Nature's bounties: reliance on pollinators for health

Human demands and impacts on the Earth's life-support systems are at an all-time high. With the sixth mass extinction,[1] climate change,[2] and other major anthropogenic disturbances underway, understanding the wide range of vital benefits that societies derive from nature has become a global priority. A key research frontier is in characterising and valuing these ecosystem services systematically to inform investments in conservation of service-providing species and their habitats. Worldwide, about 75% of leading crops have improved yield and quality thanks to pollination by animals,[3] primarily bees followed by a plethora of wild insects, and in some cases birds and bats. And the foods they pollinate are nutrient-rich fruits, vegetables, nuts, and seeds, for which dietary deficiency confers risk of non-communicable diseases, including cardiovascular disease, diabetes, and lung cancer. Altogether, 35% of global food volume derives from animal pollinated crops.[3] Yet pollinators are in rapid decline globally, probably in response to interacting pressures from pests, pathogens, agrochemicals, and loss of habitats and flowers, as well as erosion of genetic diversity in honey bees.[4] Beyond the substantial economic effect—about €153 billion in 2005[5]—pollinator decline could hurt human health. Animal-pollinated crops are among the richest in micronutrients; globally, areas with high micronutrient deficiency are disproportionally reliant on animal-pollinated crops.[6] Pollinator declines could thus precipitate micronutrient deficiencies as well as other human health concerns.[7]

In *The Lancet*, Matthew Smith and colleagues[8] quantify the global nutritional and health implications of declines in crop pollinators and decreased intake of pollinator-dependent foods for populations around the world. They compiled data on diets and on the production, nutrient composition, and pollinator dependence of 224 types of food across 156 countries. They then modelled how human health would be affected by the collapse of pollinators, under simple but clear assumptions of change that, in reality, would unfold in highly variable and unpredictable ways. They investigate 50%, 75%, and 100% losses of pollinator-dependent crops, and, in each case, assume replacement with the same caloric values from staple foods such as cereals, roots, and tubers. Overall, their modelling analysis provides a powerful assessment of the global importance of pollinators to human health. The investigators estimated that total pollinator collapse would cause new deficiency in vitamin A for 71 million (95% uncertainty interval 41–262) people and in folate for 173 million (134–225) people, and would exacerbate current deficiency in 2·2 billion (1·2–2·5) and 1·2 billion (1·1–1·3) people, respectively. Pollinator collapse would also increase global deaths from non-communicable and malnutrition-related diseases by 1·42 million (1·38–1·48) and disability-adjusted life-years (DALYS) by 27·0 million (25·8–29·1). The 50% and 75% losses affect health roughly proportionally less than those for total loss—a 50% loss of pollination services would be associated with 700 000 additional annual deaths and 13·2 million DALYs.

Although recent investigations have laid essential groundwork, this is the first study to fully link global declines in animal pollinators to human health. Most previous quantification of the importance of ecosystem services (or consequences of their decline) has focused on biophysical or economic measures, initially at a local level. The link to health is a widely recognised frontier for research.[9] Smith and colleagues' findings lend new urgency to the issue of pollinator declines globally. Yet, their finding that most pollinator-dependent crops contributing to human health are produced and consumed locally rather than imported is also important, since it shows a need for improved local and national pollinator management to avert health consequences.

Smith and colleagues developed an approach to linking nature and health that could be adapted and

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extended to other ecosystem services in at least three key dimensions. First, as this study shows, enough is known about some ecosystem services—such as wild seafood production, water purification for drinking, global climate stabilisation—to quantify the human health implications of changes in their supply. For example, natural predators of crop pests can improve yields and profits. But can bolstering predator populations reduce pests to the degree necessary to forego use of harmful agrochemicals that degrade human health?[10,11] Second, new theories could be advanced and tested to distinguish contexts in which conserving nature improves rather than threatens human health. For example, further understanding is needed to predict when conserving intact, biodiverse ecosystems mitigates[12] or increases[13] zoonotic disease transmission. Finally, so many subtle yet important connections exist between people and nature that many remain virtually unexplored in terms of human health. For example, there is emerging evidence that experiencing nature by urban residents could improve cognitive function and mental health in various ways.[14]

The research frontier advanced by Smith and colleagues is part of a revolution underway to illuminate and secure the values of natural systems not only by cultivating awareness and deeper understanding of the vital benefits of nature, but also by moving from knowledge to action. A decade or so ago, New York City invested in farming, forestry, and other practices upstream in the Catskills Mountains to secure its drinking water.[9] Costa Rica led the world in implementing a national payment system to reward forest conservation for domestic benefits to hydropower and tourism and global benefits of climate stability and biodiversity.[9] Today, China is implementing an ambitious system of land zoning to target conservation investments in the places that will deliver highest returns to society, paying 200 million people to restore ecosystems.[9] In some ways, this revolution parallels that launched by Carl Linnaeus in the 18th century. Moving from local descriptions of organisms that could not readily be shared at a higher level, he took a global view, inventing the systems used today for characterising organisms and their relations, and for communicating universally about life. Now, the frontier is moving from local descriptions of the intimate connections between people and nature to cast light on their global importance, and on the pioneering policies and governance systems—at local, national, and global scales—that will help secure the wellbeing of both people and the planet's natural systems in the future.[9]

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