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Half Earth: promises, pitfalls, and prospects of dedicating Half of Earth's land to conservation

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A growing movement of conservationists proposes to stem biodiversity losses by setting aside half of Earth's land as an interconnected global conservation reserve. As the largest land governance proposal in history, Half Earth engages with some of the wickedest challenges in land system science. How best to allocate and manage Earth's land to maximize biodiversity conservation in the face of competing demands for food, housing and other human needs? Can half of Earth's land be reallocated and governed fairly and equitably in ways that honor the rights of vulnerable populations? Who will pay for and govern this project? Half Earth's prosocial aspirational vision could help to inspire and sustain the global, regional and local efforts needed to conserve biodiversity across the Anthropocene. It is time for a broader discussion of the social-ecological opportunities, trade-offs, and challenges that a global conservation reserve project at the scale of Half Earth would create. In so doing, we must begin by recognizing the central role of social processes, institutions, and strategies in making such efforts possible, with a focus on adaptive multi-level systems of landscape governance that benefit people as much as they benefit the natural world.

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Introduction

A growing movement of conservationists is calling for a global scale-up of conservation efforts to halt massive losses of biodiversity and wild habitats, including proposals to increase global coverage of conservation areas to 50% or more of Earth's surface, beyond the 17% now planned for 2020 through existing conservation agreements (Aichi Target 11; [1,2••,3–8]. Perhaps the most widely discussed of these is E.O. Wilson' 'Half Earth' proposal [1], and the related but earlier 'Nature Needs Half' agenda [3]. Both proposals aim to set aside half of Earth's surface as an interconnected global conservation reserve, and are now under development by different organizations; the Half Earth project (HEP; http://www.half-earthproject.org) and the Nature Needs Half coalition (NNH; https://natureneedshalf.org). The proposal has inspired both supporters and critics [e.g. in Refs. 7,9,10,11•,12•] and is now under discussion, potentially as a goal of '50% by 2050' by the Convention on Biological Diversity (CBD), the United Nations body responsible for global agreements on protected areas [13,14].

Half Earth includes both marine and terrestrial efforts. This article focuses on the terrestrial component of Half Earth – a conservation reserve covering half of Earth's land surface. In addressing this proposal, we recognize that our normative positions, as land system scholars seeking to conserve Earth's remaining biodiversity while improving social conditions more generally, represents a limited perspective on the meanings, values and priorities relating to these positions held by the diverse spectrum of stakeholders connected with any project aiming to govern land systems and biodiversity at global scale [15,16]. Within this perspective, we explore the promises, pitfalls and prospects of the Half Earth proposal, including its connection with issues of power, equity and governance, to help inform societal discussions and negotiations toward better futures for people and the rest of life on Earth.

Promises

The greatest promise of Half Earth is its simplicity and potentially universal appeal. Sharing this planet half-and-half with the rest of nature appears at once fair, reasonable, and achievable, and shows clear potential to conserve most of Earth's ecological heritage into the deep future [7]. Even while its political, economic, and other implications are potentially staggering [9,11•,12•,17••], its ability to couple widespread human love of nature and aspirations for a better future with a simple goal might offer the best chance to transform these aspirations into reality [1,3,18,19]. The full potential of a Half Earth vision to achieve broader societal support for conservation

has not been well studied. Nevertheless, its broad, prosocial, proactive, and socially scalable message could go beyond the limits of conventional 'doom and gloom' environmental messaging in ways that might catalyze a whole new level of societal engagement in conservation [19–21]. Half Earth therefore deserves consideration as a planetary opportunity to conserve Earth's remaining biodiversity [22•].

Two assessments serve as the scientific basis for setting aside half of Earth's land as a biodiversity reserve. The first, cited by NNH, assessed area targets 'required to meet conservation goals' across a range of studies, which varied from 25% to 75%, and derived the 50% target by applying a 'precautionary perspective' to this range [8]. The second, supporting HEP, draws on classic island biogeography theory to estimate that conserving 50% of all habitat should sustain approximately 85% of all species [1]. Though both assessments are useful guides, neither can be considered adequate scientific support for the conservation effectiveness of a 50% global conservation area target. On the other hand, both aim to secure and protect sufficient habitat to sustain the bulk of Earth's biodiversity over the long-term – a goal most conservationists support; there is broad agreement that a 17% protected area target is nowhere near sufficient [4,5,23,24]. Raising the bar will therefore be critical if efforts and resources are to be mobilized for conservation at a level commensurate with the needs of Earth's remaining ecological heritage.

In addition to advocating for a 50% protected area target, both projects call for strategies that avoid involuntary land reallocation, that implement large interconnected reserves overlapping with Earth's remaining high biodiversity areas, and that empower Indigenous Peoples as stewards of biodiversity in their sovereign lands. NNH focuses specifically on protecting half of each of Earth's 846 ecoregions through a 'Global Deal for Nature', which would protect 50% of the terrestrial realm by 2050, and has assessed the potential for this based on land remaining unused for agriculture or settlements [2••]. NNH also explicitly embraces the full range of International Union for Conservation of Nature (IUCN) protected area categories in its protected area strategy, from 'Strict Nature Reserve' to 'Protected area with sustainable use of natural resources' [3]; Wilson's Half Earth and the HEP remains vague on this point [1]. Beyond these relatively broad considerations, the global conservation strategies of both projects remain at an early stage of development, including their funding mechanisms, governance strategies and precise land allocation priorities.

Pitfalls

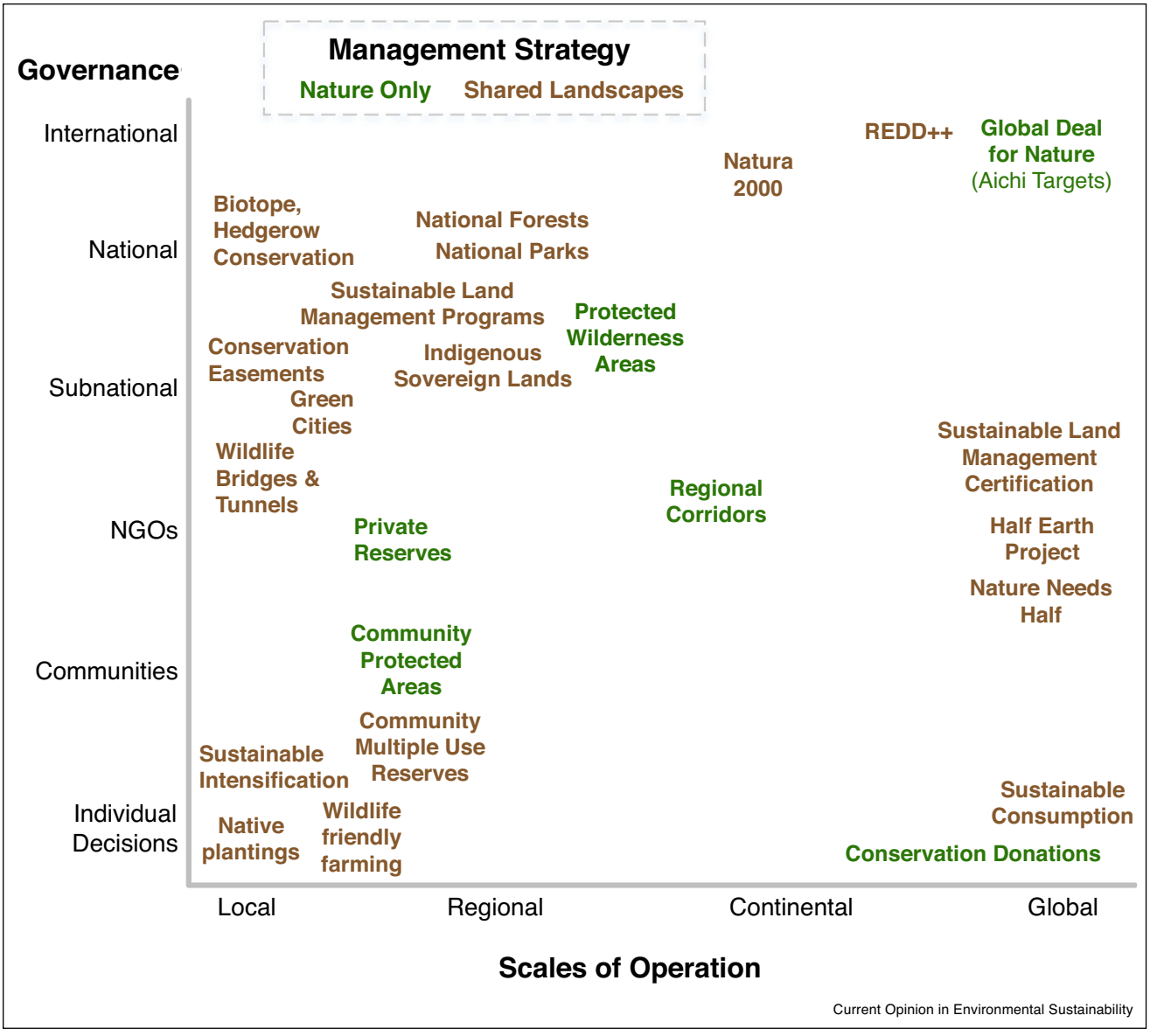
If Half Earth were to be operationalized, its scope and ambition connote an unrivalled level of land system governance. If successful, Half Earth would become the most extensive land governance project in human history, incorporating a global land area greater than 70×10^6 km^2; four times larger than Earth's largest nation (Russia) and more than fifty times larger than Earth's most extensive existing conservation network (The EU's Natura 2000 network; [12•]). While building on existing conservation efforts, such a project would clearly require the development and integration of an unprecedented portfolio of additional capacities to manage land at global, regional, and local scales, supported by governance strategies spanning international agreements, local institutions and individual decision making (Figure 1 [22•]). Moreover, by aiming to reallocate and manage a valuable, limited resource across a crowded planet, Half Earth enters the realm of wicked problems, where solutions produce both winners and losers, tradeoffs are necessary, solutions can yield additional problems, and where both problems and solutions may be defined differently by different stakeholders [25••]. Despite its simple aspirational goal, Half Earth exemplifies the complex and seemingly unsolvable social-environmental challenges inherent in any effort to govern land globally. A selection of potential challenges to implementing Half Earth and opportunities to address them are presented in Table 2 and discussed below.

Biodiversity strategies: why half, which half, where?

The proposal to focus conservation on a worldwide 50% protected area target has been criticized, even by its first proposers, as not enough to conserve biodiversity in some regions, more than necessary in others, and operationally impracticable in others [2••,3,8,11•]. Moreover, protected areas are but one of the many strategies for conserving biodiversity, which range from protecting species to restoring degraded lands, to managing working landscapes, together with a wide variety of other area-based targets like 'Other Effective Conservation Measures (OECMs)' [26•,27••]. For this reason, Half Earth's sole focus on a 50% protected area target has been widely critiqued for failing to engage with the broader set of strategies and practices that have proven essential to success in conserving biodiversity in many regions of the world [11•,12•,26•]. Moreover, pursuing larger scales of protected area operation with limited resources can even lower conservation success; greater conservation value is often produced by increasing investments in governing existing areas rather than expanding to new ones, which may serve only as 'paper parks' – conservation in name, but not in practice [28,29].

Another key issue with area-based conservation is a tendency to focus on areas unsuited for other uses and therefore easier to protect, like land covered by permanent ice, deserts, tundra, and boreal forests, rather than areas of high biodiversity conservation value [30••,31••]. Though some have argued for expanding protection on 'intact' wildlands [32], many of which fall into this

Figure 1



Land-oriented strategies for conservation in relation to scales of conservation governance and operational capacity (Table 1).

category, others have argued for a greater focus on areas with especially high value for biodiversity conservation-many of which are endemic-rich refugia located within more productive and populous regions [11•,31••,33]. For example, only about 20% of Earth's Key Biodiversity Areas are protected, and protecting these sites would only require ~3.7% of the planet's ice-free surface area [23]. To increase the success of biodiversity conservation overall, any radical expansion of protected area targets must therefore be accompanied by a focus on protecting areas of high biodiversity value and a multifold increase in conservation investments and governance; to do otherwise might yield an expanded area of paper parks with little biodiversity value, and might further drain resources from areas of higher value, yielding a net decline in conservation effectiveness at global scale [31••].

As climate change accelerates, habitats, ecoregions and even biomes are on the move, and populations need to move with them [34,35]. Both HEP and NNH therefore emphasize interconnecting conservation reserves with corridors of habitat to facilitate species movements, aligning with corridor projects, like Yellowstone to Yukon in

Table 1

Types of landscape management strategies

Management strategy		Examples
Protected	Managed exclusively for native biodiversity conservation.	Protected wilderness areas
Shared	Managed for a combination of agriculture, forestry, mining and other uses combined with protected areas and other effective biodiversity conservation measures.	Multifunctional landscape planning, wildlife friendly farming
Used	Managed entirely for production, no non-conservation use of land.	Intensive monoculture commodity production

Table 2

Half Earth: challenges, promises and pitfalls

Challenge	Promises	Pitfalls
Protected area governance	Strong governance protects biodiversity; engaging local stakeholders, including Indigenous Peoples	Weak governance fails to protect biodiversity ('Paper parks')
Protected area selection	Allocate protection to ecoregions, priority habitats and key biodiversity areas; focusing on proximity to people can add social benefits	Protection aimed at low biodiversity areas and areas not in need of protection; remoteness limits social benefits
Mobility among protected areas, especially with climate change	Interconnected reserve networks, wildlife-friendly transportation infrastructure	Isolated reserves with nonviable populations, conflicts with other land users and local populations
Conservation in shared landscapes	Wildlife friendly farming, hedgerow conservation, enhanced conservation effectiveness and expanded habitats through synergies between agricultural production, other uses and protected areas	Both productivity and conservation effectiveness can be lower compared with lands managed exclusively for production or conservation, increased human–wildlife conflicts, wildlife exposure to species invasions, pollution, hunting, pets as predators.
Displacement of agricultural production	Allocate conservation to low productivity areas, restoration of abandoned lands; conservation in shared landscapes	Protecting high productivity land causes multifold land expansion in low productivity lands, protecting land in one region increases demand in other regions
Land sovereignty	Prioritize regions with strong land/environment governance, enhanced land sovereignty of Indigenous Peoples, multi-level governance prioritizing local stakeholders and smallholders	'Fortress Conservation', Green grabbing, displacement of disempowered groups
High operating costs	A global land deal with international government support, increased participation in conservation funding outside governments, including NGOs, consumers, and corporations	Potential for underfunding, monopolization of land ownership and governance (green grabbing)

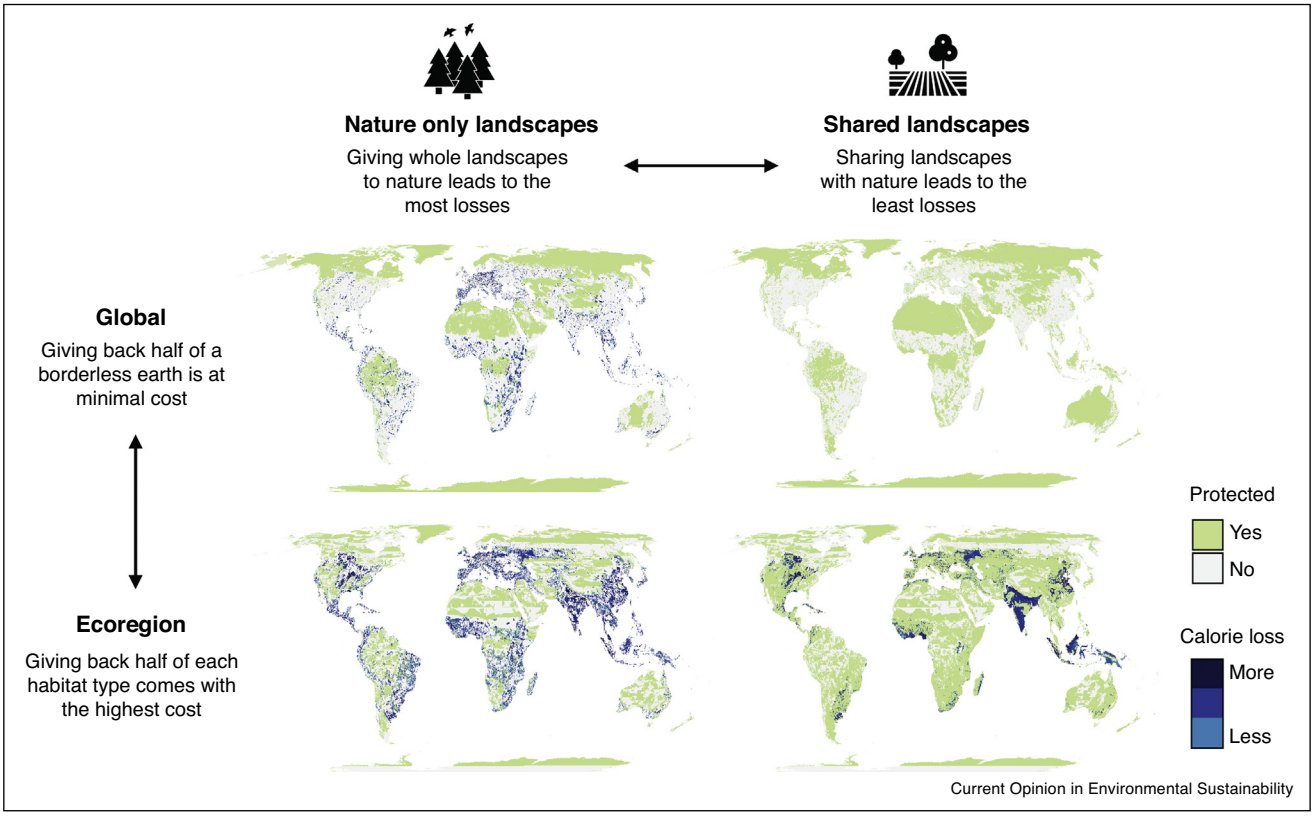
North America and Habitat 141° in Australia [36•,37]. Corridors are especially useful for biodiversity protection in the highly fragmented landscapes that now cover most of Earth's land [38,39]. It has been argued that developing networks of diffuse natural habitat might also offer additional benefits to humans by bringing them physically closer to nature, though wildlife corridors within more heavily used landscapes can also be more expensive per hectare and may heighten wildlife conflicts with agricultural and residential populations [36•,40]. Either way, a sharp focus on increasing connectivity will be needed for global upscaling of area-based conservation to be effective in the face of global changes in climate, including networks spanning geopolitical boundaries supported by internationally shared investments in conservation governance that are able to adapt to changing realities on the ground [12•].

Tradeoffs: conservation in shared landscapes

Perhaps the greatest challenge in implementing a conservation reserve across half of Earth's terrestrial surface is that agriculture, settlements and forestry already occupy roughly 57% of Earth's ice-free land area [41–44]. Cities, settlements, and other infrastructure cover about 2%, land cultivated for crops covers about 12%, livestock grazing covers about 25%, with three quarters of this area in relatively lightly grazed rangelands, and about 18% is used for production forestry and multi-use forests (about half and half).

Given that demands for agricultural production to sustain growing human populations will continue to increase, at least through 2050, a key challenge for Half Earth is how to expand conservation areas without displacing agricultural production [17••,45,46•]. A recent global analysis

Figure 2



Half Earth strategies and tradeoffs with food production in terms of calories lost (based on Ref. [17••]). Land is allocated without priority in Global strategy; Ecoregion strategy allocates land to protect half of each ecoregion. Nature only strategy allocates entire landscapes to conservation; Shared landscape strategy retains existing agricultural production.

demonstrated that such an expansion might be achieved under current food demands, but only if conservation is allocated without concern for conserving unique communities and ecosystems (i.e. allocated in proportion to ecoregions), and within parts of landscapes also managed partly for agriculture (Figure 2; 'shared landscapes' [17••]). Following a strict 'nature only' strategy in which entire landscapes must be set aside for conservation, by displacing agriculture from working landscapes across half of every ecoregion globally, would, under the most favorable scenario, cost 31% of current global cropland and 25% of crop calories; such a scenario is both unacceptable and unrealizable [17••]. Alternatively, while theoretical models have shown that it might be possible to reallocate croplands around the world to better optimize production and conservation globally, thereby eliminating the need for production losses while boosting conservation [47•], such a globally planned reallocation of agricultural land to better serve conservation goes far beyond the ambition of Half Earth, and neither NNH or the HEP have proposed this.

There are regions and conditions under which large-scale nature-only land reallocation strategies can provide major conservation benefits, especially for endangered megafauna [48,49]. Moreover, conversion of natural habitats to cropland and pasture can reduce local species richness by one third or more [50•]. Nevertheless, conserving biodiversity in shared landscapes, where agriculture and conservation are managed together, can be an effective strategy wherever tradeoffs between production and conservation can be minimized.

Even though 57% of Earth's land is now used directly to sustain human societies, more than half of this is relatively lightly used rangelands and forests. Moreover, patches of remnant, recovering, and lightly used habitats suitable for biodiversity conservation are embedded within the multifunctional landscape mosaics of anthromes, which now cover more than 75% of Earth's terrestrial surface [39,51•,52,53,54••]. Fragments of habitat embedded within more intensively used working landscapes take many forms, from hedgerows, wooded waterways, field margins, and secondary forests to remnants of relatively undisturbed native habitats – some protected, but most not [33,51•,54••,55•]. Most importantly, these fragments cover 35% or more of Earth's ice-free land area and are

abundant around the world [39]. Together with extensive areas of lightly used rangelands and forestry, conservation and restoration of habitat fragments offers more than enough area to achieve a 50% conservation area target, especially when achieved through IUCN protected area categories five and six. Still, biodiversity losses in farm fields and pastures increase in relation to management intensity, including grazing frequency and stocking rates, tillage, fertilization, pesticide application, and water use, all of which pose substantial threats to plant, pollinator, and soil biodiversity [44,46•,55•,56••]. Efforts to spare land for biodiversity protection by increasing agricultural production per unit area [46•,56••] must therefore be combined with management to reduce agriculture's negative environmental consequences within production areas and in non-agricultural lands embedded within and at the margins of agricultural production (e.g. 'sustainable intensification', 'wildlife-friendly farming', etc. [45,55•,57–59]). Management of production forestry to sustain productivity together with biodiversity is also an increasingly effective conservation strategy [53].

'Conservation outside protected areas is already recognized as critically important to the effectiveness of biodiversity conservation in general, including in protected areas, a key lesson emerging from the experience of Natura 2000 in Europe, the world's largest conservation network [12•]. Broader definitions of protection are increasingly the focus of conservation planning, including OECMs and other area-based strategies, together with strategies for effectively managing multifunctional shared landscapes that combine areas with differing levels of protection with areas managed for production [26•,27••,51•,57,60,61,62•]. Conservation outside protected areas, including habitat restoration within agricultural landscapes is becoming a central strategy; the conception of preserving a pristine nature beyond the human world is rapidly giving way to working with local communities toward shared conservation and land management goals and reducing conflicts with wildlife populations [27••,53,55•,62•,63,64••,65]. Recent innovations in this direction include time-sharing arrangements that leverage agricultural lands for conservation outside of production seasons, such as farmer payments sustaining bird-friendly winter wetlands in rice-growing regions [66]. The most effective conservation strategies overall, including any successful strategy for implementing Half Earth, will need to combine the security of well managed conventional protected areas with the adaptive flexibility of a wide array of innovative strategies for conservation and restoration in multifunctional working landscapes [27••,59,65].

Whose half: governance and ownership

Beyond the scientific and technical challenges of scaling up biodiversity conservation, there are basic questions of power, inequality, fairness, and stakeholder engagement in the ownership and governance of landscapes, both inside and outside protected areas [9,67,68•]. There is a long history of land reallocations and other conservation practices that have negatively impacted already disadvantaged rural and agricultural populations, including 'Fortress Conservation' models based on active displacements of Indigenous Peoples and worse, together with other forms of 'Green Grabs' and governance interventions that have more generally burdened local people with both the direct and opportunity costs of managing land for conservation [9,31••,45,64••,69••,70]. Indeed, the history of such efforts alone is reason enough to question the social outcomes of any future effort to expand conservation globally.

Before considering strategies for fair land allocation and governance, it is also necessary to ask: who would pay for Half Earth? Without an equally radical expansion of funding, tripling protected area globally would almost surely reduce the effectiveness of biodiversity conservation overall [11•,28]. NNH has estimated an annual cost for protecting half the 'terrestrial realm' at $80 billion [2••]; an order of magnitude greater than current expenditures, but still less than 0.1% of global GDP ($80 684 billion), <5% of annual military funding ($1700 billion) and <20% of annual soft drink consumption ($393 billion). Still, the land demands of such a major land reallocation would almost certainly drive up land prices – fueling a 'global land rush' – so conservation costs would almost certainly scale non-linearly. Yet even multiplied 10 times over, at $800 billion per year, this is still less than 1% of global GDP. Though existing cost estimates for Half Earth are very rough and likely underestimated, they do fall well within the bounds of the current global economy.

Assuming that government spending increases will likely be modest, ramping up conservation funding to support Half Earth will require resources outside governments, ranging from wealthy philanthropists and NGOs, to corporations, community conservation groups, private land easements, and even consumers engaging with global supply chains through certification of sustainable consumption [71•,72]. Even if negotiated by governments through a Global Deal for Nature, a truly equitable, effective, and sustainable global conservation system capable of integrating all of these modes of funding and governance would need to be much more than a global property portfolio managed by governments and a handful of international institutions or philanthropies. This will mean multilevel, not top–down, modes of governance, defined by strong local and regional institutions, as well as novel forms of social collaboration among private and public stakeholders at all levels [36•,61,67,68•,73]. Integrated, science-based solutions that intersect farming, food systems, development, and conservation guided by multi-level systems of adaptive governance will be needed at the core of an equitable and effective global project to conserve biodiversity while sustaining human societies [17••,22•,25••,44,61].

Prospects

Half Earth proposes a profound and unprecedented intervention into the functioning of the global land system. Sharing fully half of Earth's land equitably across ecoregions – including Earth's most productive and densely populated regions – invites global land trade-offs that will almost inevitably impact land use in support of human societies [17••]. Who will win and who will lose in this great global land trade-off? How will global changes in climate reshape native habitats and land demands for agriculture? What will the landscapes of Half Earth look like? A global patchwork of organic farms and green cities intersected by a network of small habitat patches? Separate seas of dense cities and farms, with protected wilderness areas in between? Will the experience of biodiversity and its benefits feel closer or further away [40,74,75]? These are but a few of the many questions that should guide any future efforts to realize Half Earth.

Fundamental to advancing the prospects of Half Earth as a viable proposal is the question of what happens in the 'human half'? Even the conception of separating Earth into two 'halves' is questionable and potentially counterproductive [9,10], especially given the global intermingling of habitats essential for biodiversity conservation throughout the cities, working landscapes and connective infrastructure that sustain human societies. Stemming biodiversity losses in 'nature's half' will not be possible without successful environmental governance in the 'human half', even more so under a changing climate. Realizing Half Earth is inevitably a Whole Earth project. To move forward, it must therefore go beyond any conception of dividing Earth into two parts, one for humans and one for nature, and instead focus on inspiring people worldwide into collaborative efforts to sustain a future in which biodiversity conservation is enacted at the local, regional and global scales needed to succeed in the face of the profound challenges ahead.

To make this possible, Half Earth will need to build trust by embracing and addressing, not avoiding, its many wicked challenges (Table 2), including its creation of winners and losers and a tendency for conservation costs to fall unequally on the most vulnerable [69••]. One specific opportunity to address these challenges is advancing land sovereignty by Indigenous Peoples; a conservation strategy already widely embraced, including by NNH and the HEP [2••,7,64••]. Most importantly, Half Earth cannot succeed as a single plan operated by a single institution, even one as broad and international as the CBD. Rather, it must be addressed as an emergent social project across the many diverse peoples, cultures, institutions, conceptions, definitions and practices essential to a global land system that combines livelihoods and land use together with urban food systems, environmental governance, and other social functions. Only through long-term processes of open, representative, multi-level, normative discussions, negotiations, and adaptive governance will fair and effective strategies for governing land systems globally, regionally, and locally emerge.

The challenges are clearly great, yet there is also opportunity. Current trends in the 'human half', including declining rates of population growth, increasing movements of rural people into thriving cities and urban livelihoods, increasing agricultural productivity, and increasing demands for nature conservation, are already well established and appear to be accelerating [76••]. If these trends continue and are combined with more effective environmental governance, there is real potential for an unprecedented global upscaling of conservation. Critical to any potential success however, will be the degree to which widespread social demands and aspirations for conservation can be increased, both for large-scale wilderness areas far from urban centers, and equally in the habitats embedded within the settled and working landscapes where people live. If Half Earth is to succeed, a focus on driving these demands forward will be as important as any other effort, and it will have to deliver.

Calls to scale up conservation are growing more urgent than ever, and conservationists and wealthy donors are urging CBD to ramp its global protected area target to 30% by 2030 as a first step on the road to 50% by 2050 [4,5,14,77]. Even on such a rapid timeline, Half Earth will take decades to achieve and management in perpetuity. To succeed in such a massive and long-sustained collective planetary effort, it is necessary first to recognize that its success will ultimately depend on the social processes, institutions, and strategies that make it possible [67]; adaptive multi-level systems of landscape governance that benefit people as much as they benefit the natural world.

Conflict of interest statement

Nothing declared.

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