

# Modelling the population dynamics of lizard orchids, *Himantoglossum hircinum*.



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**The aim of the project:** The lizard orchid is a long-lived perennial plant that has become increasingly abundant within the United Kingdom. It has only been in the past century that populations have emerged in the south of England and this has been linked with rising temperatures associated with global warming. The study focuses on three plots on the Royal St Georges golf course (Sandwich, Kent), where the plants have been monitored each year since 1987. There are two components of the project. The first is to develop mathematical models to understand how the population dynamics have developed over time, including covariate information relating to the weather. The second analyses whether there is any spatial pattern, particularly relating clustering of plants to the seed dispersal mechanism of the lizard orchid. The work is in collaboration with the Centre of Ecology and Hydrology (CEH).

## Population dynamics

- Matrix population models have been used to investigate changes in population over time.
- The basic model has been modified by allowing for plant dormancy between years and by including a seed bank in the reproductive component of the life cycle.
- Key transition rates have been estimated, providing intuitive and interpretable biological quantities that relate to the plant's life cycle.
- Exact methods for perturbation analysis have been developed. These method allows exact prediction of the impact changes to transition rates on the population dynamics.



Fig 1: The lizard orchid

## Spatial analysis

- The data tracks individual plants. Modelling of the spatial distribution is complicated by seeds taking up to three years to germinate and by not being able to associate new individuals to a particular parent plant.
- There is strong evidence of clustering, with new individuals clumped around parent plants
- Point process cluster models such as the Thomas and Matérn models have been modified. In particular, a Laplace distribution has been used to model the distance new individuals develop around a parent plant.
- Simulation methods have been used to estimate the key parameters that control the spatial models. The parameters of main interest have been the intensity parameter (controlling the number of new individuals per parent plant) and the radius of dispersal parameter (controlling the parent-offspring distance).