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Science for Environment Policy

New trait-based method predicts whether mammals can keep up with climate change

A new approach to modelling the spread of mammal populations under climate change has been developed. The method overcomes the problem of missing ecological data for most species by using information on species characteristics, or 'traits', associated with population demographic rates and individual movements to deduce which species move too slowly to escape climate change's effects on their habitat. The model's results suggest that around 30% of mammal species may not be able to disperse quickly enough to survive.

Climate change is expected to make many current habitats unsuitable for wild species, by creating intolerable temperatures or by reducing food supply (e.g. if prey or plants cannot thrive), for instance. Therefore, the rate at which a population can spread and move into new, suitable habitats is likely to determine how well it adapts to climate change.

Models are central to predicting population spread, but they suffer from a shortage of high-quality ecological data for individual species. To predict the spread of a specific species, data on several of its 'traits' (features or characteristics) are usually needed, but complete datasets which include several traits are not available for most species. Consequently, existing models are only useful for a relatively small number of species.

To help overcome this challenge, researchers from Italy and the UK developed a new 'trait-space' approach for predicting population spread for thousands of terrestrial mammal species. It estimates population spread rates by creating 'virtual species' which are based on likely combinations of traits that research has shown affect population dynamics.

These virtual species are not species that exist in the real world, but simulations of a realistic combination of life-history traits, and so resemble real species. For example, one virtual species may combine the body mass and sexual maturity of a tree squirrel-like species, which could represent several real species, such as the American eastern grey squirrel and the Eurasian red squirrel.

The life-history traits considered were: age at sexual maturity, litters per year, litter size, dispersal distance (any movement that has the potential to lead to gene flow, e.g. birth to breeding sites or between breeding sites), annual survival rates of adults, average longevity (life-span), home range size, population density, body mass and diet.

They first analysed which biological traits were associated with spread rate into new environments. The analysis suggests that the factor which most affects spread rate is change in average dispersal distance, followed by annual survival, sexual maturity age, litter size and litters per year.

Then, the researchers modelled the spread of 50 000 virtual species under climate change, assuming the conditions of the IPCC's A1B scenario (which simulates a future world of rapid economic growth, global population that peaks in mid-century, and the rapid introduction of new technologies – fuelled by a balance across all energy sources).

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Spread rates for real species were estimated by using virtual species generated from the real distributions of body mass and diet (which are known data) of mammals in different biomes, such as different types of natural grassland and forest (the effects of obstacles in built-up areas on spread were not considered).

Almost 30% of real species' spread rates are slower than the predicted pace of climate change, results suggest, although this figure varies by biome. For instance, about 10% of species are predicted to spread more slowly than the pace of climate change in tropical and subtropical coniferous forests, and montane (high altitude) grassland and shrublands. In flooded grasslands and savannas, boreal forests, mangroves, deserts and xeric (dry) shrublands, 36% of species may not be able to keep pace with climate change. Species with short dispersal distances and slow life histories in areas where the climate shifts quickly are predicted to be most at risk.

These estimates are likely to be optimistic; many species will not be able to disperse into new environments because they are constrained in their movements, such as mountain or insular species, or because they live in highly fragmented landscapes.

The researchers note that these figures are currently uncertain, but that the study provides a useful method of estimating mammals' dispersal that could be applied to other groups of species and for scenarios other than climate change. Furthermore, it suggests that a significant number of mammal species could lose parts of their ranges in the near future, even though mammals are better able to disperse than many other groups of species. It also allows conservation managers to focus on species groups identified as most at risk.

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