Research Communications, *Front Ecol Environ*

Importance of Indigenous Peoples' lands for the conservation of Intact Forest Landscapes

John E Fa[1,2*], James EM Watson[3,4], Ian Leiper[5], Peter Potapov[6], Tom D Evans[4], Neil D Burgess[7,8], Zsolt Molnár[9], Álvaro Fernández-Llamazares[10], Tom Duncan[5], Stephanie Wang[4], Beau J Austin[5], Harry Jonas[11], Cathy J Robinson[5,12], Pernilla Malmer[13], Kerstin K Zander[5], Micha V Jackson[5,14], Erle Ellis[15], Eduardo S Brondizio[16], and Stephen T Garnett[5]

[1]Division of Biology and Conservation Ecology, School of Science and the Environment, Manchester Metropolitan University, Manchester, UK [*](jfa949@gmail.com); [2]Center for International Forestry Research, Jalan Cifor Rawajaha, Situ Gede, Bogor Barat, Kota Bogor, Indonesia; [3]School of Earth & Environmental Sciences, The University of Queensland, Brisbane, Australia; [4]Wildlife Conservation Society, New York, NY; [5]Charles Darwin University, Casuarina, Australia; [6]Global Land Analysis and Discovery Lab, Department of Geography, University of Maryland, College Park, MD; [7]UN Environment World Conservation Monitoring Centre, Cambridge, UK; [8]Center for Macroecology, Evolution and Climate, Natural History Museum of Denmark, Copenhagen, Denmark; [9]MTA Centre for Ecological Research, Hungarian Academy of Sciences, Vácrátót, Hungary; [10]Helsinki Institute of Sustainability Studies, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland; [11]Future Law, Lorong Pokok Kapas, Taman Faber, Malaysia; [12]Commonwealth Scientific and Industrial Research Organisation, Ecoscience Precinct, Dutton Park, Australia; [13]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden; [14]School of Biological Sciences, The University of Queensland, Brisbane, Australia; [15]Geography & Environmental Systems, University of Maryland, Baltimore, MD; [16]Department of Anthropology, Indiana University, Bloomington, IN

Running heads:
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Indigenous Peoples' lands and forest conservation

Intact Forest Landscapes (IFLs) are critical strongholds for the environmental services that they provide, not least for their role in climate protection. On the basis of information about the distributions of IFLs and Indigenous Peoples' lands, we examined the importance of these areas for conserving the world's remaining intact forests. We determined that at least 36% of IFLs are within Indigenous Peoples' lands, making these areas crucial to the mitigation action needed to avoid catastrophic climate change. We also provide evidence that IFL loss rates have been considerably lower on Indigenous Peoples' lands than on other lands, although these forests are still vulnerable to clearing and other threats. World governments must recognize

Indigenous Peoples' rights, including land tenure rights, to ensure that Indigenous Peoples play active roles in decision-making processes that affect IFLs on their lands. Such recognition is critical given the urgent need to reduce deforestation rates in the face of escalating climate change and global biodiversity loss.
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It is unlikely that global climate and biodiversity targets will be met without the conservation of forest systems that remain free from extensive industrial and intensive agricultural operations (Potapov *et al*. 2017; Watson *et al*. 2018; Dinerstein *et al*. 2019). The global Intact Forest Landscape (IFL) estate consists of approximately 23% of global forests but declined in extent by nearly one-tenth between 2000 and 2016 (Potapov *et al*. 2017). IFLs can provide more than 30% of the mitigation action needed by 2050 to keep global warming below 2°C (Griscom *et al*. 2017), a level widely believed to be the threshold for avoidance of catastrophic climate change (IPCC 2018).

As defined by Potapov *et al*. (2017), IFLs are seamless mosaics of forests and associated natural treeless ecosystems that exhibit no remotely detected signs of human activity or habitat fragmentation, and that are large enough to maintain all native biological diversity, including viable populations of wide-ranging species. Although all IFLs are a part of the global forest zone, some may contain extensive naturally treeless areas, such as grasslands, wetlands, lakes, alpine areas, and ice. The definition of IFLs builds on that of the "frontier forest" developed by the World Resources Institute (Bryant *et al*. 1997). The IFLs concept was originally applied to boreal forests, where harvesting consists primarily of clearcutting (Yaroshenko *et al*. 2001), but was eventually used to describe forests worldwide, including tropical forests, where selective logging and land-use conversion prevail (Potapov *et al*. 2008, 2017).

Globally, Indigenous Peoples manage or have tenure rights over at least ~38 million km^2 of land across 87 countries or politically distinct areas on all inhabited continents (see Figure 1 in Garnett *et al.* 2018). This represents over 25% of the world's land surface and intersects with about 40% of all terrestrial protected areas and 37% of remaining natural lands. Here, we estimate the degree of overlap between IFLs and Indigenous Peoples' lands to explore the effectiveness of Indigenous Peoples as IFLs custodians. IFLs are recognized as critical strongholds for the protection of Indigenous and rural cultures and livelihoods as well as being irreplaceable in terms of biodiversity conservation and provision of ecosystem services (Watson *et al*. 2018). Moreover, IFLs in tropical, temperate, and boreal biomes contain globally important carbon (C) stocks, and store considerably more C than degraded and/or fragmented forests (eg Rozak *et al*. 2018).

Methods

For each country or administratively independent entity, we first overlaid maps of Indigenous People's lands and IFLs to determine how much they overlapped, then calculated the areal extent of the overlaps within distinct biomes and biogeographic realms. All geospatial analyses were conducted in the Mollweide projection using ArcGIS Pro v2.2.1.

We used the geospatial data on the extent of Indigenous Peoples' lands reported by Garnett *et al*. (2018), noting the challenges and ethical considerations involved in mapping such areas. These data represent the most comprehensive assessment of terrestrial lands owned and/or managed by Indigenous Peoples throughout the world. Indigenous Peoples were described in Garnett *et al*. (2018) as the approximately 370 million people around the world who define themselves as Indigenous "descended from populations who inhabited a country before the time of conquest or colonization; and who retain at least some of their own social, economic, cultural, and political institutions".

Geospatial data for IFLs were sourced from the Intact Forest Landscapes website (www.intactforests.org) for the years 2000, 2013, and 2016. Geospatial data delineating the current extent of forest landscapes, referred to as the "forest zone" and divided into regions (Potapov *et al*. 2017), were also derived from the IFLs mapping website. We obtained data about the extent of IFLs within 65 countries; the extent of Indigenous People's lands could also be determined in 50 (76%) of these (WebTable 1). We used the Terrestrial Ecoregions of the World (TEOW) classification of biomes and biogeographic realms (Olson *et al*. 2001). Geospatial data for TEOW were sourced from WWF (Olson *et al*. 2001). Geospatial data for the world's administrative areas were sourced from the 2015 Global Administrative Areas (GADM) spatial database v2 (http://gadm.org/version2); GADM data were used by Garnett *et al*. (2018) to define administrative areas for mapping Indigenous Peoples' lands and their role in conservation, and by Potapov *et al*. (2017) for assessing IFLs reduction over the period 2000–2013. No areas were consolidated for the analyses (eg Christmas, Norfolk, and Cocos [Keeling] islands were not merged with Australia).

Results

Using data from the 50 countries containing IFLs and Indigenous Peoples' lands, which accounts for 98.4% of the world's IFLs area, we estimated that 23% of the 49.7 million km^2 forest zone was IFLs (WebTable1). The forest zone in Indigenous Peoples' lands amounted to 13.1 million km^2, or at least a quarter of the total forest zone in the sampled countries.

Intact Forest Landscapes within Indigenous Peoples' lands covered 4.2 million km^2 or 35.8% of the world's IFLs area; a total of 11.6 million km^2 (Figure 2). The proportion of Indigenous Peoples' lands mapped as IFLs was considerably higher (10.9%) than the proportion of other lands (defined here as all land outside of Indigenous Peoples' lands) mapped as IFLs (6.8%).

In countries with IFLs containing both Indigenous Peoples' lands and other lands, the percentage of IFLs to forest zone area was greater for Indigenous Peoples' lands than for other lands in 36 countries (Figure 3). For each country, the percentage of the forest zone occupied by IFLs in Indigenous Peoples' lands was higher (20.8 ± 23.5%) than in other lands (13.4 ± 19.4%). In many countries Indigenous Peoples' lands had a higher proportion of the countries' IFLs than their proportion of the forest zone, in contrast to other lands (Figure 4).

The global extent of IFLs has declined by 9.4% (1.2 million km^2) since 2000. The total reduction across all countries was 8.2% on Indigenous Peoples' lands or 15.3 ± 15.4% per country, and 10% in other lands, an average of 19.6 ± 21.4% per country.

Biomes

Of the 2098 IFL patches mapped in 2016, 1277 (61%) overlapped with Indigenous Peoples' lands, including 418 (20%) where the entire extent of IFLs was located on Indigenous Peoples' lands. Of the world's IFLs, 84% of the area occurs either in "Tropical and Subtropical Moist Broadleaf Forests" (comprising 45% of IFL area) and "Boreal Forests/Taiga" (39% of IFL area) biomes (WebTable 2).

Indigenous Peoples' lands cover 32% of the forest zone and 38% of IFLs in those biomes. The reduction in IFL area since 2000 has been smaller on Indigenous Peoples' lands (7.6% reduction in IFL area) than on other lands (9.9% reduction in IFL area) in these two biomes. Within the "Tundra" biome, 75% of the forest zone was mapped as IFLs, the greatest proportion within any biome. Both Indigenous Peoples' lands and other lands have a high proportion of their forest zone within this biome classified as IFLs, and both showed a small reduction in IFLs since 2000. Since 2000, reductions in IFLs have been greatest in the "Mediterranean Forests, Woodlands, and Scrub" biome (68% reduction in IFL area), but there have also been large contractions in both "Tropical and Subtropical Dry Broadleaf Forests" (39% reduction) and "Tropical and Subtropical Grasslands, Savannas, and Shrublands" (32%). Across these three biomes, IFL reduction has been greater on other lands (41%) than on Indigenous Peoples' lands (32%).

In 2016, 71% of the area of IFLs in "Mediterranean Forests, Woodlands, and Scrub" was within Indigenous Peoples' lands, and the reduction of IFL in this biome was lower (62% reduction) than for other lands (77% reduction).

Biogeographic realms

Approximately 87% of the global extent of IFLs occurs within the three broad biogeographic realms: Neotropic (36.3%), Nearctic (28.6%), and Palearctic (22.0%) (WebTable 3). The proportion of IFLs on Indigenous Peoples' lands within these three realms ranged from 67.1% (Palearctic) to 41.1% (Neotropical) to just 3.6% (Nearctic) (Figure 5).

Less than 5% of the forest zone in the Indomalaya realm consisted of IFLs, with the majority (86.6%) of IFLs in the Indomalaya realm occurring on Indigenous Peoples' lands. Of all biogeographic realms, the Indomalaya realm also experienced the greatest reduction in IFL area between 2000 and 2016 (19.6%), with losses being far greater on other lands (36.5%) than on Indigenous Peoples' lands (16.2%). A similar proportion of IFLs was lost in the Australasian realm, with similar contractions on Indigenous Peoples' lands (19.5%) and other lands (18.4%).

Discussion

In parallel to Garnett's *et al*. (2018) analyses of the role that Indigenous Peoples play in managing natural habitats across the planet, our results show this is also the case for IFLs. The proportion of IFLs is higher on Indigenous Peoples' lands than on other lands, and our comparisons by country, biome, and biogeographic realms reveal that over one third of the world's remaining IFLs are located on Indigenous Peoples' lands. The true figure may indeed be considerably higher because we used a conservative map layer (notably in Canada) in our analysis. Understanding the scale of IFLs over which Indigenous Peoples exercise customary rights is central to engaging and supporting efforts to conserve their forests (Robinson *et al*. 2016; Schleicher *et al*. 2017).

IFLs benefit conservation and climate-change mitigation efforts in ways that transcend the local importance of any given IFL (Ricketts *et al*. 2010). However, when IFL governance is top-down and fails to consider local interests, rights, and values (including those of Indigenous Peoples), misunderstandings, conflicts, and ecological degradation of forests often result (IPBES 2019). Given the significant IFL coverage in Indigenous Peoples' lands the role of these communities (<5% of the global population) is fundamental. Indigenous Peoples have long recognized the importance of conserving and adequately managing IFLs on their lands, not only because they fulfill their material and non-material cultural needs, but also because they reinforce and/or re-establish their traditional obligations with the land. On their own, community-based institutions and local governance regimes led by Indigenous Peoples are as effective as (or even more effective than) traditional protected areas in buffering against deforestation and forest degradation (RRI 2016; Blackman *et al*. 2017; Schleicher *et al*. 2017). Formal recognition of Indigenous Peoples' rights over their forest lands can also slow deforestation (Ricketts *et al*. 2010; Ceddia *et al*. 2015). Moreover, Indigenous governance and land management regimes have also been successful at achieving sustainable human–landscape interrelationships in numerous geographical locations and circumstances (Brondizio and Le Tourneau 2016; Norman 2017).

Despite the desire of many Indigenous Peoples to protect the IFLs that occur on their lands, many of these areas are under pressure from intensive development. Although IFL losses since 2000 appear to have been slightly lower on Indigenous Peoples' lands than on other lands, the world's remaining IFLs are under considerable threat from infrastructure development and land-use change. Where loss of IFLs on Indigenous Peoples' lands has already occurred, it has often not been with Indigenous Peoples' consent but rather as a result of the lack of recognition of their rights, including land tenure (FPP *et al*. 2016; RRI 2016). In some IFLs, critical C stocks and sinks are currently threatened by the lack of recognition of the customary rights of Indigenous Peoples and other local communities (Finley-Brook 2007; FPP *et al*. 2016); land tenure insecurity in Indigenous Peoples' lands is an underlying driver of deforestation (eg Robinson *et al*. 2014; Ceddia *et al*. 2015; IPBES 2019). As such, strategies to preserve IFLs from degradation and clearance are likely to be more effective if they establish and maintain equitable partnerships with Indigenous Peoples. To this end, measures to protect IFLs will benefit greatly from collaborative partnerships that incorporate Indigenous knowledge systems, practices, and institutions as a core component. Also important is the fact that the inherent value of IFLs is also rarely addressed in most global policy frameworks (including several multilateral environmental agreements); we recommend that policy makers take further steps to recognize these values. The recent decision by the IUCN to develop a policy concerning IFLs protection is an important initiative that hopefully will prompt other institutions to follow suit. Such agreements may facilitate landscape-scale conservation and management and resolve conflicts between stakeholders.

Considering that land tenure insecurity is particularly acute across much of the tropics (Robinson *et al*. 2014; Ceddia *et al*. 2015), it is of concern that, until recently, only 21 of 131 tropical countries (16%) have formally committed to expanding Indigenous and local communities' land tenure rights under the UN Framework Convention on Climate Change's Paris Agreement (RRI 2016). More Parties to the Paris Agreement must confer legal recognition and protection to Indigenous Peoples' lands through measures such as forest titling programs, which limit new colonization and secure alienation rights (Finley-Brook 2007; Blackman *et al*. 2017). All stakeholders involved in protection of IFLs should also provide additional resources to support and/or partner with Indigenous Peoples whose relationships with intact forests offer positive biodiversity conservation outcomes and/or reduced GHG emissions. Granting Indigenous Peoples formal legal titles to their forests must be seen as the most critical mechanism for slowing forest loss and protecting these lands from uncontrolled and unregulated resource extraction (Larson and Pulhin 2012; Blackman *et al*. 2017). Collaborative governance regimes involving Indigenous and other partners (both governmental and non-governmental) that are carefully designed will also ensure that Indigenous management institutions and priorities are supported and strengthened, including those applicable to forest lands (Robinson *et al*. 2016).

Our analysis demonstrates there is a pressing need to understand better the interactions between Indigenous Peoples and their ecosystems when negotiating local or global conservation agreements both within and outside of Indigenous Peoples' lands. In particular, conservation groups should not assume that Indigenous Peoples have uniform aspirations to maintain the natural environment in its current state. A wide range of political, cultural, and economic motivations drive land management approaches and, as a result, conservation priorities and regulations may sometimes differ or even clash with Indigenous management goals (Brondizio and Le Tourneau 2016; Garnett *et al*. 2018). Indigenous Peoples cannot assume the burden of global conservation and climate mitigation challenges before land tenure rights are secure and/or without adequate resources and support. Conservation policies aimed to protect biodiversity and/or increase C storage on Indigenous Peoples' lands should not only deliver environmental returns, but also have strong local support, align with Indigenous Peoples' self-determined priorities and motivations, and provide mechanisms for benefit sharing through equitable partnerships (Larson and Pulhin 2012).

Using participatory methods to identify culturally appropriate procedures and tools that respect Indigenous Peoples' rights and institutions can improve the legitimacy and effectiveness of conservation policies (Brondizio and Le Tourneau 2016). Abiding by the principle of allowing them to give or withhold Free, Prior and Informed Consent to any project that may affect them, or their territories must be central for any ethical, equitable, and fruitful conservation partnerships (Fernández-Llamazares and Cabeza 2017; Ban *et al*. 2018). Following these procedures reinforces the importance of "bottom-up" approaches to conservation investment and policy design, particularly given the numerous examples of questionable social and ecological outcomes resulting from "top-down" conservation (Brondizio and Le Tourneau 2016). Many innovative approaches and tools facilitate discussion of collaborative partnership building, co-management, and power sharing around conservation initiatives with Indigenous Peoples (Whakatane Mechanism; http://whakatane-mechanism.org) that also can support just, inclusive, and equitable environmental governance.

Generally, the role of funders and their responsibilities in ensuring compliance with human rights must be given more attention in conservation. The multilateral Convention on Biological Diversity (CBD) agreement includes voluntary guidelines for safeguards in biodiversity financing mechanisms (CBD Decision XII/3, Annex III), stressing also the importance of the effective participation of Indigenous Peoples and local communities in the selection, design, and implementation of biodiversity conservation efforts. Ongoing development of the CBD Post-2020 Global Biodiversity Framework represents a key opportunity for biodiversity conservation to take into account Indigenous Peoples' rights (Malmer *et al*. 2018). In numerous science and policy forums, Indigenous Peoples and their representatives have repeatedly asserted that this connection should be explicitly made (e.g. in REDD+, protected areas, Indigenous and community conserved areas, and other effective area-based conservation measures). If local Indigenous communities are expected to help prevent the degradation of IFLs as part of the global effort to combat climate change, projects and partnerships will need to integrate Indigenous, biodiversity, and greenhouse-gas (GHG) emission goals.

Acknowledgements
This project was partly funded by the Wildlife Conservation Society, to whom we are grateful. JEF was funded by the US Agency for International Development as part of the Bushmeat Research Initiative of the CGIAR research program on Forests, Trees and Agroforestry. We thank R Ramsey at Charles Darwin University for her ongoing administrative support, and O Massana and A López-Baucells for providing the photograph used in Figure 1a, A Ledeu for the photograph used in Figure 1b, G Peña for the photograph used in Figure 1c, and ND Liswanti/CIFOR for the photograph in Figure 1d.

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Supporting Information
Additional, web-only material may be found in the online version of this article at

Figure captions
Figure 1. (a) The Amazonian rainforest, the largest expanse of Intact Forest Landscapes (IFLs) that is in a tropical region and that occurs within Indigenous Peoples' lands. Examples of Indigenous Peoples living within IFLs worldwide include (b) three generations of women from the Cofán people in Chontapunta, Provincia de Napo, Ecuador, within the Amazon Basin; (c) Baka Pygmy women preparing dinner in a village near Mintom, southeastern Cameroon, an area within the forests of the Congo Basin, an important tropical moist forest in Africa; and (d) members of the Kwerba community in Papua, Indonesia, on the island of New Guinea, practicing with traditionally made hunting weapons.

Figure 2. Overlap of global IFLs and Indigenous Peoples' lands; note that the resolution is by necessity imprecise, as boundaries between Indigenous and other lands are often under dispute.

Figure 3. Percentage of the forest zone mapped as IFLs for Indigenous Peoples' lands and other lands, for each of the 50 sampled countries with both IFLs and Indigenous Peoples' lands.
Gray dashed line represents a 1:1 ratio between the proportion of Indigenous Peoples' lands and other lands; all points to the right of the dashed line represent places where a higher percentage of the forest zone is IFLs for Indigenous Peoples' lands than for other lands.

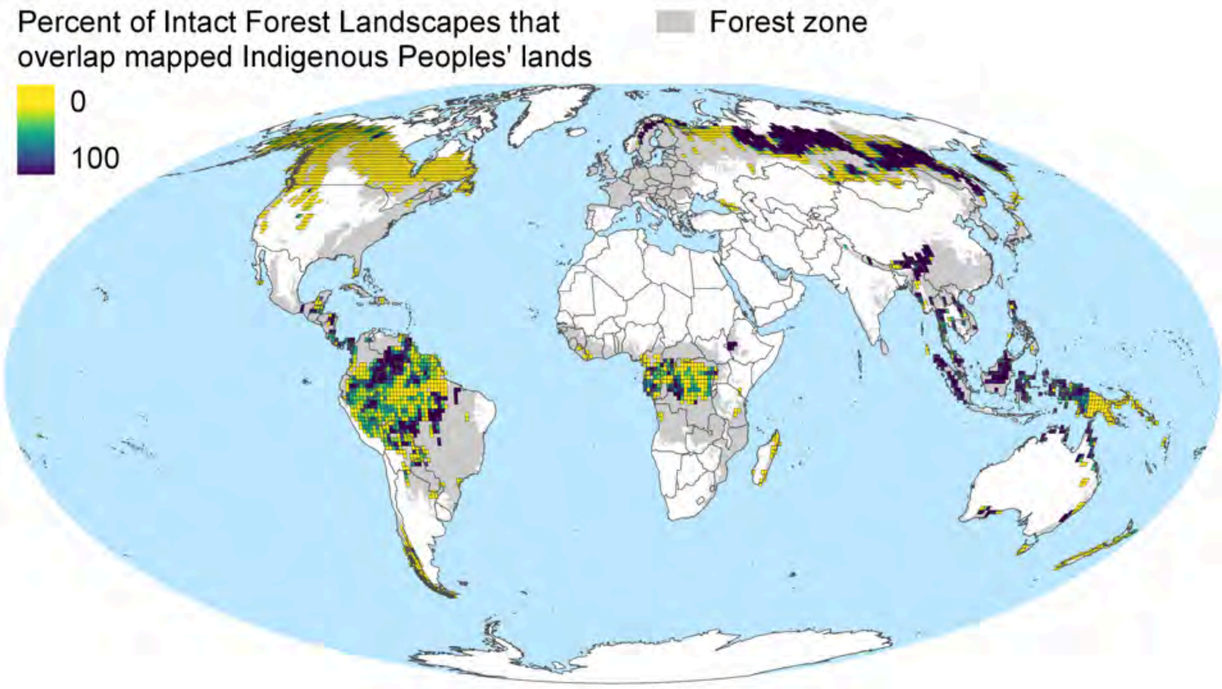
Figure 4. Comparison between the percentage of the forest zone and the percentage of IFLs for Indigenous Peoples' lands and other lands, for each country with IFLs. Each data point represents either all of a country's Indigenous Peoples' lands (blue dots) or all of its other lands (red dots). Gray dashed line represents a 1:1 ratio between the percentage of forest zone and IFLs; all points to the right of the dashed line indicate lands that a higher percentage of IFLs relative to forest zone.

Figure 5. Proportion of Indigenous Peoples' lands (blue) and other lands (orange) classified as IFL across biogeographic realms; importantly, only limited information about mapped

Indigenous Peoples' lands in the Nearctic realm is available. Oceania is not shown in this figure due to lack of information, and Antarctica is omitted because IFLs are found in this region. Both geographic regions are included in WebTable 3 for completeness.

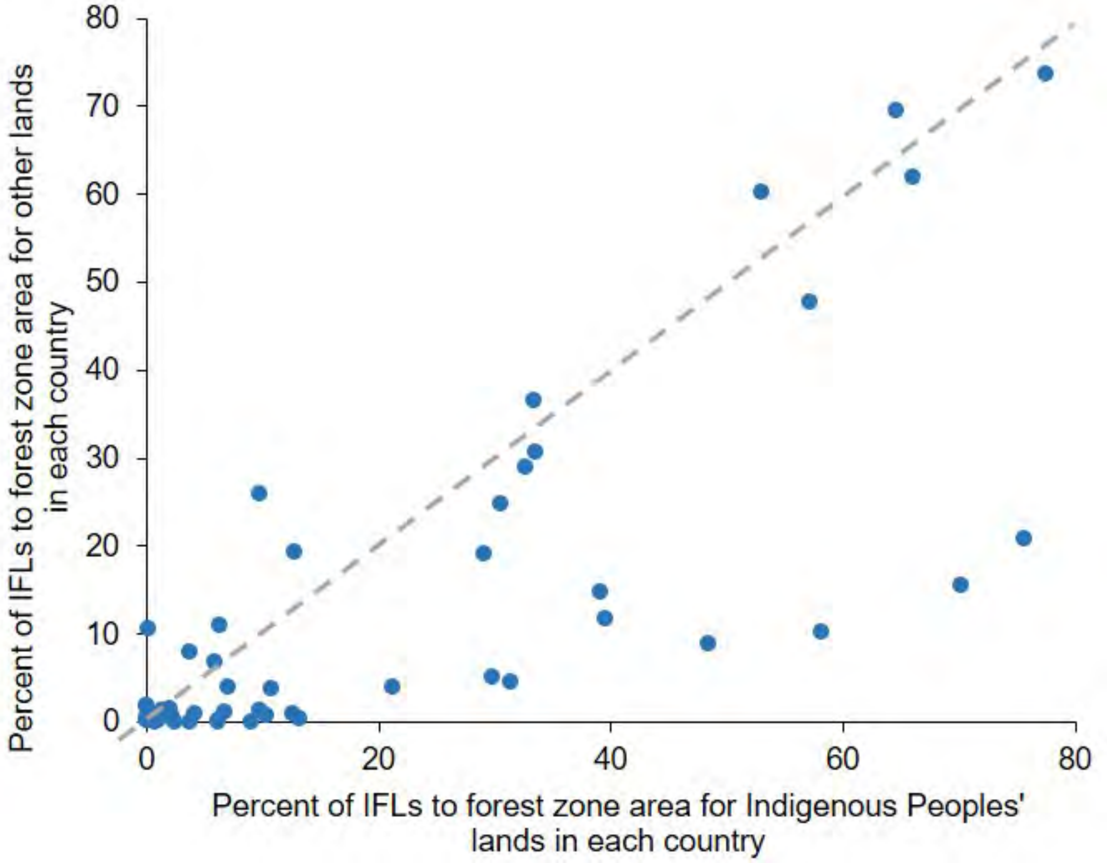
Fig. 1.

Fig. 2



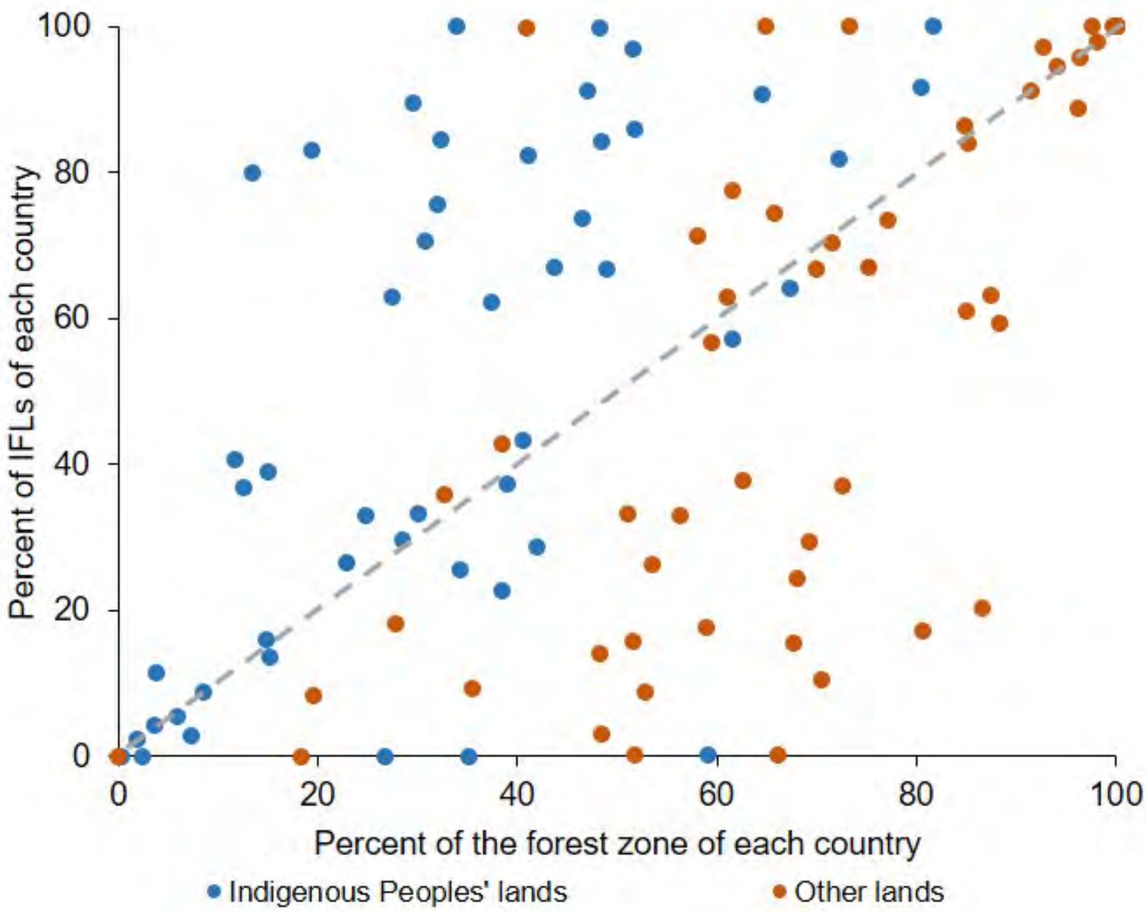
Percent of Intact Forest Landscapes that overlap mapped Indigenous Peoples' lands
0
100
Forest zone

Fig. 3



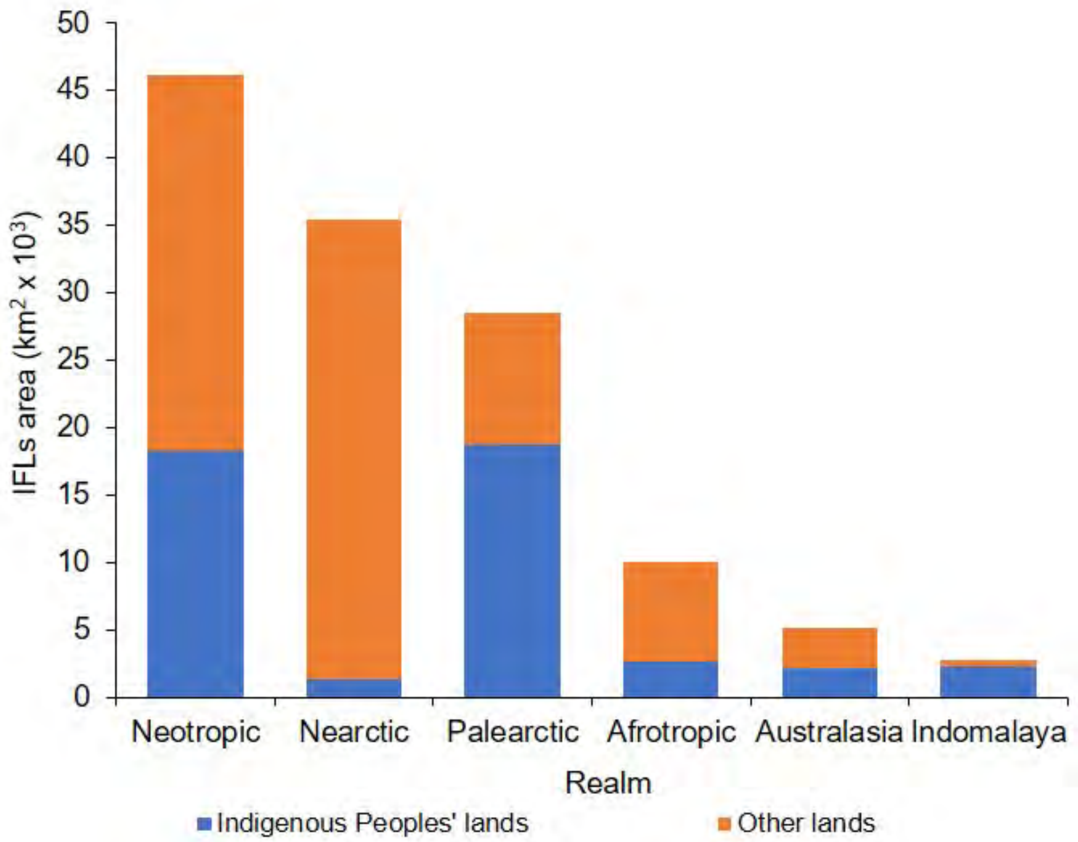
Percent of IFLs to forest zone area for other lands in each country
Percent of IFLs to forest zone area for Indigenous Peoples' lands in each country
0
10
20
30
40
50
60
70
80
0
20
40
60
80

Fig. 4



100
80
60
40
20
0
Percent of IFLs of each country
0
20
40
60
80
100
Percent of the forest zone of each country
Indigenous Peoples' lands
Other lands

Fig. 5



50
45
40
35
30
25
20
15
10
5
0
IFLs area (km^2 x 10^3)
Neotropic
Nearctic
Palearctic
Afrotropic
Australasia
Indomalaya
Realm
Indigenous Peoples' lands
Other lands