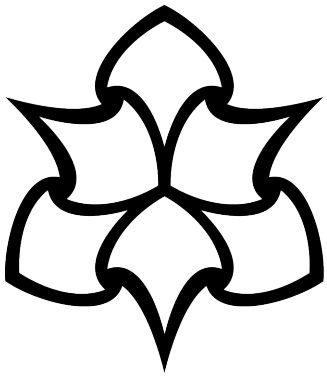

Biodiversity scientists must fight the creeping rise of extinction denial

Efforts by conservation scientists to draw public and decision-maker attention to the biodiversity crisis are increasingly met with denialist rhetoric that may jeopardize meaningful measures to avert species extinctions. We summarize some of the methods used by denialists to undermine scientific evidence on biodiversity trends, and outline pathways forward for the scientific community to counter misinformation campaigns.

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Denial of scientific evidence and rejection of scientific methods are not new phenomena, but represent an increasingly serious problem, especially when driven by politically well-connected and well-funded antagonists seeking to sabotage evidence-based policy for political and/or financial gain. Terms such as ‘science denial’ and ‘science denialism’ are employed as monikers for such anti-scientific enterprises, seeking to discredit for example, the health impacts of smoking, climate science, the teaching of evolution in schools, and vaccination campaigns. There is an emerging body of literature characterising the nature of these activities, and the personal, organizational and economic interlinkages between them[1].

The rise of organised denial of the biodiversity crisis was foreseen by conservation biologists[2] and this wave of denial emerged and broke strongly following the release of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) summary for policymakers which generated substantial media coverage. In its wake a swathe of opinion pieces criticised the report and attacked both the reputations of the report's authors and the process of estimating the total number of species threatened with extinction[3].

These attempts to downplay the biodiversity crisis follow the “Scientific Certainty Argumentation Methods” playbook, which includes all three categories of denial envisioned by Stanley Cohen in a framework first applied to the study of atrocities and other unwelcome truths[4]. These are: (1) ‘Literal denial’, an assertion that something is untrue, for example the evidence for greatly

elevated rates of species threat and extinction; 2) 'Interpretive denial', in which raw facts are not disputed but given a different spin, for example using evidence from temperate ecosystems to make claims about reduced impacts in the tropics; 3) 'Implicatory denial', in which the data itself are not denied, but their implications are, for example arguing that transformative changes to socio-ecological systems are not required to avert species extinctions.

We address each of these in detail, before exploring ways to counter erroneous claims and logical fallacies that we understand to be 'extinction denialism' or 'biodiversity loss denialism'.

Literal Denial: "Species extinctions were predominantly a historical problem"

Extinction deniers often downplay the extinction crisis by framing it as a historical problem and a trivial contemporary challenge (SOM Table 1). By focusing attention on the loss of megafauna in prehistory owing to over-hunting and rapid loss of island biodiversity in historic times it is suggested we have passed through these extinction filters and reached the 'other side' of the crisis. This 'literal denial' line of argument misses several key facets of the extinction crisis, notably that species, including island endemics, are still being lost[5] and that the catastrophic loss, degradation and fragmentation of whole ecosystems, combined with climate change, is triggering a new episode of continental extinctions[6]. This is particularly acute in the highly biodiverse tropics and where extinctions are just the endpoint of a long process of extirpation and defaunation[7] (Box 1, SOM Table 2). Moreover, biologists are typically conservative in declaring possible extinctions, and across the world there are 143 amphibians, 41 reptiles, 29 mammals and 22 bird species classed by the IUCN https://www.iucnredlist.org as Critically Endangered (Possibly Extinct). Many of these species are likely already gone, while many more, including the 75 species listed as Extinct in the Wild, are only hanging on due to expensive, last resort, conservation interventions[8].

Insert Box 1.

Interpretive denial: Economic growth alone will fix the extinction crisis

Extinction denialists often invoke an Environmental Kuznets Curve (EKC)[9] response of biodiversity to development (SOM Table 1), arguing that pressures on the environment eventually decrease with rising income levels. Yet the EKC hypothesis is misleading in this context. First, empirical evidence of the relationship between economic development and forest cover only supports the *loss* part of the curve[10]. Second, the EKC is typically a *local* rather than a *global* phenomenon, and global environmental indicators of indirect impacts such as CO_2 emissions, waste production and energy consumption are still increasing monotonically. Country-specific assessments of EKC often ignore the outsourcing of environmental degradation to poorer countries. Denialists also highlight the resurgence of certain large charismatic species such as wolves and bears in Europe and North America as evidence that we are through the worst of the extinction crisis. However, this is only a partial success story (Box 1). Similar successes in the tropics are highly unlikely: species richness, species packing and habitat and niche specialisation are all far higher at tropical latitudes, while geographic range sizes are much smaller. These

factors mean that tropical biodiversity is far more extinction-prone then temperate biodiversity[11]. The unfortunate truth is that there are many imminent or actual extinctions in highly deforested tropical regions (SOM Table 2). Finally, the so-called 'Forest Transition' model[9], which envisages an EKC-style relationship between forest cover and development, fails to differentiate between native forests and monoculture plantations of oil palm, conifers and eucalyptus, despite the expansion of plantations being an important cause of biodiversity loss. Many global forest models are not sensitive to the difference[12] and conflating plantations with natural forests has long been a key artefact in the denialist playbook.

Implicatory denial: Technological fixes and targeted conservation interventions will overcome extinction

Extinction denialists are often selective, choosing to highlight only a subset of factors causing contemporary extinctions, such as over-harvesting and predation by non-native species, while choosing not to mention habitat loss that affects the majority of species on the Red List. They then suggest that solutions are simple, requiring no change or business-as-usual actions, even though it is increasing resource demands and current socioecological and economic modes of organisation that imperil biodiversity globally[7]. Invasive species, overharvesting and pathogens are undoubtedly significant conservation issues responsible for global extinctions of many - particularly insular – species, and technological fixes form part of the portfolio of conservation interventions. However, these threats are often exacerbated by habitat loss and climate change, and all must be addressed together. A disproportionate focus on a subset of drivers is a form of 'implicatory denial' that is contrary to scientific consensus: recognising the importance of one set of threats does not obviate the need to address others[8]. Another form of 'implicatory denial' involves the misrepresentation of the land sharing/sparing concept (Box 1).

Countering denial

There are multiple ways in which conservation scientists can be proactive in countering denial (Table 1). The first is to conduct rigorous science to refine understanding of the scale, scope and causes of the extinction crisis. However, it is not enough just to get the science right, but also to communicate it to a wide audience, working with journalists, artists and other communicators to disseminate the evidence before denialists are able to contrive a consensus gap[14]. In combating the pseudo-science peddled by denialists it has been argued that the scientific consensus on climate change has been impacted by 'seepage', whereby scientists respond to critics by over-emphasising uncertainty, allowing denialist claims to impact how they portray their own research. Where modelled predictions of loss are questioned, it is useful to highlight that empirical observations of extinction risk often outpace predictions[15]. Confronting polemicists and rhetoricians well-versed in arguing positions rather than establishing truth can be a major challenge. Whilst retaining a cordial dialogue, there is little point in being respectful of insincere arguments, which should be called out for what they are and dismantled and rebutted systematically with evidence[3].

Insert Table 1.

It is important not only to communicate the science of extinction, but also to communicate the implications of biodiversity loss (Table 1). This can be most effective when conservation scientists find ways to demonstrate connections that resonate with a target audience. Examples could include making connections between deforestation, wild animal trade and zoonoses; or between foods people consume daily and their connection to conservation problems – and solutions. Care needs to be taken not to exaggerate the importance of minor threats while overlooking major ones. For example, 'implicatory denial' often involves faux-concern about wind farms as a cause of biodiversity loss, despite the evidence that wind energy – while not without negative impacts – is a relatively minor threat compared to habitat loss and climate change, or even the impact of other forms of energy production, such as extraction of shale gas or coal. Here, conservation scientists need to recognise the underlying anti-renewable energy agenda and can respond by putting threats in context, i.e. that wind farms, by being less damaging than other ways of generating energy, are a net benefit - especially when their location and management is informed by ecological science.

To generate support for solutions, conservation scientists need to show that similar challenges have been overcome in the past, that the risks are acceptable and that the benefits exceed the costs. It is also necessary to engage people's emotions, using examples from civil rights to the ozone hole to acid rain to smoking bans. These clearly show that dramatic change is not only possible, but desirable. Denialists find fault with conservationists for failing to report positive news. However, this is a talking point that originates within the conservation community itself, and as a criticism it is now somewhat redundant. Conservationists have called on each other to not only report bad news accurately but also flag up good news stories as best we can[16], e.g. via https://conservationoptimism.com, but without sugar-coating the broader truth.

Debate is vital as we search for solutions to the biodiversity crisis, but these debates are only useful where there is good will on all sides. For conservation to succeed, it will need to be inclusive, and conservation scientists need to be better at identifying useful discussions and avoiding unnecessary internal conflicts. But in cases when constructive arguments turn into dismissiveness or denial, and when vested interests are prioritized over the search for truth, good will cannot be assumed (Table 1). Unless denialists have a large platform, the best response may be to ignore them to avoid amplifying their efforts at misinformation. For this reason, we have deliberately avoided referencing the names and publications of prominent deniers here in the main text. Where responses are necessary, conservation scientists need to avoid getting dragged down into ugly arguments or personal attacks, be measured and respectful in their responses, and to reinforce their role as trusted experts by countering flawed arguments with evidence. By adopting these approaches, and learning some of the lessons of climate denial, conservation scientists can reclaim the narrative.

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166 **Contributions**

167 A.C.L., S.A., J.B. and B.P. all contributed to the writing of the manuscript.

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Box 1. Examples of species and systems misrepresented by extinction denialists.

Literal denial: e.g. underestimating and overlooking recent extinctions.

a) The Atlantic Rainforest has been long touted by deniers as an example of a biome that had lost 90% of its habitat without a single documented extinction. Yet this **Alagoas Foliage-gleaner** *Philydor novaesi* and the Cryptic Treehunter *Cichlocolaptes mazarbarnetti* were confirmed as extinct in 2019 each only ever known from two forest fragments, and seven other species have not been seen for a decade or are down to the last few individuals (SOM Table 2). Extinction deniers downplaying the relatively small number of documented extinctions are wrong for the same reasons as those who sought to downplay the impact of the SARS-CoV-2 pandemic in early 2020. Just as the true number of cases was underestimated because of widespread lack of testing, the true number of extinctions is far higher than those observed, because the majority of the Earth's species have not even been described – especially the rarer and more specialised species, which are most vulnerable. And, as with the initially unthinkable predictions of epidemiologists, conservation scientists are beginning to see their grim predictions of extinction debt borne out. Image credit: Ciro Albano.

Interpretive denial: e.g. resurgent carnivores are not umbrella species for all taxa.

b) The resurgence of **Eurasian Brown Bear** *Ursus arctos arctos*, Grey Wolf *Canis lupus,* Eurasian Lynx *Lynx lynx* and their prey base in Europe reflects land abandonment and rural depopulation associated with globalisation and mechanisation of agricultural production systems but should not be interpreted as a recovery of biodiversity more widely. These population recoveries have come alongside losses in farm income and rural employment. Other factors include reduced human-wildlife conflict and better legislative protection. Large mammals are typically habitat generalists and their recolonization of managed habitats like European forests has not been accompanied by a resurgence for habitat specialists. Old growth forest dependent White-backed Woodpeckers *Dendrocopos leucotos*, for example, remain on the cusp of extinction even in heavily-forested Scandinavia. The saproxylic beetles they rely upon are associated with ancient trees and natural large-scale fire regimes with long return times and are consequently extremely rare or extinct in Europe's managed forests. Image credit: Richard Moores.

Implicatory denial: e.g. misrepresenting land sparing as a silver bullet for conservation.

c) Vast **soy bean** *Glycine max* fields at the ecotone of the Amazon and Cerrado biomes in Brazil. Land sparing – minimising the land area of agriculture while protecting and restoring as large an area of native vegetation as possible – may well be a useful strategy to reduce extinctions associated with habitat loss. Various studies have confirmed that protection of large areas of native vegetation will be essential for the

conservation of the many specialised and threatened species that inhabit the tropics[13]. However, agricultural intensification alone is no guarantee that land will be spared for nature, and if it increases profits, there is a risk that this will encourage further deforestation. Furthermore, not all methods for increasing yields are equal. There is a need to minimise negative environmental externalities, make sure that key ecosystem services are still provided at landscape scales, and ensure that intensification does not simply result in the increased demand that characterises the great acceleration. Land-uses that incorporate people, such as indigenous reserves, are among the most effective at conserving forest cover, and are an essential complement to strictly protected areas. Image credit: Alexander Lees.

Table 1. Communicating biodiversity loss with the public in the context of Fischhoff's Stages of Risk Communication. These are recommendations for communicating with a wider audience, who might be vulnerable to believing denier messages. In the case of those who have committed to deny or dismiss the extinction crisis, it is best to ignore or respectfully (yet firmly) debunk, recognising that your target audience is those observing the conversation, rather than the deniers themselves.

Fischhoff (1995) Stages	**Conservation scientist communication recommendations**
Get the numbers right and don't over-/under-exaggerate	Business-as-usual rigorous conservation science
Tell them the numbers	Disseminating scientific findings and species loss projections far more publicly, engaging with social, print and televisual media and with politicians, policy makers and other stakeholders (e.g. industry, corporate, financial). Make messaging and communications relevant, accessible and compelling for target audiences.
Explain what we mean by the numbers	E.g., consequences of species declines and loss of ecosystem service provision, zoonoses, ecotourism, connection with nature. Consequences must resonate with audience.
Show they have accepted similar risks in the past	(a) Show they've insisting that biodiversity loss be stopped in the past (e.g. success of the Save the Whales campaign) (b) Show they've accepted similar risks (to those of mitigation and adaptation)

	in the past (e.g. Phasing out of CFCs, tighter pollution legislation)
Show that it is a good deal for them	Remind them of the ancillary benefits of action to combat biodiversity loss, wilder countryside, green jobs, food production sustainability. Play to intrinsic values of nature conservation (e.g. emotional connection to nature) AND utilitarian benefits (e.g. improved mental health, pollination)
Treat them nice	Be respectful when challenging opponents in whatever context. Provide evidence-based alternatives to fallacious arguments.
Make them partners	Try to be inclusive in deliberating solutions, acknowledging trade-offs and seeking and emphasizing co-benefits where they exist.

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