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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 Standard setting for other relevant substances within the WFD

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Abstract

Environmental risk limits for organophosphorous pesticides

The RIVM has derived environmental risk limits (ERLs) for seven organophosphates in freshwater and marine waters. Organophosphates are pesticides which are used in agriculture and horticulture. This group of substances contains azinphos-ethyl, azinphos-methyl, coumaphos, heptenophos, mevinphos, tolclofos-methyl and triazophos. They belong to the category 'other relevant substances' for the Water Framework Directive.

For deriving the environmental risk limits, RIVM used the most up-to-date ecotoxicological data in combination with the most recent methodology, as required by the European Water Framework Directive. No risk limits were derived for the sediment compartment, because sorption to sediment is assumed to be negligible.

Environmental risk limits, as derived 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 are thus preliminary values that do not have any official status. Four different risk limits are distinguished: negligible concentrations (NC), the concentration at which no harmful effects are to be expected (maximum permissible concentration, MPC), the maximum acceptable concentration for ecosystems – specifically in terms of short-term exposure (MAC_{eco}), the concentration at which possible serious effects are to be expected (serious risk concentrations, SRC_{eco}).

Key words:
environmental risk limits, maximum permissible concentration, maximum acceptable concentration, serious risk concentration, organophosphorous pesticides

Rapport in het kort

Milieurisicogrenzen voor organofosfaten

Het RIVM heeft milieurisicogrenzen afgeleid voor zeven organofosfaten in zoet en zout water. Organofosfaten zijn bestrijdingsmiddelen die in de land- en tuinbouw worden gebruikt. De groep stoffen omvat azinphos-ethyl, azinphos-methyl, coumaphos, heptenophos, mevinphos, tolclofos-methyl en triazophos. De stoffen vallen onder de categorie ‘overige relevante stoffen’ voor de Kaderrichtlijn Water.

Voor de afleiding van de milieurisicogrenzen heeft het RIVM de actuele toxicologische gegevens gebruikt, gecombineerd met de meest recente methodiek. Deze methodiek is voorgeschreven door de Europese Kaderrichtlijn Water. Voor het sediment, de waterbodem, zijn geen milieurisicogrenzen afgeleid. Dat komt omdat de mate waarin deze organofosfaten zich aan sediment binden, verwaarloosbaar wordt geacht.

Milieurisicogrenzen, zoals afgeleid in dit rapport, zijn wetenschappelijk afgeleide waardes, gebaseerd op (eco)toxicologische, milieuchemische en physisch-chemische data. Milieurisicogrenzen dienen als advieswaardes voor de Nederlandse interdepartementale Stuurgroep Stoffen, die de uiteindelijke milieukwaliteitsnormen vaststelt. Milieurisicogrenzen zijn dus voorlopige waardes zonder enige officiële status. Er bestaan vier verschillende niveaus voor milieurisicogrenzen: een verwaarloosbaar risiconiveau (VR), een niveau waarbij geen schadelijke effecten zijn te verwachten (MTR), het maximaal aanvaardbare niveau voor ecosystemen, specifiek voor kortdurende blootstelling (MAC_{eco}) en een niveau waarbij mogelijk ernstige effecten voor ecosystemen zijn te verwachten (ER_{eco}).

Trefwoorden:
milieurisicogrenzen, maximaal toelaatbaar risiconiveau, maximaal acceptabele concentratie, ernstig risiconiveau, organofosfaten

Preface

The goal of this report is to derive risk limits that protect both man and the environment. This is done in accordance with the methodology of the Water Framewerk Directive (WFD) that is incorporated in the present INS methodology, following the Guidance for the derivation of environmental risk limits within the INS framework (Van Vlaardingen and Verbruggen, 2007).

The results presented in this report have been discussed by the members of the scientific advisory group for the project ‘International and National Environmental Quality Standards for Substances in the Netherlands’ (WK-INS). This advisory group provides a non binding scientific advice on the final draft of a report. 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 preliminary values that do not have any official status.

Acknowledgements

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The results of the present report have been discussed in the scientific advisory group INS (WK INS). The members of this group are acknowledged for their contribution.

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List of abbreviations

ADI	Acceptable Daily Intake
ERL	Environmental Risk Limit
INS	International and National Environmental Quality Standards for Substances in the Netherlands
$\mathrm{MAC}_{\mathrm{eco}}$	Maximum Acceptable Concentration for ecosystems
$\mathrm{MAC}_{\mathrm{eco,water}}$	Maximum Acceptable Concentration for freshwater ecosystems
MPC	Maximum Permissible Concentration
$\mathrm{MPC}_{\mathrm{dw,water}}$	Maximum Permissible Concentration in freshwater based on abstraction of drinking water
$\mathrm{MPC}_{\mathrm{eco,marine}}$	Maximum Permissible Concentration in marine water based on ecotoxicological data
$\mathrm{MPC}_{\mathrm{eco,water}}$	Maximum Permissible Concentration in freshwater based on ecotoxicological data
$\mathrm{MPC}_{\mathrm{hhfood,marine}}$	Maximum Permissible Concentration in marine water based on consumption of fish and shellfish by humans
$\mathrm{MPC}_{\mathrm{hhfood,water}}$	Maximum Permissible Concentration in freshwater based on consumption of fish and shellfish by humans
$\mathrm{MPC}_{\mathrm{marine}}$	Maximum Permissible Concentration in marine water (transitional, coastal, and territiorial waters)
$\mathrm{MPC}_{\mathrm{sp,marine}}$	Maximum Permissible Concentration in marine water based on secondary poisoning
$\mathrm{MPC}_{\mathrm{sp,water}}$	Maximum Permissible Concentration in freshwater based on secondary poisoning
$\mathrm{MPC}_{\mathrm{water}}$	Maximum Permissible Concentration in freshwater
NC	Negligible Concentration
$\mathrm{NC}_{\mathrm{marine}}$	Negligible Concentration in marine water
$\mathrm{NC}_{\mathrm{water}}$	Negligible Concentration in freshwater
$\mathrm{SRC}_{\mathrm{eco}}$	Serious Risk Concentration for ecosystems
$\mathrm{SRC}_{\mathrm{eco,marine}}$	Serious Risk Concentration for marine ecosystems
$\mathrm{SRC}_{\mathrm{eco,water}}$	Serious risk concentration for freshwater ecosystems
TDI	Tolerable Daily Intake
$\mathrm{TL}_{\mathrm{hh}}$	Treshold Level for human health
WFD	Water Framework Directive (2000/60/EC)

Samenvatting

Milieurisicogrenzen worden afgeleid met gebruik van ecotoxicologische, fysisch-chemische en humaan-toxicologische gegevens en representeren de milieuconcentraties van stoffen waarbij verschillende niveaus van bescherming voor mens en milieu worden gegeven. De milieurisicogrenzen zijn wetenschappelijk afgeleide waardes, die dienen als basis voor de Stuurgroep Stoffen, die de milieukwaliteitsnormen vaststelt op basis van de milieurisicogrenzen. Milieurisicogrenzen zijn dus voorlopige waardes zonder officiële status. In dit rapport zijn de milieurisicogrenzen verwaarloosbaar risiconiveau (VR), maximaal toelaatbaar risiconiveau (MTR), maximaal acceptabele concentratie voor ecosystemen (MAC_{eco}) en ernstig risiconiveau voor ecosystemen (ER_{eco}) afgeleid voor zeven organofosfaten in water. Voor het sediment zijn geen risicogrenzen afgeleid omdat de triggerwaarde voor de K_{OC} niet wordt overschreden.

Voor het afleiden van het MTR en de MAC_{eco} voor water is gebruikgemaakt van de methodiek in overeenstemming met de Kaderrichtlijn Water (Lepper, 2005). Deze methodiek is gebaseerd op het EU richtsnoer voor de risicobeoordeling van nieuwe stoffen, bestaande stoffen en biociden (European Commission (Joint Research Centre), 2003). Voor ER_{eco} en VR is de handleiding voor het project (Inter)Nationale Normen Stoffen (INS) gebruikt (Van Vlaardingen and Verbruggen, 2007). Een overzicht van de afgeleide milieurisicogrenzen wordt in Tabel 1 gegeven.

Tabel 1. Afgeleide MTR, MAC_{eco}, VR en ER_{eco} waarden (in µg/L).

Milieu-risicogrens[a]	**Azinphos-ethyl**	**Azinphos-methyl**	**Coumaphos**	**Heptenophos**	**Mevinphos**	**Tolclofos-methyl**	**Triazophos**
Oude $\text{MTR}_{\text{water}}$	$1{,}1 \times 10^{-2}$	$1{,}2 \times 10^{-2}$	7×10^{-4}	$2{,}0 \times 10^{-2}$	2×10^{-3}	0,790	$3{,}2 \times 10^{-2}$
$\text{MTR}_{\text{eco,water}}$	$6{,}5 \times 10^{-3}$	$2{,}0 \times 10^{-3}$	$3{,}4 \times 10^{-3}$	$2{,}0 \times 10^{-3}$	$1{,}7 \times 10^{-4}$	1,2	$1{,}0 \times 10^{-3}$
$\text{MTR}_{\text{dw,water}}$	0,1	0.1	0,1	0,1	0,1	0,1	0,1
$\text{MTR}_{\text{sp,water}}$	0,51	n.a.[2]	$7{,}5 \times 10^{-2}$	n.a.[2]	n.a.[2]	3,4	0,48
$\text{MTR}_{\text{hh food,water}}$	n.a.[b]	n.a.[2]	340	n.a.[2]	n.a.[2]	n.a.[2]	293
$\text{MTR}_{\text{water}}$	$6{,}5 \times 10^{-3}$	$2{,}0 \times 10^{-3}$	$3{,}4 \times 10^{-3}$	$2{,}0 \times 10^{-3}$	$1{,}7 \times 10^{-4}$	1,2[c]	$1{,}0 \times 10^{-3}$
$\text{MTR}_{\text{eco,marien}}$	$1{,}3 \times 10^{-3}$	$4{,}0 \times 10^{-4}$	$6{,}8 \times 10^{-4}$	$2{,}0 \times 10^{-4}$	$1{,}7 \times 10^{-5}$	n.a.	$1{,}0 \times 10^{-4}$
$\text{MTR}_{\text{sp,marien}}$	0,51	n.a.[2]	$7{,}5 \times 10^{-2}$	n.a.[2]	n.a.	1,7	0,48
$\text{MTR}_{\text{hhfood,marien}}$	n.a.[b]	n.a.[2]	340	n.a.[2]	n.a.	n.a.[2]	293
$\text{MTR}_{\text{marien}}$	$1{,}3 \times 10^{-3}$	$4{,}0 \times 10^{-4}$	$6{,}8 \times 10^{-4}$	$2{,}0 \times 10^{-4}$	$1{,}7 \times 10^{-5}$	n.a.[2]	$1{,}0 \times 10^{-4}$
VR_{water}	$6{,}5 \times 10^{-5}$	$2{,}0 \times 10^{-5}$	$3{,}4 \times 10^{-5}$	$2{,}0 \times 10^{-5}$	$1{,}7 \times 10^{-6}$	$1{,}2 \times 10^{-2}$[c]	$1{,}0 \times 10^{-5}$
$\text{VR}_{\text{marien}}$	$1{,}3 \times 10^{-5}$	$4{,}0 \times 10^{-6}$	$6{,}8 \times 10^{-6}$	$2{,}0 \times 10^{-6}$	$1{,}7 \times 10^{-7}$	n.a.[2]	$1{,}0 \times 10^{-6}$
$\text{MAC}_{\text{eco,water}}$	$1{,}1 \times 10^{-2}$	$1{,}4 \times 10^{-2}$	$3{,}4 \times 10^{-3}$	$2{,}0 \times 10^{-2}$	$1{,}7 \times 10^{-2}$	1,2[c]	$2{,}0 \times 10^{-2}$
$\text{MAC}_{\text{eco,marine}}$	$1{,}1 \times 10^{-3}$[c]	$2{,}8 \times 10^{-3}$[c]	$6{,}8 \times 10^{-4}$[c]	$2{,}0 \times 10^{-3}$[c]	$1{,}7 \times 10^{-3}$[c]	n.a.[2]	$2{,}0 \times 10^{-3}$[c]
$\text{ER}_{\text{eco,water}}$	1,1	4,8	4,5	172	4,6	40	109
$\text{ER}_{\text{eco,marien}}$	1,1	4,8	4,5	172	4,6	n.a.	109

[a] subscript water = zoetwater; subscript marien = mariene wateren; MTR_{eco} = MTR gebaseerd op ecotoxicologische data; MTR_{dw} = MTR gebaseerd op humane consumptie van drinkwater; MTR_{sp} = MTR gebaseerd op doorvergiftiging; $\text{MTR}_{\text{hhfood}}$ = MTR gebaseerd op de consumptie van vis door mensen

[b] n.a. = niet afgeleid wegens een gebrek aan data

[c] voorlopige waarde, voor verdere informatie zie de methoden-paragraaf

Summary

Environmental risk limits (ERLs) are derived using ecotoxicological, physicochemical, and human toxicological data. They represent environmental concentrations of a substance offering different levels of protection to man and ecosystems. It should be noted that the ERLs are scientifically derived values. They serve as advisory values for the Dutch Steering committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs) from these ERLs. ERLs should thus be considered as preliminary values that do not have any official status.

In this report, the risk limits negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for ecosystems (MAC$_{eco}$), and serious risk concentration for ecosystems (SRC$_{eco}$) were derived for seven organophosphorous pesticides in water and sediment. No risk limits were derived for the sediment compartment because log K_{OC} was below the trigger value. For the derivation of the MPC and MAC$_{eco}$ for water, the methodology used is in accordance with the Water Framework Directive (Lepper, 2005). This methodology is based on the Technical Guidance Document on risk assessment for new and existing substances and biocides (European Commission (Joint Research Centre), 2003). For the NC and the SRC$_{eco}$, the guidance developed for the project 'International and National Environmental Quality Standards for Substances in the Netherlands' was used (Van Vlaardingen and Verbruggen, 2007). An overview of the derived environmental risk limits is given in Table 2.

Table 2. Derived MPC, NC, MAC$_{eco}$, and SRC$_{eco}$ values (in µg/L).

Environmental risk limit[a]	**Azinphos-ethyl**	**Azinphos-methyl**	**Coumaphos**	**Heptenophos**	**Mevinphos**	**Tolclofos-methyl**	**Triazophos**
Old MPC$_{water}$	1.1×10^{-2}	1.2×10^{-2}	7×10^{-4}	0.02	2×10^{-3}	0.790	0.032
MPC$_{eco,water}$	6.5×10^{-3}	2.0×10^{-3}	3.4×10^{-3}	2.0×10^{-3}	1.7×10^{-4}	1.2	1.0×10^{-3}
MPC$_{dw,water}$	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MPC$_{sp,water}$	0.51	n.d.[b]	7.5×10^{-2}	n.d.[b]	n.d.[b]	3.4	0.48
MPC$_{hh\ food,water}$	n.d.[b]	n.d.[b]	340	n.d.[b]	n.d.[b]	n.d.[b]	293
MPC$_{water}$	6.5×10^{-3}	2.0×10^{-3}	3.4×10^{-3}	2.0×10^{-3}	1.7×10^{-4}	1.2[c]	1.0×10^{-3}
MPC$_{eco,marine}$	1.3×10^{-3}	4.0×10^{-4}	6.8×10^{-4}	2.0×10^{-4}	1.7×10^{-5}	n.d.[b]	1.0×10^{-4}
MPC$_{sp,marine}$	0.51	n.d.[b]	7.5×10^{-2}	n.d.[b]	n.d.[b]	1.7	0.48
MPC$_{hh\ food,marine}$	n.d.[b]	n.d.[b]	340	n.d.[b]	n.d.[b]	n.d.[b]	293
MPC$_{marine}$	1.3×10^{-3}	4.0×10^{-4}	6.8×10^{-4}	2.0×10^{-4}	1.7×10^{-5}	n.d.[b]	1.0×10^{-4}
NC$_{water}$	6.5×10^{-5}	2.0×10^{-5}	3.4×10^{-5}	2.0×10^{-5}	1.7×10^{-6}	1.1×10^{-2}[c]	1.0×10^{-5}
NC$_{marine}$	1.3×10^{-5}	4.0×10^{-6}	6.8×10^{-6}	2.0×10^{-6}	1.7×10^{-7}	n.d.[b]	1.0×10^{-6}
MAC$_{eco,water}$	1.1×10^{-2}	1.4×10^{-2}	3.4×10^{-3}	2.0×10^{-2}	1.7×10^{-2}	1.2[c]	2.0×10^{-2}
MAC$_{eco,marine}$	1.1×10^{-3}[c]	2.8×10^{-3}[c]	6.8×10^{-4}[c]	2.0×10^{-3}[c]	1.7×10^{-3}[c]	n.d.[b]	2.0×10^{-3}[c]
SRC$_{eco,water}$	1.1	4.8	4.5	172	4.6	40	109
SRC$_{eco,marine}$	1.1	4.8	4.5	172	4.6	n.d.	109

[a] subscript water = freshwater; subscript marine = marine waters; MPC$_{eco}$ = MPC based on ecotoxicological data; MPC$_{dw}$ = MPC based on human consumption of drinking water; MPC$_{sp}$ = MPC based on secondary poisoning; MPC$_{hhfood}$ = MPC based on human consumption of fish.

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

[c] provisional value, for further information see the methods paragraph.

1 Introduction

1.1 Project framework

In this report, environmental risk limits (ERLs) for surface water (freshwater and marine) are derived for seven organophosphorous pesticides (azinphos-ethyl, azinphos-methyl, coumaphos, heptenophos, mevinphos, tolclofos-methyl, triazophos). The following ERLs are considered:

- negligible concentration (NC) – concentration at which effects to ecosystems are expected to be negligible and functional properties of ecosystems must be safeguarded fully. It defines a safety margin which should exclude combination toxicity. The NC is derived by dividing the MPC (see next bullet) by a factor of 100.
- maximum permissible concentration (MPC) – concentration in an environmental compartment at which:
  1 no effect to be rated as negative is to be expected for ecosystems;
  2a no effect to be rated as negative is to be expected for humans (for non-carcinogenic substances);
  2b for humans no more than a probability of 10^{-6} per year of death can be calculated (for carcinogenic substances). Within the scope of the Water Framework Directive, a probability of 10^{-6} on a life-time basis is used.

  Within the scope of the Water Framework Directive the MPC is specifically referring to long-term exposure.
- maximum acceptable concentration (MAC_{eco}) – concentration protecting aquatic ecosystems for effects due to short-term exposure or concentration peaks.
- serious risk concentration (SRC_{eco}) – concentration at which possibly serious ecotoxicological effects are to be expected.

These ERLs serve as advisory values that are used by the Steering Committee for Substances to set environmental quality standards (EQS) for various policy purposes. EQSs are all legally and non legally binding standards that are used in Dutch enviromental policy.

1.2 Selection of substances

ERLs are derived for seven organophosphorous pesticides (Table 3), which are selected by the Netherlands in the scope of the Water Framework Directive (WFD; 2000/60/EC).

Table 3. Selected compounds.

Compound	CAS number
Azinphos-ethyl	2642-71-9
Azinphos-methyl	86-50-0
Coumaphos	56-72-4
Heptenophos	23560-59-0
Mevinphos	26718-65-0
Tolclofos-methyl	57018-04-9
Triazophos	24017-47-8

1.3 Guidance followed for this project

In this report ERLs are derived following the methodology of the project 'International and national environmental quality standards for substances in the Netherlands' (INS) (Van Vlaardingen and Verbruggen, 2007). This updated INS guidance is in accordance with the guidance by Lepper (2005) which forms part of the Priority Substances Daughter Directive (2006/0129 (COD)) amending the WFD (2000/60/EC). The WFD guidance applies to the derivation of MPCs for water and sediment. ERL derivations for water and sediment are performed for both the freshwater and marine compartment. The WFD guidance introduces a new ERL, which is the Maximum Acceptable Concentration (MAC_{eco}), a concentration that protects aquatic ecosystems from adverse effects caused by short-term exposure or concentration peaks. Further, two MPC values are considered for the water compartment that are based on a human toxicological risk limit (TL_{hh}), which might be an ADI or TDI (Acceptable or Tolerable Daily Intake, respectively), etc. Discerned are (1) the $MPC_{hh\ food,water}$, which is the concentration in water that should protect humans against adverse effects from the substance via fish and shellfish consumption; (2) the $MPC_{dw,water}$, which is the concentration in water that should protect humans against adverse effects of the substance by consumption of drinking water. Note that each of these two MPCs is allowed to contribute only 10% to the TL_{hh}. Two other types of MPCs are derived for the water compartment, based on ecotoxicological data. These are (1) the $MPC_{eco,water}$ and $MPC_{eco,marine}$, which are based on direct aquatic ecotoxicological data and (2) the $MPC_{sp,water}$ and $MPC_{sp,marine}$, the MPC accounting for secondary poisoning, which is derived in case secondary poisoning in the environment is thought to be of concern. It is important to note that MPC derivation integrates both ecotoxicological data and a human toxicological threshold value. The height of this final 'environmental risk limit' is determined by the lowest of these protection objectives.

The WFD guidance departs from the viewpoint that laboratory toxicity tests contain suspended matter in such concentrations, that results based on laboratory tests are comparable to outdoor surface waters. In other words: each outcome of an ERL derivation for water will now result in a total concentration. A recalculation from a dissolved to a total concentration is thus no longer made within INS framework. This differs from the former Dutch approach, in which each outcome of a laboratory test was considered to represent a dissolved concentration. This concentration could then be recalculated to a total concentration using standard characteristics for surface water and suspended matter.

2 Methods

2.1 Data collection

An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current contents (literature from 1997 to 2006). The search resulted in hundreds of references. In addition to this, all references in the RIVM e-tox base and EPA's ECOTOX database were evaluated. Using the internet, public versions of pesticide evaluation reports were obtained (if present) for registration procedures in the United States, Canada, Europe and individual European countries. Toxicity data described in these documents (mainly mammalian and bird toxicity) were also used. All toxicity data are reported in the Appendices.

The validities (or reliabilities) of the studies are assigned using the criteria of Klimisch et al. (1997):

'*1. Reliable without restriction*

This includes studies or data from the literature or reports which were carried out or 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 (preferably performed according to GLP) or in which all parameters described are closely related/comparable to a guideline method.

2. Reliable with restrictions

This includes studies or data from the literature, reports (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.

3. Not reliable

This includes studies or data from the literature/reports 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.

4. Not assignable

This includes studies or data from the literature, which do not give sufficient experimental details and which are only listed in short abstracts or secondary literature (books, reviews, etc.).'

A validity score of 1 or 2, however, does not automatically mean that a study is selected for the derivation. The relevance of the study for derivation is not included in the validity score; a study that is not relevant will not be used, even when its validity/reliability is very good. As an example: when enough studies are available, only those with the most appropriate exposure times will be selected.

Within the basic rules of these criteria, specific choices have been made (see also Van Vlaardingen and Verbruggen, 2007):

- When a compound has not been measured, it will never get a validity of 1, but always 2, 3, or 4 depending on other criteria. A validity of 1 will only be awarded when the compound is measured and the value is based on measured data.
- When a study is performed without flaws, but not all details (e.g., pH, hardness) are specified, it will be attributed a validity of 2. A validity of 1 will only be awarded when a study is performed according to OECD guidelines, and/or raw data are also presented, or all study details are very well described without open ends. GLP is <u>not</u> a guarantee for a well-designed and performed study.
- Validities attributed in other studies are not adopted ‘as is’; only when enough information is available to make our own judgement. An exception are validities attributed by the DAR, these are automatically adopted unless study details give reason to change the validity.
- When a TLm is reported instead of an LC50, the study will not be given a validity of 1 due to the difference in calculation methods.
- An additional validity score of 2* is used, when data are used that are presented in reliable sources, but which have not been explicitly validated by us and for which sometimes not all information is known. These reliable sources include reports on ERL derivation, and toxicity handbooks or articles by Mayer and Ellersieck (1986) and Mayer (1986), etc.
- An additional validity score of 4* is used, when it can be assumed with high probability that the same data is published by different authors. Then only one of those data will be given a ‘real’ validity and the rest will be given a validity of 4*.
- The use of a commercial formulation is not a ground to reject a study (validity 3), unless it is known that other compounds in the formulation will show toxic effects. When a commercial formulation is used, concentrations are measured and all criteria for a validity of 1 are met, then the use of a commercial formulation is no reason to lower this validity. Studies with a formulation will be rewarded a validity of 2 if the study is performed well and results are expressed in concentration of the active ingredient, but may not be measured. When it can be assumed with high probability that the result is expressed in active ingredient but this is not explicitly mentioned (for instance, when only the name of the chemical is used and not of the commercial formulation) a maximum validity of 2 is still possible, because if it would be expressed in terms of the commercial formulation, results in a.i. could only be lower.
- When a compound is only referred to by its commercial name, and nothing is mentioned on the percentage of active ingredient and/or water concentrations are not measured, then a validity of 4 will be given.
- When the endpoint of an EC50 study is not specified, the validity will automatically be 4. Except for the estuarine data by Mayer (1986), who gave a general specification of all EC50s in his handbook as being ‘growth, immobility or some other identifiable endpoint’.

Wherever a study does not explicitly follow one of these rules, an explanatory note on the attribution of the validity criteria is added in the toxicity table.

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

2.2 Derivation of environmental risk limits for water and sediment

The methodology for data selection and ERL derivation is described in Van Vlaardingen and Verbruggen (2007) and follows Lepper (2005). Specific details will be discussed below.

2.2.1 Read Across among compounds

Because six of the seven organophosphorous pesticides (azinphos-ethyl, azinphos-methyl, coumaphos, heptenofos, mevinphos and triazophos) in this report are very similar, it is decided to use read across when circumstantial evidence is needed to be able to derive an environmental risk limit. For tolclofos-methyl, a fungicide, this is not the case.

2.2.2 Combination of freshwater and marine data

For pesticides, MPCs for freshwater and other surface waters (marine and estuarine waters) should be derived separately. According to Lepper (2005): ‘Freshwater effects data of plant protection products (PPP) shall normally not be used in place of saltwater data, because within trophic levels differences larger than a factor of 10 were found for several PPP. This means that for PPP the derivation of quality standards addressing the protection of water and sediment in transitional, coastal and territorial waters is not possible if there are no effects data for marine organisms available or if it is not possible to determine otherwise with high probability that marine organisms are not more sensitive than freshwater biota (consideration of the mode of action may be helpful in this assessment).’

However, for the group of organophosphorous pesticides for which environmental risk limits are derived in this report, a difference between fresh water data and marine data is not present. The mode of action of the compounds is inhibition of acetyl cholinesterase activity, and for compounds with a higher log K_{OW} narcosis may also play a role. It is not expected that these modes of action are different in marine water (Maltby et al., 2005). Besides this, the most sensitive species to this type of compounds (crustaceans) are well represented in the dataset. Insects, which are also sensitive, are not very abundant in marine waters. The availability of the compounds can be assumed to be equal between freshwater and marine waters. Thus, it was decided to use read across and combine the datasets for marine and freshwater toxicity data. Please note that although the dataset is combined, the actual ERL derivation is still performed separately for freshwater and marine water.

For tolclofos-methyl an exception is made. Since this compound is a fungicide and has a different mode of action, read across from the other compounds is not possible and thus fresh water and marine toxicity data can not be combined.

2.2.3 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). In the proposal for the daughter directive Priority Substances, however, the EC based the derivation of the AA-EQS (= MPC) 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 Waterkwaliteitseisen 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 ($MPC_{hh food, water}$); the need to derive 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.

2.2.4 $MAC_{eco,marine}$

In this report, the $MAC_{eco,marine}$ value is based on the $MAC_{eco,water}$ value when acute toxicity data for at least two specific marine taxa are available, using an additional assessment factor (analogous to the derivation of the MPC according to Van Vlaardingen and Verbruggen, 2007) of 5 when acute toxicity data for only one specific marine taxon is available and an additional assessment factor of 10 when no acute toxicity data is available for specific marine taxa. It has to be noted that this procedure is currently not agreed upon. Therefore, the $MAC_{eco,marine}$ value needs to be re-evaluated once an agreed procedure is availabe.

3 Derivation of environmental risk limits

3.1 Azinphos-ethyl

3.1.1 Substance identification, physicochemical properties, fate and human toxicology

3.1.1.1 Identity

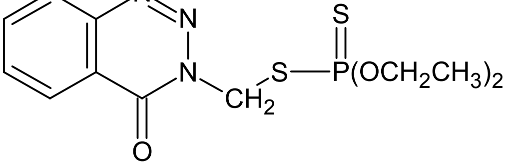


Figure 1. Structural formula of azinphos-ethyl.

Table 4. Identification of azinphos-ethyl.

Parameter	Name or number
Chemical name	O,O-diethyl S-[(4-oxo-1,2,3-benzotriazin-3(4H)-yl)methyl] phosphorodithioate or S-(3,4-dihydro-4-oxobenzo[d]-[1,2,3]-triazin-3-ylmethyl) O,O-diethyl phosphorodithioate (IUPAC)
Common/trivial/other name	Azinphos-ethyl, Triazotion, Azinugec E, Batazina, Azin, Crysthion, Ethyl Guthion, Gusathion A, Cotnion-ethyl
CAS number	2642-71-9
EC number	220-147-6
SMILES code	S=P(OCC)(OCC)SCN1N=Nc2ccccc2C1=O

3.1.1.2 Physicochemical properties

Table 5. Physicochemical properties of azinphos-ethyl.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	345.4		
Water solubility	[mg/L]	4-5	20 ºC	Tomlin, 2002
		6.7	10 ºC	Bowman and Sans, 1985
		10.5	20 ºC	Bowman and Sans, 1985
pK_a	[-]	n.a.		
log K_{ow}	[-]	3.18		Tomlin, 2002
		3.4		Deneer et al., 1999
		3.51	EpiWin	US EPA, 2007
		3.43	ClogP	BioByte, 2004
		3.4	MlogP	BioByte, 2004
log K_{oc}	[-]	**2.4**	EpiWin	US EPA, 2007
		2.69	Calculated using log K_{ow} = 3.4	According to Sabljic et al., 1995
Vapour pressure	[Pa]	3.2×10^{-4}	20 ºC	Tomlin, 2002
Melting point	[°C]	50		Tomlin, 2002
Boiling point	[°C]	147	1.3 Pa	Tomlin, 2002
Henry's law constant	[Pa.m^3.mol^{-1}]	3.1×10^{-6}		Tomlin, 2002

n.a. = not applicable.

3.1.1.3 Behaviour in the environment

Table 6. Selected environmental properties of azinphos-ethyl.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	0.17	pH 4; 22 ºC	Tomlin, 2002
		270	pH 7; 22 ºC	Tomlin, 2002
		11	pH 9; 22 ºC	Tomlin, 2002
Photolysis half-life	DT50 [d]			
Degradability	DT50 [d]	Several weeks		Tomlin, 2002
		Not ready biodegradable	EpiWin	US EPA, 2007
		9-204	Different types of water, varying in temperature and pH	Lartiges and Garrigues, 1995
Relevant metabolites	Desethyl azinphos-ethyl Sulfonmethylbenzazimid Bis(benzazimidmethyl)ether Methylthiomethylsulfoxide Methylthiomethylsulfone		Formed in soil under aerobic and anaerobic conditions	Tomlin, 2002

3.1.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for azinphos-ethyl is given in Table 7. Detailed bioaccumulation data for azinphos-ethyl are tabulated in Appendix 1.

Table 7. Overview of bioaccumulation data for azinphos-ethyl.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	256	Using lethal body burden	Ohayo-Mitoko and Deneer, 1993
		136	Using lethal body burden	Deneer et al., 1999
		101	EpiWin	US EPA, 2007
BMF	[kg/kg]	1	Default value	

3.1.1.5 Human toxicological treshold limits and carcinogenicity

Azinphos-ethyl has not been classified as carcinogenic to humans. Azinphos-ethyl is classified as T+; R28; T; R24; N; R50-53. No ADIs were found in the relevant databases.

3.1.2 Trigger values

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

Table 8. Azinphos-ethyl: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,\text{susp-water}}$	1.4	[-]	$K_{oc} \times f_{oc,susp}$[1]	K_{oc}: 3.1.1.2
BCF	≥ 136	[L/kg]		3.1.1.4
BMF	1	[-]		3.1.1.4
Log K_{ow}	3.4	[-]		3.1.1.2
R-phrases	T+; R24; T; R28; N; R50/53	[-]	http://ecb.jrc.it/esis/	3.1.1.5
A1 value	1	[µg/L]	total pesticides	
DW standard	0.1	[µg/L]	general value for organic pesticides	

[1] $f_{oc,susp} = 0.1$ kg$_{oc}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- Azinphos-ethyl has a log $K_{p,\text{ susp-water}} < 3$; derivation of MPC$_{\text{sediment}}$ is not triggered.
- Azinphos-ethyl has a log $K_{p,\text{susp-water}} < 3$; expression of the MPC$_{\text{water}}$ as MPC$_{\text{susp, water}}$ is not required.
- Azinphos-ethyl has a BCF > 100; assessment of secondary poisoning is triggered.
- Azinphos-ethyl has a BCF > 100 and an R24, R28 classification. Therefore, an MPC$_{\text{water}}$ for human health via food (fish) consumption (MPC$_{\text{hh food,water}}$) should be derived.
- For azinphos-ethyl, 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 for organic pesticides applies.

3.1.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data is given in Table 9 and an overview of the selected marine toxicity data is given in Table 10. Detailed toxicity data for azinphos-ethyl are tabulated in Appendix 2.

Table 9. Azinphos-ethyl: selected aquatic freshwater data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (μg/L)**	**Taxonomic group**	**L(E)C50 (μg/L)**
No chronic data		Mollusca	3082
		Crustacea	4
		Crustacea	3.2
		Crustacea	4.1[b]
		Insecta	1.5
		Pisces	**1.1**[c]
		Pisces	19.5[d]

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.
[b] Geomean of 4 and 4.2, parameter immobility for *Simocephalus serrulatus*
[c] Parameter mortality for *Lepomis macrochirus*, most relevant exposure duration.
[d] Geomean of 20 and 19, parameter mortality for *Oncorhynchus mykiss*

Table 10. Azinphos-ethyl: selected aquatic marine data for ERL derivation.

Chronic [a]		**Acute** [a]	
Taxonomic group	**NOEC/EC10 (μg/L)**	**Taxonomic group**	**L(E)C50 (μg/L)**
No chronic data		Crustacea	48

[a] For detailed information see Appendix 2.

3.1.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

The base–set (fish, *Daphnia*, and algae) is incomplete. No chronic data are available. According to Lepper (2005): 'However, long-term annual EQS shall not be derived exclusively on the basis of acute toxicity data'. However, because long term toxicity data are available for similar compounds (for instance azinphos-methyl, see section 3.2.3), MPC values can be derived for azinphos-ethyl.

The base-set is not complete. Toxicity data for algae are not available, but read-across to azinphos-methyl shows that algae are not sensitive to this type of compound. Thus, the $MPC_{eco,water}$ and $MPC_{eco,marine}$ are derived using the lowest LC50 (1.1 μg/L for fish). With an assessment factor of 1000, the $MPC_{eco,water}$ then becomes $1.1 / 1000 = 1.1 \times 10^{-3}$ μg/L; with an assessment factor of 10000, the $MPC_{eco,marine}$ becomes $1.1/10000 = 1.1 \times 10^{-4}$.

3.1.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Azinphos-ethyl has a BCF>100, thus assessment of secondary poisoning is triggered. The lowest MPC_{oral} is 0.07 mg/kg diet for dogs (see Table 11). Subsequently, the $MPC_{sp,water}$ can be calculated using a BCF of 136 and a BMF of 1 (section 3.1.1.4) and becomes $0.07 / (136 \times 1) = 5.1 \times 10^{-4}$ mg/L = 0.51 μg/L.

Table 11. Azinphos-ethyl: selected bird and mammal data for ERL derivation.

Species[a]	Exposure time	Criterion	Effect concentration (mg/kg diet)	Assessment factor	MPC_{oral} (mg/kg diet)
Chicken	30 days	NOEC	150	30	5.0
Dog	6 weeks	NOEC	2.1	30[b]	**0.07**
Dog	32 months	NOEC	30	30	1.0
Rat	16 weeks	NOEC	10	90	0.11

[a] For detailed information see Appendix 4. Bold values are used for risk assessment.
[b] Because the 6 week NOAEL for dogs is lower than the 32 month NOAEL, the assessment factor for this study is set at the assessment factor for the 32 month study.

For the marine environment, an extra biomagnification factor should be used. But since this factor is 1 by default for compounds with log $K_{OW} < 4.5$, the $MPC_{sp,marine}$ equals the $MPC_{sp,water}$ and is also 0.51 μg/L.

3.1.3.3 $MPC_{hh\ food,water}$ and $MPC_{hh\ food,marine}$

Derivation of $MPC_{hh\ food}$ for azinphos-ethyl is triggered (section 3.1.1.5). However, no ADI can be found for azinphos-ethyl. The case of coumaphos for example (section 3.3.3.3), shows that the $MPC_{hhfood,water}$ for coumaphos is much higher than the $MPC_{eco,water}$ and is thus of no relevance for the selection of the MPC_{water} and MPC_{marine}. Here, for azinphos-ethyl it is shown that the route of secondary poisoning leads to much higher MPC values than direct ecotoxicity. Therefore, in general the direct route of toxicity is for these type of compounds probably much more important than indirect effects through the uptake of food.

3.1.3.4 $MPC_{dw,water}$

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

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

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 1.1×10^{-3} μg/L (based on the $MPC_{eco,water}$), and the MPC_{marine} is 1.1×10^{-4} μg/L (based on the $MPC_{eco,marine}$).

3.1.3.6 MAC_{eco}

The base-set for acute data is not complete, but algae are not sensitive to this group of compounds. Normally, an assessment factor of 100 should be used, but since the BCF is larger than than 100, the assessment factor could be increased (Van Vlaardingen and Verbruggen, 2007). However, the mode of action of this compound may be either narcosis or AChE inhibition, because of its relatively high log K_{OW}. When the mode of action is narcosis, the data show that for the most sensitive species there is not much variation. When the mode of action is specifically AChE inhibition, the most sensitive species are included. Thus, an assessment factor of 100 should be used on the lowest L(E)C50 value (1.1 μg/L for fish). The $MAC_{eco,water}$ then becomes $1.1 / 100 = 1.1 \times 10^{-2}$ μg/L.

In the case of azinphos-ethyl, no acute toxicity data are available for specific marine taxa, and thus an additional assessment factor of 10 is used on the $MAC_{eco,water}$ and the provisional $MAC_{eco,marine}$ is set at $1.1 \times 10^{-2} / 10 = 1.1 \times 10^{-3}$ μg/L.

3.1.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100:
$NC_{water} = 1.1 \times 10^{-5}$ µg/L.
$NC_{marine} = 1.1 \times 10^{-6}$ µg/L.

3.1.3.8 SRC_{eco}

The $SRC_{eco,water}$ and $SRC_{eco,marine}$ can be derived using the geometric mean of all acute and marine freshwater L(E)C50 data (11 µg/L) with an assessment factor of 10. These data are normally distributed (significant at all levels except 0.1 using the Anderson-Darling test for normality). The $SRC_{eco,water}$ and $SRC_{eco,marine}$ are set at 11 / 10 = 1.1 µg/L.

3.2 Azinphos-methyl

3.2.1 Substance identification, physicochemical properties, fate and human toxicology

3.2.1.1 Identity

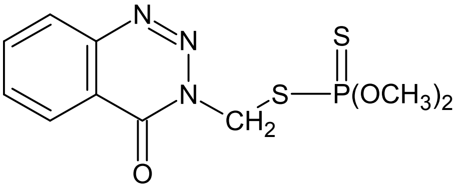


Figure 2. Structural formula of azinphos-methyl.

Table 12. Identification of azinphos-methyl.

Parameter	Name or number
Chemical name	O,O-dimethyl S-[(4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl] phosphorodithioate or S-(3,4-dihydro-4-oxobenzo[d]-[1,2,3]-triazin-3-ylmethyl) O,O-dimethyl phosphorodithioate (IUPAC)
Common/trivial/other name	Azinphos-methyl, Metiltriazotion, Gusathion M, Acifon, Azinugec, Cotnion-methyl, Guthion, Aziflo, Azin-PB, Crysthyon, Mezyl, Sniper, Valefos
CAS number	86-50-0
EC number	201-676-1
SMILES code	S=P(OC)(OC)SCN1N=Nc2ccccc2C1=O

3.2.1.2 Physicochemical properties

Table 13. Physicochemical properties of azinphos-methyl.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	317.3		
Water solubility	[mg/L]	28	20 °C	Tomlin, 2002
		30	20 °C; selected	Mackay et al., 2000
pK_a	[-]	n.a.		
log K_{ow}	[-]	**2.7**	selected slow stirring	Mackay et al., 2000
		2.72	method; 25 °C	Deneer et al., 1999
		2.76	slow stirring method	de Bruyn and Hermens, 1993;
		2.96		Tomlin, 2002; IUCLID, 2000; Anonymous, 1996
		2.53	EpiWin	US EPA, 2007
		2.75	MlogP	BioByte, 2004
		2.55	ClogP	BioByte, 2004
log K_{oc}	[-]	**2.61**	Selected	Mackay et al., 2000
		2.36	Calculated using log K_{ow} of 2.7	According to Sabljic et al., 1995
Vapour pressure	[Pa]	5.0×10^{-7}	20 °C	Tomlin, 2002
		1.0×10^{-6}	25 °C	Tomlin, 2002
		1.8×10^{-6}	20 °C	IUCLID, 2000
		3.0×10^{-5}	20 °C; selected	Mackay et al., 2000
		1.8×10^{-4}	20 °C	Anonymous, 1996
Melting point	[°C]	73		Tomlin, 2002, Anonymous, 1996, Mackay et al., 2000
Boiling point	[°C]	>200	Selected	Mackay et al., 2000
Henry's law constant	[Pa.m^3.mol^{-1}]	5.7×10^{-6}	20 °C	Tomlin, 2002
		3.2×10^{-4}	selected	Mackay et al., 2000
		2.0×10^{-3}		Anonymous, 1996

n.a. = not applicable.

3.2.1.3 Behaviour in the environment

Table 14. Selected environmental properties of azinphos-methyl.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	87	pH 4; 22 ºC	Tomlin, 2002
		50	pH 7; 22 ºC	Tomlin, 2002
		4	pH 9; 22 ºC	Tomlin, 2002
Photolysis half-life	DT50 [d]	0.4-3.2	Only an indication due to various deviations in the system	Anonymous, 1996
Biodegradation	See text below			
Relevant metabolites	Monodesmethyl compound		In mammals	Tomlin, 2002
	Benzazimide		In mammals, plants	Tomlin, 2002
	Azinphos-methyl oxon		In plants	Tomlin, 2002
	Mercaptomethyl benzazimide		In plants	Tomlin, 2002
			In soil	Panman and Linders, 1990

According to the IUCLID database, azinphos-methyl is very stable in water to hydrolysis below pH 10.0. However, the data in the pesticide manual show that already at pH 9.0, azinphos-methyl is rapidly hydrolyzed to anthranilic acid, benzamide, and other metabolites. Azinphos-methyl is rapidly degraded in water, with half-lives values ranging from less than one day to several weeks depending on the type of water. In a water/sediment-study (conducted in darkness) half-lives of less than four days are found. Under natural conditions and in the presence of light, the degradation of azinphos-methyl occurs even faster. In aerobic soils, azinphos-methyl is degraded with half-lives determined under laboratory conditions ranging from some days to some weeks. In the field the half-lives range from 1.5 to several days (IUCLID, 2000).

3.2.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for azinphos-methyl is given in Table 15. Detailed bioaccumulation data for azinphos-methyl are tabulated in Appendix 1.

Table 15. Overview of bioaccumulation data for azinphos-methyl.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	34.9	Using lethal body burden	Deneer et al., 1999
		17.8	EpiWin	US EPA, 2007
BMF	[kg/kg]	1	Default value	

3.2.1.5 Human toxicological treshold limits and carcinogenicity

Azinphos-methyl has not been classified as carcinogenic to humans. Azinphos-methyl is classified as T+; R26/28; T: R24; R43; N; R50/53. An ADI of 0.005 mg/kg bw is reported based on a NOEL (0.48 mg/kg bw/d) for reproduction in a 2-generation study in rats (Anonymous, 1996).

3.2.2 Trigger values

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

Table 16. Azinphos-methyl: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	1.61	[-]	$K_{oc} \times f_{oc,susp}$[1]	K_{oc}: 3.2.1.2
BCF	35	[L/kg]		3.2.1.4
BMF	1	[-]		3.2.1.4
Log K_{ow}	2.7	[-]		3.2.1.2
R-phrases	T+; R26/28; T; R24; R43; N; R50/53	[-]	http://ecb.jrc.it/esis/	3.2.1.5
A1 value	1	[µg/L]	total pesticides	
DW standard	0.1	[µg/L]	general value for organic pesticides	

[1] $f_{oc,susp} = 0.1$ kg_{oc}/kg_{solid} (European Commission (Joint Research Centre), 2003).

- Azinphos-methyl has a log $K_{p,\ susp-water} < 3$; derivation of $MPC_{sediment}$ is not triggered.
- Azinphos-methyl has a log $K_{p,\ susp-water} < 3$; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- Azinphos-methyl has a BCF < 100; assessment of secondary poisoning is not triggered.
- Azinphos-methyl has a BCF < 100 and an R26/28; R24; R43; R50/53 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{water,\ hh\ food}$) does not need to be derived.
- For azinphos-methyl, 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 for organic pesticides applies.

3.2.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data for azinphos-methyl is given in Table 17 and for marine toxicity data in

Table 18. Detailed toxicity data for azinphos-methyl are tabulated in Appendix 2.

Table 17. Azinphos-methyl: selected aquatic freshwater data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Algae	1800	Algae	6650
Crustacea	0.42[b]	Crustacea	21
Crustacea	0.1[c]	Crustacea	4.8
Crustacea	0.1	Crustacea	2.4[g]
Insecta	1.4	Crustacea	0.48
Insecta	0.24	Crustacea	0.18[h]
Insecta	2	Crustacea	0.24
Insecta	2.5	Crustacea	**0.14**[i]
Insecta	2.9	Crustacea	0.29
Insecta	1.7	Crustacea	0.39[j]
Insecta	1.3	Crustacea	56
Insecta	40	Insecta	4.1[k]
Pisces	100	Insecta	12.6[l]
Pisces	0.36	Insecta	14
Pisces	0.44	Insecta	2.36[m]
Pisces	0.33[d]	Insecta	26.6[n]
Pisces	5.23[e]	Pisces	2350[o]
Ampbibia	100	Pisces	695
Amphibia	30	Pisces	68
Amphibia	980	Pisces	4242[p]
Amphibia	627[f]	Pisces	3254[q]
		Pisces	52
		Pisces	10.4[r]
		Pisces	21[s]
		Pisces	120
		Pisces	5
		Pisces	5.2
		Pisces	5.4[t]
		Pisces	5.7[u]
		Pisces	4.3
		Pisces	14[v]
		Pisces	819[w]
		Pisces	57[x]
		Pisces	3
		Pisces	42.5
		Pisces	2.82[y]
		Pisces	4.0[z]
		Amphibia	1670
		Amphibia	1900
		Amphibia	10440
		Amphibia	119[aa]
		Amphibia	1170[ab]
		Amphibia	3200

	Amphibia	7600
	Amphibia	7180
	Amphibia	901[ac]

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.

[b] Geomean of 0.25 and 0.70; parameter immobility/mortality for *Asellus aquaticus.*

[c] lowest value; parameter immobility for *Daphnia magna.*

[d] Lowest value, parameter fecundity for *Pimephales promelas.*

[e] Geomean of 18, 15, 3.5, 2.3, and 1.8, parameter mortality for *Salmo salar.*

[f] Geometric mean of 820 and 480, lowest value, parameter length for *Xenopus laevis.*

[g] Geometric mean of 1.1, 1.6, 1.5, 4.4, en 6.7, parameter immobilization for *Daphnia magna;* most relevant exposure duration.

[h] Geometric mean of 0.15, 0.1, and 0.38, parameter mortality for *Gammarus fasciatus.*

[i] Geometric mean of 0.15 and 0.126, parameter mortality for *Gammarus lacustris.*

[j] Geometric mean of 1.2 and 0.13, parameter mortality after 96 hours for *Palaemonetes kadiakensis.*

[k] Geometric mean of 8.5 and 2, parameter mortality for *Acroneuria pacifica.*

[l] Geomean of 13.3 and 12, parameter immobility/mortality for *Cloeon dipterum.*

[m] Geomean of 1.9, 4.6, and 1.5, most sensitive life-stage, parameter mortality after 96h for *Pteronarcys californica.*

[n] Most sensitive life-stage, parameter mortality for *Xanthocnemis zealandica.*

[o] Geomean of 2230, 2180, 2680, 2450, 2480, 1710, 2070, 2050, 2080, 2130, 3860, 1880, 3020, 2050, 1350, 3750, 1400, 4270, 2400, 1040, and 7200, parameter mortality for *Carassius auratus.*

[p] Geomean of 4600, 4810, and 3500, parameter mortality for *Ictalurus melas.*

[q] Geomean of 3290 and 3220, most relevant exposure time, parameter mortality for *Ictalurus punctatus.*

[r] Geomean of 8.2, 8, 4.1, 17, 34, 4.8, 22, 120, 9.3, 6.9, 7.4, 4.2, 8.8, and 5.2, parameter mortality for *Lepomis macrochirus.*

[s] Geomean of 52 and 8.8, parameter mortality for *Lepomis microlophus.*

[t] Geomean of 6.1, 3.2, 3.2, 17, and 4.2, parameter mortality for *Oncorhynchus kisutch.*

[u] Geomean of 4.3, 7.1, 5.8, 6.3, 2.9, 14, 3.2, 9.1, 7, 6.8, 6.2, 5.5, 3, and 5.3, parameter mortality for *Oncorhynchus mykiss.*

[v] Geomean of 15, 40, 5.6, 2.4, 17, 29, 8.5, 29, 18, 36, 11, 27, 10, 6.5, and 13, parameter mortality for *Perca flavescens.*

[w] Geomean of 293, 148, 3260, 2170, 1060, 910, 1950, 2170, 2080, 540, 2530, 1460, 2320, 2470, 2910, 1980, 1200, 1460, 235, 1900, 65, 160, 93, and 64, parameter mortality for *Pimephales promelas*. Please note that all higher values originate from the same study by Adelman and coworkers; the study is however well-documented, concentrations are measured.

[x] Most relevant exposure duration, parameter mortality for *Poecilia reticulata.*

[y] Geomean of 2.1, 2.7, 3.2, 3.5, 3.6, 2.5, and 2.5, parameter mortality for *Salmo salar.*

[z] Geomean of 4.6, 4.3, 3.5, 6, 5.1, 6.6, 1.2, and 4, parameter mortality for *Salmo trutta.*

[aa] Geomean of 109 and 130, parameter mortality for *Bufo woodhousei fowleri.i*

[ab] Geomean of 4140, 840, and 460, parameter mortality for *Pseudacris regilla.*

[ac] Geomean of 2950, 590, and 420, parameter mortality for most sensitive life-stage of *Xenopus laevis.*

Table 18. Azinphos-methyl: selected aquatic marine data for ERL derivation.

Chronic [a]		**Acute** [a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Mollusca	410	Bacteria	315[e]
Mollusca	390[b]	Crustacea	1.99
Crustacea	**0.02**[c]	Crustacea	420[f]
Pisces	0.21[d]	Crustacea	57
		Crustacea	0.55
		Crustacea	0.24[g]
		Crustacea	0.38[h]
		Crustacea	0.55
		Crustacea	2.4[i]
		Mollusca	4700
		Pisces	2
		Pisces	49[j]
		Pisces	4.8[k]
		Pisces	28
		Pisces	17
		Pisces	1470
		Pisces	3.2
		Pisces	5.5
		Pisces	6.2[l]

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.
[b] Lowest value, parameter survival for *Mercenaria mercenaria.*
[c] Lowest value, parameter 'number of young', *Mysidopsis bahia.*
[d] Geomean of 0.17 and 0.25, parameter survival for *Cyprinodon variegatus.*
[e] Most common exposure time (15-20 min) for the parameter luminescence for *Vibrio fisherii.*
[f] Geomean of 320 and 550, parameter immobility/mortality for *Callinectes sapidus.*
[g] Geomean of 0.29 and 0.2, parameter mortality for *Mysidopsis bahia.*
[h] Most sensitive life-stage, parameter mortality for *Palaemonetes pugio.*
[i] Most sensitive life-stage, parameter mortality/immobility for *Penaeus aztecus.*
[j] Geomean of 28, 36.95, 85.1, 64.5, parameter mortality for *Fundulus heteroclitus.*
[k] Lowest value of 4.8 at highest temperature of 25 °C, parameter mortality for *Gasterosteus aculeatus.*
[l] Lowest value of 6.2 at highest temperature of 20 °C, parameter mortality for *Sciaenops ocellatus.*

3.2.3.1 MPC$_{eco,water}$ and MPC$_{eco,marine}$

Mesocosm studies

A total number of five mesocosm studies are performed with azinphos-methyl. Two of them with acute exposure, and two with chronic exposure regimes. Details are provided in Appendix 3, but in this paragraph a short description will be given.

Acute

Stay and Jarvinen (1995) used mixed flask culture microcosms for a single application of azinphos-methyl in 7 different concentrations. The microcosms were stocked with a culture of organisms from a natural community (no fish). Results of water analyses were not reported, except for a half-life of greater than 2 days. Thus, this study can only be used for acute exposure. Effects were assessed on

zooplankton, and an acute NOEC and LOEC were reported of 0.2 µg azinphos methyl/L and 0.8 µg/L, respectively. These effect concentrations should be used with outmost care within environmental quality standard setting, because of some unclarities in experimental setup and statistical treatment.
Tanner and Knuth (1995) exposed adult bluegills to a single application of azinphos-methyl in littoral enclosures in a mesotrophic pond including macrophytes. Two concentrations (1.0 and 4.0 µg/L) and a control were included. Samples were taken at various time intervals, and half-lives of 2.3 and 2.4 days were reported. No statistically significant effects were observed on fish reproduction, behaviour, and biomass, due to the large variation. Effects on copepod nauplii at 1 and 4 µg/L one week after pesticide application were the only effects significantly underpinned. Therefore, the NOEC of the present study is considered to be below the lowest tested concentration (nominal concentration 1.0 µg/L), which can be used for EQS-derivation for short-term exposure. However, results could be biased due to predation effects by fish.
A non-evaluated study by Knuth et al. (1992), mentioned in a review by Van Wijngaarden et al. (2005), yielded a ecosystem-NOEC of 0.2 µg/L and an ecosystem-LOEC (with severe effects) of 1.0 µg/L for a single application in a stagnant stream.
The study by Giddings et al. (1994), summarized below, can also be used to assess acute toxicity.

Chronic
Giddings et al. (1994) applied azinphos-methyl in 5 different concentrations in weekly intervals to 20 by 20 m ponds (400 m^3), including fish and macrophytes. Water was analyzed at various time intervals, results show that azinphos-methyl concentrations in water declined rapidly with half-lives ranging from 1 to 2 days on average over the 5 different concentrations. Effects on fish, zooplankton, and macroinvertebrates were assessed. The NOEC of the present study is the treatment with a mean peak of 0.24 µg/L and mean actual concentration of 0.13 µg/L during the application period (weekly applications during the test period of 55 days). However, introduction of fish and effects of feeding by fish on invertebrates may have biased the test results.
Dortland (1980) performed outdoor cosm experiments over two consecutive years. In the first year, one cosm was treated with 1 µg/L azinphos-methyl versus 6 controls, in the second year two cosms were treated against three controls. A constant insecticide concentration was maintained by sampling the water column twice per week for chemical analysis and reapplying the disappeared azinphos-methyl to maintain 1 µg/L. Average actual concentrations were 0.81µg/L in the first year and 0.61 µg/L in the second year. Macrofauna was only analyzed at the end of the experiment, but zooplankton was analyzed regularly, and showed that 1 µg azinphos-methyl/L can strongly reduce populations of Cladocera. Although statistics were not performed on the data and no (first year) or only one (second year) replicate was applied, from the presented figures it can be deduced that zooplankton indeed was negatively and chronically affected by the pesticide treatment. The treatments had actual concentrations of 0.81 µg/l and 0.61 µg/l and therefore, the NOEC is considered to be < 0.61 µg azinphos-methyl/L.

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

The base-set for azinphos-methyl is complete, and chronic toxicity data are also available for algae, crustaceans, mollusca, and fish, with the lowest NOEC of 0.02 for *Mysidopsis bahia*. Although azinphos-methyl was developed as an insecticide, the data show that crustaceans are also very sensitive. Thus, chronic toxicity data are available for two sensitive groups (insects and crustaceans), and an assessment factor of 10 can be used to derive the $MPC_{eco,water}$. Two mesocosm studies with long-term effects were performed. The NOECs for these studies are higher (0.13 µg/L and 0.61 µg/L) than the lowest NOEC for crustacea (0.02 µg/L). This means that the chronic tests and not the cosm studies produce the lowest data.

However, chronic toxicity data are available for algae, crustaceans, insects, fish, amphibians and molluscs, adding up to 25 species of which molluscs can be considered as typical marine species. The data requirements for applying the statistical extrapolation method are not fully met, because no toxicity data are availably for macrophytes. From the aquatic mesocosm studies (Giddings et al., 1994; Dortland, 1980) it appears that aquatic plants are not particularly sensitive to azinphos-methyl, although some effects could not be ruled out at concentrations of 0.61 to 0.81 µg/L (Dortland, 1980). Thus, a Species Sensitivity Distribution (SSD) was calculated (see Figure 3). The hazardous concentration at which 5% of the species are potentially affected (HC5), which equals the 5th percentile of the species sensitivity distribution (SSD), is 0.019 µg/L (90% CI 0.0025 to 0.086 µg/L).

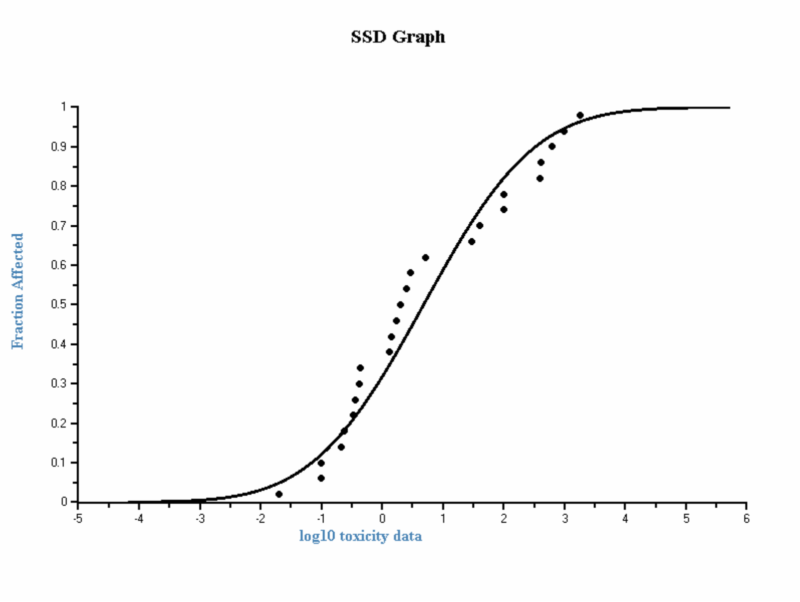


Figure 3 SSD graph for chronic toxicity data of azinphos-methyl.

To this HC5 an assessment factor varying from 1 to 5 should be applied. First, the arguments in favour of a higher assessment factor are given: some of the studies for the most sensitive taxa (crustaceans and insects) are focused on rather insensitive endpoints such as immobility and mortality. Data on macrophytes are missing, and there is only one chronic test result available for algae. Although these species are probably not amongst the most sensitive, the absence of such data may have its influence on the shape of the SSD curve and hence on the HC5. The goodness-of-fit of the curve fitting is rejected by all three testing methods (Anderson-Darling, Kolmogorov-Smirnov and Cramer von Mises) at the 0.1 significance level. The lower limit of the HC5 is a factor of eight lower than the median HC5. Although these factors would strongly imply an assessment factor not lower than 5, there are some strong arguments to lower the assessment factor as well. First, the dataset is quite comprehensive. Next to that, the mode of action is well-known for the most sensitive species (acetyl choline esterase inhibition in crustaceans, insects and other arthropoda). Arthropoda are relatively well represented in the data set (4 crustaceans and 8 insects). Further, the few available mesocosm studies show that effects in these systems are not observed at levels below 0.1 µg/L. No individual NOEC below the HC5 were observed. Overall an assessment factor of three on the HC5 is considered most appropriate. The resulting $MPC_{eco,water}$ then becomes 6.5×10^{-3} µg/L.

Regarding the $MPC_{eco,marine}$, data for one typical marine taxon are available. Therefore, in the assessment factor method an additional factor of 5 would be applied to the $MPC_{eco, water}$ value. The FHI guidance mentions only the case of applying an additional factor of 10 when no data for typical marine species are available. However, in this case two NOECs for molluscs are available and the assessment factor of 5 seems justified. The $MPC_{eco,marine}$ thus becomes 1.3×10^{-3} µg/L.

3.2.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Azinphos-methyl has a BCF<100, thus assessment of secondary poisoning is not triggered.

3.2.3.3 $MPC_{hh\ food,water}$ and $MPC_{hhfood,marine}$

Derivation of $MPC_{hh\ food}$ for azinphos-methyl is not triggered (Table 16).

3.2.3.4 $MPC_{dw,water}$

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

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

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 6.5×10^{-3} µg/L and the MPC_{marine} is 1.3×10^{-3} µg/L.

3.2.3.6 MAC_{eco}

The base-set for acute data is complete, the data for different species differ by more than a factor of 3. Enough data are present to perform an SSD. This results in a HC5 of 0.14 µg/L, with a rejected ‘goodness-of-fit’ (Figure 4). According to the guidance, a default assessment factor of 10 should be used on the results of an SSD for acute data. Because of the lack of ‘goodness of fit’, there is no justification to lower this default assessment factor, which would result in a MAC_{eco} of 0.14 / 10 = 0.014 µg/L.

However, it can be argued that the most sensitive taxonomic groups have been tested. Azinphos-methyl is an acetylcholine esterase inhibitor and therefore the substance is most toxic to arthropods. Crustaceans appear to be even more sensitive than insects (when tested with a t-test ($p = 0.06$) this difference is almost significant). And indeed, fish, amphibians, molluscs, algae, and bacteria are much less sensitive. For illustrative purposes, an SSD on the most sensitive species (crustaceans and insects) can be calculated, which results in a HC5 of 0.06 µg/L (Figure 5). Although the goodness-of-fit of this SSD is better than for the SSD of all acute data, an assessment factor of 4 or 5 on this HC5 would certainly be justified, since the fit of the SSD is not well and there is no bimodality.

Regarding the assessment factor approach, the BCF is lower than 100, which means that an assessment factor of 100 could be used on the lowest L(E)C50 value (0.14 µg/L for crustaceans). However, because of the large number of data for crustaceans and insects and the known mode of action, an assessment factor of 10 seems justified in this case. The $MAC_{eco,water}$ then becomes 0.14 / 10 = 0.014 µg/L.

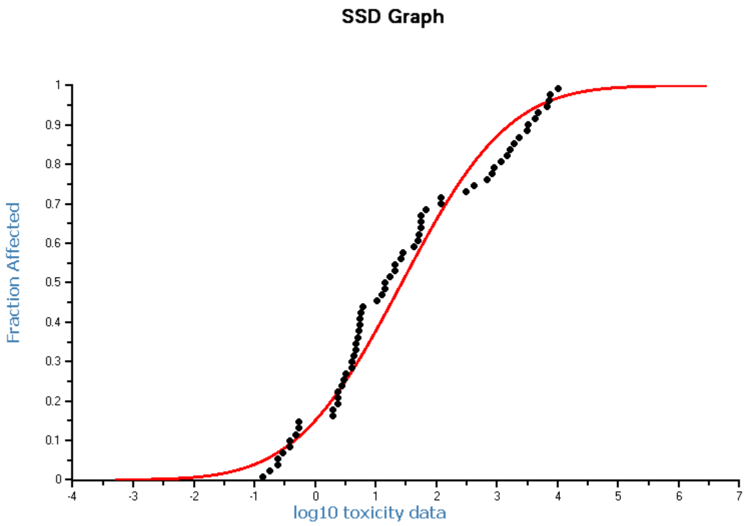


Figure 4. SSD for azinphos-methyl, using acute toxicity data for all species.

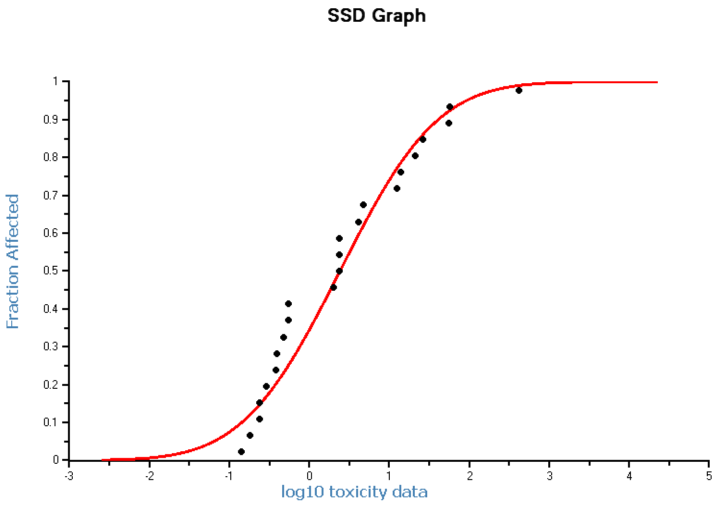


Figure 5. SSD for azinphos-methyl, using acute toxicity data for sensitive species.

According to the guidance (Van Vlaardingen and Verbruggen, 2007), data from mesocosm studies with short-term exposure can also be used to derive a $\mathrm{MAC_{eco}}$. However, chronic laboratory tests show a higher sensitivity than the mesocosm study results with a NOEC of 0.2 µg/L. This difference may be caused by the short exposure peak in the mesocosm studies, as opposed to a 96 hour exposure in acute laboratory tests. Moreover, a number of acute laboratory tests even show LC50 values which are close to this ecosystem-NOEC. Thus, the $\mathrm{MAC_{eco,water}}$ is not derived based on mesocosm studies, and the

MAC derived using the SSD for all species and the MAC derived using assessment factors is the final $MAC_{eco,water}$ (0.014 µg/L).

In the case of azinphos-methyl, acute toxicity are reported for one specific marine taxon (mollusca), and thus an additional assessment factor of 5 is used on the $MAC_{eco,water}$ and the provisional $MAC_{eco,marine}$ is set at 0.014 / 5 = 2.8×10^{-3} µg/L.

3.2.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100:
$NC_{water} = 6.5 \times 10^{-5}$ µg/L.
$NC_{marine} = 1.3 \times 10^{-5}$ µg/L.

3.2.3.8 SRC_{eco}

Chronic data are available for algae, crustacea (among which *Daphnia*), mollusca and fish, the geomean of all chronic data is 4.8 µg/L and these data are normally distributed (significant at all levels using the Anderson-Darling test for normality). When three or more NOECs are available, a comparison with acute data is not necessary. The $SRC_{eco,water}$ and $SRC_{eco,marine}$ can be derived using an assessment factor of 1 and become 4.8 / 1 = 4.8 µg/L.

3.3 Coumaphos

3.3.1 Substance identification, physicochemical properties, fate and human toxicology

3.3.1.1 Identity

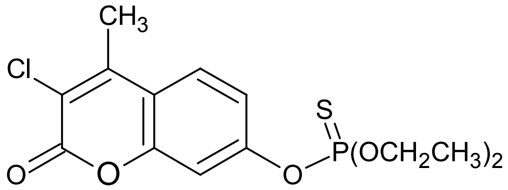


Figure 6. Structural formula of coumaphos.

Table 19. Identification of coumaphos.

Parameter	Name or number
Chemical name	O-3-chloro-4-methyl-2-oxo-2H-chromen-7-yl O,O-diethyl phosphorotioate; 3-chloro-7-diethoxyphosphinothioyloxy-4-methylcoumarin (IUPAC) or O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl) O,O-diethyl phosphorothioate (Chemical abstracts)
Common/trivial/other name	Co-Ral; Resitox; Asuntol; Perizin
CAS number	56-72-4
EC number	200-285-3
SMILES code	S=P(OCC)(OCC)Oc1ccc2C(C)=C(Cl)C(=O)Oc2c1

3.3.1.2 Physicochemical properties

Table 20. Physicochemical properties of coumaphos.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	362.8		
Water solubility	[mg/L]	1.5	20 °C	Tomlin, 2002
		2		US EPA, 2000
pK_a	[-]	n.a.		
log K_{ow}	[-]	**4.13**		Tomlin, 2002
		4.01	RP-HPLC technique	Finizio et al., 1997
		4.47	EpiWin	US EPA, 2007
		4.13	MlogP	BioByte, 2004
		4.33	ClogP	BioByte, 2004
log K_{oc}	[-]	3.58	EpiWin	US EPA, 2007
		3.6-4.1		US EPA, 2000
		3.02	Calculated using log Kow of 4.1	According to Sabljic et al., 1995
Vapour pressure	[Pa]	1.3×10^{-5}		Tomlin, 2002
Melting point	[°C]	95		Tomlin, 2002
Boiling point	[°C]	455	EpiWin	US EPA, 2007
Henry's law constant	[Pa.m^3.mol^{-1}]	3.1×10^{-3}		Tomlin, 2002

n.a. = not applicable.

3.3.1.3 Behaviour in the environment

Table 21. Selected environmental properties of coumaphos.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]		Stable to hydrolysis	Tomlin, 2002
Photolysis half-life	DT50 [d]	23.8	Soil surface	Tomlin, 2002
		1.4	Water	US EPA, 2000
Degradability	DT50 [d]	>1 yr	Sandy loam, aerobic	US EPA, 2000
		316		US EPA, 2000
Relevant metabolites	O,O-diethyl-O-(3-acetoxy)phenylphosphorothioate Coumaphoxon Chlorferon Coumaphos oxygen analog 3-methyl-6-hydroxybenzofuran			

3.3.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for coumaphos is given in Table 22. Detailed bioaccumulation data for coumaphos are tabulated in Appendix 1.

Table 22. Overview of bioaccumulation data for coumaphos.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	554.5	EpiWin	US EPA, 2007
		110	Equilibrium method after only three days exposure	Freitag et al., 1985
		541		US EPA, 2000
BMF	[kg/kg]	1	Default value	

3.3.1.5 Human toxicological treshold limits and carcinogenicity

Coumaphos has not been classified as carcinogenic to humans. The main effect of coumaphos is inhibition of cholinesterase activity. Coumaphos is classified as T+; R28; Xn; R21; N; R50/53. No ADI values are derived by European or WHO authorities, but an ADI of 0.0003 mg/kg_{bw} is proposed by the Canadian authorities, based on a NOAEL of 0.3 $mg/kg_{bw}/d$ from a 2-generation reproduction study in rats and a NOAEL of 0.36 $mg/kg_{bw}/d$ from a 2-year rat chronic carcinogenicity study (Pesticide Management Regulatory Agency, 2003). The US EPA also reports an PAD (Population Adjusted Dose, equivalent to an ADI) of 0.0003 mg/kg_{bw}, based on a NOAEL of 0.025 mg/kg day in a chronic dietary toxicity study for dogs (US EPA, 2000).

3.3.2 Trigger values

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

Table 23. Coumaphos: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	2.6-3.1	[-]	$K_{oc} \times f_{oc,susp}$[1]	K_{oc}: 3.3.1.2
BCF	541	[L/kg]		3.3.1.4
BMF	1	[-]		3.3.1.4
Log K_{ow}	4.1	[-]		3.3.1.2
R-phrases	T+; R28; Xn; R21; N; R50/53	[-]	http://ecb.jrc.it/esis/	3.3.1.5
A1 value	1.0	[µg/L]	total pesticides	
DW standard	0.1	[µg/L]	general value for organic pesticides	

[1] $f_{oc,susp} = 0.1\ kg_{oc}/kg_{solid}$ (European Commission (Joint Research Centre), 2003).

- Coumaphos has a log $K_{p,\ susp-water} < 3$; derivation of $MPC_{sediment}$ is not triggered.
- Coumaphos has a log $K_{p,\ susp-water} < 3$; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- Coumaphos has a BCF > 100; assessment of secondary poisoning is triggered.
- Coumaphos has a BCF > 100 and an R28 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{water,\ hh\ food}$) need to be derived.
- For coumaphos, 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 for organic pesticides applies.

3.3.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data for coumaphos is given in Table 24 and an overview of the selected marine toxicity data is given in Table 25. Detailed toxicity data for coumaphos are tabulated in Appendix 2.

Table 24. Coumaphos: selected aquatic freshwater data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Crustacea	**0.034**	Crustacea	0.1
Pisces	11.7	Crustacea	0.15
		Crustacea	**0.074**
		Crustacea	0.1
		Insecta	20
		Insecta	30
		Insecta	427
		Insecta	5.2
		Pisces	840
		Pisces	247[b]
		Pisces	1100
		Pisces	862
		Pisces	1155[c]
		Pisces	560
		Pisces	46
		Pisces	593
		Pisces	780

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.

[b] Geomean of 180 and 340, parameter mortality for *Lepomis macrochirus.*

[c] Geomean of 1500 and 890, parameter mortality *Oncorhynchus mykiss.*

Table 25. Coumaphos: selected aquatic marine data for ERL derivation.

Chronic [a]		Acute [a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Mollusca	20[b]	Mollusca	290[d]
Mollusca	50[c]	Crustacea	2
		Pisces	280
		Pisces	1654[e]

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.

[b] Lowest value, parameter growth for *Crassostrea virginica.*

[c] Lowest value, parameter growth for *Mercenaria mercenaria.*

[d] Lowest value and most relevant temperature (9 °C) for *Crassostrea virginica.*

[e] Geomean of 1862 and 1470, parameter mortality for *Gasterosteus aculeatus.*

3.3.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

The base-set is not complete. But because toxicity data from azinphos-methyl show that algae are not sensitive to this group of compounds and chronic data are present for both crustaceans, mollusca and fish, it is allowed to derive $MPC_{eco,water}$ and $MPC_{eco,marine}$ using the chronic dataset. With these three species, and because crustaceans are the most sensitive taxonomic group in acute toxicity studies, an assessment factor of 10 can be applied for the $MPC_{eco,water}$ and because one of these NOECs is from a marine taxonomic group, for the $MPC_{eco,marine}$ an assessment factor of 50 can be used. The lowest NOEc is 0.034 µg/L for crustaceans. Thus, the $MPC_{eco,water}$ becomes 0.034 / 10 = 3.4×10^{-3} and the $MPC_{eco,marine}$ is set at 0.034 / 50 = 6.8×10^{-4} µg/L.

3.3.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Coumaphos has a BCF>100, thus assessment of secondary poisoning is triggered. The lowest MPC_{oral} is 0.04 mg/kg diet for *Colinus virginianus* (see Table 26). Subsequently, the $MPC_{sp,water}$ can be calculated using a BCF of 541 and a BMF of 1 (section 3.3.1.4) and becomes 0.04 / (541 × 1) = 7.5×10^{-5} mg/L = 0.075 µg/L.

Table 26. Coumaphos: selected bird and mammal data for ERL derivation.

Species[a]	Exposure time	Criterion	Effect concentration (mg/kg diet)	Assessment factor	MPC_{oral} (mg/kg diet)
Anas platyrhynchos	5 days	LC50	709	3000	0.24
Colinus virginianus	5 days	LC50	120	3000	**0.04**
Coturnix c. japonica	5 days	LC50	225	3000	0.08
Phasianus colchicus	5 days	LC50	318	3000	0.11
Dog	1 year	NOEC	90	30	3.0
Rabbit	13 days	NOEC	66.6[b]	300	0.22
Rat	2 years	NOEC	5	30	0.17
Rat	10 days	NOEC	50[c]	300	0.17

[a] For detailed information see Appendix 4. Bold values are used for risk assessment.
[b] based on a NOAEL of 2 mg/kg_{bw}/day with a conversion factor of 33.3.
[c] based on a NOAEL of 5 mg/kg_{bw}/day with a conversion factor of 10.

For the marine environment, an extra biomagnification factor should be used. But since this factor is 1 by default, the $MPC_{sp,marine}$ equals the $MPC_{sp,water}$ and is also 0.075 µg/L.

3.3.3.3 $MPC_{hh\ food,water}$ and $MPC_{hh\ food,marine}$

Derivation of $MPC_{hh\ food,water}$ for coumaphos is triggered (Table 23). With an ADI of 3 $µg/kg_{bw}$ (section 3.3.1.5), a BCF of 541 and a BMF of 1 (section 3.3.1.4), the $MPC_{hh\ food}$ becomes (0.1 × 3 × 70) / 0.115 = 183 mg/kg. Subsequently, the $MPC_{hh\ food,water}$ = 183 / (541 × 1) = 0.34 mg/L = 340 µg/L.

For the marine environment, the $MPC_{hh\ food,marine}$ is equal to the $MPC_{hh\ food,water}$ and is 340 µg/L.

3.3.3.4 $MPC_{dw,water}$

The $MPC_{dw,water}$ is 0.1 $µg.L^{-1}$ according to the Drinking Water Standard.

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

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 3.4×10^{-3} µg/L and the MPC_{marine} is 6.8×10^{-4} µg/L.

3.3.3.6 MAC_{eco}

The base-set for acute data is not complete, but it can be assumed that algae are not more sensitive than fish or Crustacea. The data for different species differ by more than a factor of 3. Since the BCF is higher than 100, this means that an assessment factor of 1000 should normally be used on the lowest L(E)C50 value (0.074 µg/L for crustaceans). However, the mode of toxic action is known (acetyl choline esterase inhibitor), and the most sensitive species are tested (crustaceans). These crustaceans are not likely to be exposed for a longer period of time due to slow desorption kinetics. An assessment factor of 100 instead of 1000 for the $MAC_{eco,water}$ is therefore justified. The $MAC_{eco,water}$ then becomes $0.074 / 100 = 7.4 \times 10^{-4}$ µg/L. This is however lower than the MPC_{water}, and thus the $MAC_{eco,water}$ is set equal to the MPC_{water} at 3.4×10^{-3} µg/L.

For comparative reasons (not allowed according to the Fraunhofer methodology because not all required taxa are present) an SSD was performed on the acute toxicity data for all species and for the most sensitive species (crustaceans and insects). This resulted in a HC5 of 0.13 µg/L (with a rejected 'goodness of fit') for all species and a HC5 of 9.1×10^{-3} µg/L for the most sensitive species.

In the case of coumaphos, acute toxicity are reported for one specific marine taxon (mollusca), and thus an additional assessment factor of 5 is used on the $MAC_{eco,water}$ and the provisional $MAC_{eco,marine}$ becomes 7.4 $7.4 \times 10^{-4} / 5 = 1.5 \times 10^{-3}$ µg/L. This is however lower than the MPC_{marine}, and thus the provisional $MAC_{eco,marine}$ is set equal to the MPC_{marine} at 6.8×10^{-4} µg/L.

3.3.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100:
$NC_{water} = 3.4 \times 10^{-5}$ µg/L.
$NC_{marine} = 6.8 \times 10^{-6}$ µg/L.

3.3.3.8 SRC_{eco}

No acute and chronic toxicity data are available for algae. NOECs are available (for fish, *Daphnia* and mollusca) for which the geometric mean is 4.5 µg/L, which is more than 10 times below the geometric mean of all acute data (46.6 µg/L; not normally distributed according to the Anderson-Darling test at all levels). Thus, the $SRC_{eco,water}$ and $SRC_{eco,marine}$ can be derived using the geometric mean of the NOECs with an assessment factor of 1 and become $4.5 / 1 = 4.5$ µg/L. Because no chronic data are available for the complete base-set, this value should be compared to the value that can be derived using only acute data. With an assessment factor of 10, the SRC_{eco} using acute LC50s would be 4.7, which is higher than the SRC_{eco} based on NOECs. Thus, the SRC_{eco} is set at 4.5 ug/L for freshwater and for the marine environment.

3.4 Heptenophos

3.4.1 Substance identification, physicochemical properties, fate and human toxicology

3.4.1.1 Identity

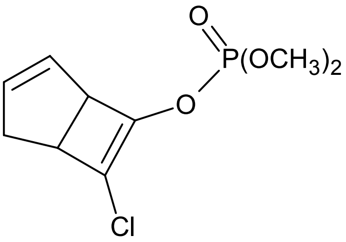


Figure 7. Structural formula of heptenophos.

Table 27. Identification of heptenophos.

Paramter	Name or number
Chemical name	7-chlorobicyclo[3,2,0]hepta-2,6-dien-6-yl dimethyl phosphate
Common/trivial/other name	Hostaquick, Ragadan
CAS number	23560-59-0
EC number	245-737-0
SMILES code	C1=CC2C(Cl)=C(OP(=O)(OC)OC)C2C1

3.4.1.2 Physicochemical properties

Table 28. Physicochemical properties of heptenophos.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	250.6		
Water solubility	[mg/L]	2200		
pK_a	[-]	n.a.		
log K_{ow}	[-]	**2.32**		Tomlin, 2002
		1.41	EpiWin	US EPA, 2007
		2.32	MlogP	BioByte, 2004
		2.67	ClogP	BioByte, 2004
log K_{oc}	[-]	**2.71**	EpiWin	US EPA, 2007
		2.17	Calculated using log K_{ow} = 2.3	According to Sabljic et al., 1995
Vapour pressure	[Pa]	0.065	15 ºC	Tomlin, 2002
		0.17	25 ºC	Tomlin, 2002
Melting point	[°C]	72	EpiWin	US EPA, 2007
Boiling point	[°C]	314	EpiWin	US EPA, 2007
Henry's law constant	[$Pa.m^3.mol^{-1}$]	5.7×10^{-5}	20 ºC	Tomlin, 2002

n.a. = not applicable.

3.4.1.3 Behaviour in the environment

Table 29. Selected environmental properties of heptenophos.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	0.12	EpiWin	US EPA, 2007
Photolysis half-life	DT50 [d]	unknown		
Degradability	DT50 [d]	1.4	Soil, field	Tomlin, 2002
		<4h	Lab, aerobic soil	Tomlin, 2002
		27-77h	Lab, water phase of sediment system	Tomlin, 2002
Relevant metabolites	7-chloro-2-bicyclo-(3,2,0)-hepten-6-one 2,3-cyclopenteno-cyclopropanecarboxyl acid			Panman and Linders, 1992

3.4.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for heptenophos is given in Table 30.

Table 30. Overview of bioaccumulation data for heptenophos.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	0.40	EpiWin calculation, using log K_{ow} of 1.41	US EPA, 2007
		19	Calculated using log K_{ow} of 2.32	QSAR in Veith et al., 1979
BMF	[kg/kg]	1	Default value	

No BCF studies for heptenophos were available. A BCF of 0.40 is calculated in EpiWin using an estimated log K_{ow} of 1.41. However, this log K_{ow} is almost an order of magnitude lower than the log K_{ow} value mentioned in the pesticide manual (Tomlin, 2002) and the MlogP value from Bioloom for this compound, 2.32. Using the log BCF- log K_{ow} relationship by Veith et al., 1979 (1979), as described by the guidance (Van Vlaardingen and Verbruggen, 2007), log BCF = 0.85 × log K_{ow} -0.70 = 0.85 × 2.32 – 0.70 = 1.27. Thus, the BCF is 19 L/kg.

3.4.1.5 Human toxicological treshold limits and carcinogenicity

Heptenophos has been classified as T; R25; N; R50/53. No international ADI has been determined by the Joint Meeting of Pesticide Residues (JMPR, 1992) or the WHO. In Germany, an ADI of 0.002 mg/kg_{bw} has been determined by the Bundesinstitut fur Risicobewertung (http://www.umwelt-online.de/recht/gefstoff/g_stoffe/adi.htm).

3.4.2 Trigger values

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

Table 31. Heptenophos: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	1.71	[-]	$K_{oc} \times f_{oc,susp}$ [1]	K_{oc}: 3.4.1.2
BCF	19	[L/kg]		3.4.1.4
BMF	1	[-]		3.4.1.4
Log K_{ow}	2.32	[-]		3.4.1.2
R-phrases	T; R25; N; R50/53	[-]	http://ecb.jrc.it/esis/	3.4.1.5
A1 value	1.0	[µg/L]	total pesticides	
DW standard	0.1	[µg/L]	general value for organic pesticides	

[1] $f_{oc,susp}$ = 0.1 kg_{oc}/kg_{solid} (European Commission (Joint Research Centre), 2003).

- Heptenophos has a log $K_{p,\ susp-water} < 3$; derivation of $MPC_{sediment}$ is not triggered.
- Heptenophos has a log $K_{p,susp-water} < 3$; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- Heptenophos has a BCF < 100; assessment of secondary poisoning is not triggered.
- Heptenophos has an R25; R50/53 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{water,\ hh\ food}$) does not need to be derived.
- For heptenophos, 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 for organic pesticides applies.

3.4.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data for heptenophos is given in Table 32. There are no marine toxicity data for heptenophos. Detailed toxicity data for heptenophos are tabulated in Appendix 2.

Table 32. Heptenophos: selected aquatic freshwater data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Algae	25000	Algae	35000
		Crustacea	**2**[b]
		Pisces	11300
		Pisces	11038[c]

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.

b Lowest value of 2, parameter mortality/immobility for *Daphnia magna*. Two values not considered equivalent due to a difference of a factor of 400.

c Geometric mean of 9300 and 13100, parameter mortality/immobility for *Poecilia reticulata*.

3.4.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

The base-set is complete. The only NOEC available is for algae, which is not enough to deviate from the assessment factor of 1000. Thus, the $MPC_{water,eco}$ is derived using the lowest LC50 (2 µg/L for crustaceans) and is set at $2 / 1000 = 2 \times 10^{-3}$ µg/L.

Although no marine data are available, the $MPC_{marine,eco}$ is also derived using this dataset and an assessment factor of 10000 and is set at $2 / 10000 = 2 \times 10^{-4}$ µg/L.

3.4.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Heptenophos has a BCF < 100, thus assessment of secondary poisoning is not triggered.

3.4.3.3 $MPC_{hh\ food,water}$ and $MPC_{hh\ food,marine}$

Derivation of $MPC_{hh\ food}$ for heptenophos is not triggered (Table 31).

3.4.3.4 $MPC_{dw,water}$

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

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

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 2×10^{-3} µg/L and the MPC_{marine} is 2×10^{-4} µg/L.

3.4.3.6 MAC_{eco}

The base-set is complete, heptenophos does not have potential to bioaccumulate. Thus, an assessment factor of 100 can be used on the lowest LC50 value to derive the $MAC_{eco,water}$, and the $MAC_{eco,water}$ becomes 2 / 100 = 0.02 µg/L. The assessment factor used can not be lowered to 10, because no data for insects are available and heptenophos is an acetylcholine esterase inhibitor. Thus, the $MAC_{eco,water}$ is set at 0.02 µg/L.

In the case of heptenophos, no acute toxicity data for specific marine taxa are available and thus an additional assessment factor of 10 is used on the $MAC_{eco,water}$ and the provisional $MAC_{eco,marine}$ is set at $0.02 / 10 = 2.0 \times 10^{-3}$ µg/L.

3.4.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100:
$NC_{water} = 2.0 \times 10^{-5}$ µg/L.
$NC_{marine} = 2.0 \times 10^{-6}$ µg/L.

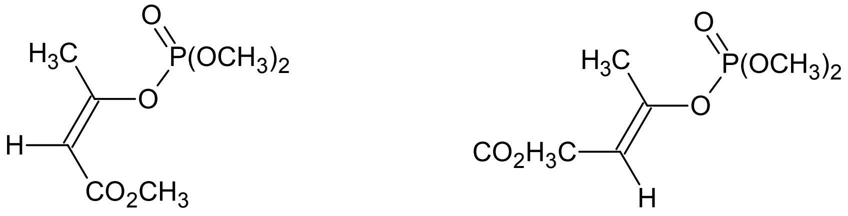
3.4.3.8 SRC_{eco}

A NOEC is available for algae (25000 µg/L), and the geometric mean of the acute data is 1719 µg/L (rejected at the 0.1 and 0.05 level but siginificant at all other levels using the Anderson-Darling test for normality), which is lower than the NOEC value. Thus, the $SRC_{eco,water}$ and $SRC_{eco,marine}$ are derived using an assessment factor of 10 on the geometric mean of the LC50s, and become 1719 / 10 = 172 µg/L.

3.5 Mevinphos

3.5.1 Substance identification, physicochemical properties, fate and human toxicology

3.5.1.1 Identity



(*Z*)-isomeer (*E*)-isomeer

Figure 8. Structural formula of mevinphos.

Table 33. Identification of mevinphos.

Parameter	Name or number
Chemical name	2-methoxycarbonyl-1-methylvinyl dimethyl phosphate or methyl 3-(dimethoxyphosphinoyloxy)but-2-enoate (IUPAC) or methyl 3-[9diemthoxyphosphinyl)oxy]-2-butenoate (Chemical Abstracts)
Common/trivial/other name	Phosdrin, Mevindrin, Duraphos
CAS number	26718-65-0 (formerly: 298-01-1 (E)-isomeer 338-45-4 (Z)-isomeer 7786-34-7 ((Z) + (E) –isomeer)
EC number	232-095-1
SMILES code	COC(=O)C=C(C)OP(=O)(OC)OC

3.5.1.2 Physicochemical properties

Table 34. Physicochemical properties of mevinphos.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	224.1		
Water solubility	[mg/L]	Completely miscible		Tomlin, 2002
pK_a	[-]	n.a.		
log K_{ow}	[-]	0.127		Tomlin, 2002
		0.5	Selected from ref's	Mackay et al., 2000
		1.2	MlogP	BioByte, 2004
		0.92	ClogP	BioByte, 2004
		-0.24	EpiWin	US EPA, 2007
log K_{oc}	[-]	2.4	EpiWin	US EPA, 2007
		1.6	20-25 ºC; soil; selected from ref's	Mackay et al., 2000
		1.65	Calculated using log K_{ow} = 1.2	According to Sabljic et al., 1995
Vapour pressure	[Pa]	0.017	20 ºC	Tomlin, 2002; Mackay et al., 2000
Melting point	[°C]	-56.1	Selected from ref's	Mackay et al., 2000;
		21	E-isomer	Tomlin, 2002
		6.9	Z-isomer	Tomlin, 2002
Boiling point	[°C]	99-103		Tomlin, 2002
Henry's law constant	[Pa.m^3.mol^{-1}]	6.4×10^{-6}	Calculated	Mackay et al., 2000

n.a. = not applicable.

3.5.1.3 Behaviour in the environment

Table 35. Selected environmental properties of mevinphos.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	120	pH = 6	Tomlin, 2002
		35	pH = 7	Tomlin, 2002
		3	pH = 9	Tomlin, 2002
		1.4h	pH = 11	Tomlin, 2002
Photolysis half-life	DT50 [d]	-		
Degradability	DT50 [d]	3	Field soil; selected from ref's	Mackay et al., 2000
Relevant metabolites	Dimethylphosphate O,O-dimethyl-2-carboxyl-1-methylvinylphosphate O-methyl-2-carbomethoxy-1-methylvinylphosphate acetone methylphosphate			Fraters and Linders, 1991

3.5.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for mevinphos is given in Table 36.

Table 36. Overview of bioaccumulation data for mevinphos.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	3.2	EpiWin calculation using log K_{ow} of -0.24	US EPA, 2007
		2.1	Calculated using log K_{ow} of 1.2	QSAR in Veith et al., 1979
BMF	[kg/kg]	1	Default value	

3.5.1.5 Human toxicological treshold limits and carcinogenicity

Mevinphos has not been classified as carcinogenic to humans. Mevinphos is classified as T+; R27/28; N; R50-53. An ADI of 0.0008 mg/kg$_{bw}$ is reported by the Joint Meeting on Pesticide Residues and the WHO (JMPR, 1992). This ADI is based on a NOAEL of 0.016 mg/kg$_{bw}$/d in a 30-day study in volunteers, using a 20-fold safety factor because of the small numbers in each group. This ADI is supported by a LOAEL in rats of 0.35 mg/kg$_{bw}$/d and NOAELs of 0.5 mg/kg$_{bw}$/d in rabbits and 0.25 mg/kg$_{bw}$/d in dogs.

3.5.2 Trigger values

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

Table 37. Mevinphos: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
log $K_{p,susp\text{-}water}$	0.6	[-]	$K_{oc} \times f_{oc,susp}$[1]	K_{oc}: 3.5.1.2
BCF	2.1	[L/kg]		3.5.1.4
BMF	1	[-]		3.5.1.4
log K_{ow}	1.2	[-]		3.5.1.2
R-phrases	R27/28, R50-53	[-]	http://ecb.jrc.it/esis/	3.5.1.5
A1 value	1.0	[µg/L]	total pesticides	
DW standard	0.1	[µg/L]	general value for organic pesticides	

[1] $f_{oc,susp}$ = 0.1 kg$_{oc}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- Mevinphos has a log $K_{p,\ susp\text{-}water}$ < 3; derivation of MPC$_{sediment}$ is not triggered.
- Mevinphos has a log $K_{p,\ susp\text{-}water}$ < 3; expression of the MPC$_{water}$ as MPC$_{susp,\ water}$ is not required.
- Mevinphos has a BCF < 100; assessment of secondary poisoning is not triggered.
- Mevinphos has an R27/28 and R50-53 classification. Since BCF < 100 an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{water,\ hh\ food}$) does not have to be derived.
- For mevinphos, 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 for organic pesticides applies.

3.5.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data for mevinphos is given in Table 38 and for marine toxicity data in Table 39. Detailed toxicity data for mevinphos are tabulated in Appendix 2.

Table 38. Mevinphos: selected aquatic freshwater data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
No chronic data		Crustacea	58[b]
		Crustacea	0.95
		Crustacea	**0.17**[c]
		Crustacea	3.1[d]
		Crustacea	130
		Crustacea	13[e]
		Crustacea	0.47[f]
		Insecta	23
		Insecta	8.8
		Insecta	5
		Pisces	2914
		Pisces	48.7[g]
		Pisces	115
		Pisces	11.9
		Pisces	11500

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.
[b] Geomean of 56 and 61, parameter mortality for *Asellus brevicaudus.*
[c] Geomean of 0.16 and 0.18, parameter immobility for *Daphnia pulex.*
[d] Geomean of 2.8 and 3.5, parameter mortality for *Gammarus fasciatus.*
[e] Geomean of 12 and 13.5, parameter mortality for *Paleomonetes kadiakensis.*
[f] Geomean of 0.43, 0.56, 0.42 and 0.49, parameter mortality for *Simocephalus serrulatus.*
[g] Geomean of 22.5, 59, and 87, parameter mortality for *Lepomis macrochirus.*

Table 39. Mevinphos: selected aquatic marine data for ERL derivation.

Chronic [a]		**Acute** [a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
No chronic data		Crustacea	13
		Crustacea	79
		Crustacea	33
		Crustacea	150
		Pisces	65
		Pisces	640
		Pisces	140[b]
		Pisces	75
		Pisces	320
		Pisces	300
		Pisces	800
		Pisces	74

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.
[b] Geomean of 65 and 300, parameter mortality for *Fundulus heteroclitus.*

3.5.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

The base–set (fish, *Daphnia*, and algae) is incomplete, because no data are available for algae. No chronic data are available. However, because long term toxicity data are available for similar compounds (for instance azinphos-methyl, see section 3.2.3), MPC values can be derived for mevinphos using read-across.

Read-across from azinphos-methyl shows that algae are not a sensitive species for this kind of compounds. Thus, with an assessment factor of 1000 on the lowest LC50 (0.17 µg/L for a crustacean species), the $MPC_{eco,water}$ is set at 0.17 / 1000 = 1.7×10^{-4} µg/L.

For the marine environment, an assessment factor of 10000 should be used and the MPCeco,marine is thus set at 0.17 / 10000 = 1.7×10^{-5} µg/L.

3.5.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Mevinphos has a BCF < 100, thus assessment of secondary poisoning is not triggered.

3.5.3.3 $MPC_{hh\ food,water}$ and $MPC_{hh\ food,marine}$

Derivation of $MPC_{hh\ food}$ for mevinphos is not triggered (Table 37).

3.5.3.4 $MPC_{dw,water}$

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

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

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 1.7×10^{-4} µg/L and the MPC_{marine} is 1.7×10^{-5} µg/L.

3.5.3.6 MAC_{eco}

The base-set is not complete, but algae are not the most sensitive species for this type of compounds. Furthermore, mevinphos does not have potential to bioaccumulate. It can be argued that the most sensitive taxonomic groups have been tested. Mevinphos is an acetylcholine esterase inhibitor and therefore the substance is most toxic to arthropods. Both crustaceans and insects have been tested and therefore an assessment factor of 10 seems justified in this case. Thus, an assessement factor of 10 can be used on the lowest LC50 value to derive the $MAC_{eco,water}$: 0.17 / 10 = 1.7×10^{-2} µg/L.

For comparative reasons (not allowed according to the Fraunhofer methodology because not all required taxa are present) an SSD was performed on the acute toxicity data for all species and for the most sensitive species (crustaceans and insects). This resulted in a HC5 of 0.70 µg/L for all species and a HC5 of 0.30 µg/L for the most sensitive species.

In the case of mevinphos, no toxicity data are available for specific marine taxa, and thus an additional assessment factor of 10 is used on the $MAC_{eco,water}$ and the provisional $MAC_{eco,marine}$ is set at 1.7×10^{-2} / 10 = 1.7×10^{-3} µg/L.

3.5.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100:
$NC_{water} = 1.7 \times 10^{-6}$ µg/L.
$NC_{marine} = 1.7 \times 10^{-7}$ µg/L.

3.5.3.8 SRC_{eco}

No NOECs are available. The geometric mean of the LC50s is 45.7 µg/L (significant at all levels using the Anderson-Darling test for normality). With an assessment factor of 10, this means that the $SRC_{eco,water}$ and $SRC_{eco,marine}$ become 45.7 / 10 = 4.6 µg/L.

3.6 Tolclofos-methyl

3.6.1 Substance identification, physicochemical properties, fate and human toxicology

3.6.1.1 Identity

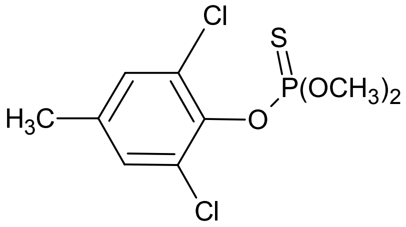


Figure 9. Structural formula of tolclofos-methyl.

Table 40. Identification of tolclofos-methyl.

Parameter	Name or number
Chemical name	O-2,6-dichloro-p-tolyl O,O-dimethyl phosphorothioate (IUPAC) or O-(2,6-dichloro-4-methylphenyl) O,O-dimethyl phosphorothioate (Chemical Abstracts)
Common/trivial/other name	Rizolex, Jiajilikulin
CAS number	57018-04-9
EC number	260-515-3
SMILES code	S=P(OC)(OC)Oc1c(Cl)cc(C)cc1Cl

3.6.1.2 Physicochemical properties

Table 41. Physicochemical properties of tolclofos-methyl.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	301.1		
Water solubility	[mg/L]	0.708		Anonymous, 2004
		1.2	25 ºC	Tomlin, 2002
		0.3	20-25 ºC; selected	Mackay et al., 2000
pK_a	[-]	n.a.		
log K_{ow}	[-]	**4.56**		Anonymous, 2004; Tomlin, 2002
		4.77	EpiWin	US EPA, 2007
		4.86	ClogP	BioByte, 2004
		4.56	MlogP	BioByte, 2004
log K_{oc}	[-]	**3.3**	Selected from ref's	Mackay et al., 2000
		3.3	EpiWin	US EPA, 2007
		3.2-3.8		Anonymous, 2004
		3.23	Calculated using log K_{ow} = 4.56	According to Sabljic et al., 1995
Vapour pressure	[Pa]	1.82×10^{-3}	25 ºC	Anonymous, 2004
		5.7×10^{-2}		Tomlin, 2002; Mackay et al., 2000
Melting point	[°C]	78-80		Tomlin, 2002; Anonymous, 2004
Boiling point	[°C]	Decomposes before boiling		Anonymous, 2004
Henry's law constant	[Pa.m^3.mol^{-1}]	0.37	Calculated	Anonymous, 2004
		57.5	Calculated	Mackay et al., 2000

n.a. = not applicable.

3.6.1.3 Behaviour in the environment

Table 42. Selected environmental properties of tolclofos-methyl.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	68	pH 4	Anonymous, 2004
		50	pH 7	Anonymous, 2004
		55	pH 9	Anonymous, 2004
Photolysis half-life	DT50 [d]	38.3	In water	Anonymous, 2004
		44	In water	Tomlin, 2002
		15-28	In lake and river water	Tomlin, 2002
		<2	On soil surface	Tomlin, 2002
Degradability	DT50 [d]	30	Field soil	Mackay et al., 2000
		-	Not readily biodegradable	Anonymous, 2004
		15-16	water-sediment system	Anonymous, 2004
Relevant metabolites	2,5-dichlorocresol			Tomlin, 2002
	3,5-dichloro-4-hydroxybenzoic acid			Anonymous, 2004
	O-methyl-O-(2,6-dichloro-4-methylphenyl)phosphorothioicacid			Anonymous, 2004; Visser and Linders, 1992

3.6.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for tolclofos-methyl is given in Table 43. Detailed bioaccumulation data for tolclofos-methyl are tabulated in Appendix 1.

Table 43. Overview of bioaccumulation data for tolclofos-methyl.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	650	k1/k2	Anonymous, 2004
		263-1283	equilibrium method; may be based on wet weights	Tsuda et al., 1997
		210		Tsuda et al., 1992
		490	geometric mean	
BMF	[kg/kg]	2	Default value, based on log K_{ow} = 4.56	

3.6.1.5 Human toxicological treshold limits and carcinogenicity

Tolclofos-methyl is not classified as carcinogenic to humans, and has the classification Xi; R43; N; R50/53. An ADI of 0.064 mg/kg was derived, based on a NOEL of 6.4 mg/kg$_{bw}$/day in a 2-year dietary study in mice (Anonymous, 2004).

3.6.2 Trigger values

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

Table 44. Tolclofos-methyl: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
log $K_{p,susp\text{-}water}$	2.3	[-]	$K_{oc} \times f_{oc,susp}$[1]	K_{oc}: 3.6.1.2
BCF	489	[L/kg]		3.6.1.4
BMF	2	[-]		3.6.1.4
log K_{ow}	4.56	[-]		3.6.1.2
R-phrases	Xi; R43; N; R50/53	[-]	DAR	3.6.1.5
A1 value	1.0	[μg/L]	total pesticides	
DW standard	0.1	[μg/L]	general value for organic pesticides	

[1] $f_{oc,susp}$ = 0.1 kg$_{oc}$/kg$_{solid}$ (European Commission (Joint Research Centre), 2003).

- Tolclofos-methyl has a log $K_{p,\ susp\text{-}water}$ < 3; derivation of MPC$_{sediment}$ is not triggered.
- Tolclofos-methyl has a log $K_{p,susp\text{-}water}$ < 3; expression of the MPC$_{water}$ as MPC$_{susp,\ water}$ is not required.
- Tolclofos-methyl has a BCF > 100; assessment of secondary poisoning is triggered.
- Tolclofos-methyl has an R43; R50/53 classification. Therefore, an MPC$_{water}$ for human health via food (fish) consumption (MPC$_{water,\ hh\ food}$) does not have to be derived.
- For tolclofos-methyl, 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 for organic pesticides applies.

3.6.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data for tolclofos-methyl is given in Table 45. There are no marine toxicity data for tolclofos-methyl. Detailed toxicity data for tolclofos-methyl are tabulated in Appendix 2.

Table 45. Tolclofos-methyl: selected aquatic freshwater data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Algae	32	Algae	**712**[c]
Algae	261[b]	Pisces	738[d]
Crustacea	26		
Pisces	**12**		

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.

[b] Geometric mean of 220 and 310, parameters biomass and growth rate, 72h, for *Scenedesmus subspicatus*.

[c] Geometric mean of 780 and 650, parameter biomass for *Scenedesmus subspicatus*.

[d] Geometric mean of 790 and 690, parameter mortality/immobility for *Oncorhynchus mykiss*.

3.6.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

Treatment of fresh- and saltwater toxicity data

Because tolclofos-methyl is a fungicide and has a different mode of action than the other organophosphorous insecticides discussed in this report, no read-across with the other compounds can be used. According to Lepper (2005): “Freshwater effects data of plant protection products (PPP) shall normally not be used in place of saltwater data, because within trophic levels differences larger than a factor of 10 were found for several PPP. This means that for PPP the derivation of quality standards addressing the protection of water and sediment in transitional, coastal and territorial waters is not possible if there are no effects data for marine organisms available or if it is not possible to determine otherwise with high probability that marine organisms are not more sensitive than freshwater biota (consideration of the mode of action may be helpful in this assessment).” This implies that for tolclofos-methyl, freshwater and marine toxicity data cannot be combined. Because there are no marine toxicity data, the consequence is that no environmental risk limits can be derived for tolclofos-methyl in marine environments.

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

Acute LC50 values are only available for algae and fish. Acute values for *Daphnia magna* are above the solubility limit, so they can not be used to derive ERLs, but can be used to complete the base-set (Van Vlaardingen and Verbruggen, 2007). With NOECs available from three trophic levels (algae, *Daphnia magna* and fish), an assessment factor of 10 can be applied to the lowest NOEC (12 µg/L for fish). This results in an $MPC_{eco,water}$ of 12 / 10 = 1.2 µg/L.

An $MPC_{eco,marine}$ can not be derived since no marine toxicity data for tolclofos-methyl are available.

3.6.3.2 $\text{MPC}_{\text{sp,water}}$ and $\text{MPC}_{\text{sp,marine}}$

Tolclofos-methyl has a BCF>100, thus assessment of secondary poisoning is triggered. The lowest MPC_{oral} is 3.3 mg/kg diet for mice (see Table 46). Subsequently, the $\text{MPC}_{\text{sp,water}}$ can be calculated using a BCF of 489 and a BMF of 2 (section 3.6.1.4) and becomes $3.3 / (489 \times 2) = 3.4 \times 10^{-3}$ mg/L = 3.4 µg/L.

For the marine environment, an extra biomagnification factor should be used. This factor is 2 by default (see Table 43), so the $\text{MPC}_{\text{sp,marine}}$ is 3.4 / 2 = 1.7 µg/L.

Table 46. Tolclofos-methyl: selected bird and mammal data for ERL derivation.

Species[a]	Exposure time	Criterion	Effect concentration (mg/kg diet)	Assessment factor	MPC_{oral} (mg/kg diet)
Anas platyrhynchos	19 weeks	NOEC	500	30	17
Colinus virginianus	21 weeks	NOEC	500	30	17
Dog	6 months	NOEC	600	30	20
Dog	1 year	NOEC	400	30	13
Mouse	9 months	NOEC	100	30	**3.3**
Mouse	2 years	NOEC	250	30	8.3
Rabbit	13 days	NOEC	9990[b]	300	33
Rat	32-34 days	NOEC	5000	3000	17
Rat	3 months	NOEC	1000	90	11
Rat	6 months	NOEC	3000	30	100

[a] For detailed information see Appendix 4. Bold values are used for risk assessment.

[b] based on an NOAEL of 300 mg/kg bw/day with a conversion factor of 33.3.

3.6.3.3 $\text{MPC}_{\text{hh food,water}}$ and $\text{MPC}_{\text{hh food,marine}}$

Derivation of $\text{MPC}_{\text{hh food,water}}$ for tolclofos-methyl is not triggered (Table 44).

3.6.3.4 $\text{MPC}_{\text{dw,water}}$

The $\text{MPC}_{\text{water,dw}}$ is 0.1 µg/L according to the Drinking Water Standard.

3.6.3.5 Selection of the $\text{MPC}_{\text{water}}$ and $\text{MPC}_{\text{marine}}$

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included ($\text{MPC}_{\text{eco,water}}$, $\text{MPC}_{\text{sp,water}}$ and $\text{MPC}_{\text{hh food,water}}$) is the value for direct aquatic toxicity. Thus, for tolclofos-methyl the value of 1.2 µg/L is selected for the $\text{MPC}_{\text{water}}$.

Because it was not possible to derive an $\text{MPC}_{\text{eco,marine}}$ no $\text{MPC}_{\text{marine}}$ can be selected.

3.6.3.6 MAC$_{eco}$

No useful acute toxicity data for *Daphnia* are available, because effect concentrations in all *Daphnia* studies were above the water solubility. However, the performed studies show that the acute toxicity to *Daphnia magna* is low. The chronic toxicity studies show that tolclofos-methyl is not particularly toxic to *Daphnia magna* in long term experiments either. In contrast to the other organophosphorous pesticides, tolclofos-methyl is not an insecticide but a fungicide and acts by inhibition of phospholipid biosynthesis. Therefore, it seems justified to derive a MAC$_{eco}$ although no useful acute data for crustaceans are available. With an assessment factor of 1000 on the lowest LC50 (712 for algae), the MAC$_{eco}$ becomes 712 / 1000 = 0.71 µg/L.

The final decision for the height of MAC$_{eco}$ depends on the final choice for the MPC$_{water}$ (See discussion in 3.6.3.6). When the final MPC$_{water}$ is indeed set at 1.2 µg/L, the MAC$_{eco}$ value of 0.71 µg/L is lower than the MPC$_{water}$, and should be adjusted to be equal to the MPC$_{water}$ (1.2 µg/L). However, when a different policy decision regarding the MPC$_{water}$ is made, it may not be necessary to make this adjustment.

No marine toxicity data are available, and thus no MAC$_{eco}$ for the marine environment is derived.

3.6.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100. However, this depends on the final choice for the MPC$_{water}$ (See discussion in 3.6.3.6). When the final MPC$_{water}$ is set at 1.2 µg/L, the NC$_{water}$ is set at 1.2 / 100 = 0.012 µg/L.

NC$_{marine}$ = not derived.

3.6.3.8 SRC$_{eco}$

Chronic toxicity data are available for algae, *Daphnia* and fish, the geometric mean of all chronic data is 40 µg/L and these data are normally distributed (significant at all levels using the Anderson-Darling test for normality).Since more than three NOECs are available, it is not necessary to make a comparison with the acute toxicity data. Thus, the SRC$_{eco,water}$ can be derived using an assessment factor of 1 and becomes 40 / 1 = 40 µg/L.

No marine toxicity data are available, and thus no SRC$_{eco}$ for the marine environment is derived.

3.7 Triazophos

3.7.1 Substance identification, physicochemical properties, fate and human toxicology

3.7.1.1 Identity

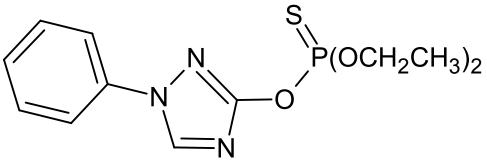


Figure 10. Structural formula of triazophos.

Table 47. Identification of triazophos.

Parameter	Name or number
Chemical name	O,O-diethyl O-1-phenyl-1H-1,2,4-triazol-3-yl phosphorothioate (IUPAC) or O,O-diethyl O-(1-phenyl-1H-1,2,4-triazol-3-yl) phosphorothioate (Chemical Abstracts)
Common/trivial/other name	Hostathion, Spark, Trelka, Triumph, Try, March, Deltaphos (mixture with Deltamethrin), Sherdiphos (mixture with cypermethrin and dimethoate)
CAS number	24017-47-8
EC number	245-986-5
SMILES code	CCOP(=S)(OCC)Oc1ncn(n1)c2ccccc2

3.7.1.2 Physicochemical properties

Table 48. Physicochemical properties of triazophos.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	313.3		
Water solubility	[mg/L]	39	20 ºC	Tomlin, 2002
pK_a	[-]	n.a.		
log K_{ow}	[-]	3.34		Tomlin, 2002;
		3.55		Anonymous, 1993
		2.92	EpiWin	US EPA, 2007
		2.90	ClogP	BioByte, 2004
		3.55	MlogP	BioByte, 2004
log K_{oc}	[-]	**2.5-2.6**		Anonymous, 1993
		2.76	Calculated using log K_{ow} = 3.55	According to Sabljic et al., 1995
Vapour pressure	[Pa]	3.9×10^{-4}	30 ºC	Tomlin, 2002
Melting point	[°C]	0-5		Tomlin, 2002; Anonymous, 1993
Boiling point	[°C]	Not determinable due to exothermic degradation above temperatures of 140 ºC		Tomlin, 2002; Anonymous, 1993
Henry's law constant	[Pa.m^3.mol^{-1}]	7.7×10^{-11}	Calculated using Bond method; EpiWin	US EPA, 2007
		1.3×10^{-8}	Calculated using Epi values, EpiWin	US EPA, 2007

n.a. = not applicable.

3.7.1.3 Behaviour in the environment

Table 49. Selected environmental properties of triazophos.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	3.8	50 ºC; pH 5	Panman and Linders, 1991
		2.8	50 ºC; pH 7	Panman and Linders, 1991
		3.5	50 ºC; pH 9	Panman and Linders, 1991
Photolysis half-life	DT50 [d]		Unknown	
Degradability	DT50 [d]	<3	Water	Tomlin, 2002
		<11	Water-sediment system	Tomlin, 2002
		< 35	Water-sediment system	Anonymous, 1993
Relevant metabolites	P=O analogue Oxytriazole Ureum			

3.7.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for triazophos is given in Table 50.

Table 50. Overview of bioaccumulation data for triazophos.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	36	EpiWin calculation using log K_{ow} = 2.9	US EPA, 2007
		208	Calculated using log K_{ow} = 3.55	QSAR in Veith et al., 1979
BMF	[kg/kg]	1	Default value	

3.7.1.5 Human toxicological treshold limits and carcinogenicity

Triazophos is not considered to be carcinogenic to humans, and is classified as T; R23/25; Xn; R21; N; R50-53. An ADI of 0.001 mg/kg is set by the JMPR, 1992 (2002), based on a NOEL of 0.12 mg/kg in a 52 week study in dogs.

3.7.2 Trigger values

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

Table 51. Triazophos: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp\text{-}water}$	1.5	[-]	$K_{oc} \times f_{oc,susp}$[1]	K_{oc}: 3.7.1.2
BCF	208	[L/kg]		3.7.1.4
BMF	1	[-]		3.7.1.4
Log K_{ow}	3.55	[-]		3.7.1.2
R-phrases	T; R23/25; Xn; R21; N; R50/53	[-]	http://ecb.jrc.it/esis/	3.7.1.5
A1 value	1.0	[µg/L]	total pesticides	
DW standard	0.1	[µg/L]	general value for organic pesticides	

[1] $f_{oc,susp}$ = 0.1 kg_{oc}/kg_{solid} (European Commission (Joint Research Centre), 2003).

- Triazophos has a log $K_{p,\ susp\text{-}water}$ < 3; derivation of $MPC_{sediment}$ is not triggered.
- Triazophos has a log $K_{p,\ susp\text{-}water}$ > 3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- Triazophos has a BCF > 100; assessment of secondary poisoning is triggered.
- Triazophos has a BCF > 100 and an R21; R23/25 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{water,\ hh\ food}$) should be derived.
- For triazophos, 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 for organic pesticides applies.

3.7.3 Toxicity data and derivation of ERLs for water

An overview of the selected freshwater toxicity data for triazophos is given in Table 52. There are no marine toxicity data for triazophos. Detailed toxicity data for triazophos are tabulated in Appendix 2.

Table 52. Triazophos: selected aquatic freshwater data for ERL derivation.

Chronic[a]		**Acute**[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Cyanobacteria	2000	Cyanobacteria	12745
Cyanobacteria	5000	Cyanobacteria	13403
Cyanobacteria	1000	Cyanobacteria	6164
Algae	100	Algae	3607[b]
Algae	1800	Algae	30117
Algae	2000	Crustacea	**2.0**[c]
Crustacea	**0.01**	Pisces	1537[d]
Pisces	0.5	Pisces	25[e]
		Pisces	35

[a] For detailed information see Appendix 2. Bold values are used for risk assessment.

[b] Geometric mean of 1430 and 9100, parameter biomass for *Scenedesmus subspicatus.*

[c] Geometric mean of 3 and 1.3; parameter mortality/immobility for *Daphnia magna.*

[d] Geometric mean of 180, 2240, and 9000, parameter mortality for *Cyprinus carpio.*

[e] Geometric mean of 16 and 38, parameter mortality for *Oncorhynchus mykiss.*

3.7.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

The base-set is complete. The lowest LC50 is 2.0 µg/L for crustaceans (*Daphnia*), while the lowest NOEC is 0.01 µg/L for crustaceans (*Daphnia*). Because long-term NOECs are available for three trophic levels, including algae, fish and *Daphnia*, and the data for the other organophosphorous insecticides have shown that not insects, but crustaceans are the most sensitive taxon, an assessment factor of 10 can be used for the $MPC_{eco,water}$ and an assessment factor of 100 can be used for the $MPC_{eco,marine}$. This results in a $MPC_{eco,water}$ of $0.01 / 10 = 1.0 \times 10^{-3}$ µg/L and a $MPC_{eco,marine}$ of $0.01 / 100 = 1.0 \times 10^{-4}$ µg/L.

3.7.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Triazophos has a BCF > 100, thus assessment of secondary poisoning is triggered.

The lowest MPC_{oral} is 0.10 mg/kg diet for dogs (see Table 53). Subsequently, the $MPC_{sp,water}$ can be calculated using a BCF of 208 and a BMF of 1 (section 3.7.1.4) and becomes $0.10 / (208 \times 1) = 4.8 \times 10^{-4}$ mg/L = 0.48 µg/L.

For the marine environment, an extra biomagnification factor should be used. But since this factor is 1 by default, the $MPC_{sp,marine}$ equals the $MPC_{sp,water}$ and is also 0.48 µg/L.

Table 53. Triazophos: selected bird and mammal data for ERL derivation.

Species[a]	Exposure time	Criterion	Effect concentration (mg/kg diet)	Assessment factor	MPC_{oral} (mg/kg diet)
Chicken	3 months	NOAEL	110	30	3.7
Dog	3 months	NOAEL	9	90	**0.10**
Dog	1 year	NOAEL	4	30	0.13
Rabbit	14 days	NOAEL	133[b]	300	0.44
Rat	3 months	NOAEL	20	90	0.22
Rat	2 generations	NOAEL	27	30	0.90

[a] For detailed information see Appendix 4. Bold values are used for risk assessment.
[b] based on a NOEC of 4 mg/kg bw/day with a conversion factor of 33.3.

3.7.3.3 $MPC_{hh\ food,water}$ and $MPC_{hh\ food,marine}$

Derivation of $MPC_{hh\ food,water}$ for triazophos is triggered (Table 23). With an ADI of 1 μg/kg bw (section 3.7.1.5), a BCF of 208 and a BMF of 1 (section 3.7.1.4), the $MPC_{hh\ food}$ becomes (0.1 × 1 × 70) / 0.115 = 60.9 mg/kg. Subsequently, the $MPC_{hh\ food,water}$ = 60.9 / (208 × 1) = 0.29 mg/L = 293 μg/L.

For the marine environment, the $MPC_{hh\ food,marine}$ is equal to the $MPC_{hh\ food,water}$ and is 293 μg/L.

3.7.3.4 $MPC_{water,\ dw}$

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

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

In the Fraunhofer document (Lepper, 2005) it is prescribed that the lowest MPC value should be selected as the general MPC. The lowest value of the routes included is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 1.0×10^{-3} μg/L and the MPC_{marine} is 1.0×10^{-4} μg/L

3.7.3.6 MAC_{eco}

The base-set for the freshwater environment is complete. Normally, an assessment factor of 100 should be used, but since the BCF is larger than than 100, the assessment factor should be increased (Van Vlaardingen and Verbruggen, 2007). However, since this BCF would be primarily a problem for fish, and fish are not the most sensitive reason, this high BCF is not regarded to be enough justification to increase the assessment factor for the MAC. For this compound the mode of action may be either narcosis or AChE inhibition, because of its relatively high log K_{OW}. The data show a high variation and thus, narcosis as mode of action for all species is less likely. When the main mode of action is AChE inhibition, the most sensitive species (insects) are not present in the dataset. With the lowest L(E)C50 of 2.0 μg/L for Crustacea, the $MAC_{eco,water}$ is set at 2 / 100 = 2.0×10^{-2} μg/L.

In the case of triazophos, no toxicity data are available for specific marine taxa, and thus an additional assessment factor of 10 is used on the $MAC_{eco,water}$ and the provisional $MAC_{eco,marine}$ is set at 2.0×10^{-2} / 10 = 2.0×10^{-3} μg/L.

3.7.3.7 NC

The negligible concentration (NC) is derived by dividing the derived MPCs by a factor of 100:
$NC_{water} = 1.0 \times 10^{-5}$ μg/L.
$NC_{marine} = 1.0 \times 10^{-6}$ μg/L.

3.7.3.8 SRC$_{eco}$

Chronic toxicity data are available for algae, *Daphnia* and fish, the geomean of all chronic data is 109 µg/L. These data are not normally distributed (only significant at the 0.01 level using the Anderson-Darling test for normality). Because more than three NOECs are available, it is not necessary to make a comparison with the acute data. The SRC$_{eco,water}$ and SRC$_{eco,marine}$ can be derived using an assessment factor of 1 and are set at 109 / 1 = 109 µg/L.

4 Conclusions

In this report, the risk limits negligible concentration (NC), maximum permissible concentration (MPC), maximum acceptable concentration for ecosystems (MAC_{eco}), and serious risk concentration for ecosystems (SRC_{eco}) are derived for azinphos-ethyl, azinphos-methyl, coumaphos, heptenophos, mevinphos, tolclofos-methyl and triazophos in water. No risk limits were derived for the sediment compartment because exposure of sediment is considered negligible.

The ERLs that were obtained are summarised in the table below. The MPC_{water} values that were set for these compounds until now, are also presented in this table for comparison reasons.

Table 54. Derived MPC, NC, MAC, and SRC values (in µg/L).

Environmental risk limit[a]	Azinphos-ethyl	Azinphos-methyl	Coumaphos	Heptenophos	Mevinphos	Tolclofos-methyl	Triazophos
Old MPC_{water}	1.1×10^{-2}	0.012	7×10^{-4}	0.02	2×10^{-3}	0.790	0.032
$MPC_{eco,water}$	6.5×10^{-3}	2.0×10^{-3}	3.4×10^{-3}	2.0×10^{-3}	1.7×10^{-4}	1.2	1.0×10^{-3}
$MPC_{dw,water}$	0.1	0.1	0.1	0.1	0.1	0.1	0.1
$MPC_{sp,water}$	0.51	n.d.[b]	0.075	n.d.[b]	n.d.[b]	3.4	0.48
$MPC_{hh\ food,water}$	n.d.[b]	n.d.[b]	340	n.d.[b]	n.d.[b]	n.d.[b]	293
MPC_{water}	6.5×10^{-3}	2.0×10^{-3}	3.4×10^{-3}	2.0×10^{-3}	1.7×10^{-4}	1.2[c]	1.0×10^{-3}
$MPC_{eco,marine}$	1.3×10^{-3}	4.0×10^{-4}	6.8×10^{-4}	2.0×10^{-4}	1.7×10^{-5}	n.d.[b]	1.0×10^{-4}
$MPC_{sp,marine}$	0.51	n.d.[b]	0.075	n.d.[b]	n.d.[b]	1.7	0.48
$MPC_{hh\ food,marine}$	n.d.[b]	n.d.[b]	340	n.d.[b]	n.d.[b]	n.d.[b]	293
MPC_{marine}	1.3×10^{-3}	4.0×10^{-4}	6.8×10^{-4}	2.0×10^{-4}	1.7×10^{-5}	n.d.[b]	1.0×10^{-4}
NC_{water}	6.5×10^{-5}	2.0×10^{-5}	3.4×10^{-5}	2.0×10^{-5}	1.7×10^{-6}	0.012	1.0×10^{-5}
NC_{marine}	1.3×10^{-5}	4.0×10^{-6}	6.8×10^{-6}	2.0×10^{-6}	1.7×10^{-7}	n.d.[b]	1.0×10^{-6}
$MAC_{eco,water}$	1.1×10^{-2}	0.014	3.4×10^{-3}	0.02	1.7×10^{-2}	1.2[c]	2.0×10^{-2}
$MAC_{eco,marine}$	1.1×10^{-3}[c]	2.8×10^{-3}[c]	6.8×10^{-4}[c]	2.0×10^{-3}[c]	1.7×10^{-3}[c]	n.d.[b]	2.0×10^{-3}[c]
$SRC_{eco,water}$	1.1	4.8	4.5	172	4.6	40	109
$SRC_{eco,marine}$	1.1	4.8	4.5	172	4.6	n.d.	109

[a] subscript water = freshwater; subscript marine = marine waters; MPC_{eco} = MPC based on ecotoxicological data; MPC_{dw} = MPC based on human consumption of drinking water; MPC_{sp} = MPC based on secondary poisoning; MPC_{hhfood} = MPC based on human consumption of fish.

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

[c] provisional value, for further information see the methods paragraph

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Appendix 1. Information on bioconcentration

Table A1.1 Bioconcentration data for Azinphos-ethyl.

Species	Species properties	Substance purity	Analysed	Test type	pH	Hardness [mg $CaCO_3$/L]	Tempe-rature [ºC]	Exposure time [d]	Exposure concentration [mg/L]	BCF [l/kg]	BCF type	Notes	Reference	Reliability index[a]
Poecilia reticulata	2-3mo; 10-140mg	98	Y	R	7-8.6	100	22	11	0.028l	135.7	Equi	1	Deneer et al., 1999	4

a According to Klimisch et al., 1997

Notes:

1 Well performed study; only to be used as an indicative value due to the use of lethal body burdens. Only the values determined at the lowest, more realistic concentrations are reported.

Table A1.2 Bioconcentration data for azinphos-methyl.

Species	Species properties	Substance purity	Analysed	Test type	pH	Hardness [mg $CaCO_3$/L]	Tempe-rature [ºC]	Exposure time [d]	Exposure concentration [mg/L]	BCF [l/kg]	BCF type	Notes	Reference	Reliability index[a]
Poecilia reticulata	2-3mo; 10-140mg	99	Y	R	7-8.6	100	22	6	0.82	34.9	Equi	1	Deneer et al., 1999	4

a According to Klimisch et al., 1997

Notes:

1 Well performed study; only to be used as an indicative value due to the use of lethal body burdens.

Table A1.3. Bioconcentration data for coumaphos.

Species	Species properties	Substance purity	Analysed	Test type	pH	Hardness [mg $CaCO_3$/L]	Tempe-rature [ºC]	Exposure time [d]	Exposure concentration [mg/L]	BCF [l/kg]	BCF type	Notes	Reference	Reliability index[a]
Lepomis macrochirus				F				30	0.01	541		1	US EPA, 2000	2
Leuciscus idus melanotus	1.5g	>98	Y	S	7		20-25	4	0.05	110	Equi	2	Freitag et al, 1985	2

a According to Klimisch et al., 1997

Notes:

1 Radioactivity method; material balance was not complete and residues in water were not characterized; majority of coumaphos residues extracted from tissues was not identified.

2 ^{14}C measurements in fish and water; not clear if equilibrium is reached after 4 days.

Table A1.4. Bioconcentration data for tolclofos-methyl.

Species	Species properties	Substance purity	Analysed	Test type	pH	Hardness [mg $CaCO_3$/L]	Tempe-rature [ºC]	Exposure time [d]	Exposure concentration [mg/L]	BCF [l/kg]	BCF type	Notes	Reference	Reliability index[a]
Carassius auratus	0.56-0.8g	>97	Y	CF	6.9-7	45-46	23	7	0.0016-0.002	263	equi	1,2	Tsuda et al., 1997	3
Lebistes reticulatus	female; 0.26-0.40 g	>97	Y	CF	6.9-7	45-46	23	7	0.0016-0.002	690	equi	1,3	Tsuda et al., 1997	3
Lebistes reticulatus	male; 0.26-0.40 g	>97	Y	CF	6.9-7	45-46	23	7	0.0016-0.002	1283	equi	1,4	Tsuda et al., 1997	3
Oryzias latipes	0.11-0.26g	>97	Y	CF	6.9-7	45-46	23	7	0.0016-0.002	720	equi	1,5	Tsuda et al., 1997	3
Tanichthys albonubes	0.06-0.09g	>97	Y	CF	6.9-7	45-46	23	3	0.0016-0.002	291	equi	1,6	Tsuda et al., 1997	3
Cyprinus carpio	14-22g	>98	Y	CF	6.7-6.9	36-38	25	14	0.00054	210	equi	7	Tsuda et al., 1992	2
Lepomis macrochirus	3.4g; 47 mm	97.7	Y	CF	8.0-8.2		22	28	0.003	670	equi	8	Anonymous, 2004	2
Lepomis macrochirus	3.4g; 47 mm	97.7	Y	CF	8.0-8.2		22	28	0.003	650	k1/k2	8	Anonymous, 2004	2

a According to Klimisch et al., 1997

Notes:

1	Probably based on wet weights but not explicitly mentioned
2	Lipid content is 2.7%
3	Lipid content is 5.7%
4	Lipid content is 4.7%
5	Lipid content is 2.2%
6	Lipid content is 1.8%
7	Kout is also calculated. It was not possible to calculate a K_{in} from the given data.
8	steady state after 7 days; CT50 = 1.1 d; 14 d depuration; fish were fed during the study; ^{14}C method

Appendix 2. Detailed aquatic toxicity data

Table A2.1. Acute toxicity of azinphos-ethyl to freshwater organisms.

Species	Species proper-ties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Mollusca															
Pomacea canaliculata				S	tw				48h	LC50	mortality	3082	1	Tejada et al., 1994	2
Crustacea															
Daphnia magna	1st instar	88		S	rw	7.1	21	44	48h	EC50	immobility	4		Mayer and Ellersieck, 1986	2
Daphnia magna	4th instar		N				27		24h	LC50	mortality	0.95	2	Gaboub et al., 1973	3
Daphnia pulex	< 24h		N	S	rw	7.4-7.8	16	47	48h	EC50	immobility	3.2		Sanders and Cope, 1966	2
Daphnia pulex	1st instar	88		S	rw	7.1	15	44	48h	EC50	immobility	3.2		Mayer and Ellersieck, 1986	4*
Daphnia pulex							21		48h	EC50	immobility	3	3	Cope, 1966	4
Simocephalus serrulatus	<24h		N	S	rw	7.4-7.8	16	47	48h	EC50	immobility	4.2		Sanders and Cope, 1966	2
Simocephalus serrulatus	<24h		N	S	rw	7.4-7.8	21	47	48h	EC50	immobility	4		Sanders and Cope, 1966	2
Simocephalus serrulatus	1st instar	88		S	rw	7.1	15	44	48h	EC50	immobility	4.2		Mayer and Ellersieck, 1986	4*
Simocephalus serrulatus							21		48h	EC50	immobility	4		Cope, 1966	4*
Insecta															
Culex ppiens fatigans	4th instar		N				27		24h	LC50	mortality	8	2	Gaboub et al., 1973	3
Pteronarcys californica	2nd year	88		S	rw	7.1	15	44	96h	LC50	mortality	1.5		Mayer and Ellersieck, 1986	2
Pteronarcys californica	Nymph						16		96h	LC50	mortality	2		Cope, 1965	4
Pteronarcys californica	Nymph						21		48h	EC50		8	3	Cope, 1966	4
Pisces															
Cyprinus carpio	Adult			S	nw				96h	LC50	mortality	50		Mulla et al., 1967	4
Cyprinus carpio	‘younger’ than adults; 217g		S						24h	LC50	mortality	1-5	4	Mulla et al., 1967	3
Lepomis macrochirus	0.8 g	88		S	rw	7.1	24	44	96h	LC50	mortality	1.1		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.8g	tg					24		48h	LC50	mortality	1.4		Cope, 1963	2
Lepomis macrochirus							24		48h	EC50		2	3	Cope, 1966	4
Oncorhynchus mykiss	1.4 g	88		S	rw	7.1	13	44	96h	LC50	mortality	20		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss	1.4g	tg					13		96h	LC50	mortality	19		Cope, 1965	2
Oncorhynchus mykiss							13		48h	EC50		23	3	Cope, 1966	4
Poecilia reticulata	1 inch			S	tw				48h	LC50	mortality	20	1,5	Tejada et al., 1994	4
Oreochromis niloticus	2wk, 1 inch		S						48h	LC50	mortality	0.001	1,6	Tejada et al., 1994	3

a According to Klimisch et al., 1997

Notes:

1 LC50 expressed as active ingredient

2 Badly described study, only gusathion is mentioned but not azinphos-ethyl

3 Review article; measured at US Bureau of sport Fisheries and Wildlife

4 15g fish/liter

5 Data from review article without further detail

6 Value does not seem correct.

Table A2.2. Chronic toxicity of azinphos-ethyl to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Protozoa															
Colpidium amylum				S	am				43h	MAD	Number of organisms	>10000	1,2,3	Dive et al., 1980	3

a According to Klimisch et al., 1997

Notes:

1 >2 times above solubility limits.

2 Minimal Active dose is calculated according to Dive and Leclerc, 1975.

3 Ciliates were kept in a bacterial suspension

Table A2.3. Acute toxicity of azinphos-ethyl to marine organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Crustacea															
Artemia sp.	neonates	>95%	N	S	rw		25	33	24h	LC50	immobility	3300	1	Guzzella et al., 1997	3
Penaeus monodon	10-20g; juvenile	40%	N	S	nw		26-28	30-33.5	96h	LC50	mortality	48	2,3	Baticados and Tendencia, 1991	2
Penaeus monodon	10-20g; juvenile	40%	N	S	nw		26-28	30-33.5	96h	LOEC	shell softening	30	2,4	Baticados and Tendencia, 1991	2
Rotifers															
Brachionus plicatilis	neonates	>95%	N	S	rw		25	33	24h	LC50	immobility	>5200	1,5	Guzzella et al., 1997	3

a According to Klimisch et al., 1997

Notes:

1 Result may have been a 1000 times lower because other compounds in the study appear to have been tested far beyond their solubility limits

2 Original results were given in mg/l Gusathion A. Results were recalculated assuming 40% of Gusathion A is azinphos-ethyl, as reported in the article.

3 Original LC50 = 120 ug/L.

4 Original LOEC = 75 ug/L.

5 Above solubility limits

Table A2.4. Acute toxicity of azinphos-methyl to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Algae															
Chlorella vulgaris			N	S	am		23		30min	NOEC	O2 production	>1000	1	Van der Heever and Grobbelaar, 1997	2
Scenedesmus subspicatus		92.5	N	S	am				96h	EC50	growth rate	6650	2	Panman and Linders, 1990	2
Scenedesmus subspicatus							23		96h	EC50		7150	3	IUCLID, 2000	4
Scenedesmus subspicatus		tg	N	S					96h	EC50		3610	3	Anonymous, 1996	4
Pseudokirchneriella subcapitata			N	S	am	7.5	23		4h	NOEC	Chl-a fluorescence	>1000	1	Van der Heever and Grobbelaar, 1998	2
Pseudokirchneriella subcapitata			N	S	am		23		30min	NOEC	O2 production	>1000	1	Van der Heever and Grobbelaar, 1997	2
Mollusca															
Aplexa hypnorum	Adult		Y	CF	nw	7.4	17	44.7	96h	LC50	mortality	>3690	6	Holcombe et al., 1987	1
Biomphalaria glabrata	adult, 18mm; 0.8g	98.3	N	S	dtw	7	22	67	96h	NOEC	movement	>15000	7	Kristoff et al., 2006	2
Crustacea															
Asellus brevicaudus	mature	93		S	rw	7.1	15	44	96h	LC50	mortality	21		Mayer and Ellersieck, 1986	2
Asellus brevicaudus	mature	tg	N	S	rw	7.1	21	47	96h	LC50	mortality	21		Sanders, 1972	4*
Asellus aquaticus	5.0mm	ag	N	S	am		18	163.9	48h	LC50	immobility/mortality	4.8		Dortland, 1980	2
Daphnia magna	1st instar	90.6	N	S	am				48h	LC50	immobilization/mortality	1.1		Panman and Linders, 1990	2
Daphnia magna	<24h	ag	N	S	am		18	163.9	48h	LC50	immobility/mortality	1.6		Dortland, 1980	2
Daphnia magna	<24h	ag	N	S	am		18	163.9	48h	LC50	immobility/mortality	1.5		Dortland, 1980	2
Daphnia magna	<24h		N	S	am	7.9	19	202	26h	LC50	mortality	0.18	8	Frear and Boyd, 1967	2
Daphnia magna							20		48h	EC50	immobility	1.1		IUCLID, 2000	4*
Daphnia magna		tg	N	S					48h	EC50	immobility	1.1		Anonymous, 1996	4*
Daphnia magna		50	Y	F					48h	EC50	immobility	4.4	9	Anonymous, 1996	2
Daphnia magna		23.8	Y	F					48h	EC50	immobility	6.7	9	Anonymous, 1996	2
Echinogammarus tibaldii	mature	99	N	S	rw	7.9	8	240	96h	LC50	immobility	0.48		Pantani et al., 1997	2
Gammarus fasciatus	mature	93		S	rw	7.1	21	44	96h	LC50	mortality	0.15		Mayer and Ellersieck, 1986	2
Gammarus fasciatus	mature	93		S	rw	7.4	15	272	96h	LC50	mortality	0.1		Mayer and Ellersieck, 1986	2
Gammarus fasciatus	mature	tg	N	S	rw	7.1	21	47	96h	LC50	mortality	0.38	10	Sanders, 1972	2
Gammarus fasciatus	mature	tg	N	S	nw	7.4	21	‘Hoog’	96h	LC50	mortality	0.1	10	Sanders, 1972	4*
Gammarus italicus	mature	99	N	S	rw	7.9	8	240	96h	LC50	immobility	0.24		Pantani et al., 1997	2
Gammarus italicus	mature		N	S	rw	8.1	8	240	24h	LC50	immobility	0.988	8	Pantani et al., 1990	2
Gammarus lacustris			N	S	rw	7.1	21	47	96h	LC50	mortality	0.15	8	Sanders, 1969	2
Gammarus lacustris				S			15		96h	LC50	immobility/mortality	0.126	8	Nebeker and Gaufin, 1964	4*
Gammarus lacustris									48h	EC50	immobility	0.3	8	Dortland, 1980: Pimentel, 1971/1972.	4
Gammarus lacustris	mature		N	S	nw		15		96h	LC50	mortality	0.126	8,10,11	Gaufin et al., 1965	2
Hyalella azteca	7-14d	>95	N	S	nw	7.4-8.5	23	42-47	96h	LC50	mortality	0.29		Ankley and Collyard, 1995	2
Palaemonetes kadiakensis	mature	93		F	rw	7.4	21	272	96h	LC50	mortality	1.2		Mayer and Ellersieck, 1986	2
Palaemonetes kadiakensis	mature	tg	N	S	nw	7.4	21	‘Hoog’	96h	LC50	mortality	0.13	10	Sanders, 1972	2
Palaemonetes kadiakensis	mature	tg	N	F	nw	7.4	21	‘Hoog’	96h	LC50	mortality	1.2	10	Sanders, 1972	4*

Palaemonetes kadiakensis	susceptible population	tg	N	S	tw	7.4	24	24	24h	LC50	mortality	8.9		Naqvi and Ferguson, 1970	2
Palaemonetes kadiakensis	resistant population (Hollandale)	tg	N	S	tw	7.4	24	24	24h	LC50	mortality	16.8		Naqvi and Ferguson, 1970	2
Palaemonetes kadiakensis	resistant population (Belzoni)	tg	N	S	tw	7.4	24	24	24h	LC50	mortality	10.5		Naqvi and Ferguson, 1970	2
Palaemonetes kadiakensis	resistant population (Sky Lake)	tg	N	S	tw	7.4	24	24	24h	LC50	mortality	4.4		Naqvi and Ferguson, 1970	2
Procambarus sp.	immature	93		S	rw	7.5	12	44	96h	LC50	mortality	56		Mayer and Ellersieck, 1986	2
Procambarus acutus acutus	0.7g		N	S	tw	7	26		96h	LC50	mortality	40	8,11,12	Carter and Graves, 1972	3
Insecta															
Acroneuria pacifica	naiads: 2-2.5 cm	89	Y	S	nw	7.8-8.2	12.8		96h	LC50	mortality	8.5	7,10,13	Jensen and Gaufin, 1966	4*
Acroneuria pacifica	naiads: 2-2.5 cm	89	Y	CF	nw	7.8-8.2	12.8		96h	LC50	mortality	2	7,10,13	Jensen and Gaufin, 1966	2
Acroneuria pacifica	naiads: 2-2.5 cm	92	N	S	nw	7.9-8.3	11.5	120-210	96h	LC50	mortality	8.5	10	Jensen and Gaufin, 1964	2
Acroneuria pacifica	naiads: 2-2.5 cm		N	S	nw		11-12		96h	LC50	mortality	8.5	8,10,11	Gaufin et al., 1965	4*
Aedes aegypti	3rd instar	ag	N	S	dw	6.3			24h	LC50	mortality	25	14	Lichtenstein et al., 1966	4
Baetis sp.		cf	Y	CF	nw	7	11		30min	LOEC	activity	0.2	7,13,15	Schulz and Dabrowski, 2001	3
Chironomus plumosus	4th instar		N	S			20		120h	LC50	mortality	1.04	2,16,17	Hilsenhoff, 1959	3
Chironomus tentans	3rd instar	>95	N	S	nw	7.4-8.5	23	42-47	96h	LC50	mortality	0.37	18	Ankley and Collyard, 1995	3
Cloeon dipterum	6.2mm	ag	N	S	am		18	163.9	48h	LC50	mortality	13.3		Dortland, 1980	2
Cloeon dipterum	6.0mm	ag	N	S	am		18	163.9	48h	LC50	mortality	12		Dortland, 1980	2
Ephemerella grandis	nymph		N	S	nw		9-10		96h	LC50	mortality	14	8,10,11	Gaufin et al., 1965	2
Pteronarcys californica	2nd year class	93		S	rw	7.1	15	44	96h	LC50	mortality	1.9		Mayer and Ellersieck, 1986	2
Pteronarcys californica	2-5 cm	tg	Y	S	nw	7.8-8.2	12.8		96h	LC50	mortality	22	7,10,13	Jensen and Gaufin, 1966	4*
Pteronarcys californica	2-5 cm	tg	Y	CF	nw	7.8-8.2	12.8		96h	LC50	mortality	4.6	7,10,13	Jensen and Gaufin, 1966	2
Pteronarcys californica	4-6cm	92	N	S	nw	7.9-8.3	11.5	120-210	96h	LC50	mortality	22		Jensen and Gaufin, 1964	2
Pteronarcys californica									48h	EC50		8		Uit Dortland, 1980: Pimentel, 1971/1972	4
Pteronarcys californica	naiads: 2-2.5 cm		N	S	nw		11-12		96h	LC50	mortality	22	8,10,11	Gaufin et al., 1965	4*
Pteronarcys californica	naiads: 30-35mm	tg	N	S	rw	7.1	15.5	47	96h	LC50	mortality	1.5		Sanders and Cope, 1968	2
Xanthocnemis zealandica	13th instar	100	N	S	tw	8	15	48	48h	LC50	mortality	45.1		Hardersen and Wratten, 2000	2
Xanthocnemis zealandica	12th instar	100	N	S	tw	8	15	48	48h	LC50	mortality	32.2		Hardersen and Wratten, 2000	2
Xanthocnemis zealandica	11th instar	100	N	S	tw	8	15	48	48h	LC50	mortality	33.1		Hardersen and Wratten, 2000	2
Xanthocnemis zealandica	9th instar	100	N	S	tw	8	15	48	48h	LC50	mortality	30.2		Hardersen and Wratten, 2000	2
Xanthocnemis zealandica	7th instar	100	N	S	tw	8	15	48	48h	LC50	mortality	26.6		Hardersen and Wratten, 2000	2
Xanthocnemis zealandica	2nd instar	100	N	S	tw	8	15	48	48h	LC50	mortality	50.2		Hardersen and Wratten, 2000	2
Plathyhelminthes (Turbellaria)															
Dugesia lugubris		ag	N	S	am		18	163.9	96h	LC50	mortality	>160		Dortland, 1980	2
Annelida															
Branchiura sowerbyi		tg	N	S	dtw		4.4		72h	LC50	mortality	<5000	15,19	Naqvi, 1973	2
Branchiura sowerbyi		tg	N	S	dtw		21		72h	LC50	mortality	<5000	15,19	Naqvi, 1973	2
Branchiura sowerbyi		tg	N	S	dtw		32.2		72h	LC50	mortality	<5000	15,19	Naqvi, 1973	2
Herpopdella octoculata		ag	N	S	am		18	163.9	96h	LC50	mortality	>160		Dortland, 1980	2
Lumbriculus variegatus	adult, 3.5cm	98.3	N	S	dtw	7	22	67	96h	LOEC	movement	<1	7,20	Kristoff et al., 2006	2
Tubifex tubifex		tg	N	S	tw	7.8	24	28	72h	NOEC		> 1000	14	Naqvi and Ferguson, 1968	3

Pisces															
Carassius auratus	0.9g	93		S	rw	7.1	18	44	96h	LC50	mortality	4270		Mayer and Ellersieck, 1986	4*
Carassius auratus	2.37g; 33.9mm	93	Y	R	rw	7.2	24.8	<220	96h	LC50	mortality	2230	13	Adelman and Smith, 1976	1
Carassius auratus	2.51g; 34.1mm	93	Y	R	rw	7.18	24.4	<220	96h	LC50	mortality	2180	13	Adelman and Smith, 1976	1
Carassius auratus	1.75g; 30.3mm	93	Y	R	rw	7.31	25.1	<220	96h	LC50	mortality	2680	13	Adelman and Smith, 1976	1
Carassius auratus	1.69g; 29.6mm	93	Y	R	rw	7.31	25	<220	96h	LC50	mortality	2450	13	Adelman and Smith, 1976	1
Carassius auratus	1.87g; 32.3 mm	93	Y	R	rw	7.34	24.7	<220	96h	LC50	mortality	2480	13	Adelman and Smith, 1976	1
Carassius auratus	1.87g; 32.3mm	93	Y	R	rw	7.39	24.8	<220	96h	LC50	mortality	1710	13	Adelman and Smith, 1976	1
Carassius auratus	1.78g; 30.7mm	93	Y	R	rw	7.12	24.8	<220	96h	LC50	mortality	2070	13	Adelman and Smith, 1976	1
Carassius auratus	1.75g; 30.3mm	93	Y	R	rw	7.09	24.4	<220	96h	LC50	mortality	2050	13	Adelman and Smith, 1976	1
Carassius auratus	1.37g; 32.6 mm	93	Y	R	rw	7.12	25	<220	96h	LC50	mortality	2080	13	Adelman and Smith, 1976	1
Carassius auratus	1.64g; 33.6mm	93	Y	R	rw	7.11	24.7	<220	96h	LC50	mortality	2130	13	Adelman and Smith, 1976	1
Carassius auratus	1.72g; 35mm	93	Y	R	rw	7.21	24.9	<220	96h	LC50	mortality	3860	13	Adelman and Smith, 1976	1
Carassius auratus	1.66g; 35.3mm	93	Y	R	rw	7.2	24.7	<220	96h	LC50	mortality	1880	13	Adelman and Smith, 1976	1
Carassius auratus	1.81g; 37.9mm	93	Y	R	rw	7.07	24.8	<220	96h	LC50	mortality	3020	13	Adelman and Smith, 1976	1
Carassius auratus	1.80g; 36mm	93	Y	R	rw	7.13	24.6	<220	96h	LC50	mortality	2050	13	Adelman and Smith, 1976	1
Carassius auratus	3.5g; 42.4mm	93	Y	R	rw	7.18	24.6	<220	96h	LC50	mortality	1350	13	Adelman and Smith, 1976	1
Carassius auratus	3.53g; 41.5mm	93	Y	R	rw	7.16	24.4	<220	96h	LC50	mortality	3750	13	Adelman and Smith, 1976	1
Carassius auratus	1-2g; 4-6cm	90	N	S	nw, diluted	7.4-7.5	25	20	96h	LC50	mortality	1400	10	Pickering et al., 1962	2
Carassius auratus	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	4270	10,21	Macek and McAllister, 1970	2
Carassius auratus	5mo-1.5y; 1.4-2.7g		Y	R	rw	7.0-7.4	25	210	96h	LC50	mortality	2400	8,9	Adelman et al., 1976	1
Carassius auratus	1.0g		Y	CF	nw	7.4	17	44.7	96h	LC50	mortality	1040	22	Holcombe et al., 1987	1
Carassius auratus	2-5g; 3-4cm	99	Y	S	dtw	7.4-7.6	20		96h	LC50	mortality	7200	13	Ferrari et al., 2004	1
Cyprinus carpio	0.6g	93		S	rw	7.1	18	44	96h	LC50	mortality	695		Mayer and Ellersieck, 1986	4*
Cyprinus carpio	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	695	10,21	Macek and McAllister, 1970	2
Gambusia affinis	>25mm; resistant	90%	N	S	tw	7.8	22	28	48h	LC50	mortality	79	23	Culley and Ferguson, 1969	3
Gambusia affinis	>25mm; susceptible	90%	N	S	tw	7.8	22	28	48h	LC50	mortality	68		Culley and Ferguson, 1969	2
Gambusia affinis	0.5g		N	S	tw	7	24		96h	LC50	mortality	78	8,11	Carter and Graves, 1972	3
Gambusia affinis	2.5-3g		N	S	dw		21		24h	LC54	mortality	50	15,24	Lewallen, 1959	2
Ictalurus melas	1.7g	93		S	rw	7.1	18	44	96h	LC50	mortality	3500		Mayer and Ellersieck, 1986	4*
Ictalurus melas	1.2g	93		S	rw	7.4	18	272	96h	LC50	mortality	4600		Mayer and Ellersieck, 1986	2
Ictalurus melas	1.2g	93		S	rw	7.7	16	135	96h	LC50	mortality	4810		Mayer and Ellersieck, 1986	2
Ictalurus melas	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	3500	10,21	Macek and McAllister, 1970	2
Ictalurus punctatus	1.5g	93		S	rw	7.1	18	44	96h	LC50	mortality	3290		Mayer and Ellersieck, 1986	4*
Ictalurus punctatus	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	3290	10,21	Macek and McAllister, 1970	2
Ictalurus punctatus	10g		N	S	tw	7	26		24h	LC50	mortality	3900	8,11,25	Carter and Graves, 1972	2
Ictalurus punctatus	6.6g		Y	CF	nw	7.4	17	44.7	96h	LC50	mortality	3220	22	Holcombe et al., 1987	1
Lepomis cyanellus	1.1g	93		S	rw	7.1	18	44	96h	LC50	mortality	52		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	1.5g	93		S	rw	7.1	18	44	96h	LC50	mortality	22		Mayer and Ellersieck, 1986	4*
Lepomis macrochirus	0.9g	93		S	rw	7.1	12	44	96h	LC50	mortality	8.2		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.9g	93		S	rw	7.1	18	44	96h	LC50	mortality	8		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.9g	93		S	rw	7.1	24	44	96h	LC50	mortality	4.1		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.5g	93		S	rw	6.5	12	44	96h	LC50	mortality	17		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.5g	93		S	rw	8.5	12	44	96h	LC50	mortality	34		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	2.2g	93		F	rw	7.5	12	314	96h	LC50	mortality	4.8		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	22	10,21	Macek and McAllister, 1970	2
Lepomis macrochirus	0.5g		N	S	tw	7	23		96h	LC50	mortality	120	8,11	Carter and Graves, 1972	2
Lepomis macrochirus	1.0g		Y	CF	nw	7.4	17	44.7	96h	LC50	mortality	9.3	22	Holcombe et al., 1987	1

Lepomis macrochirus	juvenile			S	nw				96h	LC50	mortality	9		Stay and Jarvinen, 1995	4
Lepomis macrochirus	0.6-1.5g	tg	N	S	rw	7.1	12.7	47	96h	LC50	mortality	6.9	10,21	Macek et al., 1969	2
Lepomis macrochirus	0.6-1.5g	tg	N	S	rw	7.1	18.3	47	96h	LC50	mortality	7.4	10,21	Macek et al., 1969	2
Lepomis macrochirus	0.6-1.5g	tg	N	S	rw	7.1	23.8	47	96h	LC50	mortality	4.2	10,21	Macek et al., 1969	2
Lepomis macrochirus		22	N	S					96h	LC50	mortality	8.8	7	Anonymous, 1996	2
Lepomis macrochirus	1-2g; 4-6cm	93	N	S	nw	7.4	25	20	96h	LC50	mortality	5.2	21	Henderson et al., 1960	2
Lepomis microlophus	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	52	10,21	Macek and McAllister, 1970	2
Lepomis microlophus		22	N	S					96h	LC50	mortality	8.8	7	Anonymous, 1996	2
Leuciscus idus melanotus							21		96h	LC50	mortality	120		IUCLID, 2000	2
Leuciscus idus melanotus		tg	N	S					96h	LC50	mortality	120	7	Anonymous, 1996	4*
Micropterus salmoides	0.9g	93		S	rw	7.1	18	44	96h	LC50	mortality	4.8		Mayer and Ellersieck, 1986	4*
Micropterus salmoides	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	5	10,21	Macek and McAllister, 1970	2
Oncorhynchus kisutch	0.7g	93		S	rw	7.5	12	44	96h	LC50	mortality	6.1		Mayer and Ellersieck, 1986	2
Oncorhynchus kisutch	4.7g	93		S	rw	7.1	12	44	96h	LC50	mortality	3.2		Mayer and Ellersieck, 1986	2
Oncorhynchus kisutch	9.5g	93		S	rw	7.1	12	44	96h	LC50	mortality	3.2		Mayer and Ellersieck, 1986	2
Oncorhynchus kisutch	0.6-1.7g	100		S	rw	7.1	13	47	96h	LC50	mortality	17	10,21	Macek and McAllister, 1970	2
Oncorhynchus kisutch	2.7-4.1g; 5.7-7.6cm	93		S	nw	6.8-7.4	20	45-57	96h	LC50	mortality	4.2	10,21	Katz, 1961	2
Oncorhynchus mykiss	1.0g	93		S	rw	7.1	12	44	96h	LC50	mortality	4.3		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss	1.5g	93		S	rw	7.1	2	44	96h	LC50	mortality	7.1		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss	1.5g	93		S	rw	7.1	7	44	96h	LC50	mortality	5.8		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss	1.5g	93		S	rw	7.1	12	44	96h	LC50	mortality	6.3		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss	1.5g	93		S	rw	7.1	18	44	96h	LC50	mortality	2.9		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss									96h	EC50		14	26	Uit Dortland, 1980: Pimentel, 1971/1972	4
Oncorhynchus mykiss		tg		S			12	soft	96h	EC50		7.1	26	Marking and Mauck, 1975	4
Oncorhynchus mykiss	0.6-1.7g	100		S	rw	7.1	13	47	96h	LC50	mortality	14	21	Macek and McAllister, 1970	2
Oncorhynchus mykiss	3.2g; 5.1-7.9cm	93		S	nw	6.8-7.4	20	45-57	96h	LC50	mortality	3.2	10,21	Katz, 1961	2
Oncorhynchus mykiss	4.6g		Y	CF	nw	7.4	17	44.7	96h	LC50	mortality	9.1	22	Holcombe et al., 1987	1
Oncorhynchus mykiss	2.7g	99	Y	S	dtw	7.4-7.6	16		96h	LC50	mortality	7	13	Ferrari et al., 2004	2
Oncorhynchus mykiss	0.6-1.5g	tg	N	S	rw	7.1	1.6	47	96h	LC50	mortality	6.8	10,21	Macek et al., 1969	2
Oncorhynchus mykiss	0.6-1.5g	tg	N	S	rw	7.1	7.2	47	96h	LC50	mortality	6.2	10,21	Macek et al., 1969	2
Oncorhynchus mykiss	0.6-1.5g	tg	N	S	rw	7.1	12.7	47	96h	LC50	mortality	5.5	10,21	Macek et al., 1969	2
Oncorhynchus mykiss							11.5		96h	LC50	mortality	3		IUCLID, 2000	2
Oncorhynchus mykiss		tg	N	S					96h	LC50	mortality	20	7	Anonymous, 1996	4
Oncorhynchus mykiss		tg	N	S					96h	LC50	mortality	3	7	Anonymous, 1996	4
Oncorhynchus mykiss		25	Y	S					96h	LC50	mortality	5.3	9	Anonymous, 1996	2
Oncorhynchus mykiss		22	N	S					96h	LC50	mortality	6.2	21	Anonymous, 1996	4
Oncorhynchus tshawytscha	1.5-5g; 5.1-11.4cm	93		S	nw	6.8-7.4	20	45-57	96h	LC50	mortality	4.3	10,21	Katz, 1961	2
Perca flavescens	1.4g	93		S	rw	7.1	18	44	96h	LC50	mortality	15		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	7.5	7	44	96h	LC50	mortality	40		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	7.5	17	44	96h	LC50	mortality	5.6		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	7.5	22	44	96h	LC50	mortality	2.4		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	6.5	12	44	96h	LC50	mortality	17		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	7.5	12	44	96h	LC50	mortality	29		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	8.5	12	44	96h	LC50	mortality	8.5		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	9	12	44	96h	LC50	mortality	29		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	8	12	12	96h	LC50	mortality	18		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	8	12	44	96h	LC50	mortality	36		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	8	12	170	96h	LC50	mortality	11		Mayer and Ellersieck, 1986	2

Perca flavescens	0.9g	93		S	rw	8	12	300	96h	LC50	mortality	27		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	7.5	12	44	96h	LC50	mortality	10		Mayer and Ellersieck, 1986	2
Perca flavescens	0.9g	93		S	rw	7.5	12	44	96h	LC50	mortality	24	27,28	Mayer and Ellersieck, 1986	3
Perca flavescens	0.9g	93		S	rw	7.5	12	44	96h	LC50	mortality	20	27,29	Mayer and Ellersieck, 1986	3
Perca flavescens	0.9g	93		S	rw	7.5	12	44	96h	LC50	mortality	33	27,30	Mayer and Ellersieck, 1986	3
Perca flavescens	15g	93		F	rw	7.5	12	314	96h	LC50	mortality	6.5		Mayer and Ellersieck, 1986	2
Perca flavescens									96h	EC50		13	26	Uit Dortland, 1980: Pimentel, 1971/1972	4
Perca flavescens	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	13	10,21	Macek and McAllister, 1970	2
Pimephales promelas	70-74d	91	Y	F	fw	7.7	19	48	96h	LC50	mortality	64		Geiger et al., 1990	1
Pimephales promelas	1.2g	93		S	rw	7.1	18	44	96h	LC50	mortality	235		Mayer and Ellersieck, 1986	4*
Pimephales promelas	1.2g	93		S	rw	7.4	18	272	96h	LC50	mortality	293		Mayer and Ellersieck, 1986	2
Pimephales promelas	0.8g	93		S	rw	7.1	17	40	96h	LC50	mortality	148		Mayer and Ellersieck, 1986	2
Pimephales promelas	0.27g; 26mm	93	Y	R	rw	7.32	24.9	<220	96h	LC50	mortality	3260	13	Adelman and Smith, 1976	1
Pimephales promelas	0.28g; 26.7mm	93	Y	R	rw	7.32	24.8	<220	96h	LC50	mortality	2170	13	Adelman and Smith, 1976	1
Pimephales promelas	0.20g; 25.5mm	93	Y	R	rw	7.25	24.8	<220	96h	LC50	mortality	1060	13	Adelman and Smith, 1976	1
Pimephales promelas	0.19g;m 25.6mm	93	Y	R	rw	7.32	24.7	<220	96h	LC50	mortality	910	13	Adelman and Smith, 1976	1
Pimephales promelas	0.29g; 27.7mm	93	Y	R	rw	7.36	24.9	<220	96h	LC50	mortality	1950	13	Adelman and Smith, 1976	1
Pimephales promelas	0.29g; 27.7mm	93	Y	R	rw	7.37	24.6	<220	96h	LC50	mortality	2170	13	Adelman and Smith, 1976	1
Pimephales promelas	0.38g; 29.7mm	93	Y	R	rw	7.38	24.6	<220	96h	LC50	mortality	2080	13	Adelman and Smith, 1976	1
Pimephales promelas	0.37g; 29.7mm	93	Y	R	rw	7.4	24.2	<220	96h	LC50	mortality	540	13	Adelman and Smith, 1976	1
Pimephales promelas	0.21g; 24.6mm	93	Y	R	rw	7.23	24.8	<220	96h	LC50	mortality	2530	13	Adelman and Smith, 1976	1
Pimephales promelas	0.22g; 24.9mm	93	Y	R	rw	7.24	24.4	<220	96h	LC50	mortality	1460	13	Adelman and Smith, 1976	1
Pimephales promelas	0.28g; 27.4mm	93	Y	R	rw	7.24	24.9	<220	96h	LC50	mortality	2320	13	Adelman and Smith, 1976	1
Pimephales promelas	0.26g; 26.1mm	93	Y	R	rw	7.21	24.8	<220	96h	LC50	mortality	2470	13	Adelman and Smith, 1976	1
Pimephales promelas	0.20g; 20mm	93	Y	R	rw	7.24	25	<220	96h	LC50	mortality	2910	13	Adelman and Smith, 1976	1
Pimephales promelas	0.17g; 19.6mm	93	Y	R	rw	7.23	25	<220	96h	LC50	mortality	1980	13	Adelman and Smith, 1976	1
Pimephales promelas	0.27g; 26.4mm	93	Y	R	rw	7.39	24.8	<220	96h	LC50	mortality	1200	13	Adelman and Smith, 1976	1
Pimephales promelas	0.27g; 26.7mm	93	Y	R	rw	7.35	24.6	<220	96h	LC50	mortality	1460	13	Adelman and Smith, 1976	1
Pimephales promelas			N	S			20		120h	LC50	mortality	107	2,16,31	Hilsenhoff, 1959	3
Pimephales promelas	0.6-1.7g	100		S	rw	7.1	18	47	96h	LC50	mortality	235	10,21	Macek and McAllister, 1970	2
Pimephales promelas	11wk; 0.12-0.38g		Y	R	rw	7.0-7.4	25	210	96h	LC50	mortality	1900	9,22	Adelman et al., 1976	1
Pimephales promelas	0.2g		Y	CF	nw	7.4	17	44.7	96h	LC50	mortality	65	22	Holcombe et al., 1987	1
Pimephales promelas	1-2g; 4-6cm	93	N	S	nw	8.2	25	400	96h	LC50	mortality	160	21	Henderson et al., 1960	2
Pimephales promelas	1-2g; 4-6cm	93	N	S	nw	7.4	25	20	96h	LC50	mortality	93	21	Henderson et al., 1960	2
Pimephales promelas	1 day old			S	nw				96h	LC50	mortality	297		Stay and Jarvinen, 1995	4
Pimephales promelas	30 day old			S	nw				96h	LC50	mortality	37		Stay and Jarvinen, 1995	4
Pimephales promelas		99.9	Y	S					96h	LC50	mortality	1600	9,10,32	Solon and Nair, 1970	4
Pimephales promelas									96h	LC50	mortality	93		Morton et al., 1997: Henderson et al., 1959	4
Pimephales promelas									96h	LC50	mortality	93		Morton et al., 1997: Henderson et al., 1959	4
Poecilia reticulata	0.1-0.2g; 2-2.5cm	90	N	S	nw, diluted	7.4-7.5	25	20	96h	LC50	mortality	120	10	Pickering et al., 1962	2
Poecilia reticulata		99%	Y	R					14d	LC50	mortality	57	7,33,34 ,35	De Bruijn and Hermens, 1993	2
Pomoxis nigromaculatus	1.0g	93		S	rw	7.1	18	44	96h	LC50	mortality	3		Mayer and Ellersieck, 1986	2
Rasbora heteromorpha	1-3cm	25	N	CF		8.1	20	220	96h	LC50	mortality	42.5	36	Tooby et al., 1975	2
Salmo salar	0.5g	93		S	rw	7.5	12	44	96h	LC50	mortality	2.1		Mayer and Ellersieck, 1986	2
Salmo salar	0.8g	93		S	rw	7.5	12	44	96h	LC50	mortality	2.7		Mayer and Ellersieck, 1986	2
Salmo salar	0.8g	93		S	rw	7.5	12	44	96h	LC50	mortality	3.2		Mayer and Ellersieck, 1986	2
Salmo salar	0.8g	93		S	rw	7.5	12	44	96h	LC50	mortality	3.5		Mayer and Ellersieck, 1986	2

Salmo salar	0.8g	93		S	rw	7.5	12	44	96h	LC50	mortality	>15		Mayer and Ellersieck, 1986	2
Salmo salar	0.5g	93		S	rw	7.5	12	44	96h	LC50	mortality	3.6		Mayer and Ellersieck, 1986	2
Salmo salar	0.5g	93		S	rw	7.5	12	40	96h	LC50	mortality	2.5		Mayer and Ellersieck, 1986	2
Salmo salar	fingerling	93		F	rw	7.5	12	312	96h	LC50	mortality	2.5		Mayer and Ellersieck, 1986	2
Salmo trutta	1.5g	93		S	rw	7.5	12	44	96h	LC50	mortality	4.6		Mayer and Ellersieck, 1986	2
Salmo trutta	1.5g	93		S	rw	6.5	12	44	96h	LC50	mortality	4.3		Mayer and Ellersieck, 1986	2
Salmo trutta	1.5g	93		S	rw	9.5	12	44	96h	LC50	mortality	3.5		Mayer and Ellersieck, 1986	2
Salmo trutta	1.5g	93		S	rw	7.5	12	12	96h	LC50	mortality	6		Mayer and Ellersieck, 1986	2
Salmo trutta	1.5g	93		S	rw	7.5	12	170	96h	LC50	mortality	5.1		Mayer and Ellersieck, 1986	2
Salmo trutta	1.5g	93		S	rw	7.5	12	40	96h	LC50	mortality	6.6		Mayer and Ellersieck, 1986	2
Salmo trutta	1.2g	93		S	rw	7.5	12	40	96h	LC50	mortality	1.2		Mayer and Ellersieck, 1986	2
Salmo trutta	0.6-1.7g	100		S	rw	7.1	13	47	96h	LC50	mortality	4	21	Macek and McAllister, 1970	2
Amphibia															
Ambystoma gracile	larvae, 6wk	22	Y	CF	nw	6.7	20	49	96h	LC50	mortality	1670	9	Nebeker et al., 1998	1
Ambystoma maculatum	larvae, 8wk	22	Y	CF	nw	6.7	20	23	96h	LC50	mortality	1900	9	Nebeker et al., 1998	1
Bufo arenarum	larvae stage 25	99	Y	S	am		16	540?	96h	LC50	mortality	10440	13	Ferrari et al., 2004	1
Bufo woodhousei fowleri	tadpole	93		S	rw	7.1	15	44	96h	LC50	mortality	109		Mayer and Ellersieck, 1986	2
Bufo woodhousei fowleri	tadpole, 4-5wk	tg		S	rw	7.1	15.5	30	96h	LC50	mortality	130	10	Sanders, 1970	2
Pseudacris regilla	tadpole; 3wk	99	Y	R	nw	7.3	23	37.2	96h	LC50	mortality	4140	9	Schuytema et al., 1995	1
Pseudacris regilla	tadpole; 3wk	22	Y	R	nw	7.3	24	37.2	96h	LC50	mortality	840	9	Schuytema et al., 1995	1
Pseudacris regilla	tadpole; 3wk	22	Y	R	nw	7.3	24	37.2	96h	LC50	mortality	460	9	Schuytema et al., 1995	1
Pseudacris regilla	tadpole; 3wk	99	Y	CF	nw	6.7	19	44	96h	LC50	mortality	>3600	9	Nebeker et al., 1998	1
Pseudacris triseriata	tadpole	93		S	rw	7.4	15	272	96h	LC50	mortality	3200		Mayer and Ellersieck, 1986	2
Rana catesbeiana	tadpole; 3.4g		N	S	tw	7	23-26	2-	96h	LC50	mortality	7600	8,11	Carter and Graves, 1972	2
Rana ridibunda	tadpole; 20d	23%	Y	S	dw	7.55	23	17.1	24h	LC50	mortality	7180	37	Ozmen et al., 1999	2
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	23	46	96h	LC50	mortality	6100		Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	23	46	96h	LC50	mortality	6280		Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	24	46	96h	LC50	mortality	11890	9	Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	24	46	96h	LC50	mortality	10630	9	Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	22	Y	R	nw	7.4	24	46	96h	LC50	mortality	1600	8	Schuytema et al., 1994	1
Xenopus laevis	tadpole; 2wk	99	Y	R	nw	7.3	23	37.2	96h	LC50	mortality	2950	9	Schuytema et al., 1995	1
Xenopus laevis	tadpole; 2wk	22	Y	R	nw	7.3	24	37.2	96h	LC50	mortality	590	9	Schuytema et al., 1995	1
Xenopus laevis	tadpole; 2wk	22	Y	R	nw	7.3	24	37.2	96h	LC50	mortality	420	9	Schuytema et al., 1995	1

a According to Klimisch et al., 1997

Notes:

1 Purity not clear, probably technical grade and reported in a.i.

2 EC50 was calculated using reported effect and concentration data provided by author

3 Endpoint unknown

4 Far above solubility limits

5 Terrestrial plant but study conducted in nutrient solution; Concentration after 16 d 70% of initial concentration
6 Corrected for measured recoveries
7 Based on nominal concentrations
8 Purity unknown
9 Based on measured concentrations
10 TLm is used as LC50
11 According to standard protocol of the American Public Health Association
12 Lined with plastic bags
13 Measured concentrations close to nominal concentrations
14 Vague description; unclear how LC50 or NOEC is calculated
15 Only one concentration tested
16 Badly described study
17 Sediment present in the systems
18 A layer of sand was present in the systems
19 100 % mortality at 5 mg/L
20 Lowest concentration tested resulted in significant effects
21 Concentrations reported as active ingredient/liter
22 Corrected for measured recoveries
23 Fish from resistant population
24 Average 53% mortality after 24h
25 2.5-5g fish/liter
26 Endpoint not clear
27 Unclear if conc is measured; toxicity is determined after degradation
28 7 day degradation experiment
29 14 day degradation experiment
30 21 day degradation experiment
31 Not clear if sediment was added to the experimental systems so exposure concentrations may have been lower than nominal
32 Based on standard procedure of Dept. Of Fisheries and Wildlife.
33 Very few experimental details. Test conditions following Hermens et al., 1987.
34 Measured concentrations >70% of nominal concentrations.
35 Values reported in log umol/l; recalculated into ug/l.
36 Original results were given in mg/l Gusathion. Results were recalculated assuming 25% of Gusathion is azinphos methyl, as reported in the article.
37 Results reportedly based on measured concentrations but no info on analytical methods

Table A2.5. Chronic toxicity of azinphos-methyl to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Protozoa															
Colpidium campylum			am	S					43h	MAD	numbers	1000	1,2	Dive et al., 1980	4
Algae															
Scenedesmus subspicatus		92	N	S	am				96h	NOEC		1800		Crommentuijn et al., 1997	4*
Scenedesmus subspicatus		92.5	N	S	am				96h	NOEC	growth rate	1800	3	Panman and Linders, 1990	2
Scenedesmus subspicatus		tg	N	S					96h	NOEC		1800		Anonymous, 1996	4*
Annelida/oligochaeta															
Branchiura sowerbyi	mature	tg	N	S	tw				90d	LC100	mortality	5000	4	Naqvi, 1973	3
Crustacea															
Asellus aquaticus									21d	NOEC	immobility/ mortality	0.25		Crommentuijn et al., 1997	2
Asellus aquaticus	4.6mm	ag	N	S	am		18	163.9	21d	EC50	immobility/ mortality	2.4		Dortland, 1980	2
Asellus aquaticus	4.6mm	ag	N	S	am		18	163.9	21d	NOEC	immobility/ mortality	0.5-1.0	5	Dortland, 1980	2
Daphnia magna									21d	NOEC	immobility	0.1		Dortland, 1980	2
Daphnia magna	<24h	ag	N	S	am		18	163.9	21d	EC50	immobility/ mortality	0.28		Dortland, 1980	2
Daphnia magna	<24h	ag	N	S	am		18	163.9	21d	EC50	immobility/ mortality	0.26		Dortland, 1980	2
Daphnia magna	<24h	ag	N	S	am		18	163.9	21d	NOEC	Reproduction	0.2		Dortland, 1980	2
Daphnia magna							20		21d	NOEC	Reproduction	0.24		IUCLID, 2000	2
Daphnia magna			Y						21d	NOEC	Reproduction	0.25	6	Anonymous, 1996	2
Gammarus pseudolimnaeus									30d	NOEC	immobility/ mortality	0.1		Crommentuijn et al., 1997	2
Insecta															
Acroneuria lycorias									30d	NOEC	immobility/ mortality	1.4		Crommentuijn et al., 1997	2
Acroneuria pacifica	naiads: 2-2.5 cm	89	Y	CF	nw	7.8-8.2	12.8		30d	LC50	mortality	0.24	7,8,9	Jensen and Gaufin, 1966	2
Cloeon dipterum	5.8mm	ag	N	S	am		18	163.9	21d	EC50	immobility/ mortality	3.4		Dortland, 1980	2
Cloeon dipterum	5.8mm	ag	N	S	am		18	163.9	21d	NOEC	immobility/ mortality	2		Dortland, 1980	2
Ephemerella subvaria									30d	NOEC	immobility/ mortality	2.5		Crommentuijn et al., 1997	2
Hydropsyche bettoni									30d	NOEC	immobility/ mortality	2.9		Crommentuijn et al., 1997	2
Ophiogomphys rupinsulensis									30d	NOEC	immobility/ mortality	1.7		Crommentuijn et al., 1997	2
Pteronarcys californica	2-5 cm	tg	Y	CF	nw	7.8-8.2	12.8		30d	LC50	mortality	1.3	7,8,9	Jensen and Gaufin, 1966	2
Xanthocnemis zealandica	eggs	100	N	S	tw	8	20	48	19-23d	NOEC	hatching	40		Hardersen and Wratten, 2000	2

Pisces															
Cyprinus carpio	embryos	22%	N	R	nw	6.9	26-28	109	96h	NOEC	hatching	100	9,10	Malone and Baylock, 1970	2
Esox lucius	yolk-sac fry	93		S	rw	7.5	12	44	96h	LC50	mortality	0.36		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss							15		21d	LC50	mortality	2.33		IUCLID, 2000	4
Oncorhynchus mykiss		tg	Y	F					85d	NOEC	survival	0.44	6,11	Anonymous, 1996	2
Oryzias latipes	embryos	cf	N	S	rw		25		7d	NOEC	survival of fry	≤0.06	12	Teather et al., 2005	2
Oryzias latipes	embryos	cf	N	S	rw		25		7d	NOEC	hatching	≤0.06	12	Teather et al., 2005	2
Oryzias latipes	embryos	cf	N	S	rw		25		7d	NOEC	fry length	<0.06	12	Teather et al., 2005	2
Pimephales promelas	from fry onward	93%	Y	CF	nw	7.5	22.4-24.6	220	57d	NOEC	survival of fry	0.51	13	Adelman and Smith, 1976	1
Pimephales promelas	from fry onward	93%	Y	CF	nw	7.5	22.4-24.6	220	90d	NOEC	growth	0.51	13	Adelman and Smith, 1976	1
Pimephales promelas	from fry onward	93%	Y	CF	nw	7.5	22.4-24.6	220	121-230d	NOEC	fecundity: # off eggs produced	0.33	13,14	Adelman and Smith, 1976	1
Salmo salar	green egg	93		S	rw	6.6	7	12	96h	LC50	mortality	>50		Mayer and Ellersieck, 1986	2
Salmo salar	green egg	93		S	rw	7.4	7	44	96h	LC50	mortality	>50		Mayer and Ellersieck, 1986	2
Salmo salar	green egg	93		S	rw	7.8	7	170	96h	LC50	mortality	>50		Mayer and Ellersieck, 1986	2
Salmo salar	yolk-sac fry	93		S	rw	6.6	7	12	96h	LC50	mortality	>15		Mayer and Ellersieck, 1986	2
Salmo salar	yolk-sac fry	93		S	rw	7.4	7	44	96h	LC50	mortality	18		Mayer and Ellersieck, 1986	2
Salmo salar	yolk-sac fry	93		S	rw	7.8	7	170	96h	LC50	mortality	15		Mayer and Ellersieck, 1986	2
Salmo salar	yolk-sac fry	93		S	rw	6.6	12	12	96h	LC50	mortality	3.5		Mayer and Ellersieck, 1986	2
Salmo salar	yolk-sac fry	93		S	rw	7.4	12	44	96h	LC50	mortality	2.3		Mayer and Ellersieck, 1986	2
Salmo salar	yolk-sac fry	93		S	rw	7.8	12	170	96h	LC50	mortality	1.8		Mayer and Ellersieck, 1986	2
Amphibia															
Ambystoma gracile	larvae, 6wk	22	Y	CF	nw	6.7	20	49	10d	NOEC	growth	100	6,15	Nebeker et al., 1998	1
Ambystoma maculatum	larvae, 8wk	22	Y	CF	nw	6.7	20	23	10d	NOEC	growth	30	6,16	Nebeker et al., 1998	1
Bufo americanus	stage 17	50	N	R	tw		20		96h+48h	NOEC	deformities at hatching	>5000	9,17	Harris et al., 2000	2
Pseudacris regilla	tadpole; 3wk	99	Y	CF	nw	6.7	19	44	10d	NOEC	growth	980	6,18	Nebeker et al., 1998	1
Rana clamitans	9h after fertilization	50	N	R	tw		20		13d	LC50	mortality	2610	9	Harris et al., 1998	2
Rana clamitans	9h after fertilization	50	N	R	tw		20		96h	LC50	mortality	>5000	9	Harris et al., 1998	2
Rana clamitans	9h after fertilization	50	N	R	tw		20		16d	LC50	mortality	>5000	9	Harris et al., 1998	2
Rana pipiens	stage 15	50	N	R	tw		20		96h+48h	NOEC	deformities at hatching	>5000	9,17	Harris et al., 2000	2
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	23	46	96h	NOEC	deformity	510	6,19	Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	23	46	96h	NOEC	deformity	3200	6,20	Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	tg	Y	R	nw	7.4	23	46	96h	NOEC	length	820	6,19	Schuytema et al., 1994	1
Xenopus laevis	embryos stage 10-11	22	Y	R	nw	7.4	23	46	96h	NOEC	length	480	6,21	Schuytema et al., 1994	1

a According to Klimisch et al., 1997

Notes:

1 Minimal Active dose is calculate according to Dive and Leclerc, 1975.

2 Ciliates were kept in a bacterial suspension

3 NOEC was calculated using concentration data provided by author

4 Only 0% or 100% mortality observed. In the acute study 100% mortality at 5 mg/l was observed, in the chronic study 0% mortality at 4 mg/l. No other concentrations tested or reported.

5 Geomean = 0.70 ug/L

6 Based on measured concentrations

7 TLm is used as LC50

8 Measured concentrations close to nominal concentrations

9 Based on nominal concentrations a.i.

10 LOEC = 1000 ug/L

11 LOEC = 0.98 ug/L

12 Only one concentration tested

13 Same results with slightly different test characteristics also reported in Adelman et al., 1976. Bull. Environ. Cont. Toxicol. 15(6): 726-733

14 Begin of spawning after 121d, end of spawning after 230d; Same results with slightly different test characteristics also reported in Adelman et al., 1976. Bull. Environ. Cont. Toxicol. 15(6): 726-733

15 LOEC = 220; commercial formulation used but results based on measured concentrations

16 LOEC = 110; commercial formulation used but results based on measured concentrations

17 Exposure for 96h at stage 15 and 48h at first limb emergence

18 LOEC = 3600 ug/L

19 LOEC = 1310 ug/L

20 LOEC = 6360 ug/l

21 LOEC = 1300 ug/L

Table A2.6. Acute toxicity of azinphos-methyl to marine organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Bacteria															
Vibrio fisherii		cf	N	S			15	20	5min	EC50	luminescence	351	1,2	Benson and Long, 1991	3
Vibrio fisherii		Cf	N	S			15	20	15min	EC50	luminescence	370	1,2	Benson and Long, 1991	3
Vibrio fisherii		Cf	N	S			15	20	30min	EC50	luminescence	409	1,2	Benson and Long, 1991	3
Vibrio fisherii		22	N	S		6.8-7.2		20	5min	EC50	luminescence	300	3,4	Kadlec and Benson, 1995	2
Vibrio fisherii		22	N	S		6.8-7.2		20	15min	EC50	luminescence	315	3,4	Kadlec and Benson, 1995	2
Mollusca															
Cardium edule				S	nw		15		48h	LC50	mortality	>10000	5	Portmann, 1971	2
Cerastoderma edule			N	S	nw		15		48h	LC50	mortality	>10000		Portmann, 1992	2
Crassostrea virginica	juvenile	96	N	F			29	28	96h	EC50		>1000		Mayer, 1986	2
Crassostrea virginica			N	CF	nw		13	14	96h	EC50	shell growth rate	>1000		Butler, 1963	2
Crassostrea virginica			N	CF	nw		30	28	96h	EC50	shell growth rate	>1000		Butler, 1963	2
Crassostrea virginica									48h	EC50		620	6	Morton et al., 1997: Davis and Hidu, 1969	4
Crustacea															
Amphiascus tenuiremis		tg	Y	S	rw		20	30	96h	LC50	mortality	1.99	7	Klosterhaus et al., 2003	2
Amphiascus tenuiremis		tg	Y	S	rw		20	30	96h	LC50	mortality	5	8	Klosterhaus et al., 2003	3
Artemia salina	24h old	ag	N	S	am	8.6	25	35	24h	LC50	mortality	24290	9	Sánchez-Fortún et al., 1995	3
Artemia salina	48h old	ag	N	S	am	8.6	25	35	24h	LC50	mortality	15260	9	Sánchez-Fortún et al., 1995	3
Artemia salina	72h old	ag	N	S	am	8.6	25	35	24h	LC50	mortality	12510	9	Sánchez-Fortún et al., 1995	3
Artemia sp.	neonates	>95%	N	S	rw		25	33	24h	LC50	immobility	23000	9	Guzzella et al., 1997	3
Callinectes sapidus	juvenile	96	N	F			27	27	48h	EC50	immobility	320		Mayer, 1986	2
Callinectes sapidus	juvenile		N	CF	nw		27		48h	EC50	mortality	550		Butler, 1963	2
Carcinus maenas				S	nw		15		48h	LC50	mortality	33-100	5	Portmann, 1971	2
Crangon crangon				S	nw		15		48h	LC50	mortality	0.3-1	5	Portmann, 1971	2
Crassostrea virginica		tg	Y	F					96h	LC50	mortality	4700	7	Anonymous, 1996	2
Leiostomus xanthurus	juvenile		N	F	nw		21	21	48h	EC50	mortality	50	10	Butler, 1964	3
Mysidopsis bahia			Y	S	nw	6-8	25-28(day); 17-20(night)	15	96h	LC50	immobility	0.811	12	Lauth et al., 1996	3
Mysidopsis bahia	<24h	98	Y	IF	nw		26	20	96h	LC50	mortality	0.29	3,13	Morton et al., 1997	2
Mysidopsis bahia		tg	Y	F					96h	LC50	mortality	0.2	7	Anonymous, 1996	2
Palaemonetes pugio			Y	S	nw	6-8	25-28(day); 17-20(night)	15	96h	LC50	immobility	1.34	12	Lauth et al., 1996	3
Palaemonetes pugio	Adult	tg	Y	R	nw		25	20	96h	LC50	mortality	1.64	3,13	Key et al., 1998	2
Palaemonetes pugio	larvae, 18d old	tg	Y	R	nw		25	20	96h	LC50	mortality	0.38	3,13	Key et al., 1998	2
Palaemonetes pugio	larvae, newly hatched	tg	Y	R	nw		25	20	96h	LC50	mortality	0.52	3,13	Key et al., 1998	2
Palaemonetes pugio									96h	LC50	mortality	1		Morton et al., 1997: Scott et al., 1990	4
Palaemonetes pugio	adults							5	96h	LC50	mortality	0.97		Hall and Anderson, 1995.: Scott et al., 1990	4
Palaemonetes pugio	adults							20	96h	LC50	mortality	1.05		Hall and Anderson, 1995.: Scott et al., 1990	4
Pandalus montagui				S	nw		15		48h	LC50	mortality	0.3-1	5	Portmann, 1971	2

Penaeus aztecus	juvenile	96	N	F			31	25	48h	EC50	mortality	2.4		Mayer, 1986	2
Penaeus aztecus	adult		N	CF	nw		31		48h	EC50	mortality	4.4		Butler, 1963	2
Rotifers															
Brachionus plicatilis	neonates	>95%	N	S	rw		25	33	24h	LC50	immobility	85000	9	Guzzella et al., 1997	3
Pisces															
Atherinops affinis	35d; 20.3mg; 13.5mm	98	Y, stocks	S		7.1-8.2	20	20	96h	LC50	mortality	3.4	14,15,16	Hemmer et al., 1992	3
Cyprinodon variegatus	juvenile	97	Y	R	nw			25	14d	LOEC	mortality	0.83	7,17	Crommentuijn et al., 1997	2
Cyprinodon variegatus	indigenous population; 66 days old	98	Y	IF	nw		25	20	96h	LC50	mortality	2	3,13	Morton et al., 1997	2
Cyprinodon variegatus		tg	Y	F					96h	LC50	mortality	2700	7,18	Anonymous, 1996	4
Fundulus heteroclitus	0.32g (0.12-1.06g)		N	S	nw diluted with dw	8.0-8.2	30	25	24h	NOEC	oxygen uptake	10	19	Cochran and Burnett, 1996	2
Fundulus heteroclitus		22	N	R			20-25	5	96h	LC50	mortality	28		Fulton and Scott, 1991	2
Fundulus heteroclitus		22	N	R			20-25	25	96h	LC50	mortality	36.95		Fulton and Scott, 1991	2
Fundulus heteroclitus	3-7cm		Y	R	nw		20	5	96h	LC50	mortality	85.1	3,13	Van Dolah et al., 1997	2
Fundulus heteroclitus	3-7cm		Y	R	nw		20	20	96h	LC50	mortality	64.5	3,13	Van Dolah et al., 1997	2
Fundulus heteroclitus	adults							20	96h	LC50	mortality	36.95		Hall and Anderson, 1995: Scott et al.,1991	4
Gasterosteus aculeatus	0.4-0.8g; 2.2-4.4cm	93		S	nw	6.8-7.4	20	5	96h	LC50	mortality	12.1	3	Katz, 1961	2
Gasterosteus aculeatus	0.4-0.8g; 2.2-4.4cm	93		S	nw	6.8-7.4	20	25	96h	LC50	mortality	4.8	3	Katz, 1961	2
Leiostomus xanthurus	juvenile	96	N	F			21	21	48h	LC50	mortality	28		Mayer, 1986	2
Leiostomus xanthurus	0.32g (0.12-1.06g)		N	S	nw diluted with dw	8.0-8.2	30	25	24h	NOEC	oxygen uptake	10	19	Cochran and Burnett, 1996	2
Limanda limanda				S	nw		15		48h	LC50	mortality	10-30	5	Portmann, 1971	2
Litopenaeus stylirostis	larvae	cf	N	S		8.4-8.7	22-24	33-35	48h	LC50	mortality	1470.3	11	Galindo Reyes et al., 2002	2
Menidia beryllina	29d; 42.9mg; 15.9mm	98	N	S		7.1-8.2	25	20	96h	LC50	mortality	22.8	14,15,16	Hemmer et al., 1992	3
Menidia menidia			Y	S	nw	6-8	25-28(day); 17-20(night)	15	96h	LC50	immobility	1.19	12	Lauth et al., 1996	3
Mugil cephalus	juvenile	96	N	F			28	25	48h	LC50	mortality	3.2		Mayer, 1986	2
Mugil curema	juvenile		N	CF	nw		28		48h	LC50	mortality	5.5		Butler, 1963	2
Salmo salar	3-4cm; 1g	>95	N	S			15		24h	NOEC	temperature selection	0.01	20	Peterson, 1976	3
Sciaenops ocellatus	3-7cm		Y	R	nw		20	5	96h	LC50	mortality	7.1	3,13	Van Dolah et al., 1997	2
Sciaenops ocellatus	3-7cm		Y	R	nw		20	20	96h	LC50	mortality	6.2	3,13	Van Dolah et al., 1997	2

a According to Klimisch et al., 1997

Notes:
1 Commercial fomulation may be 22% active ingredient?
2 No record on correction for purity
3 Results in nominal concentration a.i.
4 Test waters were stream waters with 2% NaCl
5 Methods reported in Portmann, 1968 and Portmann and Connor, 1968.
6 Not clear which egg stage tested
7 Results based on measured concentrations
8 Results based on measured pore water concentrations from sediment assays!
9 Result may have been 1000 times lower (mg/µg confusion?) because other compounds in the study appear to have been tested far beyond their solubility limits
10 Vague description of test conditions; no controls; no description of test compound or purity; results could very well be based on commercial formulation instead of ai.
11 Food provided twice per day
12 Salt marsh model ecosystem experiment with animals in small containers exposed within the mesocosms; varying conditions during time.
13 Measured concentrations close to nominal concentrations
14 Low oxygen concentrations reported
15 Fed during exposure
16 Results are given in nominal exposures, calculated from measured stock solutions
17 54% mortality at 0.83 ug/L
18 Very high LC50, maybe factor 1000 wrong?
19 1 concentration measured
20 Not clear if azinphos-methyl or azinphos-ethyl is tested. Vaguely described study.

Table A2.7. Chronic toxicity of azinphos-methyl to marine organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Mollusca															
Crassostrea virginica	Eggs		N	R	nw		24		48h	EC10	eggs developing	410	1,2	Davis and Hidu, 1969	2
Mercenaria mercenaria	Eggs		N	R	nw		24		48h	EC10	eggs developing	890	1,2	Davis and Hidu, 1969	2
Mercenaria mercenaria	2d old larvae		N	R	nw		24		12d	EC10	survival	390	1,2	Davis and Hidu, 1969	2
Mercenaria mercenaria	2d old larvae		N	R	nw		24		12d	EC10	growth	>1000	1,2	Davis and Hidu, 1969	2
Crustacea															
Mysidopsis bahia	<24h	98	Y	IF	nw		26	20	26d	NOEC	time of reproduction	0.097	3,4,5	Morton et al., 1997	2
Mysidopsis bahia	<24h	98	Y	IF	nw		26	20	26d	NOEC	# of young	0.02	3,4,6	Morton et al., 1997	2
Mysidopsis bahia	<24h	98	Y	IF	nw		26	20	26d	NOEC	mortality	0.097	3,4,7	Morton et al., 1997	2
Pisces															
Cyprinodon variegatus	embryo --> adult	96	Y	S	nw(filtered)		30	25(8-34)	219d	NOEC	reproduction	0.25	3,4,8,9	Cripe et al., 1984	2
Cyprinodon variegatus	embryos	98	Y	IF	nw		25	20	28d	NOEC	survival	0.17	3,4,10	Morton et al., 1997	2
Cyprinodon variegatus	embryos	98	Y	IF	nw		25	20	28d	NOEC	growth	0.34	3,4,11	Morton et al., 1997	2

a According to Klimisch et al., 1997

Notes:

1 EC10 was calculated using reported effect and concentration data provided by author
2 Purity unknown
3 Measured concentrations within range of nominal concentrations
4 Results based on nominal concentrations
5 LOEC = 0.18 ug/L
6 LOEC = 0.030 ug/L
7 LOEC = 0.18 ug/L
8 LOEC = 0.5 ug/L
9 Life cycle test; methods well described, results not well described
10 LOEC = 0.34 ug/L
11 LOEC = 0.62 ug/L

Table A2.8. Acute toxicity of coumaphos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Crustacea															
Daphnia magna	<24h		N	S	am	7.9	19	202	26h	LC50	mortality	0.1	1	Frear and Boyd, 1967	2
Gammarus fasciatus	mature	tg	N	S	rw	7.1	21	47	96h	LC50	mortality	0.15	2	Sanders, 1972	2
Gammarus lacustris		tg	N	S	rw	7.1	21	47	96h	LC50	mortality	0.074		Sanders, 1969	2
Gammarus lacustris	mature	tg	N	S		7.1	21	44	96h	LC50	mortality	0.074		Mayer and Ellersieck, 1986	4*
Simocephalus serrulatus	1st	tg	N	S		7.1	15	44	48h	EC50	mor/immo	0.1		Mayer and Ellersieck, 1986	2
Insecta															
Aedes taeniorhynchus	4th instar larvae	tg	Y	S	dw		25		24h	LC50	mortality	30	3	Schmidt and Weidhaas, 1958	2
Anopheles quadrimaculatus	4th instar larvae	tg	Y	S	dw		25		24h	LC50	mortality	20	3	Schmidt and Weidhaas, 1958	2
Culex pipiens molestus	larvae	25% wettable powder	N	S	tw		20-22		48h	LC100	mortality	>10	4,5	Rettich, 1979	3
Hexagenia	naiads	97.5	N	S	nw		22-24		24h	LC50	mortality	427	2	Carlson, 1966	2
Hydropsyche	larvae	97.5	N	S	nw		22-24		24h	LC50	mortality	5.2	2	Carlson, 1966	2
Pisces															
Carassius auratus	1-2g; 4-6 cm	97.5	N	S	nw, diluted	7.4-7.5	25	20	96h	LC50	mortality	>18000	2,6	Pickering et al., 1962	3
Gambusia affinis	>25mm; susceptible	tg	N	S	tw	7.8	22	28	48h	LC50	mortality	3500	6	Culley and Ferguson, 1969	3
Ictalarus punctatus	1.0g	tg	N	S		7.4	18	44	96h	LC50	mortality	840		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	1-2g; 4-6cm	100	N	S	nw	7.4	25	20	96h	LC50	mortality	180	4	Henderson et al., 1960	2
Lepomis macrochirus	1.3g	tg	N	S		7.1	18	44	96h	LC50	mortality	340		Mayer and Ellersieck, 1986	2
Lepomis macrochirus									48h	LC50	mortality	8000	6	Wellborn, 1971: Willford, 1967	3
Micropterus salmoides	0.9g	tg	N	S		7.4	18	272	96h	LC50	mortality	1100		Mayer and Ellersieck, 1986	2
Morone saxatilis	0.93g; 46mm	25% wettable powder	N	S	dtw	7.9	21	35	96h	LC50	mortality	15500	6,7,8,9	Wellborn, 1971	3
Oncorhynchus clarki	0.3g	tg	N	S		7.4	12	44	96h	LC50	mortality	862		Mayer and Ellersieck, 1986	2
Oncorhynchus kisutch	2.7-4.1g; 5.7-7.6cm	98		S	nw	6.8-7.4	20		96h	LC50	mortality	15000	2,4,6	Katz, 1961	3
Oncorhynchus mykiss	3.2g; 5.1-7.9cm	98		S	nw	6.8-7.4	20		96h	LC50	mortality	1500	2,4	Katz, 1961	2
Oncorhynchus mykiss	1.2g	tg	N	S		7.1	12	44	96h	LC50	mortality	890		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss									48h	LC50	mortality	550		Wellborn, 1971: Willford, 1967	4
Pimephales promelas	1-2g; 4-6cm	100	N	S	nw	8.2	25	400	96h	LC50	mortality	>18000	4,6	Henderson et al., 1960	3
Pimephales promelas	1-2g; 4-6cm	100	N	S	nw	7.4	25	20	96h	LC50	mortality	>18000	4,6	Henderson et al., 1960	3
Poecilia reticulata	0.1-0.2g; 2-2.5cm	97.5	N	S	nw, diluted	7.4-7.5	25	20	96h	LC50	mortality	560	2	Pickering et al., 1962	2
Rasbora heteromorpha	1.3-3cm	cf: asuntol	N	R	'standard quality dilution water'	7.2	20	20	48h	LC50	mortality	46	1,10,11	Alabaster, J.S. 1969	2
Salvelinus namaycush	2.1g	tg	N	S		7.4	12	162	96h	LC50	mortality	593		Mayer and Ellersieck, 1986	2
Stizostedion vitreum vitreum	0.8g	tg	N	S		7.4	18	272	96h	LC50	mortality	780		Mayer and Ellersieck, 1986	2

a According to Klimisch et al., 1997

Notes:

1 Purity unknown
2 TLm is used as LC50
3 No mention on the amount of acetone used as solvent
4 Based on nominal concentrations a.i.
5 Including a 2-3 cm layer of decaying leaves
6 Far above solubility limits
7 Exposure in plastic bags
8 Fish exposed in suspensions with insoluble wettable powder
9 LC50 recalculated from the reported concentration wettable powder (62000)
10 Standardised procedure according to Pesticides Safety Precaution Scheme, 1966
11 Median lethal concentrations determined by graphical interpolation

Table A2.9. Chronic toxicity of coumaphos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Crustacea															
Daphnia magna		99.1	Y							NOEC	Survival	0.0337	1	US EPA, 2000	2
Pisces										NOEC	Length and weight	11.7	1	US EPA, 2000	2
Oncorhynchus mykiss		99.2	Y												

a According to Klimisch et al., 1997

Notes:

1 Results based on mean measured concentrations

Table A2.10. Acute toxicity of coumaphos to marine organisms.

Species	Species proper-ties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Mollusca															
Crassostrea virginica	juvenile	95	N	F			9	21	96h	EC50		290		Mayer, 1986	2
Crassostrea virginica	juvenile	95	N	F			30	23	96h	EC50		880		Mayer, 1986	2
Oyster (no further reference of species)	juvenile		N	F	nw		30	23	48h	EC50	50% decrease in shell growth	950	1	Butler, 1964	3
Oyster (no further reference of species)	juvenile		N	F	nw		9	21	48h	EC50	50% decrease in shell growth	510	1	Butler, 1964	3
Crustacea															
Artemia salina	24h old	ag	N	S	am	8.6	25	35	24h	LC50	mortality	21230	2	Sánchez-Fortún et al., 1995	3
Artemia salina	48h old	ag	N	S	am	8.6	25	35	24h	LC50	mortality	5510	2	Sánchez-Fortún et al., 1995	3
Artemia salina	72h old	ag	N	S	am	8.6	25	35	24h	LC50	mortality	5220	2	Sánchez-Fortún et al., 1995	3
Penaeus duorarum	juvenile	95	N	F			28	29	48h	EC50		2		Mayer, 1986	2
Penaeus duorarum			N	F	nw		28	29	48h	EC50	mortality or loss of equilibrium	3.6	1	Butler, 1964	3
Pisces															
Cyprinodon variegatus	juvenile	95	N	F			12	28	48h	LC50	mortality	280		Mayer, 1986	2
Gasterosteus aculeatus	0.4-0.8g; 2.2-4.4cm	98		S	nw	6.8-7.4	20	5	96h	LC50	mortality	1862		Katz, 1961	2
Gasterosteus aculeatus	0.4-0.8g; 2.2-4.4cm	98		S	nw	6.8-7.4	20	25	96h	LC50	mortality	1470	3	Katz, 1961	2

a According to Klimisch et al., 1997

Notes:

1 Vague description of test conditions, no controls, no description of test compound of purity, could very well have been the commercial formulation instead of the active ingredient.

2 Far above solubility limits

3 Results based on nominal concentrations a.i.

Table A2.11. Chronic toxicity of coumaphos to marine organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Mollusca															
Crassostrea virginica	eggs		N	R	nw		24		48h	EC10	eggs developing	70	1,2	Davis and Hidu, 1969	2
Crassostrea virginica	2d old larvae		N	R	nw		24		12d	EC10	survival	>1000	1,2	Davis and Hidu, 1969	2
Crassostrea virginica	2d old larvae		N	R	nw		24		12d	EC10	growth	20	1,2	Davis and Hidu, 1969	2
Mercenaria mercenaria	eggs		N	R	nw		24		48h	EC10	eggs developing	4780	1,2	Davis and Hidu, 1969	2
Mercenaria mercenaria	2d old larvae		N	R	nw		24		12d	EC10	survival	120	1,2	Davis and Hidu, 1969	2
Mercenaria mercenaria	2d old larvae		N	R	nw		24		12d	EC10	growth	50	1,2	Davis and Hidu, 1969	2

a According to Klimisch et al., 1997

Notes:

1 EC50s recalculated using graphpad

2 Purity unknown

Table A2.12. Acute toxicity of heptenophos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Algae															
Scenedesmus subspicatus		95%		S					72h	EC50	biomass	35000	1,2	Panman en Linders, 1992	2
Crustacea															
Daphnia magna		96	Y	S	tw	7.5	-		48	LC50	mor/immo	2		Crommentuijn et al., 1997	2
Daphnia magna		96	Y	S	tw:dw (80:20) filtered	7.5	21		48h	LC50	mortality	2	3	Panman en Linders, 1992	4*
Daphnia magna	1.2-1.4 mm	cf; 50%		S	aquarium water	7.7-7.9	15.8	243-260	48h	LC50	mortality	800	4	Panman en Linders, 1992	2
Pisces															
Idus melanotus	1.7-2.1g	cf; 50%		S	tw:dw (50:50)	7.1-7.3	21	238	96h	LC50	mortality	11300	5	Panman en Linders, 1992	2
Poecilia reticulata	1wk, 1.2-1.7cm		N	S	tw/am	7.1-7.3		170-240	96	LC50	mor/immo	9300		Crommentuijn et al.,1997	2
Poecilia reticulata	1wk; 1.2-1.7cm			S	tw:dw (50:50)	7.1-7.3	21	170-240	96h	LC50	mortality	9300	2,6	Panman en Linders, 1992	4*
Poecilia reticulata	1.7-2.1g	cf; 50%		S	tw:dw (50:50)	7.1-7.3	21	170-201	96h	LC50	mortality	13100	7	Panman en Linders, 1992	2

a According to Klimisch et al., 1997

Notes:

1 According to NEN guideline 6506
2 Results based on nominal concentrations a.i.
3 According to BBA guidelines
4 LC50 reported as 1600 mg/L nominal Hostaquick; recalculated into active ingredient
5 LC50 reported as 1600 mg/L nominal Hostaquick; recalculated into active ingredient
6 Length of 1.7 cm at age of 1 week does not seem correct.
7 LC50 reported as 26200 mg/L nominal Hostaquick; recalculated into active ingredient

Table A2.13. Chronic toxicity of heptenophos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Algae															
Scenedesmus subspicatus		95	N						72h	NOEC	Growth rate	25000		Crommentuijn et al., 1997	2
Scenedesmus subspicatus		95							72h	NOEC	biomass	25000	1,2	Panman and Linders, 1992	2

a According to Klimisch et al., 1997

Notes:

1 According to NEN guideline 6506

2 Results based on nominal concentrations a.i.

Table A2.14. Acute toxicity of mevinphos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Mollusca															
Australorbis glabratus	300mg		N	S	am		25-27	203	24h	LC100	mortality	10000	1,2,3	Hopf and Muller, 1962	3
Annelida/oligochaeta															
Branchiura sowerbyi	mature	tg	N	S	tw				90d	LC100	mortality	≤500	4	Naqvi, 1973	3
Crustacea															
Asellus brevicaudus	mature	tg	N	S	rw	7.1	21	47	96h	LC50	mortality	56	5	Sanders, 1972	2
Asellus brevicaudus	early instar	60	N	S		7.4	15	44	96h	LC50	mortality	61		Mayer and Ellersieck, 1986	2
Ceriodaphnia dubia	<48h	95-99	N	S	dw				48h	LC50	mortality	0.95	6	Ankley et al., 1991	2
Cyclopoid copepods	field population from pesticide-free area	tg	N	S	tw	7.8	24	28	48h	LC50	immobility	30	7	Naqvi and Ferguson, 1968	3
Daphnia magna	<72h	ag	N	S		7-7.8	22		24h	EC50	immobility	1000-3500	8	Devillers et al., 1985	3
Daphnia pulex	< 24h		N	S	rw	7.4-7.8	16	47	48h	EC50	immobility	0.16	9	Sanders and Cope, 1966	2
Daphnia pulex	1st isntar	60	N	S		7.4	15	44	48h	EC50	immobility	0.18		Mayer and Ellersieck, 1986	2
Gammarus fasciatus			N	S	rw	7.1	21	47	96h	LC50	mortality	3.5	5	Sanders, 1972	2
Gammarus fasciatus			N	S	nw	7.4	21	high	96h	LC50	mortality	2.8	5,10	Sanders, 1972	2
Gammarus fasciatus	immature	60	N	S		7.4	15	272	96h	LC50	mortality	2.8		Mayer and Ellersieck, 1986	4*
Gammarus fasciatus	immature	60	N	S		7.4	15	44	96h	LC50	mortality	3.5		Mayer and Ellersieck, 1986	4*
Gammarus lacustris	immature	60	N	S		7.4	21	44	96h	LC50	mortality	130		Mayer and Ellersieck, 1986	4*
Gammarus lacustris			N	S	rw	7.1	21	47	96h	LC50	mortality	130		Sanders, 1969	2
Palaemonetes kadiakensis	mature	tg	N	S	nw	7.4	21	high	96h	LC50	mortality	12	5,10	Sanders, 1972	2
Palaemonetes kadiakensis	immature	60	N	S		7.4	15	272	96h	LC50	mortality	13.5		Mayer and Ellersieck, 1986	2
Simocephalus serrulatus	<24h		N	S	rw	7.4-7.8	16	47	48h	EC50	immobility	0.43	9	Sanders and Cope, 1966	2
Simocephalus serrulatus	<24h		N	S	rw	7.4-7.8	21	47	48h	EC50	immobility	0.56	9	Sanders and Cope, 1966	2
Simocephalus serrulatus	1st instar	60	N	S		7.4	15	44	48h	EC50	immobility	0.42		Mayer and Ellersieck, 1986	2
Simocephalus serrulatus	1st instar	60	N	S		7.4	21	44	48h	EC50	immobility	0.49		Mayer and Ellersieck, 1986	2
Insecta															
Chironomus riparius	4th instar	95	N	S	am				24h	EC50	impaired movement	22.5	6,11	Fisher et al., 1993	2
Chironomus tentans	4th instar	98	N	S	standard reference water	7.95	20	moderately hard	96h	EC50	impaired movement	8.78	6	Pape-Lindstrom and Lydy, 1997	2
Pteronarcys californica	naiads: 30-35mm	tg	N	S	rw	7.1	15.5	47	96h	LC50	mortality	5		Sanders and Cope, 1968	2
Pteronarcys californica	nymph						16		96h	LC50	mortality	4.9		Cope, 1965	4*
Pteronarcys californica	1st year class	tg	N	S		7.4	15	44	96h	LC50	mortality	5		Mayer and Ellersieck, 1986	4*
Pisces															
Brachydanio rerio	mature	ag	N	S		7.8-8	24		24h	EC50		35000-100000	8	Devillers et al., 1985	3
Cyprinus carpio		>95							48h	LC50	mortality	33000	12	Fraters and Linders, 1991	4
Gambusia affinis	>25mm;	100	N	S	tw	7.8	22	28	48h	LC50	mortality	2914		Culley and Ferguson, 1969	2

	susceptible														
Ictalurus punctatus	1.0g	60	N	S		7.4	18	44	96h	LC50	mortality	<280		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.87g	tg					24		96h	LC50	mortality	23		Cope, 1965	4*
Lepomis macrochirus			N						96h	LC50	mortality	70		Verschueren, 1983	4
Lepomis macrochirus	1.3g	60	N	S		7.4	18	44	96h	LC50	mortality	59		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	1.0g	60	N	S		7.4	18	272	96h	LC50	mortality	87		Mayer and Ellersieck, 1986	2
Lepomis macrochirus	0.9g	60	N	S		7.4	24	44	96h	LC50	mortality	22.5		Mayer and Ellersieck, 1986	2
Micropterus salmoides	0.8g	60	N	S		7.4	18	272	96h	LC50	mortality	115		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss	0.9g	60					13		96h	LC50	mortality	12		Cope, 1965	4*
Oncorhynchus mykiss	0.9g	tg	N	S		7.4	12	44	96h	LC50	mortality	11.9		Mayer and Ellersieck, 1986	2
Oncorhynchus mykiss		>95							48h	LC50	mortality	70	12	Fraters and Linders, 1991	4
Oreochromis niloticus	2wk, 1 inch		S	tw				48h		LC50	mortality	35	6	Tejada et al., 1994	4
Poecilia reticulata		>95							48h	LC50	mortality	4000	12	Fraters and Linders, 1991	4
Rasbora heteromorpha	1.3-3cm	99.5	N	R	standard quality dilution water	7.2	20	20	48h	LC50	mortality	11500	13,14	Alabaster, 1969	2
Amphibia															
Pseudacris triseriata triseria	tadpole, 0.2g	60	N	S		7.4	16	272	96h	LC50	mortality	>3200		Mayer and Ellersieck, 1986	2

a According to Klimisch et al., 1997

Notes:

1 Badly described study; no mention on purity or controls
2 7.5g organism/Liter
3 24h exposure and 24 or 48h recovery
4 Only 0% or 100% mortality observed. 100% mortality at 0.5 mg/l and three different temperatures; no other concentrations tested.
5 TLm is used as LC50
6 Results based on nominal concentrations a.i.
7 Field population used; species and age unknown
8 French study with english abstract; toxicity not given in concentrations but in classes.
9 Purity unknown
10 Hardness reported as 'high', probably 272 mg $CaCO_3$/L (reported in Mayer and Ellersieck)
11 Objective of the study was to determine QSARs. Some details are missing, but the experiment seems to be performed well. Animals that were immobile after 24 hours, had died after 48 hours. So this EC50 is approximately the 48 LC50.
12 Hungarian study with english summary
13 Standardised procedure according to Pesticides Safety Precaution Scheme, 1966.
14 Median lethal concentrations determined by graphical interpolation

Table A2.15. Chronic toxicity of mevinphos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Algae															
Scenedesmus obtusiusculus						7	25-30		8d	NOEC	Dry matter increase	50000	1,2	Fraters and Linders, 1992	4

a According to Klimisch et al., 1997

Notes:

1 Purity unknown

2 Hungarian study with abstract in English and figure and table subscriptions in German

Table A2.16. Acute toxicity of mevinphos to marine organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Mollusca															
Crassostrea virginica	juvenile	100	N	F			22	30	96h	EC50		>1000		Mayer, 1986	2
Mercenaria mercenaria	21g		N	S	saline well water	8	20	24	96h	NOEC	mortality	>25000	1	Eisler, 1970	2
Nassa obsoleta	0.16g		N	S	saline well water	8	20	24	96h	NOEC	mortality	>25000	1	Eisler, 1970	2
Oyster	juvenile		N	F	nw		22	30	48h	EC50	shell growth	>1000	2	Butler, 1964	3
Crustacea															
Crangon septemspinosa	0.25g		N	S	nw	8	20	24	48h	LC50	mortality	13	3,4,5	Eisler, 1969	2
Palaemonetes vulgaris	0.47g		N	S	nw	8	20	24	48h	LC50	mortality	79	3,4,6	Eisler, 1969	2
Pagurus longicarpus	0.28g		N	S	nw	8	20	24	48h	LC50	mortality	33	3,4,7	Eisler, 1969	2
Penaeus aztecus	juvenile	100	N	F			24	32	48h	EC50		150		Mayer, 1986	2
Pisces															
Anguila rostrata	0.14g		N	S	nw	8	20	24	96h	LC50	mortality	65	3,4	Eisler, 1970	2
Cyprinodon variegatus	juvenile	100	N	F			24	31	48h	LC50	mortality	640		Mayer, 1986	2
Fundulus heteroclitus	42mm		N	S	nw	8	20	24	10d	LC50	mortality	13	3,4,8	Eisler, 1970	2
Fundulus heteroclitus	42mm		N	S	nw	8	20	24	96h	LC50	mortality	65	3,4,8	Eisler, 1970	2
Fundulus heteroclitus	2.5g		N	S	nw	8	20	24	96h	LC50	mortality	300	3,4	Eisler, 1970	2
Fundulus majalis	6.5g		N	S	nw	8	20	24	96h	LC50	mortality	75	3,4	Eisler, 1970	2
Menidia menidia	0.8g		N	S	nw	8	20	24	96h	LC50	mortality	320	3,4	Eisler, 1970	2
Mugil cephalus	12.6g		N	S	nw	8	20	24	96h	LC50	mortality	300	3,4	Eisler, 1970	2
Sphoeroides maculatus	100g		N	S	nw	8	20	24	96h	LC50	mortality	800	3,4,9	Eisler, 1970	2
Thalassoma bifasciatum	5.4g		N	S	nw	8	20	24	96h	LC50	mortality	74	3,4	Eisler, 1970	2

a According to Klimisch et al., 1997

Notes:

1 100% survival after 96h exposure, and also after 133d recovery period

2 Vague description of test conditions, no controls, no description of test compound or purity, could very well be expressed in commercial formulation instead of a.i.

3 Results reported as nominal concentration a.i./L

4 Following procedure of American Public Health Association

5 96h LC50 = 11 ug/L

6 96h LC50 = 69 ug/L

7 96h LC50 = 28 ug/L

8 Unclear how many fish/L are used.

9 5.3g fish/L.

Table A2.17. Acute toxicity of tolclofos-methyl to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Algae															
Scenedesmus quadricauda		98.3		S					96h	EC50		>5600		Baumann et al., 1991	3
Scenedesmus quadricauda		98.3	N	S	am		20		7d	EC50		>5600	1,2,3	Anonymous, 2004	3
Scenedesmus quadricauda		98.3		S	am		20		7d	ErC50	growth rate	>5600	3,10,11,12	Visser and Linders, 1992	3
Scenedesmus subspicatus		98.3	Y	S	am	7.3 (start); 8.6-9.7 (end)	23-24		72h	EC50	biomass	780	4,5,6,7,8	Anonymous, 2004	1
Scenedesmus subspicatus		98.3	Y	S	am	7.3 (start); 8.6-9.7 (end)	23-24		72h	EC50	growth	>1100	4,5,6,7,8	Anonymous, 2004	1
Scenedesmus subspicatus		50	Y	S	am	7.1-7.3 (start); 7.6-9.2 (end)	20-24		72h	EC50	biomass	650	4,6,7,8,9,10	Anonymous, 2004	1
Scenedesmus subspicatus		50	Y	S	am	7.1-7.3 (start); 7.6-9.2 (end)	20-24		72h	EC50	growth rate	>1700	4,6,7,8,9,10	Anonymous, 2004	1
Crustacea															
Daphnia magna	1st instar	50		S	rw	8	21	202	24h	EC50	immobility	19900	1,13	Visser and Linders, 1992	3
Daphnia magna		99.8	Y	S		7.9-8.1	20-21		48h	EC50	immobility	48000	1,4,5,7,8,14	Anonymous, 2004	3
Daphnia magna		50	N	S		8	21		24h	EC50	immobility	5200	1,2,5,15	Anonymous, 2004	3
Daphnia magna		50	Y	S		7.9-8.2	20-21	160	48h	EC50	immobility	30000	1,4,5,7,8,16	Anonymous, 2004	3
Pisces															
Brachydanio rerio	2.1cm	50		F	rw		20	21.5	96h	LC50	mortality	154400	1,17	Visser and Linders, 1992	3
Cyprinus carpio		99.8	Y	R		7.3-7.8		50-70	96h	LC50	mor/immo	2000	1	Crommentuijn et al., 1997	3
Cyprinus carpio	0.46g	99.8	Y	R	dtw	7.3-7.8	23	50-70	96h	LC50	mor/immo	1980	1,18	Visser and Linders, 1992	4*
Cyprinus carpio	4.5cm	50		S	rw	7.5	22	280.5	96h	LC50	mortality	333200	1,19	Visser and Linders, 1992	3
Lepomis macrochirus	0.48g	50		S	rw	7.52	22	45.5	96h	LC50	mortality	118000	,120	Visser and Linders, 1992	3
Oryzias latipes		99.8	Y	R		7.3-7.8		50-70	96h	LC50	mor/immo	2600	1	Crommentuijn et al., 1997	3
Oryzias latipes	0.36g	99.8	Y	R	dtw	7.3-7.8	23	50-70	96h	LC50	mor/immo	2610	1,18	Visser and Linders, 1992	4*
Oncorhynchus mykiss		99.8	Y	R		7.2-7.7		50-60	96h	LC50	mor/immo	790		Crommentuijn et al., 1997	2
Oncorhynchus mykiss	0.85g	99.8	Y	R	dtw	7.2-7.7	15	50-60	96h	LC50	mor/immo	790	18	Visser and Linders, 1992	4*
Oncorhynchus mykiss	8cm	50		S	rw	7.5	16	280.5	96h	LC50	mortality	211000	1,19	Visser and Linders, 1992	3
Oncorhynchus mykiss	0.85g; 3.75cm	99.8	Y	R	dw	7.2-7.7	15		96h	LC50	mortality	870	2,15,21	Anonymous, 2004	3
Oncorhynchus mykiss	5cm; 0.8-1.9 g	99.8	Y	F		6.5-7.6	11-13	42	96h	LC50	mortality	690	4,5,7,8,22	Anonymous, 2004	1
Oncorhynchus mykiss		50	N	S			11-13		96h	LC50	mortality	26000	1,8,15	Anonymous, 2004	3
Oncorhynchus mykiss	5cm; 0.8-1.9 g	50	Y	R		6.6-7.3	12-15	42	96h	LC50	mortality	>20000	1,4,5,7,8,23,24	Anonymous, 2004	3
Lepomis macrochirus	4.6g	50		S	rw	7.52	12	45.5	96h	LC50	mortality	52000	1,20	Visser and Linders, 1992	3
Lepomis macrochirus		50	N	S			21-22		96h	LC50	mortality	59000	1,8,15	Anonymous, 2004	3
Lepomis macrochirus	juveniles	99.8	Y	F		7.7-8	21-22		96h	LC50	mortality; behaviour	>720	4,5,8,25,26	Anonymous, 2004	1
Lepomis macrochirus	4-5cm; 0.9-2.4 g	50	Y	R		6.7-7.7	20-23	42	96h	LC50	mortality	>54000	1,4,5,7,8,27,28	Anonymous, 2004	3
Poecilia reticulata		99.8	Y	R		7.4-7.8		40-45	96h	LC50	mor/immo	3000	1	Crommentuijn et al., 1992	3
Poecilia reticulata	3w; 40mg	99.8	Y	R	dtw	7.4-7.8	23	40-45	96h	LC50	mor/immo	3000	1,18	Visser and Linders, 1992	4*

a According to Klimisch et al., 1997

Notes:
1 Far above solubility limits
2 Reliability according to DAR: 3
3 No exponential growth to be expected after 7 days.
4 Data protection claimed
5 According to GLP
6 Mean measured concentrations were 53-97% of nominal concentrations
7 Results based on mean measured concentrations
8 Reliability according to DAR: 1
9 Mean measured concentrations were 56-80% of nominal concentrations
10 According to OECD 201
11 According to NEN 6506
12 Highest concentration tested was 5.6mg/L due to solubility limits
13 According to AFNOR protocols
14 Measured concentrations were 56-71% of nominal values
15 Results based on nominal concentrations a.i.
16 Measured concentrations were 54-89% of nominal values
17 According to guidelines issues by the British Pesticides Safety Precautions Scheme
18 Results based on measured concentrations
19 According BBA guidelines
20 According EPA guidelines
21 Measured concentrations were 70-95% of nominal concentrations
22 Measured concentrations were 50-82% of nominal concentrations
23 Mean measured concentrations were 58-68% of nominal concentrations
24 20 mg/L was highest concentration tested but at 2.2 mg/L solubility was exceeded
25 Measured concentrations were 93-100% of nominal concentrations
26 720 ug/L was the highest concentration tested
27 54 mg/L was highest concentration tested
28 Mean measured concentrations were 53-65% of nominal concentrations

Table A2.18. Chronic toxicity of tolclofos-methyl to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [°C]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Algae															
Scenedesmus quadricauda		98.3	N	S					96h	NOEC	biomass	32		Crommentuijn et al., 1992	4*
Scenedesmus quadricauda		98.3		S	am		20		7d	NOErC	growth rate	5600	1,2,3	Visser and Linders, 1992	3
Scenedesmus quadricauda		98.3		S	am		20		7d	NOEbC	biomass	32	2,3	Visser and Linders, 1992	2
Scenedesmus quadricauda		98.3	N	S	am		20		7d	NOEbC	biomass	32	4	Anonymous, 2004	4*
Scenedesmus subspicatus		98.3	Y	S	am	7.3 (start); 8.6-9.7 (end)	23-24		72h	NOEC	biomass and growth rate	220	5,6,7,8,9	Anonymous, 2004	2
Scenedesmus subspicatus		50	Y	S	am	7.1-7.3 (start); 7.6-9.2 (end)	20-24		72h	NOEC	biomass and growth rate	310	2,5,6,8,9,10	Anonymous, 2004	2
Crustacea															
Daphnia magna		99.8	Y	F		7.4-8.1	20-21		21d	NOEC		26	6,8,9,11,12	Anonymous, 2004	1
Insecta															
Chironomus riparius	3d old	99.8	Y	S	nw	5.5-7.7	19-21	42	28d	NOEC		250	5,6,9,13,14,15,16	Anonymous, 2004	3
Pisces															
Oncorhynchus mykiss	eggs	50	Y (weekly)	F		8.0-8.7	9-11		97d	NOEC	growth	12	5,6,9,17,18,19	Anonymous, 2004	1

a According to Klimisch et al., 1997

Notes:

1 Far above solubility limits
2 According to OECD guideline 201
3 According to NEN 6506
4 Reliability according to DAR: 3
5 Data protection claimed
6 According to GLP
7 Mean measured concentrations were 53-97% of nominal concentrations
8 Results based on mean measured concentrations
9 Reliability according to DAR: 1
10 Mean measured concentrations were 56-80% of nominal concentrations

11 LOEC = 62 ug/L

12 Mean measured concentrations were 89-129% of nominal concentrations

13 According to OECD guideline 219

14 LOEC = 500 ug/L

15 Including sediment with 2.4% OC in a sediment: water ratio of 1:4; analysis revealed that all of the test substance in the water column degraded to metabolites, but that 80% of the substance bound to sediment stayed the parent compound

16 Results based on nominal concentrations a.i.

17 Measured concentrations were within 20% of nominal concentrations

18 Results based on measured concentrations

19 LOEC = 28 ug/L

Table A2.19. Acute toxicity of triazophos to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Cyanobacteria															
Anabaena flos-aquae		80	N	S	am		24		96h	EC50	growth	12745	1	Ma et al., 2004	2
Microcystis aeruginosa		80	N	S	am		24		96h	EC50	growth	13403	1	Ma et al., 2004	2
Microcystis flos-aquae		80	N	S	am		24		96h	EC50	growth	6164	1	Ma et al., 2004	2
Algae															
Scenedesmus subspicatus		92.1		S		7.7			96h	EC50	biomass	1430	2,3	Panman and Linders, 2001	2
Scenedesmus subspicatus		hostathion		S	am		25		72h	EC50	biomass	9100	4,5,6	Anonymous, 1993	2
Chlorella pyrenoidosa		80	N	S	am		24		96h	EC50	growth	30117	1	Ma et al., 2004	2
Crustacea															
Daphnia magna				S		7.7-7.8		91	48h	LC50	mor/immo	3		Crommentuijn et al., 1997	4*
Daphnia magna	1.2-1.4 mm					7.7-7.8	16	91	48h	LC50	immobility	3	7	Panman and Linders, 2001	2
Daphnia magna		Hostathion	N	S	70% tw; 30% dw				48h	LC50	mortality	1.3	3,6,8	Anonymous, 1993	2
Pisces															
Cyprinus carpio		40		S					96h	LC50	mortality	2240	9,10	Panman and Linders, 2001	2
Cyprinus carpio	1yr; 7-10cm	40		S			21		48h	LC50	mortality	180	11	Panman and Linders, 2001	2
Cyprinus carpio	4mo, 2.2-2.6g	hostathion	Y	S			22		96h	LC50	mortality	9000	12,13	Anonymous, 1993	2
Oncorhynchus mykiss		40		S					96h	LC50	mortality	16	9,14	Panman and Linders, 2001	2
Oncorhynchus mykiss		hostathion	Y	S					96h	LC50	mortality	38	12,15	Anonymous, 1993	2
Oreochromis niloticus	2wk, 1 inch			S	tw				48h	LC50	mortality	35	6	Tejada et al., 1994	2
Tilapia mossambica									96h	LC50	mortality	24		Anonymous, 1993	4
Amphibia															
Bufo calamita	larvae; 1.5-2cm	40		S			22		48h	LC50	mortality	8000-14000	11,16	Panman and Linders, 2001	3

a According to Klimisch et al., 1997

Notes:

1 Not clear if concentrations are based on a.i.
2 According to OECD guidelines
3 Results based on the assumption of 100% purity
4 Based on OECD guideline 201
5 GLP
6 Results based on nominal concentrations a.i..
7 Purity unknowm
8 According to OECD guideline 202

9 According to BBA guidelines
10 LC50 as nominal concentrations hostathion (5600 ug/L); recalculated into active ingredient
11 No information on water type and correction for purity or use of nominal concentration
12 According to OECD guideline 203
13 All measured values were above or very close to 80% of nominal values
14 LC50 as nominal concentrations hostathion (41 ug/L); recalculated into active ingredient
15 Measured concentrations were always >70% of nominal concentrations
16 Validity assigned by Panman and Linders: 3

Table A2.20. Chronic toxicity of triazophos to freshwater organisms.

Species	Species proper-ties	Purity [%]	A	Test type	Test water	pH	T [ºC]	HH [mg $CaCO_3$/L]	Exp. time	Criterion	Test endpoint	Value [ug/l]	Notes	Reference	Reliability index[a]
Cyanobacteria															
Anabaena flos-aquae		80	N	S	am		24		96h	NOEC	growth	2000	1,2	Ma et al., 2004	2
Microcystis aeruginosa		80	N	S	am		24		96h	NOEC	growth	5000	1,3	Ma et al., 2004	2
Microcystis flos-aquae		80	N	S	am		24		96h	NOEC	growth	1000	1,4	Ma et al., 2004	2
Algae															
Scenedesmus subspicatus		92.1	N			7.7-10			96h	NOEC	growth	100		Crommentuijn et al., 1997	4*
Scenedesmus subspicatus		92.1		S		7.7			96h	NOEC	growth	100	5,6	Panman and Linders, 2001	2
Scenedesmus subspicatus		hostathion		S	am		25		72h	NOEC	Biomass	1800	7,8	Anonymous, 1993	2
Chlorella pyrenoidosa		80	N	S	am		24		96h	NOEC	growth	2000	1,2	Ma et al., 2004	2
Crustacea															
Daphnia magna									21d	NOEC		0.32		Crommentuijn et al., 1997	4
Daphnia magna	1-24h old	hostathion	Y	S					21d	NOEC		0.01	8,9,10	Anonymous, 1993	2
Pisces															
Oncorhynchus mykiss									21d	NOEC		0.5		Crommentuijn et al., 1997	4*
Oncorhynchus mykiss	5mo; 2.3-5.5 g; 4.0-6.5 cm		Y	F					21d	NOEC		0.5	11,12,13	Anonymous, 1993	2

[a] According to Klimisch et al., 1997

Notes:

1 Not clear if concentrations are based on a.i

2 LOEC = 5000 ug/L

3 LOEC = 10000 ug/L

4 LOEC = 2000 ug/L

5 According to OECD guidelines

6 Results based on the assumption of 100% purity

7 Based on OECD guideline 201

8 GLP

9 Based on OECD guideline 202

10 Mean measured concentrations were above 80% of the nominal values

11 Following OECD guideline 204

12 Measured recovery of test substance was between 82.6 and 114.7%

13 LC50 = 10 ug/L

Appendix 3. Description of mesocosm studies

Azinphos-methyl

Emans et al., 1993

Validation of extrapolation methods was carried out by comparing NOECs derived from multiple-species (semi-) field experiments with extrapolated values. The validation was carried out using data of 29 compounds. This summary only focuses on the tests with azinphos methyl.

TEST DESIGN

An on-line literature search was performed and several research centers and chemical industries were asked for data. The experiments were evaluated using criteria derived from Touart (1988), Dortland (1980) and Persoone (1988):

1. A distinct concentration-effect relationship should be obtained
2. A reliable multi-species NOEC should be derived
3. Several taxonomic groups, in more or less natural ecosystems, should be exposed to one test concentration for a longer period.
4. In each experiment several concentrations should be tested, consisting of one control and at least two test concentrations.
5. Each test concentration should have at least one replica.
6. The concentration of the test compound should be measured several times during the experiment
7. Physicochemical parameters like pH, temperature and hardness should be measured
8. Apart from effect parameters like population density and biomass, effect parameters on higher integration levels such as species diversity and species richness should be measured.

These criteria were modified, because none of the experiments were performed in accordance with all criteria. Criteria 1, 2, 3 and 6, with additionally criteria no. 7 for metals, were considered to be the most important criteria.

Studies were classified as reliable, less reliable and unreliable. An experiment was classified as reliable if it was carried out according to all criteria or was missing one or two less important criteria. If one important or several less important criteria were missing, the experiment was classified as less reliable. An experiment was classified as unreliable if several important criteria were missing.

NOECs were only calculated for direct effects that influenced the population level, e.g. effects on growth, reproduction and survival. Indirect effects were not considered because for these effects often no concentration-effect relationship could be distinguished.

Chronic single species were sought and evaluated. If no chronic data were available for algae, crustaceans and fish, then acute toxicity data were sought.

Calculations and statistics

NOEC-values were estimated by means of three procedures:

1. Comparison of effect parameters in treated and control systems.
2. Determination of the actual concentration at the start of recovery of the most sensitive species. For that purpose the concentration of the compound immediately after the last application was determined. In addition, the time needed for recovery after the last application was determined. By means of the estimated half-life of the test compound, the concentration at the time of recovery was determined. This last concentration was regarded as the NOEC.
3. Derivation of a NOEC from a LOEC as follows:

- If LOEC showed 10 to 20% effect, the NOEC was LOEC/2
- If LOEC showed ≥ 20% effect and there was a clear concentration-effect relationship, the EC_{10} was extrapolated and considered to be the NOEC
- If LOEC showed ≥ 20% effect and there was no concentration-effect relationship, the NOEC was LOEC/3 in case of 20 to 50% effect and LOEC/10 in case of ≥ 50% effect.

The authors commended on the second procedure that the first-order kinetics was not always applicable. Moreover, the authors mentioned that recovery time could often only be estimated inaccurately. Additionally, the NOEC was estimated from a point in time at which recovery starts, so from a point in time at which effects did occur. Finally, it was mentioned to be known that population recovery does not necessarily occur when the concentration decreases below the NOEC, but can be restricted to specific periods in the season. For these reasons, the authors consider the NOEC derived by the second procedure as less reliable or unreliable.
The authors commended on the third procedure that this procedure is based on expert judgment and that the mentioned factors are not experimentally determined. NOECs obtained with this procedure had to be carried out according to slightly different criteria as described under point 3, i.e. a distinct concentration-effect relationship and the use of more than one test concentration are not strictly necessary. On the other hand, the effect of the lowest concentration should be lower than 50%.

The extrapolation methods developed by Aldenberg and Slob (1993), Wagner and Løkke (1991) and an OECD guideline were used for validation. The extrapolation method of Wagner and Løkke (1991) is a variant of Aldenberg and Slob (1993), with the exception that it assumes a log-normal distribution instead of a log-logistic one. The OECD method estimates an environmental concern level assuming constant differences between acute and chronic toxicity and between laboratory and field effects. These assessment factors are presented below:

Assessment factors applied to derive environmental concern levels, according to the modified EPA method.

Available information	Assessment factor
Lowest acute L(E)C50 value or QSAR estimate for acute toxicity	1,000
Lowest acute L(E)C50 value or QSAR estimate for minimal algae/crustaceans/fish	100
Lowest NOEC value or QSAR estimate for chronic toxicity	10
Lowest NOEC value or QSAR estimate for chronic toxicity for minimal algae/crustaceans/fish	10

Differences between NOECs and values calculated with the extrapolation methods, a model II regression procedure was performed. However, this method does not allow significance tests on the obtained values. For this reason, separate tests were performed for significance of correlation coefficients and for differences between means.

RESULTS
For azinphos methyl, a multi species NOEC could be obtained by the second and the third procedure from Dortland (1980). However, this study was considered to be less reliable. Endpoints analysed were chlorophyll, Gastropoda, Branchiopoda, Ostracoda, Copepoda and Diptera with Branchiopoda as most sensitive endpoints on which the NOEC was based and criteria were density and density recovery. NOEC derived by the second procedure was 0.25 µg/L and by the third procedure was 0.081 µg/L. Extrapolation according to Aldenberg and Slob (1993) resulted in a HC_5 of 0.085 µg/L with 50% confidence and a HC_5 of 0.015 µg/L with 95% confidence. The method of Wagner and Løkke (1991) resulted in a HC_5 of 0.074 µg/L with 50% confidence and a HC_5 of 0.018 µg/L with 95% confidence. The OECD method resulted in a NOEC of 0.01 µg/L.

Data gathered for all 29 substances were used to analyze consistency of multiple species NOECs and endpoints extrapolated by the three methods described in the Methods section. Correlations of multiple species NOECs were significant for both reliable and unreliable studies for Aldenberg and Slob (1993) with 95% confidence, for Wagner and Løkke (1991) with 95% confidence. Comparison of Aldenberg and Slob with Wagner and Løkke with multispecies NOEC showed that reliable and less reliable studies did not correlate significantly with Aldenberg and Slob (1993) and Wagner and Løkke (1991), both with 50%

confidence. Unreliable study NOECs correlated with both Aldenberg and Slob (1993) and Wagner and Løkke (1991) with 50% confidence at 0.05 significance level.

CONCLUSIONS FROM THE AUTHORS

Conclusions from the authors were not drawn at substance level. On basis of the results of the study, the authors saw no reason to believe that organisms differ in sensitivity under field and laboratory conditions. The reliability of both the second and third procedure to obtain a multispecies NOEC was found to be questionable.

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? Answer: unclear. The underlying study of Dortland (1980) was not evaluated in this article.
2. Is the description of the experimental set-up adequate and unambiguous? Answer: no. See answer above.
3. Is the exposure regime adequately described? Answer: no. See answer above.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Answer: no. See answer above.
5. Is it possible to evaluate the observed effects statistically? Answer: no. See answer above.

It is concluded that this article only can not be used for to estimate azinphos methyl toxicity, because underlying data of Dortland (1980) were not evaluated in the present article.

EVALUATION OF THE RESULTS OF THE STUDY

- Criteria to classify the studies were not clear. For instance, which criteria could be missed in order to still consider a study reliable?
- Indirect effects were not considered because for these effects often no concentration-effect relationship could be distinguished.
- From the study could not be extrapolated which criteria were not meet in order to classify the study of Dortland (1980) as a study with shortcomings or as less reliable.
- For the OECD method was not reported on basis of what data and assessment factors the NOEC was derived.

Since this article did not present the evaluation of the underlying field studies, the presented endpoints can not be judged on reliability. Therefore, this article can not be used for estimation of environmental risk.

Giddings et al., 1994

Guidelines

US EPA 1988

TEST DESIGN

The study was performed in ponds at the Kansas Aquatic Mesocosm Facility. Ponds were 20 by 20 m, resulting in 400 m^2, filled to a depth of 2 m. Sides of the ponds had a 2:1 slope, water volume was about 400 m^3.

Sediment originated from a nearby farm pond, water was aged pond water from a reservoir on site. Fifty adult bluegill sunfish (*Lepomis macrochirus*) with an average weight of 59 g were introduced. Sex of the bluegill was not determined. Ponds were allowed to develop for eight months. Dense macrophyte beds grew throughout the mesocosms. *Potamogeton* sp., *Chara* sp. and *Naja* sp. were the most dominant macrophytes in the ponds.

Application, concentrations, replicates

Azinphos methyl was applied as Guthion 35 WP (29% azinphos methyl), starting on July 19th, 1988. Control, 0.056, 0.28, 1.3, 6.7 and 34 µg Guthion/l. Application eight times at weekly intervals, treatments and control in duplicate. Simulation of Guthion application on cotton showed that Guthion would reach the surface water via runoff, not via drift. Therefore, Guthion was mixed in a tank with pond water and then pumped back at three points, entering the water just below the surface, 1 m from shore. Application took 4 hours, water circulation thereafter an additional two hours.

Biological observations

Zooplankton samples were taken every four weeks from November 1987 until April 1988 and at weekly intervals thereafter. Sampling by vertical hauls with 20 cm diameter 80 µm mesh plankton nets, one tow in shallow zone and one tow in deep zone per mesocosm. Counting and identification using a zooplankton counting wheel.

Benthic sampling with a 230-cm^2 Ekman dredge twice per month. Three samples per location (one shallow and one deep per pond). Samples per location were combined, counted and identified.

Emerged adult insects were collected weekly sing semi-submerged inverted funnel traps with a 75 * 75 cm base. Per pond one trap in the shallow area and one trap in the deep area.

Emergence of odonates and some other insects, which normally emerge by crawling out of the water on a solid surface, vertical screens of 0.75 m^2, extending approximately 30 cm above the water surface, were placed in shallow water near the north and south shore of each mesocosm. Exuviae were removed from the screens on weekly basis.

Four baited minnow traps per pond were placed for 24 hours, three to seven times per week, beginning half of July 1988. Fish were weighed, measured and returned to their pond. At test termination, fish were dissected to determine their sex.

Environmental conditions

Not evaluated.

Verification of concentrations

Periodically sampling of water and sediment for analysis of azinphos methyl and its oxygen analog. Water samples were taken at different depths, were composited and extracted by chloroform partition. Extracts were evaporated to dryness, redissolved and analysed by HPLC.

Sediment samples were of 5 cm deep were collected from each quarter of the pond with a coring device. Samples were frozen before analysis. Azinphos methyl and its oxygen analog were extracted from the sediment by refluxing with 50% methanol and 50% dichloromethane. Extract was partitioned with dichloromethane, dried through sodium sulfate and evaporated to dryness. Residues were dried down, submitted to silica gellcolumn chromatography and residues were collected. Residues were dissolved in acetonitrile:water and analysed by HPLC. Recovery of from quality control samples were 70 to 120%. Reported concentrations were not corrected for QC recovery. LOD was 0.02-0.04 µg/l in water and 25 µg/kg in sediment for both azinphos methyl and its oxygen analog.

Physical en chemical analyses

Temperature, conductivity, dissolved oxygen, pH, harndess alkalinity, suspended solids, total Kjeldahl nitrogen and total phosphorus. Frequency of measurements were not reported.

Calculations and statistics

Williams' Test and linear regression. Ln-transformation of abundances and of mean actual concentrations. Fish survival, length and weight were not transformed.

Linear regression was performed on the portion of the exposure gradient where the exposure-response relationship was the strongest. The resulting regression equation was then used to estimate the EC$_0$.

RESULTS

Chemical analysis

Azinphos methyl concentrations in water declined rapidly after application, i.e. more than 90% within a week. Half-life ranged from 1 to 2 days. Peak concentrations in the two replicates of the highest treatment level were 22 and 26 µg product/L. After six days, concentration in the two replicates of the highest treatment was 4.8 and 1.8 µg/L, corresponding to 15 and 7% of the peak concentration, respectively. Actual concentrations in the water column were summarized as follows:

Azinphos methyl concentrations in the water phase. This table is copied from the original article.

Azinphos methyl concentration (µg/l)		
Nominal concentrations[a]	Mean peak[b]	55-day average[c]
0.056	0.054	0.023
0.056	0.055	0.027
0.28	0.19	0.078
0.28	0.24	0.13
1.3	0.89	0.29
1.3	1.0	0.45
6.7	4.2	1.2
6.7	6.2	3.1
34	26	10
34	33	16

[a]: expected concentration immediately after each application
[b]: mean of eight peak concentrations measured with 4 hours after each application
[c]: calculated by integrating the area under the concentration vs. time curve for each pond

Physical en chemical analyses

No results were presented.

Fish

Fish began reproducing before the first application. No fish were trapped from any of the three highest dosed mesocosms (average ≥ 3.1 μg as/l), but in all other cosms. During August, the 3 to 4 cm size class was the most frequently trapped in the controls and lower dosed mesocosms (≤ 0.13 μg/l) and the 2 to 3 cm class in the higher dosed mesocosms (0.29 to 1.2 μg/l). Juveniles longer than 4 cm were trapped only in mesocosms with mean concentrations of ≤ 0.13 μg/l. In September and October, the 3 to 4 cm size class was the most frequently trapped size class at ≤ 1.2 μg/l. Dead adult and juvenile fish were observed within two days in the cosms with mean actual concentration of ≥ 1.2 μg as/l. After the second application dead adults also appeared at 0.45 μg as/l. At the end of the treatment period, 36 to 40 dead adults had been collected from the three cosms with the highest actual concentrations, eight dead from the cosm with 1.2 μg/l average concentration, 7 from the 0.45 μg/l cosm and one from one of the control cosms. Findings after drainage in November are presented below:

Numbers, lengths and weights of bluegill sunfish collected after test termination. Table copied from the original article.

Nominal	Control	Control	0.056	0.056	0.28	0.28	1.3	1.3	6.7	6.7	34	34
Mean peak	0	0	0.054	0.055	0.19	0.24	0.89	1.0	4.2	6.2	26	33
Mean actual	0	0	0.023	0.027	0.078	0.13	0.29	0.45	1.2	3.1	10	16
Number of adults	44	39	36	38	37	39	42	23	1[s]	0[s]	0[s]	0[s]
Adult biomass (g)	3,377	2,909	2,795	2,890	3,059	3,270	3,051	1,567	107[s]	0[s]	0[s]	0[s]
Average adult weight (g)	77	75	78	76	83	84	73[s]	68[s]	107			
Average adult length (cm)	15.6	15.9	15.6	15.6	16.2	16.0	15.2[s]	15.1[s]	17.5			
Number of juveniles	7,869	9,213	7,050	6,135	11,932	7,902	14,307	9,589	4,248[s]	0[s]	0[s]	0[s]
Juvenile biomass	1,017	1,917	2,275	1,363	1,989	1,270	2,375	1,297	882	0[s]	0[s]	0[s]
Average juvenile weight (g)	0.13	0.21	0.32	0.22	0.17	0.16	0.17	0.14	0.21			
Average juvenile length	2.15	2.32	2.92	2.33	2.22	2.14	2.24	2.02	2.36			

(cm)												
Total biomass (g)	4,394	4,826	5,070	4,253	5,048	4,540	5,426	2,864	989 ^{s}	0 ^{s}	0 ^{s}	0 ^{s}

^{s}: significantly different from the control

Estimated EC_0 values were 0.20 µg/l for adult umber, 0.17 µg/l for adult biomass, 0.29 µg/l for total biomass, 0.64 µg/l for juvenile number and 0.58 µg/l for juvenile biomass.

Zooplankton

During the treatment period, rotifers and copepods dominated the controls, cladocerans were relatively scarce. Copepod abundance increased significantly on the 8th of August the four highest treatments, on the 22nd of August in the two highest treatments, in the six highest treatments on the 5th of September, in four highest on the 19th of September, in no treatment on the 3rd of October and in the two highest treatments on the last sampling occasion (17th of October).

Abundances of cladocerans were similar to the control in all treatments for the whole testing period. Exceptions were the first samplings after application (25th of July) in which significant differences were found for the two highest treatments. However, at that sampling period one and four individuals were found in the controls and in both the two highest treatments no individuals were found. Another exception is the last sampling period in which higher abundances compared to the control were found in the 0.29, 0.45, 1.2, 3.1, 10 and 16 µg/l treatments. The authors report that cladocerans data suggest that Guthion concentrations of at least 3.1 µg/l (mean) affect this taxa.

Rotifers were significantly affected in any of the treatments.

EC_0-values could not be calculated due to no consistent exposure-response trends.

Macroinvertebrates

Pond insect communities were dominated by dipterans. Significant reductions in dipteran densities in the two highest treatments were observed. EC_0-values were 1.26 µg/l for benthic dipterans and 1.43 µg/l for emergent dipterans. Most abundant dipterans were the Chironomidae. Chironomidae and Chironomini were significantly lower in the two highest treatments compared to the controls. EC_0-values for benthic Chironomidae were 1.23 µg/l and 0.61 µg/l for emergent Chironomidae. For Chironomini, EC_0-values were 0.91 µg/l for benthic sampled species and 0.26 µg/l for emergence traps species.

Ceratopogonidae were most abundant in the ponds exposed to 1.2 and 3.1 µg/l and least abundantn in ponds exposed to 10 and 16 µg/l. The EC_0-values for Ceratopogonidae were 0.98 µg/l for the benthic samples and 7.74 µg/l for the emergence traps.

Abundances of benthic and emergent ephemeropterans were significantly reduced in the 10 and 16 µg/l cosms. The EC_0-values for ephemeropterans were 0.59 and 1.19 µg/l, respectively.

Odonates occurred in emergent samples, but rarely in benthic samples. A dose-response relationship was found for odonates abundance, but no significant differences between controls and treatments were found. The EC_0-value for emergent odonates was estimated to be 16.7 µg/l.

Abundance of snails was higher in treatments of $\geq$ 0.29 µg/l.

Conclusions from the authors

The authors found that no EC_0-values or significant reductions occurred at $\leq$ 0.13 µg/l. At 0.29 µg/l, the EC_0-values were exceeded for adult bluegill growth and for two major insect taxa, while abundances of snails and copepods increased. At 1.2 µg/l, effects were found to be evident for adult and juvenile bluegill and for most insect taxa. The lowest LOEC for Guthion was found to be 0.29 µg/l on basis of mean actual concentration. The effects of Guthion were summarized as follows:

Summary of the effects of Guthion. Table is copied from the original article.

Nominal (µg/l)	1.3	1.3	6.7	6.7	34	34
Mean peak	0.89	1.0	4.2	6.2	26	33
Mean actual	0.29	0.45	1.2	3.1	10	16
Adult bluegill number, biomass	↓	↓	↓	↓	↓	↓
Juvenile bluegill number, biomass			↓	↓	↓	↓
Cladocerans				?	↓	↓
Rotifers						?
Copepods	↑	↑	↑	↑	↑	↑
Dipterans benthic					↓	↓
Dipterans emergent					↓	↓
Chironomidae benthic					↓	↓
Chironomidae emergent					↓	↓
Chironomini benthic					↓	↓
Chironomini emergent			↓	↓	↓	↓
Pseudochionomini benthic			↓	↓	↓	↓
Tanytarsini emergent			↓	↓	↓	↓
Ceratopogonidae benthic						
Ceratopogonidae emergent						
Ephemeropterans benthic					↓	↓
Ephemeropterans emergent					↓	↓
Odonates emergent					?	?
Snails benthic	↑	↑	↑	↑	↑	↑

↑↓: significantly different from the control. ?: presumed negative effect, based on conservative interpretation of data.

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? Answer: yes. The period in which the test systems were allowed to reach equilibrium was relatively long (eight months).
2. Is the description of the experimental set-up adequate and unambiguous? Answer: yes. However, analytical method was not mentioned.
3. Is the exposure regime adequately described? Answer: yes.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Answer: unclear. Azinphos methyl is an insectide and invertebrates are included in the test. However, fish are added as well, which may have suppressed effects on the invertebrates.
5. Is it possible to evaluate the observed effects statistically? Answer: no. However, most statistical results are presented.

Evaluation of the results of the study

- Phytoplankton was not assessed.
- Environmental conditions were not reported
- The EC_0-values were estimated by performing linear regression was performed on the portion of the exposure gradient where the exposure-response relationship was the strongest. The resulting regression equation was then used to estimate the EC_0. This procedure is considered to be sensitive to personal choices. In view of the figures presented in the article, the resulting EC_0-values seem to have very low confidence.
- Azinphos methyl is an insecticide. Invertebrates are expected to be affected by this substance. Introduction of fish may have biased test outcome.
- Effects on zooplankton are considered to be indirect (increase in abundance, probably due to reduced predation pressure.
- Effects on macroinvertebrates are considered to be direct. However, statistics on macroinvertebrate taxa are performed on abundances summed for the entire treatment and post treatment interval.

Below, the effects as reported by the authors are presented. Effects on fish variables and on macroinvertebrates are based on effects observed at the end of the study and on mean abundance during the whole study period. If effects on these variables are seen, it can not be excluded that effects have phased out at test termination. Therefore, effects on these variables are classified as class effect 4.

Summary of effect classes observed for several categories of endpoints in the outdoor enclosure study treated with azinphos methyl. Effect classes are applied after de Jong et al. (2006).

	Treatment levels									
Nominal	0.056	0.056	0.28	0.28	1.3	1.3	6.7	6.7	34	34
Mean peak	0.054	0.055	0.19	0.24	0.89	1.0	4.2	6.2	26	33
Mean actual	0.023	0.027	0.078	0.13	0.29	0.45	1.2	3.1	10	16
<u>Zooplankton</u>										
Copepods	1	1	1	1	2-3A↑	2-3A↑	3A↑	3A↑	4↑	4↑
Cladocerans	1	1	1	1	4↑	4↑	4↑	4↑	4↑	4↑
Rotifers	1	1	1	1	1	1	1	1	1	1
<u>Macroinvertebrates</u>										
Dipterans benthic	1	1	1	1	1	1	1	1	4↓	4↓
Dipterans emergent	1	1	1	1	1	1	1	1	4↓	4↓
Chironomidae benthic	1	1	1	1	1	1	1	1	4↓	4↓
Chironomidae emergent	1	1	1	1	1	1	1	1	4↓	4↓
Chironomini benthic	1	1	1	1	1	1	1	1	4↓	4↓
Chironomini emergent	1	1	1	1	1	1	4↓	4↓	4↓	4↓
Pseudochionomini benthic	1	1	1	1	1	1	4↓	4↓	4↓	4↓
Tanytarsini emergent	1	1	1	1	1	1	4↓	4↓	4↓	4↓
Ceratopogonidae benthic	1	1	1	1	1	1	1	1	1	1
Ceratopogonidae emergent	1	1	1	1	1	1	1	1	1	1
Ephemeropterans benthic	1	1	1	1	1	1	1	1	4↓	4↓
Ephemeropterans emergent	1	1	1	1	1	1	1	1	4↓	4↓
Odonates emergent	1	1	1	1	1	1	1	1	?	?
Snails benthic	1	1	1	1	4↑	4↑	4↑	4↑	4↑	4↑
Lepomis macrochirus[a]										
Number of adults	1	1	1	1	1	1	4↓	4↓	4↓	4↓
Total adult biomass	1	1	1	1	1	1	4↓	4↓	4↓	4↓
Adult weight and length	1	1	1	1	4↓	4↓				
Number of juveniles	1	1	1	1	1	1	4↓	4↓	4↓	4↓
Total juvenile biomass	1	1	1	1	1	1	1	4↓	4↓	4↓
Juvenile weight and length	1	1	1	1	1	1				
Most sensitive endpoint	1	1	1	1	4↓↑	4↓↑	4↓↑	4↓↑	4↓↑	4↓↑

?: presumed negative effect, based on conservative interpretation of data

The peak concentrations mainly caused the casualties among fish in the treatments. Mortality among fish caused a positive response on zooplankton taxa and snails. Negative effects were observed on macroinvertebrates. However, only statistics on mean abundance per taxa were performed and no statistics per sampling period. Therefore, as worse case it is assumed that effects on macroinvertebrates lasted until the end of the experimental period.

NOEC of the present study is the treatment with a mean peak of 0.24 µg/l and mean actual concentration of 0.13 µg/l during the application period. The NOEC of 0.13 µg/l can be used for chronic exposure (i.e. 55 days).

<u>Stay and Jarvinen, 1995</u>

Results from the mixed flask culture (MFC) microcosms were related to littoral enclosure studies and fish toxicity tests. The littoral enclosure studies are reported to be described elsewhere (for azinphos methyl in Knuth et al (1992). The present evaluation only focuses on the microcosm experiments.

TEST DESIGN

Mixed flask culture (MFC) microcosms were prepared by adding 50 ml of stock culture of organisms to 950 ml of media. Stock culture was a culture of organisms collected from a natural community which was acclimated to experimental conditions in 37 l aquaria for at least two months. Each microcosm was reinoculated weekly with 10 ml of stock culture to simulate refugia. The MFC microcosms did not contain any fish.

Application, concentrations, replicates

Single application of azinphos methyl. Control, 0.05, 0.2, 0.8, 2.0, 8.0, 20.0 and 50.0 µg/l. Five replicates for the control and each treatment.

Biological observations

Net primary productivity (P) and dark respiration (R) were estimated by the amount of DO change during the 12-h light and 12-h dark periods, respectively. Production/respiration (P/R) ratios were calculated using 12 h net productivity and 12 h dark respiration.

Zooplankton counts were performed on samples taken on days 1, 2, 3, 5, 7, 10, 14, 21, 28, 35 and 42 after pesticide addition.

Verification of concentrations

Analyses according to Knuth et al, 1992.

Physical en chemical analyses

Measurements of DO and pH, frequency not reported.

Calculations and statistics

Because variance was not constant among replicate enclosures, before and after treatment comparisons were used to determine change.

Dunnett's procedure to determine significant differences between controls and treatments.

RESULTS

Chemical analysis

Results were not reported. Only a half-life of azinphos-methyl in the microcosms greater than two days was reported. In a table it was reported that over 27% loss of azinphos-methyl from the water phase in 48 h occurred.

Physical en chemical analyses

No results were presented.

Zooplankton

Effects on zooplankton are described only briefly and summarized accordingly. Below the table summarizing zooplankton effects is copied from the original article.

Table summarizing zooplankton effects after azinphos methyl application. This table is copied from the original article.

Effect category	µg/l	Microcosm response
NOEC	0.2	No significant change in any response variable
LOEC (most sensitive group)	0.8	Slight, but significant reduction in cladoceran populations
LOEC (less sensitive group)		
Amphipods	2.0	Populations reduced slightly followed by rapid recovery
Copepods	8.0	Populations increased by 100%, recovered to control levels by day 42
Ecosystem processes	<50	No effect on primary populations, respiration or P/R ratio
Major changes in predominant groups		
Amphipods	8.0	Populations almost eliminated (>95%)
Cladocerans	2.0	Populations almost eliminated (>95%), no recovery
Copepods	20	Populations increased by 400%, recovered to control levels by day 42
Ecosystem processes	>50	No major changes in primary production, respiration, or P?R ratio
Catastrophic changes	20	Most invertebrates reduced >95%; copepods reach maximum densities
Persistence of toxicant		Over 27% loss of azinphos-methyl from the water phase in 48 h

Conclusions from the authors

The NOEC was concluded to be the 0.2 µg azinphos methyl/l treatment and the LOEC the 0.8 µg/l treatment. However, the small magnitude of change that occurred at 0.8 µg/l suggests that the true NOEC would be at concentrations much closer to 0.8 µg/l than to 0.2 µg/l.

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? Answer: unclear. The cosms are small of size. Moreover, taxa are not further specified in the report. Also, it is unclear if the inoculations before test start resulted in a stable community.
2. Is the description of the experimental set-up adequate and unambiguous? Answer: no. Sampling frequencies are not reported.
3. Is the exposure regime adequately described? Answer: no. Method of application is not reported, sampling frequencies are not reported and LOD or LOQ are not reported. However, LOD or LOQ might be found elsewhere (i.e. Knuth et al, 1992).
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Answer: yes. Azinphos methyl is an insectide and invertebrates are included in the test.
5. Is it possible to evaluate the observed effects statistically? Answer: no. No rough data were presented.

Evaluation of the results of the study

The results presented in the article could not be reproduced, because no rough data were presented. Therefore, no dose-effect relationships could be evaluated as well as the course of effects in time. Moreover, no figures on actual concentrations were given, only an order of magnitude of degradation rate (i.e. half-life > 2 days in the water phase and > 27% loss of azinphos methyl within 48 hours).

The description of the degradation rate suggests that degradation of azinphos methyl was rapid. Therefore, this study can not be used for EQS-derivation for chronic exposure, but only for acute exposure.

The acute NOEC and LOEC (nominal concentrations of 0.2 and 0.8 µg/l, respectively) can only be based on the data presented in the table copied from the article presented above. These effect concentrations should be used with outmost care within environmental quality standard setting, because of above mentioned reasons.

Tanner and Knuth, 1995

Guidelines

Not referred to.

TEST DESIGN

Adult bluegills were exposed to a single application of azinphos methyl in littoral enclosures situated in the littoral zone of a 2-ha mesotrophic pond located in Northern Minnesota. Enclosures were 5 x 10 m; two blocks of six each. Enclosures were built using three plastic walls with the natural shoreline constituting the fourth side (8th of May). Enclosures extended from the natural shore to about 1.3 m depth and had a mean water depth of 0.72 m and a mean water volume of 37 m^3.Enclosed aquatic vegetation consisted primarily of *Typha* sp., *Chara* sp., *Najas flexilis*, *Potamogeton natans*, *Potamogeton foliosus* and *Potamogeton pusillus*. Sediment was characterized by unconsolidated and highly organic material. For additional information concerning the design and construction of littoral enclosures is referred to several references. After installation of the enclosures, native fish were removed with minnow traps. Adult bluegills were commercially obtained and sexed. Eight males and eight females were randomly assigned to the enclosures (22nd of May). Fish that died were replaced until 10th of June. Ten spawning substrates per enclosure were placed before the addition of the bluegills. Spawning substrates were black plastic pans filled with gravel and were placed in the sediment.

Application, concentrations, replicates

Single application of azinphos methyl (11th of July) in the form of Guthion 2S (238 g as/l EC) over the entire surface of the enclosures with a hand-pressurized sprayer. Control, 1.0 and 4.0 µg/l. Four replicates for the control and for both treatments.

Biological observations

Daily observation of behavior. Hatchability was assessed by placing a watch glass in the center of the spawning substrates to obtain subsamples of the embryos. Viability and time of swim-up were determined by siphoning a few of the larvae from the center of the nest.

Free swimming young-of-year were sampled weekly with diphnets (500 to 1000 µm). These individuals were used for determination of total length and wet weight. Male and female ratio was determined at test termination as well as young-of-year and adult length and wet weight.

Zooplankton was sampled approximately on weekly basis using inverted funnel traps, four traps per enclosure, 24-h sampling period. Samples were counted for Cladocera, Copepoda, Ostracoda, Protozoa, Hydrachnida and Rotifera.

Environmental conditions

Mean alkalinity 97 mg/l, mean pH 8.0.

Verification of concentrations

Depth-integrated samples were taken after 1 h and after 1, 2, 4, 8 and 22 days after application. Analysis by GC after extraction with 20% dichloromethane: 80% hexane. LOD 0.24 µg/l, LOQ 0.42 µg/l, recovery was 94.4 ± 22.0%. Mean relative percentage difference of enclosure duplicate samples was 11.1 ± 3.7%. The CV for the 1.0 and 4.0 µg/l treatment was 14.3 ± 10.6% and 20.5 ± 3.45%, respectively.

Physical en chemical analyses

Water temperatures were recorded daily and dissolved oxygen on weekly basis.

Calculations and statistics

Larval growth is described by linear regression. Growth was determined from the exposnential regression of wet weight relative to days after embryo hatch. Means of regression slopes for each treatment were compared by means of ANOVA. Larvae from the first and second spawning periods were used in these regressions. Larvae from the third and fourth spawning periods were not used because they were much younger and comprised only 1 % of the total biomass.

Spawning was expressed as percentage change in spawning before and after treatment. Zooplankton was analysed by two-way ANOVA to determine treatment and block effects for all dates sampled. Tukey's HSD procedure was used to compare all pairs of treatment means.

RESULTS

Chemical analysis

Maximum azinphos methyl concentrations were measured after 1 hour, i.e. 114.5 and 121.2% of nominal at 1 and 4 µg/l, respectively. Concentrations decreased to levels below LOQ after 4 and 8 days, resulting in half-lives of 2.3 and 2.4 days and DT_{95}'s of 10.0 and 10.4 days, respectively. Maximum actual concentrations (after 1 h) ranged from 0.95 to 1.46 µg/l in the 1 µg/l enclosures and from 4.36 to 6.01 µg/l in the 4 µg/l enclosures.

Physical en chemical analyses

Not reported.

Fish

Behavioural effects at 4 µg/l after 24 hours after application were coughing, rolling and darting swimming movements. Overall lightening or darkening of body coloration was observed. After 48 hours, one each fish was found in both a 1 and 4 µg/l enclosure.

Spawning occurred in all enclosures except in one enclosure of 1 µg/l. Bluegills spawned from June 8th to August 2nd with the majority (68%) spawning from June 18th to June 27th. The greatest reduction after treatment occurred in the 4 µg/l enclosures (90%), followed by the controls (60%) and the 1 µg/l treatment (30% reduction). The following table presented data on spawning, hatching success and male:female ratio.

Number of bluegill spawnings, range of spawning dates, hatching success and male:female ratio. Table is adapted after a table in the original article.

	Number of spawnings (number of nests)		Range of spawning dates	Mean percentage of embryo hatching	Male:female ratio
Treatment	Before application	After application	(day/month)	(range)	
Control	1 (1)	2 (1)	26/6-2/8	33 (0-100)	2:13
Control	1 (1)		26/6	17 (17)	8:5
Control	1 (1)	1 (1)	19/6-27/6	92 (92)	4:4
Control	1 (1)		26/6	20 (20)	5:11
1.0	0				7:6
1.0	3 (3)	1 (1)	26/6-17/7	48 (0-88)	11:6
1.0	2 (2)	2 (2)	19/6-17/7	40 (6-70)	5:7
1.0	1 (1)	1 (1)	27/6-18/7	83 (66-100)	7:9
4.0	4 (3)	1 (1)	19/6-16/7	30 (6-94)	10:7
4.0	1 (1)		25/6	24 (24)	5:7
4.0	2 (2)		25/6-27/6	66 (35-97)	12:3
4.0	3 (2)		8/6-19/6	72 (72)	5:9

Larval growth rates varied as much within treatments as among treatments. Means of length and weight regression slopes of the treatments were not significantly different from those of the control.
Young-of-year biomass varied between blocks, treatments, enclosures and spawning periods. The first block of enclosures had a much lower total biomass (25.2 g) than the third block (226.4 g). Each of the control enclosures' total biomass was higher than all treated enclosures. Exception was an enclosure at 4 µg/l where total biomass was higher than most of the controls. This specific enclosure had the highest measured 1-h actual concentration, i.e. 6.0 µg/l. Total biomass of controls was not significantly different from the treatments.

Cladocerans, copepods (adults, copepodites, nauplii) and rotifers exhibited a succession of population peaks and only nauplii numbers were significantly reduced by treatment. Copepod nauplii were significantly reduced at 1 and 4 µg/l compared to the control one week after pesticide application.

Conclusions from the authors
Azinphos-methyl were found to not have caused any significantly long-term effect on bluegill reproduction, embryo hatchability, larval survival until swim-up, year-of-young growth and total biomass. Absence of long-term effects was explained by the brief period of exposure.

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? Answer: unclear. Native fish were removed from the enclosures and adult bluegills were introduced on the 22nd of May. Pesticide application took place on the 11th of July. From the pictures on zooplankton can not be concluded that between these two dates, a stable community was reached. PRC-analysis would have aided the evaluation of equilibrium state before pesticide application.
2. Is the description of the experimental set-up adequate and unambiguous? Answer: yes.
3. Is the exposure regime adequately described? Answer: yes.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Answer: unclear. The focus of the study was on the introduced fish. Zooplankton was identified at high taxonomic level.

5. Is it possible to evaluate the observed effects statistically? Answer: no. No rough data were presented. Data were evaluated by means of complex statistics, but not with PRC.

Evaluation of the results of the study

From the short half-life of azinphos-methyl in the present study can be concluded that the study can be used for short-term exposure, but not for chronic exposure EQS-derivation.

The results presented in the article could not be reproduced, because no rough data were presented. However, on basis of figures made for zooplankton taxa can be concluded that effects were consistent among treatment replicates.

For the experiment, native fish were removed from the enclosures and a non-native species (bluegills, *Lepomis macrochirus*) was introduced. From this species was reported that these are more sensitive to azinphos-methyl, responds faster and recover more slowly than other fish species. This was concluded from a study originating from 1961 and can not be validated from available toxicity tests.

Azinphos methyl is an insecticide. Invertebrates are expected to be affected by this substance. Introduction of fish may have biased the test outcome.

Effects on fish were not statistically founded, due to great data variation or small numbers of observations. Effects on copepod nauplii at 1 and 4 µg/l one week after pesticide application were the only effects significantly underpinned. Therefore, the NOEC of the present study is considered to be below the lowest tested concentration (nominal concentration 1.0 µg/l), which can be used for EQS-derivation for short-term exposure.

Dortland, 1980, chapter 6: Model ecosystems (MES) studies

Outdoor cosm experiments were performed spread over two consecutive years with parathion and azinphos methyl. The present evaluation only focuses on the results of the azinphos-methyl treatment.

Guidelines

Not referred to.

TEST DESIGN

Four plastic containers were dug into the soil. Three containers were made of polythene and were 3x1x1 m. The fourth container was made of transparent Perspex and was 2.7x0.87x0.9 m.

The top of the containers was covered with wire-nettings with mesh size 11 mm. A sediment layer of 0.1 m was introduced and was collected from a watercourse without significant urban influences (Tutenburgse Wetering). Before introduction, the material was sterilized for one day by steaming under a sheet.

Subsequently, the containers were filled with tap water, originating from deep groundwater. The polythene containers were filled in October 1975, the Perspex one in August 1976. Three weeks later *Elodea nuttallii*, *Ceratophyllum demersum*, *Callitrich* sp., *Potamogeton crispus* and *Potamogeton berchtoldii* were introduced. Snails, leeches, flatworms and oligochaete worms were introduced through the plant material. The containers were inoculated with microorganisms, small crustaceans, etc., by introducing 2 l fresh bottom sludge.

In each subsystem four cylinders of stainless-steel wire-netting were placed upright in the water and partially sunk into the bottom. These wire-netted cylinders were used for sampling of water and zooplankton.

All four containers were divided into two subsystems at the start of the treatment period which lasted from the half of May to the half of August. Observations were made until half of October.

Application, concentrations, replicates

The experiment was partly performed in 1977 and partly in 1978. In 1977, one cosm was treated with azinphos-methyl to reach a final concentration of 1 µg/l and six other cosms were controls (one other cosm was treated with parathion). In 1978, two cosms were treated with azinphos-methyl against three controls (the remaining cosms were again treated with parathion).

The insecticide was equally distributed over the water surface and thoroughly mixed. A constant insecticide concentration was maintained by sampling the water column twice per week for chemical analysis. From these analyses was calculated how much of the active ingredient had degraded and how much should be added to reach the initial concentration again. Chemical analyses and adding of pesticide took place twice a week.

Biological observations

Macrophytes were assessed at the end of May, half-way of August and at the end of October. Covering percentage in both the floating and submerse layer was estimated.

The wire-netted cylinders prevented that macrophytes developed dense vegetation over the whole area. Without the cylinders, repeated sampling would have resulted in a permanently suppressed layer of water plants. As an extra advantage, the author mentioned that the cylinders created open spots, thereby creating a higher diversity of niches. For sampling of zooplankton, a 1-m long, 44 cm i.d. Perspex tube was rapidly sunk into the cylinder. A zooplankton sample of a subsystem was made up of six subsamples. Zooplankton samples were sieved over a net with mesh 55 µm and counted.

Macrofauna was assessed at the start of both rounds of experiments, i.e. in November 1976 and 1977. At that time, half of the vegetation of the cosms was removed to prevent the vegetation becoming choked the year following, as well as to simulate the cleaning regime normally carried out in ditches in the Netherlands. The aquatic plants collected in this way were then searched for macrofauna, which were subsequently identified and counted.

Environmental conditions

Not reported.

Verification of concentrations

Analysis by GLC.

Physical en chemical analyses

Daily analysis of pH, dissolved oxygen and minimum and maximum temperature. Every two weeks measurement of total PO_4, orthoPO_4, NO_3, hardness as CaO and HCO_3. Monthly analysis of NO_2, NH_4, Ca, Mg, K and Cl. Chloride was measured every two months and conductivity twice a year.

Calculations and statistics

Not reported.

RESULTS

Chemical analysis

Average actual concentration in the period of 25th of April to 15th of August, 1977 was 0.81 µg/l. As incidental extremes were three events reported in which concentrations of 1.2, 1.2 and 1.1 µg/l were measured. In 1978, average actual concentration was 0.61 µg/l in the period of the 30th of May to the 18th of August, 1978. As incidental extremes, three events were reported, i.e. 0.10 and 1.1 µg/l and one undetectable concentration.

Azinphos-methyl concentrations were reported, sampled inside the cylinder and between vegetation, six hours after pesticide application. On the 15th of July 1977, actual concentrations were reported measured in samples taken on the 15th of July 1977 and on the 9th of August 1977 between the vegetation or inside the cylinder. Actual concentrations on the 15th of July 1977 were 0.98 and 0.80 µg/l inside the cylinder and between the vegetation, respectively. Actual concentrations on the 9th of August 1977 were 0.94 and 0.92 µg/l, respectively.

Also, a vertical distribution of substance is reported to be measured, on the 25th of October 1977. Actual concentration on that day was 0.26 µg/l in the “lower part water column”, 0.25 µg/l in “the upper part water column” and 0.26 µg/l in the “total water column”. Specification of lower part and upper part is not given.

Calculated half-lives were 168 ± 50 hours in 1977 and 68 ± 34 hours in 1978, corresponding to 7 and 2.8 days, respectively.

Physical en chemical analyses

Average pH of all cosms ranged between 7.6 and 9.5 in 1977 and between 8.0 and 9.3 in 1978. Differences in pH were found to be generally small. The pH in the treated subsystem was lower on one sunny day compared to the control (20th of July 1977), but similar between subsystems two other sunny days (4th of July 1977 and 31st of May 1978).

Minimum temperature was 12.9-13.3 in 1977 and 12.9-13.2 in 1978. Maximum temperature was 15.0-16.7 in 1977 and 14.7-15.6 in 1978. The lower temperatures were found in cosms shaded by beech-hedges or by duckweed cover.

Oxygen concentrations were generally high, ranging between 5 and 19 µg/l throughout 1977 and 1978. Other physicochemical variables are tabulated. Differences between subsystems and systems were found to be small.

Macrophytes

Elodea nuttallii was the dominant species in the pre-experimental period, comprising 50 to 95% of the vegetation. In 1977, hardly any *Elodea* was observed, but it was abundant again in 1978. *Ceratophyllum demersum* was virtually absent at that time, but became dominant in the following years. Generally, the vegetation was dense. However, large open areas were present in the subsystem treated with azinphos-methyl in 1977. These areas were filled with large algal mats of *Oedogonium* sp. until the end of the experimental period. The untreated subsystem hardly contained any of these algal mats. In 1978, no algal mats appeared in the azinphos-treated subsystem.

Zooplankton and macrofauna

Marked reductions were reported for *Daphnia* spp. in 1977 and for *Simocephales vetulus* in both 1977 and 1978. From the text and a figure can be extracted that *Simocephales vetulus* abundance decreased after pesticide application and abundance numbers tended to increase thereafter. However, control levels were not reached within the treatment period. Moreover, in 1977, after the application no recovery took place, which was thought to be due to the presence of algal mats. In 1978, recovery took place at the time the algal mats had disappeared (one month after the last application).

Similar effects were observed for *Daphnia* spp. In 1978, abundances had not recovered at the end of the experimental period. Data of 1977 were not presented.

For *Chydorus sphaericus*, *Graptoleberis testudinaria*, *Cyclopoida*, *Ostracoda* and *Chaoborus crystallinus* no effects were reported. This seems to be confirmed by the figures presenting zooplankton abundances in time. However, from the figure presenting 1977 data can be observed that no effects on *Chydorus sphaericus* could be observed for the treatment period, but abundances of this species declined more rapidly in time in the treated subsystem compared to the control subsystem. From the graph made for 1978, abundances in the control and treated subsystem look very similar.

For macrofauna, numbers were presented in a table. From the table, no differences between cosms can be distinguished.

Conclusion from the authors

Under near-natural conditions, 1 µg azinphos-methyl/l can strongly reduce populations of Cladocera for at least as long this concentration is maintained. Cyclopoida and Ostracoda were found not to be sensitive to the concentration of azinphos-methyl applied.

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? Answer: yes.
2. Is the description of the experimental set-up adequate and unambiguous? Answer: no. Cosms were divided into halves. One subsystem was treated and the other one was considered to be the control. Thus, no replicates were present. Only the controls present in other cosms give a notion of the variance in biota data. Macroinvertebrates and macrofauna were only assessed at the end of the experimental periods.
3. Is the exposure regime adequately described? Answer: yes.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Answer: unclear. Zooplankton was assessed satisfactorily, but macrofauna was only analyzed once, after the experimental period.
5. Is it possible to evaluate the observed effects statistically? Answer: no. Treatments and controls were not replicated. Variation may be estimated with care on basis of the other subsystem controls.

Evaluation of the results of the study

In both 1977 and 1978, the zooplankton community was affected at 1 µg/l. Although statistics was not performed on the data and no replicates were applied, from the presented figures can be deduced that zooplankton indeed was negatively and chronically affected by the pesticide treatment.

The treatments had actual concentrations of 0.81 µg/l and 0.61 µg/l in the exposure periods of 1977 and 1978, respectively. Therefore, the NOEC is considered to be < 0.61 µg azinphos-methyl/l.

Appendix 4. Detailed bird and mammal toxicity data

Table A4.1. Toxicity of azinphoethyl to birds and mammals.
Table A4.2. Toxicity of coumaphos to birds and mammals.
Table A4.3. Toxicity of tolclofos-methyl to birds and mammals.
Table A4.4. Toxicity of triazophos to birds and mammals

Table A4.1. Bird and mammal toxicity data for azinphos-ethyl.

Species	Species properties	purity	Application route[b]	Exposure time	Criterion	Test endpoint[c]	Effect concentration gavage [mg/kg bs/d]	Effect concentration diet [mg/kg diet]	Notes	Reference	Reliability index[a]
chicken	female		diet	30d	NOEC	body weight		150	1	HSDB, 2007	2
chicken	female		diet	30d	NOEC	clinical or histological signs of toxicity		>600	2	WHO, 1994	2
dog	young		diet	6 weeks	NOEC	clinical signs of cholinesterase poisoning		2.1	3	HSDB, 2007	2
dog	male and female		diet	32 months	NOEC	clinical signs of toxicity		30		WHO, 1994	2
mouse	male and female		diet	2 year	NOEC	carcinogenicity		>11.3	4	WHO, 1994	2
rat	male and female		diet	3 months	NOEC	growth rate, food consumption, mortality		>8	5	HSDB, 2007; WHO, 1994	2
rat	male		diet	16 weeks	NOEC	body weight		10	6	HSDB, 2007; WHO, 1994	2
rat	male		oral	28d	NOAEL	weight gain; signs of poisoning	>1			HSDB, 2007; WHO, 1994	2
rat	male and female		diet	2 year	NOEC	carcinogenicity		>32	7	WHO, 1994	2

a According to Klimisch et al., 1997

b Studies with irrelevant application routes (single oral gavage, dermal, intreperitoneal, etc.) not included

c Studies with irrelevant endpoints (for instance, ChE activity) not included

Notes:

1 LOEC = 300 ppm

2 600 ppm is highest concentration tested

3 LOEC = 3 ppm

4 32 ppm is highest concentration tested

5 8 ppm is highest concentration tested

6 LOEC = 50 ppm

7 32 ppm is highest concentration tested

Table A4.2. Bird and mammal toxicity data for coumaphos.

Species	Species properties	purity	Application route[b]	Exposure time	Criterion	Test endpoint[c]	Effect conc. gavage [mg/kg bw/d]	Effect conc. diet [mg/kg diet]	Notes	Reference	Reliability index[a]
Anas platyrhynchos	10d	95	diet	5d	LC50			709	1	Hill et al., 1975	1
Anas platyrhynchos		98.25	diet		LD50			401.9		US-EPA, 2000	4
Colinus virginianus	14d	95	diet	5d	LC50			120	1	Hill et al., 1975	1
Colinus virginianus		98.25	diet		LD50			82.1		US-EPA, 2000	4
Coturnix c. japonica	14d	95	diet	5d	LC50			225	1	Hill et al., 1975	1
Phasianus colchicus	14d	95	diet	5d	LC50			318	1	Hill et al., 1975	1
dog	Beagles	98-99	diet	1 year	NOEC	systemic changes		90		US EPA, 2000	2
mouse	B6C3F1	95	diet	103 weeks	LOEC	carcinogenity		>10		US EPA, 2000	2
rabbit	American Dutch; 7d old	tg	oral gavage	13d	NOAEL	maternal toxicity	2		2	US EPA, 2000	2
rat	female; SPF Winstar	99.2	diet	2 year	NOEC	body weight		5		US EPA, 2000	2
rat	F33	95	diet	103 weeks	NOEC	body weight		<10		US EPA, 2000	2
rat	Charles River CDBS; 6d old	tg	oral gavage	10d	NOAEL	maternal toxicity; clinical signs of cholinesterase toxicity	5		3	US EPA, 2000	2
rat	Sprague-Dawley	99	diet	2 generation	NOEC	systemic toxicity; reproduction		>25		US EPA, 2000	2
rat	Sprague-Dawley; 7-8 weeks; male and female	tg	diet	multi-generation	NOEC	mean body weight of F1 generation		1	4	Astroff et al., 1998	3
rat	Sprague-Dawley; 7-8 weeks; male and female	tg	diet	multi-generation	NOEC	Reproduction, litter size, food consumption etc.		>25	5	Astroff et al., 1998	2

a According to Klimisch et al., 1997

b Studies with irrelevant application routes (single oral gavage, dermal, intraperitoneal, etc.) not included

c Studies with irrelevant endpoints (for instance, ChE activity) not included

Notes:

1 LC50 determined after 8 days; 5 days exposure followed by 3 days untreated diet. LC50 in mg/kg active ingredient. Report precedes Heath et al.,1972

2 NOEL for developmental effects >18 mg/kg day

3 NOEL for developmental effects >25 mg/kg day

4 NOEL is 1 ppm; effect at 5 ppm; no effect at 10 ppm. Thus, "Significance unclear". Well described study.

5 25 ppm is highest concentration tested

Table A4.3. Bird and mammal toxicity data for tolclofos-methyl.

Species	Species properties	purity	Application route[b]	Exposure time	Criterion	Test endpoint[c]	Effect conc. gavage [mg/kg bw/d]	Effect conc. diet [mg/kg diet]	Notes	Reference	Reliability index[a]
Anas platyrhynchos	chicks	97.7	diet	5 d	NOEC	mortality, health, weight		5620		Anonymous, 2004	1
Anas platyrhynchos	41wks and eggs	97.7	diet	19 wk	NOEC	mortality, signs of toxicity; reproduction		500		Anonymous, 2004	1
Colinus virginianus	chicks	97.7	diet	5 d	NOEC	mortality, health, weight		5620	1	Anonymous, 2004	3
Colinus virginianus	22wks	97.7	diet	21 wk	NOEC	mortality, signs of toxicity; reproduction		500		Anonymous, 2004	1
dog	beagle	98.7	diet	6 mo	NOEC	increased liver weight		600		Anonymous, 2004	2
dog	beagle	96.7 / 97.6	diet	1 yr	NOEC	changes in organ weight		400		Anonymous, 2004	2
mouse	ddY strain	97	diet	9 mo	NOEC	body weight gain		100		Anonymous, 2004	1
mouse	Crj:B6C3F1 strain	94.3	diet	2 yr	NOEC	body weight gain; food consumption		250		Anonymous, 2004	1
rabbit	New Zealand White Rabbits	98.7	oral	13 d	NOAEL	body weight gain; food consumption	300			Anonymous, 2004	1
rat	Sprague-Dawley		diet	32-34 d	NOEC	body weight gain		5000		Anonymous, 2004	2
rat	Sprague-Dawley	96.6	diet	90 d	NOEC	body weight gain; increased liver weight		1000		Anonymous, 2004	1
rat	Sprague-Dawley	97	diet	6 mo	NOEC	body weight gain; increased liver and kidney weight		3000		Anonymous, 2004	1
rat	Fischer 344 CD®F rats	94.9-98.7	diet	>2 yr	NOEC	carcinogenity		>1000		Anonymous, 2004	1
rat	Sprague-Dawley	97.9-98.7	diet	100 wk	NOEC	reproduction		>1000		Anonymous, 2004	1
rat	Fischer 344 CD®F rats	94.9	oral	10 d	NOAEL	teratogenity	>50			Anonymous, 2004	2

a According to Klimisch et al., 1997

b Studies with irrelevant application routes (single oral gavage, dermal, intraperitoneal, etc.) not included

c Studies with irrelevant endpoints (for instance, ChE activity) not included

Notes:

1 high mortality

Table A4.4. Bird and mammal toxicity data for triazophos.

Species	Species properties	purity	Application route[b]	Exposure time	Criterion	Test endpoint[c]	Effect conc. gavage [mg/kg bw/d]	Effect conc. diet [mg/kg diet]	Notes	Reference	Reliability index[a]
chicken	White Leghorn hens	96.8	diet	20 d	NOEC	neurotoxicity		>200		JMPR, 2002	2
chicken	White Leghorn hens	96.8	diet	3 mo	NOEC	neurotoxicity; food consumption		110		JMPR, 2002	2
Dog	Beagle	92.6	diet	13 wk	NOEC	clinical signs of toxicity		9		JMPR, 2002	2
Dog	beagle	92.6	diet	52 wk	NOEC	clinical signs of toxicity		4		JMPR, 2002	2
Mice	NMRKf(SPF71)	93.1	diet	13 wk	NOEC	clinical signs of toxicity		>320	1,2	JMPR, 2002	2
Mice	NMRI	93.1-95.9	diet	24 mo	NOEC	clinical signs of toxicity; carcinogenity		>150		JMPR, 2002	2
rabbit	New Zealand white	92.1	diet	14 d	NOEC	developmental effects		unclear	3	JMPR, 2002	3
rabbit	New Zealand white	92.1	oral gavage	14 d	NOAEL	developmental effects	4			JMPR, 2002	2
Rats	Wistar	92.6	diet	13 wk	NOEC	clinical signs of toxicity		>400	1,2	JMPR, 2002	
Rats	Wistar/SPF	92.6	diet	2 yr	NOEC	clinical signs of toxicity; carcinogenity		>240		JMPR, 2002	2
rats	Wistar/HAN	92.6	diet	3 mo	NOEC	mortality; clinical signs of toxicity		20	4	JMPR, 2002	2
rats	Wistar/HAN	92.6	diet	2-generation study	NOEC	reproduction; mortality		27		JMPR, 2002	2
rats	Wistar	89.4	diet	10 d	NOEC	developmental effects		>250		JMPR, 2002	2

a According to Klimisch et al., 1997

b Studies with irrelevant application routes (single oral gavage, dermal, intraperitoneal, etc.) not included

c Studies with irrelevant endpoints (for instance, ChE activity) not included

Notes:

1	According to EPA guidelines
2	GLP
3	Animals in bad health
4	Preliminary study

Appendix 5. References used in the appendices

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Erratum bij rapport 601714004/2008: Environmental risk limits for organophosphorous pesticides

Erratum to report 601714004/2008: Environmental risk limits for organophosphorous pesticides

- Page 49, section 3.3.3.3
  The ADI is given as 3 µg/kg$_{bw}$, this should read **0.3 µg/kg$_{bw}$**. The units of the MPC are given in mg/kg and mg/L, which should be **µ**g/kg and **µ**g/L. The MPC$_{hh\ food}$ should read **18.3 µg/kg**, the MPC$_{hh\ food,\ water}$ and MPC$_{hh\ food,\ marine}$ are **0.034 µg/L = 3.4 x 10^{-2} µg/L**.

- Page 50, section 3.3.3.6
  The provisional MAC$_{eco,\ marine}$ is given as “7.4 7.4 x 10^{-4} / 5 = 1.5 x 10^{-3} µg/L”. This should read: “7.4 x 10^{-4} / 5 = 1.5 x 10$^{\mathbf{-4}}$ µg/L.”

- Page 68, section 3.6.3.6
  The first and last line of the second paragraph should be deleted. The second paragraph should read as follows: “The MAC$_{eco,\ water}$ value of 0.71 µg/L is lower than the MPC$_{water}$, and should be adjusted to be equal to the MPC$_{water}$ (1.2 µg/L).”

- Page 73, section 3.7.3.3
  The units of the MPC are given in mg/kg and mg/L, this should be **µ**g/kg and **µ**g/L. The MPC$_{hh\ food}$ should read **60.9 µg/kg**, the MPC$_{hh\ food,\ water}$ and MPC$_{hh\ food,\ marine}$ are **0.29 µg/L**.

- Summary tables on page 17 (Tabel 1), page 19 (Table 2) and page 75 (Table 54)
  - The corrected MPC$_{hh\ food,\ water}$ and MPC$_{hh\ food,\ marine}$ as given under the 1st and 4th bullet should be implemented in these tables.
  - The environmental risk limits for azinphos-ethyl and azinphos-methyl as presented in the tables are not correctly copied from the main text.
  - Reference to the footnotes is not complete.

A corrected version of the tables is presented on the following page.

Tabel 1. Afgeleide MTR, VR, MAC$_{\text{eco}}$ en ER$_{\text{eco}}$ waarden (in µg/L).

Milieurisico-grens[a]	**azinphos-ethyl**	**azinphos-methyl**	**coumaphos**	**heptenophos**	**mevinphos**	**tolclofos-methyl**	**triazophos**
Oude MTR$_{\text{water}}$	1,1 × 10^{-2}	1,2 × 10^{-2}	7,0 × 10^{-4}	2,0 × 10^{-2}	2,0 × 10^{-3}	0,79	3,2 × 10^{-2}
MTR$_{\text{eco, water}}$	1,1 × 10^{-3}	6,5 × 10^{-3}	3,4 × 10^{-3}	2,0 × 10^{-3}	1,7 × 10^{-4}	1,2	1,0 × 10^{-3}
MTR$_{\text{dw, water}}$	0,1	0,1	0,1	0,1	0,1	0,1	0,1
MTR$_{\text{sp, water}}$	0,51	n.a.[c]	7,5 × 10^{-2}	n.a.[c]	n.a.[c]	3,4	0,48
MTR$_{\text{hh food, water}}$	n.a.[b]	n.a.[c]	3,4 × 10^{-2}	n.a.[c]	n.a.[c]	n.a.[c]	0,29
MTR$_{\text{water}}$	1,1 × 10^{-3}	6,5 × 10^{-3}	3,4 × 10^{-3}	2,0 × 10^{-3}	1,7 x 10^{-4}	1,2	1,0 × 10^{-3}
MTR$_{\text{eco, marien}}$	1,1 × 10^{-4}	1,3 × 10^{-3}	6,8 × 10^{-4}	2,0 × 10^{-4}	1,7 x 10^{-5}	n.a.[b]	1,0 × 10^{-4}
MTR$_{\text{sp, marien}}$	0,51	n.a.[c]	7,5 × 10^{-2}	n.a.[c]	n.a.[c]	1,7	0,48
MTR$_{\text{hh food, marien}}$	n.a.[b]	n.a.[c]	3,4 × 10^{-2}	n.a.[c]	n.a.[c]	n.a.[c]	0,29
MTR$_{\text{marien}}$	1,1 × 10^{-4}	1,3 × 10^{-3}	6,8 × 10^{-4}	2,0 × 10^{-4}	1,7 × 10^{-5}	n.a.[b]	1,0 × 10^{-4}
VR$_{\text{water}}$	1,1 × 10^{-5}	6,5 × 10^{-5}	3,4 × 10^{-5}	2,0 × 10^{-5}	1,7 × 10^{-6}	1,2 × 10^{-2}	1,0 × 10^{-5}
VR$_{\text{marien}}$	1,1 × 10^{-6}	1,3 × 10^{-5}	6,8 × 10^{-6}	2,0 × 10^{-6}	1,7 × 10^{-7}	n.a.[b]	1,0 × 10^{-6}
MAC$_{\text{eco, water}}$	1,1 × 10^{-2}	0,014	3,4 × 10^{-3}	2,0 × 10^{-2}	1,7 × 10^{-2}	1,2	2,0 × 10^{-2}
MAC$_{\text{eco, marien}}$[d]	1,1 × 10^{-3}	2,8 × 10^{-3}	6,8 × 10^{-4}	2,0 × 10^{-3}	1,7 × 10^{-3}	n.a.[b]	2,0 × 10^{-3}
ER$_{\text{eco, water}}$	1,1	4,8	4,5	1,7 × 10^{2}	4,6	40	1,1 × 10^{2}
ER$_{\text{eco, marien}}$	1,1	4,8	4,5	1,7 × 10^{2}	4,6	n.d.[b]	1,1 × 10^{2}

a: subscript: water = zoetwater; marien = mariene wateren; eco = gebaseerd op ecotoxicologische data; dw = gebaseerd op humane concumptie van drinkwater; sp = doorvergiftiging; hh food = gebaseerd op humane visconsumptie

b: niet afgeleid wegens ontbreken gegevens

c: niet afgeleid, drempelwaarden voor afleiding niet overschreden

d: voorlopige waarde, zie methoden-paragraaf

Table 2 and 54. Derived MPC, NC, MAC$_{\text{eco}}$, and SRC$_{\text{eco}}$ values (in µg/L).

Environmental risk limit[a]	**azinphos-ethyl**	**azinphos-methyl**	**coumaphos**	**heptenophos**	**mevinphos**	**tolclofos-methyl**	**triazophos**
old MPC$_{\text{water}}$	1.1 × 10^{-2}	1.2 × 10^{-2}	7.0 × 10^{-4}	2.0 × 10^{-2}	2.0 × 10^{-3}	0.79	3.2 × 10^{-2}
MPC$_{\text{eco, water}}$	1.1 × 10^{-3}	6.5 × 10^{-3}	3.4 × 10^{-3}	2.0 × 10^{-3}	1.7 × 10^{-4}	1.2	1.0 × 10^{-3}
MPC$_{\text{dw, water}}$	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MPC$_{\text{sp, water}}$	0.51	n.d.[c]	7.5 × 10^{-2}	n.d.[c]	n.d.[c]	3.4	0.48
MPC$_{\text{hh food, water}}$	n.d.[b]	n.d.[c]	3.4 × 10^{-2}	n.d.[c]	n.d.[c]	n.d.[c]	0.29
MPC$_{\text{water}}$	1.1 × 10^{-3}	6.5 × 10^{-3}	3.4 × 10^{-3}	2.0 × 10^{-3}	1.7 x 10^{-4}	1.2	1.0 × 10^{-3}
MPC$_{\text{eco, marine}}$	1.1 × 10^{-4}	1.3 × 10^{-3}	6.8 × 10^{-4}	2.0 × 10^{-4}	1.7 x 10^{-5}	n.d.[b]	1.0 × 10^{-4}
MPC$_{\text{sp, marine}}$	0.51	n.d.[c]	7.5 × 10^{-2}	n.d.[c]	n.d.[c]	1.7	0.48
MPC$_{\text{hh food, marine}}$	n.d.[b]	n.d.[c]	3.4 × 10^{-2}	n.d.[c]	n.d.[c]	n.d.[c]	0.29
MPC$_{\text{marine}}$	1.1 × 10^{-4}	1.3 × 10^{-3}	6.8 × 10^{-4}	2.0 × 10^{-4}	1.7 × 10^{-5}	n.d.[b]	1.0 × 10^{-4}
NC$_{\text{water}}$	1.1 × 10^{-5}	6.5 × 10^{-5}	3.4 × 10^{-5}	2.0 × 10^{-5}	1.7 × 10^{-6}	1.2 × 10^{-2}	1.0 × 10^{-5}
NC$_{\text{marine}}$	1.1 × 10^{-6}	1.3 × 10^{-5}	6.8 × 10^{-6}	2.0 × 10^{-6}	1.7 × 10^{-7}	n.d.[b]	1.0 × 10^{-6}
MAC$_{\text{eco, water}}$	1.1 × 10^{-2}	0.014	3.4 × 10^{-3}	2.0 × 10^{-2}	1.7 × 10^{-2}	1.2	2.0 × 10^{-2}
MAC$_{\text{eco, marine}}$[d]	1.1 × 10^{-3}	2.8 × 10^{-3}	6.8 × 10^{-4}	2.0 × 10^{-3}	1.7 × 10^{-3}	n.d.[b]	2.0 × 10^{-3}
SRC$_{\text{eco, water}}$	1.1	4.8	4.5	1.7 × 10^{2}	4.6	40	1.1 × 10^{2}
SRC$_{\text{eco, marine}}$	1.1	4.8	4.5	1.7 × 10^{2}	4.6	n.d.[b]	1.1 × 10^{2}

a: subscript: water = freshwater; marine = marine waters; eco = based on ecotoxicologal data; dw = based on human consumption of drinking water; sp = secondary poisoning; hh food = based on human fish consumption

b: not derived due to lack of data

c: not derived, triggers for derivation not met

d: provisional value, see methods section

Voor accoord,

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