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1 **Global no net loss of natural ecosystems**

2

3 **Abstract**

4 A global goal of No Net Loss (NNL) of natural ecosystems or better has recently been
5 proposed, but such a goal would require equitable translation to country-level contributions.
6 Given the wide variation in ecosystem depletion, these could vary from Net Gain (for
7 countries where restoration is needed), to Managed Net Loss (in rare circumstances where
8 natural ecosystems remain extensive and human development imperative is greatest).
9 National contributions and international support for implementation also must consider non-
10 area targets (e.g. for threatened species) and socioeconomic factors such as the capacity to
11 conserve and the imperative for human development.

12

13 **Main text**

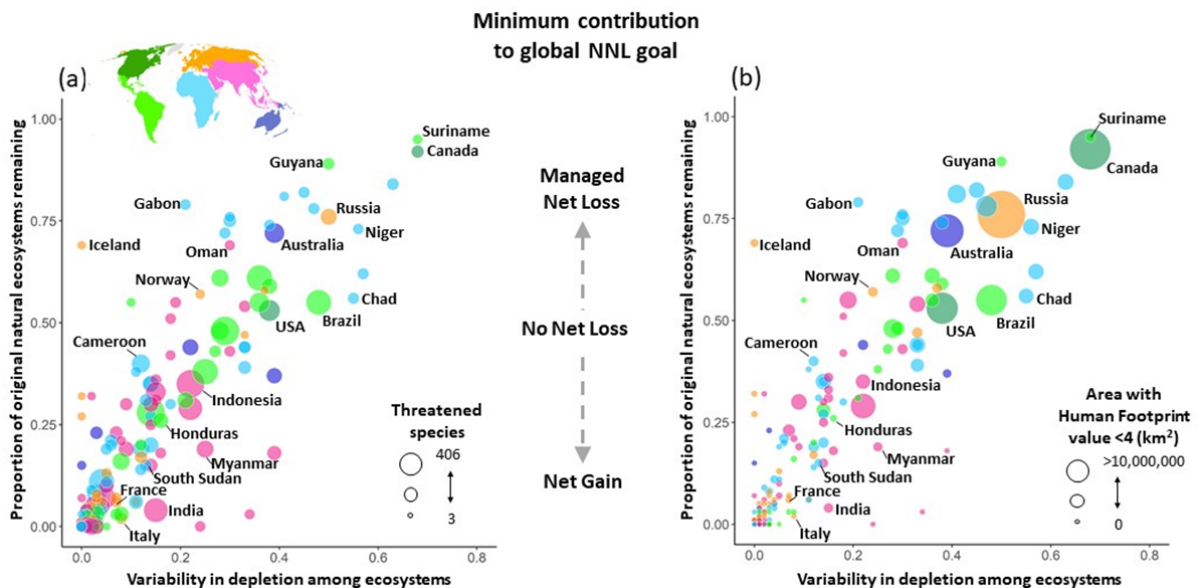
14 Momentum is building for an ambitious new commitment to be signed at the Conference of
15 the Parties to the Convention on Biological Diversity (CBD) in 2020 as a global framework
16 for nature conservation¹⁻⁴. Notable are calls for retention of half the Earth's natural
17 ecosystems^{5,6}, to be enshrined by 2030 as a target under the deal. Yet this leaves little 'room
18 to move'—approximately half the Earth's terrestrial ecosystems have already been lost⁷.
19 Nevertheless, complete cessation of anthropogenic impacts on natural ecosystems is
20 infeasible, given the imperative for socioeconomic development where current levels of
21 human development are low⁸. Conservation that ignores such differences among nations is
22 likely to be unjust⁹.

23 In this context, a goal of global No *Net* Loss (NNL) of natural ecosystems is likely the most
24 ambitious target that society can realistically achieve^{10,11}, at least by 2030. Such a goal allows
25 for losses in some places and gains in others, which, taken together, ensure no further net
26 decline of natural ecosystems, benefitting the species and people which rely upon them¹².
27 Global NNL implies an absolute cessation of decline in net terms—a key distinction from the
28 relative 'NNL' that characterises biodiversity offset policies¹³.

29 It is far from trivial to translate a global NNL goal to effective policy mechanisms and
30 mitigation approaches at the national level; indeed, the problem is akin to dividing

31 humanity's 'carbon budget' equitably^{14,15}. Here, we examine how different countries might
 32 set goals for retention and restoration as part of a contribution to achieving global NNL of
 33 natural ecosystems, using terrestrial ecosystems as an example.

34 Translating a global NNL goal to a blanket requirement for each nation to achieve NNL
 35 would clearly be inappropriately coarse. Instead, a global NNL target would act as an
 36 umbrella for a range of minimum net outcome goals adopted by each country as their
 37 respective contributions to global NNL (Fig. 1). Some countries support natural ecosystems
 38 across almost their entire extent—10 have more than 75% of original natural ecosystems
 39 according to the latest published human footprint¹⁶ (e.g. Suriname and Canada Fig. 1; see
 40 Supplementary Information for methods), while others retain close to none of their original
 41 natural ecosystems in reasonable condition (68 countries including France, Italy and India
 42 have <5% remaining; Fig. 1). Countries also vary tremendously in the imperative to convert
 43 or degrade those ecosystems in the pursuit of needed economic development, and in their
 44 capacity to protect and restore ecosystems. So, under a global NNL commitment, some
 45 countries might focus on restoring earlier losses, while others might further deplete their
 46 remaining ecosystems. Thus, some countries might commit to Net Gain, some to NNL, and in
 47 some circumstances, controlled loss, or drawdown, of ecosystems (here termed Managed
 48 Loss).



49

50 **Fig. 1.** Potential contributions of countries to global NNL. The proportion of natural ecosystems (Human
 51 Footprint value <4) remaining per country varies enormously, as does variation in the depletion among different
 52 ecosystems (Gini coefficient; see Supplementary Information). The minimum country-level contribution to a

53 global NNL goal must reflect this, as well as the absolute area of natural ecosystems remaining (Fig. 1b).
54 Ecosystem depletion must be considered alongside other factors in setting targets; e.g., the number of threatened
55 species according to the IUCN Red List of Threatened Species (for fully-assessed taxa only - mammals, birds
56 and amphibians) relates only weakly to retention of ecosystems (Fig. 1a).

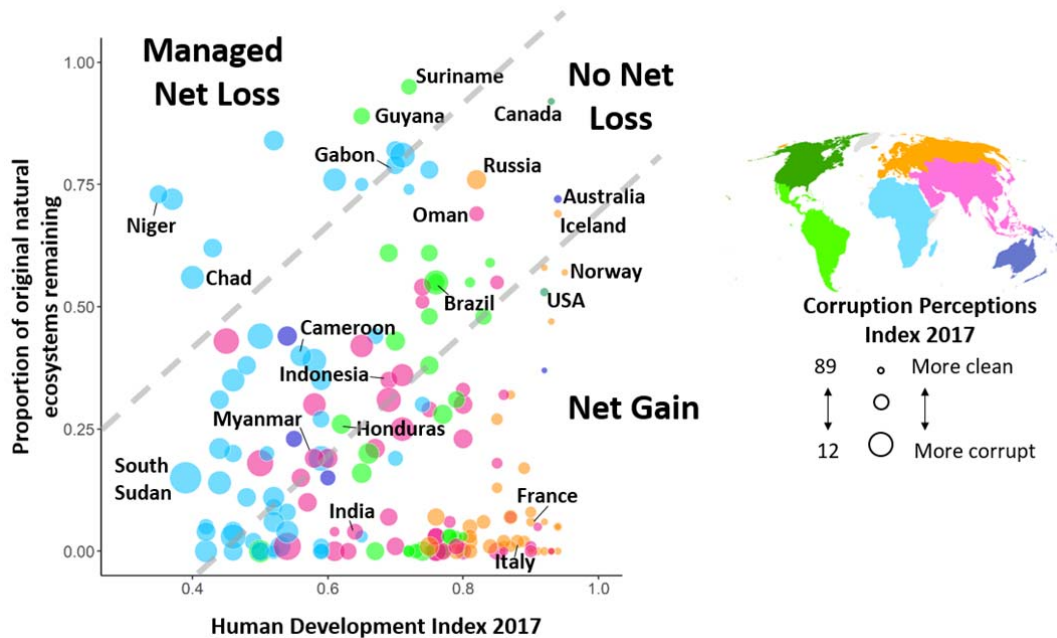
57

58 Information about depletion of natural ecosystems can help frame both country-level
59 conservation goals, and policy mechanisms for achieving those goals. For example, even
60 NNL is likely to be inadequate to conserve threatened species and functioning ecosystems for
61 countries whose natural ecosystems are most severely depleted. Therefore, for such countries,
62 Net *Gain* in the extent of their natural ecosystems is likely to be essential. For example, the
63 UK has only 6% of ecosystems with a Human Footprint of <4 remaining (a threshold used as
64 a proxy for ecosystem intactness⁷). The UK government recently proposed biodiversity Net
65 Gain as a requirement for new development projects¹⁷. Similarly, France has committed to
66 zero net conversion of natural land¹⁸. On the other hand, those countries with largely intact
67 remaining ecosystems (e.g. Suriname, Gabon) may, in some circumstances, be able to accept
68 further limited and controlled depletion ('Managed Net Loss') (Fig. 1). However, even if all
69 countries with less than 25% of natural ecosystems remaining adopt Net Gain and seek to
70 double the extent of those ecosystems through restoration, this would only contribute 4% to
71 global ecosystem extent. Conversely, even a small percentage of net loss from countries with
72 extensive remaining natural ecosystems, such as Australia and Brazil (5,535,401 km² and
73 4,643,615 km², respectively), would shift a very substantial restoration burden to other
74 countries, if global NNL is to be achieved.

75 Even within countries that retain similar amounts of natural ecosystems, variation in
76 depletion among different ecosystems can be lower (e.g. Norway, where retention of all its
77 different ecosystem types is similarly high) or higher (e.g. Chad, where some ecosystems are
78 much more depleted than others). In such cases, approvals for unavoidable losses of less-
79 depleted ecosystem types might be tied to requirements to restore other, more-depleted
80 ecosystems, using compensatory policy mechanisms like biodiversity offsetting^{19,20}. Further
81 complexity is introduced by the fact that some ecosystems may be extensive within a country,
82 but globally rare; conversely, others are highly-depleted at a country level, yet globally
83 common. Therefore, both country-level goal-setting, and trading losses for gains among
84 different ecosystems within a country, must reflect this variation to ensure all ecosystem
85 types can be adequately conserved.

86 We use the retention of terrestrial natural ecosystems to illustrate the complexity of
87 translating global NNL to country-level goals, and propose that a similar exercise could
88 consider the translation of the concept to the marine realm, or indeed to non-political units
89 such as ecoregions. However, area-based retention is only one type of target that must be set
90 for biodiversity to be adequately conserved. For example, the number of species listed as
91 threatened with extinction does not correlate strongly with the depletion of natural
92 ecosystems within a country (Spearman's $R = 0.17$; Figure 1a), though species decline often
93 lags behind habitat loss²¹. Therefore, further ecosystem losses even from countries with
94 relatively extensive natural systems could have a disproportionately negative impact in the
95 most diverse but imperilled places (e.g., Brazil; 55% ecosystems remaining but 290 globally-
96 threatened species birds, mammals and amphibians).

97 A purely biophysical basis for conservation goal-setting in a country ignores important
98 socioeconomic realities, which may further modify appropriate relative contributions of
99 countries to a global NNL goal. Countries vary enormously in their levels of human
100 development; people's basic needs in many countries are not currently being met¹². Rapid
101 economic growth for those at the bottom of the global wealth rankings is the most important
102 goal for governments in many such countries and is essential from a human rights
103 perspective. The countries with the most severe ecosystem depletion (and therefore requiring,
104 in principle, biodiversity Net Gain) include many countries with the lowest Human
105 Development Index (HDI) values (e.g. numerous African countries) (Fig. 2). Given that
106 converting ecosystems can contribute to much needed development, and significant amounts
107 of ecosystem degradation in poorer countries has contributed to fuelling economic growth in
108 richer countries²², it is unrealistic as well as unjust for goals to be set without socio-economic
109 circumstances being considered. Addressing these equity implications, while also recognising
110 the fundamental role of nature in supporting achievement of the Sustainable Development
111 Goals¹², will also be essential to secure support for a global NNL commitment.



112

113 **Fig. 2.** The degree of human development should affect minimum country-level contributions to achievement of
 114 global NNL, such that high HDI countries commit to at least country-level NNL. Bubble size reflects the
 115 Corruption Perceptions Index (2017) for each country; see Supplementary Information.

116

117 Given that globally, biodiversity loss already exceeds safe levels²³, NNL at the country level
 118 might be the minimum acceptable standard for wealthy, developed countries where standards
 119 of living are already high (e.g. Australia, Canada; Fig. 2). We suggest their conservation
 120 goals should be set such that further degradation and loss of ecosystems is halted—at least in
 121 net terms. This may require radical solutions including moving away from the paradigm that
 122 economic growth is always desirable⁹.

123 Countries with low HDI are more likely to face further pressure on their natural ecosystems
 124 to facilitate urgently-needed economic development. Therefore, even where the level of
 125 depletion of natural ecosystems implies a NNL goal, Managed Net Loss may be unavoidable
 126 for such countries (Fig. 2), at least temporarily²⁴. Countries with a low HDI may reasonably
 127 expect support from the international community to deliver on their contribution to a global
 128 NNL goal. Unfortunately, weak governance in some low HDI countries discourages such
 129 investment²⁵ and can limit the effectiveness of any development support²⁶ or of any in-
 130 country mechanisms to compensate for biodiversity losses. For example, many of the
 131 countries to which assistance may need to be provided score poorly on the Corruption

132 Perceptions Index (Fig. 2). Achievement of global biodiversity conservation arguably is most
133 sensitive not to the global goals and targets that are agreed, but to how well such wicked
134 challenges to their implementation are addressed²⁷.

135 Our framework provides guidance on the principles through which different countries could
136 identify appropriate respective contributions toward a global goal of NNL of biodiversity.
137 Any agreed set of contributions must tackle the reality of both biodiversity depletion, its
138 causes, and global inequity in both ongoing pressures and capacity to respond to them. Goals
139 must be transparently managed to avoid the task falling inequitably upon the world's poorest
140 countries, while recognising that development at the expense of biodiversity is
141 unsustainable²⁸.

142 Loss without limit is the paradigm under which natural ecosystems are currently being
143 destroyed³. The need to clarify the overarching goal of the CBD and sharpen our
144 commitments to retain, restore, and protect natural ecosystems was underscored resoundingly
145 by the recent release of the IPBES global assessment²⁹. So, as the focus turns to setting post-
146 2020 conservation targets under the CBD, calls to dramatically increase their ambition^{1,30} and
147 to set explicit nature retention targets³ must be heeded—and a pathway to translate them to
148 country-level contributions laid out. A global NNL goal sets a limit to the loss we—and
149 biodiversity—can tolerate, while allowing for human development where it is most urgently
150 needed. Any basis for country-level commitments to a global NNL goal must reflect the
151 substantial variation among countries in the level of depletion of their natural ecosystems—
152 but also the degree to which capacity to conserve and the imperative for human development
153 varies globally.

154

155

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235

1 **Supplementary Information**

2 We used the depletion of natural ecosystems as one proxy for biodiversity loss, and the global
3 Human Footprint 2009 dataset¹ as an indicator of this depletion. The Human Footprint is a
4 comprehensive representation of anthropogenic threats to biodiversity, which cumulatively
5 accounts for eight human pressures—built environments, crop lands, pasture lands, human
6 population density, night lights, railways, major roadways, and navigable waterways¹. It is
7 mapped across the terrestrial surface of the globe at a 1 km² resolution, on a scale of 0
8 (lowest Human Footprint) to 50 (highest Human Footprint). Human Footprint values of 0-3
9 are representative of land that is largely devoid of infrastructure and development (although
10 may support sparse human populations)^{2,3}. We therefore considered areas with a Human
11 Footprint value of ≥ 4 to be transformed – in other words, no longer supporting a natural
12 ecosystem (as per Watson, et al.³).

13 For 170 countries (for which data were also available for all measures), we calculated the
14 area of the country that is mapped with Human Footprint values of 0-3, as a proportion of the
15 area of the country (for which Human Footprint mapping was available). This represented our
16 measure of the proportion of the original natural ecosystems remaining in each country. We
17 also calculated the variance in depletion of specific natural ecosystem types in each country.
18 To do this, we used the map of global terrestrial ecoregions⁴, to represent the broad
19 ecosystem types that do or would have naturally occurred in each country. We calculated the
20 loss of each ecoregion type per country, by overlaying the Human Footprint map (value ≥ 4).
21 To calculate the variation in depletion among ecoregion types within each country, we used
22 the Gini coefficient – a metric frequently used to indicate dispersion within a frequency
23 distribution. Although most commonly used as an index of income inequality, it can be used
24 as an index of inequality for disparate datasets; a value of 0 indicates all values are identical
25 and 1 indicates extreme disparity among values. All GIS analysis was undertaken using
26 ArcMap6.1, with spatial datasets projected to a Mollweide coordinate system.

27 To explore the extent to which countries differ in their biophysical context, we plotted the
28 proportion of the original natural ecosystems remaining in each country against the variance
29 in depletion of natural ecosystems. We also considered two other measures of the status of a
30 country's biodiversity: the number of species listed as threatened under the IUCN Red List of
31 Threatened Species (restricted to fully assessed taxa only, as of November 2018: mammals,

32 birds, amphibians; note that most taxa are poorly known, so this too is a partial measure); and
33 the total area (km²) of natural ecosystems remaining in each country.

34 To examine how countries varied in environmental *and* socioeconomic contexts, we
35 incorporated two further datasets into our analysis. We used the 2017 Human Development
36 Index (HDI)⁵ as a representation of key elements of human development at the national level.
37 This composite metric subsumes indices relating to life expectancy, education and per capita
38 income. We also considered the 2017 Corruption Perceptions Index (CPI)⁶, which represents
39 relative public sector corruption levels of nations as perceived by experts and businesspeople,
40 and has been linked with the strength of a nation's democratic institutions⁷. We plotted these
41 variables as they relate to a nation's level of depletion of ecosystems, to examine how
42 variation in a country's socioeconomic factors potentially affect its capacity to contribute to a
43 goal of global NNL.

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