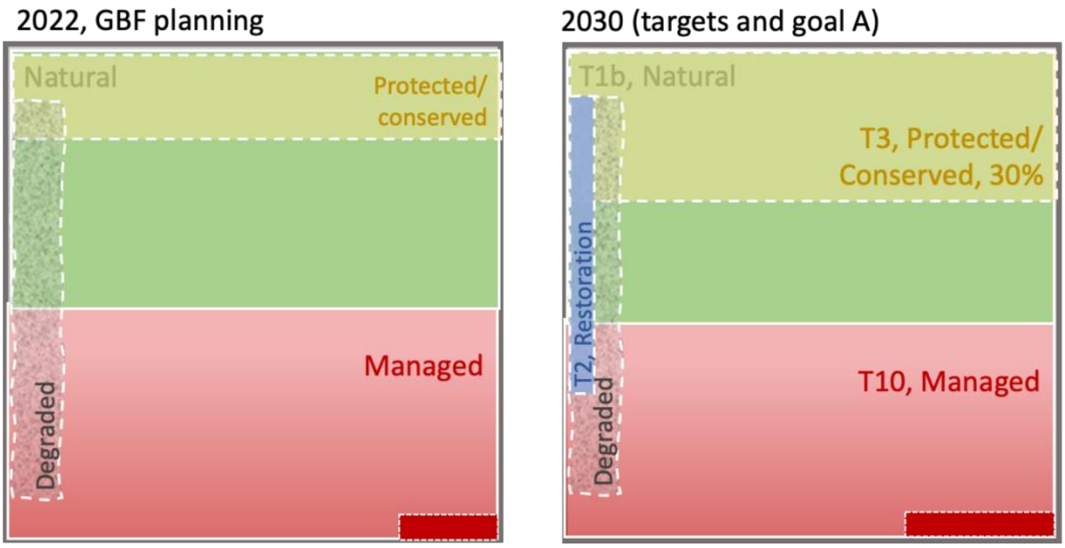

Figure 2. Illustration of area-based targets (1, 2, 3 & 10) in a national context. *Left, the proportions of terrestrial area that is considered 'natural' is approximately 50% globally (green) while a slightly smaller proportion is managed under agriculture and other production systems, and about 1% is urban. Approximately one third of managed lands may be considered 'degraded' (see Figure 1), with some spill-over into the most degraded parts of natural lands. Right, achievement in 2030 of Targets 1b (retention of intact/wilderness areas), 2 (restoration of 20% of degraded), 3 (protection of areas most important for biodiversity, to 30% of national area) and 10 (sustainable management of managed lands), and of goal A of an increase in intact ecosystem area of 5%.*

This illustration shows a number of features of importance to countries in implementing Targets 1, 2, 3 and 10, and the 2030 and 2050 ambitions for Goal A:

- target application starts with a country's reality today, and in this globally average case, land is split approximately equally between natural and managed landscapes. Communities and low-impact livelihoods and economies are strongly integrated within the former, while in the latter more intensive practices have significantly altered ecosystems to meet peoples' needs.
- Target 1 blankets the country to assure national assets are most efficiently used, now on a primary foundation of assuring environmental sustainability (addressed by the term 'biodiversity-inclusive' in the target wording).
- Target 10 meets this need by assuring all intensive production activities are changed to minimize impacts to nature.
- Targets 3 (conservation) and 1 (retaining intact/wilderness/critical ecosystems) seek to assure fully functioning components of nature, and those that are most important for biodiversity conservation and meeting critical human needs (such as carbon sequestration), are not degraded any further than the baseline in 2020.
- A significant proportion of natural but lightly impacted lands, not covered under the bullet points above (i.e., is neither under strong protection/conservation, nor transformed to production status, in this case almost 20% of all lands) is managed through spatially explicitly planning under Target 1 providing many options for development under the constraint of no further conversion to altered states, or degradation of nature.
- Degraded ecosystems, estimated at one third of managed ecosystems, likely overlap into the least intact natural areas. Restoration within these, under Target 2, can focus on local contexts and human needs as well as nature's needs.
- Achieving the increase in natural ecosystem area of 5% by 2030 requires some lands are taken out of production (T10) and put under restoration (T2) actions. Achieving the increase in ecosystem integrity targeted for 2030 is assisted by expanding protection and targeted restoration, particularly in the lands shifted from production to conservation. By simultaneously

implementing sustainable food and business commitments linked through the SDGs (e.g., by reducing consumption of meat, food waste at source and sink, etc.), the decrease in production area may be more than offset by biodiversity-friendly agricultural practices and transformations in food demand (see Science Brief on Target 10).

- This illustration has been based on land area, but the same principles apply for freshwater and marine ecosystems. The proportions may be different and primary condition variables may also be different based on fundamental differences in the environment (e.g., freshwater flows for rivers rather than area), but analogous principles can be applied.

As the ‘globally average’ case, Figure 2 illustrates how actions across all countries are aggregated to achieve the global goal. But implementation of targets must address different national contexts, so three country cases are presented (Figure 3). These illustrate countries with different starting points of natural vs. managed/transformed ecosystems. The figure illustrates the 2030 outcome, corresponding to the right panel in Figure 2.

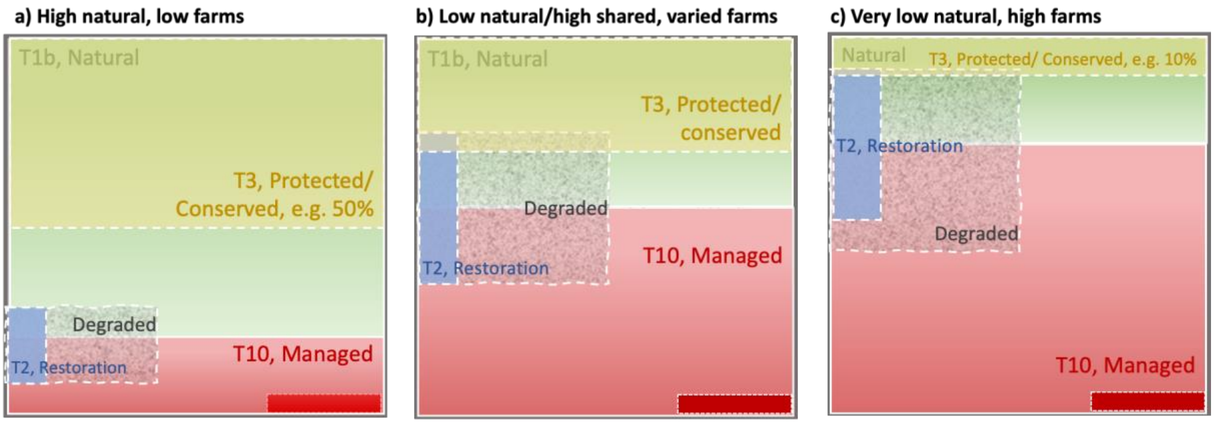

***Figure 3. Illustration of proportion of national area addressing Targets 1, 2, 3 and 10, among three country case studies** varying from high biodiversity/intactness at left to very low at right.*

These illustrations facilitate consideration of critical issues in achieving the four targets across countries, and ecosystem area and integrity outcomes of Goal A:

Case a:

- intact/natural area is high, so the country can contribute proportionately more towards the global protection/conservation target (T3).
- degraded area is low, so restoration may target improving sustainable production practices to ensure sustainability. There will be less need to address the specific target of increasing natural area as it is already high, and instead increasing integrity in existing (but somewhat degraded) natural areas could be prioritized.

Case b:

- with moderate natural areas grading into ‘shared’ areas (i.e., see condition 2 under the 3 conditions framework, Science Brief on Target 3) the country is capable of protecting 30% of area alongside targeted management and restoration actions to increase ecosystem area and integrity.
- restoration of ecosystem integrity in managed lands is a significant commitment that may increase the area of natural ecosystems, and does increase the integrity, and therefore the sustainability, of managed ecosystems.

Case c:

- transformed and production ecosystems are very high, so the contribution to global protection/ conservation may be low by area, but may be very significant for rare, vulnerable and their last remaining intact ecosystems.

- Restoration may address three options: a) restoring transformed (production) ecosystems back to natural, which would contribute to the increase in natural area required for goal A; or b) restoring degraded but still natural ecosystems to higher levels of health, and c) restoring production ecosystems to more sustainable and healthy production ecosystems. Neither b) nor c) would contribute to increasing ecosystem area, but they would contribute to increasing ecosystem integrity.

These cases illustrate the complex accounting that needs to be done of differing national contexts, and their differing contributions to meeting the global targets. Thus some countries may make high contributions to conservation and less to restoration, while other countries make lower contributions to conservation, but high to restoration, contributing to overall equity across the GBF. Realization of any of these cases is dependent on national circumstances, the requisite level of resource mobilization for implementation of the GBF and application of these global targets in the context of national priorities. Costs and benefits of the outcomes need to be weighed, acknowledging the findings in the accompany briefs on e.g., pollution (Target 7), climate (Target 8) and sustainable production systems (Target 10), that alongside supply and demand side efficiencies and waste reduction, and transformations to sustainable practices, that benefits often outweigh costs of assuring sustainability (Strassburg et al. 2020). The importance of fully national spatial planning (T1) is further emphasized by this, and of the multilateral cooperation framework among countries, to equitably address Targets 1b, 2, 3 and 10. Equity is also achieved through the resource mobilization framework, to assure adequate funding for actions to achieve the global targets.

3) Glossary

Notes to the reader: Underlined terms and definitions in plain font are from the GBF Glossary (CBD/WG2020/3/3/Add.2/Rev.1). *Text in italics* are additions to or comments made on GBF Glossary definitions.

Baseline condition or Reference state - A reference state for the ecological, economic or social condition describing the state of the system in question. The baseline condition may be associated with a historical state in the past, or a contemporary state observed in a relevant geographic location.

Baseline period - A historical period used to identify a specific baseline condition.

Baseline - Reference reporting period - The time period used as the starting point for reporting progress on targets and goals (most reasonably 2020, which was the end of the Strategic Plan for Biodiversity 2011-2020). "Baseline" is often used in place of "reference reporting period". This has led to considerable confusion in negotiations. Consistently using "reference reporting period" would avoid further confusion.

***Critical ecosystems** - Ecosystems that are rare, unique, threatened, essential for planetary function, or which cannot be readily restored (Díaz et al. 2020, see Glossary Appendix-Box 1 for more detailed definition)*

Connectivity (Ecosystem) - "Connectivity (i.e., ecological connectivity) is the unimpeded movement of species and the flow of natural processes that sustain life on Earth. It may thus also refer to continuous ecosystems often connected through ecological corridors. There are two types of connectivity: structural (in which the continuity between ecosystems is identified) and functional (in which the movement of species or processes is verified)."[1]

***Converted ecosystems (see also transformed ecosystems):** Converted ecosystems are ecosystems that have been transformed from a natural state to non-natural state. This term is principally used for terrestrial ecosystems. On land converted ecosystems are primarily croplands and pastures that have the potential to be restored to natural ecosystems (Strassburg et al. 2020). Strassburg et al. (2020) identified 2,870 Mha of converted lands globally, including "54% were originally forests, 25% grasslands, 14% shrublands, 4% arid lands and 2% wetlands." Note that this estimate of converted area is considerably less than the approximately 4900 Mha of land in crops and pastures identified by*

[1] UNEP/CMS/Resolution 12.26 (Rev.COP13)

the FAO (=38% of land area, IPBES 2019), perhaps because of substantial differences in defining natural vs. managed grasslands.

Degraded ecosystems - "Land degradation can occur either through a loss of biodiversity, ecosystem functions or services. From an ecological perspective, land degradation may include complete transformation in the class or use of the ecosystem, such as the conversion of natural grassland to a crop field, delivering a different spectrum of benefits, but also degradation of the "natural" or "transformed" system. Natural ecosystems are often degraded prior to being transformed. The transformed ecosystem that results from this conversion can, in turn, be degraded and see a reduction in the delivery of its new functions (e.g., an agricultural field where soil degradation and reduced soil fertility leads to reduced crops).

The same concepts are applicable to the degradation of marine and freshwater ecosystems. It may take the form of changed trophic structures in a marine community (through fishing pressure and selective removal of species), transformation of the soft and hard benthos (through repetitive sweeps of contacting gears, such as trawls) or artificial reef construction, to cite only a few examples. In the case of aquatic freshwater ecosystems, the construction of dams and reservoirs over river courses or the conversion of natural wetlands into rice paddies are examples of ecosystem transformation."[2]

Comments:

- *The definition of "degraded" ecosystems is highly value laden and also depends greatly on the metric that is used to measure degradation (IPBES 2019, UNCCD 2022). Because of this, the UNCCD (2022) estimated that degraded lands are roughly between 20 and 40% of total land surface. Substantially larger ranges have been reported previously (Gibbs & Salmon 2015). Estimates of degraded marine ecosystems also vary greatly: the percentage of stocks fished at biologically unsustainable levels was 34% in 2017 (FAO & INRAE 2020). A much stricter definition could be based on the observation that 87% of the ocean is sufficiently impacted by human influence that it should not be considered wilderness (Jones et al. 2018).*
- *Closer alignment with UNCCD definitions would provide more consistency across Multilateral Environmental Agreements (MEAs).*

Ecosystem / ecological integrity: "An ecosystem is generally understood to have integrity when its dominant ecological characteristics (e.g., elements of composition, structure, function, and ecological processes) occur within their natural ranges of variation and can withstand and recover from most perturbations" (CBD/SBSTTA/24/3/Add.2/Rev.1, para. 18). Moreover, Add.2 refers to "including species diversity and abundance and communities of interacting species within ecosystems" (para. 21). Indicators of ecosystem integrity may include the "structure, function and composition of an ecosystem relative to the pre-industrial range of variation of these characteristics" (Hansen et al. 2021. Towards monitoring ecosystem integrity within the Post-2020 Global Biodiversity Framework, https://doi.org/10.32942/osf.io/eyqw5)"

Comments:

- *See discussion of issues of definition of ecosystem and ecological integrity in Section 1.b.*

Intact ecosystems: *See "wilderness" since the definition in the GBF glossary is for "intact and wilderness areas" which are not necessarily the same thing. The term "intact" does not have a clear, commonly accepted definition in the scientific literature, but commonly refers to ecosystems that have a species composition and ecological functioning that is close to the natural state of the ecosystem under the prevailing soil and climate conditions as result of absence of disturbance, currently and in the mid to long-term past.*

Like-for-like compensation *- To be successful in compensating for losses in natural ecosystem area, restoration should focus on replacing destroyed or badly degraded natural ecosystems with a similar ecosystem type, using a relatively fine level of definition of ecosystem type. These principals are often collectively referred to as like-for-like compensation (Díaz et al. 2020, Maron et al. 2021).*

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[2] CBD/POST2020/WS/2019/11/3, see also IPBES 2018, UNCCD 2022

Managed ecosystems*: We suggest using the definition of Díaz et al. (2020). "Managed ecosystems are those whose biotic composition is the result of deliberate manipulation by people, this often being a stronger factor than climate or substrate. In many cases the main plant or animal assemblages are designed anew for the purposes of serving human ends, such as providing food, fibers, energy or recreation. Obvious examples are agricultural fields, orchards, urban parks, aquaculture ponds, artificial reefs, rice paddy terraces, and many plantations. "Managed" landscapes and seascapes should not be considered as "lost for nature"; they host the greatest proportion of the world's biodiversity of domesticated organisms… and also a significant proportion of wild biodiversity, including wild relatives of crops…" See also Glossary Appendix-Box 2*

Natural ecosystems: "Areas composed of viable assemblages of plant and/or animal species of largely native origin and/or where human activity had not essentially modified an area's primary ecological functions and species composition.[3]

Comments:

- *The term "natural ecosystem" does not have a clear, commonly accepted definition in the scientific literature.*
- *Highly natural and highly managed are two ends of a gradient. It is essential to address this issue in the glossary and indicate where the line between natural and managed is based on considerations below (see Glossary Appendix-Box 2 for details).*
- *In this brief we have used a pragmatic definition that focuses on high integrity, but allows for moderate human influence following the definition used in Díaz et al. (2020, Glossary Appendix-Box 2). This is not as strict as the criteria of very high integrity, intactness and large size used to define "wilderness". Estimates of global natural area based on criteria of similar those of Díaz et al. (2020), that is, ecosystems with low, but not necessarily very low human influence, are close to 50% of ice-free land area (range 48-56%, see synthesis of Riggio et al. 2020). Greater precision in quantifying natural area results from the lack of a widely accepted definition, and the difficulty in distinguishing between semi-natural and natural states, especially for grasslands (Riggio et al. 2020).*
- *IPBES (2019, natural ecosystem indicator based on FAO data) defines natural terrestrial ecosystems as all ecosystems that have not undergone transformation to croplands, grasslands or urban areas (about 38% of land). This definition means that a wide range of modified ecosystems are included, for example many moderate to heavily exploited forests, secondary forests, and extensive pasture are classified as natural using this definition. A case can be made for including some secondary forests and extensive pastures in the 'natural' category, but is a source of considerable debate and very large uncertainty in land cover classifications (Prestele et al. 2016).*
- *Some definitions of 'natural' are very strict such as: "An ecosystem where human impact has been of no greater influence than that of any other native species, and has not affected the ecosystem's structure since the industrial revolution. Human impact excludes changes of global proportions, such as climate change due to global warming." EEA (https://www.eea.europa.eu/help/glossary/eea-glossary/natural-ecosystem). Only about a quarter of the ice-free land surface is considered to have very low human influence (range 20-34%, see synthesis of Riggio et al. 2020).*
- *The choice of definition of "natural" greatly alters calculations of the extent and feasibility of net gains at global and national levels. Retaining a very strict definition of "natural" would mean excluding a very large fraction of restoration activities from consideration as contributing to increasing natural ecosystem area. It would also substantially lower estimates of the rates of natural ecosystem area loss and make it much easier to attain net gain objectives in Goal A (because the denominator for calculating net gain is much smaller, see Section 2b)[4] Such a definition could be harmful to biodiversity and NCP because areas outside such strictly defined areas play important roles in biodiversity conservation (Locke et al. 2019).*

[3] Definition used in UNEP-WCMC glossary www.biodiversitya-z.org
[4] UNCCD (2022)

Net gain - A goal either of no net loss or net gain of biodiversity is typically set (also referred to as net neutral and net positive goals, respectively) relative to a predetermined baseline and can entail concomitant absolute losses and gains across different places, the sum of which leads to zero or positive change at an aggregated spatial scale. The process is implemented through national planning processes and negotiations between government agencies, conservation actors, and developers, with elements of the process often formalized within an Environmental and Social Impact Assessment. The mitigation hierarchy comprises four broad steps that are intended to be implemented in order of priority sequentially: (1) avoiding, (2) minimizing, (3) remediating, and (4) offsetting.[5]

Comments:

- *This definition would gain in clarity by adding mathematical definitions of net gain in natural ecosystem area and natural ecosystem integrity (at least in an annex).*
- *It is unclear what the second sentence above has to do with the definition, it focuses on a particular case of implementation, and could be removed.*
- *Caveats concerning net loss / no net gain objective would provide a more complete definition of net gain (see Section 1.b)*

Restoration - IPBES has defined restoration as "any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state" (2019). This definition covers all forms and intensities of the degradation state and, in this sense, is inclusive of the definition adopted by the Society for Ecological Restoration.[6] Ecosystem restoration means "assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact". Restoration can happen in many ways – for example, through actively planting or by removing pressures so that nature can recover on its own. It is not always possible – or desirable – to return an ecosystem to its original state.[7]

Comments:

- *As note in Sections 1b and 1c, it could be very helpful to have a coarse typology of restoration actions indicating how they contribute to ecosystem integrity and natural ecosystem area.*

Semi-natural ecosystems *- Semi-natural habitats have ecological assemblages that have been substantially modified in their composition, balance or function by human activities. They may have evolved through traditional agricultural, pastoral or other human activities and depend on their continuation to retain their characteristic composition, structure and function. Despite not being natural, these habitats and ecosystems often have high value in terms of biodiversity and the services they provide.*[8]

Shared lands *- sensu Locke et al. (2019).*

Transformed ecosystem *– Ecosystems that are transformed from a natural state to a non-natural state, typically for agriculture or forestry. See Glossary Appendix-Box 2*

Wilderness - The term "wilderness" is used to describe landscapes and seascapes that are biologically and ecologically largely intact, with a low human population density and that are mostly free of industrial infrastructure. The term "wilderness" is therefore not exclusive of people but, rather, of human uses resulting in significant biophysical disturbance that lead to significant changes in species composition or ecological functions. As a result, wilderness quality is often defined in terms of remoteness from urban settlements and modern infrastructure and the degree of ecological impacts from industrial activity. However, the term is not meant to suggest an area must be completely "pristine" or "untouched"

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[5] See Arlidge et al, "A Global Mitigation Hierarchy for Nature Conservation", BioScience, vol. 68, Issue 5, May 2018, pp. 336-347, https://doi.org/10.1093/biosci/biy029; Business and Biodiversity Offsets Porgramme, (2012) Standard on Biodiversity Offsets et al. 2018, "The many meanings of no net loss in environmental policy", Nature Sustainability 1, 19–27 (2018) https://www.nature.com/articles/s41893-017-0007-7.

[6] https://www.cbd.int/doc/c/fcd6/bfba/38ebc826221543e322173507/post2020-ws-2019-11-03-en.pdf

[7] United Nations Decade on Ecosystem Restoration, https://www.decadeonrestoration.org/what-ecosystem-restoration

[8] Definition in UNEP-WCMC glossary www.biodiversitya-z.org

as there are few places remaining on Earth that meet this standard. Further, it must be recognized that the terms "intactness" and "integrity" are measured on a continuum and are not binary.[9]

Comments:

- *In addition to the criteria above, wilderness definitions typically include specific reference to very large size; i.e., large enough that all native biodiversity, including viable populations of wide-ranging species, can be maintained.*
- *Ambiguities in the definition of wilderness, challenges in data availability and interpretation, and differences in indicators used has resulted in a large range of estimates of what could be classified as wilderness.*
- *Locke et al. (2019) found that 18% of global land area could be considered wilderness. Using a criteria of "very low human influence" gives a range of 20-34% of land area for intact ecosystems, and could be used as an estimate of wilderness (see Riggio et al. 2020). At the extreme for terrestrial ecosystems, a recent study suggested that only "2.9% of the land surface can be considered to be faunally intact" (Plumptre et al. 2021, but see Grantham et al. (2020), suggesting that this is based on overly strict criteria) .*
- *In this and other briefs, we use the wilderness estimates of Locke et al. (2019) for terrestrial ecosystems. We do this because it is the most operational indicator for wilderness. Other estimates of wilderness area on land differ from this substantially (Riggio et al. 2020, see discussion in 'natural' definition).*
- *Jones et al. (2018) estimated that about 13% of the ocean can be considered wilderness because it is sufficiently free of human influence.*
- *There is large spatial overlap in areas considered wilderness and indigenous territories on land; as such, the role of IPLCs in the use and conservation of these areas should be taken into consideration (Fernández-Llamazares et al. 2020).*

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[9] Kormos et al. (2017). World Heritage, Wilderness and Large Landscapes and Seascapes. Gland, Switzerland: IUCN. viii + 70pp, https://portals.iucn.org/library/sites/library/files/documents/2017-028.pdf). See also Locke et al. 2019

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5) Background and Glossary Appendixes

Background Appendix-Box 1: Assumptions for net change in natural terrestrial ecosystem area calculations

Comments

These calculations for the two scenarios in Figure 1 are based on simple assumptions. They are principally intended to highlight how calculations of net changes in ecosystem area can be made, how they depend on actions taken in Targets 1 and 2, and general levels of ambition that are needed to achieve the net gain objectives in goal A of the first draft of the GBF.

Wording of targets

Wording of Targets 1 and 2 has been modified in the figure to reflect suggested wording in Section 1d. Similar assumptions about losses and restoration could have been made without this assumption, but this was done to illustrate how quantitative relationships between targets and Goal A are more straightforward with rewording.

Assumptions for all scenarios

- Global ice-free land area: About 13000 Mha (FAO ref)
- Percent land area natural: Approximately 50% of ice-free land is currently natural (Riggio et al. 2020, see discussion in Section 1 and Glossary).
- Current rates of loss of natural ecosystems: the current gross rate of deforestation is about 10 Mha per year (SCBD 2020, although other data sets suggest higher rates, for example the Global Forest Watch reports 11 Mha of tropical forest cover loss in 2021). The rate of loss of other ecosystems is not well known, in part because of the difficulty in distinguishing between the loss of pasture and natural grassland. As an educated best guess, it is assumed that total losses of natural ecosystem area are about double rates deforestation = 20 Mha per year. This rate of loss is used in all scenarios for the period 2021-2023. Global scenarios provide a very wide range of projected losses from 2020-2050: from about 10 Mha/yr to over 60 Mha / yr (see Section 2b).

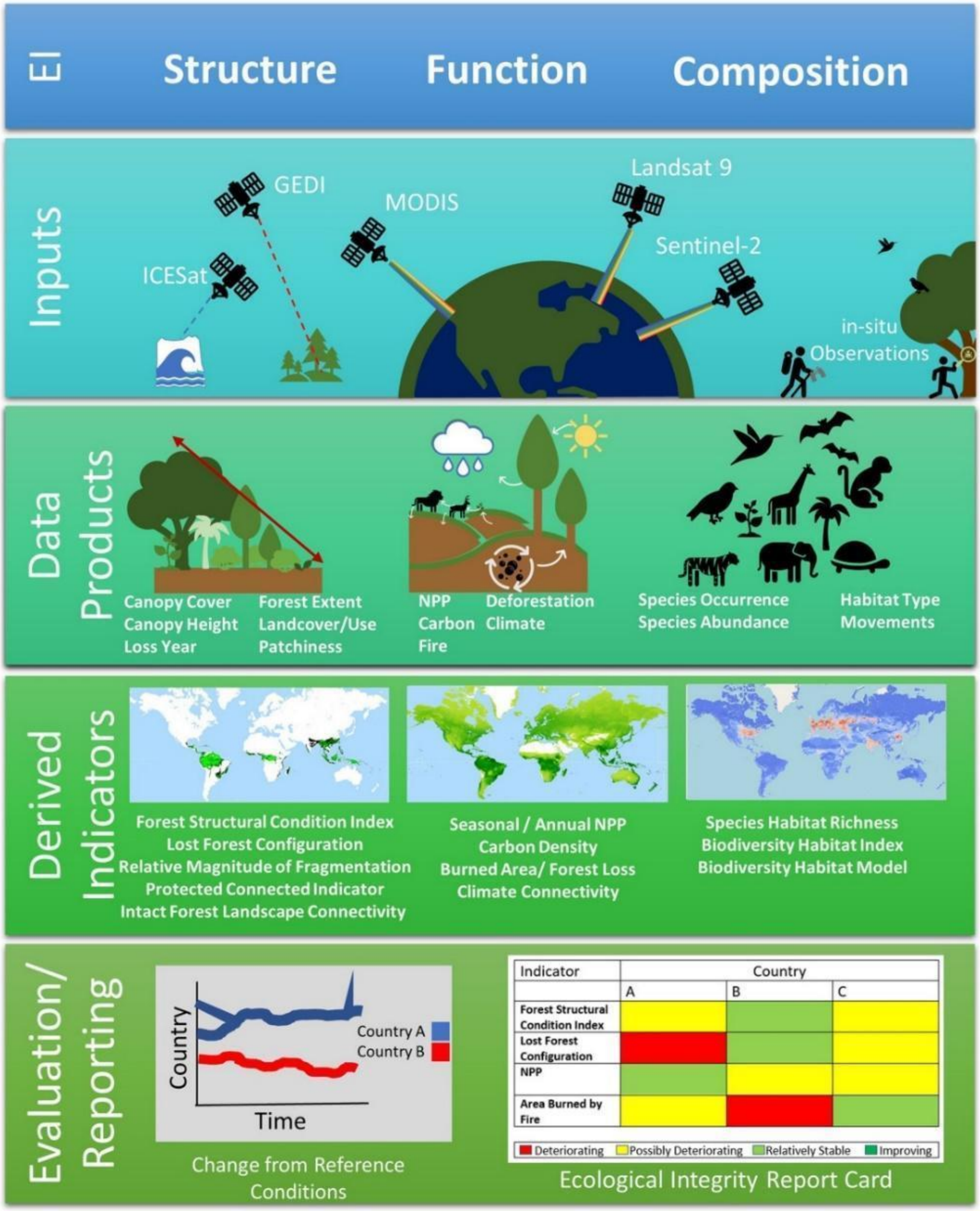
Assumptions for scenarios that meet Goal A net gain targets

- Reductions in losses: For the period 2023-2030 it is assumed that loss is halted in wilderness areas (as a proxy for critical ecosystems) and reduced by 70% (a quantitative translation of "significant reduction"). For the period 2031-2050 it is assumed that rates of loss are zero for all natural ecosystems. These are very ambitious objectives for 2030 and are exceptionally ambitious for 2050 (Strassburg et al. 2020).
- Rates of restoration of transformed to natural: For these scenarios, the rates of restoration were set based on what was needed to reach 5% net gain in natural ecosystem area in 2030 (=400 Mha) and 15% in 2050 (=1050 Mha). Note that Strassburg et al. (2020) estimated that 430 Mha of restoration of transformed to natural ecosystems " could avoid 60% of expected extinctions while sequestering 299 gigatonnes of CO2" and could be done without compromising food security.

Assumptions for scenarios that meet Goal A net gain targets

- Reductions in losses: Current rates of losses (20 Mha per year) are used for the time periods 2021-2030 and 2031-3050, as the simplest business-as-usual scenario.
- Rates of restoration of transformed to natural: The Bonn Challenge is for 350 Mha of forest restoration, but 66% of this commitment are forest plantations or agroforestry, putting an upper limit on the increase in natural area of forests of 115 Mha (SCBD 2020, UNCCD 2022). Restoration rates that would create new natural ecosystem area for non-forest ecosystems are poorly bounded. As a best educated guess, the rate of restoration of 150 Mha per decade was used for the period 2021-2030. This same rate of restoration was assumed for the period 2030.

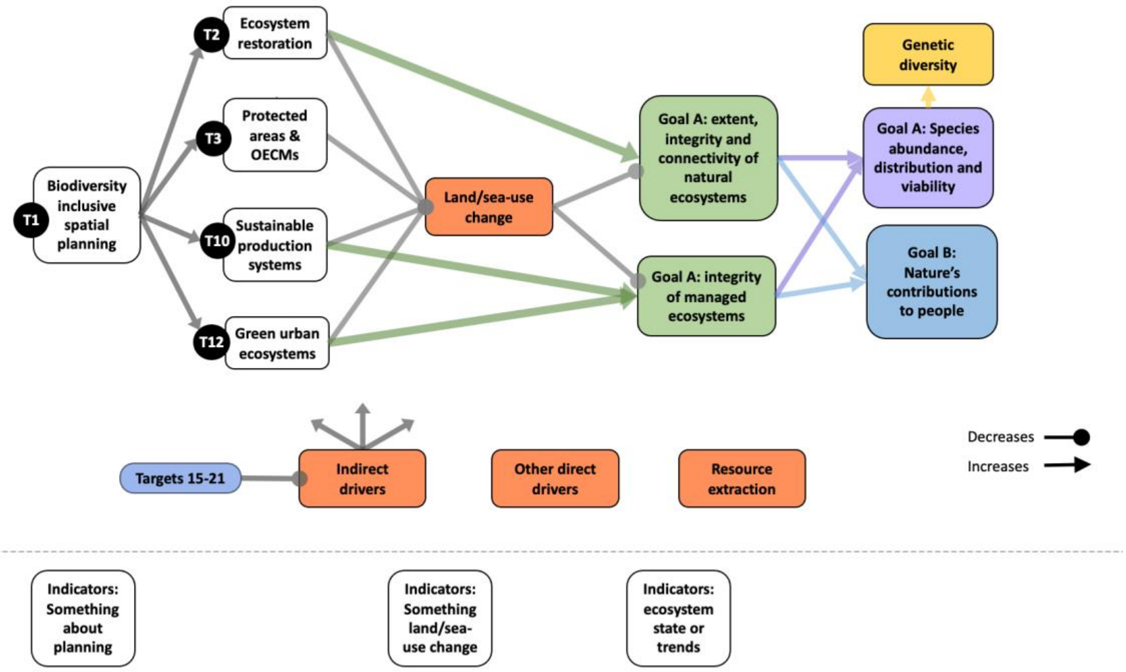
Background Appendix-Figure 1. Flow diagram of the recommended approach for tracking indicators of ecosystem integrity. From Hansen et al. (2021).



Background Appendix-Table 1. Description of indicators recommended for forest ecosystem integrity in the context of the post 2020 GBF. These individual metrics combine to form the Ecological Integrity Index. Steps are: 1) Identify "natural" cells within an ecoregion (e.g., Human Footprint < .4); 2) use the average value of the metric for these natural cells as representing maximum integrity; 3) derive a relative value for each cell across the ecoregion as a percentage of this average for natural cells); 4) average these relative values across all the metrics to derive the Ecological Integrity Index. Countries may choose to weight the individual relative metrics differentially based on national goals and targets. From Hansen et al. (2021).

Ecosystem Component / Indicator	**Description**	**Spatial / Temporal Resolution**	**Citation and Data Source**
Ecosystem Structure			
Forest Structural Condition Index (FSCI)	Vegetation structure within forest stands. Inputs include canopy cover, canopy height, and time since disturbance.	30 m 2012-2019 Tropical forests	Hansen et al. 2019
Lost Forest Configuration (LFC)	Index of the current patchiness of forest areas relative to the natural potential in forests without extensive human modification.	300m 2019. Plans for annual updates.	Grantham et al. 2020
Ecosystem Function			
MODIS Net Primary Productivity (NPP)	Functional measure of new biomass fixed by green plants through photosynthesis.	1 km 2000-2020	Running et al. 2004 Scurlock & Olson 2013
MODIS Burned Area	Fire history relates directly to the function of a given ecosystems disturbance regime. ….	250 m 2000-2020	Chuvieco et al. 2018
Ecosystem Composition			
Species Habitat Index by group	Average decrease in suitable habitat and populations of amphibian, bird and mammal species.	1km 2000-2018	Powers & Jetz 2019 Jetz et al. 2019
Local Biodiversity Intactness Index (BII)	Estimates how much of a terrestrial site's original biodiversity remains in the face of human land use and related pressure.	1 km 2001=2020	Newbold et al. 2016
Biodiversity Habitat Index (BHI)	Proportion of gamma diversity retained in any specified spatial reporting unit by combining best-available mapping of ecosystem integrity with beta-diversity modelling.	1 km 2005-2015 (2020 update in progress).	Hoskins et al. 2020 Mokany et al. 2020

Background Appendix-Figure 2. Contributions of spatial planning to ecosystem objectives of the GBF



Glossary Appendix. Additional comments on glossary definitions

Glossary Appendix - Box 1: Definition of critical ecosystems - Excerpt from CBD/SBSTTA/24/INF/9

"Ecosystems for which evidence of potential for restoration or replacement is lacking should be considered "no loss" ecosystems, because gains could not counterbalance losses of such ecosystems. NNL will almost certainly lead to inadequate outcomes for those ecosystems: for example, the inability to compensate for losses in some ecosystems, or the long time lags involved in such compensation, may lead to collapse of these ecosystems or have large impacts on planetary functions. These critical ecosystems may already be rare (small spatial area, e.g. specific island ecosystems), vulnerable (substantial habitat loss, intrinsically rare, or containing particularly important biotic assemblages, e.g. the Atlantic forest), or so important for planetary function, that any further decline in their area or integrity will lead to either a collapse/extinction of the ecosystem or of the function it provides, e.g. mangrove and seagrass ecosystems (Bland et al 2017 and 2018, Hughes et al 2018). For these critical ecosystems, an immediate "no loss" goal starting in 2020 should apply, complemented by increases in area and condition essential to mitigate their risk of collapse or loss of function. To support this, an inventory or catalogue of no loss critical ecosystems should be developed at national and global levels."

Glossary Appendix - Box 2: Natural to managed ecosystem gradient - Excerpt from Díaz et al. (2020) Supplement S3.

Goals for "natural" and "managed" ecosystems

On land and in water, ecosystems span a wide gradient of human influence, from those with relatively low human imprint (sometimes called wilderness) to those almost entirely assembled by humans, such as croplands, aquaculture ponds or green urban spaces. Goals need to be set across the whole gradient, attending to the specificities and values of these different landscapes. A pragmatic distinction between "natural" and "managed" ecosystems is needed to accommodate the different approaches these require in global goal-setting, policy and action, and also to avoid perverse outcomes from substitution among them (26) (see S4, annotations b-d).

"Natural" ecosystems, in the context of this article, are those whose species composition is predominantly native and determined by the climatic and geophysical environment. This is not to say they are devoid of human influence. The majority of "natural" ecosystems have been reconfigured by people to a significant extent, although not to a degree that would make them "human-made" in the same way that "managed" ecosystems are. Even those that would qualify as "wilderness" (7), such as the Amazonia, the great Western Woodlands of Australia, the Congo forests of central Africa, or the Canadian Arctic Archipelago, do not necessarily exclude human habitation, management and use, sometimes for millennia (27-29). Moreover, many of them are strongly managed to maintain their perceived natural state (30, 31). "Natural" ecosystems are not only reservoirs of biodiversity *per se*; even those at the most intact extreme have high practical value to people. For example, large areas of carbon-dense old-growth forest, quintessential examples of "human-less" nature, are crucial to global climate stability: halting their conversion and loss is essential to protecting nature and to achieving the Paris Climate Agreement (32).

"Managed" ecosystems, in the context of this article, are those whose biotic composition is the result of deliberate manipulation by people, this often being a stronger factor than climate or substrate. In many cases the main plant or animal assemblages are designed anew for the purposes of serving human ends, such as providing food, fibers, energy or recreation. Obvious examples are agricultural fields, orchards, urban parks, aquaculture ponds, artificial reefs, rice paddy terraces, and many plantations. "Managed" landscapes and seascapes should not be considered as "lost for nature"; they host the greatest proportion of the world's biodiversity of domesticated organisms (33) and also a significant proportion of wild biodiversity, including wild relatives of crops (33, 34).

While the "wildest" extreme of "natural" ecosystems and the most artificial extreme of "managed" ecosystems are starkly different, the limits between the highest-integrity "managed" ecosystems and the most heavily reconfigured "natural" ecosystems are necessarily arbitrary. Many traditional cultural landscapes lie in the transition zone. Examples include traditionally burned hunting and grazing lands in Africa and Australia (35), "dehesas" in southern Europe (36), hay and sheep grasslands in Europe and Asia (37, 38), and "vegas" (wet meadows) in the high Andes (39). This practical and somewhat artificial distinction therefore should not be conflated with unhelpful dichotomies such as "natural (=human-less) ecosystems for nature" versus "managed ecosystems for people"."

Glossary Appendix - Box 3: Land degradation (IPBES 2018)

Legend: "Land degradation can occur either through a loss of biodiversity, ecosystem functions or services, without a change in land cover class or use (1), or by the transformation to a derived ecosystem type such as the conversion of natural cover to a crop field (2), delivering a different spectrum of benefits, but also typically involving loss of biodiversity and reduction of some ecosystem functions and services. The transformed ecosystem can also be degraded with respect to the new social expectations associated with that land use (3). Degraded natural ecosystems can also be transformed to another ecosystem (4), or restored towards their original natural state, either completely or partially ("rehabilitated") (5). Degraded transformed ecosystems can be rehabilitated towards a less degraded state, with respect to the expectation for a deliberately modified landscape (6). Both degraded and undegraded transformed lands can, under many circumstances, be restored or rehabilitated towards their original natural state (7 and 8).