Scenario DOCTORAL TRAINING PARTNERSHIP

NERC SCIENCE OF THE ENVIRONMENT

Predicting species' responses to climate change using spread models, data inference and climate velocities

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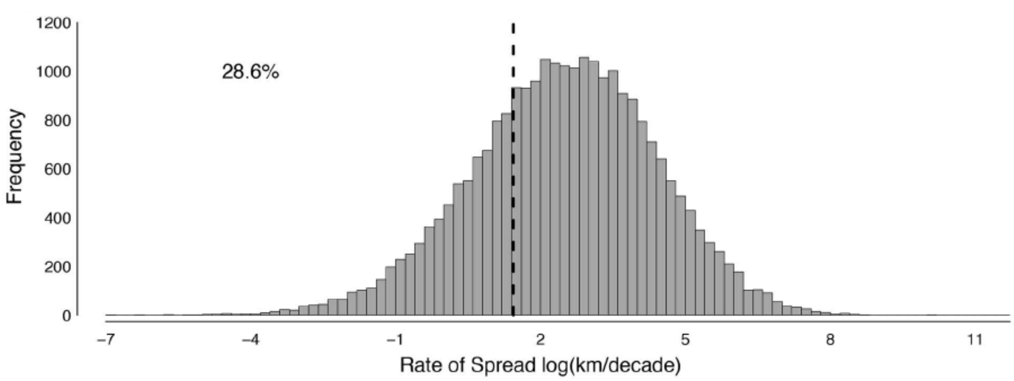
Climate change is arguably the greatest threat that biodiversity will be facing over the next decades. While the threats to certain individual species are well characterized, there is a remarkable paucity of realistic assessments of how a wide range of species might respond to climate change, or of which types of species will be most affected. Those assessments that have been done have the drawback that they rarely take account of the fact that that individuals disperse. The realistic spatial dynamics of populations must be integral to analyzing how species may respond to a changing climate.

This PhD project will address the questions: 1) What proportions of species in different taxonomic groups will be able to track climate change?; 2) Which life history traits are related to this ability to track climate?; and 3) Can we therefore predict which types of species are most at risk from a changing climate? We will use and develop new approaches to combining spatial population models with data on demography and dispersal to project shifts in distribution across a wide range of species.

The project will use the "climate velocity" concept, i.e. the rate at which a climate isocline moves across the Earth's surface at any particular location. It can be thought of as the rate at which a species will need to shift its range to stay in its optimal climate space. We[1,2] have been modelling the rate at which different types of species can spread, given their dispersal abilities and population growth rates, and comparing these with climate velocities as an assessment of their ability to track a shifting climate.

The student will work within existing collaborations between CEH and U. Reading, U. Aberdeen and U. Sheffield to develop new modelling studies. Our models of population spread (integro-difference equations) allow different degrees of complexity from simple, homogeneous landscapes, to simulations over highly varying space and time. A key aspect will be using novel methods to address the critical lack of data on species' demography and dispersal to allow cross-comparisons across many species and multiple taxa, including plants, butterflies and mammals. This will involve using the COMADRE and COMPADRE databases of animal and plant demography, Bayesian methods for data inference[2] and our work collating dispersal data across many species. It will also be possible to validate models against our data on actual range shifts in multiple species[3].



Predictions, based on the virtual species approach, of rates of spread across all mammals[2]. The percentage is those species with a predicted spread rate slower than the mean climate change velocity, which is shown by the dashed line.

Training opportunities:
This studentship will provide training with some of NERC's "most needed" skills; in particular, high performance computing and use of big data, together with Bayesian approaches for data analysis and model fitting. While working mainly with JB, the student will benefit from a diverse supervisory team, which will provide training in key areas: climate change impacts (JB, TO), modelling population spread (JB, SW, TO, JT), comparative population (JB, RSG) and dispersal ecology (JB, TO, JT), statistical approaches for data inference (JB, JT), and the ecology and conservation of a wide range of taxa (plants, butterflies, mammals, birds). The student will learn about the use of computing clusters and manipulation of big data using Matlab and R.

The student will be working with a thriving group of ecological modellers at CEH and Reading and will benefit also from interacting with the Biological Records Centre and Disease Modelling group at CEH and the Process Modelling group and Phylogenetics group at Reading. The student will make use of the supervisory group by spending two weeks at Aberdeen learning the Bayesian approach developed for trait-space modelling and two weeks at Sheffield to learn about use and analysis of the COMADRE and COMPADRE databases.

Student profile:
This project would be suitable for students with a degree in ecology or applied maths. We are seeking a numerate student with interests in modelling and statistical analysis. They will have a knowledge of climate change science and will be seeking to make their research relevant to policy makers as well as the scientific community. While they need not know modelling languages (Matlab, R) they will have a propensity for learning how to programme. We are seeking someone able to come up with their own ideas and to drive forward their own research agenda.

References:

[1]Bullock et al (2012). Modelling spread of British wind-dispersed plants under future wind speeds in a changing climate. J. Ecol., 100, 104.
[2]Santini et al. (2016). A trait-based approach for predicting species responses to environmental change from sparse data: how well might terrestrial mammals track climate change? Global Change Biol., 22, 2415.
[3]Mason et al (2015). Geographical range margins of many taxonomic groups continue to shift polewards. Biol. J. Linn. Soc., 115, 586.

http://www.reading.ac.uk/nercdtp