On the refinement of biodiversity models and estimates of the Biodiversity Intactness Index (BII): a response to Martin et al.

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We thank Martin et al.[1] for starting an interesting and important discussion. They highlight some unexpected patterns in our spatial extrapolations of the abundance-based Biodiversity Intactness Index (BII)[2] that principally result from two known limitations with the approach we used, both of which were acknowledged in our original papers[2,3]. Here we discuss these limitations in more detail, present new estimates of the BII that begin to address the limitations, and compare the old and new estimates for biodiversity hotspots, which were identified as a key point of concern by Martin et al.'s paper.

1. Use of a 'shifted' baseline: Newbold et al. (2016)[2] used all sites within primary vegetation as the baseline when modelling compositional turnover among land uses, recognising that the baseline sites may have considerable human impact[2,4]. Expansion of the database[5] has since allowed us to take instead only minimally-used primary vegetation sites as the baseline[6,7], thus accounting better for degradation of natural habitats. We also now model compositional similarity on a logit (rather than log) scale, which better captures differences among land uses[6,7]. In a new study[8], which also models responses to land use separately for islands and mainlands, BII for all hotspots is estimated to be below 90%, and always lower – often markedly lower – than in our previous paper (Figure 1).

2. Coarse and incomplete land-use estimates: Issues with the available global land-use projections[9,10] (spatial extrapolations of current patterns as well as projections into the future) help to explain some of the unusual patterns identified by Martin et al.[1]. The best global land-use projections available until recently did not distinguish managed pasture from rangelands (in which livestock are grazed on natural grassland), leading to overestimation of biodiversity impacts in arid areas, notably Australia; they also did not explicitly represent exotic forest plantation, leading to underestimation of biodiversity impacts in parts of Southeast Asia and in parts of the UK. The newest version of the global land-use estimates (http://luh.umd.edu/) separates rangelands from pastures, leading to more reasonable BII estimates for semi-arid areas (e.g., the average BII for Australia has risen from 0.66 to 0.84[6]). There are still no well-resolved global maps of exotic forest plantation. As an interim approximation, De Palma et al.[7], modelling BII for the tropical forest biomes, equated plantation forest to lightly- or intensely-used secondary forest. This change led (along with the modelling improvements outlined in the paragraph above) to markedly lower values of BII across much of Southeast Asia[7]. It is important to note that uncertainties in model inputs (in this case land-use estimates) do not invalidate the BII metric or model itself. The models can be applied to any available estimates of land use.

We recognised and acknowledged both of these limitations in our original papers[2,3]; so emphasised that the Biodiversity Intactness Index (BII) was already – even if overestimated – below 90% across most of the world[2]. We have been further testing and rigorously improving our modelling framework since, as behoves any biodiversity modelling initiative, and have provided the latest results to IPBES and the Biodiversity Indicators Partnership (BIP; e.g., http://bipdashboard.natureserve.org/bip/map.html?ind=BIITropicalForests). The latest global projections are also now publicly available (DOI: 10.6084/m9.figshare.7951415), and will be provided to IPBES and the BIP shortly. Models and indicators form an important part of our understanding about global biodiversity changes[11]. However, differences in the aspects of biodiversity captured by different indicators, and in the assumptions and uncertainties of different modelling approaches, mean that agreement between modelled indicators is often limited[12]. Consequently there exists a very wide range of estimates of global biodiversity change, from no net species losses[13,14], or even regional increases[15], to an average 60% reduction in the size of vertebrate populations[16], or a greater than 75% decline in invertebrate biomass in Europe[17]. Understanding the causes of disagreement among indicators is crucial. As far as we are aware, the modelling approach that we used remains the only way to estimate global land-use impacts on the biodiversity of a broad set of species (plants, invertebrates and vertebrates). We agree with Martin et al.’s assertion that the uncritical use of any biodiversity model should be avoided, and stress the importance of model limitations and uncertainties being made clear. Only through the continued refinement of models, and through open dialogue, will we generate more accurate estimates of the impact that human activities have had on biodiversity globally.

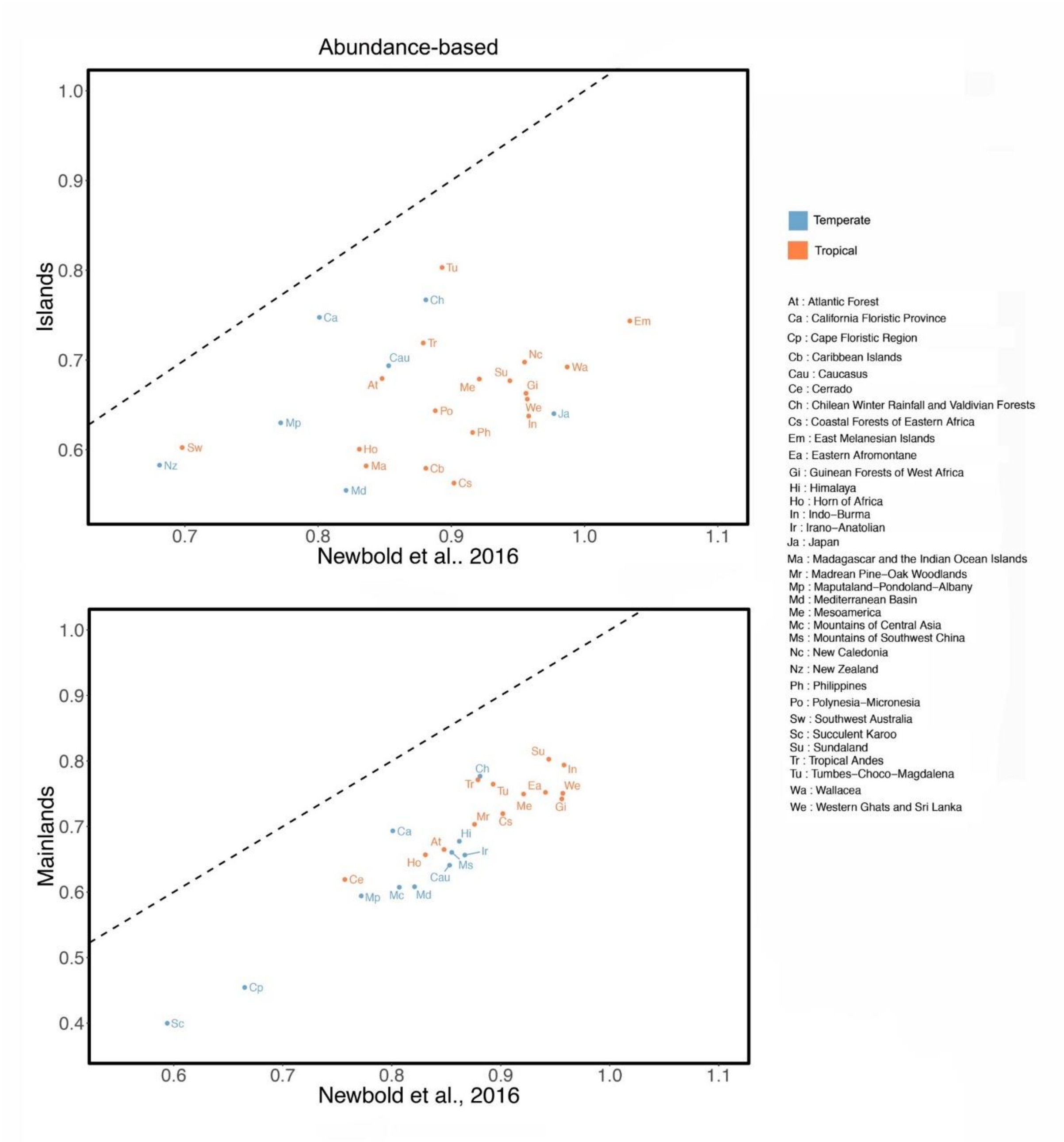

Figure 1: Updated estimates of the Biodiversity Intactness Index for biodiversity hotspots (a) on islands and (b) on mainlands, compared with the estimates in Newbold et al. (2016)[2].

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