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

Ines Hotopp and Olaf Fülling

tier3 solutions GmbH, Leverkusen, Germany, e-mail:ines.hotopp@tier3.de

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.

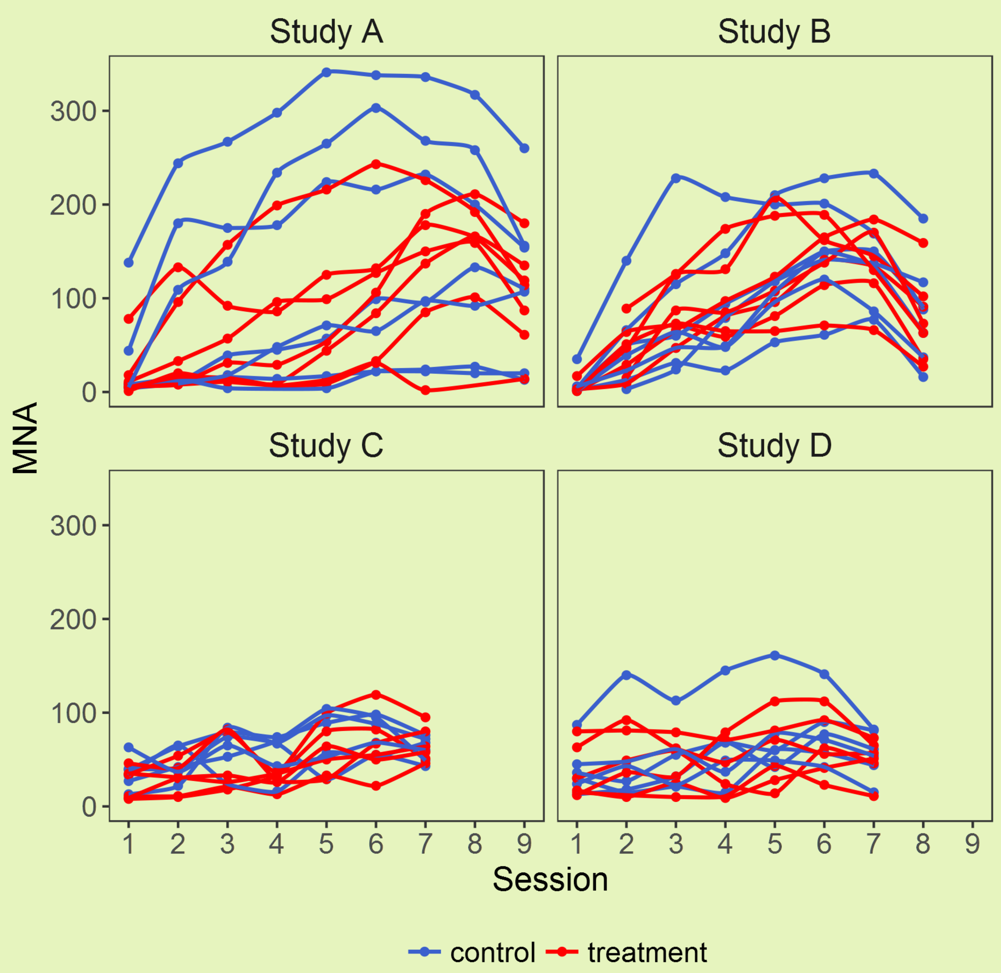

Fig.1: MNAs for vole populations of four field studies.

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).

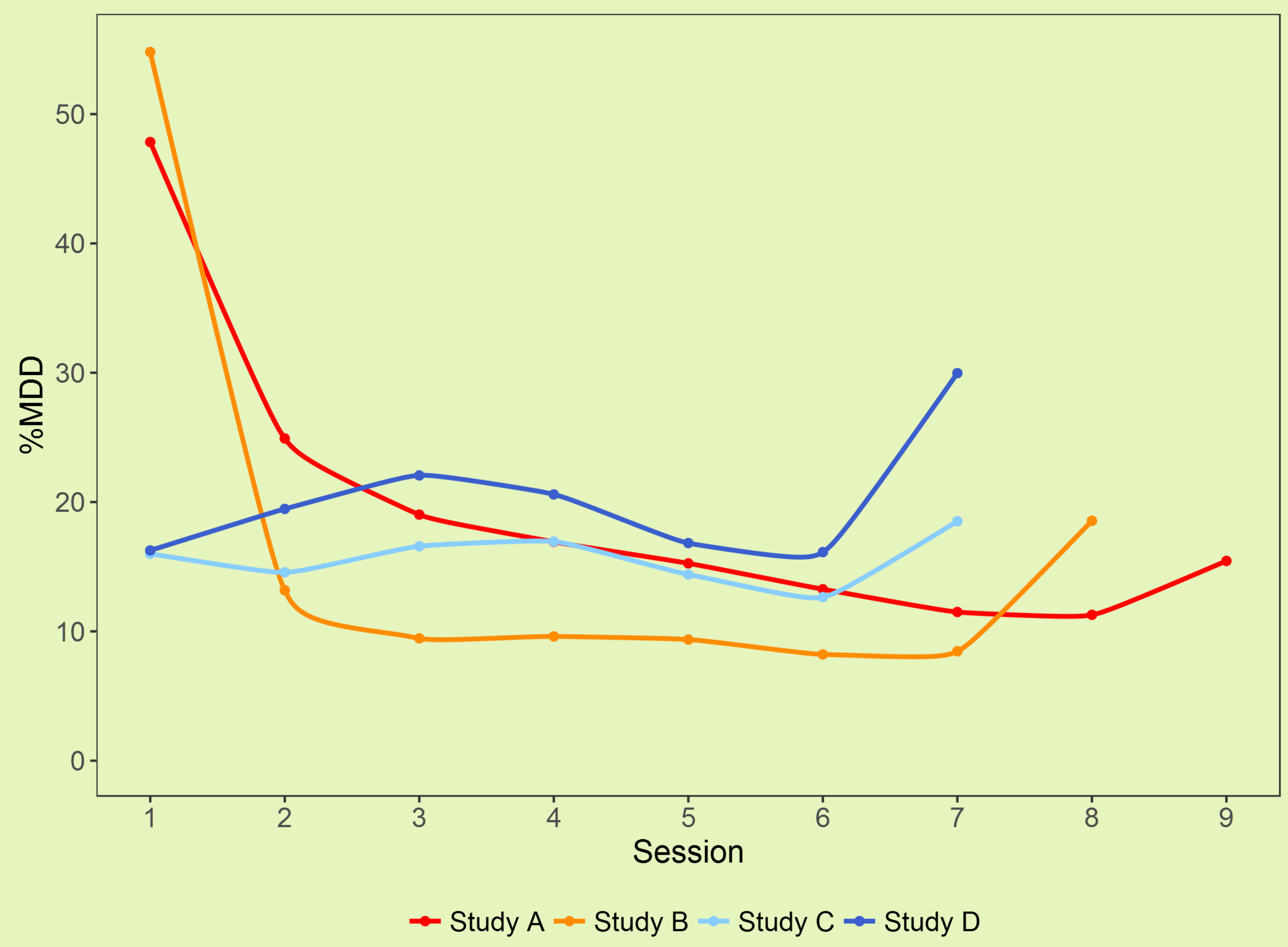

Fig.2: MDD% calculated for each trapping session of the four field effect studies.

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

MDD evaluation in aquatics

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

MDD class	%MDD	Comment
0	>100%	No effects can be determined statistically
I	90-100%	Only large effects can be determined statistically
II	70-90%	Large to medium effects can be determined statistically
III	50-70%	Medium effects can be determined statistically
IV	<50%	Small effects can be determined statistically

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

Differences between natural, untreated common vole populations

We compared the differences between common vole populations from the same area and the same year (accounting for multi-annual fluctuations). Only populations from untreated grasslands were considered. These vole populations showed a minimal difference of 17.39% and a maximal difference of 109.18%. Thus, a field effect study design that finds MDDs of less than 20% between treated and untreated study fields is capable of detecting all relevant PPP effects on common vole populations.

DEVIATION FROM MEAN

Trapping Session	Deviation from mean in controls [%]			
	Study A	Study B	Study C	Study D
1	109.18	101.28	32.09	45.67
2	98.40	67.58	28.54	62.89
3	90.88	63.42	26.03	50.16
4	73.81	52.96	31.76	47.12
5	83.85	33.46	35.02	39.56
6	75.22	24.57	22.98	29.99
7	69.82	26.25	17.39	32.94
8	62.33	46.85		
9	53.31			

Tab.2: Absolute %deviation from the mean MNA of the control fields.

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

[1] Brock et al. (2014). The minimum detectable difference (MDD) and the interpretation of treatment-related effects of pesticides in experimental ecosystems. Environ Sci Pollut Res., 22:1160-1174.

[2] Peters et al. (2016). Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds on pollinating insects in Northern Germany: effects on red mason bees (*Osmia bicornis*). Ecotoxicology, 25:1679-1690.

[3] EFSA PPR Panel (2013). Guidance on tiered risk assessment for plant protection products for aquatic organisms in edge-of-field surface waters. EFSA Journal, 11(7):3290, 268 pp.

For more information about us, scan it!