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

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Parks *et al.* (2023) modelled the future climatic connectivity of the global Protected Area network, and came to the conclusion that Protected Areas (PAs) are unlikely to act as steppingstones for most species undergoing range changes towards the poles, thereby not enabling them to reach newly suitable climatic conditions.

However, we have empirical evidence that PAs have already acted as steppingstones for a large proportion of range-shifting species under recent climate change. Of 256 species across eight taxonomic groups that have been expanding their distributions within Great Britain with sufficient data for analysis, predominantly in response to climate change, 251 (98%) were more reliant on PAs for this expansion than expected by chance, with PAs more important for habitat specialists than generalists (Thomas *et al.* 2012). Across the two taxa with available abundance data, PAs supported higher abundances in colonised regions than non-PA land for a majority of species (Gillingham *et al.* 2015). Moreover, PAs have also acted as landing pads for eight birds colonising Great Britain naturally from Europe, whilst resisting invasion by six introduced species (Hiley *et al.* 2014).

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

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

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

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

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