What is biodiversity conservation?

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PERSPECTIVE

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Abstract Conservation science is a new and evolving discipline, so it seems prudent to explore different approaches. That said, we should examine what we know and, vitally, what works to conserve biodiversity and what does not. Ecosystem processes determine the fate of many species, but many attempts to theorise about ecosystems have led to ever more fanciful descriptions of nature. All conservation is local. It will only succeed if we find ways to accommodate people and nature. That does not mean indigenous knowledge acquired over millennia will be sufficient to our ever more overcrowded planet. Observational and experimental studies of small populations of wild species, however, do provide practical insights into how to manage biodiversity across much larger geographical extents.

Keywords Biodiversity · Ecosystem processes · Indigenous peoples · Habitat fragment · Savingnature

INTRODUCTION

The conservation of biodiversity is easy enough to define. Elliot Norse coined the now-standard three-part definition of biodiversity—roughly genes, species, and the different kinds of ecosystems (Norse and Carlton 1986). Human actions destroy all three. The types of ecosystems—I'll call them biomes—are evident in simple language—forests, grasslands, deserts, and so on. Many maps delineate their extents, though there is inevitable debate about how many classes to use. There is no debate that human actions clear tropical forests, for example. We also destroy genetic diversity. Often overlooked is the fact that we diminish our own diversity. While overall, human populations are increasing, indigenous peoples, many speaking unique languages, are being lost as we encroach upon their lands (Pimm 2000). Most often, we equate biodiversity with species. Taxonomic quibbles notwithstanding, they provide the best documentation of biodiversity loss.

"Conservation" begs the question of how badly we are not conserving biodiversity. Statements claiming a "sixth mass extinction" and wild claims of how many species go extinct per day, may grab media headlines, but do nothing to quantify the problem. Comparisons of prevailing conditions to the fossil record are fraught with uncertainties (Pimm et al. 2014). So, too are estimates of how many species there are. We have scientific names for about two million. Confident estimates that there is a total of eight million species clash with equally confident estimates that there are many more or many fewer (Scheffers et al. 2012). For diverse groups such as fungi and insects, we simply do not know (Scheffers et al. 2012). With that ignorance comes the inability to count species lost per day.

Nonetheless, the conservation question does have a simple, quantitative, if prosaic answer—quantify extinctions as a death rate. We estimate human death rates as so many individual deaths per million per year. Let's treat extinction similarly: so many species extinctions per million species, per year (Pimm et al. 1995). Those rates run to hundreds, perhaps thousands, for the groups of species we know best—vertebrates and flowering plants. That begs the question of what the normal rates should be. We get only a rough idea from fossils, from a handful of species groups that leave abundant fossil remains, yet which are very coarsely resolved in time. In contrast, abundant evidence from molecular phylogenies tells us how fast species are "born"—i.e. the rate of speciation (De Vos et al. 2015). For species, death rates are about a thousand times faster than birth rates (Pimm et al. 2014).

This massive loss of biodiversity is the most severe environmental challenge of the age. Certainly, human actions are heating the planet alarmingly, but reducing carbon emissions and sequestering carbon, not least through restoring lost forests, are entirely possible actions. We cannot recreate species once we have exterminated them.

What actions must we take? The problem is a global one. It poses difficult ethical, economic, ecological, and social issues across the entire range of human societies. There cannot be a one-size-fits-all solution; we must encourage a diversity of solutions. That said, not all approaches work, some are detached from reality, and some may be harmful. The three *Ambio* papers illustrate this.

FROM "ECOSYSTEM RENEWAL CYCLES" TO AN "UPDATED BIOSPHERE INTEGRITY BOUNDARY"

Bengtsson et al. (2003) bring a world view of how they suppose ecosystems to work:

> Although reserves have been crucial for preserving species and habitats in the short term, with few exceptions they have not incorporated the long-term and large-scale dynamics of ecosystems as parts of dynamic landscapes. In this article, we argue that when the natural dynamics of communities and ecosystems are taken into account, a reconsideration is required of how reserves are designed and managed as parts of dynamic landscapes increasingly dominated by humans.

Their key ingredient appears to be: "For ecosystems to reorganize after large-scale natural and human-induced disturbances, spatial resilience in the form of ecological memory is a prerequisite." "Resilience", "spatial resilience", "ecological memory", "functional systems", "biological legacies", "ecosystem renewal cycles", and "ecosystem reorganisation" are all terms from the first page. None of these terms is defined operationally, none is measured, and no units are specified (Montoya et al. 2018a).

The scientific community has ignored the "ecosystem renewal cycle(s)" which constitutes the paper's Fig. 1. The term has been cited only a few times since by other authors. A predilection for undefined, perhaps undefinable terms, would continue with and find its voice in the global view espoused by Rockström and some of Bengtsson's co-authors in global tipping points and planetary boundaries. Our criticisms of this legacy (Montoya et al. 2018a) generated even more jargon: the latest measures appear to be "a biodiversity intactness index" (Steffen et al. 2015) and an "updated integrity boundary" (Montoya et al. 2018b).

The triumph of verbiage over content is not inevitable in ecosystem studies. Resilience is easy to measure (Pimm et al. 2019). The Oxford English Dictionary records "resilience" has meant "rebounding" since the 17th century. A simple measure is to record how long something takes to rebound. Resilience has units of time (Pimm 1984). Despite decades of pleading the primacy of resilience and other measures the Bengtsson et al. paper proposes, data tables rich in estimates are entirely lacking in the subsequent literature. The fingerprint of a tipping point would be a time series that did not return to its original value. "Sustainability" is easy to define and measure too. Measurements of it are similarly scarce.

THE WISDOM OF INDIGENOUS PEOPLES?

Gadgil et al.'s writings on the conservation of India's biodiversity span almost half a century. His 1993 paper in *Ambio* (Gadgil et al. 1993) is justifiably influential. It introduced Gadgil's career-long inspiration to look at how indigenous knowledge shapes conservation.

> Indigenous knowledge is herein defined as a cumulative body of knowledge and beliefs handed down through generations … about the relationship of living beings (including humans) with another and with their environment.

No country shouts the need to understand the collision of peoples and biodiversity better than India. Indians speak a large number of languages. They preserve a unique cultural diversity that is shrinking faster than species diversity across so much of the planet (Pimm 2000). The 1.3 billion Indians live uniquely intertwined with nature. For three other large, biodiverse countries—Brazil, China, the United States—people live in the east, and protected areas are in the west, which are sparsely populated. Not so India. Its protected areas are across the country with all of its people near national parks. Many of them are within them (Ghosh-Harihar et al. 2019). That species survive, let alone tigers, lions, and rhinos is remarkable even without visiting. Once there, I am further amazed.

In winter, in the flood plain of the Brahmaputra river in Assam, the fertile agricultural fields are various stages of flooding. They teem with wintering ducks, geese, cranes—and people. A few hundred kilometres to the east in Yunnan, China, one rarely sees birds larger than a sparrow because of hunting. In these India fields, there is an extraordinary tolerance, especially given how limited is the access to protein among poor people. This care, perhaps reverence for wildlife, simply because it's there, surely explains why with so many people and so very few areas set aside for protection, India has lost almost no species completely.

Gadgil writes with the experience of people living with nature on biodiverse landscapes. He "calls for empowering communities of indigenous people to manage their own resource base."

Gadgil's Indian colleagues worry that his views of indigenous wisdom are all too rosy (Madhusudan and Karanth 2002). "Blame it all on the British" is facile (Shyamsunder and Parameshwarappa 2014). They were just one of many cultures that imposed themselves on earlier peoples in India—those who Brahmin Gadgil calls "indigenous." Certainly not perfect, the British created forest reserves in the 1860s. India's best forests and wildlife are now within them (Shyamsunder and Parameswarappa 1987). In contrast, where local communities managed forests, they cleared them. While many Indians eschew meat, many do not. In Nagaland's forests, in the far east, hunters have emptied forests of wildlife. They were outside the domain of colonial hunters (Madhusudan and Karanth 2002). India has lost many large-bodied species across much of its landscape. Within its national parks, residual human populations cause massive harm (Karanth et al. 2010).

LANDSCAPES AND BUTTERFLIES

Landscapes shape our science and no more so than for Ilkka Hanski. Decades ago, we first talked at length one night on a ship on our way to Helsinki from Sweden. The Åland Islands we passed in the moonlight inspired a career-long investigation into isolated habitat fragments. The islands themselves are fragments in a sea. Within the larger islands were meadows that are "habitat islands" where the intervening forest is nonetheless a barrier to the dispersal of open habitat loving butterflies.

Hanski understood that the greatest threat to biodiversity is not just that we have destroyed habitats, but what we have left behind is in fragments. This paper, in particular, calls for increasing the fraction of the planet we protect, but also the need to be smart in working with the fragmented landscapes that dominate so much area (Hanski 2011). His book (Hanski 1999) and review in *Nature* (Hanski 1998) defined a field of research that engages to this day.

> For a given species, the number of habitat fragments… must exceed a threshold value for the species to persist. (Hanski 2011).

Hanski had good taste in problems. This quote is a crucial insight. It means that leaving habitats behind isn't going to be sufficient to save species if the network of fragments is too scattered and the fragments themselves too small.

He combined insightful population modelling with keen observations of the fritillary butterflies he loved and ingenious experiments. He counts his populations, some go extinct, some recolonise. When he needs a technical term—meta-population capacity—he defines it. It's how far a network of connected populations is above the threshold needed to persist.

We know that small isolated populations can become inbred too, so further damaging their chances of survival. Careful natural history that understood populations' histories—and breeding experiments in "common gardens—showed that effect, too.

NO MORE FAIRY TALES

Some view the ecosystem school of Bengtsson and his co-authors at the Stockholm Resilience Centre as a provocation to inspire action. "Ecosystem renewal cycles" and "planetary boundaries" should serve as warnings akin to the wolf in Little Red Riding Hood. "We are not really supposed to measure these variables," people tell me. Like the wolf in grandmother's clothes, they are convenient fiction to alert an unwary public about messing with ecosystems. We read fairy tales to our children because they warn of the world's dangers. Some of those by the Brothers Grimm are so terrifying in the original that we must gentle them. What threatens our planet is far scarier.

Equally certainly, we should listen to the wisdom of people who live surrounded by nature and depend upon it daily. Above all, we must respect their rights. The Frog Prince fairy tale has a happy ending, but we should not kiss frogs or get unnecessarily close to them. As peoples intrude on the world's forest, their actions kill frog species at unprecedented rates (Pimm et al. 2014).

Science does not need fairy tales. The facts are clear enough. Human actions are killing off species, threatening the survival of many others. One can follow the consequences as close as the fishmonger's slab at the local grocery store. Within a couple of decades, farm-raised species have replaced wild-caught ones. Or one can marvel at the satellite imagery taken far above us showing how we shrink tropical forests year after year. Live in the wrong places, and the smoke from the burning trees choke us. We swelter in the summer heat, each year hotter than the last, even if the impressive graphs of relentlessly warming temperatures are too complex for many. The rates of species extinction, readily documented to be a thousand times greater than the rates at which evolution allows species to diversify, may also be technical. Photos of species now gone are haunting.

THE NECESSITY OF PRACTICAL SOLUTIONS

Gagdil's embrace of traditional wisdom tells us that all conservation is local—it's about the people who live in nature. In few places is that more intimate than India. Notions that people living harmoniously with nature in the past should guide future actions are inadequate. There might never have been harmony, but it becomes every less credible as human populations double every few decades.

Of course, solutions come down to working with people, their lives, aspirations, fears, and social complexity. Importantly, such solutions must recognise that people and nature will not always coexist happily. Rigorous science and intelligent technology can help. An example is Karanth's use of cell phones to pinpoint wildlife conflict (Ghosh-Harihar et al. 2019). In theory, India's government compensates those who lose lives or property to tigers, elephants, and other wildlife. Getting that compensation was not easy. That lead to hostility in those living next to national parks. With Karanth's programme, help is now a phone call away.

There's a strong sense of "today Finnish butterflies, tomorrow the world" in what Hanski was able to accomplish. We live in a world of fragmented habitats, and Hanski studied them. He developed rigorous theory, experiment, and above all, measurement—of numbers, time, area, and gene frequencies. Explicit is the recognition that we cannot preserve all of nature, so what's the best we can do with what remains? His paper provides numerical estimates of how large connected landscapes should be.

Put together, his work shapes practical and entirely measurable conservation outcomes. For instance, his work inspires the projects done by Saving Nature, www.savingnature.earth, a non-profit I direct that helps local conservation organisations reconnect fragmented landscapes across the worlds biodiversity hotspots. Practical actions restore habitat to degraded land, and so establish the connectivity essential for conserving biodiversity (Pimm and Jenkins 2019).

What must we do to prevent the loss of our natural heritage? What kinds of knowledge do we need to provide effective solutions? By any criteria, conservation is a new field of study, all the more pressing because of its undeniable urgency, its sense of mission.

Surely, we should try lots of different approaches—and lots of different combinations of approaches—because there isn't enough experience to know yet what will work best. The rub is in that penultimate word: "work." In its short history, conservation science has had impressive success. Nonetheless, self-inspection of what hasn't worked would be prudent.

REFERENCES

Bengtsson, J., P. Angelstam, T. Elmqvist, U. Emanuelsson, C. Folke, M. Ihse, F. Moberg, and M. Nyström. 2003. Reserves, resilience and dynamic landscapes. *Ambio* 32: 389–396. https://doi.org/10.1579/0044-7447-32.6.389.

De Vos, J.M., L.N. Joppa, J.L. Gittleman, P.R. Stephens, and S.L. Pimm. 2015. Estimating the normal background rate of species extinction. *Conservation Biology* 29: 452–462.

Gadgil, M., F. Berkes, and C. Folke. 1993. Indigenous knowledge for biodiversity conservation. *Ambio* 22: 151–156.

Ghosh-Harihar, M., R. An, R. Athreya, U. Borthakur, P. Chanchani, D. Chetry, A. Datta, A. Harihar, K.K. Karanth, and D. Mariyam. 2019. Protected areas and biodiversity conservation in India. *Biological Conservation* 237: 114–124.

Hanski, I. 1998. Metapopulation dynamics. *Nature* 396: 41–49.

Hanski, I. 1999. Metapopulation ecology. Oxford University Press.

Hanski, I. 2011. Habitat loss, the dynamics of biodiversity, and a perspective on conservation. *Ambio* 40: 248–255. https://doi.org/10.1007/s13280-011-0147-3.

Karanth, K.K., J.D. Nichols, K.U. Karanth, J.E. Hines, and N.L. Christensen Jr. 2010. The shrinking ark: Patterns of large mammal extinctions in India. *Proceedings of the Royal Society B: Biological Sciences* 277: 1971–1979.

Madhusudan, M., and K.U. Karanth. 2002. Local hunting and the conservation of large mammals in India. *Ambio* 31: 49–54.

Montoya, J.M., I. Donohue, and S.L. Pimm. 2018a. Planetary boundaries for biodiversity: Implausible science, pernicious policies. *Trends in Ecology & Evolution* 33: 71–73.

Montoya, J.M., I. Donohue, S.L. Pimm, et al. 2018b. Why a planetary boundary, if it is not planetary, and the boundary is undefined? A reply to rockström. *Trends in Ecology & Evolution* 33: 234.

Rosenbaum, K.L., D.S. Wilcove, B.A. Wilcox, W.H. Romme, D.W. Johnston, and M.L. Stout. 1986. *Conserving biological diversity in our national forests*. Washington, DC: The Wilderness Society.

Pimm, S.L. 1984. The complexity and stability of ecosystems. *Nature* 307: 321–326.

Pimm, S.L. 2000. Biodiversity is us. *Oikos* 90: 3–6.

Pimm, S.L., I. Donohue, J.M. Montoya, and M. Loreau. 2019. Measuring resilience is essential to understand it. *Nature Sustainability* 2: 895–897.

Pimm, S.L., and C.N. Jenkins. 2019. Connecting habitats to prevent species extinctions. *American Scientist* 107: 162–169.

Pimm, S.L., C.N. Jenkins, R. Abell, T.M. Brooks, J.L. Gittleman, L.N. Joppa, P.H. Raven, C.M. Roberts, and J.O. Sexton. 2014. The biodiversity of species and their rates of extinction, distribution, and protection. *Science* 344: 1246752.

Pimm, S.L., G.J. Russell, J.L. Gittleman, and T.M. Brooks. 1995. The future of biodiversity. *Science* 269: 347.

Scheffers, B.R., L.N. Joppa, S.L. Pimm, and W.F. Laurance. 2012. What we know and don't know about Earth's missing biodiversity. *Trends in Ecology & Evolution* 27: 501–510.

Shyamsunder, S., and S. Parameshwarappa. 2014. *Forestry Concerns in India*. Dehra Dun: Bishen Singh Mahendra Pal Singh.

Shyamsunder, S., and S. Parameswarappa. 1987. Forestry in India-The Foresters View. *Ambio* 16: 332–337.

Steffen, W., K. Richardson, J. Rockström, S.E. Cornell, I. Fetzer, E.M. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, and C.A. de Wit. 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* 347: 1259855.

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