
This is the **accepted version** of the journal article:

Terraube, Julien; Fernández-Llamazares, Álvaro. «Strengthening protected areas to halt biodiversity loss and mitigate pandemic risks». *Current opinion in environmental sustainability*, Vol. 46 (October 2020), p. 35-38. DOI 10.1016/j.cosust.2020.08.014

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1 **Author Accepted Version of the manuscript:**

2 Terraube, J., Fernández-Llamazares, Á. (2020) Strengthening protected areas to halt
3 biodiversity loss and mitigate pandemic risks. *Current Opinion in Environmental*
4 *Sustainability*, 46: 35–38. doi: [10.1016/j.cosust.2020.08.014](https://doi.org/10.1016/j.cosust.2020.08.014)

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6 **Strengthening protected areas to halt biodiversity loss and mitigate pandemic risks**

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20 **Protected areas mitigate zoonotic disease spillover risks**

21 In the midst of the current pandemic caused by the emergence of the SARS-CoV-2 virus
22 causing COVID-19, it is more evident than ever that emerging infectious diseases are a major
23 threat for our global health and political stability. Ecosystem disruption and subsequent
24 biodiversity loss are related to the emergence of infectious zoonoses worldwide [1]. Land
25 conversion has been linked to changing host population densities and increased pathogen
26 diversification, driving disease spillover in modified landscapes [2,3]. Land-use changes are
27 also associated to the creation of road networks, further enhancing hunting pressure on wildlife
28 populations [4]. A series of emerging infectious diseases, e.g. SARS, Ebola and MERS, have
29 been linked to wildlife use, trade and consumption [5]. Wildlife trade in Chinese wet markets
30 has also been implicated as an important factor in the COVID-19 emergence [6].

31

32 Land-use changes and wildlife consumption and trade are two important threats impacting the
33 global protected area network [7]. Hunting-induced defaunation has been shown to impact
34 20% of tropical forest protected areas [8]. Recent research has shown that numerous protected
35 areas are facing intense human pressures [1,9,10], resulting in increased downgrading,
36 downsizing and degazettement events [11]. However, large, well-funded and well-managed
37 PAs are effective in preserving ecosystem health [12–14]. There is increasing recognition that
38 PAs may buffer against the emergence of novel infectious diseases by avoiding drastic changes
39 in host/reservoir abundance and distribution, and reducing contact rates between humans,
40 livestock and wildlife [15–18]. The current COVID-19 pandemics further emphasizes the fact
41 that PAs are at the forefront of preventing future disease outbreaks by maintaining ecosystem
42 integrity [19]. Overall, these successive disease outbreaks have highlighted the importance of
43 a collaborative, multi-sectoral, and transdisciplinary *One Health* approach with the goal of
44 achieving optimal health outcomes that recognize the inter-connections between people,
45 animals, and the environment [20]. Given ongoing discussions on the elaboration of a post
46 2020 Global Biodiversity Framework, the time is ripe for showcasing the essential role of PAs
47 in maintaining biodiversity and promoting global human health.

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49 **A line of defence against emerging zoonoses and illegal wildlife trade**

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51 There is well-established evidence that PAs are a major source of illegal wildlife trade [7, 21].
52 With wild vertebrates being reservoirs of a large repertoire of zoonotic pathogens, wildlife

53 trade enhances several pathways of zoonotic pathogen spillover [5]. Hence, in response to
54 COVID-19, there have been several calls to ban all wildlife trade and shut local wet markets
55 [22]. Many of these large-scale blanket bans do have unintended consequences for PAs, as they
56 can undermine safe, legal and sustainable wildlife trade for communities living in and around
57 PAs for whom wildlife constitutes a safety net [21–24]. In the absence of strong law
58 enforcement, wildlife trade bans can also drive wildlife trade to move underground [25]. Where
59 bans remove legal supply options (e.g., captive breeding), they can accelerate illegal trade,
60 increasing prices on black markets and driving over-exploitation of wild species [26]. In fact,
61 there are emerging reports that the loss of conservation revenue caused by COVID-19 and the
62 reduced capacity for patrolling and law enforcement has resulted in increasing levels of illegal
63 poaching in many PAs worldwide [23,27,28]. PA managers are one of the first lines of defence
64 against both emerging zoonoses and illegal wildlife trade. Therefore, they can play a critical
65 role in better characterizing wildlife trade pathways, assessing conflicts emerging from wildlife
66 bans, and promoting larger on-the-ground discussions on the complex web of inter-relations
67 between wildlife trade, conservation, and global disease risk [22,29]. We believe that the
68 COVID-19 pandemics offers an interesting opportunity to reify the role of PAs in reducing the
69 risk of further zoonoses and supporting human health.

70

71 **Monitoring biodiversity on the frontlines of pandemic risk**

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73 High-risk areas for the mitigation and surveillance of novel disease emergence can be identified
74 depending on levels of habitat fragmentation and human encroachment into natural habitats
75 [30]. In addition, competent reservoir species are more likely to be generalist species that have
76 adapted to human-dominated landscapes [31,32]. Therefore, shifts in mammalian community
77 composition could be an early warning system indicating decline in threatened wildlife
78 populations, ongoing homogenization at the community level, and ultimately poor PA
79 effectiveness, and high risk of infectious disease emergence. Integrating remote sensing and
80 emerging technologies like iDNA (invertebrate-derived DNA) into PA monitoring schemes is
81 a promising approach to monitor habitat degradation, vertebrate populations, and specific or
82 novel pathogens [33–36]. Increased conservation resources are thus needed to mainstream this
83 *One Health* approach to wildlife monitoring across networks of PAs [37]. This will allow
84 identifying PAs and surrounding buffer areas needing urgent attention, and funding to restore
85 ecological integrity and decrease risk for infectious disease emergence. We argue that a
86 ‘disease risk mitigation’ dimension would complement new protected area targets post-2020

87 based on ecological outcomes [38] and would improve integration of human health into global
88 biodiversity conservation policies.

89

90 **Concluding remarks**

91 The current COVID-19 pandemic poses an exceptional opportunity to raise awareness not
92 only of the complex inter-connections between the health of people, wildlife, and our shared
93 environment [5], but also of the important role that a well-managed, sustainable and effective
94 PA network plays in preventing the spillover of diseases from wildlife to people [39]. Rampant
95 levels of deforestation, increasing levels of illegal wildlife trade and encroachment in natural
96 areas, threaten the ecology integrity of many PAs and should be therefore understood as a
97 ticking time bomb for further zoonotic disease spill-over [40–42]. With a rapidly accelerating
98 human footprint [1], the role that PAs have historically played in regulating zoonotic disease
99 dynamics cannot be considered as unlimited anymore [39]. As such, there is a greater need than
100 ever to adopt a *One Health* approach in PA management, targeting areas with a high-risk of
101 emergence of zoonotic diseases for integrated conservation planning and management, and
102 implementing monitoring systems for early detection of emerging infectious disease events and
103 illegal wildlife trade. More broadly, we argue that effective and equitably managed networks
104 of PAs can and should be part of the response to reduce the risk of future zoonotic pandemics.

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107 **Acknowledgements:** J. Terraube has been supported by the WWF and Detection Dogs for
108 Conservation. Á. Fernández-Llamazares has been supported by the Academy of Finland (grant
109 agreement nr. 311176), and the Helsinki Institute of Sustainability Science (HELSUS).

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