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# The role of protected areas in supporting human health: a call to broaden the assessment of conservation outcomes

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Ongoing global biodiversity loss has far-reaching consequences for human health and well-being. While protected areas (PAs) have become a major policy instrument for biodiversity conservation, their role in supporting human health remains unclear. Here, we synthesize both positive and negative aspects of PAs on different dimensions of human health and provide several theoretical advances to assess the effectiveness of PAs in promoting human health. We finally identify three major research gaps requiring urgent attention. Implementing an interdisciplinary research program remains a priority to better comprehend the linkages between human health, ecosystem services and conservation policies at global scale. We believe this is key to improve the management of PAs and their surrounding areas and foster co-benefits for biodiversity and human health.

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## Linkages between environmental degradation and human health

Global biodiversity is decreasing at unprecedented rates, as a result of a wide range of anthropogenic activities [1–3]. Such planetary-scale transformations erode the ecosystem services on which society relies, posing numerous threats to human health [2,3]. Epidemiological studies have argued that a significant proportion of the global burden of illness is attributable to degraded ecosystems [4]. In this context, several policy instruments have been developed to bridge environmental and health policy agendas. For example, the notion that ecosystem health and human well-being are mutually reinforcing (Box 1) is increasingly being picked up by several international health strategies such as *OneHealth* [5] or *Planetary Health* [6••]. Similarly, the importance of biodiversity for human well-being is a core element of the United Nations Sustainable Development Goals.

Environmental change and biodiversity loss have been shown to affect existing health burdens, increasing food insecurity and annihilating rates of human development [7,8]. As a case in point, the decline in the availability of fish stocks is expected to spell malnutrition in many countries [9]. Furthermore, according to the "biodiversity hypothesis", reduced contact of people with natural environments leads to inadequate stimulation of immunoregulatory circuits. Declining biodiversity in an increasingly urbanized world may thus explain the global rise in the prevalence of allergies and chronic inflammatory diseases [3]. Rapid population growth, land-use change and increasing overlap between human and wildlife populations are also related to the recent spread of zoonotic and vector-borne diseases [10]. Finally, there is increasing evidence that degraded ecosystems also affect mental health [11].

Biodiversity-health linkages have often been explored by looking at ecosystem service flows (e.g., water provision) at multiple scales [4,12••], but rarely taking PAs as a leading analytical unit. Consequently, the health outcomes of PAs have been largely overlooked. Calls for increasing the coverage of PAs have resulted in growing research addressing their performance in halting biodiversity loss and securing ecosystem services, with overall positive (albeit modest) outcomes [16]. This scholarly work is gradually broadening its analytical scope to link PAs with larger debates on human health and wellbeing [17•]. Yet, a substantial share of the research has focused on examining predominantly the negative impacts of PAs on human health. This is partly because conservation planning is inherently spatial, often segregating people from nature and undermining the well-being of Indigenous Peoples and Local Communities (IPLCs) living close to PAs [13]. Such potential negative impacts of PAs on human well-being were recognized in the Convention on Biological Diversity, asserting that PAs should not harm the well-being of IPLCs [14••]. Along these lines, the Conceptual Framework of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) explicitly incorporates the notion

**Box 1 Human Health, Well-Being and Ecosystem Health**

Numerous frameworks exist for conceptualizing health and well-being, ranging in focus from the individual to the nation, and hailing from such diverse disciplines as anthropology, economics or epidemiology [62,63]. Such frameworks have used a wide array of indicators to measure the health, ranging from mortality (e.g., child mortality), morbidity (e.g., prevalence, incidence), health status (e.g., high blood pressure), nutritional (e.g., children stuntness), social health (e.g., substance abuse), or health-system (e.g., healthcare delivery) indicators.

Although a full review of these frameworks is beyond the scope of this paper, it is important to note that despite their theoretical differences, most of these works share a general vision of linking human and ecosystem health [18,64]. Frameworks in this vein resonate with indigenous peoples' philosophical concepts of living in harmony with nature (e.g., Andean notion of Mother Earth), identifying kinship between people and nature as a determinant of human well-being [15]. Overall, these ever-more holistic definitions of human health (reflecting the origin of the word, derived from the Greek '*hal*' or 'whole') are providing new opportunities for conservation managers to play a greater role in supporting human health than in the past [32]. As a result, there have been recurrent calls for a shift from purely biophysical measures of health to broader well-being indicators, targeting life satisfaction, good quality of life, or happiness, to cite just a few [62,65]. Many of these indicators have also started to gain prominence in environmental discourses (e.g., *Sumak Kawsay* in Ecuador; Gross National Happiness in Bhutan).

of "good quality of life" in the analysis of institutional arrangements for biodiversity governance [15].

In the following section, we review the contributions of PAs to human health and well-being from a diversity of angles.

## Do protected areas support human health?

Despite increasing awareness of the inter-linkages between nature and human health (Box 1), the overall health potential of PAs remains under-recognized. The few case-based studies assessing the impacts of PAs on human health have been addressed in different strands of literature, with distinct theoretical and methodological frames. For instance, while some of the works focus on biophysical indicators, most of them rely only on notions of subjective well-being or good quality of life [14••], with few works integrating health and well-being outcomes (Figure 1).

A first body of literature has examined the effectiveness of PAs in delivering ecosystem services with direct health benefits that would have potentially been eroded had the PAs not been established [18,19]. For example, it has been shown that nearly two-thirds of the global population relies directly on PAs for freshwater provision [20]. Similarly, several studies have demonstrated the role of PAs in providing pollination services for food production [21] or in contributing to air purification and temperature regulation [22]. Many works have also underlined the positive role of PAs in conserving medicinal plants that sustain both local and global pharmacopeias [23], or the numerous recreational services provided by PAs, promoting healthy lifestyles [24].

In contraposition to this literature, some works have focused on examining the health impacts of PAs in the light of ecosystem disservices [25]. Under the idea that "nature sometimes kills us", this literature argues that IPLCs often carry a disproportionate burden of the health risks derived from living close to PAs [26•]. Some of these ecosystem disservices include the spread of vector-borne diseases [27], animal attacks on humans living close to PAs [28], or lower food security through the destruction of crops by wildlife [29].

Precisely, research on social aspects of conservation has also looked at the impact of some PAs upon nutrition, showing that displacements of IPLCs and restrictions to resource extraction have often resulted in increasing food insecurity and malnutrition [30,31]. Although the research on PAs and nutrition is not particularly comprehensive [32], some works have shown that closing off forests to IPLCs through strict regulations generally leads to reduced food supply and nutrition deficits, e.g., anemia [33•,34].

However, other studies have also shown PAs under some circumstances can contribute to alleviate malnutrition, by maintaining stocks of wild food to later be harvested beyond PA boundaries [35,13]. With most evidence confined to marine environments, this literature has shown that strict PAs may enhance local nutrition and health by rebuilding wildlife stocks, improving catch rates outside PAs and helping local people to meet their dietary requirements [36,37]. As for terrestrial ecosystems, some authors have showed that children stunting is lower close to PAs in the Congo Basin [38]. Moreover, it has also been discussed that the establishment of PAs often introduces new livelihoods that can result in positive health effects through PA-related income [13,39]. As a consequence, there is debate on whether the net impact of PAs on local people's nutrition is positive or negative [14••]. Part of this debate is arguably explained by the distinct health effects of PAs under different management categories [17•]. Moreover, with the establishment of new PAs promoting co-management, agrobiodiversity or sustainable production systems in the PA periphery, the potential of PAs to improve food security should not be under-stated [40,41].

Arguably the most well-researched aspect of the link between PAs and health is their effects on psychological well-being [11,14••]. Research has shown the restorative capacity of PAs and their role in fostering recovery from mental fatigue, reducing stress levels, assisting cognitive functioning, and improving the overall psychological state [32,42]. Interestingly, these psychological benefits have been shown to be higher in areas of greater biodiversity