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Environmental risk limits for deltamethrin

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This investigation has been performed by order and for the account of Directorate-General for Environmental Protection, Directorate for Soil, Water and Rural Area (BWL), within the framework of the project "Standard setting for other relevant substances within the WFD".

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Rapport in het kort

Environmental risk limits for deltamethrin

Dit rapport geeft milieurisicogrenzen voor het insecticide deltamethrin in water en sediment. Milieurisicogrenzen zijn de technisch-wetenschappelijke advieswaarden voor de uiteindelijke milieukwaliteitsnormen in Nederland. De milieurisicogrenzen zijn afgeleid volgens de methodiek die is voorgeschreven in de Europese Kaderrichtlijn Water. Hierbij is gebruikgemaakt van de beoordeling in het kader van de Europese toelating van gewasbeschermingsmiddelen (Richtlijn 91/414/EEG), aangevuld met gegevens uit de openbare literatuur.

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1 Introduction

1.1 Background and scope of the report

In this report, environmental risk limits (ERLs) for surface water and sediment are derived for the insecticide deltamethrin. The derivation is performed within the framework of the project 'Standard setting for other relevant substances within the WFD', which is closely related to the project 'International and national environmental quality standards for substances in the Netherlands' (INS). Deltamethrin is part of a series of 25 pesticides that appeared to have a high environmental impact in the evaluation of the policy document on sustainable crop protection ('Tussenevaluatie van de nota Duurzame Gewasbescherming'; MNP, 2006) and/or were selected by the Water Boards ('Unie van Waterschappen'; project 'Schone Bronnen'; http://www.schonebronnen.nl/).

The following ERLs are considered:

- Maximum Permissible Concentration (MPC) – the concentration protecting aquatic ecosystems and humans from effects due to long-term exposure
- Maximum Acceptable Concentration (MAC_{eco}) – the concentration protecting aquatic ecosystems from effects due to short-term exposure or concentration peaks.
- Serious Risk Concentration (SRC_{eco}) – the concentration at which possibly serious ecotoxicological effects are to be expected.

More specific, the following ERLs can be derived depending on the availability of data and characteristics of the compound:

$MPC_{eco,\ water}$	MPC for freshwater based on ecotoxicological data (direct exposure)
$MPC_{sp,\ water}$	MPC for freshwater based on secondary poisoning
$MPC_{hh\ food,\ water}$	MPC for fresh and marine water based on human consumption of fishery products
$MPC_{dw,\ water}$	MPC for surface waters intended for the abstraction of drinking water
$MAC_{eco,\ water}$	MAC for freshwater based on ecotoxicological data (direct exposure)
$SRC_{eco,\ water}$	SRC for freshwater based on ecotoxicological data (direct exposure)
$MPC_{eco,\ marine}$	MPC for marine water based on ecotoxicological data (direct exposure)
$MPC_{sp,\ marine}$	MPC for marine water based on secondary poisoning
$MAC_{eco,\ marine}$	MAC for marine water based on ecotoxicological data (direct exposure)

1.2 Status of the results

The results presented in this report have been discussed by the members of the scientific advisory group for the INS-project (WK-INS). It should be noted that the Environmental Risk Limits (ERLs) in this report are scientifically derived values, based on (eco)toxicological, fate and physico-chemical data. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs). ERLs should thus be considered as proposed values that do not have any official status.

2 Methods

The methodology for the derivation of ERLs is described in detail by Van Vlaardingen and Verbruggen (2007), further referred to as the 'INS-Guidance'. This guidance is in accordance with the guidance of the Fraunhofer Institute (FHI; Lepper, 2005).

The process of ERL-derivation contains the following steps: data collection, data evaluation and selection, and derivation of the ERLs on the basis of the selected data.

2.1 Data collection

In accordance with the WFD, data of existing evaluations were used as a starting point. For pesticides, the evaluation report prepared within the framework of EU Directive 91/414/EC (Draft Assessment Report, DAR) was consulted (EC, 1998; further referred to as DAR). An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current contents (literature from 1997 to 2007). In addition to this, all potentially relevant references in the RIVM e-tox base and EPA's ECOTOX database were checked.

2.2 Data evaluation and selection

For substance identification, physico-chemical properties and environmental behaviour, information from the List of Endpoints of the DAR was used. When needed, additional information was included according to the methods as described in Section 2.1 of the INS-Guidance. Information on human toxicological threshold limits and classification was also primarily taken from the DAR.

Ecotoxicity studies (including bird and mammal studies) were screened for relevant endpoints (i.e. those endpoints that have consequences at the population level of the test species). All ecotoxicity and bioaccumulation tests were then thoroughly evaluated with respect to the validity (scientific reliability) of the study. A detailed description of the evaluation procedure is given in the INS-Guidance (see Section 2.2.2 and 2.3.2). In short, the following reliability indices were assigned:

- Ri 1: Reliable without restriction
  'Studies or data … generated according to generally valid and/or internationally accepted testing guidelines (preferably performed according to GLP) or in which the test parameters documented are based on a specific (national) testing guideline … or in which all parameters described are closely related/comparable to a guideline method.'
- Ri 2: Reliable with restrictions
  'Studies or data … (mostly not performed according to GLP), in which the test parameters documented do not totally comply with the specific testing guideline, but are sufficient to accept the data or in which investigations are described which cannot be subsumed under a testing guideline, but which are nevertheless well documented and scientifically acceptable.'
- Ri 3: Not reliable
  'Studies or data … in which there are interferences between the measuring system and the test substance or in which organisms/test systems were used which are not relevant in relation to the exposure (e.g., unphysiologic pathways of application) or which were carried out or generated according to a method which is not acceptable, the documentation of which is not sufficient for an assessment and which is not convincing for an expert judgment.'

- Ri 4: Not assignable
  'Studies or data … which do not give sufficient experimental details and which are only listed in short abstracts or secondary literature (books, reviews, etc.).'

All available studies were summarised in data-tables, that are included as Annexes to this report. These tables contain information on species characteristics, test conditions and endpoints. Explanatory notes are included with respect to the assignment of the reliability indices.

With respect to the DAR, it was chosen not to re-evaluate the underlying studies. In principle, the endpoints that were accepted in the DAR were also accepted for ERL-derivation with Ri 2, except in cases where the reported information was too poor to decide on the reliability or when there was reasonable doubt on the validity of the tests. This applies especially to DARs prepared in the early 1990s, which do not always meet the current standards of evaluation and reporting.

In some cases, the characteristics of a compound (i.e. fast hydrolysis, strong sorption, low water solubility) put special demands on the way toxicity tests are performed. This implies that in some cases endpoints were not considered reliable, although the test was performed and documented according to accepted guidelines. If specific choices were made for assigning reliability indices, these are outlined in Section 3.3 of this report.

Endpoints with Ri 1 or 2 are accepted as valid, but this does not automatically mean that the endpoint is selected for the derivation of ERLs. The validity scores are assigned on the basis of scientific reliability, but valid endpoints may not be relevant for the purpose of ERL-derivation (e.g. due to inappropriate exposure times or test conditions that are not relevant for the Dutch situation).

After data collection and validation, toxicity data were combined into an aggregated data table with one effect value per species according to Section 2.2.6 of the INS-Guidance. When for a species several effect data were available, the geometric mean of multiple values for the same endpoint was calculated where possible. Subsequently, when several endpoints were available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.3 Derivation of ERLs

For a detailed description of the procedure for derivation of the ERLs, reference is made to the INS-Guidance. With respect to the selection of the final MPC_{water} an additional comment should be made:

2.3.1 Drinking water

The INS-Guidance includes the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw,\ water}$) as one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see INS-Guidance, Section 3.1.6 and 3.1.7). According to the proposal for the daughter directive Priority Substances, however, the derivation of the AA-EQS (= MPC) should be based on direct exposure, secondary poisoning, and human exposure due to the consumption of fish. Drinking water was not included in the proposal and is thus not guiding for the general MPC value. The exact way of implementation of the $MPC_{dw,\ water}$ in the Netherlands is at present under discussion within the framework of the "AMvB Kwaliteitseisen en Monitoring Water". No policy decision has been taken yet, and the $MPC_{dw,\ water}$ is therefore presented as a separate value in this report. The MPC_{water}, is thus derived considering the individual MPCs based on direct exposure ($MPC_{eco,\ water}$), secondary poisoning ($MPC_{sp,\ water}$) or human consumption of fishery products ($MPC_{hh\ food,\ water}$); derivation of the latter two depends on the characteristics of the compound.

Related to this, is the inclusion of water treatment for the derivation of the $MPC_{dw, water}$. According to the INS-Guidance (see Section 3.1.7), a substance specific removal efficiency related to simple water treatment should be derived in case the $MPC_{dw, water}$ is lower than the other MPCs. For pesticides, there is no agreement as yet on how the removal fraction should be calculated, and water treatment is therefore not taken into account. In case no A1 value is set in Directive 75/440/EEC, the $MPC_{dw, water}$ is set to the general Drinking Water Standard of 0.1 μg/L for organic pesticides as specified in Directive 98/83/EC.

3 Derivation of environmental risk limits for deltamethrin

3.1 Substance identification, physico-chemical properties, fate and human toxicology

3.1.1 Identity

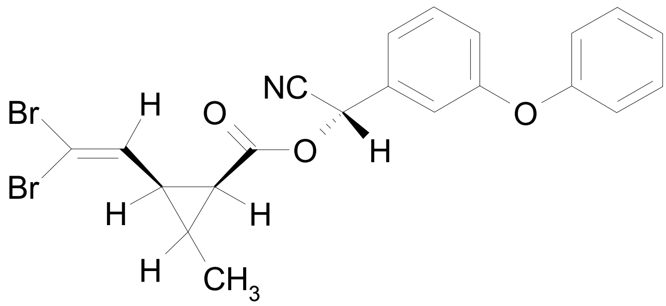

Figure 1. Structural formula of deltamethrin.

Table 1. Identification of deltamethrin.

Parameter	Name or number	Source
Common name	Deltamethrin; Decamethrin	
Chemical name	IUPAC: (*S*)-α-cyano-3-phenoxybenzyl (1*R*,3*R*)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylate Chemical abstracts: 1*R*-[1α(S^*),3α]]-3-(2,2-dibromoethenyl)-2,2-dimethyl-cyclopropanecarboxylic acid, cyano(3-phenoxyphenyl) methyl ester	EC, 1998
CAS number	52918-63-5	EC, 1998
EC number	2582566	EC, 1998
SMILES code	CC1(C)C(C=C(Br)Br)C1C(=O)OC(C#N)c3cccc(Oc2ccccc2)c3	EPI-suite
Use class	Insecticide	EC, 1998
Mode of action	Non-systemic insecticide with contact and stomach action. Fast-acting.	Tomlin, 2002
Authorised in NL	Yes	
Annex 1 listing	No	SANCO

3.1.2 Physico-chemical properties

Table 2. Physico-chemical properties of deltamethrin.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	505.2		EC, 1998
Water solubility	[mg/L]	0.2×10^{-3}	25ºC; pH 7.49-7.85; not pH dependent	EC, 1998
		$< 0.2 \times 10^{-3}$	25°C	Mackay: Tomlin 1994
		$< 2 \times 10^{-3}$	20°C	Mackay: Hartley & Kidd 1987
		$< 5 \times 10^{-3}$	20ºC; pH 6.2, column elution	EC, 1998
pK_a	[-]	-	does not dissociate	EC, 1998
log K_{OW}	[-]	4.6		EC, 1998
		4.60		Mackay: Tomlin 1994
		5.20	HPLC-RT correlation	Mackay: Muir et al., 1985b
		5.74	HPLC-RT correlation	Mackay: Donovan & Pescatore 2002
		6.20	Mlog P	BioLoom
		6.20	shake flask	Mackay: Hansch & Leo 1987
		6.20	recommended	Mackay: Sangster, 1993
		6.20	recommended	Mackay: Hansch et al., 1995
		6.21	HPLC-RT correlation	Mackay: Hu & Leng, 1992
log K_{OC}	[-]	7.01	mean; range 5.66 – 7.11	Smith 1990 (DAR)
Vapour pressure	[Pa]	1.24×10^{-8}	25 °C	EC, 1998
		2.0×10^{-6}	25°C	Mackay: Hartley & Kidd 1987
Melting point	[°C]	100-102	technical grade	EC, 1998
		98–101		Mackay: Hartley & Kidd 1987
		98–102		Mackay: Tomlin 1994
Boiling point	[°C]	-	decomposes	EC, 1998
Henry's law constant	[Pa.m^3/mol]	3.1×10^{-2}	25 °C	EC, 1998
		12.6	gas stripping-LSC	Mackay: Muir et al. 1985a

n.a. = not applicable.

For the log K_{ow}, the value of 6.20 is proposed based on Mackay and BioLoom. For water solubility it is suggested to take the lowest because this is the only real (measured) value and the pH range in which it was determined covers the pH of most toxicity experiments evaluated for this study.

3.1.3 Behaviour in the environment

Table 3. Selected environmental properties of deltamethrin.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	Stable	pH 5 and 7 and 25°C	EC, 1998
		31	pH 8 and 23°C	
		2.5	pH 9 and 25°C	
Photolysis half-life	DT50 [d]	>48	direct	EC, 1998
		4	indirect	
Readily biodegradable		No		EC, 1998
Soil half-life	DT50 [d]	22 - 35 d	25°C, aerobic	EC, 1998
		3 weeks	field	
Water/sediment half-life	DT50 [d]	65	whole system	EC, 1998
Relevant metabolites	3-phenoxy-benzoic acid		photolytic degradation	EC, 1998
	decamethrinic acid		aerobic degradation	EC, 1998

3.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for deltamethrin is given in Table 4. Detailed bioaccumulation data for deltamethrin are tabulated in Appendix 1.

Table 4. Overview of bioaccumulation data for deltamethrin.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	1400		EC, 1998
BMF	[kg/kg]	1	Default value for BCF < 2000 L/kg	

3.1.5 Human toxicological threshold limits and carcinogenicity

Deltamethrin has the following human toxicological R phrases: R23/25. The ADI is 0.01 mg/kg$_{bw}$/day, based on a NOEL of 1 mg/kg$_{bw}$/day with safety factor of 100.

3.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 5. deltamethrin: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	6.01	[-]	$K_{OC} \times f_{OC,susp}$[1]	K_{OC}: 3.1.2
BCF	1400	[L/kg]		3.1.4
BMF	1	[kg/kg]		3.1.4
Log K_{OW}	6.2	[-]		3.1.2
R-phrases	R23/25; R50/53	[-]		3.1.5
A1 value	1.0	[µg/L]	Total pesticides	

[1] $f_{OC,susp}$ = 0.1 kg$_{OC}$/kg$_{solid}$ (EC, 2003).

- deltamethrin has a log $K_{p, susp-water} \geq 3$; derivation of MPC$_{sediment}$ is triggered.
- deltamethrin has a log $K_{p, susp-water} \geq 3$; expression of the MPC$_{water}$ as MPC$_{susp, water}$ is required.
- deltamethrin has a BCF > 100 L/kg; assessment of secondary poisoning is triggered.
- deltamethrin has an R25 classification. Therefore, an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{hh\ food,\ water}$) should be derived.
- For deltamethrin, no specific A1 value or Drinking Water Standard is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general Drinking Water Standard of 0.1 µg/L for organic pesticides applies.

3.3 Toxicity data and derivation of ERLs for water

3.3.1 MPC$_{eco,\ water}$ and MPC$_{eco,\ marine}$

An overview of the selected toxicity data for deltamethrin is given in Table 6 for freshwater. Marine toxicity data are given in Table 7. Detailed toxicity data for deltamethrin are tabulated in Appendix 2.

Because of the very low solubility of deltamethrin in water the following criteria for validity were applied to the experiments:

- If concentrations were not measured: Ri 3;
- If concentrations were measured (> 80%) and results were based on nominal concentrations: Ri 2;
- If the test results were above the solubility of 0.2 µg/L: Ri 3;
- If the concentration of the active ingredient in a used formulation was below 10% and results were based on measured concentrations: Ri 2;

Table 6. deltamethrin: selected freshwater toxicity data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Crustacea	0.0041	Crustacea	0.05
Pisces	0.17	Crustacea	**0.00031**

[a] For detailed information see Appendix 2. Bold values are used for ERL derivation.

Table 7. deltamethrin: selected marine toxicity data for ERL derivation.

Chronic [a]		Acute [a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Crustacea	0.0047	Crustacea	0.015

[a] For detailed information see Appendix 2.

3.3.1.1 Treatment of fresh- and saltwater toxicity data

ERLs for freshwater and marine waters should be derived separately. For pesticides, data can only be combined if it is possible to determine with high probability that marine organisms are not more sensitive than freshwater organisms (Lepper, 2005). For deltamethrin, it is not possible to make a valid comparison, and datasets are kept separated.

3.3.1.2 Mesocosm and field studies

Several mesocosm and field experiments were performed, summaries of which are included in Appendix 3. Most of the mesocosm studies were performed at concentrations at which substantial mortality occurred, leading to LC_{50}-values that were lower than the tested concentration. These studies are therefore not useful for deriving ERLs. In the Addendum to the DAR (EC, 2002), mesocosm studies are reported in which the exposure levels were much lower.

During the peer review of the DAR it was concluded that the data from one study on invertebrates in the water column and macro-invertebrates were inconclusive and data on sediment living organisms were contradictory to other available data on toxicity to chironomids.
Data from the other mesocosm study, described in Schanné (2001ab) and Schanneé and Van der Kolk (2001) were more conclusive. In this study, which is summarised as Study 7 in Appendix 3, the nominal target concentrations per application ranged from 1.0 - 180 ng a.s./L water. The application was done 3 times with 7 days interval. At the lowest nominal test concentration of 1 ng/L short-term effects on Phantom midge larvae with full recovery were observed. Very late (and thus not necessarily test item related) effects on *Asellus aquaticus* were observed. No recovery was observed but the remaining abundance indicated the potential for recovery. At 3.2 ng/L similar effects on Phantom midge larvae and isopods were observed. At 18 ng/L a total of 10 groups were affected. For 7 of these, reversible effects were noted within 21 to 71 days after the 1st treatment. For isopods and Calanoida (FW), there was no observation of recovery at this level. Based on these findings an Ecologically Acceptable Concentration EAC was derived of the nominal concentration of 10 ng/L.

Because deltamethrin concentrations show a relatively fast decline with time (DT_{50} in the waterphase ≤ 17 hours), the study does not allow for the assessment of effects due to chronic exposure, it will, however, be considered for the derivation of the MAC.

3.3.1.3 Derivation of $MPC_{eco, water}$ and $MPC_{eco, marine}$

For deltamethrin a complete dataset is unavailable, but based on the specific mode of action and after accepting that algae and fish have a higher LC_{50} than crustacean, an $MPC_{eco, water}$ can be calculated based on the lowest crustacea data. Because the LC_{50} for *Gammarus fasciatus* (0.00031 µg/L) is lower than the lowest NOEC (0.0041 µg/L for *Daphnia magna*), an assessment factor of 100 is put on the LC_{50} value of 0.00031 µg/L for *G. fasciatus*. The $MPC_{eco, water}$ is 3.1 x 10^{-6} µg/L (3.1 pg/L)

An $MPC_{eco, marine}$ cannot be derived due to the insufficient amount of data available.

3.3.2 $MPC_{sp, water}$ and $MPC_{sp, marine}$

Deltamethrin has a BCF ≥ 100 L/kg, thus assessment of secondary poisoning is triggered. Toxicity data for birds and mammals are given in Table 8. The lowest MPC_{oral} is 0.22 mg/kg_{diet} for the rat. For this species, however, a long-term study is available which prevails over the 90-days test. Therefore, the $MPC_{oral, min}$ is set to 2.67 mg/kg_{diet} for the rat.

Table 8 deltametrin: selected bird and mammal data for ERL derivation.

Species	Exposure time	Criterion	Effect concentration (mg/kg diet)	Assessment factor	MPCoral (mg/kg diet)
Duck	8 d	LC50	8039	3000	2.68
Rat	90 days	NOAEL	20	90	0.22
Rat	2-generation	NOEL	80	30	**2.67**
Dog	91 d	NOEL	250	90	2.78
Dog	1 year	NOAEL	100	30	3.33

The $MPC_{sp\ water}$ is calculated using a BCF of 1400 L/kg and a BMF of 1 and becomes 2.67 / (1400*1) = 1.9 x 10^{-3} mg/L = 1.9 µg/L.

The $MPC_{sp, marine}$ is calculated with an extra BMF_2 = 10 and becomes 2.67 / (1400*1*10) = 0.19 x 10^{-3} mg/L = 0.19 µg/L.

3.3.3 $MPC_{hh\ food, water}$

Derivation of $MPC_{hh\ food, water}$ for deltamethrin is triggered (Table 5). $MPC_{hh, food}$ is calculated from the ADI (0.01 mg/kg bw), a body weight of 70 kg and a daily fish consumption of 115 g, as $MPC_{hh\ food}$ = 0.01 x 0.1 x 70/0.115 = 0.609 mg/kg (Van Vlaardingen en Verbruggen, 2007). Subsequently the $MPC_{hh\ food, water}$ is calculated according to $MPC_{hh\ food, water}$ = 0.609/(BCF_{fish} x BMF_1) = 0.609/1400 x 1 = 4.4 x 10^{-4} mg/L = 0.44 µg/L.

3.3.4 $MPC_{dw,water}$

The Drinking Water Standard is 0.1 µg/L. Thus, the $MPC_{dw, water}$ is also 0.1 µg/L.

3.3.5 Selection of the MPC_{water} and MPC_{marine}

The lowest value of the routes included (see Section 2.3.1) is the ecotoxicological $MPC_{eco, water}$. Therefore, the MPC_{water} is 3.1 x 10^{-6} µg/L (3.1 pg/L).

Because the $K_{p, susp-water} \geq 3$, the MPC_{water} should be recalculated to $MPC_{susp, water}$, which refers to the concentration in suspended matter. The $MPC_{susp, water}$ is calculated according to:

$$MPC_{susp,water} = MPC_{water,total} / (C_{susp, Dutch standard} \times 10^{-6} + (1/ K_{p,susp-water,Dutch standard}))$$

For this calculation, $K_{p,susp-water,Dutch standard}$ is calculated using K_{OC} and the $f_{OC,susp,Dutch standard}$. This is not the same as the European standard $f_{OC,susp}$ which is used in the table with trigger values. With an $f_{OC,susp,Dutch standard}$ of 0.1176 and a log K_{OC} of 7.01, the $K_{p,susp-water,Dutch standard}$ can be calculated to be 1.20×10^6 L/kg.

The $MPC_{susp, water}$ is 0.101 µg/kg_{dw}.

No MPC_{marine} can be selected due to the insufficient amount of data.

3.3.6 MAC_{eco}

3.3.6.1 $MAC_{eco, water}$

The $MAC_{eco, water}$ could be derived from the labotatory acute toxicity data. Taking into consideration the less reliable data for fish and algae $L(E)C_{50}$ values for three trophic levels (fish, *Daphnia* and algae) are available, deltamethrin has a potential to bioaccumulate (BCF ≥ 100 L/kg), the mode of action for the tested species is specific and the interspecies variation is high. Therefore, an assessment factor of 10 has to be applied to the lowest $L(E)C_{50}$, i.e. the LC_{50} for *Gammarus fasciatus*: 0.31 ng/L, resulting in a MAC_{eco} of 0.031 ng/L (31 pg/L).

It should however be noted that the LC_{50} for *G. fasciatus* of 0.31 ng/L was dertermined under flow-through conditions. When tested after one-pulse application to a water/sediment system, the LC_{50} was > 43 ng a.s./L. As stated in the INS-guidance, the MAC is intended to protect the aquatic ecosystem against acute toxic effect exerted by exposure to short-term peak concentrations. Therefore, the one-pulse application may be considered more relevant for deriving the $MAC_{eco, water}$ than the tests performed under flow-through conditions. In that respect, the available mesocosm also becomes more relevant. As shown in Appendix 4 some short-term effects were observed on Phantom midge larvae at the lowest test concentration of 1 ng/L, but these occured not earlier than around the third application. Very late, and thus not necessarily test item related, effects were observed on *Asellus aquaticus*. The other species tested were not affected. At the next test concentration of 3.2 ng/L, the same species were affected but for Phantom midge larvae this occurred already after the first application. A concentration of 1 ng/L can therefore be considered as a NOEC for short-term exposure. From a comparison of mesocosm studies with the insecticides chlorpyrifos and lambda-cyhalothrin, it can be concluded that an assessment factor of 3 may be necessary to cover variation at the level of the NOEAEC[1] in case one reliable study is available (De Jong et al., 2008, based on Brock et al., 2006).
Lepper (2005) argues that the scope of protection of an environmental quality standard under the WFD is broader than that of the "acceptable concentration" under Directive 91/414. It should be considered that the quality standard must be protective for all types of surface waters and communities that are addressed by the respective standard. Mesocosm studies performed in the context of 91/414 are normally focused on agricultural ditches that can be characterised as eutrophic shallow water bodies. Environmental quality standards under the WFD, however, must assure protection also for water bodies that significantly differ from this paradigm (Lepper, 2005). It is therefore in principle proposed to use

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[1] NOEAEC = No Observed Ecologically Adverse Effect Concentration. Concentration at which effects observed in a study are considered acceptable from a regulatory point of view.

an assessment factor of 3 on the NOEC instead of on the NOEAEC, resulting in a $MAC_{mesocosm}$ of 0.3 ng/L.

Although most acute toxicity data are considered less reliable for the purpose of setting an $MAC_{eco,\ water}$, for reason of comparison it might still be usefull the note that in the DAR acute toxicity data were selected for 28 arthropod species from the deltamethrin dossier and from the open literature (databases searched ECOTOX, ECDIN, HSDB, and review by Sowig, 2001) for calculating an HC_5 based on acute effects. Only 24- to 96-hour mortality or immobilisation data were used. If more than one result was available for a species, only those from flow-through or static-renewal tests were used. Results from measured concentrations were preferred over nominal. For each species, the geometric mean was calculated from the results selected as above. The resulting dataset is given Table 9.

Table 9. Acute toxicity data used to construct Species Sensitivity Distribution (SSD) for deltamethrin. Based on 24 - 96 hour EC/LC_{50} values(source: EC 2002).

Species	Common name	Species mean LC_{50} (ng/L)
Gammarus fasciatus	amphipod	0.31
Asellus aquaticus	isopod	5.1
Culex pipiens quinquefasciata	mosquito	20.0
Culex quinquefasciatus	mosquito	21.9
Daphnia hyaline	water flea	30.0
Gammarus pulex	Amphipod	30.0
Eudiaptomus gracilis	Copepod	50.0
Procladius	midge	67.0
Crocothemis erythraea	odonate	82.5
Daphnia magna	water flea	110
Tanypus nubifer	midge	110
Cricotopus	midge	129
Gammarus roeseli	amphipod	130
Aedes aegypti	mosquito	150
Pseudagrion spec.	odonate	188
Chironimus utahensis	midge	290
Baetis parvulus	may-fly	400
Hydropsyche californica	caddis-fly	400
Chironomus decorus	midge	545
Chironomus salinarius	midge	710
Daphnia similis	water flea	870
Brachythemis contaminata	odonate	890
Dicrotendipes californicus	midge	1715
Anisops bouvieri	hemipteran, water-bug	2250
Ranatra elongata	hemipteran, water scorpion	2300
Ranatra filiformis	hemipteran, water scorpion	2300
Diplonychus indicus	hemipteran, water-bug	26500
Chironomus spec.	midge	39000

To perform a Species Sensitivity Distribution (SSD) at least 10 values (preferable 15) are necessary for different species covering at least eight taxonomic groups. The taxonomic groups to be coverd are as follows:

- Fish: -
- A second family in the phylum Chordata: -
- Crustacea: represented by *Gammarus* species and *Daphnia* species

- Insects: represented by *Chironomus* species
- A family in another phylum than Arthropoda or Chordata: -
- A family in any order of insect or any phylum no already represented: *Baetis parvus*
- Algae: represented by: -
- Macrophyta: -

The presented data cover only 3 taxa, but contains a broad range on sensitivity. A lognormal model was fitted to the data, and the HC_5 (5^{th} percentile of the SSD of EC/LC_{50} values) was calculated to 2.5 ng/L. Excluding the lowest value for *G. fasciatus* and the two highest E/LC_{50} values (which are far above the water solubility), the HC_5 is 5.7 ng/L. Applying the default assessment factor of 10 to the HC_5 results in a MAC_{HC5} of 0.57 ng/L.

In view of the uncertainty related to the SSD with respect to data quality and taxa included, it is not considered justified to replace the $MAC_{mesocosm}$ of 0.3 ng/L by the MAC_{HC5}. Therefore the $MAC_{eco,\ water}$ is 0.3 ng/L.

3.3.6.2 $MAC_{eco,\ marine}$

Not sufficient data is available for marine organisms therefore no $MAC_{eco,\ marine}$ can be derived.

3.3.7 $SRC_{eco,\ water}$

Two NOECs are available, representing *Daphnia* and fish. The geometric mean of the available NOECs is 26.4 ng/L. The geometric mean of the accepted LC_{50}s is 3.9 ng/L. The geometric mean of the LC_{50}s divided by 10 is 0.39 ng/L. This is lower than the geometric mean of the NOECs, and therefore the value of 0.39 ng/L is used for the $SRC_{eco,\ water}$.

3.4 Toxicity data and derivation of ERLs for sediment

3.4.1 Sediment toxicity data

An overview of the selected freshwater sediment toxicity data for deltamethrin is given in Table 10. Detailed toxicity data for deltamethrin are tabulated in Appendix 4.

Table 10. deltamethrin: selected freshwater sediment data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/$kg_{dwt,\ standard\ sediment}$)**	**Taxonomic group**	**L(E)C50**
Insecta	**54.2**		

[a] For detailed information see appendix 5. Bold values are used for risk assessment.

3.4.2 Derivation of $MPC_{sediment}$

3.4.2.1 Freshwater sediment

Only one chronic test for sediment organisms is available (*Chironomus riparius*, 54.2 µg/kg_{dw} for standard sediment). Therefore an assessment factor of 100 is be used, resulting in an $MPC_{Dutch\ standard\ sediment,\ dw}$ of 54.2/100 = 0.54 µg/kg_{dw}.

3.4.2.2 Marine sediment

Not enough data is available to derive an $MPC_{sediment}$ for the marine environment.

3.4.3 Derivation of $SRC_{eco, sediment}$

Based on the single NOEC available the $SRC_{eco, sediment}$ is 54.2 µg/$kg_{dwt\ standard\ sediment}$.
For comparison the $SRC_{eco, sediment}$ has been calculated applying the equilibrium partition method (EqP), using the lowest LC_{50} value of 0.31 ng/L and mean log K_{oc} of 7. The calculated value is 0.19 mg/$kg_{dw,\ standard\ sediment}$, which is higher than $SRC_{eco, sediment}$ based on the single NOEC value. Therefore, the $SRC_{eco, sediment}$ is set to 54 µg/$kg_{dwt\ standard\ sediment}$.

4 Conclusions

In this report, the risk limits Maximum Permissible Concentration (MPC), Maximum Acceptable Concentration for ecosystems (MAC_{eco}), and Serious Risk Concentration for ecosystems (SRC_{eco}) are derived for deltamethrin in water and sediment. No risk limits were derived for the marine compartment because not enough data were available.

The ERLs that were obtained are summarised in the table below. The MPC value that was set for this compound until now, is also presented in this table for comparison reasons.

Table 11. Derived MPC, MAC_{eco}, and SRC values for deltamethrin.

ERL	Unit	MPC	MAC_{eco}	SRC
Water, old[a]	µg/L	0.4×10^{-3}		
Water, new[b]	µg/L	3.1×10^{-6}	0.3×10^{-3}	3.9×10^{-4}
Water, suspended mater	$µg/kg_{dw}$	0.101		
Drinking water[b]	µg/L	0.1[c]	-	-
Marine	µg/L	n.d.[d]	n.d.[d]	-
Sediment	$µg/kg_{dw}$	0.54	-	54

[a] MPC based on total content, source: Risico's van Stoffen http://www.rivm.nl/rvs/

[b] The $MPC_{dw, water}$ is reported as a separate value from the other MPC_{water} values ($MPC_{eco, water}$, $MPC_{sp, water}$ or $MPC_{hh food, water}$). From these other MPC_{water} values (thus excluding the $MPC_{dw, water}$) the lowest one is selected as the 'overall' MPC_{water}.

[c] provisional value pending the decision on implementation of the $MPC_{dw, water}$ (see Section 2.3.1)

[d] n.d. = not derived due to lack of data

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Appendix 1. Information on bioconcentration

Species	Species Properties	Substance purity(%)	Analysed	Test type	Test water	pH	Hardness/ Salinity [g/L]	Temperature [°C]	Exposure time	Exp. concn. [mg/L]	BCF [L/kg$_{ww}$]	BCF type	Method	Ri	Notes	Reference
Insecta																
Chironomidae									24h		213-3035			3	1	Addendum 2002
Chironomidae									24h		145-303			3	2	Addendum 2002
Pisces																
fish											1400			2		Addendum 2002

NOTES
1 sediment exposed
2 overlying water exposed

Appendix 2. Detailed aquatic toxicity data

Table A2.1. Acute toxicity of deltamethrin to freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Protozoa																
Paramecium aurelia		N	Sc	Decis		am		rt		1.5 h	NOEC	mortality	1000	3	6,34,48,49,50	Joshi and Misra, 1986
Paramecium aurelia		N	Sc	Decis		am		20±2		15 min	NOEC	mortality	≥5000	3	6,34,48,49,51	Joshi and Misra, 1986
Paramecium aurelia		N	Sc	Decis		am		20±2		30 min	NOEC	mortality	1000	3	6,34,48,49,51	Joshi and Misra, 1986
Paramecium aurelia		N	Sc	Decis		am		20±2		45 min	NOEC	mortality	1000	3	6,34,48,49,51	Joshi and Misra, 1986
Paramecium aurelia		N	Sc	Decis		am		20±2		60 min	NOEC	mortality	1000	3	6,34,48,49,51	Joshi and Misra, 1986
Paramecium aurelia		N	Sc	Decis		am		20±2		1,5 h	NOEC	mortality	1000	3	6,34,48,49,51	Joshi and Misra, 1986
Spirostomu ambiguum		N	Sc			rw	7.4±0.2	25	4.44	24h	EC50	deformation	78000	3	6,9,32,34	Nałęcz-Jawecki et al., 2002
Algae																
Chlorella vulgaris								23-25			NOEC	cell density	620	3	6,62	HSE 2004
Scenedesmus subspicatus		N	S		ag	am	8.3±0.2	22±2		72 h	EC50	growth rate	9850	3	6,58	Burkiewicz *et al.*, 2005
Scenedesmus subspicatus		N	S		ag	am	8.3±0.2	22±2		72 h	EC50	growth curve area	2560	3	6,58	Burkiewicz *et al.*, 2005
Selenastrum capricornutum					tg			23-24			NOEC	growth rate	9100	3	2,6,62	HSE 2004
Mollusca																
Anodonta anatina	larvae (glochidia)	N	S	K-Othrin ULV	0.12	nw	8.4	22	259.5	96h	LC50	mortality	264	3	6,7,22	Varanka, 1986
Anodonta anatina	larvae (glochidia)	N	S	K-Othrin ULV	0.12	nw	8.4	22	259.5	48h	LC50	mortality	2760	3	6,7,22	Varanka, 1986
Anodonta anatina	larvae (glochidia)		S				8.4	22		96h	LC50		23.4	4*	6,58,59	Pawlisz et al.1998
Anodonta anatina	75mm; 18g	N	S	K-Othrin ULV	0.12			22 ± 1		96 h	LC50	mortality	23400	3	6,7,22	Varanka, 1987
Anodonta cygnea	larvae (glochidia)		S				8.4	22		96h	LC50		12.0	4*	6,58,59	Pawlisz et al.1998
Anodonta cygnea	92mm; 22.8g	N	S	K-Othrin ULV	0.12		8.4	22 ± 1		96 h	LC50	mortality	12000	3	6,7,22	Varanka, 1987
Anodonta cygnea	larvae (glochidia)	N	S	K-Othrin ULV	0.12	nw	8.4	22	259.5	96h	LC50	mortality	492	3	6,7,22	Varanka, 1986
Anodonta cygnea	larvae (glochidia)	N	S	K-Othrin ULV	0.12	nw	8.4	22	259.5	48h	LC50	mortality	11040	3	6,7,22	Varanka, 1986
Anodonta cygnea	adults, 12-15 cm	N	S	Decis 2.5 EC	2.5	nw		18-22		30 min	NOEC	filtering activity	5	3	6,7,34	Kontreczky *et al.*, 1997
Lymnaea acuminata	2.6±0.3cm	N	S		tg	dtw		26-29		96h	EC10	mortality	300	3	6,18	Sahay, Agarwal, 1997
Lymnaea acuminata	2.6±0.3cm	N	S		tg	dtw		26-29		96h	EC50	mortality	440	3	6,18	Sahay, Agarwal, 1997
Lymnaea acuminata	2.6±0.3cm	N	S		tg	dtw		26-29		96h	LC90	mortality	650	3	6,18	Sahay, Agarwal, 1997
Lymnaea acuminata	2.6±0.3cm	N	S		tg	dtw		26-29		48h	EC10	mortality	350	3	6,18	Sahay, Agarwal, 1997
Lymnaea acuminata	2.6±0.3cm	N	S		tg	dtw		26-29		48h	EC50	mortality	500	3	6,18	Sahay, Agarwal, 1997
Lymnaea acuminata	2.6±0.3cm	N	S		tg	dtw		26-29		48h	LC90	mortality	720	3	6,18	Sahay, Agarwal, 1997
Lymnaea acuminata	adult, 2.6±0.3cm	N	S			dtw		26-29		24 h	LC50	mortality	0.56	3	6	Sahay et al., 1991
Lymnaea acuminata	adult, 2.6±0.3cm	N	S			dtw		26-29		48 h	LC50	mortality	0.5	3	6	Sahay et al., 1991
Lymnaea acuminata	adult, 2.6±0.3cm	N	S			dtw		26-29		72 h	LC50	mortality	0.47	3	6	Sahay et al., 1991
Lymnaea acuminata	adult, 2.6±0.3cm	N	S			dtw		26-29		96 h	LC50	mortality	0.45	3	6	Sahay et al., 1991
Lymnaea acuminata	adult, 2.0 ± 0.3 cm					dtw		23-25		24 h	LOEC	phospholipid levels	0.2	4		Singh and Agarwal, 1996
Lymnaea acuminata										48 h	LC50		0.5	3	6,58	Singh and Agarwal, 1996
Unio pictorum	larvae		S				8.4	22		48 h	LC50		31.8	4*	6,58	Pawlisz et al.1998
Unio pictorum	larvae		S				8.4	22		72 h	LC50		9.7	4*	6,58	Pawlisz et al.1998
Unio pictorum	larvae		S				8.4	22		96 h	LC50		7	4*	6,58,59	Pawlisz et al.1998
Unio pictorum	70mm; 10g	N	S	K-Othrin ULV	0.12		8.4	22 ± 1		96 h	LC50	mortality	7000	3	6,7,22	Varanka, 1987
Unio pictorum	larvae		S				8.4	22		7 d	LC50		6	3	6,58,59	Pawlisz et al.1998
Crustacea																

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Amphipoda											EC50		0.0014	4	30,58	Day, 1989
Asellus aquaticus	8.85±3.01 mg, 6.75±0.85 mm	Y	R	Decis EC						96 h	NOEC		0.00025	3	3,**17**,20,21,64	Addendum, 2002
Asellus aquaticus	8.85±3.01 mg, 6.75±0.85 mm	Y	R	Decis EC						96 h	EC50	partial loss of equilibrium	0.00035	3	3,**17**,20,21,64	Addendum, 2002
Asellus aquaticus	8.85±3.01 mg, 6.75±0.85 mm	Y	R	Decis EC						96 h	EC50	complete loss of equilibrium	0.00051	3	3,**17**,20,21,64	Addendum, 2002
Asellus aquaticus	8.85±3.01 mg, 6.75±0.85 mm	Y	R	Decis EC						48 h	LC50	mortality	>0.016	3	3,**17**,20,21,64	Addendum, 2002
Asellus aquaticus	8.85±3.01 mg, 6.75±0.85 mm	Y	R	Decis EC						96 h	LC50	mortality	0.0051	3	3,**17**,20,21,64	Addendum, 2002
Asellus aquaticus		N								48 h	LC50	mortality	0.002	4	**17,9**	Addendum, 2002
Asellus aquaticus			R	Decis EC						96 h	LC50		0.01	4	**17**,21	List of end points, 2002
Asellus aquaticus	field population	N	S				7.1		164	24 h	LC50		1.80	3	**6,17**,58	Crommentuijn et al. 2001
Asellus aquaticus		N	S	Deltamethrin			7.1	18	160	48h	LC50		0.002	3	27	Thybaud et al., 1987
Ceriodaphnia quadrangula	24-48 h old	N	S	Decamethrin	2.5	tw/nw	7.3/8.4	21±1	160/345	1h	EC 20	mortality	0.00013	4	7	Mansour, Hassan, 1993
Daphnia hyalina			S	form.	0.12	nw		22-23		48 h	LC50	mortality	0.03	3	7,**17**,21	Addendum, 2002
Daphnia hyalina				K-Othrin						48h	LC50		0.03	4*	58	Pawlisz et al. 1998
Daphnia hyalina	Adults (4th instar)		S	K-Othrin				19-20		48h	LC50		0.03	4*	58	Pawlisz et al. 1998
Daphnia hyalina	adult ad mature (4th instar)	N	S	K-Othrin	0.12	nw		19-20		48 h	LC50	mortality	0.03	3	**7,17**,21	Presing 1989
Daphnia hyalina				K-Othrin						96h	LC50		0.013	4	58	Pawlisz et al. 1998
Daphnia hyalina				K-Othrin						24h	LC50		0.35	4*	6,58	Pawlisz et al. 1998
Daphnia hyalina	Adults (4th instar)		S	K-Othrin				19-20		24h	LC50		0.35	4*	6,58	Pawlisz et al. 1998
Daphnia hyalina	adult ad mature (4th instar)	N	S	K-Othrin	0.12	nw		19-20		24 h	LC50	mortality	0.35	3	6,7,21	Presing 1989
Daphnia hyalina	Adults (4th instar)		S	K-Othrin				19-20		96h	LC50		0.013	4*	58	Pawlisz et al. 1998
Daphnia hyalina	adult ad mature (4th instar)	N	S	K-Othrin	0.12	nw		19-20		96 h	LC50	mortality	0.01	3	**7,17**,21	Presing 1989
Daphnia magna		Y	F							48 h	EC50		0.56	3	2,**6**,**9**,16,20	Addendum, 2002
Daphnia magna		Y	F								NOEC	adverse effects	< 0.11	4	2,9,16,20	Addendum, 2002
Daphnia magna			S	form.	0.12	nw		22-23		48 h	LC50	mortality	2.5	3	6,7,17,21	Addendum, 2002
Daphnia magna			R							48 h	EC50		0.11	4	13,16	Addendum, 2002
Daphnia magna			R							48 h	NOEC		<0.082	4	13,16	Addendum, 2002
Daphnia magna	4th instar juveniles (approx. 4-5 days old)	Y	S		99.8	am	8.3	20		48 h	EC50	immobilisation	0.16	2	2,9,13,16,19	Barata *et al.*, 2006
Daphnia magna	4th instar juveniles (approx. 4-5 days old)	Y	S		99.8	am	8.3	20		24 h	EC50	immobilisation	0.05	2	9,13,16,19,47	Barata *et al.*, 2006
Daphnia magna	<24 h old	N	S	Decis 2.5 EC	2.5	nw	7.5 ± 0.7	20 ± 3	2.34 ± 0.23	96 h	LC50	mortality	0.0293	3	**7,17**,36,43	Beketov, 2004
Daphnia magna			F	IS-002A						48 h	EC50		0.56	4	16,21	List of end points, 2002
Daphnia magna			R	IS-002A						48 h	EC50		0.11	4	16,21	List of end points, 2002
Daphnia magna	neonates		S		ag			20-21		48 h	EC50		0.07	4*	58	Pawlisz et al. 1998
Daphnia magna	<24 h old	N	S		>95	nw		20-21		48 h	EC50	immobilisation	0.07	3	9,15,**17**	Day and Maguire, 1990
Daphnia magna	neonates		S		ag			20-21		48 h	EC50		0.05	4*	58	Pawlisz et al. 1998
Daphnia magna	<24 h old	N	S		>95	nw		20-21		48 h	EC50	immobilisation	0.05	3	9,15,**17**	Day and Maguire, 1990
Daphnia magna										48h	EC50	mortality	0.04	4	58.00	Robinson, 1999
Daphnia magna					tg					48h	LC50	mortality	5	4	6,21,31	L'Hotellier, Vincent, 1986
Daphnia magna	48h old						28±0.5			48h	NOEC	mortality	$1.008x10^{-2}$	3	10,34,54	Ratushnyak et al., 2005
Daphnia magna		N	S		99.9	nw	6.9-7.3			24 h	EC50	immobilisation	0.64	3	6,9,11	Day, 1991
Daphnia magna		N	S		99.9	nw	6.9-7.3			24 h	EC50	immobilisation	3.42	3	6,9,11	Day, 1991

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [μg/L]	Ri	Notes	Reference
Daphnia magna		N	S		99.9	nw	6.9-7.3			24 h	EC50	immobilisation	4.65	3	6,9,11	Day, 1991
Daphnia magna	adult	N	S		99.9	nw	6.9-7.3			48 h	EC50		0.05	4*	9,11,58	Crommentuijn et al. 2001
Daphnia magna		N	S		99.9	nw	6.9-7.3			48h	EC50	immobilisation	0.05	3	6,9,11	Day, 1991
Daphnia magna		N	S		99.9	nw	6.9-7.3			48h	EC50	immobilisation	1.01	3	6,9,11	Day, 1991
Daphnia magna		N	S		99.9	nw	6.9-7.3			48h	EC50	immobilisation	0.85	3	6,9,11	Day, 1991
Daphnia magna	neonates		S				7.8-8.0	20		24h	LC50		0.13	4*	58	Pawlisz et al. 1998
Daphnia magna	neonates 6-24 h	N	Rc				7.8-8.0	20 ± 0.5	250	24h	LC50	mortality	0.133	3	4,9,11	Xiu et al. 1989
Daphnia magna	neonates		S				7.8-8.0	20		48h	LC50		0.04	4*	58	Pawlisz et al. 1998
Daphnia magna	neonates 6-24 h	N	Rc				7.8-8.0	20 ± 0.5	250	48h	LC50	mortality	0.038	3	4,9,11	Xiu et al. 1989
Daphnia magna	neonates		S				7.8-8.0	20		96h	LC50		0.003	4*	58	Pawlisz et al. 1998
Daphnia magna	neonates 6-24 h	N	Rc				7.8-8.0	20 ± 0.5	250	96h	EC50	immobilisation	0.003	3	4,9,11	Xiu et al. 1989
Daphnia magna	neonates		S				7.8-8.0	20		24h	EC50		0.11	4*	58	Pawlisz et al. 1998
Daphnia magna	neonates 6-24 h	N	Rc				7.8-8.0	20 ± 0.5	250	24h	EC50	immobilisation	0.113	3	4,9,11	Xiu et al. 1989
Daphnia magna	neonates		S				7.8-8.0	20		48h	EC50		0.03	4*	58	Pawlisz et al. 1998
Daphnia magna	6-24 h	N	R				7.9		250	48 h	EC50		0.03	4*	9,11,58	Crommentuijn et al. 2001
Daphnia magna	neonates 6-24 h	N	Rc				7.8-8.0	20 ± 0.5	250	48h	EC50	immobilisation	0.031	3	4,9,11	Xiu et al. 1989
Daphnia magna	neonates		S				7.8-8.0	20		96h	EC50		0.01	4*	58	Pawlisz et al. 1998
Daphnia magna	neonates 6-24 h	N	Rc				7.8-8.0	20 ± 0.5	250	96h	LC50	mortality	0.010	3	4,9,11	Xiu et al. 1989
Daphnia magna	juveniles		S				7.8-8.0	20		24h	LC50		520	4*	6,58	Pawlisz et al. 1998
Daphnia magna	juveniles 48-72 h	N	Rc				7.8-8.0	20 ± 0.5	250	24h	LC50	mortality	520	3	4,6,9,11	Xiu et al. 1989
Daphnia magna	juveniles		S				7.8-8.0	20		48h	LC50		0.04	4*	58	Pawlisz et al. 1998
Daphnia magna	juveniles 48-72 h	N	Rc				7.8-8.0	20 ± 0.5	250	48h	LC50	mortality	0.037	3	4,9,11	Xiu et al. 1989
Daphnia magna	juveniles		S				7.8-8.0	20		96h	LC50		0.02	4*	58	Pawlisz et al. 1998
Daphnia magna	juveniles 48-72 h	N	Rc				7.8-8.0	20 ± 0.5	250	96h	LC50	mortality	0.021	3	4,9,11	Xiu et al. 1989
Daphnia magna	juveniles		S				7.8-8.0	20		24h	EC50		0.29	4*	6,58	Pawlisz et al. 1998
Daphnia magna	juveniles 48-72 h	N	Rc				7.8-8.0	20 ± 0.5	250	24h	EC50	immobilisation	0.290	3	4,6,9,11	Xiu et al. 1989
Daphnia magna	juveniles		S				7.8-8.0	20		48h	EC50		0.03	4*	58	Pawlisz et al. 1998
Daphnia magna	48-72 h	N	R				7.9		250	48 h	EC50		0.03	4*	9,11,58	Crommentuijn et al. 2001
Daphnia magna	juveniles 48-72 h	N	Rc				7.8-8.0	20 ± 0.5	250	48h	EC50	immobilisation	0.029	3	4,9,11	Xiu et al. 1989
Daphnia magna	juveniles		S				7.8-8.0	20		96h	EC50		0.02	4*	58	Pawlisz et al. 1998
Daphnia magna	juveniles 48-72 h	N	Rc				7.8-8.0	20 ± 0.5	250	96h	EC50	immobilisation	0.018	3	4,9,11	Xiu et al. 1989
Daphnia magna	Adults (4th instar)		S					22-23		24h	LC50		26.0	4*	6,58	Pawlisz et al. 1998
Daphnia magna	adult ad mature (4th instar)		S	K-Othrin	0.12	nw		22-23		24 h	LC50	mortality	26.0	3	6,7,17	Presing 1989
Daphnia magna	Adults (4th instar)		S					22-23		48h	LC50		2.50	4*	6,58	Pawlisz et al. 1998
Daphnia magna	adult ad mature (4th instar)		S	K-Othrin	0.12	nw		22-23		48 h	LC50	mortality	2.50	3	6,7,17	Presing 1989
Daphnia magna	Adults (4th instar)		S					22-23		96h	LC50		1.0	4*	6,58	Pawlisz et al. 1998
Daphnia magna	adult ad mature (4th instar)		S	K-Othrin	0.12	nw		22-23		96 h	LC50	mortality	1.0	3	6,7,17	Presing 1989
Daphnia magna										24 h	EC50		8.00	4	6,62	HSE 2004
Daphnia magna										48 h	EC50		5.00	4	6,62	HSE 2004
Daphnia magna										24 h	EC50		18.0	4	3,6,62	HSE 2004
Daphnia magna										48 h	EC50		3.50	4	3,6,62	HSE 2004
Daphnia magna											NOEC		1.80	4	3,6,62	HSE 2004
Daphnia similis	0.4 mg		S	Decametrin	2.5					24 h	LC50		0.87	4*	6,7,58,61	Pawlisz et al. 1998
Daphnia spinulata	3-4 d	N	R		99	nw	7.2-7.6		87	48 h	LC50		0.99	4*	6,58	Crommentuijn et al. 2001
Daphnia spinulata	3-4 d	N	Rc		99	AM	7.4 ± 0.2		86.5 ± 3.3	48 h	LC50	mortality	0.99	3	6,45	Alberdi et al. 1990

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Decapoda											EC50		0.0014	4	30,58	Day, 1989
Eudiaptomus gracilis			S	form.	0.12	nw		22-23		48 h	LC50	mortality	0.05	3	7,17,21	Addendum, 2002
Eudiaptomus gracilis				K-Othrin						24 h	LC50		0.08	4*	58	Pawlisz et al. 1998
Eudiaptomus gracilis	Adult	N	S	K-Othrin	0.125	nw		23		24 h	LC50	mortality	0.08	3	**7**,21	Presing 1989
Eudiaptomus gracilis				K-Othrin						48 h	LC50		0.05	4*	58	Pawlisz et al. 1998
Eudiaptomus gracilis	Adult	N	S	K-Othrin	0.125	nw		23		48 h	LC50	mortality	0.05	3	**7**,21	Presing 1989
Eudiaptomus gracilis				K-Othrin						96 h	LC50		0.02	4*	58	Pawlisz et al. 1998
Eudiaptomus gracilis	Adult	N	S	K-Othrin	0.125	nw		23		96 h	LC50	mortality	0.02	3	**7**,21	Presing 1989
Gammarus fasciatus	juveniles	Y	F	form.	2.7					48 h	LC50		0.00049	4	3,7,16,20,21	Addendum, 2002
Gammarus fasciatus	**juveniles**	**Y**	**F**	**form.**	**2.7**					**96 h**	**LC50**		**0.00031**	**2**	**3,7,16,20,21**	**Addendum, 2002**
Gammarus fasciatus	juveniles	Y	F	form.	2.7					96 h	NOEC	adverse effects	<0.00028	4	3,7,16,20,21	Addendum, 2002
Gammarus fasciatus	juveniles	N	F	form.	2.7					96 h	LC50		0.0032	3	3,7,17,20,21	Addendum, 2002
Gammarus fasciatus	juveniles	N	F	form.	2.7					96 h	NOEC	adverse effects	<0.0027	3	3,7,17,20,21	Addendum, 2002
Gammarus fasciatus		Y		form.	2.7					96 h	LC50	mortality	>0.043	3	3,7,17,20,21,41	Addendum, 2002
Gammarus fasciatus		Y		form.	2.7					96 h	NOEC	mortality	0.0054	3	3,7,17,20,21,41	Addendum, 2002
Gammarus fasciatus		Y		form.	2.7					96 h	NOEC	mortality	0.00034	3	3,7,17,20,21,41	Addendum, 2002
Gammarus fasciatus		Y		form.	2.7					96 h	LOEC	mortality	0.011	3	3,7,17,20,21,41	Addendum, 2002
Gammarus fasciatus			F	Decis EC						96 h	LC50		0.0003	4	16,21	List of end points, 2002
Gammarus fasciatus			F	Decis EC						96 h	LC50		0.0032	4	17,21	List of end points, 2002
Gammarus fasciatus				Decis EC						96 h	LC50		>0.043	4	17,21,40	List of end points, 2002
Gammarus pulex				form.	2.5					48h	LC50	mortality	0.03	3	7,21,31	L'Hotellier, Vincent, 1986
Gammarus roeseli			S	form.	0.12	nw		13-15		48 h	LC50	mortality	0.09	3	7,17,21	Addendum, 2002
Gammarus roeseli			S	K-Othrin				14-15		24 h	LC50		0.2	4*	58	Pawlisz et al. 1998
Gammarus roeseli	*mature, 15-17 mm*	N	S	form.	0.12	nw		14-15		24 h	LC50	mortality	0.20	3	7,17,21	Presing 1989
Gammarus roeseli			S	K-Othrin				14-15		48 h	LC50		0.09	4*	58	Pawlisz et al. 1998
Gammarus roeseli	*mature, 15-17 mm*	N	S	form.	0.12	nw		14-15		48 h	LC50	mortality	0.09	3	7,17,21	Presing 1989
Gammarus roeseli			S	K-Othrin				14-15		96 h	LC50		0.03	4*	58	Pawlisz et al. 1998
Gammarus roeseli	*mature, 15-17 mm*	N	S	form.	0.12	nw		14-15		96 h	LC50	mortality	0.03	3	7,17,21	Presing 1989
Isopoda											EC50		0.0014	4	30,58	Day, 1989
Scapholeberis kingi				2.8% EC	2.8					3 h	LC50		4.0	3	6,7,29	Sun 1987
Insecta																
Aedes sp.	4th instar larvae		S							24 h	LC50	mortality	<0.2	4	6,30	Anderson, 1989
Aedes aegypti	late 3rd and early 4th instar	N	S		tg			27±1		24h	EC100	mortality	5	3	6,10,11,53	Verma and Rahman, 1984
Aedes aegypti	larvae										LC50		0.12	4	34,58	Corbel *et al.*, 2004
Aedes aegypti	early 4th instar larvae; ROCK (susceptible reference strain)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	2.9	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes aegypti	early 4th instar larvae; AA-PAEA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	2.2	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes aegypti	early 4th instar larvae	N	S		98.8					24h	LC50	mortality	0.118	3	1,27	Kumar et al., 2002
Aedes albopictus	4th instar larvae	N	S	NRDC 161	tg	tw				24h	LC50	mortality	9.1	3	6,9,11	Gill, 1977
Aedes albopictus	4th instar larvae	N	S	NRDC 161	tg	tw				24h	LC10	mortality	2.02	3	6,9,23	Gill, 1977
Aedes albopictus	4th instar, strain MAmAal	N	S		99.9	tw		25		24 h	LC50	mortality	100	3	6	Liu *et al.*, 2004
Aedes albopictus	4th instar, strain HAmAal	N	S		99.9	tw		25		24 h	LC50	mortality	1100	3	6	Liu *et al.*, 2004
Aedes albopictus	4th instar, strain VBFmAal	N	S		99.9	tw		25		24 h	LC50	mortality	300	3	6	Liu *et al.*, 2004

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Aedes albopictus	4th instar, strain SFmAal	N	S		99.9	tw		25		24 h	LC50	mortality	30	3	6	Liu *et al.*, 2004
Aedes albopictus	4th instar, strain Ikaken	N	S		99.9	tw		25		24 h	LC50	mortality	50	3	6	Liu *et al.*, 2004
Aedes nigromaculis	4th stage larvae, filed population, strain Kern County	N	S	FMC - 45498	tg	tw				24h	EC50	mortality	0.4	3	6,8,25,27,35	Mulla et al., 1978a
Aedes nigromaculis	4th stage larvae, filed population, strain Kern County	N	S	FMC - 45498	tg	tw				24h	EC10	mortality	0.1778	3	8,23,25,27,35	Mulla et al., 1978a
Aedes nigromaculis	4th stage larvae, filed population, strain Tulare County	N	S	FMC - 45498	tg	tw				24 h	EC50	mortality	0.2	3	8,25,27,35	Mulla et al., 1978a
Aedes nigromaculis	4th stage larvae, filed population, strain Tulare County	N	S	FMC - 45498	tg	tw				24 h	EC10	mortality	0.08	3	8,23,25,27,35	Mulla et al., 1978a
Aedes polynesiensis	early 4th instar larvae; PAPARA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	2.4	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; PAPARA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	5.5	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; FAIE (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	6.1	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; OPOA-1 (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	6.3	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; OPOA-2 (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	7.8	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; TAORU (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	2.9	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; FAAFAU (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	4.5	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; MARATA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	5.6	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; KAINA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	4.2	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Aedes polynesiensis	early 4th instar larvae; TOAU (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	4.6	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; ARATIKA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	4.8	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; TEPU (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	5.8	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; RURUTU (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	5.8	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; TAIOHAE-1 (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	6.3	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; TAIOHAE-2 (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	2.5	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Aedes polynesiensis	early 4th instar larvae; MANGAREVA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	3.9	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Anisops bouvieri	20 mg		S	Decametrin	2.5					24 h	LC50		0.15	4*	58	Pawlitsz et al. 1998
Anopheles gambiae	larvae										LC50		0.44	3	6,34,58	Corbel *et al.*, 2004
Anopheles stephensi	late 3rd and early 4th instar	N	S		tg			27±1		24h	EC100	mortality	10	3	6,10,11,53	Verma and Rahman, 1984
Anopheles taeniorhynchus	larvae		S					20		24h	LC50		0.05-0.09	4*	58	Pawlitsz et al. 1998
Baetis parvus											LC50		0.01	4*	58	Pawlitsz et al. 1998
Baetis parvus	naiads	N	S	K-Othrin	2.5			20±1		1 h	EC50	mortality	0.01	3	7,39,**42**,56	Mohsen, Mulla, 1981
Baetis rhodani											LC50		0.005	4*	58	Pawlitsz et al. 1998
Baetis parvus	naiads	N	S	K-Othrin	2.5			20±1		1 h	EC10	mortality	0.005	3	7,23,39,**42**,56	Mohsen, Mulla, 1981
Baetis parvus	larvea		F	K-Othrin				20		24 h	LC50		0.4	4*	6,58	Pawlitsz et al. 1998
Caenis miliaria	larvae	N	S	Decis		nw	7.5 ± 0.7	20 ± 3	2.34 ± 0.23	96 h	LC50	mortality	0.0091	3	17,34,36	Beketov, 2004
Canopheles nigromaculis	4th stage larvae		S							24h	LC50		0.2	4*	46,58	Pawlitsz et al. 1998
Chironomus decorus	4th instar larvae	N								24 h	LC50	larval mortality	0.27	3	6,17,34	Ali and Mulla, 1980
Chironomus decorus	4th instar larvae	N								24 h	LC10	larval mortality	0.083	4	6,17,34	Ali and Mulla, 1980
Chironomus decorus	4th instar larvae, field collected			FMC-4549 (NRDC-161-)						24 h	LC50	larval mortality	1.1	3	6	Ali and Mulla, 1978
Chironomus salinarius	3rd and 4th instar larvae	N			tg					24 h	LC50	larval mortality	0.71	4	6,9,17,34,41	Ali et al., 1985
Chironomus salinarius	3rd and 4th instar larvae	N			tg					24 h	LC10	larval mortality	0.1172	4	9,17,23,34,41	Ali et al., 1985
Chironomus tentans			S							24 h	NOEC		0.03-0.05	4	16,21	List of end points, 2002
Chironomus tentans			S							24 h	EC100		3.5	4	6,16,21	List of end points, 2002

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Chironomus utahensis	4th instar larvae, field collected			FMC-4549 (NRDC-161-)						24 h	LC50	larval mortality	0.77	3	6	Ali and Mulla, 1978
Cloeon dipterum	larvae	N	S	Decis		nw	7.5 ± 0.7	20 ± 3	2.34 ± 0.23	96 h	LC50	mortality	0.005	3	17,34,36	Beketov, 2004
Cordulia aenea	larvae	N	S	Decis		nw	7.5 ± 0.7	20 ± 3	2.34 ± 0.23	96 h	LC50	mortality	0.76	3	17,34,36	Beketov, 2004
Cricotopus spp.	4th instar larvae	N								24 h	LC50	larval mortality	0.11	4	17,34	Ali and Mulla, 1980
Cricotopus spp.	4th instar larvae	N								24 h	LC10	larval mortality	0.024	4	17,23,34	Ali and Mulla, 1980
Cricotopus spp.	4th instar larvae	N								24 h	LC50	larval mortality	0.15	4	17,34	Ali and Mulla, 1980
Cricotopus spp.	4th instar larvae	N								24 h	LC10	larval mortality	0.05	4	17,23,34	Ali and Mulla, 1980
Cricotopus sp.										24	LC50		0.15	4*	58	Pawlitsz et al. 1998
Culex sp.	4th instar larvae		S							24 h	LC50	mortality	<0.2	4	17	Anderson, 1989
Culex pipiens pallens	4th instar larvae, TAIZHOU (susceptible strain)	N	S		98					20 min	LC50	mortality	9.2	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, TAIZHOU (resistant strain)	N	S		98					20 min	LC50	mortality	1754.4	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, TAIZHOU (field population)	N	S		98					20 min	LC50	mortality	54.9	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, JINHUA (susceptible strain)	N	S		98					20 min	LC50	mortality	8.4	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, JINHUA (resistant strain)	N	S		98					20 min	LC50	mortality	1792.2	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, JINHUA (field population)	N	S		98					20 min	LC50	mortality	74.4	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, JIAXING (susceptible strain)	N	S		98					20 min	LC50	mortality	13.7	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, JIAXING (resistant strain)	N	S		98					20 min	LC50	mortality	1415.6	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, JIAXING (field population)	N	S		98					20 min	LC50	mortality	82.4	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, HZOUSHAN (susceptible strain)	N	S		98					20 min	LC50	mortality	7.4	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, HZOUSHAN (resistant strain)	N	S		98					20 min	LC50	mortality	2474.7	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, HZOUSHAN (field population)	N	S		98					20 min	LC50	mortality	134.3	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, HANZHOU (susceptible strain)	N	S		98					20 min	LC50	mortality	8.6	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, HANZHOU (resistant strain)	N	S		98					20 min	LC50	mortality	2165.6	3	1,6,9,35,57	Wang, 1999

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Culex pipiens pallens	4th instar larvae, HANZHOU (field population)	N	S		98					20 min	LC50	mortality	164.3	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, NINGBO (susceptible strain)	N	S		98					20 min	LC50	mortality	10.9	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, NINGBO (resistant strain)	N	S		98					20 min	LC50	mortality	2597.7	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, NINGBO (field population)	N	S		98					20 min	LC50	mortality	189.4	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, WENZHOU (susceptible strain)	N	S		98					20 min	LC50	mortality	8.1	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, WENZHOU (resistant strain)	N	S		98					20 min	LC50	mortality	2774.3	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	4th instar larvae, WENZHOU (field population)	N	S		98					20 min	LC50	mortality	200.3	3	1,6,9,35,57	Wang, 1999
Culex pipiens pallens	early 4th instar larvae	N	S		95					24h	LC50	mortality	40	3	6,27,35	Li et al., 2002
Culex pipiens pallens	early 4th instar larvae, F12	N	S		95					24h	LC50	mortality	24660	3	1,6,27,35	Li et al., 2002
Culex pipiens pallens											LC50	mortality	0.50	3	6,29	Chen, 1990
Culex pipiens pallens											LC50	mortality	68.0	3	6,29	Chen, 1990
Culex pipiens quinquefasciatus	4th stage larvae, laboratory reared	N	S	FMC - 45498	tg	tw				24h	EC50	mortality	0.02	3	8,**25**,27	Mulla et al., 1978b
Culex pipiens quinquefasciatus	4th stage larvae, laboratory reared	N	S	FMC - 45498	tg	tw				24 h	EC10	mortality	0.01	3	8,23,**25**,27	Mulla et al., 1978b
Culex pipiens quinquefasciatus	early 4th instar larvae; S-LAB (susceptible reference strain)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	1.2	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Culex pipiens quinquefasciatus	early 4th instar larvae; CP-PAEA (natural population)	N	S	form.	2.5	dw		26±1		24 h	LC50	mortality	1.5	3	1,6,7,10,11,24, 34	Failloux *et al.*, 1994
Culex quinquefasciatus	4th stage larvae, laboratory reared	N	S	FMC - 45498	tg	tw				24h	EC50	mortality	0.02	3	8,**25**,27	Mulla et al., 1978a
Culex quinquefasciatus	4th stage larvae, laboratory reared	N	S	FMC - 45498	tg	tw				24h	EC10	mortality	0.00889	3	8,23,**25**,27	Mulla et al., 1978a
Culex quinquefasciatus	early 4th instar larvae, S-Lab strain	N	S		tg/ag	dw				24h	LC50	mortality	0.024	3	8,27	Magnin et al.,1988
Culex quinquefasciatus	early 4th instar larvae, BOUAKE strain	N	S		tg/ag	dw				24h	LC50	mortality	0.34	3	6,8,27	Magnin et al.,1988
Culex quinquefasciatus	early 4th instar larvae, B-Del strain	N	S		tg/ag	dw				24h	LC50	mortality	1.5	3	6,8,27,35	Magnin et al.,1988
Culex quinquefasciatus	early 4th instar larvae, PERM-R	N	S		tg/ag	dw				24h	LC50	mortality	4.3	3	6,8,27,35	Magnin et al.,1988

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	strain															
Culex quinquefasciatus	larvae, strain COLONY	N	S		tg					24h	LC50	mortality	1.5	3	1,6,10,11,27,34,35	Mainkar et al., 1999
Culex quinquefasciatus	larvae, strain DHAHISAR	N	S		tg					24h	LC50	mortality	1.7	3	1,6,10,11,27,34,35	Mainkar et al., 1999
Culex quinquefasciatus	larvae, strain DADAR	N	S		tg					24h	LC50	mortality	1.5	3	1,6,10,11,27,34,35	Mainkar et al., 1999
Culex quinquefasciatus	larvae, strain SANTACRUZE	N	S		tg					24h	LC50	mortality	1.8	3	1,6,10,11,27,34,35	Mainkar et al., 1999
Culex quinquefasciatus	larvae, strain BANDRA	N	S		tg					24h	LC50	mortality	1.9	3	1,6,10,11,27,34,35	Mainkar et al., 1999
Culex quinquefasciatus	larvae, strain BORIVLI	N	S		tg					24h	LC50	mortality	1.6	3	1,6,10,11,27,34,35	Mainkar et al., 1999
Culex quinquefasciatus	SS Pel strain, 4th instar larvae	N	S			dw		25±1		24 h	LC50	mortality	3	3	6,10,17,34,38	Amin and Hemingway, 1989
Culex quinquefasciatus	JPal strain, 4th instar larvae, parental generation	N	S			dw		25±1		24 h	LC50	mortality	14	3	6,10,17,34,38	Amin and Hemingway, 1989
Culex quinquefasciatus	JPal strain, 4th instar larvae, F5 generation	N	S			dw		25±1		24 h	LC50	mortality	233	3	6,10,17,28,34,38	Amin and Hemingway, 1989
Culex quinquefasciatus	JPal strain, 4th instar larvae, F20 generation	N	S			dw		25±1		24 h	LC50	mortality	19670	3	6,10,17,28,34,38	Amin and Hemingway, 1989
Culex quinquefasciatus	late 3rd and early 4th instar	N	S		tg			27±1		24h	EC100	mortality	1	3	17	Verma and Rahman, 1984
Culex quinquefasciatus	larvae										LC50		0.12	4	34,58	Corbel *et al*., 2004
Culex quinquefasciatus	4th stage larvae		S							24h	LC50		0.02	4	58	Pawlitsz et al. 1998
Culex quinquefasciatus	4th instar, VBFmCq	N	S		99.9	tw		25		24 h	LC50	mortality	100	3	6	Liu *et al*., 2004
Culex quinquefasciatus	4th instar, HAmCq	N	S		99.9	tw		25		24 h	LC50	mortality	200	3	6	Liu *et al*., 2004
Culex quinquefasciatus	4th instar, MAmCq	N	S		99.9	tw		25		24 h	LC50	mortality	600	3	6	Liu *et al*., 2004
Culex quinquefasciatus	4th instar, S-Lab	N	S		99.9	tw		25		24 h	LC50	mortality	2	3	6	Liu *et al*., 2004
Culex tarsalis	4th stage larvae		S					20		24 h	LC50		0.06	4*	58	Pawlitsz et al. 1998
Culiseta sp.	4th instar larvae		S							24 h	LC50	mortality	<0.2	3	9,17	Anderson, 1989
Culiseta incidens	4th stage larvae		S					20		24 h	LC50		0.30	4*	6,58	Pawlitsz et al. 1998
Culiseta incidens	pupae		S					20		24 h	LC50		0.07	4*	58	Pawlitsz et al. 1998
Dicrotendipes californicus	4th instar larvae	N								24 h	LC50	larval mortality	2.1	3	6,17,36	Ali and Mulla, 1980
Dicrotendipes californicus	4th instar larvae	N								24 h	LC10	larval mortality	0.601	3	6,17,23,36	Ali and Mulla, 1980
Dicrotendipes californicus	4th instar larvae	N								24 h	LC50	larval mortality	1.4	3	6,17,34	Ali and Mulla, 1980
Dicrotendipes californicus	4th instar larvae	N								24 h	LC10	larval mortality	0.527	4	6,17,23,36	Ali and Mulla, 1980
Ephemerella ignita											LC50		0.05	4*	58	Pawlitsz et al. 1998
Hydropsyche californica	larvae	N	S	K-Othrin	2.5			20±1		1 h	EC50	mortality	0.01	3	7,21,39,**42**,55,56	Mohsen, Mulla, 1981
Hydropsyche californica	larvae	N	S	K-Othrin	2.5			20±1		1 h	EC10	mortality	0.0044	3	7,21,23,39,**42**,55,56	Mohsen, Mulla, 1981
Hydropsyche californica	larvae		F	K-Othrin	2.5			20		24 h	LC50		0.4	4*	6,7,58	Pawlitsz et al. 1998
Hydropsyche californica											LC50		0.01	4*	58	Pawlitsz et al. 1998
Hydropsyche											LC50		0.01	4*	58	Pawlitsz et al. 1998

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
pellucidula																
Lestes sponsa	larvae	N	S	Decis		nw	7.5 ± 0.7	20 ± 3	2.34 ± 0.23	96 h	LC50	mortality	0.0145	3	17,34,36	Beketov, 2004
Phorophora columbiae	4th stage larvae		S					20		24 h	LC50		0.1	4*	58	Pawlitsz et al. 1998
Phorophora columbiae	Pupae		S					20		24 h	LC50		0.1	4*	58	Pawlitsz et al. 1998
Procladius spp.	4th instar larvae, field collected			FMC-4549 (NRDC-161-)						24 h	LC50	larval mortality	0.067	4	37	Ali and Mulla, 1978
Simulium sp.	larvae									24 h	LC50	mortality	<0.1	4	30,39	Anderson, 1989
Simulium sp.	larvae		F							24 h	LC50		0.10	4*	39,58	Pawlitsz et al. 1998
Simulium ornatum											LC50		0.10	4*	58	Pawlitsz et al. 1998
Simulium virgatum	larvae		F	K-Othrin	2.5			20		24 h	EC50		0.02	4*	7,58	Pawlitsz et al. 1998
Simulium virgatum	penltimate and ultimate larvae	N	F	K-Othrin	2.5			20±1		1 h	EC50	mortality	0.0225	3	7,21,39,56	Mohsen, Mulla, 1981
Simulium virgatum	penltimate and ultimate larvae	N	F	K-Othrin	2.5			20±1		1 h	EC10	mortality	0.0045	3	7,21,23,39,56	Mohsen, Mulla, 1981
Simulium virgatum											LC50		0.02	4*	58	Pawlitsz et al. 1998
Tanypus grodhausi	4th instar larvae	N								24 h	LC50	larval mortality	0.11	4	17,34	Ali and Mulla, 1980
Tanypus grodhausi	4th instar larvae	N								24 h	LC10	larval mortality	0.0504	4	17,34	Ali and Mulla, 1980
Pisces																
Alburnus alburnus					tg					96h	LC50	mortality	0.69	3	6,21,31	L'Hotellier, Vincent, 1986
Alburnus alburnus				form.	0.1					96h	LC50	mortality	82	3	6,7,21,31	L'Hotellier, Vincent, 1986
Alburnus alburnus			S		tg					96h	LC50		0.69	4*	6,58	Pawlisz et al. 1998
Astyanax (Astyanax) fasciatus fasciatus	1.48g, 42.3±1.1mm	N	S	Decis 2-5		tw	8.1-8.5	18-22	90-130	1h	NOEC	mortality	250	3	6,7,21	Salibian, Fichera, 1981
Astyanax (Astyanax) fasciatus fasciatus	1.48g, 42.3±1.1mm	N	S	Decis 2-5		tw	8.1-8.5	18-22	90-130	1h	EC100	mortality	2500	3	6,7,21	Salibian, Fichera, 1981
Astyanax (Astyanax) fasciatus fasciatus	1.48g, 42.3±1.1mm	N	S	Decis 2-5		tw	8.1-8.5	18-22	90-130	2.5h	EC50	mortality	250	3	6,7,21	Salibian, Fichera, 1981
Astyanax (Astyanax) fasciatus fasciatus	1.48g, 42.3±1.1mm	N	S		ag	tw	8.1-8.5	18-22	90-130	0.5h	NOEC	mortality	125	3	6,21	Salibian, Fichera, 1981
Astyanax (Astyanax) fasciatus fasciatus	1.48g, 42.3±1.1mm	N	S		ag	tw	8.1-8.5	18-22	90-130	1.5h	EC100	mortality	22500	3	6,21	Salibian, Fichera, 1981
Astyanax (Astyanax) fasciatus fasciatus	1.48g, 42.3±1.1mm	N	S		ag	tw	8.1-8.5	18-22	90-130	1.5h	EC50	mortality	250	3	6,21	Salibian, Fichera, 1981
Channa punctatus	13-15cm, 20-22g	N	S	Decis 2.8	2.8	tw	7.2±0.02	22.4±1.6	118±12.2	96h	LC50	mortality	440	3	6,7,34	Kumar et al., 1999b
Clarias batrachus	50g			Decis 2.8	2.8	dtw	7.6-8.0			96h	LC50	mortality	480	3	6,7,34	Ravinder, et al., 1989
Clarias gariepinus	4.54±0.349 cm, 1.13±0.134 g	N	S	K-Obiol: 2.5 WP	2.5	dtw	8.23 ± 0.04	28 ± 0.2	249.33±11 .01	96 h	LC50	mortality	40010	3	5,6,7,34	Datta and Kaviraj, 2003a
Clarias gariepinus	4.54±0.349 cm, 1.13±0.134 g	N	S	K-Obiol: 2.5 WP	2.5	dtw	8.23 ± 0.04	28 ± 0.2	249.33±11 .01	96 h	NOEC	mortality	30000	3	5,6,7,34	Datta and Kaviraj, 2003a
Clarias gariepinus	5.07±0.438 cm, 1.27±0.136 g	N	S	K-Obiol: 2.5 WP	2.5	dtw	8.23 ± 0.04	28 ± 0.2	249.33±11 .01	96 h	LC50	mortality	4	3	5,6,7,9,11,34	Datta and Kaviraj, 2003a
Clarias gariepinus	5.07±0.438 cm, 1.27±0.136 g	N	S	K-Obiol: 2.5 WP	2.5	dtw	8.23 ± 0.04	28 ± 0.2	249.33±11 .01	96 h	NOEC	mortality	<3	3	5,6,7,9,11,34	Datta and Kaviraj, 2003a
Ctenopharyngodon idella	17 g, 72 mm			Decis, 25 EC	25					96 h	LC50	mortality	91	3	6,34,58	Calta and Ural, 2004
Cyprinodon macularius											LC50		0.6	4*	6,62	Bocquet and L´Hotellier, 1984
Cyprinodon macularius				form.	2.5					96h	LC50	mortality	0.6	4*	6,7,21,31	L'Hotellier, Vincent, 1986
Cyprinodon macularius			S							96h	LC50		0.6	4*	6,58	Pawlisz et al. 1998
Cyprinodon macularius										48h	LC50		0.6	4*	6,58	Pawlisz et al. 1998
Cyprinodon macularius	4-5cm	N	S	form.		nw		11-16.6		48h	LC50	mortality	0.6	3	6,16,34	Mulla et al., 1978b
Cyprinodon macularius	4-5cm	N	S	form.		nw		11-16.6		48h	LC10	mortality	0.36	3	6,23,26,34	Mulla et al., 1978b
Cyprinodon macularius			S							48h	LC50		1	4*	6,58,60	Pawlisz et al. 1998

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Cyprinodon variegatus				form.	2.5					96h	LC50	mortality	0.9	4	6,7,21,31	L'Hotellier, Vincent, 1986
Cyprinodon variegatus		Y	F							96 h	LC50		0.48	4	3,6,62	HSE 2004
Cyprinodon variegatus		Y	F							96 h	NOEC		0.35	4	3,6,62	HSE 2004
Cyprinus carpio	4 months, 5.0 cm	N	S					25-28		24 h	LC50	mortality	21000	3	6,17	Azmi *et al*., 1997
Cyprinus carpio	9.1 g	N	S		98.5	tw	7.9		200	96h	LC50		0.86	4	6,61	Crommentuijn et al. 2001
Cyprinus carpio			F							96h	LC50		0.86	4	6,58	Pawlisz et al. 1998
Cyprinus carpio											LC50		0.86	4	6,62	Bocquet and L´Hotellier, 1984
Cyprinus carpio	3.5-5.8 g, 6.2-7.4 cm	N	S	DECIS, 2.5 EC	2.5	dtw	8.4 ± 0.04	20.5 ± 0.5	180-200	96 h	LC50	mortality	1.65	3	5,6,7,34	Calta and Ural, 2004
Cyprinus carpio	42 g		S	DECIS, 2.5 EC	2.5					96 h	LC50	mortality	3.5	3	6,7,34,58	Calta and Ural, 2004
Cyprinus carpio				form.	2.8					96 h	LC50	mortality	2.3	3	6,7,34,58	Calta and Ural, 2004
Cyprinus carpio	12 g, 60 mm			Decis, 25 EC	25					96 h	LC50	mortality	78	3	6,7,34,58	Calta and Ural, 2004
Cyprinus carpio	embryos	N	R	form.	2.5	nw	7.4±0.2	24±1	125.8±4.3	48 h	LC50	mortality	0.213	3	6,7,9,13,34	Köprücü and Aydin, 2004
Cyprinus carpio	larvae	N	R	form.	2.5	nw	7.4±0.2	24±1	125.8±4.3	48 h	LC50	mortality	0.074	3	**7,9,14**,34	Köprücü and Aydin, 2004
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	6.9	21.8-22.7	69.9	24 h	NOEC	larval survival	2	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	6.9	21.8-22.7	2050	24 h	NOEC	larval survival	8	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	7.8	21.8-22.7	69.9	24 h	NOEC	larval survival	2	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	7.8	21.8-22.7	2050	24 h	NOEC	larval survival	8	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	9.0	21.8-22.7	69.9	24 h	NOEC	larval survival	4	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	9.0	21.8-22.7	2050	24 h	NOEC	larval survival	4	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	6.9	21.8-22.7	69.9	24 h	NOEC	larval survival	4	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	6.9	21.8-22.7	2050	24 h	NOEC	larval survival	8	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	7.8	21.8-22.7	69.9	24 h	NOEC	larval survival	4	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	7.8	21.8-22.7	2050	24 h	NOEC	larval survival	8	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	9.0	21.8-22.7	69.9	24 h	NOEC	larval survival	4	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	9.0	21.8-22.7	2050	24 h	NOEC	larval survival	16	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	6.9	21.8-22.7	69.9	24 h	NOEC	larval survival	8	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	6.9	21.8-22.7	2050	24 h	NOEC	larval survival	16	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	7.8	21.8-22.7	69.9	24 h	NOEC	larval survival	8	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	7.8	21.8-22.7	2050	24 h	NOEC	larval survival	16	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	9.0	21.8-22.7	69.9	24 h	NOEC	larval survival	4	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio	10 days old larvae	Y	S		99.6	rw	9.0	21.8-22.7	2050	24 h	NOEC	larval survival	16	3	6,10,13,17,32,24	Ghillebaert *et al*., 1996a
Cyprinus carpio			F		tg					96h	LC50		1.84	4*	6,58	Pawlisz et al. 1998
Cyprinus carpio					tg					96h	LC50	mortality	1.84	4*	6,21,62	L'Hotellier, Vincent, 1986
Cyprinus carpio			F	EC						96h	LC50		0.65	4*	6,58	Pawlisz et al. 1998
Cyprinus carpio				form.	2.5					96h	LC50	mortality	0.65	4*	6,7,21,62	L'Hotellier, Vincent, 1986

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Cyprinus carpio			F							96h	LC50		210	4*	6,58	Pawlisz et al. 1998
Cyprinus carpio				form.	0.1					96h	LC50	mortality	210	4*	6,7,21,62	L'Hotellier, Vincent, 1986
Cyprinus carpio			F							96h	LC50		0.86	4*	6,61	Pawlisz et al. 1998
Cyprinus carpio				Decis	2.5					96 h	LC50		1.45	4*	6,7,58,63	Cengiz, 2006
Cyprinus carpio	Juveniles; 72.6 ± 3.61 mm; 9.9 ± 1.19 g		R	Decis	2.5		7.8	19-21	14	96 h	LC50		1.45	3	2,6,7	Svobodova et al. 2003
Cyprinus carpio	eggs	N		Decis 2.8 EC?		tw	7.5 ± 0.2	24 ± 1	272 ± 2	48 h	LC50	mortality, viable hatching	1120	3	6,7,34	Dhawan and Kaur 1996
Cyprinus carpio				2.8% EC	2.8					48 h	LC50		4	3	6,7,29	Sun 1987
Cyprinus carpio				2.8% EC	2.8					96 h	LC50		2.3	3	6,7,29	Sun 1987
Danio rerio					tg					96h	LC50	mortality	2.0	4*	6,21,62	L'Hotellier, Vincent, 1986
Danio rerio										96h	LC50		2	4*	6,61	Pawlisz et al. 1998
Esox lucius	65 mg, 25 mm			Decis	25					96 h	LC50	mortality	23	3	6,7,34,58	Calta and Ural, 2004
Gambusia affinis	25-30cm	N	S		99.7	tw				96h	LC50		7.5	4*	6,58	Crommentuijn et al. 2001
Gambusia affinis	25-30 mm	N	S		99.7	tw					LC50	mortality	7.5	3	6,10,12,17,21	Mittal *et al.*, 1991
Gambusia affinis	25-30 mm	N	S		99.7	tw					LC10	mortality	3.31	3	6,10,12,17,21,23	Mittal *et al.*, 1991
Gambusia affinis	25-30 mm	N	S	K-othrine	2.5	tw					LC50	mortality	5000	3	6,7,17,21	Mittal *et al.*, 1991
Gambusia affinis	25-30 mm	N	S	K-othrine	2.5	tw					LC10	mortality	1517	3	6,7,17,21, 23	Mittal *et al.*, 1991
Gambusia affinis	25-30 mm	N	S	Decis	2.5/2.8	tw					LC50	mortality	6.6	3	6,7,17,21	Mittal *et al.*, 1991
Gambusia affinis	25-30 mm	N	S	Decis	2.5/2.8	tw					LC10	mortality	4.355	3	6,7,17,21, 23	Mittal *et al.*, 1991
Gambusia affinis											LC50		1	3	6,62	Bocquet and L´Hotellier, 1984
Gambusia affinis	4-5cm	N	S	form.		nw		8.8-16		48h	LC50	mortality	1	3	6,16,34	Mulla et al., 1978b
Gambusia affinis	4-5cm	N	S	form.		nw		8.8-16		48h	LC10	mortality	5	3	6,23,34,26	Mulla et al., 1978b
Gambusia affinis				form.	2.5					48h	LC50	mortality	10	3	6,7,21,31	L'Hotellier, Vincent, 1986
Gambusia affinis				EC	2.8					48 h	LC50		1.8	3	6,7,29	Sun 1987
Heteropneustes fossilis	38-47g, both sex	N	S	Decis		tw	7.21 ± 0.06		167.31	96 h	LC50		1.86	4*	6	Srivastav et al. 2002
Heteropneustes fossilis	38-47g, both sex	N	R			tw	7.21±0.06	25.8±1.8	167.32±5.81	96h	LC50	mortality	1.86	3	6,34	Srivastava et al., 1997
Heteropneustes fossilis	38-47g, both sex	N	R			tw	7.21±0.06	25.8±1.8	167.32±5.81	96h	LC10	mortality	1.109	3	6,23,34	Srivastava et al., 1997
Heteropneustes fossilis	30-35g, 12-15cm	N	S	form.	2.8					96h	LC50	mortality	520	3*	6,7,34,58	Kumar et al., 1999a
Heteropneustes fossilis	13-15cm, 20-23g	N	S	Decis	2.8	tw	7.2±0.02	22.4±1.6	118±12.2	96h	LC50	mortality	520	3	6,7,34	Kumar et al., 1999b
Ictalurus nebulosus	2.1g	N	S			rw	7-7.8		43	96h	LC50		1.2	4	6,61	Crommentuijn et al. 2001
Ictalurus nebulosus					tg					96h	LC50	mortality	1.2	4	6,21,62	L'Hotellier, Vincent, 1986
Ictalurus nebulosus			F							96h	LC50		1.2	4	6,61	Pawlisz et al. 1998
Ictalurus nebulosus		N	S							96h	LC50		1.2	4	2,6,62	HSE 2004
Ictalurus nebulosus			F							96h	LC50		2.3	4	6,61	Pawlisz et al. 1998
Ictalurus nebulosus				form.	2.5					96h	LC50	mortality	2.3	4	6,7,21,36,62	L'Hotellier, Vincent, 1986
Ictalurus punctatus			F							96h	LC50		0.63	4	6,61	Pawlisz et al. 1998
Ictalurus punctatus					tg					96h	LC50	mortality	0.63	4	6,21,62	L'Hotellier, Vincent, 1986
Idus melanotus			S							96h	LC50		1.2	4	6,58,61	Pawlisz et al. 1998
Idus idus melanotus					2.5					96h	LC50	mortality	1.2	4	6,21,62	L'Hotellier, Vincent, 1986
Lepomis gibbosus					tg					96h	LC50	mortality	0.58	4	6,21,62	L'Hotellier, Vincent, 1986
Lepomis gibbosus											LC50		0.58	4	6,62	Bocquet and L´Hotellier, 1984
Lepomis gibbosus			S							96h	LC50		0.58	4	6,61	Pawlisz et al. 1998
Lepomis gibbosus	1.7 g	N	S		98.5	tw	7.9		180	96h	LC50		0.58	4	6,61	Crommentuijn et al. 2001
Lepomis gibbosus			F							96h	LC50		0.58	4	6,61	Pawlisz et al. 1998
Lepomis gibbosus			S							96h	LC50		0.87	4	6,61	Pawlisz et al. 1998
Lepomis gibbosus				form.	2.5					96h	LC50	mortality	0.87	4	6,7,21,36,62	L'Hotellier, Vincent, 1986
Lepomis macrochirus					tg					96h	LC50	mortality	1.2	4	6,21,62	L'Hotellier, Vincent, 1986

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Lepomis macrochirus			F							96h	LC50		1.2	4	6,61	Pawlisz et al. 1998
Lepomis macrochirus		N	F							96 h	LC50		1.2	4	3,6,62	HSE 2004
Lepomis macrochirus	0.67-2.04g						6.1-7.2	21-23	25.35	96h	LC50		0.36	4	6,58	Pawlisz et al. 1998
Lepomis macrochirus		N	S							96 h	LC50		1.4	4	3,6,62	HSE 2004
Lepomis macrochirus		N	S							96 h	NOEC		0.41	4	3,6,62	HSE 2004
Leuciscus cephallus	18.14±4.53g, 12.43±1.06cm	N	S	form.	25	tw	7.3-7.5	20±1	61-65	96h	LC50	mortality	5.338	3	6,7,9,34	Verep, 2006
Leuciscus cephallus	18.14±4.53g, 12.43±1.06cm	N	S	form.	25	tw	7.3-7.5	20±1	61-65	96h	LC10	mortality	2.088	3	6,7,9,34	Verep, 2006
Oncorhynchus mykiss			F		IS-002A					96 h	LC50		0.26	3	6,16,21	List of end points, 2002
Onkorhynchus mykiss										48h	LC50		0.5	4*	6,58	Pawlisz et al. 1998
Oncorhynchus mykiss											LC50		0.5	4*	6,62	Bocquet and L´Hotellier, 1984
Onkorhynchus mykiss	5-6cm	N	S	formulation		nw		12-25.5		48h	LC50	mortality	0.5	3	6,7,34	Mulla et al., 1978b
Onkorhynchus mykiss	5-6cm	N	S	formulation		nw		12-25.5		48h	LC10	mortality	0.225	3	6,23,26,34	Mulla et al., 1978b
Oncorhynchus mykiss	2.6 g		S	Decis 2.5 EC						96 h	LC50	mortality	2.3	3	6,7,34,58	Calta and Ural, 2004
Oncorhynchus mykiss	28.32±0.387 cm, 285.55±11.27 g	N	S	Decis 2.5 EC	2.5 S	tw		16		10-20 min	NOEC	mortality	≥50	3	6,7,9,11,21,24	Hughes and Biró, 1993
Oncorhynchus mykiss	28.32±0.387 cm, 285.55±11.27 g	N	S	Decis 2.5 EC	2.5 S	tw		16		60 min	NOEC	mortality	<62.5	3	6,7,9,11,21,24	Hughes and Biró, 1993
Onkorhynchus mykiss	juvenile, 4.1±0.39g, 65.1±3.61mm	N	R	Decis EW 50	4.8	rw		14.5-16.5		96h	LC0	mortality	0.48	3	6,7,22	Velíšek et al., 2007
Onkorhynchus mykiss	juvenile, 4.1±0.39g, 65.1±3.61mm	N	R	Decis EW 50	4.8	rw		14.5-16.5		96h	LC50	mortality	0.96	3	6,7,22	Velíšek et al., 2007
Onkorhynchus mykiss	juvenile, 4.1±0.39g, 65.1±3.61mm	N	R	Decis EW 50	4.8	rw		14.5-16.5		96h	LC100	mortality	24	3	6,7,22	Velíšek et al., 2007
Onkorhynchus mykiss	1.9-2.5g, 4.7-6.4cm	N	S	DECIS 2.5 EC		dtw	8.5±0.06	15.5±0.5	184-202	96h	LC50	mortality	0.6961	3	6,7,34	Ural and Sağlam, 2005
Onkorhynchus mykiss	1.9-2.5g, 4.7-6.4cm	N	S	DECIS 2.5 EC		dtw	8.5±0.06	15.5±0.5	184-202	96h	LC10	mortality	0.3238	3	6,7,34	Ural and Sağlam, 2005
Onkorhynchus mykiss			F							96h	LC50		0.39	4	6,61	Pawlisz et al. 1998
Onkorhynchus mykiss					tg					96h	LC50	mortality	0.39	4	6,21,62	L'Hotellier, Vincent, 1986
Onkorhynchus mykiss				form.	2.5					96h	LC50	mortality	2.2	4	6,7,21,62	L'Hotellier, Vincent, 1986
Onkorhynchus mykiss			F							96h	LC50		2.2	4	6,61	Pawlisz et al. 1998
Onkorhynchus mykiss		N	S							96 h	LC50		0.91	4	3,6,62	HSE 2004
Onkorhynchus mykiss		N	S							96 h	NOEC		0.2	4	3,6,62	HSE 2004
Oreochromis niloticus	1.6g		S				6.3-7.6	24-30	10.8	96h	LC50		14.5	4*	6,58	Pawlisz et al. 1998
Oreochromis niloticus	fingerlings, 1.6±0.61 g fresh weight, 2.41±1.10 cm fresh length	N	R	form.	2.5	rw	6.26-7.60	24-30	43-59	96 h	LC50	mortality	14.5	3	6,7,10,32,34	Golow and Godzi, 1994
Oreochromis niloticus	fingerlings, 15±2g	N	S		98	tw	6.8	22±1	79	48h	LC50	mortality	4.85	3	6,9,13,52	Yildirim et al., 2006
Oreochromis niloticus	fingerlings, 15±2g	N	S		98	tw	6.8	22±1	79	48h	LC10	mortality	2.8	3	6,9,13,52	Yildirim et al., 2006
Osteochilus hasselti				form.	2.5					96h	LC50	mortality	1.2	4*	6,7,21,62	L'Hotellier, Vincent, 1986
Osteochilus hasselti			S							96h	LC50		1.2	4*	6,61	Pawlisz et al. 1998
Poecilia reticulata	adult,	N	S		98	tw		22±1		48h	LC50	mortality	5.1251	3	6,9,13,52	Viran et al., 2003
Poecilia reticulata	adult,	N	S		98	tw		22±1		48h	LC10	mortality	1.8341	3	6,9,13,52	Viran et al., 2003
Poecilia reticulata	2.5-3.0cm	N	S		tg					24h	LC50	mortality	16	3	6,21	Mittal et al., 1994
Poecilia reticulata	2.5-3.0cm	N	S		tg					24h	LC10	mortality	4.9	3	6,21,23	Mittal et al., 1994
Poecilia reticulata	2.5-3.0cm	N	S	K-Othrine	2.5					24h	LC50	mortality	18000	3	6,7,21	Mittal et al., 1994
Poecilia reticulata	2.5-3.0cm	N	S	K-Othrine	2.5					24h	LC10	mortality	7088	3	6,7,21,23	Mittal et al., 1994
Poecilia reticulata				form.	2.5					96h	LC50	mortality	1.8	3	6,7,21,62	L'Hotellier, Vincent, 1986

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Poecilia reticulata			F							96h	LC50		1.8	3	6,61	Pawlisz et al. 1998
Poecilia reticulata			F							96h	LC50		0.87	3	6,61	Pawlisz et al. 1998
Puntius gonionotus				form.	2.5					96h	LC50	mortality	0.87		6,7,21,62	L'Hotellier, Vincent, 1986
Puntius gonionotus			F							96h	LC50		0.87	3	6,61	Pawlisz et al. 1998
Rhodeus sericeus amarus		S								96h	LC50		1.12	3	6,61	Pawlisz et al. 1998
Rhodeus sericeus amarus					tg					96h	LC50	mortality	1.12	3	6,21,62	L'Hotellier, Vincent, 1986
Rhodeus sericeus amarus		F								96h	LC50		140	3	6,61	Pawlisz et al. 1998
Rhodeus sericeus amarus				form.	0.01					96h	LC50	mortality	140	3	6,7,21,62	L'Hotellier, Vincent, 1986
Salmo salar				form.	2.5					96h	LC50	mortality	0.59	3	6,7,21,62	L'Hotellier, Vincent, 1986
Salmo salar		Y	R	Decis				10		96h	LT50		0.59	3	6,61	Pawlisz et al. 1998
Salmo salar			F			tg				96h	LC50		1.97	4*	6,58	Pawlisz et al. 1998
Salmo salar		Y	R					10		96h	LT50		1.97	4*	6,58	Pawlisz et al. 1998
Salmo salar					tg					96h	LC50	mortality	1.97	4*	6,21,31	L'Hotellier, Vincent, 1986
Salmo salar	juvenile, 9.6cm, 9.4g	Y	R	NRDC 161				10		96h	MATC	mortality	1.97	3	6,10,33,34,44	Zitko et al., 1979
Salmo trutta				form.	2.5					48h	LC50	mortality	4.7	4	6,7,21,62	L'Hotellier, Vincent, 1986
Salmo trutta			F							96h	LC50		4.7	4	6,61	Pawlisz et al. 1998
Salmo trutta			F							96h	LC50		3.2	4	6,58,60	Pawlisz et al. 1998
Sarotherodon mossambicus			F							96h	LC50		3.5	4	6,61	Pawlisz et al. 1998
Sarotherodon mossambicus			F							96h	LC50		2	4	6,61	Pawlisz et al. 1998
Silurus glanis	fingerlings, 15-18 g weight, 13-15 cm length	N	S	Decis 2.5 EC		dtw	8.4±0.1	17±1	196±15	96 h	LC50	mortality	0.686	3	5,6,7,9,10,13,34	Köprücü *et al*., 2006a
Silurus glanis	fingerlings, 15-18 g weight, 13-15 cm length	N	S	Decis 2.5 EC		dtw	8.4±0.1	17±1	196±15	96 h	LC10	mortality	0.392	3	5,6,7,9,10,13,34	Köprücü *et al*., 2006a
Tilapia mossambica					tg					96h	LC50	mortality	3.5	4	6,21,31	L'Hotellier, Vincent, 1986
Tilapia mossambica				form.	2.5					96h	LC50	mortality	2	4	6,7,21,31	L'Hotellier, Vincent, 1986
Tilapia mossambica				form.	2.5					96h	LC50	mortality	0.8	4*	6,7,21,31	L'Hotellier, Vincent, 1986
Tilapia mossambica			S							48h	LC50		0.8	4*	6,58	Pawlisz et al. 1998
Tilapia mossambica											LC50		0.8	4*	6,62	Bocquet and L´Hotellier, 1984
Tilapia mossambica			F							96h	LC50		0.8	4*	6,58	Pawlisz et al. 1998
Tilapia mossambica	5-6cm	N	S	form.		nw		15-21.4		48h	LC50	mortality	0.8	3	6,26,34	Mulla et al., 1978b
Tilapia mossambica	5-6cm	N	S	form.		nw		15-21.4		48h	LC10	mortality	0.4	3	6,23,26,34	Mulla et al., 1978b
Amphibia																
Anisops bouvieri	adults	N	S		98.8					24 h	LC50	mortality	2.86	3	5,6	Jebanesan and Angelo, 1991
Anisops bouvieri	adults	N	S		98.8					96 h	LC50	mortality	2.25	3	5,6,36	Jebanesan and Angelo, 1991
Bufo arenarum	tadpole, 12-15 mm	N	R		99.70				80	96	LC50		4.4	4	6,58	Crommentuijn et al. 2001
Bufo bufo	larvae			form.	2.5					96h	LC50	mortality	0.93	4	6,7,21,31	L'Hotellier, Vincent, 1986
Bufo bufo	larvae	N	S							72h	LC50		1	3	6,58	Crommentuijn et al. 2001
Diplonychus indicus	adults	N	S		98.8					24 h	LC50	mortality	4.5	3	5,6	Jebanesan and Angelo, 1991
Diplonychus indicus	adults	N	S		98.8					96 h	LC50	mortality	26.5	3	5,6,36	Jebanesan and Angelo, 1991
Rana temporaria	tadpole	N	S				7.1		160	48h	LC50		20	4	6,20,58	Crommentuijn et al. 2001
Ranatra elongata	adults	N	S		98.8					24 h	LC50	mortality	2.8	3	5,6	Jebanesan and Angelo, 1991
Ranatra elongata	adults	N	S		98.8					96 h	LC50	mortality	2.3	3	5,6,36	Jebanesan and Angelo, 1991
Ranatra filiformis	adults	N	S		98.8					24 h	LC50	mortality	3	3	5,6	Jebanesan and Angelo, 1991
Ranatra filiformis	adults	N	S		98.8					96 h	LC50	mortality	2.3	3	5,6,36	Jebanesan and Angelo, 1991

NOTES

1 Followed WHO guidelines
2 Following the OECD protocols.
3 EPA guideline followed
4 ISO conditions used
5 According to a APHA (American Public Health Association) method.
6 Test result and/or some test concentrations above solubility limits.
7 Concentration active compound in formulation lower than 10%
8 high concentration of solvents (>0.01%)
9 Acetone used as solvent.
10 Ethanol used as solvent
11 no control reported

12 Tests were repeated if more than 20% control mortality was observed.
13 Solvent control mortality <10%
14 Solvent control mortality >10%
15 Mortality in solvent controls was never greater than 12% and was often 0 %.
16 Test result based on measured concentrations.
17 Test result based on nominal concentrations.
18 results are expressed as final nominal concentration
19 Values of EC50 were calculated from nmol/l.
20 Measured concentration < 80 % of nominal.
21 Results are reported in active ingredient.
22 recalculated and corrected for formulation, original results are for formulated product

23 E/LC10 calculated from E/LC50 and E/LC90
24 Conducted in plastic cups.
25 test provided in waxed paper cups
26 fiberglass tank
27 not exact written if corrected for purity
28 Strain previously exposed to other pesticide
29 Paper not in English data from english abstract
30 Review.
31 review, refs not given
32 Hardness calculated
33 not exact written if results are based on nominal or measured test concentration (suppose nominal)
34 Not clear if results are reported in mg/L formulation or mg/L active ingredient
35 Restant strain used
36 Static test → concentration of deltamethrin surely decreased over exposure time.
37 Mixture of 2 species
38 LC50 determined at 48 hours
39 EC50 determined at 24h
40 One pulse exposure, followed by flow-through of clean water;sediment/water system.
41 Sediment-water system.
42 with a layer of small gravel
43 Performed by conventional methods: Method for Measuring Water Toxicity by Mortality and Fecundity Changes in Daphnia. PND FT 14.1:2:3:4.3-99. Moscow: Gosudarstvennyi komitet Rossiiskoi Federatsii po okhrane okruzhayushchei sredy, 1999.
44 test according Zitko et al. 1976
45 LC50 calculated from data in paper
46 Actually Anopheles nigromaticulatus??
47 Feeding during the exposure; conducted in darkness.
48 Possibility of induction of enhanced toxicity of pesticides in the presence of light was studied.
49 Control experiment revealed no toxicity to *Paramecium* with deltamethrin when the organisms were kept in the dark for up to six hours.
50 Cells were observed after 90 minutes in the dark in the presence of deltamethrin.
51 Cells were observed after 15,30,45,60 and 90 minutes of exposure to sunlight in the presence of deltamethrin.
52 all aquaria were aerated
53 EC100 in results as a MLD minimum lethal doses - 100%mortality in 24 hours (according WHO standard method 1963)
54 too high temperature

55 benthic species
56 flushing bioassay system
57 Control performed but no results reported
58 Data cited from other source
59 error in conversion; values based on original data of Varanka are a factor of 1000 higher
60 value could be retrieved in cited reference
61 Data cited from other unavailable source, indicated by Pawlisz et al. 1998 as incomplete
62 Data cited from other source but no reference given
63 error in reported value, given as active ingredient but was concentration of the formula
64 Data cited from other unavailable source

Table A2.2. Acute toxicity of deltamethrin to marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/l]	Ri	Notes	Reference
Bacteria																
Vibrio fischeri	NRRL B-111 77	N	S			am			20	30 min	EC50	bioluminiscence inhibition	101 x10^3	3	12,13,14,15	Farré *et al.*, 2002
Vibrio fischeri											EC50		>212x10^3	4*	13,28,62	HSE 2004
Mollusca																
Crassostrea virginica					2.5					96h	LC50	mortality	12	4*	15,24,25,30	L'Hotellier, Vincent, 1986
Crassostrea virginica	38 mm		F	Decis 2.5 EC				19-22		96 h	EC50		15	4*	15,28,29	Pawlisz et al. 1998
Crassostrea virginica	38 mm		F	Decis 2.5 EC				19-22		96 h	NOEC		4	4*	15,29	Pawlisz et al. 1998
Crassostrea virginica										96 h	EC50		8.20	4*	15,27,28,62	HSE 2004
Crassostrea virginica										96 h	NOEC		3.40	4*	15,27,28,62	HSE 2004
Crustacea																
Americamysis bahia	Juveniles		S				8	23-25		96 h	LC50		0.0017	4*	29	Pawlisz et al. 1998
Americamysis bahia	Juveniles		S				8	23-25		96 h	NOEL		0.00057	4*	29	Pawlisz et al. 1998
Americamysis bahia		Y	R		tg					96 h	LC50		3700	4*	15,27,28,62	HSE 2004
Americamysis bahia		Y	R		tg						NOEC		60	4*	15,27,28,62	HSE 2004
Ceratothoa gaudichaudii	1-1.5cm		S	K-othrina EC		nw		15		60min	LOEC, EC 100	mortality	≤8000	3	14,15,16	Sievers et al., 1995
Ceratothoa gaudichaudii	2-3cm		S	K-othrina EC		nw		15		60min	LOEC, EC 100	mortality	≤8000	3	14,15,16	Sievers et al., 1995
Decapoda											EC50		0.0014	4*	9,10	Day, 1989
Homarus americanus	adult, 450g	Y	R	NRDC 161		nw		10	30	96h	MATC	mortality	0.0014	4	4,5,6,7,8	Zitko et al., 1979
Homarus americanus	450 g		S							96 h	LT50		0.4	3	15,28	Pawlisz et al. 1998
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population N- Trondelag	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.04	3	18,19,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population Rogaland	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.254	3	15,.18,19,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population S - Trondelag	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.062	3	18,19,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population Agder	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.104	3	18,19,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.356	3	15,18,19,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population Rogaland	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	5	3	15,18,19,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population S - Trondelag	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	1.85	3	15,17,18,20,21	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population N- Trondelag	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.517	3	15,18,19,21,22	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population Rogaland	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.819	3	15,18,19,21,22	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population S - Trondelag	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.198	3	18,19,21,22	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population Agder	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.516	3	15,18,19,21,22	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	1.149	3	15,17,18,21,22	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population Rogaland	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	0.926	3	15,17,18,21,22	Sevatdal, Hrosberg, 2003
Lepeophtheirus salmonis	preadult II lice from 1st generation lab. reared population S - Trondelag	Y	F	AlphaMax	1	nw		12	32-34	30min	EC50	imobilisation	4.455	3	15,17,18,21,22	Sevatdal, Hrosberg, 2003
Penaeus duorarum				form.	2.5					96h	LC50	mortality	0.35	3	15,24,25,26	L'Hotellier, Vincent, 1986
Penaeus duorarum			S	Decis				22		24 h	LC50		0.56	3	15,28	Pawlisz et al. 1998
Penaeus duorarum			S	Decis				22		96 h	LC50		0.35	3	15,28	Pawlisz et al. 1998

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/l]	Ri	Notes	Reference
Penaeus duorarum			F							96 h	LC50		1.5	3	15,28	Pawlisz et al. 1998
Tisbe battagliai	new-born (nauplii)	Y	R		99.8	nw	8.1	20±1	30	96 h	LC10	mortality	0.0049	2	1,2,3	Barata et al., 2002
Tisbe battagliai	new-born (nauplii)	Y	R		99.8	nw	8.1	20±1	30	96 h	LC50	mortality	0.0151	2	1,2,3	Barata et al., 2002
Uca pugilator				form.	2.5					96h	LC50	mortality	1.1	4*	15,24,25,30	L'Hotellier, Vincent, 1986
Uca pugilator	Adult			Decis				15-19		96 h	LC50		1.1	4*	15,29	Pawlisz et al. 1998
Uca pugilator	Adult			Decis				15-19		24 h	LC50		1.9	4*	15,29	Pawlisz et al. 1998
Uca pugilator										96 h	LC50		0.56	4*	15,29	Pawlisz et al. 1998
Pisces																
Cyprinodon variegatus			F							96 h	LC50		0.90	4*	15,29	Pawlisz et al. 1998
Cyprinodon variegatus	0.11-0.35 g		S				8.0	21-24		96 h	LC50		0.36	4*	15,29	Pawlisz et al. 1998
Cyprinodon variegatus	0.11-0.35 g		S				8.0	21-24		96 h	NOEC		0.25	4*	15,29	Pawlisz et al. 1998
Salmo salar	100g	N	S	K-othrina EC		nw				60min	LOEC, EC100	mortality	≤8000	3	14.15	Sievers et al., 1995

1 Test animals were fed during the exposure.
2 Acetone used as solvent; it was allowed to evaporate.
3 Test result based on measured concentrations.
4 LT - lethal threshold - geometric mean of the highest concentration without and the lowest concentration with mortality
5 test provided in fibreglass
6 test compound dissolved in ethanol, no other information about amount of solvent in test concentration
7 not exact written if results are based on nominal or measured test concentration (suppose nominal)
8 not clear purity (formulated product)
9 Review.
10 From National Research Council of Canada. 1986. Pyrethroids: Their effects on aquatic and terrestrial ecosystems. NRCC/CNRC 24376. Ottawa, Ontario, Canada.
11 Cellsense is an amperometric biosensor which measures the electrical current produced by the bacteria's electron transport chain, the current generated being proportional to the level of metabolic activity of the cells. For further details: Farré M, Pasini O, Alonso MC, Castillo M, Barceló D (2001) Anal Chim Acta 426:155-165; Evans MR, Jordinson GM, Rawson DM, Rogerson JG (1998) Pestic Sci 54: 447-451.
12 Tox Alert 100 system. For further details: Farré M, Garcia MJ, Tirapu L, Ginebreda A, Barceló D (2001) Anal Chim Acta 427:181-189; Farré M, Garcia MJ, Castillo M, Riu J, Barceló D (2001) J Environ Monit 3: 232-237; Perez S, Farré M, Garcia MJ, Barceló D (2001) Chemosphere 45: 705-712.
13 Methanol used as solvent in order not to exceed the maximum allowed percentage (10%).
14 Purity is not clear; it is also not clear if results are reported in mg/L formulation or mg/L active ingredient.
15 Test result and/or some test concentrations above solubility limits.
16 followed by 15 h recovery time
17 exposed on fish (salmon) - ectoparasitic copepod
18 formulation (10mg deltaethrin/ml), test concentration and results as nominal test concentration, only slight reduction of deltamethrin 10-20%
19 sea lice were kept in polystyrene boxes with holes in the bath (20l tanks)-ectoparasitic copepod
20 30min exposure was followed by 24 h of recovery time and than evaluated
21 Ec50 values are estimate from fig 1(p26) using techdig
22 30min exposure was followed by 6 h of recovery time and than evaluated
24 Results are reported in active ingredient.
25 review, it is not written were the data (LC50) are from - no reference cited, there are also some data about biodegradability, bioaccumulation, bioconcentration and field experiments
26 too low purity
27 EPA guidelines followed
28 Data cited from other source
29 Data cited from other un available source, indicated by Pawlisz et al. 1998 as incomplete
30 Data cited from other source but no reference given

Table A2.3. Chronic toxicity of deltamethrin to freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness CaCO3 [mg/L]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Algae																
Scenedesmus subspicatus		N	S		ag	am	8.3±0.2	22±2		72 h	NOEC	growth rate	1250	3	7,16,17	Burkiewicz *et al.*, 2005
Mollusca																
Anodonta cygnea	adults, 12-15 cm	N	S	Decis	2.5	nw		18-22		7 d	NOEC	filtering activity	1	3	7,19,20	Kontreczky *et al.*, 1997
Lymnaea stagnalis	shell height 48-53mm, width 28-33mm	N		K-Othrine	0.12	dtw				7w	NOEC	mortality	≥100	3	7,21,22	Présing, 1993
Lymnaea stagnalis	shell height 48-53mm, width 28-33mm	N		K-Othrine	0.12	dtw				7w	LOEC	reproduction	≤1	3	7,21,22	Présing, 1993
Lymnaea stagnalis	shell height 48-53mm, width 28-33mm	N		K-Othrine	0.12	dtw				7w	NOEC	embryonic dev.	≥100	3	7,21,22	Présing, 1993
Lymnaea stagnalis	F2 from treated F0	N		K-Othrine	0.12	dtw				17w	LOEC	mortality	≤1	3	7,21,22	Présing, 1993
Lymnaea stagnalis	F2 from control F0	N		K-Othrine	0.12	dtw				17w	LOEC	mortality	≤1	3	7,21,22	Présing, 1993
Lymnaea stagnalis	F2 from treated F0	N		K-Othrine	0.12	dtw				17w	LOEC	reproduction	≤1	3	7,21,22	Présing, 1993
Lymnaea stagnalis	F2 from control F0	N		K-Othrine	0.12	dtw				17w	LOEC	reproduction	≤1	3	7,21,22	Présing, 1993
Lymnaea stagnalis	F2 from treated F0	N		K-Othrine	0.12	dtw				17w	NOEC	embryonic dev.	≥100	3	7,21,22	Présing, 1993
Lymnaea stagnalis	F2 from control F0	N		K-Othrine	0.12	dtw				17w	NOEC	embryonic dev.	≥100	3	7,21,22	Présing, 1993
Crustacea																
Daphnia magna	48h old	N					23±0.5			7d	EC100	mortality	10.08	3	7,16,23	Ratushnyak et al., 2005
Daphnia magna	48h old	N					23±0.5			7d	LOEC	mortality	≤$1.008x10^{-20}$	4	16,23	Ratushnyak et al., 2005
Daphnia magna	48h old	N					23±0.5			11d	LOEC	mortality	≤$1.008x10^{-5}$	4	16,23	Ratushnyak et al., 2005
Daphnia magna	48h old	N					23±0.5			11d	LOEC	reproduction	≤$1.008x10^{-5}$	4	16,23	Ratushnyak et al., 2005
Daphnia hyalina			S	form.	0.12	nw		22-23			LOEC	reproduction	0.0050	3	2,3,4	Addendum, 2002
Daphnia magna		Y	F							21 d	NOEC		0.0041	2	1,4	List of end points, 2002
Insecta																
Chironomus riparius			S							28 d	NOEC		0.01	4	2,4	List of end points, 2002
Chironomus riparius		Y					7.0	20±2		28 d	NOEC	emergence rate	0.01	4	2,5,6,8,16	Addendum, 2002
Chironomus riparius		Y					7.0	20±2		28 d	LOEC	emergence rate	0.02	4	2,5,6,8,16	Addendum, 2002
Chironomus riparius		Y					7.0	20±2		28 d	NOEC	development rate	0.05	4	2,5,6,8,16	Addendum, 2002
Pisces																
Abramis brama	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		24h	NOEC	mortality	250	3	7,9	Tóth et al., 1995
Abramis brama	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		72h	EC100	mortality	2500	3	7,9,10	Tóth et al., 1995
Abramis brama	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		288h	NOEC	hatching time	0.03	3	9,11	Tóth et al., 1995
Barbus barbus	embryos		R	DECIS	2.5	nw	8.4-8.6	16±0.5		24h	NOEC	mortality	250	3	7,9	Tóth et al., 1995
Barbus barbus	embryos		R	DECIS	2.5	nw	8.4-8.6	16±0.5		72h	EC100	mortality	2500	3	7,9,1 3	Tóth et al., 1995
Cyprinus carpio	eggs (early cleavage stages)	N	S	Decis	2.8	tw	7.5±0.2	24±1	272±2	until complete hatching	EC100	hatching	560	3	7,18	Dhawan and Kaur, 1996
Cyprinus carpio	eggs (early cleavage stages)	N	S	Decis	2.8	tw	7.5±0.2	24±1	272±2	48 h after completed atching	EC100	viable hatch	140	3	7,18	Dhawan and Kaur, 1996
Cyprinus carpio var, communis	4.5±0.5g	N	R	EC	2.8	am		28±1		30d	LOEC	food uptake	≤0.5	4	7,16	Ramakrishnan et al., 1991
Danio rerio	eggs 2h	Y	CF		>98%	tw	7.5-8.5		408	6d	NOEC	hatching	0.50	3	7,24,26	Crommentuijn et al. 2001
Danio rerio	eggs 2h	Y	CF		>98%	tw	7.5-8.5		408	35d	NOEC	mortality	0.17	2	24,26	Crommentuijn et al. 2001
Danio rerio	eggs 2-3h	Y	CF		>98%	tw	8 ± 0.5	27 ± 1	428 ± 2	35d	LC50	mortality	0.52	3	7,24,25	Gorge & Nagel 1990
Danio rerio	eggs 2-3h	Y	CF		>98%	tw	8 ± 0.5	27 ± 1	428 ± 2	4d	NOEC	hatching	0.50	3	7,24,25	Gorge & Nagel 1990
Esox lucius	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		24h	NOEC	mortality	250	3	7,9	Tóth et al., 1995
Esox lucius	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		118h	EC100	mortality	2500	3	7,9,14	Tóth et al., 1995
Oncorhynchus mykiss			F							28 d	NOEC		< 0.032	4	1,4	List of end points, 2002
Rutilus rutilus	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		24h	NOEC	mortality	250	3	7,9	Tóth et al., 1995
Rutilus rutilus	embryos		R	DECIS	2.5	nw	8.4-8.6	12.0±0.5		72h	EC100	mortality	2500	3	7,9,12	Tóth et al., 1995

NOTES

1 Test result based on measured concentrations.
2 Test result based on nominal concentrations.
3 Présing M, 1989. Data on the toxic effect of K-Othrine on crustaceans. Report No. C015982. Archiv Hydrobiologie 114 (4), 621-630. Also published in Hungarian in 1986, with summary in English: Hidrológiai Közlöny 66 (2), 90-93.
4 Results are reported in active ingredient.
5 Followed the 1995 proposal for a BBA-guideline.
6 Acetone was used as solvent in non exceeding concentration.
7 Test result and/or some test concentrations above solubility limits.
8 Heusel R, Gildemeister H and Gosch H, 1998. Chronic toxicity to the sediment dwelling chironomid larvae Chironomus riparius. Report No. A74315. Study Id. CE96/126. Hoechst Schering AgrEvo GmbH, Frankfurt am Main.
9 corrected for purity (in the study)
10 control mortality about 75%
11 control mortality about 98%
12 control mortality about 10%
13 control mortality about 50%
14 control mortality about 55%
16 Purity is not clear; it is also not clear if results are reported in mg/L formulation or mg/L active ingredient
17 Following the standard protocol of ISO 8692: International Organization for Standardization (1989) Fresh water algal growth inhibition test with *Scenedesmus subspicatus* and *Selenastrum capricornutum*. International Standard 8692, Geneve (Switzerland).
18 Test results corrected for purity.
19 Conducted in plastic cups.
20 Not clear if results are reported in mg/L formulation or mg/L active ingredient.
21 exposure in deltamethrin solutions during 1st, 4th, and 7th weeks, during 2-3rd abd 5-6 weeks they were kept in clean water
22 Results are reported in active ingredient.
23 value estimate using techdig from fig. 2a and recalculated from M
24 control mortality about 20%
25 actone used as co-solvent but earlier controls showed no toxic effect from the acetone
26 Data cited from other source

Table A2.4. Chronic toxicity of deltamethrin to marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [µg/L]	Validity	Notes	Reference
Crustacea																
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	LC10	mortality	0.0047	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	LC50	mortality	0.0106	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	EC10	feeding rate	0.0281	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	EC50	feeding rate	0.0581	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	EC10	clutch size	0.0087	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	EC50	clutch size	0.0138	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	EC10	reproductive success	0.0161	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	EC50	reproductive success	0.0378	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	LC10	egg survival	0.0641	2	1,2,3	Barata et al., 2002
Tisbe battagliai	adult females	Y	R		99.8	nw	8.1	20±1	30	6 d	LC50	egg survival	0.0887	2	1,2,3	Barata et al., 2002
Echinodermata																
Lytechinus variegatus	eggs	N	S		2.5	nw				24 h	LOEC	development	≤0.01041	3	4,5,6	Medina et al., 1994

NOTES
1 Test animals were fed during the exposure.
2 Acetone used as solvent; it was allowed to evaporate.
3 Test result based on measured concentrations.
4 too low purity
5 not exact written if corrected for purity
6 recalculated form 2.06*10-5 M

Appendix 3. Description of mesocosm studies

Study 1
The toxicity of deltamethrin to the mosquito *Aedes cantans* was investigated under field conditions (Rettich, 1980). An LD100 was observed at 30 mg/L.

Study 2
The effect of deltamethrin was investigated in prairie ponds via application by air at a rate of 7.5 g/ha (Morrill and Neal, 1989). The concentration of deltamethrin in the water column peaked at 0.2 – 0.23 µg/L within 1 h of application, then declined to 0.01 – 0.02 µg/L 48 h after application. Due to this application, the density of chironomid larvae declined by two orders of magnitude, with all genera being affected. The two treated ponds recovered at different rates: the community in one pond appeared to have recovered by 2 months after treatment, whereas that of the other pond showed little recovery until 1 year following treatment.

Study 3
Lahr investigated the effect of deltamethrin to invertebrates in temporary ponds in the Sahel (Lahr, 1998). The initial concentration ranged from 0.01 – 1.28 µg/L. The aquatic invertebrate *Streptocephalis spp*. and *Anisops sardeus* were used as indicator species. In a static laboratory test the LC_{50} of this species for deltamethrin was 0.018 and 0.012 µg/L. In the ponds, large effects were observed together with effects on *Ceriodaphnia quadrangular*. It was concluded that deltamethrin was likely to wipe out all groups of indicator species.

Study 4
During tsetse control operations near Bouaflé, Ivory Coast, Africa a study was made of environmental side-effects of helicopter sprayings with permethrin and deltamethrin in a riverine forest (Everts *et al*., 1983). Deltametrin was sprayed five times at 12.5 g a.i./ha. Concentrations in the aquatic environment were not reported and the study is therefore not very useful for deriving a MPC. The most severe effects were observed for the smaller shrimps (*Caridina Africana*) which were virtually eliminated.

Study 5
Deltamethrin was employed in a mesocosm experiment at a concentration of 13 µg/L (Tidou *et al*., 1992). One day after treatment, all species of zooplankton were found dead. The elimination of filter-feeding zooplankton was followed by an increase of the concentration of chlorophyll a in the post-treatment period. Two months later recovery of the orginal zooplankton was observed, though some species remain rare (e.g. rotifers).

Study 6
Caquet *et al*. (1992) studied the effect of deltamethrin in freshwater mesocosm after a single dose equivalent to 10 g a.i.ha-1, resulting in an initial concentration of 0.5 µg/L. Four days after this treatment, the remaining concentration was 0.1%. From this data a DT_{50} in water was estimated of 1 – 2 hours. The mortality of surface living insects such as water-striders (*Gerris thoracicus* and *G. lacustris*) and water-measurers (*Hydrometra stagnorum*) was very high during the first hours. Also other arthropods, such as aquatic beetles and water bugs, were found dead. Dead larvae were found in the glass containers used for sediment sampling. One month after treatment a phytoplantonic bloom was observed. An increase in periphyton ash-free dry weight occurred. The deltamethrin has a strong effect on the insect community. The number of adults captured decreased sharply during the three weeks following the application. After three weeks the rate of emergence was undetectable.

Evaluation of the scientific reliability of the field or mesocosm studies 1 up to 6
The field or mesocosm studies were performed at high water concentrations, substantially higher than the reported LC_{50} value. These studies are therefore not considered to be usefull for deriving ERLs for water.

The following summaries are taken from the first revison of the DAR (EC, 2002)

Study 7

Schanné and van der Kolk, 2001, and Schanné, 2001a and b
Method
An outdoor microcosm study was performed to study deltamethrin's effects on zooplankton, sediment and macroinvertebrate populations, and to determine the fate and distribution of the substance. Deltamethrin (^{14}C-gem-dimethyl-labelled) was formulated as DECIS 25 g/l EC.

Sediment, water and naturally occurring biota were taken from parts of the Central-European Lake Constance. The sediment (from "Bay of Fussarch" in Austria, being a large littoral area typical of an oligotrophic lake site) contained 65% sand, 29% silt, 6% clay, and 1% OC. The systems were established in March, with physical/chemical monitoring starting in mid-April, and biological monitoring in early May. Due to the expected sensitivity of *Asellus aquaticus*, about 300 individuals of this isopod species were introduced to the basin in mid-April.

Eight treatment levels in triplicate and six untreated control replicates were set up. Thirty stainless steel cylindric enclosures (∅ 1.1 m, height 1.7 m, water volume about 0.95 m^3) were thus established into a concrete basin (9 m x 9 m x 1.5 m, water depth about 1 m) lined with polyethane coating. The test substance was applied to the water surface by means of pipettes, thereafter sticks were used to slowly mix the water, to achieve homogenous distribution in the upper water column. Nominal target concentrations per application were: 1.0, 3.2, 10, 18, 32, 56, 100 and 180 ng a.s./l water. The enclosures were introduced on 7 June. Application was done 3 times, starting on 13 June (Day 0), with 7 days interval.

At test initiation, naturally growing macrophytes occupied about 19% of the water column (approx. 50 g dw per enclosure). They consisted of *Chara spec.* (95%) reaching a height of about 10 cm above the sediment and *Potamogeton pectinatus* and *Zanniechellia palustris* (5%) reaching > 10 cm. Before the first treatment, six bundles of *Elodea canadensis* were placed in each enclosure to provide additional biomass for sampling (each bundle about 100 g fw, total 60 g dw per enclosure). At each sampling for chemical analysis, about half of each bundle was removed.

Samples of biota in water, sediment and trapping systems (cages, plates, and emerging insect traps), water (depth-integrated) and sediment (down to 20 cm depth) were collected regularly until early November (Day 140-145). Data obtained from the cages of each enclosure (subsurface, mid water, and above sediment) were individually recorded but then added to receive abundance enough for interpretation. A total of 50 groups of biota were identified, based on taxonomy/form of an organism (e.g. nauplii)/eco-functional group (e.g. bacterivorous ciliates)/place of occurrence within the system/abundance and occurrence in time. Ciliates were investigated only on days 16, 29 and 42 due to their short generation time (and thus high possibility for recovery between each treatment). In addition, ciliates were not investigated at all treatment levels. Concentrations of chlorophyll(a) and phaeophytin in the water samples were determined. Physical/chemical characterization included pH, dissolved oxygen, temperature, conductivity, N/P-ratio, alkalinity, hardness, and TOC/DOC.

In addition to analysis with LSC, TLC was used to characterize residues in samples of organosoluble fractions in the water (extraction in dichloromethane). Analysis was performed on samples collected from the three highest test concentrations. Analysis in sediments (0-5 cm layer) was only possible at the highest treatment level. To avoid excess of algae in the system, algae were removed when necessary. The estimate of total radioactive residues (TRR) in algae was added to the TRR in macrophyta.
A p-value of 0.05 was used for the statistical evaluation[2]. Significant differences from the controls which occurred only at single days per test level, or without dose-response relationship were not considered to be test item related.

Results

[2] A non-parametric test was used to identify outliers (defined as values above or below 3 times the interquartile range from the 75th percentile). Shapiro-Wilk's and Levene's tests were used to analyse the data (transformed) for normal distribution and homogeneity of variance, respectively. Data which followed a normal distribution were analysed by the parametric univariate analysis of variance. In case H_0 (means are equal) was rejected, one of the following tests was performed (depending on the results from the Levene's test) to establish whether or not the difference between a treatment group and control was significant: the 2-sided Dunnett pair-wise comparison test was conducted for equal variances; the Games-Howell pair-wise comparison test was conducted for unequal variances. Data which did not follow normal distribution were analysed by the non-parametric Kruskal-Wallis ANOVA test by ranks. In case H_0 (means are equal) was rejected, the pair-wise non-parametric Mann-Whitney U-test was performed to establish statistically significant differences.

Distribution and mass balance: Total radioactive residues in the **water** (TRR_{water}) reached maxima which represented 70-123% of the total nominal concentrations (e.g. 3.7 ng deltamethrin equivalents/l and 380 ng a.s. equivalents/l at the lowest and highest treatment levels, respectively). These maximum levels were measured during day 13-15 or as a delayed peak on day 21. The delay was probably due to release of water soluble metabolites from sediment and/or macrophytes. At test termination, the TRR_{water} varied between 32 and 60% of the total applied radioactivity. DT_{50} values for the decline in TRR_{water} from day 21 were 86-142 days in the different treatment levels, with an average of 116 days.

In the **macrophyte**, the radioactivity showed a sharp peak during the treatment period followed by a fast decline until day 29. Thereafter, the macrophyte associated residues either increased constantly or showed a plateau towards the end of the study. At test termination, 7.4% of the applied radioactivity was found in macrophyte. Maximum mean residues found in macrophyta were 15, 35 and 56 µg a.s. equivalents/kg fresh weight, in the 56, 100 and 180 ng a.s./l enclosures, respectively. These concentrations were measured on day 8 or 15. At test termination, 13, 23 and 36 µg a.s. equivalents/kg were still found, respectively.

The **sediment** showed a more or less constant residue content throughout the study (as determined at the highest test level only); 139-451 ng deltamethrin equivalents/kg fresh weight sediment, with the maximum value measured at test termination. This represented only 4.1% of the applied radioactivity.

Characterisation of residues: HPLC-RAM characterization of the test substance showed >96% deltamethrin, with the remaining activity as α,R-deltamethrin. At 3 hours after application, deltamethrin accounted for 47-75% of the TRR_{water}; α,R-deltamethrin 25-44%; and *trans*-deltamethrin was detected as < LOD to 8.9%. After 24 hours deltamethrin accounted for 24-48% of the TRR_{water}; α,R-deltamethrin for 21-38%; and *trans*-deltamethrin as < LOD to 17%. In addition to the isomers, metabolites accounted for 14-48% of the TRR_{water} 24 hours after the 1st application. There was thus a rapid isomerization and metabolization. Dissipation half-life for deltamethrin in the water was ≤ 17 hours. As determined at the highest test concentration, deltamethrin and the two isomers were not detectable in the water from day 21. Instead, seven other radioactive fractions were found. One of them was identified as Br_2CA as maximum 20% of the TRR_{water} on day 21. Four other fractions made up maxima of 3.7-18% each. One fraction accounted for 50% of TRR_{water} on day 21 and then steadily decreased. All these fractions decreased to <LOD within the study, but one fraction F7 was present at a maximum of 22% of the TRR_{water} on day 145. F7 was more polar than deltamethrin and the isomers, but less polar than Br_2CA.

Physical/chemical characterization:
Water temperature: 19.2 - 22.7°C until day 71; thereafter decreasing to min. 7.4°C.
Dissolved oxygen (at mid-depth): 8.6 - 14.8 mg/l, depending on season.
pH: 8.3 - 9.3 before and during treatments; thereafter 8.5-10.1, indicative of a high production.
Conductivity: about 150 µSi/cm (125 - 176 µSi/cm)
Alkalinity: 40-60 mg/l $CaCO_3$ until day71; thereafter increase to max. 90 mg/l $CaCO_3$
Hardness: about 60-80 mg/l $CaCO_3$ (moderately soft)
No statistically significant difference was observed in the physical/chemical parameters.

Productivity: No effect on the phytoplankton biomass was observed as there was no statistically significant difference from controls in either the concentration of chlorophyll(a), or the ratio chloro-phyll(a) to phaeophytin. A chlorophyll(a) peak (max 16.8 µg/l) was seen between days 13 to 29, thereafter the concentrations decreased to a minimum of 1.8 µg/l in early September (day 99). Towards the end of the study the levels increased slightly. The systems can be characterized as mesotrophic.

Biological effects: The effects for all groups (except Ciliata) are summarised in Table 8.2.2.d. Further details are given in Appendix I to section B.8 Ecotoxicology.

Data on taxonomic richness (number of determination groups in different sampling devices) showed:
- The diversity of the macrophyte associated community was significantly reduced from 56 ng a.s./l, with recovery observed day 57-71. Below this concentration, only occasional significances were calculated. Separate analyses show that the reduction was a result of effects on the insect community.
- The taxonomic richness among the emerging insect adults was affected at 100 and 180 ng a.s./l.
- The diversity of the zooplankton community in the free water column was reduced from 32 ng a.s./l, with recovery observed by day 57 at the highest treatment level. Below 32 ng a.s./l isolated significancies were calculated down to 10 ng a.s./l.

Table 8.2.2.d. Summary of effects of three applications of ^{14}C-deltamethrin, formulated as DECIS 25 g/l EC, to microcosm enclosures, at eight different nominal concentrations. Numbers represent days of onset and end of statistically significant effects. Numbers in brackets represent the day at which the organism had recovered at the latest. Day 0 = 13 June, 1st application. The 2nd and 3rd applications were done with 7 days interval.

Nominal concentration per application (ng a.s./l) :	**1.0**	**3.2**	**10**	**18**	**32**	**56**	**100**	**180**
Keratella quadrata MA								NOEC
Remaining Rotifera MA								NOEC
Rotifera (all) MA								NOEC
Nauplii MA								NOEC
Daphnia spp. MA								NOEC
Sida crystallina MA								NOEC[1]
Chydorus sphaericus FW								NOEC
Acropercus harpae MA								NOEC
Alona spp. MA								NOEC
Alonella spp. MA								NOEC
Graptol. testudinaria MA								NOEC
Remaining Chydoridae MA								NOEC
Ostracoda FW								NOEC
Ostracoda MA								NOEC
Nematoda SED								NOEC
Oligochaeta SED								NOEC
Remaining Oligochaeta MA								NOEC
Tardigrada SED								NOEC
Bithynia tentaculata MA								NOEC
Radix peregra MA								NOEC
Gyraulus albus MA								NOEC
Physidae MA								NOEC
Remaining Gastropoda MA								NOEC
Erpobdella octoculata MA								NOEC
Hirudinea clutches								NOEC
Chironomidae adults EK								NOEC
Chironomidae adults T4 EK								NOEC
Simocephalus vetulus FW							NOEC	13-16 (21)
Cyclopoida FW						NOEC	2-16 (21)	2-21 (29)
Copepoda MA						NOEC	6-16 (21)	2-29 (42)
Nauplii FW						NOEC	2-16 (21)	2-21 (29)
Copepoda FW						NOEC	2-16 (21)	2-21 (29)
Chydorus sphaericus MA						NOEC	2-29 (42)	2-29 (42)
Stylaria lacustris MA						NOEC	19-71 (85)	42-71 (85)
Ephemeroptera adults EK						NOEC	≥ 29 (na)	≥ 29 (na)
Chironomidae adults T1 EK						NOEC	13-29 (na)	13-29 (na)
Cyclopoida MA					NOEC	21-29 (42)	9-21 (29)	2-29 (42)
Helobdella stagnalis MA					NOEC	21-71 (85)	29-42 (57)	21-71 (85)
Corixidae MA					NOEC	9-29 (42)	9-29 (42)	9-29 (42)
Keratella quadrata FW				NOEC	13-21 (29)	13-29 (42)	9-29 (42)	9-29 (42)
Odonata larvae MA				NOEC	≥ 126 (-)	≥ 126 (-)	≥ 16 (-)	≥ 16 (-)
Calanoida FW			NOEC	≥ 29 (-)	≥ 29 (-)	≥ 21 (-)	≥ 29 (-)	≥ 21 (-)
Calanoida MA			NOEC	71-99 (na)	71-≤ 84 (na)	71-99 (na)	71-99 (na)	71-99 (na)
Simocephalus vetulus MA			NOEC	2-9 (13)	2-16 (21)	2-21 (29)	2-29 (42)	2-29 (42)
Trichoptera larvae MA			NOEC[1]	29-42 (57)	29-57 (71)	29-57 (71)	29-57 (71)	29-57 (71)
Chironomidae larvae MA			NOEC	2-16 (21)	13-16 (21)	2-29 (42)	2-29 (42)	2-21 (29)
Daphnia spp. FW		NOEC	13-21 (29)	13-42 (57)	13-85 (-)	13-71 (112)	13-42 (57)	13-29 (42)
Chaoborus adults EK		NOEC[1]	29-42 (57)	29-57 (71)	42-57 (71)	13-57 (71)	29-57 (71)	29-57 (71)
Ephemeroptera larvae MA	NOEC	42-57 (71)	29-42 (57)	9-57 (71)	6-42 (57)	6-71 (85)	6-57 (71)	2-57 (71)
Asellus aquaticus MA	≥99 (-)	≥ 71 (-)	6-71 (85)	≥ 2 (-)	≥ 2 (-)	≥ 2 (-)	≥ 2 (-)	≥ 2 (-)
Chaoborus larvae MA	13-16 (21)	2-16 (21)	2-16 (21)	2-16 (21)	2-16 (21)	2-16 (21)	2-21 (29)	2-29 (42)

MA Macrophyte Associated (Substrate associated). FW Free Water. SED Sediment EK Emergent Insect Trap (Eklektor)
(-) No recovery was observed within the duration of the test.
(na) A recovery statement was not applicable, e.g. when also control counts were very low.
1 For *S. crystallina*, Trichoptera larvae, and Chaoborus adults; see comment by RMS below.

Ciliata: NOEC based on counts for **algivorous ciliates** was 1.0 ng a.s./l, since at higher levels differences from the control from day 29 remained on day 42. NOEC for **bacterivorous ciliates** was 18 ng a.s./l based on a statistically significant reduction in number at 180 ng a.s./l on day 42. Due to the limited number of analyses beyond day 42 an assessment of recovery was not possible for ciliates.

More than half of the determination groups were not affected by any treatment level, directly or indirectly. At the four highest treatment levels (32-180 ng a.s./l) 12-24 groups (23-46%) were affected by acute and/or chronic effects, some of them irreversibly (e.g., dragonfly larvae). The results from the lowest test concentrations were:

1.0 ng a.s./l:	Two groups affected; Short-term effects on Phantom midge larvae with full recovery observed. Very late (and thus not necessarily test item related) effects on *Asellus aquaticus*. No recovery observed but the remaining abundance indicated the potential for recovery.
3.2 ng a.s./l:	Similar effects on Phantom midge larvae and isopods as at 1.0 ng/l. In addition, late effects on may-fly larvae, with recovery due to re-colonization (egg-deposition).
10 ng a.s./l:	In contrast to the findings at lower test concentrations, recovery in the isopod population was observed. Similar effects on Phantom midge larvae as at lower concentrations, but here also the emerging adults were affected, however, reversibly. The effect on may-fly larvae was similar as at 3.2 ng/l. Short-term effects on daphnids were also observed at this level.
18 ng a.s./l:	A total of 10 groups were affected at this level. For 7 of these, reversible effects were noted within 21 to 71 days after the 1st treatment. For isopods and Calanoida (FW), there was no observation of recovery at this level. Finally, for Calanoida (MA) a recovery assessment was not possible.

Evaluation of the scientific reliability of the field study

Criteria for a suitable (semi)field study

1. Does the test system represent a realistic freshwater community? Yes.
2. Is the description of the experimental set-up adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? Yes. Overall mean measured concentrations after application are in good agreement with calculated nominal concentrations. There is no evidence of accumulation of the compound in the water column between applications and calculated nominal concentrations can be used to express the endpoints.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes. Crustaceans are most sensitive in laboratory studies, representatives of these groups are present in the mesocosms and show effects. It should however be noted that under a flow through conditions *Gammarus G. fasciatus* appears to be the most sensitive species which is not tested in this mesocosm studies
5. Is it possible to evaluate the observed effects statistically? Yes. However as noted in the DAR it is unclear how large deviation from the control (in %) was needed to produce significant effects, at the different sampling dates

This criteria result in an overall assessment of the study reliability. The study is considered to be reliable (Ri 2).

For reasons of completeness the comments raised in the DAR are given below

The study was well performed and reported. The recovery of radioactive residues indicates that the treatments were successful and thus the results can be interpreted in terms of nominal concentrations. It is considered justified to base the risk assessment for aquatic invertebrates on this microcosm study.

The RMS agrees to the author's proposal for an ecologically acceptable concentration (EAC) of 10 ng/l for deltamethrin and its residues, as a pulse concentration at three occasions.

The interpretation of the data relies heavily on the identification of statistically significant effects, and the variation in the control replicates is thus of great importance. It would have been valuable if the following question had been addressed in the report: For each taxa, how large deviation from the control (in %) was needed to produce significant effects, at the different sampling dates? That would have facilitated an assessment of the validity of the results.

"Recovery", determined as absence of significant difference in abundance from control, does not necessarily mean that the population has recovered from the effect of the toxic agent. For instance, it may also reflect a natural decrease in the control population. Since it is not possible to investigate the potential to start a population peak the next season, it is difficult to determine the biological meaning of the recovery or lack of recovery observed. With time, each isolated enclosure develop their own population dynamics, not necessarily test item related. "Recovery" may also reflect recolonization by individuals not exposed to the toxic agent. However, a successful recolonization implies that the toxic agent is no longer present at harmful levels. In principle (though not always possible), time to recovery should be determined for each taxa, and not for functional groups. This is because presence of opportunistic groups makes it difficult to bring about a totally disfunctional aquatic ecosystem by toxic agents. From these considerations, it seems justified to base the conclusion from the study on the sensitive and relatively immobile species *A. aquaticus*, having relatively low possibilities for recolonization. An EAC set to 18 ng/l is therefore not accepted.

For the reasons mentioned above it is difficult to judge whether or not the significances calculated at 1.0 and 3.2 ng a.s./l for *A. aquaticus* towards the end of the study were test item related: Such a delay in observable effect is less likely for deltamethrin which disappears rapidly from the water. On the other hand, the depressed amplitude of the population peaks during summer at 1.0 and 3.2 ng a.s./l may have resulted in the observed differences to the control when the populations declined during autumn. In any case, the population growth observed during July and August does indicate a potential for recovery. At the next higher test concentration, 10 ng a.s./l, the population peak was much lower, but instead no statistically significant differences were noted from day 85. There was a marked difference in response at 10 and 18 ng a.s./l. Taken together, the arguments for the determination of 10 ng/l as an EAC seem justified. However, the approach to compare only certain selected replicates (see last "*" in the rationale for *Asellus* above) is not considered valid.

In addition to calculated statistical significances, the overall pattern in deviation from controls needs to be considered in such a complex material. Therefore, the RMS agrees in principle to the approach to interpret significances which were observed at isolated sampling points as not necessarily being test item related. However, for some taxa, this approach may be questioned. In the case of *S. crystallina*, statistically significant effects were noted at a single occasion (day 16) but at *all* doses ≥ 32 ng a.s./l. Given that this was soon after the last treatment, and the abundance remained low at those concentrations post-treatment (not significantly but there was also a large variability in the controls), it seems likely that the effect on day 16 was test item related. If so, NOEC would be 18 instead of 180 ng a.s./l, with recovery within 2 months. Similarly, the NOEC for Trichoptera larvae as 10 ng a.s./l could be questioned, since a statistically significant decrease in counts were observed at that treatment level on day 29. The same day, significant effects were noted at *all* higher treatment levels and the abundance in the 10 ng a.s./l enclosures remained low. In any case, recovery was fairly rapid for this species. Finally, NOEC for adult chaoboridae should possibly be 1.0 instead of 3.2 ng a.s./l, because of a statistically significant decrease in day 42, and if so, the effect had diminished by day 57. This comment does not change the overall conclusions from the study.

Although specimens of the genera Chironomus were not abundant enough for separate evaluation (they probably emerged prior to treatment), the Chironomids were represented by other genera. It is noted that the EAC proposed equals the NOEC obtained in laboratory study on *Chironomus riparius*.

The effects on Ciliata are difficult to interpret due to the limited number of sampling dates. Given their short generation time, the presence of significant effects among algivorous Ciliata on day 42 is surprising. For this group the range in counts day 42 in samples from individual enclosures were: 12-35 (controls), 7-28 (1 ng/l), 6-13 (3.2 ng/l), 5-12 (10 ng/l), 8-9 (18 ng/l), 2-4 (180 ng/l). It is suggested that the effects at least up to the 10 ng/l level are within the acceptable range.

For daphnids inhabiting the free water column, the NOEC observed (3.2 ng a.s./l) was close to the NOEC obtained in the 3-week reproduction study (NOEC 4.1 ng a.s./l). The microcosm data are uncertain due to variation among controls, and lack of dose-response relationship in time to recovery. However, increased populations were noted among replicates at all treatment levels (except 32 ng/l) and at 10 ng a.s./l this increase started relatively early after the last application. The EAC of 10 ng/l therefore seems to be justified also for daphnids.

The maximum DT_{50} for deltamethrin observed in the study (17 h) equals the relevant worst case half-life which ECCO agreed on, despite the fact that volatilization was reduced in this study because deltamethrin was applied below the water surface (in most of the earlier studies, it was sprayed on the surface). The high pH value in the microcosms (8.3-9.3 during treatment) may have contributed to the rapid dissipation of deltamethrin (hydrolytic half-life is 2.5 days at pH 9, 31 days at pH 8). Thus, in less alkaline waters, deltamethrin may remain longer in the system. However, the rate of dissipation from the water phase is likely to depend more on adsorption than on hydrolysis (see also section B.7.4.1 above), so the effect of pH is considered as marginal. Finally, "Aufwuchs" (or growth by epiphyta) may have posed a problem, but the system seems to have been well functioning during the test. The results of the N/P and the TOC/DOC measurements were not reported.

Study 8
Süss, Schmidt and Schmidt, 2000

Method and Results
Effects on the sediment macrofauna in a small stream (flow-rate 0.3 m/s) in Baden-Württemberg in Germany was investigated. Decis Flüssig was applied in May to an initially measured maximum concentration of 38 µg deltamethrin/l immediately below the contamination site. From 4 hours after application, until 24 hours, the concentrations varied between 0.36 µg/l and <0.005 µg/l from the site of application and 240 m downstream. Adsorption to the sediment was fast; 0.5 µg/kg was measured already 1 h after application, and the maximum level (3.5 µg/kg) was reached after 72 hours. Among the 41 species or taxa determined, definite effects on population density was only observed in the dominant freshwater shrimp *Gammarus fossarum*; 3 days after treatment, the population density was only 2% of the upstream control station's density. Recovery was complete after 4 months. Other taxa determined were chironomids, gnats, caddis-flies, oligochaetes, and hidden pea shells. Finally, a model study was conducted on *G. fossarum* with 14 days of exposure. The results indicated that 20 µg/l resulted in 70% mortality after only 1 minute of exposure.

Evaluation of the scientific reliability of the field study
The study was reported as a brief summary only. The results are therefore only indicative.

Appendix 4. Detailed bird and mammal toxicity data

Species	Species properties (age, sex)	Purity [%]	Application route	Exp. time	Criterion	Test endpoint	NOAEL [$mg/kg_{bw}/d$]	NOAEC Diet [mg/kg_{diet}]	Ri	Notes	Reference
Rat			oral	90 days	NOAEL		1	20	2	1	List of endpoints, 2002
Rat					NOAEL/NOEL		1	20	4	1,3	List of endpoints, 2002
Rat			oral	2-gen	NOEL			80	2	2	List of endpoints, 2002
Dog			oral	91 d	NOEL		2.5	250	2	1	List of endpoints, 2002
Dog			oral	1 year	NOAEL		1	100	2	1	List of endpoints, 2002
bird (*Colinus virginianus*)			oral	5 d	LC50			> 5620	4	2	List of endpoints, 2002
bird (*Colinus virginianus*)			oral		NOEC			> 450	4	2	List of endpoints, 2002
duck (*Anas platyrhynchus)*			oral	5 d	LC50			8039	2	2	List of endpoints, 2002
duck (*Anas platyrhynchus)*			oral		NOEC			> 450	4	2	List of endpoints, 2002

Notes

1 NOAEC calculated with default conversion factor
2 NOEAC based on dietary concentrations used in test
3 test duration not given

Appendix 5. Detailed sediment toxicity data

Table A4.1. Acute toxicity of deltamethrin to freswater sediment organisms.

Species	Species properties (age, sex)	Sediment type	A	Test compound	Purity [%]	pH	o.m. [%]	Clay [%]	T [°C]	Exp. time	Criterion	Test endpoint	Result test sediment [mg/kg_{dw}]	Result std. sediment [$\mu g/kg_{dw}$]	Ri	Notes	Reference
Crustacea																	
Hyalella azteca	6-12 days old		Y				1.87	31.7	23	10 d	LC50	mortality	0.01	53.5	4	1,2,3,5	Amweg *et al*., 2005
Hyalella azteca	6-12 days old		Y				2.38	43.1	23	10 d	LC50	mortality	0.0098	4.12	4	1,2,3,5	Amweg *et al*., 2005
Hyalella azteca	6-12 days old		Y				1.87	31.7	23	10 d	LOEC	growth	> 0.0173	> 9.25	4	1,2,3,4,5	Amweg *et al*., 2005
Hyalella azteca	6-12 days old		Y				2.38	43.1	23	10 d	LOEC	growth	0.0028	11.8	4	1,2,3,4,5	Amweg *et al*., 2005
Insecta																	
Chironomus riparius	larvae		Y		98%	6.0-7.8	4.8	20%		28 d	EC10	survival	0.026	54.2	2	6	Akerblom et al. 2008

Notes

1 Pesticide was dissolved in an acetone carrier and spiked into sediment using <200 µl acetone/kg wet sediment (0.02%). Solvent control survival averaged 95 %.

2 Performed using standard U.S. EPA protocols: U.S. Environmental Protection Agency. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates, 2nd ed. EPA/600/R-99/064. Office of Research and Development, Washington, DC.

3 Test result based on nominal concentrations, measured concentrations were 80 % of nominal.

4 Result recalculated from µg/g o.c.

5 Purity is not clear; it is also not clear if results are reported in mg/L formulation or mg/L active ingredient.

6 Perfomed according to OECD protocol

Appendix 6. References used in the appendices

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