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Perspective

Smaller human populations are neither a necessary nor sufficient condition for biodiversity conservation

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ABSTRACT

Human population (often treated as overpopulation) has long been blamed as the main cause of biodiversity loss. Whilst this simplistic explanation may seem convenient, understanding the accuracy of the statement is crucial to develop effective priorities and targets to manage and reverse ongoing biodiversity loss. If untrue, the assertion may undermine practical and effective measures currently underway to counter biodiversity loss by distracting from true drivers, alienating some of the most diverse countries in the world, and failing to tackle the structural inequalities which may be behind global biodiversity declines. Through examining the drivers of biodiversity loss in highly biodiverse countries, we show that it is not population driving the loss of habitats, but rather the growth of commodities for export, particularly soybean and oil-palm, primarily for livestock feed or biofuel consumption in higher income economies. Thus, inequitable consumption drives global biodiversity loss, whilst population is used to scapegoat responsibility. Instead, the responsibilities are clear and have recently been summarized by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services IPBES: Leverage points for

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biodiversity conservation lie in reducing unsustainable consumption through diet shifts, tracking supply chains, and technological innovation as well as ensuring sustainable production to reduce biodiversity losses associated with industrial agriculture.

1. Main text

One of the recurring narratives in socio-environmental discussions is that environmental degradation is caused by high human population densities resulting in resource scarcity, which leads to various crises such as biodiversity loss or the climate crisis. The solutions of this narrative focus on control-oriented management through restrictive demographic policies and the exclusion of human populations from certain areas (such as protected areas), which frequently undermines human rights and perpetuates neocolonialism in the name of conservation. This has been the case since Ehrlich's *The Population Bomb* and other writings by him and others in the 20th century that brought to the forefront the Environmental Malthusian ideology (Ehrlich, 1968; Ehrlich and Holdren, 1971; Ehrlich and Ehrlich, 1981; Ehrlich and Ehrlich, 2009). This argument that human population is the main cause of environmental degradation has been stated for decades, and is often used as an ideological justification to defend uneven development and structural racism in the context of environmental change, distracting from more proximate causes (Merchant, 2022; Scoones, 2022).

We stress that it is time for conservation scientists, and ecologists more broadly, to build on the critiques of neo-Malthusianism that have emerged from the social, economic, historical, and environmental sciences (Burkett, 1998; Schultz, 2021; Merchant, 2022; Scoones, 2022). For example, in West Africa, neo-Malthusian narratives strongly link population growth with deforestation but have seriously distorted real people–forest relationships by concealing significant sociological, historical, and ecological dynamics (Leach and Fairhead, 2000). Such narratives badly misrepresent and oversimplify reality, and ignore a large part of what social anthropology shows on the long-term preservation of biodiversity, vegetation, and landscapes through local practices (Fairhead and Leach, 1996). It is also crucial to recognize the importance of traditional management practices in conservation and sustainable development perspectives, which are largely ignored in neo-Malthusian perspectives. The case studies by Leach and Fairhead (2000, 2002) in Ghana and Guinea show that these narratives mainly serve the institutions and individuals who promote them and cannot be used as a basis to effectively protect local biodiversity, especially because the local populations have to be included in the effort.

This is a challenge because the thesis of population growth as a central cause of ecological and societal threats has solidified internationally. Coupled with a semblance of scientific consensus on the links between human population and the natural environment, these assertions blaming human population as the root cause of biodiversity losses are devastating on the ethical level (Schultz, 2021; Merchant, 2022). An illustrative example of this ethical crossroad is the blurred relationship between human well-being and natural ecosystems (Raudsepp-Hearne et al., 2010). The "environmentalist paradox" raises the contradiction between increasing human well-being and depleting natural systems and offers pathways to understand such complex relationships. However, none of them blame population growth as even a candidate cause of environmental crises.

Recently, Cafaro et al. (2022) argued that overpopulation is the major cause of various environmental issues such as biodiversity loss and climate change. This highlights two fundamental issues; firstly, it implicitly assumes there are too many people. However, many papers discussing population have no definition of what constitutes overpopulation versus high or increasing population. These definitions generally fail to reference carrying capacity, marking a lack of understanding of mechanistic issues underlying biodiversity loss.

Secondly, these arguments conflate a high human population with biodiversity loss, which is not evidenced (Almond et al., 2020). Taking on a long-held but overly simplistic and inaccurate assertion, this argument leads to the problematic conclusion that conservation scientists should "*advocate for smaller populations, through improved access to modern contraception and explicit promotion of small families*" to preserve biodiversity. However, mechanisms employed (such as China's one-child policy and various policies on controlling Indigenous populations; Buller et al., 2019) have major ethical issues and are not associated with biodiversity gains (Howden and Zhou, 2014; Zacharias, 2021).

Furthermore, not only is there little evidence for ethical ways of imposing control on human population, but there is no scientific evidence that overpopulation, or more accurately, high population, is a direct driver of biodiversity loss (Mora, 2014). Such an assertion ignores both actual drivers of biodiversity loss and the substantial socioeconomic inequalities among and within nations (Green et al., 2022), which often contribute to the loss of biodiversity in remaining hotspots (Mommer et al., 2022). When environmental degradation is misattributed to overpopulation, the 'necessary actions' are generally focused on lower-income countries, which continue to harbor most of the global biodiversity, also in areas with high human populations. Perpetuating the idea that "population is to blame" diminishes the toll that racism, colonialism, and imperialism have played on environmental degradation (Randrup, 2010; Domínguez and Luoma, 2020; Enuoh and Ogogo, 2018) and overlooks the continued role of inequitable consumption patterns as a major driver of biodiversity loss, deforestation, overfishing, and zoonotic diseases (Gibb et al., 2020; IPBES, 2022).

Whilst "human population" has long been used as a convenient way to blame parts of the developing world for biodiversity loss, such an assertion is out of step with real-world trends and current knowledge. Papers such as Cafaro et al. (2022) and Ehrlich's papers (Ehrlich, 1968; Ehrlich and Ehrlich, 1981, 2009; Ehrlich and Holdren, 1971) show major gaps in reasoning. In addition to diverting attention away from actionable targets, scapegoating developing nations as responsible for biodiversity losses may increase antagonism between actors at a time when cooperation is urgently needed. Here, we unpack some of their more problematic assertions used to apportion the majority of blame for global biodiversity loss to human population, highlight how this continued rhetoric undermines the generation of effective and collaborative solutions, and discuss workable and equitable solutions to mitigate biodiversity loss and allow the functional recovery of ecosystems.

1.1. Are human population levels responsible for biodiversity decline?

If biodiversity loss was directly attributable to population, historical extinctions would be directly correlated to the growth of human populations, but this is not the case. Human-driven extinctions were mostly driven by direct disturbance or destruction of sensitive ecosystems and species, or the development of agricultural systems that replaced habitat. The vanishing of megafauna in the Pleistocene period is thought to have been caused or at least accelerated by small populations of prehistoric humans with hunter-gatherer habits (Monjeau et al., 2017). Islands have a disproportionate number of lost species due to hunting and the release of non-native species by first settlers or European colonists (Whittaker et al., 2017; Heinen et al., 2018; Bochaton et al., 2021). Yet, it was not the number of people per se that caused those losses, but their outsized impact on the planet, and the introduction of predators and omnivores to regions and faunas not adapted to them. Such trends have continued, from European colonists ravaging island systems, driving major extinctions through collecting animals, changing habitats and introducing Alien species, to the unsustainable harvest of wildlife for pets and food today (Bush et al., 2022; Marshall et al., 2020).

There is also no reason to expect that the depopulation of rural areas alone would reduce environmental degradation or have positive effects on biodiversity (Queiroz et al., 2014), as asserted by various perspectives on the role of population on biodiversity loss (e.g. Almeida, 2007; Cafaro et al., 2022). Cafaro et al. (2022) use as an example the European case, where in recent decades there has been a process of agricultural abandonment in rural areas. They simplify it and argue it is due to population decline, whereas Keenleyside and Tucker (2010) and Dax et al. (2021) point out that the high disparity in agricultural competitiveness between regions (at a fine geographical scale) and an increase in non-agrarian livelihoods is the main driving force. So, land abandonment is understood as the outcome of a multitude of factors of socio-ecological systems and a combination of farm-specific, internal regional, and trans-regional factors. This highlights how Cafaro et al. (2022), and other studies making similar claims, do not analyze issues in a multifactorial way. For example, in Brazil and Europe, mountain, riverside, and degraded land are increasingly abandoned (Dax et al., 2021; CGEE, 2016; Rezende et al., 2018), driven by high production costs on such land in mechanized agriculture. However, the mechanisms that act in the process of land abandonment in Europe differ from those in Brazil. Despite the decline in its rural population after the 1970s, Brazil has expanded large-scale mechanized agriculture on potentially productive flat lands in previously forested areas due to the high demand for commodities, especially from G7 countries. This process is ongoing, with agribusiness causing habitat loss in areas such as the Brazilian Cerrado and the Amazon (Song et al., 2021; Benton et al., 2021). Contrastingly, Europe has already occupied its productive lands, yet population declines have not caused an expansion of natural areas within Europe (Schuh et al., 2020). Furthermore, up to 80–85 % of food in some European countries is already imported (Edwards, 2019; NOAA, 2022). They are outsourcing their impacts, thus driving biodiversity declines across low and middle-income economies. Additionally, leakage needs to become a significant governance concern, yet, it remains loosely conceptualized and poorly understood as a phenomenon in policymaking (WWF European Policy Office, 2022; Bastos Lima et al., 2019).

Rather than removing pressure, depopulation is likely to alter the type of pressure and may directly drive extensive biodiversity declines. According to the World Bank (Deininger et al., 2011), between 1961 and 2007, the area of cultivated land expanded by approximately 3.8 million hectares per year globally. This increase was unevenly distributed between developed and developing countries, with small declines in industrial and transition economies and an increase of 5.0 million ha/year in developing countries. Regionally, expansion was most pronounced in Sub-Saharan Africa, Latin America and the Caribbean, and East Asia, driven by the international markets for export. Worldwide, more than 30 million hectares were acquired by just 490 landowners or companies, though predominantly companies (Grain et al., 2014). Land grabbing is also serious in various African countries, where the report points to numerous land conflicts, with traditional communities being expelled from their lands or displaced to the suburbs of large cities (Ojeda, 2012).

Terrestrial areas are not the only areas affected by unsustainable use. Since the Second World War, the fishery resources of most of the exclusive economic zones of lower-income countries have also been systematically exploited by the increasing fishing pressure and geographical expansion of highly subsidized distant water fishing fleets (Pauly, 2018; Tickler et al., 2019). This expansion of fishing pressure is largely from large companies registered in developed countries (namely from Japan and European Union member states) and, more recently, from Asian countries such as Taiwan, South Korea and China (Villasante et al., 2014; Sumaila et al., 2021). The global impacts of distant water fishing fleets include overexploiting fishery resources, acting as a driver for illegal fishing, and exacerbating inequality by undermining the viability of small-scale producers (Alder and Sumaila, 2004; Tickler et al., 2018). These issues have little to do with human population but are directly linked to overconsumption of wealthy nations, whilst simultaneously acting to hinder broader efforts to protect biodiversity, reduce poverty, provide nutritious food, and secure coastal livelihoods at all scales (Schuhbauer and Sumaila, 2016; Skerritt and Sumaila, 2021).

These examples also contradict arguments stating; "*Population decline opens up important opportunities for ecological restoration*" (Cafaro et al., 2022), which is another common misconception in papers blaming population for environmental degradation. Indeed, the reduction of local populations is often associated with urbanization and agricultural industrialization, thus contributing to increased habitat loss rates and homogenisation (Rademaekers et al., 2010; Fraundorfer, 2022). In contrast, more biodiversity-friendly agricultural practices, summarized under the umbrella term agroecology, often require more labour than conventional practices (Wezel et al., 2014). This example shows how rural depopulation could become a hindrance rather than a contributor to biodiversity conservation. Similarly, natural areas have largely been safeguarded by many Indigenous peoples and local communities (Fa et al., 2020), and many current and historical examples demonstrate that the removal of these groups can provide opportunities for unsustainable use of natural resources by large companies rather than advancing environmental protection (Gadgil et al., 1993; Hill et al., 2020; Hoffman et al., 2021; Walker et al., 2020). Once again, assertions blaming population alone misdirect the point away from actual drivers of biodiversity loss by misattributing it to the number of people.

Unsustainable consumption remains a major driver of global biodiversity loss. For example, over three quarters of all farmland is exclusively used for livestock grazing or feed production; thus reducing meat consumption is an essential component of addressing habitat loss and degradation (Poore and Nemecek, 2018). This is also evidenced by per-capita environmental footprints, which are much larger in developed economies compared to low-income ones, regardless of population (Lin et al., 2018; Fig. 1). Furthermore, the essential part played by consumption patterns, and especially meat production, has been incorporated in some countries' climate targets. For example China, aiming to cut meat consumption by up to 50 % to meet climate targets (Sutherland et al., 2022).

Thus, papers stating population is the main cause of biodiversity losses, and rather than suggesting a necessary shift in governance, human behavior, and consumption, suggest impractical, often unethical and unnecessary changes in human populations. This is especially clear when Cafaro et al. (2022) state: "*Besides a few statements that growth in human numbers and excessive economic activity are driving the biodiversity crisis,* IPBES (2019) *has many pages of convoluted, unquantified speculation about how "values," "institutions," "laws," "behaviors," "trends" and scores of other factors might play a role in the problem.*" which suggests a preference for neat, parsimonious solutions in the face of complex, non-linear, and multi-faceted problems, even if not substantiated by fact. Counter to this assertion, the IPBES (2022) report notes that a "race for profit" is fueling the collapse of biodiversity, highlighting that urgent cross-sectorial actions are needed to counter these losses, and these transcend issues of "how many people". These challenges have been recognised, and work done to reconcile them, and they highlight that blaming "population" undermines our ability to deal with the real issues (Randers et al., 2019).

1.2. Do countries with growing populations contribute more to global biodiversity loss?

Population size is rarely a direct driver of biodiversity loss, however how individuals and societies consume resources, and the governance and management of land and seas does determine impacts on biodiversity. For example, when some countries have made efforts to reduce unsustainable actions in their own countries, they have sometimes

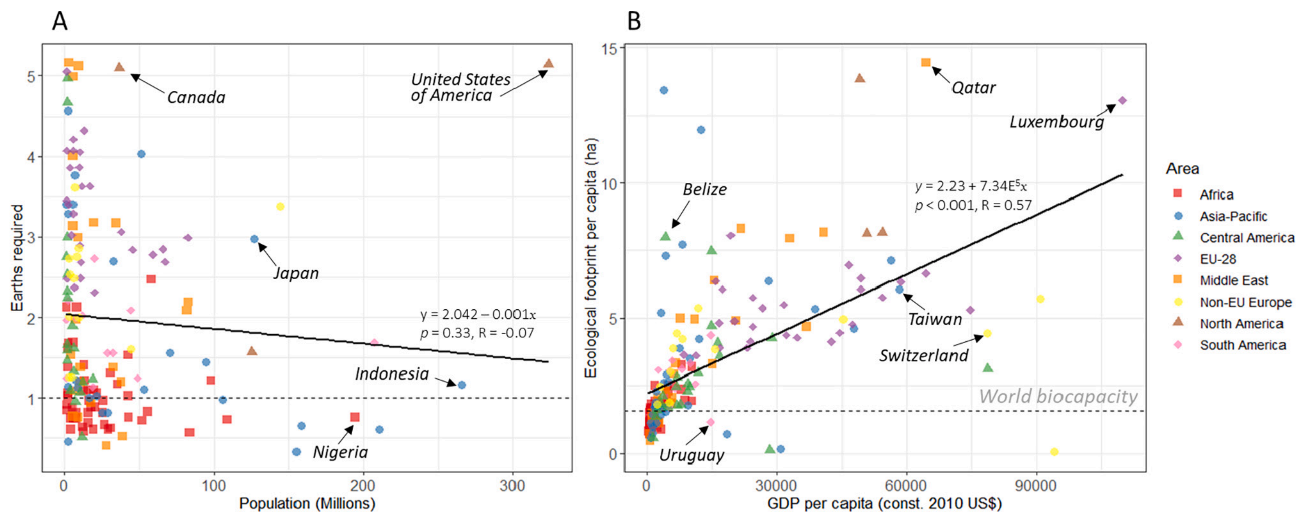

Fig. 1. A. The relationship between the national population and the number of earths needed to provide for consumption rates on a national basis. B. The relationship between per capita footprint with Gross Domestic Product per capita. No relationship exists between national population and global environmental footprint (earths required), whilst a clear and strong relationship exists with GDP per capita. The statistical analyses presented are Pearson correlation tests and results from linear regression models. Note that some countries are not displayed in the figure because of particularly high populations (for information, China: 2.4 earths required/1412M inhabitants/3.8 (ecological footprint per capita)/10,100$ GDP per capita and India: 0.8 earths required/1393M inhabitants/1.2 (ecological footprint per capita)/2000$ GDP per capita).
Source: Ecological Footprint per Capita (in global ha): National Footprint and Biocapacity Accounts, 2022 Edition, Global Footprint Network. GDP per capita source: The World Bank, 2019 ("World Development Indicators").

exported that footprint elsewhere. The agricultural expansion of crops such as soy, beef, and oil palm account for up to 80 % of all tropical deforestation driving major biodiversity loss, with major demand within high-income countries (Hallux, 2022; FAO, 2016; Többen et al., 2018). In addition, pushes for biofuel production and increased demand for food means (often with particularly high land-area requirements) the vast majority of the footprint in lower-income regions is for exported products. The footprint of many higher-income nations have been increasingly outsourced to the developing world (Laroche et al., 2020). The impacts of this outsourced demand are clear and can be both quantified and mapped (Hoang and Kanemoto, 2021; Godar et al., 2015), with crops like soybean, in particular, contributing to global biodiversity loss (Shandra et al., 2020; Tasmim et al., 2022). In some cases this outsourcing has been targeted as a mechanism to reduce domestic footprints, as in the case of China outsourcing 90 % of its soybean supply between 2004 and 2016 (Ren et al., 2021), accounting for almost 60 % of the area devoted to soybean production worldwide by 2013 (Liu et al., 2021). Furthermore, 77 % of soy crops are used as livestock feed, and most of the remainder is for biofuels. The combination of soybean, palm oil, pasture, and pulp paper remain the main drivers of global deforestation (Richie and Roser, 2021; Richie, 2021). The increasing import of crops such as soybeans for feeding growing livestock numbers has increased the environmental footprint of many countries and thus the impact of agriculture on biodiversity (Escobar et al., 2020). This highlights once again that the role of diet in food security and impacts of agriculture on biodiversity cannot be ignored (Ghose, 2014).

Similarly, a few rich nations produce greenhouse gas emissions (Malik and Lan, 2016; Nielsen et al., 2021; Chancel, 2022), highlighting the inescapable reality that global environmental goals cannot be achieved without considering telecoupled impacts (Dai et al., 2021). These telecoupled impacts have continued to increase, with 23.4 % of agricultural land used for export in 2013, representing a 17 % increase since 2000. This increase is almost entirely to support expanding footprints in high-income nations, in the absence of population growth in these importers or the restoration of land previously used for agriculture (Schwarzmueller and Kastner, 2022). Agriculture for international trade has been shown to disproportionately impact biodiversity (Kastner et al., 2021). As much of half this export is for uses other than food (Yu et al., 2013) and could likely be replaced by non-crops. Land cover change for export crops is projected to be responsible for a minimum of 25 % of predicted extinctions (Chaudhary and Brooks, 2019). Consequently, the per-capita footprint of high-income countries has continued to rise, whilst those of low- and middle-income countries have not (Bjelle et al., 2021; Fig. 1). Recognition of these issues is becoming more widespread, with increasing pledges to remove deforestation from national supply chains on key commodities. Yet, more work is needed to substantiate the impacts and effectiveness of such measures (zu Ermgassen et al., 2020). The environmental impacts in low-income countries cannot be decoupled from the role of rich countries in the exploitation of resources (Fig. 1).

2. Changing the narrative and moving forward

Clearly, the central problem is not too many people on the planet, and with human population growth already consistently slowing, demographers expect this growth to stop by 2100, with the majority of countries stabilizing or declining by 2050 (Vollset et al., 2020). Now that it is possible to demonstrate that world population growth is not a real problem and is confusing the message and efforts to conserve biodiversity, our main point is to demonstrate that the problem lies elsewhere; in consumption patterns and their impacts on nature. Furthermore, whilst declines in fertility and birthrates are generally the bi-product of holistic conservation and development programs, there is no need for population reduction to be the main goal (Gurtner, 2010).

Political Ecology (the interaction between economic, social, and political factors and environmental issues; Watts, 2017) offers further perspectives, and just by addressing one simple question, we can highlight the inequalities between those driving losses and those suffering the consequences. This is: Who are the ones that carry the burden of environmental problems? Answering this question leads us to the fact that the ones that caused environmental degradation are often not the same who suffer the consequences. The population growth and biodiversity loss discourse leans towards hegemonic tendencies as we continue to ignore the impacts of colonialism. The same has allowed for the propagation of "green capitalism" (environmentally conscious/driven economic approaches and models: Tienhaara, 2014;

D'Alessandro et al., 2020), which often lacks sufficient safeguards to prevent unsustainable use (Lynch et al., 2018). Green capitalism uses the ideology of sustainability and may aspire to improved ecological awareness and reduced environmental impact, but may lack the necessary rigor to avoid environmental degradation and is at risk of greenwashing (using unsubstantiated "green credentials" for false legitimacy and to inflate profits: Jones, 2019). Multi-millionaires frequently talk about controlling the population of communities in lower-income countries, yet the megarich do not address the means of their wealth accumulation and overconsumption of resources and may not implement sustainable sourcing policies even within their own companies (Dyett and Thomas, 2019).

Thus, whilst studies such as that of Cafaro et al. (2022) assert that "population is to blame", this represents a superficial understanding of the relationships between humans and the environment and is out of step with concrete realities, which demonstrate that higher income countries often have disproportionately large footprints and the consideration of embodied biodiversity loss is crucial (Wiedmann and Lenzen, 2018). With aging populations and urbanization representing increasingly global phenomena, it is essential to focus on genuine solutions to encourage sustainable development and reduce per-capita consumption of richer countries whilst improving access to goods and services in lower-income countries. To halt and reverse global trends in biodiversity loss efforts should go towards finding solutions to establishing social justice, conservation and restoration, mainstreaming of sustainable and transformative initiatives, critical points in sustainable development, and improving governance to moderate human consumption to circumvent ever-growing per-capita footprints. In this respect, conservation biology will benefit from the critiques of neo-Malthusianism established in the social sciences (Editor, 2022). New technologies make such initiatives feasible, enabling the tracking of supply-chains to remove deforestation and preventing other unsustainable resource use (Sanyé-Mengual et al., 2022; Verones et al., 2020). Importantly, we recall that the solutions to food insecurity and biodiversity loss are not mutually exclusive (Chappell and LaValle, 2011). Therefore, an important lever for action will be to accomplish an agroecological transition in both high and low-income countries to minimize the impacts of agriculture on local biodiversity whilst maintaining food security, which is sustainable regardless of population size (Altieri, 2010; Wezel et al., 2016). Understanding leverage points, enabling effective policy change to reconcile unsustainable consumption primarily by high income countries is essential to halting and reversing biodiversity loss (Liang and Zhong, 2023; Bolton, 2022).

Ultimately understanding genuine drivers of biodiversity loss is critical to interventions to reverse continued environmental degradation, yet blaming population, and scapegoating lower-income countries, precludes the development of the necessary solutions to the continued unsustainable use and mismanagement of natural resources. As noted in the IPBES (2022) report, transformations to more sustainable supply chains and diets in high-income economies will be essential to maintain global biodiversity, and meet both climate and biodiversity targets, and actions will be needed at global, regional, national and individual levels (e.g., see Zhao et al., 2021). Fortunately, through IPBES we have a united global scientific consensus on where the leverage points for these transitions are: embrace diverse visions of a good life, reduce total consumption and waste, unleash values and action, reduce inequalities, practice justice and inclusion in conservation, internalize externalities and telecouplings, ensure environmentally friendly technology, innovation and investment, and promote education and knowledge generation and sharing (IPBES, 2019). Reducing human populations does not form part of these solutions, and the suggestion actively hinders the development of collaborations needed to effect positive sustainable change. Smaller human populations are therefore neither a necessary nor sufficient condition for biodiversity conservation, and global action on the multifaceted drivers of biodiversity loss will be needed if we are to halt ongoing declines.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability

No data was used for the research described in the article.

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