Development of a forecast model for outbreaks of common voles (*Microtus arvalis*) in Germany

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Intensely fluctuating abundances are a profound part of the population dynamics of common voles (*Microtus arvalis*). Though peak numbers can vary widely, during gradation events the population density can simultaneously rise up to several thousand individuals per hectare at a national or even continental scale and cause massive crop losses in agriculture and forestry. Consequently, common voles are of great concern for crop protection and so far no reliable method is established to predict such population outbreaks. Measures to combat vole outbreaks are usually taken when the damage is already clearly visible.

The aim of this project is to identify potential predictors and to develop a predictive model for the population dynamics of common voles based on weather parameters as well as landscape factors. Such a model would enable farmers to take spatially and temporally targeted preventive measures that could minimise the effects of vole outbreaks. Additionally, such an approach would lead to an overall reduction in the use of rodenticides and eventually reduce the contamination risk for non-target species.

To achieve this aim, long-term historic datasets on population dynamics in common voles were located and digitalized from the archives of various institutions. A total of nearly 4,500 single abundance measures spanning more than 25 years were used for subsequent analyses. Potential predictors were readily available extrinsic factors such as weather (monthly mean of temperature, snow cover, precipitation and sunshine duration) as well as landscape factors (elevation, soil type, groundwater fluctuations, etc.). Both analyses were done separately to identify potential predictors of both parameter types. Non-parametric methods such as boosted regression tree- (BRT) and classification and regression tree- (CART) analyses were used to quantify the influence of single predictors (BRT) as well as identity predictor constellations and their thresholds leading to differences in vole densities (CART).

For landscape factors site elevation and soil type played a key role in shaping the distribution of common vole outbreak risks. Additionally, this study demonstrated that weather parameters were closely related to the variation in regional outbreak risk of common voles. Mostly weather parameters in winter and early spring were identified to be highly important. For perennial grassland in autumn for example the snow days in January as well as the sunshine duration in March and the temperature of the previous October seemed to be decisive factors. Validation of the deduced set of rules showed that the predictive model based on weather parameters can successfully predict around 70% of the historic population fluctuation. Validation on external data to assess potential extrapolation of the model to other areas is currently ongoing. Through a combination of both approaches (landscape and weather parameters) but also through increasing the forecast resolution through interpolated weather data such a forecast model might be as reliable as more complex but often impractical biological models.