The Minimum Detectable Differences
A way to estimate the power of a small mammals field effects study a posteriori

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INTRODUCTION

As an alternative to an a priori Power Analysis, Brock et al. (2015) invented the concept of a posteriori Minimal Detectable Differences (MDD) to evaluate the statistical power of aquatic mesocosm studies in the context of plant protection product EU registration. While Brock et al. (2015) calculated their MDDs for t-tests, Peters et al. (2016, supporting information) modified the concept for statistical methods such as Generalized Linear Mixed Models (GLMMs). With these modifications the MDD concept can be applied to evaluate long term field effect studies, for example on the common vole.

Here we provide MDD results for four different field effect studies on the common vole (Microtus arvalis) and discuss a way of evaluating such results.

FIELD STUDIES

Study design

4 field effects studies on common voles from different years and locations were analysed. 12 to 14 study fields were used in each study, in equal shares treated fields and untreated fields as controls. 7 to 9 trapping sessions were conducted, test item applications started always after the 1st session. 3 trap-nights per session were performed with a regular interval of 3 weeks between sessions. Voles were trapped in multiple-capture life traps and individually marked.

Data analysis

Vole populations were estimated as Minimum Number Alive (MNA). Results were compared by Generalized Linear Mixed Model (GLMM) with a Poisson family and the ‘Field’ as random effect. ‘Treatment’ was analysed in interaction with ‘Time’ to account for pre- and post-treatment changes. Model formulas with different powers for ‘session’ were compared by AIC to account for a nonlinear population development.

RESULTS

The population development (as MNA) for all study fields of each field effects study was analysed for differences between treated and untreated fields (see Fig. 1).

No significant differences were found. The Minimal Detectable Difference was calculated as %MDD. At the 2nd session all MDDs were below 30% and remained below 20% for the rest of the following sessions (Fig. 2).

Fig.1: MNAs for vole populations of four field studies.

Fig.2: MDD% calculated for each trapping session of the four field effect studies.

Is a MDD of 20% acceptable for a field effects study on common voles?

MDD evaluation in aquatcis

The EFSA guidance document for aquatic organisms (EFSA, 2013) provides five (0 to IV) MDD classes to evaluate mesocosm studies.

<table>
<thead>
<tr>
<th>MDD class</th>
<th>%MDD</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&gt;100%</td>
<td>No effects can be determined statistically</td>
</tr>
<tr>
<td>I</td>
<td>90-100%</td>
<td>Only large effects can be determined statistically</td>
</tr>
<tr>
<td>II</td>
<td>70-90%</td>
<td>Large to medium effects can be determined statistically</td>
</tr>
<tr>
<td>III</td>
<td>50-70%</td>
<td>Medium effects can be determined statistically</td>
</tr>
<tr>
<td>IV</td>
<td>&lt;50%</td>
<td>Small effects can be determined statistically</td>
</tr>
</tbody>
</table>

Tab.1: MDD classes as proposed in the EFSA Aquatic Guidance Document (2013).

CONCLUSIONS

- Natural variation in common vole population sizes in the same area and year is quite high (average deviation from the mean 52.76%).
- The smallest deviation found in untreated vole populations was 17.39%. Smaller effects are probably ecologically irrelevant.
- On average the field effects studies on common voles achieved an MDD of 18% meaning that differences of more than 18% between treatment and control in the GLMM predicted results could be identified as significant.

We are aware of the drawback that the untreated vole populations that were used to calculate the natural occurring differences were also used as controls in the field effect studies. However, with additional field data this can be a way to obtain acceptable MDD classes of ecological relevant effects from natural population differences.

Literature


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