

that remains. Therefore, without taking our eyes off the long game (e.g., carbon neutrality, strategic agriculture, reduced meat dependence, and greater appreciation of conservation value), there is an obvious need, and opportunity, for immediate change. Less obvious, but gravely important, is how best to attend to the details of that change, and these details matter greatly. We suggest that a socially just analysis of the diverse risks and ramifications of trade in wildlife, illegal and legal, should be the priority starting point.

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References

1. Wu, F. *et al.* (2020) A new coronavirus associated with human respiratory disease in China. *Nature* 579, 265–269
2. Taylor, L.H. *et al.* (2001) Risk factors for human disease emergence. *Philos. Trans. R. Soc. B* 356, 983–989
3. Bramanti, B. *et al.* (2016) Plague: a disease which changed the path of human civilization. In *Yersinia pestis: Retrospective and Perspective*, pp. 1–26, Springer
4. Macdonald, D.W. and Laurenson, M.K. (2006) Infectious disease: inextricable linkages between human and ecosystem health. *Biol. Cons.* 2, 143–150
5. Faria, N.R. *et al.* (2014) The early spread and epidemic ignition of HIV-1 in human populations. *Science* 346, 56–61
6. Fraser, C. *et al.* (2009) Pandemic potential of a strain of influenza A (H1N1): early findings. *Science* 324, 1557–1561
7. Dawood, F.S. *et al.* (2012) Estimated global mortality associated with the first 12 months of 2009 pandemic influenza A H1N1 virus circulation: a modelling study. *Lancet Infect. Dis.* 12, 687–695
8. Wan, Y. *et al.* (2020) Receptor recognition by the novel coronavirus from Wuhan: an analysis based on decade-long structural studies of SARS coronavirus. *J. Virol.* 94, e00127–20
9. Andersen, K.G. *et al.* (2020) The proximal origin of SARS-CoV-2. *Nat. Med.* 26, 450–452
10. Cantlay, J.C. *et al.* (2017) A review of zoonotic infection risks associated with the wild meat trade in Malaysia. *EcoHealth* 14, 361–388
11. Daszak, P. *et al.* (2000) Emerging infectious diseases of wildlife—threats to biodiversity and human health. *Science* 287, 443–449
12. Zhou, Z.-M. *et al.* (2020) China: clamp down on violations of wildlife trade ban. *Nature* 578, 217
13. Montgomery, R.A. (2020) Poaching is not one big thing. *Trends Ecol. Evol.* 36, 472–475

Science & Society

Reframing the Wilderness Concept can Bolster Collaborative Conservation

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Indigenous territories represent ~45% of land categorized as wilderness in the Amazon, but account for <15% of all forest loss on this land. At a time when the Amazon faces unprecedented pressures, overcoming polarization and aligning the goals of wilderness defenders and Indigenous peoples is paramount, to avoid environmental degradation.

The Wilderness Debate Revisited

While the notion of wilderness dates back centuries in popular culture, the arts, and ecology, it has frequently resurfaced at the heart of the contentious history of conservation policy across much of the Global South, up to this day [1,2]. In fact, the idea of protecting large areas in which humans have theoretically had little or no ecological impact has exercised a strong role in the history of the conservation movement, and remains appealing

to some sectors [2]. Yet, the notion of wilderness is rooted in Western and idealized visions of a pristine nature devoid of the destructive impacts of human activity [3,4]. Not surprisingly, and linked to ongoing disagreements around approaches to nature conservation, debates around the concept of wilderness have been polarized and acrimonious [1,2,5].

On the one hand, conservationists using a wilderness framing claim that wilderness areas are critical strongholds for endangered biodiversity, underpinning key regional- and planetary- scale ecological functions, and acting as refugia where ecological and evolutionary processes operate with minimal outside interference [6,7]. However, the implementation of these wilderness preservation agendas has often led to local communities' displacement, land alienation, and restrictions on both livelihood activities and access to resources [3,4]. On the other hand, detractors of the wilderness concept claim that some of the best-conserved forest ecosystems in the world have been actively shaped and managed by humans over millennia [8,9].

The assumption underlying mainstream conceptualizations of wilderness is that a dichotomy exists between people and nature, and that humans have inherently negative impacts on nature [10]. As such, the continuing use of wilderness as a conservation framing has been seen as reifying the long-standing nature-culture dualism, and conflicting with Indigenous understandings of nature as an interconnected web of life, linking humans and non-humans in complex relationships [4]. However, these conceptualizations of wilderness have not been universally applied, and more recently some conservationists calling for wilderness preservation have emphasized that its core notion does not necessarily exclude people and does not always mean pristine ecosystems

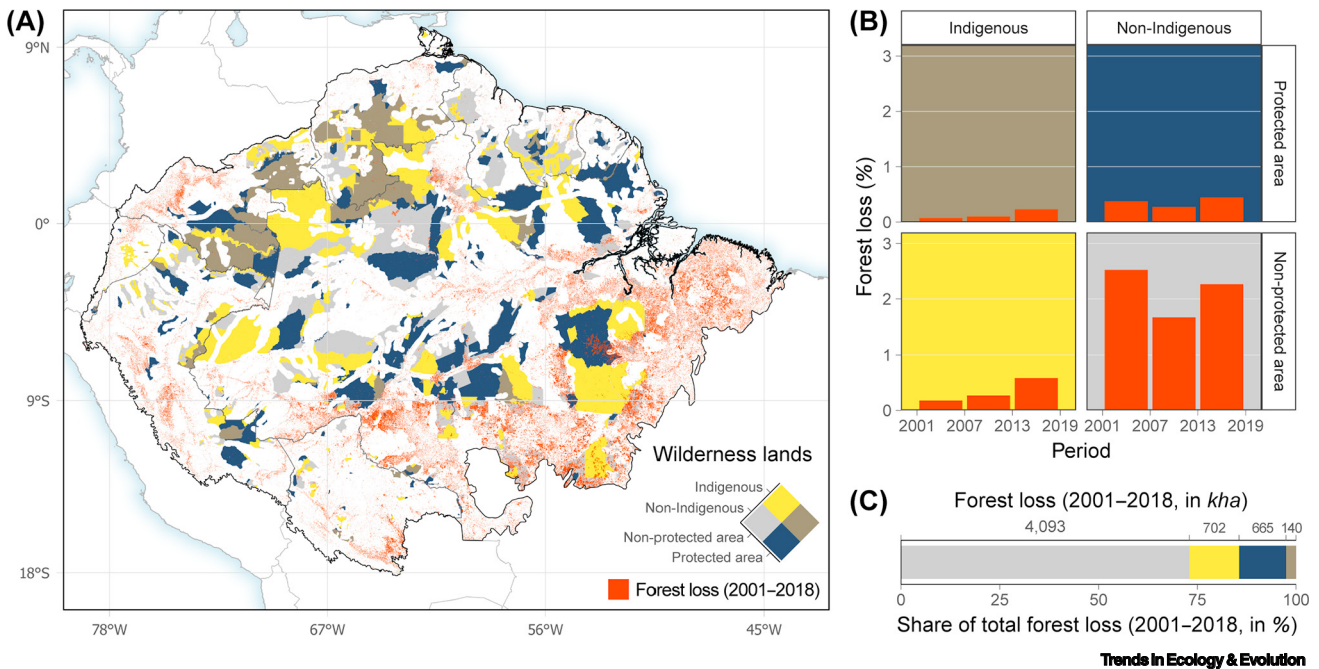


Figure 1. Patterns of Forest Loss (2001–2018) within Areas Considered as Wilderness (by Land Regime) across the Amazon Biome. From all the land cover categorized as wilderness in the Amazon (i.e., 223 million hectares), 45% overlaps with Indigenous territories, 42% intersects protected areas and 28% is both unprotected and uninhabited by Indigenous communities (see the supplemental information online). Data from [14,15] and Amazon Geo-Referenced Socio-Environmental Information Network (<https://www.amazoniasocioambiental.org/en/about/>).

or untouched habitats [6]. For example, at the global level, the concept of wilderness has most recently been operationalized to identify areas in which industrial levels of human disturbance (e.g., intensive development) are absent or minimal [7]. It is believed that this shift in the framing of wilderness from a strict absence of human influence to one focused on the lack of industrial impacts, provides a more inclusive framing for considering the long-term interactions between Indigenous peoples and their environments in regions such as the Amazon, opening up opportunities for local collaboration and broader policy dialogues around biocultural conservation [3,4]. Although this article focuses specifically on Indigenous peoples, it also yields insights applicable to other local and rural communities with close relations with their local environments.

Amazonian Indigenous Territories are Crucial for Conservation

Across the Amazon, the notion of wilderness continues to be associated with social imaginaries of the region as an empty and pristine *terra nullius* [10], a framing that has been contested since at least the 1970s. Botanical, ethnoecological, and archaeological research has shown the long-history legacy of human management of Amazonian forests, highlighting that a significant portion of the region's supposedly pristine forests are in fact cultural forests [8,9]. With over 300 Indigenous groups and more species of plants and animals recorded than in any other terrestrial ecosystem on the planet, the Amazon is considered a global hotspot of biocultural diversity and a classic example of how the presence of humans can be intricately linked to certain positive environmental

outcomes [10,11]. This includes the long-term contributions of Indigenous and other rural communities to the formation of large and regionally important forest and agroforestry-based economies, which offer alternative pathways to reconcile conservation and economic development, amid current threats of expanding extractive and commodity frontiers across the region [9,11].

The geospatial analyses presented show that Indigenous territories account for at least 45% of all the remaining land considered as wilderness across the entire Amazon biome (Figure 1), covering a surface of up to 103 million hectares. The role of these territories in buffering against deforestation is also substantial, accounting for less than 15% of all the forest loss occurring within the Amazon's last wilderness frontiers. Yet, long-

standing debates around approaches to conservation, the concept of wilderness, and its application in nature conservation can obstruct the potential for productive collaboration between Indigenous peoples and conservationists, who could together confront the mounting pressures of environmental degradation and social conflict across the region.

Debates around the concept of wilderness have taken many forms over the years, such as opposing intrinsic and instrumental values of nature [1] or eco-centric and anthropocentric viewpoints [5]. On the ground, the intractable nature of these debates can essentially prevent constructive dialogue aimed at reconciling conservation and Indigenous peoples' rights, which in turn put the biological and cultural values of these lands in jeopardy. Although there is a long history of collaboration between conservationists and Indigenous peoples in the Amazon [10], tensions around the concept of wilderness are still prominent across the region, particularly when the implementation of conservation policies results in displacements and restrictions over access rights to land and resources. In fact, most wilderness defenders have, until relatively recently, maintained a quiet position in debates regarding the land claims of Amazonian Indigenous Peoples [10]. As of today, wilderness preservation is gaining renewed attention in the context of ongoing calls to extend the global conservation estate to cover half the Earth (i.e., 'Nature Needs Half' Initiative), including many natural areas traditionally owned, managed, used, or occupied by Indigenous peoples [5,12].

Converging Agendas to Tackle Current Conservation Challenges

At a time when the Amazon rainforests face unprecedented weakening of environmental protection [13], it is argued that disputes around the notion of wilderness could

undermine potential collaboration between conservation organizations and Indigenous peoples' movements. The spatial overlap between Indigenous territories and areas commonly represented as the last wilderness frontiers is large (i.e., around three times the area of Germany), with many of the current struggles of wilderness defenders and Indigenous peoples against development pressures being fought in the same locales (Figure 1). As such, both the wilderness-focused conservation agenda and Indigenous peoples' self-determined visions are arguably threatened by the same macroeconomic and political forces. A more socially inclusive notion of wilderness could contribute to the convergence of the agendas and priorities of both wilderness-focused conservationists, and Indigenous peoples, against a new wave of frontier expansion. This is particularly important as some of the Governments in the region start to fall behind on, or even trample over, their international commitments towards both the environment and Indigenous peoples' rights [13].

Far from opportunistic essentialism of Indigenous peoples as wilderness custodians [10], it is posited that the future of a substantial proportion of the Amazon's biodiversity depends largely on coordinated action to support, strengthen and enforce Indigenous peoples' rights across the whole region. The fights for wilderness conservation and for Indigenous peoples' rights have the potential to coalesce around at least some core priorities that could be strategically harnessed to broaden the scope and magnitude of their respective struggles. For example, there is increasing recognition, within applied ecology and other conservation-related disciplines, as well as among policy-makers, that strengthening the rights of Indigenous peoples can be one of the most powerful ways to buffer against deforestation and protect nature from intensive development [4,12,13]. While their actions are not comparable to intensive development, Amazonian

Indigenous peoples do have a range of legitimate social, political, and economic aspirations that do not always align with all the goals of certain biodiversity conservation organizations [3,11]. However, there are also numerous examples of local governance regimes and management systems by Indigenous peoples that are significantly contributing to conserve entire ecosystems, while also safeguarding their rights and futures, including their customary uses of biodiversity [12]. This is evidenced throughout the southern rim of the Amazon, where today Indigenous territories represent the only islands of biological and cultural diversity in the larger landscape.

It is therefore hoped that conservation organizations will contribute to support Indigenous peoples in their struggles to reclaim their rights, as these same struggles are in the interest of the conservation agenda [4]. Land grabbing, resource extraction, deforestation, and environmental degradation are likely to increase if urgent measures are not put into place to recognize and protect Indigenous peoples' rights across the entire Amazon [13]. However, hope is found in the recent trends across multiple academic disciplines, including applied ecology, toward recognizing that biocultural approaches offer more effective and just models for conservation (e.g., [2–4]). As evidenced by the recently launched IPBES Global Assessment on Biodiversity and Ecosystem Services [12], supporting Indigenous peoples and local communities to secure and self-strengthen their collective systems of tenure, governance, and sustainable ways of life is fundamental to achieving numerous local, national, and global biodiversity and climate goals, on which human well-being depends.

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References

1. Tallis, H. *et al.* (2014) Working together: a call for inclusive conservation. *Nature* 515, 27–28
2. Mace, G.M. (2014) Whose conservation? *Science* 345, 1558–1560
3. Gavin, M.C. *et al.* (2015) Defining biocultural approaches to conservation. *Trends Ecol. Evol.* 30, 140–145
4. Lyver, P. *et al.* (2019) Biocultural hysteresis inhibits adaptation to environmental change. *Trends Ecol. Evol.* 34, 771–780
5. Kopnina, H. *et al.* (2018) The 'future of conservation' debate: defending ecocentrism and the Nature Needs Half movement. *Biol. Conserv.* 217, 140–148
6. Watson, J.E.M. *et al.* (2018) Protect the last of the wild. *Nature* 563, 27–30
7. Di Marco, M. *et al.* (2019) Wilderness areas halve the extinction risk of terrestrial biodiversity. *Nature* 573, 582–585
8. Levis, C. *et al.* (2017) Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science* 355, 925–931
9. Maezumi, S.Y. *et al.* (2018) The legacy of 4,500 years of polyculture agroforestry in the eastern Amazon. *Nat. Plants* 4, 540–547
10. Vadjunec, J.M. and Schmink, M. (2012) *Amazonian Geographies: Emerging Identities and Landscapes*, Routledge
11. Brondizio, E.S. and Le Toumeau, F.M. (2016) Environmental governance for all. *Science* 352, 1272–1273
12. IPBES (2019) *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*, UN-IPBES
13. Begotti, R.A. and Peres, C.A. (2019) Brazil's indigenous lands under threat. *Science* 363, 592
14. Venter, O. *et al.* (2016) Global terrestrial Human Footprint maps for 1993 and 2009. *Sci. Data* 3, 1–10
15. Hansen, M.C. *et al.* (2013) High-resolution global maps of 21st-century forest cover change. *Science* 342, 850–853

Science and Society

After the Megafires:
What Next for
Australian Wildlife?

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The 2019–2020 megafires in Australia brought a tragic loss of human life and the most dramatic loss of habitat for threatened species and devastation of ecological communities in postcolonial history. What must be done now to keep impacted species from extinction? What can be done to avoid a repeat of the impacts of such devastating bushfires? Here, we describe hard-won lessons that may also be of global relevance.

A Season in Hell

Despite the familiarity of Australia with fire, the timing, ferocity, and extent of the 2019–2020 fires was shocking. By area burnt, it was the largest fire season in eastern Australia since European occupation. The total area burnt in eastern Australia from August 2019 to March 2020 was almost 126 000 km² or 12.6 million hectares, almost the area of England (13 million ha) (Figure 1). Megafires have occurred intermittently in Australia over the past 150 years, possibly facilitated by the removal of traditional land practices of indigenous people. For example, in 2009, fires in eastern Australia burnt an area <10% of the most recent fires, killing 173 people and destroying >2000 dwellings. However, this most recent fire season was unprecedented in geographical scale, duration, and intensity, and has had major impacts on species and ecosystems that were already under immense stress from prolonged drought. The comprehensiveness of the destruction

is striking. Postfire aerial reconnaissance revealed vast landscapes of grey ash extending as far as the eye can see: grey, not a hint of green, bounded only by the blue of sea and sky (Figure 1).

The full impacts on biodiversity will not be fully understood for years to come as extinction debts are realised. Some coarse surrogates paint a stark picture: 327 (272 plants, and 55 animals, including five invertebrates) of the ~1800 listed threatened species in Australia had a significant portion (>10%) of their known distribution within the fire footprint¹, of which 31 were already critically endangered. Among the significantly impacted species, 114 have lost at least half of their habitat and 49 have lost over 80%. Although these numbers are still being refined, this is likely to result in significant population losses. The conservation status of many species [e.g., gang gang cockatoo (*Callocephalon fimbriatum*) and yellow-bellied glider (*Petaurus australis*)] previously considered secure, will now need to be reconsidered. Impacts will be long-lasting, because many of the fire-affected species were dependent upon long-unburnt habitats that take decades to re-establish and many have slow reproductive output and, thus, it will take many years for populations to re-establish. Thousands of less well-known species, including invertebrates and plants, many yet to be described and many with very localised distributions, will have suffered dramatic impacts. Some may even have become extinct before being discovered or named.

Most fires leave a scattering of unburnt patches within the fire footprint, often in small topographical features such as sheltered, wetter gullies, but sometimes also due to the vagaries of sudden windshifts that send the fire in a different direction. Although a comprehensive analysis of the spatial variation in fire intensity across the