Global change ecology

https://doi.org/10.1038/s41559-023-02259-7

Bird vulnerability to forest loss

Montague H. C. Neate-Clegg

Check for updates

Two recent studies come to different yet complementary conclusions about the factors – species traits, climate conditions and past disturbances – that determine the responses of bird species to forest loss and fragmentation.

Habitat loss is the greatest threat to terrestrial biodiversity around the world[1,2]. Deforestation, in particular, erases the habitat on which most species depend, and leaves behind fragmented landscapes that are devoid of forest-interior specialists[3,4]. However, not all species lose out in deforested landscapes; many species benefit from the new agricultural matrix or from the edge habitat created where forest meets farm[5,6]. Furthermore, the balance of winners versus losers varies biogeographically: there is a notable increase in sensitivity to forest loss towards lower latitudes[7]. The question arises of what might explain the variation in sensitivity among species around the world. Writing in *Nature Ecology & Evolution*, two separate studies sought to unravel the traits and ecological filters that predict how bird species respond to deforestation and fragmentation (Fig. 1). In the first, Weeks et al.[8] provide evidence that sensitivity to forest fragmentation is driven by dispersal ability. In the second, Hua et al.[9] found support for environmental variability and agricultural history as predictors of responses to deforestation, with less negative responses in drier environments with a long history of anthropogenic land-use change.

Both studies test the importance of seasonality, disturbance and dispersal ability (Fig. 1), and both conclude that tropical bird species are the most threatened by deforestation and fragmentation. Yet, these studies find opposing support for the relative importance of dispersal ability versus 'ecological filtering', which has important implications for understanding the impacts of habitat loss. The ecological filtering hypothesis posits that historical disturbance regimes, such as fire and tropical storms, remove those species that are most sensitive to disturbance and leave a pool of species that are more tolerant of deforestation[7]. The alternative hypothesis (although not mutually exclusive) is that intrinsic functional traits, such as dispersal ability, make species more or less susceptible to forest loss and fragmentation[10]. Both landscape disturbance and functional traits vary greatly across the planet, including along strong latitudinal gradients[7,11], and so it is critical to understand how these factors shape the responses of wildlife to forest loss and fragmentation.

One trait – dispersal ability, as represented by the hand–wing index (a measure of wing 'pointedness')[12] – emerged as the most important factor for explaining variation in species' responses to fragmentation in the paper by Weeks and colleagues. They used the BIOFRAG dataset[13], a cross-taxa compilation of fragmentation responses that classifies species on the basis of their forest association and avoidance of forest edges. At the landscape level, the proportion of fragmentation-sensitive bird species decreased with the average dispersal ability of the bird community, a relationship that was also supported at the population level. This makes sense, as species with short, rounded wings (such as terrestrial insectivores) are reluctant to leave the safety of the forest[14] and have difficulty crossing gaps between fragments[15]. However, Weeks et al. did not find that fragmentation sensitivity was predicted by historical land disturbance (which combined glaciation, fires, tropical storms and long-term deforestation). Geographical variation in dispersal ability itself was better explained by temperature seasonality than by latitude or historical

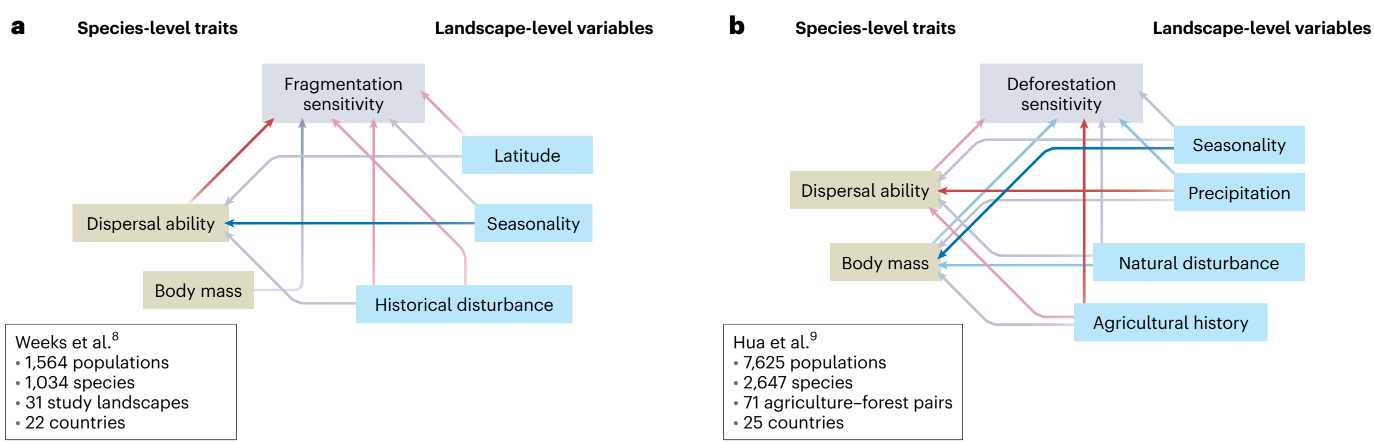

Fig. 1 | The relationships among species traits, geographical properties and sensitivity to deforestation and fragmentation in birds. a,**b**, Weeks et al. investigated the predictors of fragmentation sensitivity (**a**) and Hua et al. investigated the predictors of deforestation sensitivity (**b**). Species-specific traits are shown in tan and landscape-level variables are shown in blue. Arrows represent tested relationships: each arrow points from an explanatory variable to a response variable. Arrows are grey when no relationship was found; pink for nonsignificant negative associations; red for significant negative associations; light blue for nonsignificant positive associations; and dark blue for significant positive associations. For **b**, there are numerous other traits that were included in the analyses but are not shown here.

disturbance, as species in more seasonal environments must be able to move around the landscape — or even migrate — during periods of low food availability[12].

By contrast, dispersal ability and seasonality did not emerge as important drivers of deforestation sensitivity in the paper by Hua and colleagues. Their analyses were based on a newly assembled dataset of deforestation response ratios, calculated for each bird population as the ratio between its abundance in agriculture-dominated habitat and abundance in a paired site of native forest. Deforestation-driven declines were greater in landscapes with higher rainfall and a shorter history of agriculture, which supports the role of both natural and anthropogenic filters[7], although the importance of disturbance regimes (for example, fires and storms) was less evident. At the population level, response ratios were associated with a suite of functional traits that included clutch size, diet specialization, foraging height and forest dependency — but, notably, not dispersal ability.

There are several reasons why these two studies may have come to different conclusions. They differ in the number of species and study populations included (Fig. 1), and in their geographical coverage. Hua et al. also incorporate several additional functional traits that could compete with dispersal ability to explain filtering effects. However, perhaps the most important distinction is in the nature of the response variables that were investigated. Weeks and colleagues restrict their analyses to species with a preference for forest, and then classify species as fragmentation sensitive on the basis of their edge avoidance. Their analysis thus hinges on differentiating between forest species that avoid edge habitat and forest species that can tolerate edge habitat. By contrast, Hua and colleagues compare the abundances of populations within forest to those in agricultural habitats. In essence, these two response metrics represent two different filtering steps: the species that decrease in agricultural habitat relative to forest versus the species that decrease in forest edge relative to forest interior. Because these filtering steps are different, they have the potential to be driven by different factors. A long agricultural history and several traits such as small clutch size and foraging height filter out species that are intolerant of open habitat, and low dispersal ability filters out forest species that are intolerant of edge habitat. Dispersal ability is not necessarily important when many forest-associated species are dispersive edge or canopy dwellers, but it is critical for species that rarely leave the safety of dark interior forest.

Taken together, these two studies provide a complementary narrative for understanding how birds respond to both forest loss and edge effects in remaining forest. It is clear that functional traits once again prove to be important predictors of anthropogenic impacts[10,16–18], yet the distribution of traits in bird communities is also shaped by a history of environmental variation and human pressure. Future studies could build on this work by demonstrating how different filters act sequentially over time, perhaps even addressing how these past processes affect contemporary responses to climate change.

Montague H. C. Neate-Clegg
Ecology and Evolutionary Biology, University of California, Los Angeles, CA, USA.
e-mail: monteneateclegg@gmail.com

Published online: 05 January 2024

References

1. Newbold, T. et al. *Science* **353**, 291–288 (2016).
2. Ducatez, S. & Shine, R. *Conserv. Lett.* **10**, 186–194 (2017).
3. Betts, M. G. et al. *Nature* **547**, 441–444 (2017).
4. Stouffer, P. C. *The Condor* **122**, duaa005 (2020).
5. Fahrig, L. *Ann. Rev. Ecol. Evol. Syst.* **48**, 1–23 (2017).
6. Lees, A. C. & Peres, C. A. *Biol. Conserv.* **133**, 198–211 (2006).
7. Betts, M. G. et al. *Science* **366**, 1236–1239 (2019).
8. Weeks, T. L. et al. *Nat. Ecol. Evol.* **7**, 1079–1091 (2023).
9. Hua, F. et al. *Nat. Ecol. Evol.* https://doi.org/10.1038/s41559-023-02280-w (2024).
10. Bregman, T. P. et al. *Proc. R. Soc. Lond. B* **283**, 20161289 (2016).
11. Tobias, J. A. et al. *Ecol. Lett.* **25**, 581–597 (2022).
12. Sheard, C. et al. *Nat. Commun.* **11**, 2463 (2020).
13. Pfeifer, M. et al. *Ecol. Evol.* **4**, 1524–1537 (2014).
14. Jirinec, V., Rodrigues, P. F., Amaral, B. R. & Stouffer, P. C. *Ecology* **103**, 3645 (2022).
15. Claramunt, S., Hong, M. & Bravo, A. *Biotropica* **54**, 860–868 (2022).
16. Neate-Clegg, M. H. C. et al. *Curr. Biol.* **33**, 1677–1688.e6 (2023).
17. Sunday, J. M. et al. *Ecol. Lett.* **18**, 944–953 (2015).
18. Bjorkman, A. D. et al. *Nature* **562**, 57–62 (2018).

Competing interests

The author declares no competing interests.