THE USE OF THE MINIMUM DETECTABLE DIFFERENCE CAN IMPROVE THE ASSESSMENT OF EFFECTS IN COMMUNITY STUDIES

Monika Hammers-Wirtz and Tido Strauss

Research Institute for Ecosystem Analysis and Assessment – gaiac, RWTH Aachen University, Germany
hammers-wirtz@gaiac.rwth-aachen.de

Introduction

Complex community studies such as **aquatic mesocosm** studies are used in higher tier risk assessment of plant protection products. In such studies the species follow the **seasonal dynamic** of natural populations. Thus most of the species show fluctuating abundances over the study period resulting in a varying detection level for pesticide-related effects over time.

In community studies different kinds of effects can be observed:

1. immediate effects, **2.** delayed effects due to biological reasons, **3.** presumed delayed effects due to low abundances and/or high variability between replicates after pesticide application.
Furthermore, in mesocosm studies, the **recovery** of affected species is an important factor for the risk assessment. An increasing NOEC over time indicating a recovery can be caused by a "real recovery" of a population, but also by a statistical difference no longer significant to control populations without a real recovery.

The objective is to analyse mesocosm data of some species with respect to their NOEC and the detection level (MDD´s) in order to improve the risk assessment.

Materials and Methods

Aquatic mesocosm studies

The mesocosm data under analysis here have been taken from several studies conducted at Research Institute gaiac at RWTH Aachen University since 2003. The mesocosms used are situated outdoors and contain a natural plankton and macroinvertebrate community in a water column of 4900 L and 1 m depth and a sediment layer of 0.1 m. Usually the possible effects on the phyto- and zooplankton community, macrophytes and the macroinvertebrates sampled by emergence traps, artificial substrate samplers and sediment samplers are investigated. Additionally other species of concern, e.g. periphyton, Asellus, can be addressed in these studies.

Minimum detectable difference (MDD)

The MDD indicates the lowest significant difference between control and treatment which can be detected by a statistical test. The calculations presented here, are based on the Williams' multiple t-test (one-sided, α=0.05). A low variance between replicates decreases the MDD. The %MDD represents the relative minimum detectable difference between control and treatment.

Results

%MDD > 99% | %MDD < 99% | Significant difference to control

1 Immediate Effects

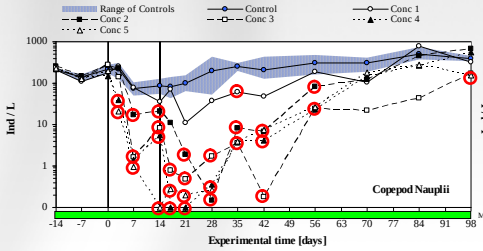

Fig. 1: Mean abundances of the copepod nauplii in pesticide-treated mesocosms (Conc 1 to 5, two applications on Day 0 and 14)

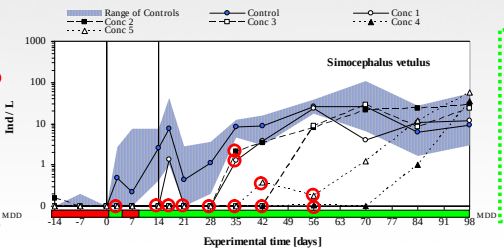

Fig. 2: Mean abundances of the cladoceran *Simocephalus vetulus* in pesticide-treated mesocosms (Conc 1 to 5, two applications on Day 0 and 14)

1 Copepod nauplii
Treatment-related decrease of abundance immediately after first application with recovery to the control level

Simocephalus vetulus
Treatment-related delayed population development with recovery to the control level

Tab. 1: NOEC values (anonymous) for the selected species from several mesocosms studies investigating pesticide-related effects

Experimental Day	*Copepod Nauplii*	*Simocephalus vetulus*
-14	Conc 5	Conc 5
-7	Conc 5	Conc 5
0	Conc 5	Conc 5
3	Conc 3	< Conc 1
7	Conc 1	Conc 5
14	Conc 1	< Conc 1
17	Conc 2	Conc 1
21	Conc 1	< Conc 1
28	Conc 1	< Conc 1
35	< Conc 1	< Conc 1
42	Conc 1	Conc 2
56	Conc 1	Conc 3
70	Conc 5	Conc 5
84	Conc 5	Conc 5
98	Conc 4	Conc 5

2 Delayed Effects

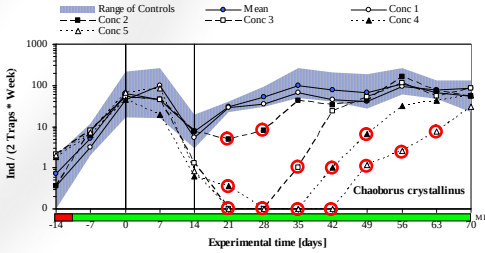

Fig. 3: Mean abundances of the phantom midge *Chaoborus crystallinus* emerged from pesticide-treated mesocosms (Conc 1 to 5 two applications on Day 0 and 14)

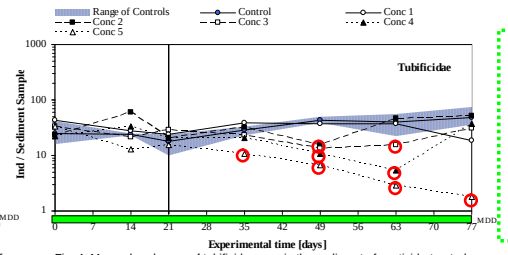

Fig. 4: Mean abundances of tubificid worms in the sediment of pesticide-treated mesocosms (Conc 1 to 5, two applications on Day 0 and 21)

2 *Chaoborus crystallinus*
Delayed treatment-related decrease of emergence rates from Day 14 onwards with recovery to the control level

Tubificidae
Delayed and increasing treatment-related decrease in population density without recovery to the control level

Tab. 2: NOEC values (anonymous) for the selected species from several mesocosms studies investigating pesticide-related effects

Experimental Day	*Chaoborus crystallinus*	*Tubificidae*
-14	Conc 5	
-7	Conc 5	
0	Conc 5	Conc 5
7	Conc 5	
14	Conc 5	Conc 5
21	Conc 1	Conc 5
28	Conc 1	
35	Conc 2	Conc 4
42	Conc 3	
49	Conc 3	Conc 1
56	Conc 4	
63	Conc 4	Conc 2
70	Conc 5	
77		Conc 4

3 Delayed Effects due to seasonal dynamics

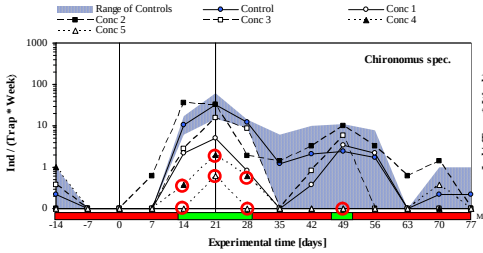

Fig.5: Mean abundances of the midge Chironomus spec. emerged from pesticide-treated mesocosms (Conc 1 to 5, two applications on Day 0 and 21)

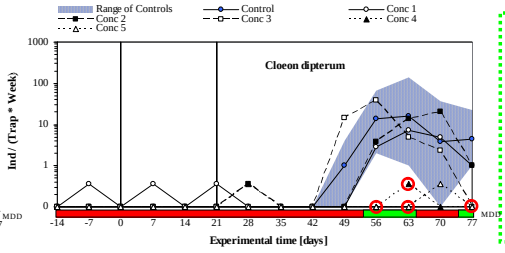

Fig. 6: Mean abundances of the ephemeropteran *Cloeon dipterum* emerged from pesticide-treated mesocosms (Conc 1 to 5, two applications on Day 0 and 21)

3 *Chironomus* spec.
Delayed treatment-related decrease of emergence rates due to seasonal dynamics without recovery although the NOECs indicate recovery

Cloeon dipterum
Extreme delayed treatment-related decrease in emergence rates without recovery to the control level

Tab. 3: NOEC values (anonymous) for the selected species from several mesocosms studies investigating pesticide-related effects

Experimental Day	*Chironomus spec.*	*Cloeon dipterum*
-14	Conc 5	Conc 5
-7	Conc 5	Conc 5
0	Conc 5	Conc 5
7	Conc 5	Conc 5
14	Conc 3	Conc 5
21	Conc 3	Conc 5
28	Conc 3	Conc 5
35	Conc 5	Conc 5
42	Conc 5	Conc 5
49	Conc 3	Conc 5
56	Conc 5	Conc 3
63	Conc 5	Conc 3
70	Conc 5	Conc 5
77	Conc 5	Conc 2

Conclusions

A Due to the seasonal dynamic of many species and their biological variability, in complex community studies it is not possible to detect a treatment-related effect for all taxa on each sampling date.

B The calculation of the MDD can easily be performed by using statistical software. The MDD provides important information about the detection level and can help to distinguish between "No effect" and "No detectable effect".

C The detection level can be easily integrated in the risk assessment of community studies by highlighting NOEC values with an MDD larger than e.g. 99% in order to point out that here the detection of any effect was not possible.