Unequivocal principles for area-based biodiversity conservation

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Abstract

Recent agreements have strengthened and expanded ongoing international commitments to protect and restore native habitats. Nevertheless, how such commitments should be implemented has been historically controversial, and nuances in ongoing debates are often misunderstood, hindering biodiversity conservation. We propose three unequivocal principles that must be central to how area-based biodiversity conservation will occur in the coming decades. These principles relate to habitat coverage, amount, and connectivity, and their enunciation clarifies apparent contradictions in the literature. We explain why socio-economic considerations that are central to current biodiversity conservation cannot override these principles. Biodiversity must be supported everywhere on Earth, especially when considering the right of human population to access nature and to benefit from countless ecosystem services.
Abstract:
Recent agreements have strengthened and expanded ongoing international commitments to protect and restore native habitats. Nevertheless, how such commitments should be implemented has been historically controversial, and nuances in ongoing debates are often misunderstood, hindering biodiversity conservation. We propose three unequivocal principles that must be central to how area-based biodiversity conservation will occur in the coming decades. These principles relate to habitat coverage, amount, and connectivity, and their enunciation clarifies apparent contradictions in the literature. We explain why socio-economic considerations that are central to current biodiversity conservation cannot override these principles. Biodiversity must be supported everywhere on Earth, especially when considering the right of human population to access nature and to benefit from countless ecosystem services.

Main Text:
The 2022 United Nations Biodiversity Conference (COP-15) addressed five “horsemen of the biodiversity apocalypse”: climate change, pollution, invasive species, overexploitation, and land use change. Policies to regulate land use are especially important because land use contributes the most to ongoing biodiversity loss (1, 2). At the same time, such policies are especially delicate because land use change is inherently intertwined with how people benefit from and depend on nature (3).

While land use change continues to increase (2, 4), the complexity of species responses to such change has spurred debates on how to best manage habitat for sustaining biodiversity. For instance, how often does habitat fragmentation exacerbate or interact with the effects of habitat loss on biodiversity (5, 6)? And when can land sharing be considered alongside land sparing in conservation planning (7, 8)? Deciding which habitat is most valuable based on its pattern and amount has proven difficult because different spatio-temporal scales and ecosystems evaluated in different studies can generate different answers to analogous questions. These debates might lead managers and policy makers to believe that scientists cannot agree on how biodiversity should be preserved in the face of widespread and increasing global land use.

Ongoing debates should not distract from the areas of consensus reached after decades of research in biodiversity conservation. We therefore take this opportunity to share a message of agreement among scientists who work in this field. We highlight three fundamental principles (Fig. 1):

1) To protect Earth’s biodiversity, we must protect and restore native habitats in all biomes and ecoregions (Fig. 1.1). This will safeguard the unique contribution of each ecoregion to our biological heritage. Biodiversity has intrinsic value and is not fungible; this must be kept in mind, especially as the world weighs biodiversity credits.

2) Protecting as much native habitat as possible is our best way to safeguard biodiversity (Fig. 1.2). The total area of habitat is paramount, and includes both the remaining large native ecosystems and the many...
small native patches in human-dominated regions. Habitat restoration will be especially important to reach minimum area targets in regions where most native habitat has already been converted to human land uses.

3) Habitat patches must be functionally connected (Fig. 1.3). Connectivity ensures access to sufficient and complementary resources when habitat patches are too small for a single patch to sustain a species. Connectivity is also fundamental when patches are larger, as migration between them decreases population extinction risk, facilitates re-colonization, and may allow species to shift their ranges in response to shifting climate.

**Putting disagreement into context**

Highlighting these three, unequivocal principles is important because ecologists and conservation biologists have long discussed how best to manage native habitat to sustain biodiversity (5, 6). Earlier discussions revolved around the SLOSS question (should conservation prioritize ‘a single large or several small’ habitat patches?). Through time, SLOSS matured into a conversation around the effects of habitat fragmentation relative to effects of habitat amount. And more recently, the discussion among scientists has focused on whether habitat fragmentation may even have a positive effect on species. The problem is, while disagreement is healthy in an academic setting, it confuses management and policy making.

Still, the extensive body of literature addressing these topics has not been sufficient to reach consensus on them. Some scientists have concluded that landscapes containing many small patches of native habitat can sustain rare and/or habitat specialist species (e.g., due to beta diversity patterns or spatio-temporal dynamics across patches) (5, 9), whereas others have suggested that the detrimental effects of reduced patch size inevitably depauperate biodiversity even at high cumulative habitat areas (e.g., due to extinction debt that might be paid in landscapes containing many small patches) (6, 8). Underlying different perspectives are several factors determining our understanding of patterns in species occurrence and biodiversity. Some of these factors are contextual to different ecosystems, including biogeographical differences or intraspecific variation, and some theoretical, including issues of spatial scaling or the balance between deterministic and stochastic forces across landscapes.

Despite the different schools of thought in this field, there is no debate about the need to conserve habitat: the effects for biodiversity of increasing native habitat area are overwhelmingly positive. Furthermore, embracing the three principles we outline (Fig. 1) helps to put disagreements in the conservation literature into perspective. For instance, it is true that large areas of nature are important and must be protected (2), as much as it is true that ensuring the conservation or restoration of multiple small habitat patches is fundamental for global biodiversity conservation, particularly in regions with high land use (2). These are neither incompatible nor competing strategies; instead, they are complementary approaches to protect biodiversity across all regions. Healthy disagreement can be wrongly translated into a false dichotomy between the protection of large or small patches, a mistake that must be avoided at all costs for the sake of biodiversity conservation because both are important.

Habitat existing as small patches is often deemed less valuable than large swaths of habitat in less modified regions (8), which is inadvertently leading to widespread cumulative losses of habitat from millions of small patches across the globe. For instance, a recent global analysis found that smaller (< 1000 ha) forest patches are more likely to suffer a given amount of habitat loss than larger (> 10,000 ha) patches (4). Policies that protect only patches larger than a minimum size hinder biodiversity conservation as they fail to protect biodiversity in highly-modified regions that clearly need protection. In Southern Ontario, Canada, where only about 15% of native habitat remains, about 95% of recent wetland habitat loss has occurred below the 2-ha minimum area criterion used to identify “Provincially Significant Wetlands” (10). Failing to maintain small habitat patches also reduces landscape connectivity among larger patches, due to the loss of “stepping stones” (Fig. 1.3), where small patches distributed through a landscape can facilitate movement between larger patches.

At the same time, very large tracts of native habitat are now limited to a small number of regions (2), and their continued conversion to human land uses is placing biodiversity at risk. For instance, continued
Deforestation in the Amazon could trigger an ecosystem state-shift, because the persistence of this biome depends on feedbacks between vegetation and climate (11). Losing even a fifth of the Amazonian forest could shift the remaining area of forest into savanna, a death-knell for the forest-dependent species of the Amazon (11). Similarly, while the few remaining extensive grasslands worldwide sequester large amounts of carbon and host unique species, they remain poorly protected and continue to shrink (12). Beyond biodiversity per se, loss of these extensive, natural habitats would bring significant losses to the economic, cultural, and ecological identity of large regions (11, 12).

Ultimately, initiatives that set targets for habitat protection in the coming decades require protection of both small and large areas of native habitat. In ecoregions where vast areas of native habitat still exist, ongoing habitat transformation needs to stop to both protect biodiversity and reduce the pace of climate change. In ecoregions with high land use, urgent protection and restoration of large numbers of small patches is needed to sustain not only biodiversity but also crucial ecosystem services including soil retention, water security, pest control, pollination, and human well-being and health.

Protecting biodiversity with people and for people

Biodiversity conservation is destined to fail unless the rights and needs of people enter the equation. While the necessity to protect native habitat is undeniable, the provision of food, water, shelter, and energy to humans often implies the sacrifice of large areas of native habitat. How can we halt this habitat loss to sustain biodiversity, while at the same time supporting the needs of an increasing global human population?

Some changes will positively affect biodiversity by increasing the total area of habitat reserved for nature, including top-down (e.g., market regulations and policies) and bottom-up (e.g., efforts to reduce waste and shift to plant-based food consumption) mechanisms. These are important societal changes that we hope will occur rapidly as we transition to a biodiversity-friendly future. But equally importantly, careful planning that does not affect the total area reserved to nature can optimize conservation investments. For instance, natural habitats can be maintained within agricultural landscapes to sustain several crucial services (e.g., pollination, pest control, and nutrient retention). In the Midwestern US, removing from crop production sub-field areas that are consistently under-yielding makes realistic conservation possible across millions of hectares (13). Avoiding growing food in such locations can reduce the total surface of land needed to feed humanity, while maintaining production. As a further example, restoration of small (≤ 0.16 ha) forest patches in oil palm plantations can enhance biodiversity and multiple ecosystem services without compromising yield (14). Thus, it is possible to reduce the area allocated to land used by people and increase land for nature, while also guaranteeing the services that people rely on.

Meanwhile, area-based conservation actions are inherently intertwined with socio-political dynamics and ethics (3), and require integrating biodiversity policy with other goals (e.g., the 17 United Nations sustainable development goals, particularly goals tied to biodiversity conservation such as “Zero hunger” and “Clean water and sanitation”). For instance, heterogeneous landscape mosaics where nature and people have coexisted for thousands of years (e.g., Indigenous lands) typically bolster both the intrinsic and utilitarian values of nature (3). At the same time, actions to sustain wilderness are not always desirable for people. For instance, global conservation of large carnivores is complex because human-wildlife conflicts disproportionately affect people in the global South, who already incur disproportionately high costs for global biodiversity conservation. Such costs include regulations on land use. For example, the Brazilian Forest Code imposes a minimum of native habitat area to be retained on private lands, and riparian zones are legally protected both in Brazil and Malaysia. Thus, the burden of global biodiversity conservation is placed upon the global South countries that are experiencing the fastest population and economic growths, whereas countries in the global North did not incur comparable limitations during their development.

Consequently, consideration of aspects beyond – but dependent on – biodiversity, such as productivity and ecosystem services, must be central in the dialogue around how to implement area-based conservation efforts. This dialogue requires weighing different conservation, ethical, social, and economic priorities. It also requires confronting debates such as the land sharing vs. land sparing debate, and the debate over whether organic
farming is the most effective approach for biodiversity-friendly agricultural landscapes (7, 8, 15). We stress that the principles we champion here must be central to the process of weighing these different priorities, because failing to halt biodiversity loss entails a real risk of societal collapse.

Coda

National and international policies have embraced the principle of conserving 30% of land and water by 2030. To protect biodiversity, this so-called ‘30×30’ must be achieved in each ecoregion. This can be achieved through conservation of the large habitat areas that resemble wilderness, combined with protection and restoration of many small habitat patches in ecoregions severely affected by human activities. In fact, in heavily populated and highly human-modified regions, reaching area targets will be possible only through protection of small patches and habitat restoration. In such regions, new conservation of many small areas is essential to get to 30×30, and such areas may represent the greatest net gains for conservation going forward.

More broadly, realizing 30×30 and other ambitious, collective, area-based plans will be possible only if we recognize that common ground far exceeds disagreement among researchers working on area-based biodiversity conservation. All sides agree that reversing biodiversity declines cannot be accomplished without conservation and restoration of native habitat, especially in regions where most native habitat is already gone. The disagreements are secondary to the general principles we outline in this letter, and we are confident that they will be resolved as data accumulate and science progresses. In the meantime, to address a global biodiversity emergency, proactive implementation of the unequivocal principles that we all agree upon will bolster our chances of preserving the Earth’s biodiversity heritage.

References


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Supplementary Materials

No supplementary material

Fig. 1. Three principles for area-based biodiversity conservation. (1) To protect Earth’s biodiversity, we must protect and restore native habitat in all biomes and ecoregions. Shown are Earth’s 14 biomes. (2) Protecting as much native habitat as possible is our best way to safeguard biodiversity, and requires protecting both smaller and larger patches. For instance, while in some tropical biomes forest may exist in large, continuous patches, other biomes have been reduced to highly fragmented habitat. Green circles represent habitat patches separated by anthropogenic land use in two adjacent biomes (green and blue background); the fading, green area on the bottom-left corner of the inset represents a large expanse of wilderness. (3) Habitat patches must be functionally connected. Habitat connectivity can increase with stepping stone habitat (a), corridors (b), or by reducing distances between patches (i.e., increasing patch density in the landscape) (c).
Figure 1

Protect habitat in every biome and ecoregion

Protect as much habitat as possible, including smaller and larger patches

Protect habitat to facilitate connectivity

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