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**Is biodiversity as intact as we think it is?**

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Since it was first proposed as a metric for assessing progress in reducing the rate of loss of biodiversity, the intactness of biodiversity has become an influential concept in the measurement of the state of wild nature [1]. The Biodiversity Intactness Index (BII) is intended to be an indicator of the average abundance of a large and diverse set of wild species in a given geographical area, relative to a reference level: either the abundance assumed in pre-modern times [1] or that expected to prevail in vegetation cover unaffected by human activities under current climate conditions [2]. Global mapping of the BII [2] is based upon regression models of the total abundance of species of several taxa in relation to land use, land use intensity, human population density and distance from roads extrapolated using largely remotely-sensed data. It is a modelled estimate of current total abundance expressed as a proportion of the total abundance expected in primary vegetation in the same locality in the absence of human activities.

The BII has several advantages, not least that it reduces the risk of setting conservation goals that are insufficiently ambitious because of the shifting baselines syndrome [3] in which misleading short-term comparisons are made of the current state of biodiversity with that in the recent past. These advantages have been widely recognised. The BII has been endorsed by the Group on Earth Observations of the Biodiversity Observation Network and adopted by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) as a "core" indicator of trends and biodiversity and ecosystem services. This means that IPBES assessments must use it to report on progress towards the Convention on Biodiversity’s Aichi targets 12 and 14 (extinction risk and ecosystem resilience). It has also been adopted by the Biodiversity Indicators Partnership as an indicator to track progress towards Aichi target 5 (that the rate of habitat loss is reduced by half by 2020).

Our experience as field biologists leads us to be surprised by several features of the global BII map [2]. The degree to which total abundance is reduced relative to that expected in primary vegetation is modelled as being quite low (10-20% reduction) in many areas, such as large parts of the northern European lowlands, peninsular India and the Atlantic Forest region of Brazil, where a substantial proportion of the native primary vegetation cover has been replaced in historical times by farmland with a plant cover of non-native crops and fodder grasses and plantations of non-native trees. In the Atlantic Forest region of Brazil, the spatial extent of the primary vegetation types originally present has been reduced by 92.5% [4], but the BII indicates a reduction in relative total abundance of native species of just 15%. Similarly, large parts of Sundaland, southern China and Southeast Asia in which a substantial fraction of primary vegetation has been removed are indicated by the BII as having lost <5% of their total biodiversity. This low level of reduction in abundance arises to a similar extent both in areas where the primary vegetation cover in the absence of human intervention is forest and for those where it is extensive wetlands, which have been drained and replaced by farmland in historical times, such as the extensive Fenland Basin in eastern England. Populations of some wild species that occur in natural habitats such as forest and wetland can also persist on farmland. However, even for those that can, comparative studies of species’ population densities on farmland relative to that in primary vegetation, where soils and topography in the survey areas were matched [5], indicate that densities of most species of all of the several taxa studied were reduced on farmland to a greater extent than is indicated by the BII results. Had these studies examined a range of taxa more representative of metazoan biodiversity as a whole, for example by including, in proportion to their numbers of species, native herbivorous insect species associated with one or a few native plant species, we would expect the reduction in total abundance relative to that in primary vegetation to be even more substantial. Hence, we doubt that the true reduction in the average abundance of a representative set of native species, relative to that in primary vegetation, is as low as the global average reduction of about 15% indicated by the BII.

As well as the low average level of reduction in abundance suggested by the BII, we also find surprising the weak correlation between geographical variation in the BII and that in other measures of human pressures and intactness. The human footprint (HF) is a composite measure of the pressure on natural ecosystems from humans and includes several of the variables used in modelling BII, including the extent of the extents of cropland and pastures, human population density and proximity to roads [6]. However, the spatial patterns of HF and BII are quite dissimilar. A striking illustration is the difference between the northern European lowlands (very high HF; quite low reduction in abundance according to BII) and southern Africa (low/moderate HF, but with among the largest reductions in BII of >40%). Another measure of intactness is current biomass stock relative to that without human activities, which we call biomass intactness (BMI) [7]. BMI is much reduced by farming, grazing and forest management, with very large spatial variation associated with the distribution of these human activities. We would expect the average abundance of wild species, relative to that in primary vegetation, to correlate positively with BMI, for the reasons we give above. On average, BMI is much lower and much more variable than BII (Figure 1A), with about half of biomass stock having been lost globally due to human activities. However, BII and BMI are only weakly correlated, and the correlation is, if anything negative (Figure 1A). For the 32 (of 34) biodiversity hotspots for which we have data on both indices, the mean BII of hotspots showed a highly significant negative correlation with mean BMI (Spearman correlation: *rS* = -0.595, *P*= 0.0003). BMI was much lower in hotspots than outside them, as is expected because hotspots were selected partly on the basis of pressure from human activities, but BII was slightly higher in hotspots than outside them. A large fraction of the Earth’s land area has high BII but low BMI (red on Fig 1B), with a smaller but still substantial area with the opposite mismatch (blue on Figure 1B). Hence, the BII and BMI concur (grey on Figure 1B) on much less than half of the Earth’s land surface, mostly in areas of boreal taiga and tundra and large remnants of tropical rain forest.

We are concerned that uncritical acceptance of the BII as a metric the safety of biodiversity will lead to unjustified complacency about the security of wild nature. The safe operating space for humanity, proposed under the planetary boundaries framework, suggests that BII should be maintained at values above a threshold somewhere between 30% and 90% (a 70% to 10% reduction in total abundance) [8]. Using a 30% BII threshold, the mean BII in every WWF ecoregion on Earth is well above the safe planetary boundary. Even using the 90% threshold, about half of the ecoregions, and over half of those in biodiversity hotspots, are above the planetary boundary. We are sceptical that biodiversity is really as intact and secure as the BII suggests. We recommend rigorous further testing and, if necessary, the development of alternative methods.

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