The importance of indigenous peoples' lands for the conservation of terrestrial mammals

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Abstract

Indigenous Peoples' lands cover over one-quarter of Earth's surface, a significant proportion of which is still free from industrial-level human impacts. As a result, Indigenous Peoples and their lands are crucial for the long-term persistence of Earth's biodiversity and ecosystem services. Yet, information on species composition within Indigenous Peoples' lands globally remains largely unknown. Here, we provide the first comprehensive analysis of terrestrial mammal composition across mapped Indigenous lands by using area of habitat data for 4,460 IUCN-assessed mammal species. We estimated that 2,175 species (49%) have ≥ 10% of their ranges in Indigenous Peoples' lands, and 646 species (14%) have > half of their ranges within these lands. For the threatened species assessed, 413 (41%) occur in Indigenous Peoples' lands. We also found that 935 mammal species (of which 131 are threatened with extinction) have ≥ 10% of their range in Indigenous Peoples' lands that have low human pressure. This analysis shows how important Indigenous Peoples and their lands are to the successful implementation of international conservation and sustainable development agendas.

1. INTRODUCTION

Through well-established traditional knowledge systems and governance practices, Indigenous Peoples are the environmental stewards of their lands. This is gradually being recognized in domestic and international policy (IPBES 2019). A recent analysis indicates that Indigenous Peoples' lands cover at least a quarter of terrestrial Earth, overlapping with 37% of all terrestrial protected areas and with 40% of landscapes without industrial-level human impacts (Garnett et al. 2018). Some countrywide assessments demonstrate the importance of Indigenous Peoples' lands in terms of the biodiversity contained within them. In Australia, for example, 45-60% of the country's threatened species are found in

Indigenous Peoples' lands (Renwick et al. 2017; Leiper et al. 2018) and vertebrate biodiversity has been found to be equal in Indigenous People's lands and protected areas in three countries (Australia, Brazil and Canada; Schuster et al. 2019). However, global assessments of the overlap between Indigenous Peoples' lands including areas free from industrial-level human impacts and species distributions (including threatened species) are lacking. Any regions free from industrial-level human impacts are likely to be of high conservation value (Di Marco et al. 2018), given the connection between land use transformation and species declines (Newbold et al. 2015; Tilman et al. 2017). These landscapes may also be important ecological refugia (Scheffers et al. 2016; Allan et al. 2019), offering some protection against the pressures of expanding resource extraction frontiers (Rehbein et al. 2020).

Here, we provide the first global assessment of the overlap between mapped Indigenous Peoples' lands (Garnett et al. 2018) and terrestrial mammal area of habitat maps (Rondinini et al. 2011). We also assess mammal species composition within low-pressure Indigenous Peoples' lands using updated 'Human Footprint' data (Williams et al. 2020). These results are relevant to the development and implementation of the post-2020 Global Biodiversity Framework agreement that will emerge from the Convention on Biological Diversity's (CBD) discussions on abating species extinctions and reducing the erosion of ecosystem services (CBD 2018), as well as for countries trying to implement actions to achieve the 2030 United Nation's Sustainable Development Goals.

2. METHODS

Species distribution data

We focused our analysis on terrestrial mammals that have been comprehensively assessed by the International Union for Conservation of Nature (IUCN). Spatial data on mammal habitat

were obtained from Rondinini and colleagues' area of habitat maps (Rondinini et al. 2011). We excluded species considered extinct and any other extant native and reintroduced species whose area of habitat maps did not fully intersect with the combined spatial datasets employed in this study (4,460 species included, and 1,070 species were excluded from the analysis, many of which had a portion of their range on islands and other features outside the extent of our combined spatial intersection layers).

Spatial data on Indigenous Peoples' lands

Globally, more than 370 million persons in more than 70 countries self-identify as Indigenous Peoples (Garnett et al. 2018). We used a recently-compiled global spatial dataset on Indigenous Peoples' lands, located or delineated on the basis of open-access published sources (Garnett et al. 2018) that, while certainly incomplete, is the best currently-available spatial layer at a global scale.

Spatial data on human pressure

Advances in remote sensing coupled with bottom-up survey data have enabled the development of a spatially explicit, validated, high-resolution global dataset on human pressures (Venter et al. 2016). These datasets permit the quantification of the extent of intense pressures on individual species (Di Marco et al. 2018; Allan et al. 2019; O'Bryan et al. 2020). We used the most current Human Footprint map available (from 2013; Williams et al. 2020), comprising a composite spatial index of key human pressures on natural ecosystems at a 1 km^2 resolution.

Eight human pressure variables were used in the Human Footprint: 1) built environments, 2) population density, 3) electrical infrastructure, 4) crop lands, 5) pasture lands, 6) roads, 7)

railways, and 8) navigable waterways. These eight individual pressures were scaled between 0 and 10 based on their estimated environmental impact and summed in 1 km^2 grid cells. Some pressures co-occur whilst others are mutually exclusive; resulting in a combined global scale between 0 and 50 where 0 has no detectable change, and 50 is extreme urban conglomerates. We reclassified the Human Footprint map to a discrete index threshold of < 3 because this threshold is now considered the standard for evaluating the degree of low human pressure across ecosystems (Di Marco et al. 2018; Jones et al. 2018; O'Bryan et al. 2020). A threshold of ~ 3 is where areas with low states of human pressure transition to human-dominated activities such as pastureland. Importantly, index values at or > 3 reveal an increased extinction risk in mammals (Di Marco et al. 2018).

Analysis

We combined the spatial datasets on Indigenous Peoples' lands (mean individual size of 485.52 km^2; SD 34,348.43 km^2) and low-pressure lands (i.e. Human Footprint Index of < 3) into a single spatial data layer based on overlap with the center of the pixel in a geographic information system raster calculator (ESRI ArcGIS) at a 1 km^2 resolution (45.2% of Indigenous Peoples' lands contain low-pressure lands). We calculated the proportion of mammal species' habitat in all Indigenous Peoples' lands and in low-pressure Indigenous Peoples' lands by intersecting individual species' habitat rasters with the combined spatial dataset mentioned above using R statistical software (R Core Team 2017). Mammals were not included if their raster layer did not fully overlap with the intersection layer.

3. RESULTS

Occurrence of species in Indigenous Peoples' lands

Indigenous Peoples' lands encompass a total of at least 38 million km^2 (28.3 %) of terrestrial Earth (Garnett et al. 2018; Table S1). We found that 2,175 (48.8%) of all mammal species assessed have at least 10% of their ranges within Indigenous Peoples' lands, and 646 (14.5%) have > 50% of their range in these lands (Figure 1). Mammals in the order Scandentia (the treeshrews of Southeast Asia) have the highest average percentage of their suitable habitat overlapping with Indigenous Peoples' lands (47.1% ± SD 15.8%) compared to other orders such as Colugo (arboreal gliding mammals of Southeast Asia; 34.3% ± SD 18.9%) and Proboscidea (elephants; 33.6% ± SD 17.5%). Southeast Asia, the grassland and semiarid regions of Africa, and southern Central America have the highest number of species with > 50% of their range within Indigenous Peoples' lands (Figure 2). For example, tigers (*Panthera tigris*) and red pandas (*Ailurus fulgens*) have 55% and 63% of their suitable habitat in Indigenous Peoples' lands, respectively (Figure 2).

Of the 1,002 mammal species assessed that are classified as threatened (i.e. Vulnerable, Endangered, or Critically Endangered on the IUCN Red List [2019; version 6.2]), 413 (41.2%) have at least 10% of their ranges within Indigenous Peoples' lands, with 214 (21.4%) being Vulnerable, 144 (14.4%) being Endangered, and 55 (5.5%) being Critically Endangered on the IUCN Red List. We also found that 200 (20.0%) of all threatened species have >50% of their ranges within these lands, with 93 (9.3%) being Vulnerable, 77 (7.7%) Endangered, and 30 (3.0%) Critically Endangered species.

Occurrence of species in low-pressure Indigenous Peoples' lands

Nearly 21 million km^2 of Indigenous Peoples' lands have low pressure (15.5% of terrestrial Earth, and 45.2% of all Indigenous Peoples' lands; Table S1). We found that 935 (21.0%) of species assessed have at least 10% of their range in these low-pressure Indigenous Peoples' lands, with 118 (2.6%) having >50% of their ranges in these lands (Figure 1). Mammals in the order Dasyuromorphia (the carnivorous marsupials of Australia) have the highest average percentage of their habitat in these lands (23.7% ± SD 24.2%) compared to other orders such as Pilosa (anteaters and sloths of the Americas; 19.0% ± SD 11.1%) and Diprotodontia (non-carnivorous marsupials of Australia; 15.6% ± SD 21.3%).

Not surprisingly, the percentage of threatened species within low-pressure Indigenous Peoples' lands is considerably lower than that of threatened species across all Indigenous Peoples' lands (Figure 3). As many as 131 (13.1%) of the threatened species assessed have at least 10% of their ranges in low-pressure Indigenous Peoples' lands, with 81 (8.1%) of these being Vulnerable, 35 (3.5%) Endangered, and 15 (1.5%) Critically Endangered species. We also estimated that 25 (2.5%) of the threatened species assessed have >50% of their ranges in these lands, with 19 (1.9%) of these being Vulnerable, five (0.5%) Endangered, and one (0.1%) Critically Endangered species (Figure 3B).

4. DISCUSSION

Indigenous Peoples' lands cover a large portion of Earth's land surface (Garnett et al. 2018), and also include some of the highest quality forest lands worldwide (Fa et al. 2020). It follows that Indigenous Peoples are stewards of a substantial proportion of Earth's biodiversity. While it has long been suspected that the proportion of biodiversity that occurs on Indigenous Peoples' lands was likely to be high (Toledo 2013), our study is to our best

knowledge the first to use robust, repeatable methods for determining this at the global scale. The numbers we have derived are substantial: globally, 49% of all mammals assessed and 41% of threatened mammals assessed have ≥ 10% of their range within Indigenous Peoples' lands; for 15% of mammals, including 20% of threatened mammals, the proportion of their habitat is > 50%, suggesting that Indigenous Peoples' lands contain critical habitat for many mammalian species assessed.

Our results show that Indigenous Peoples' lands with low human pressure contain at least 10% habitat for 935 species. Such areas may serve as critical refugia from anthropogenic threats, especially for the 131 threatened species with at least 10% of their habitat within these lands, which require safeguarding from ongoing and future habitat loss and exploitation pressures. Our analysis also suggests that 57% of species that have some portion of their habitat within Indigenous Peoples' lands may also be exposed to increased unsustainable human pressure within these lands (i.e. Human Footprint Index ≥ 3), pointing to an even greater need for Indigenous-led and collaborative conservation efforts. Here it is important to note that pressure to exploit Indigenous Peoples' lands and in some cases deny their rights to use and access these areas is alarmingly high all over the world (Fernández- Llamazares et al. 2020; Scheidel et al. 2020).

The results we present highlight future opportunities for improving our understanding of species composition and opens up important conservation agendas to build alliances that respect Indigenous rights and agendas. For example, the taxonomic groups for which we have area of habitat data – mammals – is but a small fraction of the biodiversity found (Larsen et al. 2017), and there is great opportunity for expanding this work to other taxonomic groups as area of habitat data become more accessible (Brooks et al. 2019). However, our results, based

on best available globally consistent mammal data, may likely be true for other vertebrates (Leal et al. 2010), as well as plants, invertebrates and others forms of biodiversity (but see Oberprieler et al. 2019). Future work can also improve temporal overlap of species' habitat layers with mapped Indigenous Peoples' lands and human footprint data, as our analysis is limited to spatial data across varying time periods; for example, the area of habitat maps were published in 2011, the maps of Indigenous Peoples' lands in 2017, and the human footprint data is updated only to 2013. Temporal mismatch may be reduced as species area of habitat data become more widely available both spatially and temporally across taxonomic groups (Brooks et al. 2019).

We note that the mapped Indigenous Peoples' lands data used in our analysis are still incomplete and may under- or overestimate coverage of Indigenous Peoples' lands depending on if and how groups self-identify as Indigenous Peoples' and how lands are defined (Garnett et al. 2018). Moreover, because stringent legislation often controls access to and activities within Indigenous Peoples' lands, affecting the extent to which biodiversity is documented and mapped (dos Santos et al. 2015), it is very likely that survey efforts in these lands are incomplete (e.g., Bernard et al. 2011). Partnerships to resource and support Indigenous Peoples to fill knowledge gaps about significant and threatened species (including those that are culturally significant to local communities) will greatly improve our understanding of the conservation status and population trends of these species and measures needed for their survival (Johnson et al. 2015; Garnett et al. 2018).

Myriad examples are available on how collaboration between Indigenous Peoples and researchers has refined knowledge of species ecological distribution ranges, baselines, and trends and opened up new understandings of biodiversity conservation that takes into account

Indigenous rights, values and aspirations (e.g. Ross et al. 2009; Mistry & Berardi 2016; Skroblin et al. 2019). However, such knowledge partnerships need to be negotiated and provide appropriate benefits to local Indigenous people (Robinson et al. 2016). The central message from this analysis is that Indigenous Peoples' participation, lands and perspectives are vital to any policies and programs aiming to further global biodiversity conservation. This conclusion strongly aligns with that of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Diaz et al. 2019; IPBES 2019) and many other studies (e.g. Dinerstein et al. 2019; Reyes-García et al. 2019).

Our results point to the fact that, regardless of what results from discussions through the Convention on Biological Diversity (CBD) about species and ecosystems targets within the post-2020 Global Biodiversity Framework, Indigenous Peoples will play a globally important role in the conservation of biodiversity into the future. Indigenous Peoples' rights must be fully respected, including their full and effective participation in developing laws, policies, and programs that affect them. Although representatives of Indigenous Peoples are engaging in global environmental forums through frameworks such as IPBES, the Intergovernmental Panel on Climate Change (IPCC), and the CBD, this often occurs in the face of substantial barriers to engagement related to scale, knowledge, and power (Brugnach et al. 2017). Greater recognition and support for the close relationships that Indigenous Peoples have with their lands and their natural resources is therefore a pressing imperative from the perspective of both social equity and biodiversity conservation (Howitt 2018). Only through rights-based, equitable and respectful partnerships, and other forms of dialogue and collaboration with Indigenous Peoples, will it be possible to ensure the long-term and equitable conservation of biodiversity.

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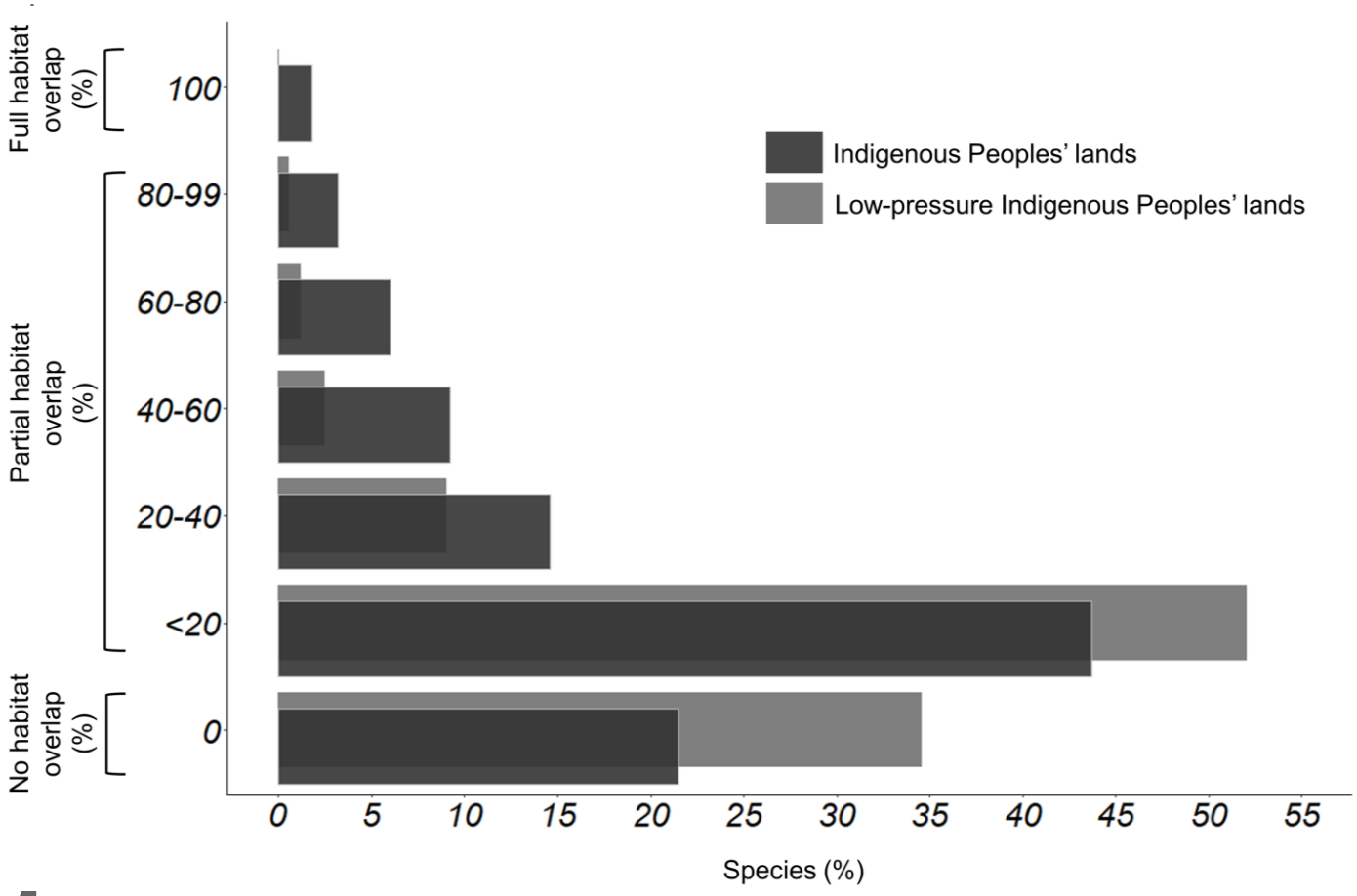

Figure 1. The area of habitat overlap of terrestrial mammals in mapped Indigenous Peoples' lands (Garnett et al. 2018; dark grey bars) and with low-pressure Indigenous Peoples' lands (i.e. < 3 on the Human Footprint Index; light grey bars). The figure shows that if one is to consider only low-pressure Indigenous Peoples' lands within species' area of habitat, then the percentage of species that have their habitat within these lands is generally much lower (but see 0-20% overlap bin) than if we consider all Indigenous Peoples' lands.

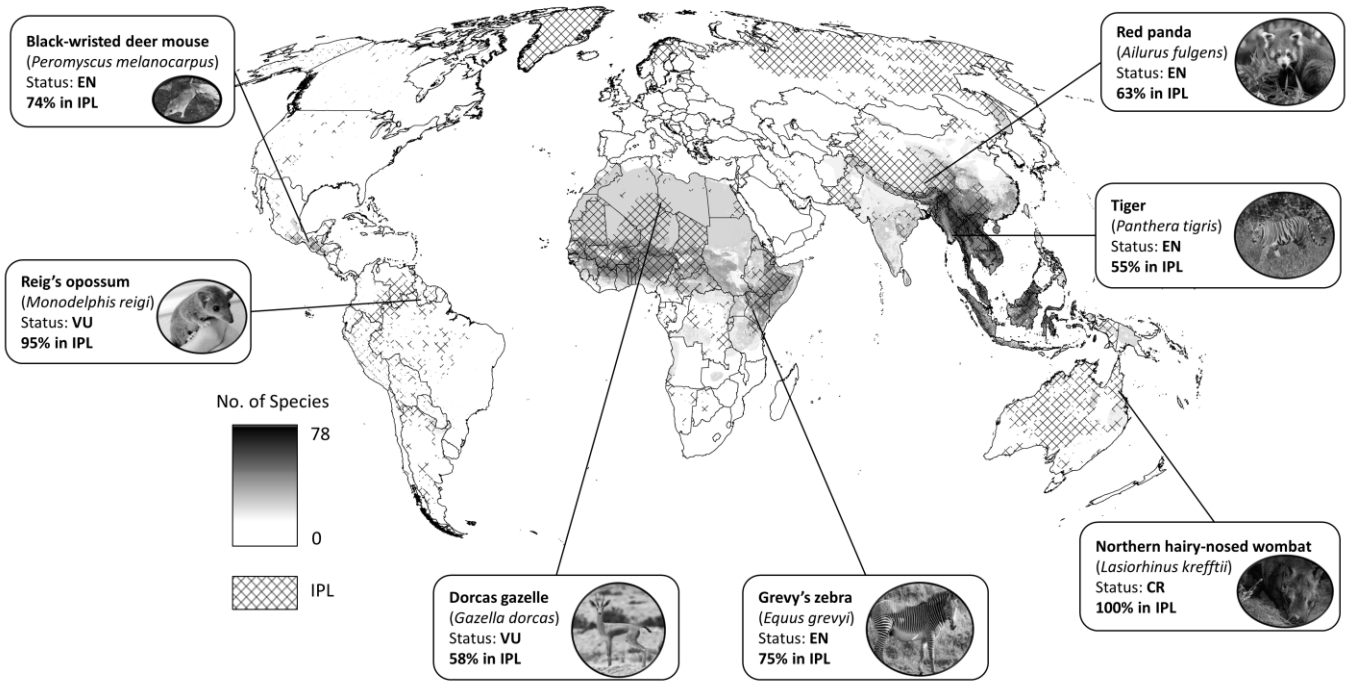

Figure 2. The number of species that have >50% of their habitat in mapped Indigenous Peoples' lands (IPL), with a subset of exemplar species. The hatched areas represent mapped Indigenous Peoples' lands (Garnett et al. 2018).

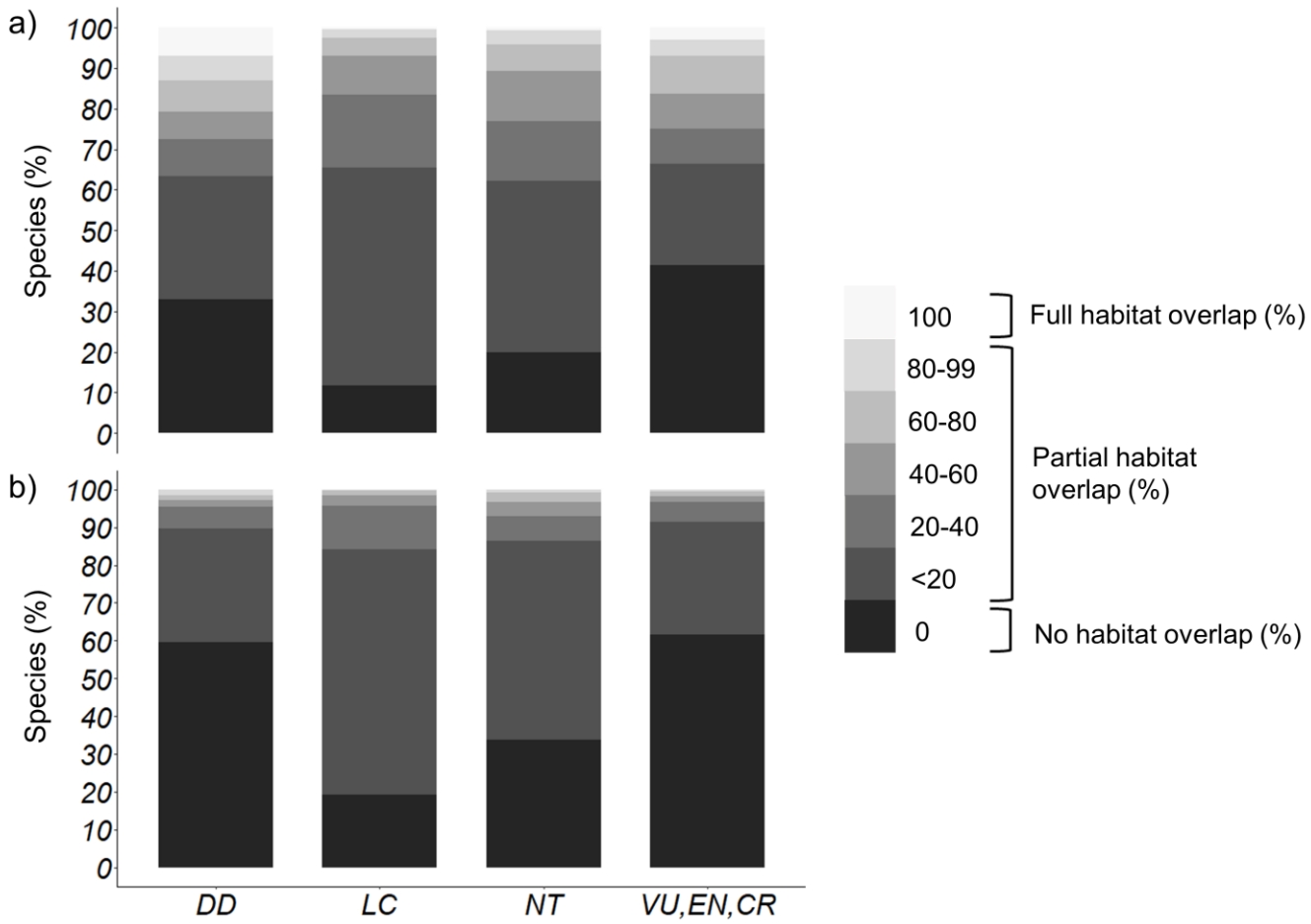

Figure 3. The area of habitat overlap of terrestrial mammals in mapped Indigenous Peoples' lands (Garnett et al. 2018) broken down by IUCN Red List category ("DD" = data deficient, "LC" = least concern, "NT" = near threatened, "VU,EN,CR" = vulnerable, endangered, and critically endangered) for, a) all Indigenous Peoples' lands and, b) low-pressure Indigenous Peoples' lands (i.e. < 3 on the Human Footprint Index). The figure shows that if one is to consider only low-pressure Indigenous Peoples' lands within species' area of habitat, then the percentage of species that have their habitat within these lands across all IUCN categories is generally much lower (but see 0-20% overlap bins) than if we consider all Indigenous Peoples' lands.