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**Article:**

Gillingham, Phillipa and Thomas, Chris D [orcid.org/0000-0003-2822-1334](https://orcid.org/0000-0003-2822-1334) (2023)  
Protected areas do already act as steppingstones for species responding to climate change. *Global Change Biology*. ISSN 1354-1013

<https://doi.org/10.1111/gcb.16941>

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1 Author accepted version, Global Change Biology (2023), <https://doi.org/10.1111/gcb.16941>

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4 Protected areas do already act as steppingstones for species responding to climate change

5

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11

12 Parks *et al.* (2023) modelled the future climatic connectivity of the global Protected Area network,

13 and came to the conclusion that Protected Areas (PAs) are unlikely to act as steppingstones for most

14 species undergoing range changes towards the poles, thereby not enabling them to reach newly

15 suitable climatic conditions.

16

17 However, we have empirical evidence that PAs have already acted as steppingstones for a large

18 proportion of range-shifting species under recent climate change. Of 256 species across eight

19 taxonomic groups that have been expanding their distributions within Great Britain with sufficient

20 data for analysis, predominantly in response to climate change, 251 (98%) were more reliant on PAs

21 for this expansion than expected by chance, with PAs more important for habitat specialists than

22 generalists (Thomas *et al.* 2012). Across the two taxa with available abundance data, PAs supported

23 higher abundances in colonised regions than non-PA land for a majority of species (Gillingham *et al.*

24 2015). Moreover, PAs have also acted as landing pads for eight birds colonising Great Britain

25 naturally from Europe, whilst resisting invasion by six introduced species (Hiley *et al.* 2014).

26

27 If PAs can act as steppingstones for species shifting their distributions within Britain, the same is  
28 likely true elsewhere, as the country has low levels of land under protection (at the time of our  
29 analyses just 6% of England was protected within areas the IUCN would consider as PAs), with little  
30 semi-natural habitat available outside PAs (Lawton *et al.* 2010). We do agree that PAs may not be  
31 sufficient to allow species to 'keep up' with climate change (Willis *et al.* 2009), but the above  
32 evidence suggests that they do contribute to the range expansions of many species into climatically-  
33 suitable regions, despite some lags.

34

35 This is not the only contribution of PAs to species survival; they play a key role in facilitating species  
36 survival in climatic 'overlap zone' (past, current and future climates all suitable for a particular  
37 species in a given PAs) and enable species to shift their distributions *within* large, montane and  
38 otherwise heterogenous reserves (via elevational and aspect shifts, see Thomas & Gillingham 2015  
39 for a review of the within- as well as between- contributions of PAs to species distributions and  
40 survival under climate change). Since suitable habitats for individual species are often patchily-  
41 distributed within, for example, large and mountainous PAs, this may commonly represent a within-  
42 PA steppingstone effect.

43

44 We agree with Parks *et al.* (2023), however, that PAs and the management of intervening landscapes  
45 will be insufficient to enable many, especially localised species, to track suitable climates, and that  
46 assisted colonisation will be required if they are to survive in future (e.g., Hoegh-Guldberg *et al.*  
47 2008; Willis *et al.* 2009). We also agree with the authors that 30x30 targets for protection may  
48 contribute if located strategically to facilitate both between-PA steppingstone contributions to  
49 latitudinal range shifts and within-PA heterogeneity contributions to smaller-scale elevational and  
50 other shifts. Appropriate management of PAs for biodiversity can also increase the likelihood of  
51 colonisation (and thus expansion), as illustrated by the silver-spotted skipper butterfly *Hesperia*  
52 *comma* in the UK (Lawson *et al.* 2014).

53

54 Suggestions that PAs are unlikely to act as steppingstones in the context of climate change are  
55 contrary to the evidence. They often fulfil this function. However, we agree that this is not sufficient  
56 on its own to protect all species. Additional strategically-placed PA designations and identifying  
57 opportunities for management (inside PAs and in connecting landscapes) that increase persistence  
58 and expansion rates are all areas for consideration for ongoing conservation decision-making – as  
59 well as the development of assisted colonisation strategies and decision-making protocols, which are  
60 currently insufficient. There is room for hope here since reserve managers are beginning to manage  
61 with climate change in mind (e.g. see Prober *et al.* 2019).

62

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