Evaluating Ecological Recovery in Mechanistic Effect Models for Environmental Risk Assessment

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Meet us at booth 55

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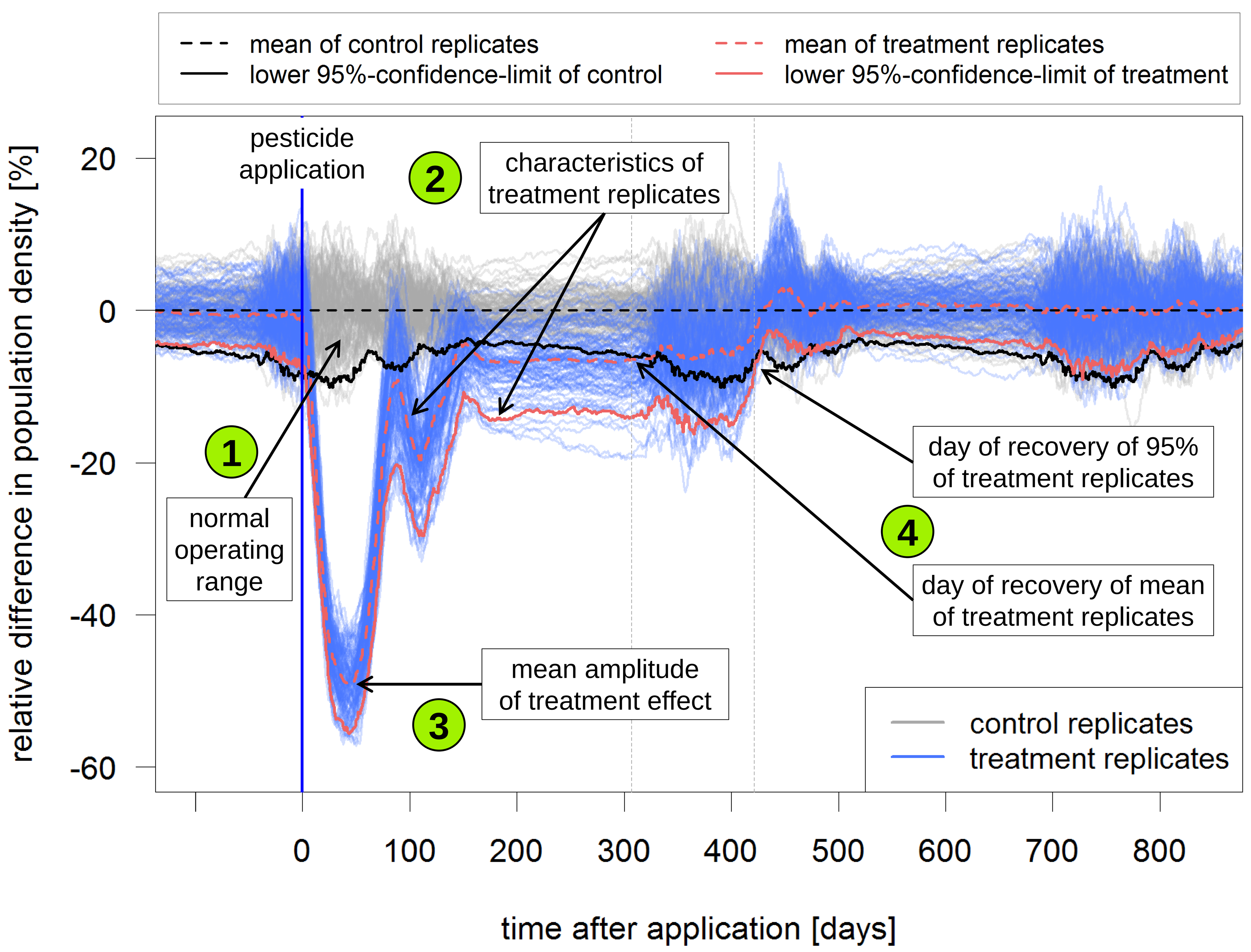
Introduction

In environmental risk assessments (ERA) for plant protection products (PPP) one possible protection goal option at the population level is recovery (EFSA, 2016). This recovery option accepts "*some population-level effects of a potential stressor if recovery takes place within an accepted time period*". However, general guidelines on how to address ecological recovery in ERA, particularly when performing population modelling, are not yet available. **We suggest and exemplify an approach to quantify ecological recovery after PPP application for population modelling studies using stochastic models (such as individual-based models), in the context of ERA**.

Methods

The population's normal operating range (NOR) 1 is compared to characteristics of treatment simulations 2 (that were impacted by a stressor) to detect the amplitude 3 and duration 4 of an effect for a certain endpoint (see box for details). Time till recovery is defined as the number of days until a certain proportion of treatment replicate simulations is back in the NOR for a certain period of time (ensuring sustained recovery).

We exemplify the approach using the individual-based, spatially-explicit simulation model *eVole*. We simulated the population dynamics of common voles (*Microtus arvalis*) impacted by a hypothetical pesticide causing increased individual mortality. The substance was applied once on May 1st. Results are derived from 100 replicate runs for both control and treatment simulations and shown for population density as an endpoint.



Approach in a nutshell

1. **Estimation of normal operating range (NOR) of a system variable**
   → normal variability of a set of replicate control simulations at each day of a year
2. **Estimation of characteristics of treatment simulations**
   → e.g. daily mean and lower 95% confidence limit of replicate treatment simulations
3. **Estimation of amplitude of the effect caused by a stressor**
   → maximum difference between daily mean of control and treatment simulations
4. **Estimation of time till recovery**
   → time until e.g. the mean or 95% of the treatment simulations are back to NOR for a certain period of time (in the illustrated example "above the minimum lower 95% confidence limit for 365 days")

Results

In the illustrated example, the application of the pesticide leads on average to 3 a maximal reduction in the population density in treatment replicates of ca. 50% compared to the control. This is about five times larger than the normal variance in the control simulations (referred to as NOR). 4 Time till recovery is concluded to be 307 days (considering the mean of the treatment simulation replicates as assessment criterion) and 421 days (considering the lower 95% confidence limit, i.e. recovery of 95% of the treatment simulation).

Conclusion and outlook

The presented method …

- quantitatively assesses the effect of a stressor on a population in terms of amplitude of the effect and time to recovery after application (and can thus be used to address the recovery option in ERA)
- ensures that recovery persists over a sufficient period of time (chosen depending on the species)
- can be applied for all population relevant endpoints (population density, age class distribution, sex ratio, etc.)
- **can be a useful tool for environmental risk assessment for plant protection products using mechanistic effect modelling in weight of evidence approaches**

References: EFSA Scientific Committee (2016). Scientific opinion on recovery in environmental risk assessments at EFSA. EFSA Journal 2016; 14(2):431. 835 pp.