National Institute
for Public Health
and the Environment

Letter report 601716022/2008
C.T.A. Moermond

Environmental risk limits for pyriproxyfen

rivm

RIVM Letter report 601716022/2008

Environmental risk limits for pyriproxyfen

Caroline Moermond

Contact:
Caroline Moermond
Expertise Centre for Substances
caroline.moermond@rivm.nl

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

rivm

Rapport in het kort

Environmental risk limits for pyriproxyfen

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

rivm

Contents

rivm

1 Introduction

1.1 Background and scope of the report

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

The following ERLs are considered:

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

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

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

1.2 Status of the results

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

2 Methods

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

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

2.1 Data collection

In accordance with the WFD, data of existing evaluations were used as a starting point. For pyriproxyfen, the evaluation report prepared within the framework of EU Directive 91/414/EC (Draft Assessment Report, DAR) was consulted (EC, 2005). An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current Contents (literature from 1997 to 2007). In addition to this, all potentially relevant references in the RIVM e-tox base and EPA's ECOTOX database were checked.

2.2 Data evaluation and selection

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

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

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

according to a method which is not acceptable, the documentation of which is not sufficient for an assessment and which is not convincing for an expert judgment.'

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

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

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

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

Endpoints with Ri 1 or 2 are accepted as valid, but this does not automatically mean that the endpoint is selected for the derivation of ERLs. The validity scores are assigned on the basis of scientific reliability, but valid endpoints may not be relevant for the purpose of ERL-derivation (e.g. due to inappropriate exposure times or test conditions that are not relevant for the Dutch situation). Endpoints from tests with formulated products were not selected if the results (expressed on the basis of the active substance) differed by more than a factor of 3 from the results obtained with the active substance itself.

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

2.3 Derivation of ERLs

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

2.3.1 Drinking water

The INS-Guidance includes the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw, water}$) as one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see INS-Guidance, Section 3.1.6 and 3.1.7). According to the proposal for the daughter directive Priority Substances, however, the derivation of the AA-EQS (= MPC) should be based on direct exposure, secondary poisoning, and human exposure due to the consumption of fish. Drinking water was not included in the proposal and is thus not guiding for the general MPC value. The exact way of implementation of the $MPC_{dw, water}$ in the Netherlands is at present under discussion within the framework of the "AMvB Kwaliteitseisen en Monitoring Water". No policy decision has been taken

yet, and the $MPC_{dw, water}$ is therefore presented as a separate value in this report. The MPC_{water} is thus derived considering the individual MPCs based on direct exposure ($MPC_{eco, water}$), secondary poisoning ($MPC_{sp, water}$) or human consumption of fishery products ($MPC_{hh\ food, water}$); the need for derivation of the latter two is dependent 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 (Section 3.1.7), a substance specific removal efficiency related to simple water treatment should be derived in case the $MPC_{dw, water}$ is lower than the other MPCs. For pesticides, there is no agreement as yet on how the removal fraction should be calculated, and water treatment is therefore not taken into account. In case no A1 value is set in Directive 75/440/EEC, the $MPC_{dw, water}$ is set to the general Drinking Water Standard of 0.1 µg/L for organic pesticides as specified in Directive 98/83/EC.

3 Derivation of environmental risk limits for pyriproxyfen

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

3.1.1 Identity

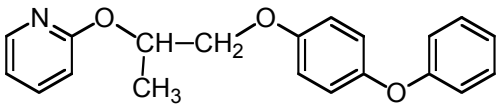

Figure 1. Structural formula of pyriproxyfen.

Table 1. Identification of pyriproxyfen.

Parameter	Name or number	Source
Common name	Pyriproxyfen	EC, 2005
Chemical name	4-phenoxyphenyl (*RS*)-2-(2-pyridyloxy)propyl ether	EC, 2005
CAS number	95737-68-1	EC, 2005
EC number	429-800-1	EC, 2005
SMILES code	n1ccccc1OC(C)COc2ccc(Oc3ccccc3)cc2	
Use class	Insecticide	Tomlin, 2002
Mode of action	Juvenile hormone mimic	Tomlin, 2002
Authorised in NL	Yes	
Annex 1 listing	No	

3.1.2 Physico-chemical properties

Table 2. Physico-chemical properties of pyriproxyfen.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	321.4		EC, 2005
Water solubility	[mg/L]	0.367		EC, 2005
pK_a	[-]	Not relevant		
log K_{OW}	[-]	5.37	pH 5.6	EC, 2005
		5.64	Calculated	ClogP
log K_{OC}	[-]	4.33		EC, 2005
Vapour pressure	[Pa]	1.33×10^{-5}	23 ºC	EC, 2005
Melting point	[°C]	48-50		EC, 2005
Boiling point	[°C]	318		EC, 2005
Henry's law constant	[Pa.m^3/ mol]	1.16×10^{-5}	Calculated	EC, 2005

3.1.3 Behaviour in the environment

Table 3. Selected environmental properties of pyriproxyfen.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]		Hydrolytically stable at pH 4, 7, and 9	EC, 2005
Photolysis half-life	DT50 [d]	3.72-6.36	23 ºC	EC, 2005
Readily biodegradability		No		EC, 2005
Biodegradation in water/sediment systems	DT50 [d]	6.6	20 ºC; system	EC, 2005
Relevant metabolites	4'-OH-pyriproxyfen PYPAC			EC, 2005

3.1.4 Bioconcentration and biomagnification

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

Table 4. Overview of bioaccumulation data for pyriproxyfen.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	581		EC, 2005
BMF	[kg/kg]	1	Default value for BCF < 2000 L/kg	

3.1.5 Human toxicological threshold limits and carcinogenicity

Pyriproxyfen does not have any R-phrases related to human toxicology. There is no evidence that pyriproxyfen has carcinogenic potential (EC, 2005).
A NOAEL of 10 mg/kg_{bw}/d from a 1-year oral toxicity study (with capsules) in dogs is used with a safety factor of 100 to account for inter- and intraspecies differences, to set the ADI at 0.1 mg/kg_{bw}/d (EC, 2005).

3.2 Trigger values

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

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

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp\text{-}water}$	3.33	[-]	$K_{OC} \times f_{OC,susp}$ [1]	K_{OC}: 3.1.2
BCF	581	[L/kg]		3.1.4
BMF	1	[kg/kg]		3.1.4
Log K_{OW}	5.64	[-]		3.1.2
R-phrases	R50/53	[-]		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} (EC, 2003).

- pyriproxyfen has a log $K_{p,\ susp\text{-}water} \geq 3$; derivation of $MPC_{sediment}$ is triggered.
- pyriproxyfen has a log $K_{p,\ susp\text{-}water} \geq 3$; expression of the MPC_{water} as $MPC_{susp,\ water}$ is required.
- pyriproxyfen has a BCF > 100 L/kg; assessment of secondary poisoning is triggered.
- pyriproxyfen has no human toxicological R-phrases or classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{water,\ hh\ food}$) does not have to be derived.
- For pyriproxyfen, 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 Toxicity data and derivation of ERLs for water

3.3.1 $MPC_{eco, water}$ and $MPC_{eco, marine}$

An overview of the selected freshwater toxicity data for pyriproxyfen is given in Table 6. Data on marine toxicity are given in Table 7. Detailed toxicity data for pyriproxyfen are tabulated in Appendix 2.

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

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Algae	51[b]	Algae	128[d]
Crustacea	0.015	Crustacea	276[e]
Crustacea	0.010[c]	Crustacea	80
Insecta	**0.0015**	Insecta	**0.26**
Pisces	4.3	Pisces	220

[a] For detailed information see Appendix 2. Bold values are used for ERL derivation.
[b] Geometric mean of 0.050 and 0.052 mg/L; preferred endpoint, parameter growth rate for *Pseudokirchneriella subcapitata*.
[c] Lowest endpoint for *Daphnia pulex*, parameter length.
[d] Geometric mean of 0.11 and 0.15 mg/L; preferred endpoint, parameter growth rate for *Pseudokirchneriella subcapitata*.
[e] Geometric mean of 0.40 and 0.19 mg/L, parameter mortality for *Daphnia magna*.

Table 7. Pyriproxyfen: selected marine toxcity data for ERL derivation.

Chronic [a]		Acute [a]	
Taxonomic group	**NOEC/EC10 (µg/L)**	**Taxonomic group**	**L(E)C50 (µg/L)**
Crustacea	0.81		

[a] For detailed information see Appendix 2.

3.3.1.1 Treatment of fresh- and saltwater toxicity data

ERLs for freshwater and marine waters should be derived separately. For pesticides, data can only be combined if it is possible to determine with high probability that marine organisms are not more sensitive than freshwater organisms (Lepper, 2005). For pyriproxyfen, not enough marine data are available to make this comparison and ERLs for the marine compartment cannot be derived.

3.3.1.2 Mesocosm and field studies

In the DAR (EC, 2005) an indoor microcosm study performed with pyriproxyfen 10EC in compliance with GLP is evaluated (Appendix 3, study 1). In 18L cylinders with a layer of sediment, a eutrophic community with phyto- and zooplankton (cladocera, ostracoda, copepoda and rotifera) was exposed to a single application of pyriproxyfen. For acute effects (3 days post-exposure), the NOEC was the 5 µg as/L treatment. After 7 days, actual concentration in the 5 µg as/L treatment was 0.012 µg as/L. Thereafter, pyriproxyfen concentrations were not detectable anymore (LOD 0.006 µg/L). The first

order DT_{50} value was calculated to be 0.8 days and the DT_{90} value 2.6 days. The 3-d acute NOEC is 5 µg as/L, based on the initial measured concentrations. Further details can be found in Appendix 3.

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

The base-set for freshwater toxicity data is complete. Chronic NOECs are available for algae, crustaceans, insects and fish. The lowest NOEC is 0.0015 µg/L for insects. It should be noted that there are a number of chronic EC_{50} values for insects (see Appendix 2), which are very low (starting at only a factor of three higher than the chronic NOEC for insects). This small difference (smaller than a factor of 10) between chronic NOECs and EC_{50}-values, combined with the vast amount of non-valid chronic insect data showing the same trend, leads to the conclusion that an assessment factor of 10 may not be protective enough and an assessment factor of 50 is warranted. This results in an $MPC_{eco, water}$ of $0.0015 / 50 = 3 \times 10^{-5}$ µg/L (0.03 ng/L).

Only acute-exposure cosm studies are performed. Since the MPC aims to protect the aquatic ecosystem against toxic effects during chronic exposure these studies cannot be used for derivation of the $MPC_{eco, water}$. The cosm studies can be used for derivation of the $MAC_{eco, water}$, which aims to protect the aquatic ecosystem against acute toxic effects during exposure to short-term peak concentrations.

For the marine environment, the base set is not complete and thus an $MPC_{eco, marine}$ cannot be derived.

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

Pyriproxyfen has a BCF >100 L/kg, thus assessment of secondary poisoning is triggered.

The lowest MPC_{oral} is 3.3 mg/kg diet for rats (see Table 8). Subsequently, the $MPC_{sp, water}$ can be calculated using a BCF of 581 L/kg and a BMF of 1 kg/kg (Table 5) and becomes $3.3 / (581 \times 1) = 5.7 \times 10^{-3}$ mg/L = 5.7 µg/L.

The 1-year dog study on which the ADI is based (section 3.1.5), is not included in this table since exposure was through capsules and not through their diet.

The $MPC_{sp, marine}$ can be calculated with an extra biomagnifcation factor and becomes: $3.3 / (581 \times 1 \times 1) = 5.7 \times 10^{-3}$ mg/L = 5.7 µg/L.

Table 8. Pyriproxyfen: selected mammal data for ERL derivation

Species[a]	Exposure time	Criterion	Effect concentration (mg/kg diet)	Assessment factor	MPC_{oral} (mg/kg diet)
Rats	28 days	NOAEL	**1000**	**300**	**3.3**
Rats	13 weeks	NOAEL	2000	90	22
Rats	6 months	NOAEL	2000	30	67
Rats	2 years	NOAEL	120	30	4.0
Rats	2 generation	NOAEL	1000	30	33
Mice	78 weeks	NOAEL	120	30	4.0

[a] For detailed information see Appendix 4. Bold values are used for ERL derivation.

3.3.3 $MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for pyriproxyfen is not triggered (Table 5).

3.3.4 $MPC_{dw,\ water}$

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

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

The lowest value of the routes included (see Chapter 2.3) is the value for direct aquatic toxicity. Therefore, the MPC_{water} is 3.0×10^{-5} µg/L (based on the $MPC_{eco,\ water}$). No MPC_{marine} can be selected because the marine base set is not complete and an $MPC_{eco,\ marine}$ could not be derived.

Because the log $K_{p\ susp\text{-}water} \geq 3$ (Table 5), the final MPC_{water} has to be recalculated into an $MPC_{susp,\ water}$, which refers to the concentration in suspended matter. The $MPC_{susp,\ water}$ is calculated according to:

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

For this calculation, $K_{p,susp\text{-}water,Dutch\ standard}$ is calculated using K_{OC} and the $f_{OC,susp,\ Dutch\ standard}$. This is not the same as the European standard $f_{OC,susp}$ which is used in the table with trigger values. With an $f_{OC,susp,Dutch\ standard}$ of 0.1176 and a log K_{OC} of 4.33, the $K_{p,susp\text{-}water,\ Dutch\ standard}$ can be calculated to be 2514 L/kg.

This results in an $MPC_{susp,\ water}$ of $3.0 \times 10^{-5} / (30 \times 10^{-6} + (1 / 2514)) = 7.0 \times 10^{-2}$ µg/kg_{dw}.

3.3.6 MAC_{eco}

3.3.6.1 $MAC_{eco,\ water}$

From the cosm-study (see 3.3.1.2) , a 3-d acute NOEC of 5 µg/L was derived. However, this study was not conducted with insects, which are the most sensitive species for this compound. All acute LC_{50} values for insects are clearly below this 3-d acute NOEC from the cosm-study without insects. Therefore, the MAC is based on the lowest acute LC_{50}, which is 0.26 µg/L for insects.

Although the BCF is higher than 100 L/kg, an assessment factor of 10 (instead of 100) is applied for the derivation of the MAC, for several reasons. First, the BCF primarily plays a role for the MAC if fish or other 'accumulating' taxa are the most sensitive species. This is clearly not the case. Further, the mode of toxic action is known and the most sensitive species is included in the dataset. Thus, the $MAC_{eco,\ water}$ is set at 0.26 / 10 = 0.026 µg/L.

3.3.6.2 $MAC_{eco,\ marine}$

Not enough marine toxicity data are available to derive a $MAC_{eco,\ marine}$.

3.3.7 $SRC_{eco,\ water}$

Chronic data are available for algae, crustaceans (among which *Daphnia*), insects and fish, the geometric mean of all chronic data is 0.14 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 $SRC_{eco,\ water}$ can be derived using an assessment factor of 1 and becomes 0.14 / 1 = 0.14 µg/L.

3.4 Toxicity data and derivation of ERLs for sediment

The log $K_{p,\ susp\text{-}water}$ of pyriproxyfen is above the trigger value of 3, therefore, ERLs need to be derived for sediment.

3.4.1 Sediment toxicity data

One sediment toxicity study is reported in the DAR (EC, 2005). *Chironomus riparius* was exposed to pyriproxyfen for 28 days in a water-spiked sediment test (see Appendix 2, table A2.2). Sediment was analysed, but the data do not allow for an adequate estimate of time weighted average exposure concentrations. Results cannot be used for risk limit derivation.

3.4.2 Derivation of $MPC_{sediment}$

Because there are no sediment toxicity data, the $MPC_{sediment}$ needs to be derived by applying the equilibrium partitioning method on the $MPC_{eco,\ water}$.

First, the $MPC_{sediment}$ is calculated using TGD default values, and subsequently this $MPC_{sediment}$ is recalculated to Dutch standard sediment.

$$MPC_{\text{sediment, TGD, EqP, ww}} = \frac{K_{susp-water}}{RHO_{susp}} \times MPC_{\text{eco, water}} \times 1000$$

with $K_{susp\text{-}water}$:

$$K_{\text{susp-water}} = F\text{air}_{susp} \times K_{\text{air-water}} + F\text{water}_{susp} + F\text{solid}_{susp} \times \frac{K\text{p}_{susp}}{1000} \times RHO\text{solid}$$

$$MPC_{\text{sediment, TGD, EqP, dw}} = \frac{RHO_{susp}}{F\text{solid}_{susp} \times RHO\text{solid}} \times MPC_{\text{sediment, TGD, EqP, ww}}$$

$$MPC_{\text{Dutch standard sediment, EqP, dw}} = \frac{Foc_{\text{Dutch standard sediment}}}{Foc_{\text{susp, TGD}}} \times MPC_{\text{sediment, TGD EqP, dw}}$$

Pyriproxyfen had a log $K_{ow} > 5$. For these compounds, an additional assessment factor of 10 should be used to account for extra uncertainty due to uptake by ingestion of food.

3.4.2.1 Freshwater sediment

Using $K_{p,susp}$ = 2138 L/kg (log $K_{p,susp}$ = 3.33), $F\text{air}_{susp}$ = 0, $F\text{water}_{susp}$ = 0.9, $F\text{solid}_{susp}$ = 0.1, RHO_{susp} = 1150 kg/m^3, $F\text{solid}_{susp}$ = 0.1, RHO_{solid} = 2500 kg/m^3, $Foc_{\text{Dutch standard sediment}}$ = 0.0588 and $Foc_{susp,TGD}$ = 0.1 and the $MPC_{eco,water}$ of 3.0×10^{-5} µg/L, $MPC_{sediment}$ is calculated according to:

$$K_{\text{susp-water}} = 0 + 0.9 + 0.1 \times \frac{2138}{1000} \times 2500 = 535$$

$$MPC_{\text{sediment, TGD, EqP, ww}} = \frac{535}{1150} \times 3.0 \times 10^{-5} \times 1000 = 0.014 \text{ µg/kg}_{ww}.$$

$$MPC_{\text{sediment, TGD, EqP, dw}} = \frac{1150}{0.1 \times 2500} \times 0.014 = 0.064 \text{ µg/kg}_{dw}$$

$$MPC_{\text{Dutch standard sediment, EqP, dw}} = \frac{0.0588}{0.1} \times 0.064 = 0.038\ \mu g/kg_{dw}$$

Because pyriproxyfen has a log $K_{ow} > 5$, an additional assessment factor of 10 should be used. Thus, the $MPC_{sediment} = 3.8 \times 10^{-2} / 10 = 3.8 \times 10^{-3}$ $\mu g/kg_{dw}$.

3.4.2.2 Marine sediment

The derivation of $MPC_{marine\ sediment}$ cannot performed because no $MPC_{eco,\ marine}$ could be derived due to a lack of data.

3.4.3 Derivation of $SRC_{eco,\ sediment}$

The $SRC_{eco,\ sediment}$ is calculated using the $SRC_{eco,\ water}$ and the partitioning method, analogous to the calculation of the $MPC_{sediment}$, including the additional assessment factor of 10 because of the high log K_{ow} of the compound. This results in an $SRC_{eco,\ sediment}$ of 18 $\mu g/kg_{dw}$.

4 Conclusions

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

The ERLs that were obtained are summarised in the table below. The MPC value that was set for this compound until now, is also presented in this table for comparison reasons. It should be noted that this is an indicative MPC ('ad-hoc MTR'), derived using a different methodology and based on limited data.

Table 9. Derived MPC, MAC_{eco}, and SRC values for pyriproxyfen.

ERL	Unit	MPC	MAC_{eco}	SRC
Water, old[a]	µg/L	1.5×10^{-4}	-	-
Water, new[b]	µg/L	3.0×10^{-5}	0.026	0.14
Water, suspended matter	$\mu g/kg_{dw}$	7.0×10^{-2}	-	-
Drinking water[b]	µg/L	0.1[d]	-	-
Sediment	$\mu g/kg_{dw}$	3.8×10^{-3}	-	18

[a] indicative MPC ('ad-hoc MTR'), source: Helpdesk Water http://www.helpdeskwater.nl/emissiebeheer/normen_voor_het/zoeksysteem_normen/

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

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

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

References

EC. 2003. Technical Guidance Document in support of Commission Directive 93/67/EEC on Risk Assessment for new notified substances, Commission Regulation (EC) No 1488/94 on Risk Assessment for existing substances and Directive 98/9/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market. Part II. Ispra, Italy: European Chemicals Bureau, Institute for Health and Consumer Protection. Report no. EUR 20418 EN/2.

EC. 2005. Pyriproxyfen, Draft Assessment Report. Rapporteur Member State: The Netherlands.

Lepper P. 2005. Manual on the Methodological Framework to Derive Environmental Quality Standards for Priority Substances in accordance with Article 16 of the Water Framework Directive (2000/60/EC). 15 September 2005 (unveröffentlicht) ed. Schmallenberg, Germany: Fraunhofer-Institute Molecular Biology and Applied Ecology.

MNP. 2006. Tussenevaluatie van de nota Duurzame gewasbescherming. Bilthoven, The Netherlands: Milieu- en Natuurplanbureau. MNP-publicatienummer: 500126001.

Mayer FL. 1986. Acute toxicity handbook of chemicals to estuarine organisms. Gulf Breeze, FL, USA: Environmental Protection Agency.

Mayer FLJr, Ellersieck MR. 1986. Manual of acute toxicity: interpretation and data base for 410 chemicals and 66 species of freshwater animals. Resource Publication 160. Washington, D.C., USA: United States Department of the Interior. Fish and Wildlife Service. 579 pp.

Schaefer CH, T. Miura. 1990. Chemical Persistence and Effects of S-31183, 2-[1-Methyl-2-(4-Phenoxyphenoxy)Ethoxy]Pyridine, on Aquatic Organisms in Field Tests. J Econ Entomol 83: 1768-1776.

Tomlin CDS. 2002. e-Pesticide Manual 2002-2003 (Twelfth edition) Version 2.2. British Crop Protection Council.

Van Vlaardingen PLA, Verbruggen EMJ. 2007. Guidance for the derivation of environmental risk limits within the framework of the project 'International and National Environmental Quality Standards for Substances in the Netherlands' (INS). Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 601782001. 146 pp.

Appendix 1. Information on bioconcentration

Table A1.1 Bioconcentration data for pyriproxyfen

Species	Species properties	Substance purity	Analysed	Test type	pH	Hardness $CaCO_3$ [mg/L]	T [°C]	Exposure time [d]	Exposure concentration [mg/L]	BCF [L/kg]	BCF type	Ri	Notes	Reference
Lepomis macrochirus		98.9	LSC, TLC, and RP-HPLC	F	6.4-7.1		20.4-22.1	28	0.020	581	Equi	2	1	EC, 2005

Notes:

1 Steady state was reached within 3 days. Average concentration in fish over days 3-28 is used to calculate BCF. Concentrations are measured using ^{14}C techniques. The value of 581 is an average value of 660 and 501 L/kg from two simultaneous tests with p techniques. The value of 581 is an average value of 660 and 501 L/kg from two simultaneous test with phenoxyphenyl and pyridyl labelled material.

Appendix 2. Detailed aquatic toxicity data

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

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. Time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Protozoa															
Colpoda aspera		0.5	N						24h	EC50	growth rate	164280	3	1,2	Kakuchi et al., 1996
Colpoda aspera		0.5	N						24h	EC10	growth rate	44160	3	1,2	Kakuchi et al., 1996
Algae															
Pseudokirchneriella subcapitata		97.2	Y	S					72h	EC50	growth rate	150	2	1,3	EC, 2005
Pseudokirchneriella subcapitata		97.2	Y	S					72h	EC50	biomass	94	2	1,3	EC, 2005
Pseudokirchneriella subcapitata		10.4	Y	S					72h	EC50	growth rate	110	2	1,3	EC, 2005
Pseudokirchneriella subcapitata		10.4	Y	S					72h	EC50	biomass	74	2	1,3	EC, 2005
Pseudokirchneriella subcapitata									72h	EC50	abundance	54	4	1	Office of Pesticide programs, 2000
Macrophyta															
Lemna gibba G 3		98.4	Y	R					14d	EC50	growth rate	> 0.180	2	4,5	EC, 2005
Lemna gibba G 3		98.4	Y	R					14d	EC50	biomass	> 0.180	2	4,5	EC, 2005
Crustacea															
Daphnia magna		95.3	Y	F					48 h	EC50	mortality	400	2	5	EC, 2005
Daphnia magna		95.3	Y	F					48 h	NOEC	mortality	43	2	5	EC, 2005
Daphnia magna		10.4	Y	S					48 h	EC50	mortality	190	2	5	EC, 2005
Daphnia magna		10.4	Y	S					48 h	NOEC	mortality	28	2	5	EC, 2005
Daphnia carinata	neonates<12hr old	96.60	N	S	nw		24±1		48 h	EC50	mortality	80	2		Trayler and Davis, 1996
Insecta															
Aedes aegypti	4th instar	96.2	N	S			25±1		6 h	LC50	mortality	0.26	2	6	Loh and Yap, 1989
Aedes aegypti	4th instar	96.2	N	S			25±1		6 h	LC10	mortality	0.10	2	6,7	Loh and Yap, 1989
Aedes aegypti	3th and 4th instar	0.50	N	S						NOEC	Mortality	<10	3	10,11	De Resende & Gama, 2006
Pisces															
Lepomis macrochirus		95.3	Y	F					96 h	EC50	mortality	> 270	2	5	EC, 2005
Lepomis macrochirus		95.3	Y	F					96 h	NOEC	mortality	≥ 270	2	5	EC, 2005
Lepomis macrochirus									96 h	EC50	mortality	5900	3	2	Office of Pesticide programs, 2000
Melanotaenia duboulayi	juvenile <72 hr old	2.00	N	S	dw		25		1h	NOEC	mortality	100	3	13,14	Brown et al., 2002
Oncorhynchus mykiss		95.3	Y	F					96 h	EC50	mortality	> 325	2	5	EC, 2005
Oncorhynchus mykiss		95.3	Y	F					96 h	NOEC	mortality	102	2	5	EC, 2005
Oncorhynchus mykiss		10.4	Y	S					96 h	EC50	mortality	220	2	5	EC, 2005
Oncorhynchus mykiss		10.4	Y	S					96 h	NOEC	mortality	68	2	5	EC, 2005
Oncorhynchus mykiss									96 h	EC50	mortality	450	4		Office of Pesticide programs, 2000

Notes:

1 Result based on nominal concentration a.i.
2 Above solubility limits.
3 Measured concentrations within 80% of nominal concentrations.
4 No effect at the highest test concentration.
5 Result based on mean measured concentration.
6 Kept until emergence to adult, single short exposure at larval stage but mortality only recorded after emergence.
7 LC10 calculated using Graphpad.
8 Continuous exposition until emergence to adult, daily recorded mortality.
9 LC90 = 2.45 * 10-4 mg/L.
10 Purity too low.
11 Study reported in Portuguese language, not all details copied in this table.
12 According to WHO standard bioassay protocols.
13 Juveniles were exposed for 1 hr (stirred twice every 15 min), removed and maintained 24 hr in recovery tanks without test compounds.
14 Only two test concentrations are reported.

Table A2.2. Chronic toxicity of pyriproxyfen to freshwater organisms.

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Exp. Time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Protozoa														
Colpoda aspera		0.5	N					24h	EC10	growth rate	44160	3	1,11	Kakuchi et al., 1996
Algae														
Pseudokirchneriella subcapitata		97.2	Y	S				72h	NOEC	growth rate	50	2	1,2	EC, 2005
Pseudokirchneriella subcapitata		97.2	Y	S				72h	NOEC	biomass	25	2	1,2	EC, 2005
Pseudokirchneriella subcapitata		10.4	Y	S				72h	NOEC	growth rate	52	2	1	EC, 2005
Pseudokirchneriella subcapitata		10.4	Y	S				72h	NOEC	biomass	26	2	1	EC, 2005
Macrophyta														
Lemna gibba G 3		98.5	Y	R				14d	NOEC	growth rate	≥ 0.180	2	45	EC, 2005
Lemna gibba G 3		98.5	Y	R				14d	NOEC	biomass	≥ 0.180	2	45	EC, 2005
Crustacea														
Daphnia carinata	neonates<12hr old	96.6	N	R	nw		24±1	14 d	LOEC	reproduction	< 10	3	3	Trayler and Davis, 1995
Daphnia magna	1st instar, <24hr old	100	Y	F		8.2-8.4	19-20	21 d	NOEC	reproduction	0.015	1	4,5	EC, 2005
Daphnia pulex	1st instar, <24hr old	97	N	R		7.4-8.3	19-21	21 d	NOEC	reproduction	0.03	2	6	EC, 2005
Daphnia pulex	1st instar, <24hr old	97	N	R		7.4-8.3	19-21	21 d	NOEC	length	0.01	2	6	EC, 2005
Asesllus hilgendorfii	juveniles	97	N	R			25	21 d	NOEC	length	> 0.01	2	6	EC, 2005
Asesllus hilgendorfii	juveniles	97	N	R			25	19-24 d	NOEC	reproduction	> 0.01	2	6	EC, 2005
Insecta														
Aedes aegypti		0.5						5-6 d	LOEC	emergence	> 25	3	3,7,8,9	Adames and Rovira, 1993
Aedes aegypti	egg	0.5	N	S				3d	NOEC	eclosion	31250	3	1,9,10,11	Sihuincha et al., 2005
Aedes aegypti	4th instar	0.5	N	Sc	tw			10 d	LC50	mortality	0.004	3	1,9,12	Sihuincha et al., 2005
Aedes aegypti	4th instar	0.5	N	Sc	tw			10 d	LC50	mortality	0.014	3	1,9,12	Sihuincha et al., 2005
Aedes aegypti	4th instar	0.5	N	Sc	tw			10 d	LC50	mortality	0.024	3	1,9,12,13	Sihuincha et al., 2005
Aedes aegypti	late 3rd, early 4th instar	0.5	N	S	nw		25±1	7 d	EC100	emergence	20	3	1,14,15,16	Nayar et al., 2002
Aedes aegypti	late 3rd, early 4th instar	0.5	N	Sc	nw		13.4 - 30.2	7 d	EC100	emergence	20	3	1,14,15,17	Nayar et al., 2002
Aedes aegypti	early 4th instar larvae		N		tw				EC50	mortality	7	4	8,18,19	Dash and Ranjit, 1992
Aedes aegypti	egg		N	S	tw				EC26	hatching	7	4	8,18,20	Dash and Ranjit, 1992
Aedes aegypti	egg		N	S	tw				EC37	hatching	660	4	8,18,21	Dash and Ranjit, 1992
Aedes aegypti	egg		N	S	tw				EC72	emergence	7	4	8,18,20	Dash and Ranjit, 1992
Aedes aegypti	egg		N	S	tw				EC27	fecundity	7	4	8,18,20	Dash and Ranjit, 1992
Aedes aegypti	3rd instar, Bora strain	98.7	N	S	dw		27	to adult	LC50	mortality	0.11	3	22,23	Darriet and Corbel, 2006
Aedes aegypti	early 4th instar larvae	99.5	N	Sc	dw		25	10 d	EC50	emergence	0.0017	3	22	Paul et al., 2006
Aedes aegypti	4th instar, Gose strain	0.5	N	S	dw			7 d	EC100	emergence	< 10	3	8,9,15	Kawada et al., 1988
Aedes aegypti	4th instar	96.2	N	S			25±1	until emergence	LC10	mortality	0.0015	2	24,25	Loh and Yap, 1989
Aedes aegypti	4th instar	96.2	N	S			25±1	until emergence	LC50	mortality	0.021	2	24	Loh and Yap, 1989
Aedes aegypti	4th instar	96.2	N	S			25±1	until emergence	NOEC	pupation	> 0.0214	3	3,22	Loh and Yap, 1989
Aedes aegypti	4th instar	96.2	N	S			25±1	until emergence	LOEC	emergence	< 0.0214	3	3,22	Loh and Yap, 1989
Aedes aegypti	4th instar	96.2	N	S			25±1	until emergence	LOEC	hatchability	< 0.0214	3	3,22	Loh and Yap, 1989
Aedes aegypti	3th and 4th instar	0.5	N	S					NOEC	emergence	< 10	3	9,26	De Resende & Gama, 2006
Aedes aegypti	4th instar	97.2			dw		26	until emergence	EC50	emergence	0.023	2		Hatakoshi et al., 1987
Aedes albopictus	late 3rd, early 4th instar	0.5	N	S	nw		25±1	7 d	EC100	emergence	20	3	1,9,14,15	Nayar et al., 2002
Aedes albopictus	late 3rd, early 4th instar	0.5	N	Sc	nw		13.4 - 30.2	7 d	EC100	emergence	20	3	1,9,14,15,17	Nayar et al., 2002
Aedes albopictus	late 3rd, early 4th instar	97	N	S	tw		26±2	7-10 d	EC50	mortality	0.11	3	27,28	Ali et al., 1995
Aedes albopictus	late 3rd, early 4th instar	97	N	S	tw		26±2	7-10 d	EC90	mortality	0.376	3	27,28	Ali et al., 1995
Aedes taeniorhynchus	late 3rd, early 4th instar	0.5	N	S	nw		25±1	7 d	EC100	emergence	20	3	1,9,14,15	Nayar et al., 2002

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Exp. Time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Aedes taeniorhynchus	late 3rd, early 4th instar	0.5	N	Sc	nw		13.4 - 30.2	7 d	EC100	emergence	20	3	1,9,14,15,17	Nayar et al., 2002
Anopheles albimanus		0.5						5-6 d	LOEC	emergence	25	3	3,7,8,9,29	Adames and Rovira, 1993
Anopheles albimanus	4th instar, strain SUS	5	N	S	dw		25		IC50	emergence	0.016	3	8,9,22,30	Kawada et al., 1993
Anopheles albimanus	4th instar, OPC-R	5	N	S	dw		25		IC50	emergence	0.00042	3	8,9,22,31	Kawada et al., 1993
Anopheles balabacensis	4th instar		N	S	dw			48 h	LC50	mortality	0.04	3	8,28,32	Iwanaga and Kanda, 1988
Anopheles balabacensis	4th instar		N	S	dw			48 h	LOEC	mortality	<0.001	3	8,28,32	Iwanaga and Kanda, 1988
Anopheles balabacensis	4th instar		N	S	dw			48 h	LC95	mortality	88	3	8,28,32	Iwanaga and Kanda, 1988
Anopheles balabacensis	4th instar		N	S	dw			48 h	LC5	mortality	1.8E-05	3	8,46,28,32	Iwanaga and Kanda, 1988
Anopheles balabacensis	4th instar, female		N	S	dw			48 h	LOEC	oviposition	<0.005	3	3,8,28,32	Iwanaga and Kanda, 1988
Anopheles balabacensis	4th instar, male		N	S	dw			48 h	LOEC	spermiogenesis	<0.005	3	3,8,28,32	Iwanaga and Kanda, 1988
Anopheles culicifacies	3rd and 4th instar	0.5	N	Sc	nw				LOEC	emergence	10	3	1,3,33	Yapabandara and Curtis, 2004
Anopheles farauti	4th instar	5	N	S	dw		25		EC50	emergence	0.0017	3	3,9,22	Kawada et al., 1993
Anopheles gamiae	4th instar,strain SUS	5	N	S	dw		25		EC50	emergence	0.025	3	8,9,22,30	Kawada et al., 1993
Anopheles gamiae	4th instar, strain DLD-R	5	N	S	dw		25		EC50	emergence	0.0098	3	8,9,22,31	Kawada et al., 1993
Anopheles gamiae	4th instar, strain DDT-R	5	N	S	dw		25		EC50	emergence	0.004	3	8,9,22,31	Kawada et al., 1993
A. quadrimaculatus	late 3rd, early 4th instar	0.5	N	S	nw		25±1	7 d	EC100	emergence	20	3	1,9,14,15	Nayar et al., 2002
A. quadrimaculatus	late 3rd, early 4th instar	0.5	N	Sc	nw		13.4 - 30.2	7 d	EC100	emergence	20	3	1,9,14,15,17	Nayar et al., 2002
Anopheles stephensi	early 4th instar		N		tw		26-28		EC50	mortality	2	4	8,18,34	Dash and Ranjit, 1992
Anopheles stephensi	egg		N	S	tw		26-28		EC22	hatching	2	4	8,20	Dash and Ranjit, 1992
Anopheles stephensi	egg		N	S	tw		26-28		EC31	hatching	110	4	8,20	Dash and Ranjit, 1992
Anopheles stephensi	egg		N	S	tw		26-28		EC89	emergence	2	4	8,21,35	Dash and Ranjit, 1992
Anopheles stephensi	egg		N	S	tw		26-28		EC24	emergence	2	4	8,21,35	Dash and Ranjit, 1992
Anopheles stephensi	4th instar, Gose strain	0.5	N	S	dw			7 d	EC100	emergence	< 10	3	3,8,9,15	Kawada et al., 1988
Anopheles stephensi	4th instar, strain SUS	5	N	S	dw		25		EC50	emergence	0.043	3	8,9,22,30	Kawada et al., 1993
Anopheles stephensi	4th instar, strain MLT-R	5	N	S	dw		25		EC50	emergence	0.025	3	8,9,22,31	Kawada et al., 1993
Anopheles stephensi	4th instar	97.2			dw		26	until emergence	EC50	emergence	0.0430	2		Hatakoshi et al., 1987
Anopheles culicifacies	larvae from field strain	0.5		S				until emergence	NOEC	emergence	< 10	3	9	Yapabandara and Curtis, 2004
Anopheles subpictus	larvae from field strain	0.5		S				until emergence	NOEC	emergence	< 10	3	9	Yapabandara and Curtis, 2004
Chironomus riparius	2 day old, 1st instar	97.9	Y	S		7.6-8.2	19-22	28 d	NOEC	development	10	3	36	EC, 2005
Culex nigripalpus	late 3rd, early 4th instar	0.5	N	S	nw		25±1	7 d	EC100	emergence	20	3	1,9,14,15	Nayar et al., 2002
Culex nigripalpus	late 3rd, early 4th instar	0.5	N	Sc	nw		13.4 - 30.2	7 d	EC100	emergence	20	3	1,9,14,15,17	Nayar et al., 2002
Culex pipens pallens	4th instar, TH strain	97.2	N	S					EC50	emergence	0.016	4	37	Kawada et al., 1988
Culex pipens pallens	4th instar, Gose strain	0.5	N	S	dw			7 d	EC 100	emergence	< 10	3	8,9,14,15	Kawada et al., 1988
Culex pipens pallens	4th instar, Gose strain	5	N	S	dw			7 d	EC 100	emergence	< 10	3	8,9,14,15	Kawada et al., 1988
Culex pipens pallens	4th instar, Gose strain	5	N	S	dw			7 d	EC 100	emergence	< 10	3	8,9,14,15	Kawada et al., 1988
Culex pipens pallens	4th instar, Gose strain	0.5	N	S	dw			7 d	EC 100	emergence	< 10	3	3,8,9,15	Kawada et al., 1988
Culex pipens pallens	4th instar, Gose strain	0.5	N	S	nw	9.2	24-29	7 d	LOEC	emergence	< 0.05	3	3,8,9,19	Kawada et al., 1988
Culex pipens pallens	4th instar, Gose strain	5	N	S	nw	8.4	24-29	7 d	LOEC	emergence	< 0.05	3	3,8,9,19	Kawada et al., 1988
Culex pipiens pallens	4th instar	97.2			dw		26	until emergence	EC50	emergence	0.0046	2		Hatakoshi et al., 1987
Culex quinqefasciatus		0.5						5-6 d	LOEC	emergence	25	3	3,7,8,9	Adames and Rovira, 1993
Culex quinqefasciatus	late 3rd, early 4th instar	0.5	N	S	nw		25±1	7 d	EC100	emergence	20	3	1,9,14,15	Nayar et al., 2002
Culex quinqefasciatus	late 3rd, early 4th instar	0.5	N	Sc	nw		13.4 - 30.2		EC100	emergence	20	3	1,9,14,15,17	Nayar et al., 2002
Culex quinqefasciatus	early 4th instar		N		tw				EC50	mortality	16	4	8,18,38	Dash and Ranjit, 1992
Culex quinqefasciatus	egg		N	S	tw				EC19	hatching	16	4	8,18,20	Dash and Ranjit, 1992
Culex quinqefasciatus	egg		N	S	tw				EC21	hatching	760	4	8,18,21	Dash and Ranjit, 1992
Culex quinqefasciatus	egg		N	S	tw				EC77	emergence	16	4	8,18,20	Dash and Ranjit, 1992
Culex quinqefasciatus	egg		N	S	tw				EC18	fecundity	16	4	8,18,20	Dash and Ranjit, 1992
Culex quinqefasciatus	larvae	97	N	S	tw		28±3	7-10 d	EC50	mortality	0.29	4	27	Ali et al., 1999
Culex quinqefasciatus	larvae	97	N	S	tw		28±3	7-10 d	EC90	mortality	1.1	4	27	Ali et al., 1999
Culex quinqefasciatus	4th instar	96.6		S	dw		27	until emergence	EC50	Mortality	0.083	2	39	Kasai et al., 1998

Species	Species properties	Purity [%]	A	Test type	Test water	pH	T [ºC]	Exp. Time	Criterion	Test endpoint	Value [µg/L]	Ri	Notes	Reference
Musca domestica	4d old; WHO strain	97.2			am		26	until emergence	EC50	emergence	0.0091	3	40	Hatakoshi et al., 1987
Musca domestica	4d old, CSMA strain	97.2			am		26	until emergence	EC50	emergence	0.0031	3	40	Hatakoshi et al., 1987
Musca domestica	4d old, WHO strain	97.2			am		26	until emergence	EC50	emergence	0.0030	3	41	Hatakoshi et al., 1987
Musca domestica	eggs, WHO strain	97.2			am		26	until emergence	EC50	emergence	0.0270	3	40	Hatakoshi et al., 1987
Musca domestica	eggs, WHO strain	97.2			am		26	until emergence	EC50	emergence	0.0120	3	41	Hatakoshi et al., 1987
Polypedilum nubifer	late instar	0.5	N	S					EC 90	emergence	10	3	8,9,42,43	Trayler et al., 1994
Pisces														
Oncorhynchus mykiss	eggs	97.2	Y	F		8-8.6	10-11	95 d	LOEC	hatchability	> 30	1	2	EC, 2005
Oncorhynchus mykiss	eggs	97.2	Y	F		8-8.6	10-11	95 d	NOEC	length, immobility	4.3	1	2,44	EC, 2005

Notes:

1 Result based on nominal concentration a.i.
2 Measured concentrations within 80% of nominal concentrations.
3 Only one test concentration.
4 Radiochemical purity, chemical purity not reported.
5 LOEC is 0.020 µg/L.
6 DAR: not acceptable because of lack of documentation on measurement of water quality parameters and because compound is not analyzed. For the purpose of the derivation of environmental risk limits this is validity = 2.
7 Only abstract with no exact data.
8 Not clear if reported in mg a.i./L or in mg formulation/L.
9 Purity too low.
10 Hay/water infusion(10 g hay/1l water boiled for 5 min).
11 Far above water solublity.
12 Exposure in 'disposable pots', most likely not glass.
13 LC90 = 0.00061 mg/L.
14 Only two test concentrations.
15 100% of emergence inhibition at LOEC.
16 Exposure in plastic tubs.
17 Outdoor condition -temperature, light.
18 According to WHO 1981, without any other information about test condition.
19 Field experiment, larvae were released into a cage placed at the centre of each pot, tested only at two test concentration, 100% inhibition of emergence
20 Tested at one concentration which is the LC50 for mortality.
21 Tested at one concentration; which is the LC90 for mortality.
22 Too much solvent used (1%).
23 LC95 = 0.00061 mg/L.
24 Continuous exposition until emergence to adult, daily recorded mortality.
25 EC10 calculated using Graphpad prism.
26 Study reported in Portuguese language, not all details copied in this table.
27 Concentration solvent probably too high, 1% in control, not reported for test.
28 Exposure in paper cups.
29 Only one addition, effects noted 21 days after exposure.
30 Strain which shows normal susceptibility to insecticides.
31 Resistant strain; LC50 for resistant strain in this test was lower than the LC50 for the susceptible strain.
32 Exposure was 48 hours followed by next 6 days without exposure; tests were evaluated after that period.
33 Field experiments, not determined exp. duration, no data about water, temperature; significant reduction *An. culicifacies* (78%) and *An. subpictus* (72%).
34 LC90 = 0.11 mg/L.
35 All successful adults that emerged after treatment of eggs were allowed to mate and lay eggs.
36 spiked water test, endpoint based on nominal initial concentrations in water phase; not possible to derive TWA-concentration in sediment
37 Study not described in methods, probably data from a former study.
38 LC90 = 0.66 mg/L.
39 According to WHO standard bioassay protocols
40 Artificial medium with large amount of bran and animal food.
41 Artificial medium with chicken manure.
42 Exposure time not clear. The test was terminated when pupal mortality in the control aquaria reached 20%.
43 Including 2 cm layer of sand.
44 LOEC is 0.0067 mg/L.
45 Results based on mean measured concentrations.
46 LC5 calculated from LC90 and LC50

Table A2.3. Acute toxicity of pyriproxyfen to marine organisms.

Species	Species properties	Purity	A	Test type	Test water	pH	T	Salinity	Exp. time	Criterion	Test endpoint	Value	Ri	Notes	Reference
		[%]					[°C]	[‰]				[µg/L]			
Crustacea															
Leander tenuicornis	Adult, 2.41±0.16 cm	2	N	S	nw	7.6	25	27.5	96 h	LC50	mortality	98	3	1	Brown et al., 1996
Americamysis bahia									96 h	LC50	mortality	70	4		Officie of Pesticide programs, 2000
Pisces															
Pseudomugil signifer	late juvenile to adult, 27.1 mm	2	N	S	nw	7.5	25	31	96 h	LC50	mortality	845	3	1,2	Brown et al., 1998
Cyprinodon variegatus									96 h	LC50	mortality	> 320	4		Officie of Pesticide programs, 2000

Notes:
1 Purity too low
2 Above water solubility

Table A2.4. Chronic of pyriproxyfen to marine organisms.

Species	Species properties	Purity	A	Test type	Test water	pH	T	Salinity	Exp. time	Criterion	Test endpoint	Value	Ri	Notes	Reference
		[%]					[°C]	[‰]				[µg/L]			
Crustacea															
Americamysis bahia	1st instar, <24hr old	95.3	Y	F		8.0-8.5	26-27	24-26	28 d	NOEC	reproduction	0.81	1	1	EC, 2005
Palaemonetes pugio	larvae, <12hr old		N	R	nw		25	20	20 d	NOEC	growth	≥ 10	2	2,3	Tuberty and McKenney, 2005
Palaemonetes pugio	larvae, <12hr old		N	R	nw		25	20	11 d	NOEC	Mortality	≥ 10	2	2,3	Tuberty and McKenney, 2005
Palaemonetes pugio	larvae, <12hr old		N	R	nw		25	20	20 d	LOEC	Development duration	< 10	2	2,3	Tuberty and McKenney, 2005
Rhithropanopeus harrisii	larvae, <12hr old		N	R	nw		25	20	14 d	NOEC	Growth	≥ 10	2	2,3	Tuberty and McKenney, 2005
Rhithropanopeus harrisii	larvae, <12hr old		N	R	nw		25	20	13 d	NOEC	Mortality	≥ 10	3	2,3,4	Tuberty and McKenney, 2005
Rhithropanopeus harrisii	larvae, <12hr old		N	R	nw		25	20	14 d	LOEC	development duration	< 10	2	2,3	Tuberty and McKenney, 2005
Tigriopus japonicus	juveniles	97%	N				25		5d	NOEC	Development, sex ratio, mortality	≥ 0.01	2	5	EC, 2005
Tigriopus japonicus	juveniles	97%	N				25		8d	NOEC	reproduction	≥ 0.01	2	5	EC, 2005

Notes:
1 LOEC = 0.0016 mg/l
2 Growth was measured as a dry weights
3 Only one test concentration used
4 Control percentage survival was 45%
5 DAR: not acceptable because of lack of documentation on measurement of water quality parameters and because compound is not measured. For the purpose of environmental risk limit derivation this is validity =2.

Appendix 3. Description of mesocosm studies

Study 1

Species; Population; Community	algae; cladocerans; copepods; ostracods; rotifers
Test Method	indoor microcosms
System properties	eutrophic, 18 l volume
Formulation	Pyriproxyfen 10EC, 102 g as.L^{-1}
Exposure regime	single application below water surface
Analysed	Y
Temperature [°C]	18.6-20.6
pH range	
Hardness [mg $CaCO_3$/L]	
Exposure time	3 d
Criterion	$NOEC_{acute}$
Test endpoint	Community
Value [µg/L]	5
GLP	Y
Guideline	-
Ri	2
Reference	EC, 2005 (study of van Wijngaarden, 2004)

In the DAR for pyriproxyfen, an indoor microcosm study performed with Pyriproxyfen 10EC in compliance with GLP is evaluated. The present evaluation of the microcosm study is solely based on the summary of the microcosm study in the DAR.
The cosm contained a plankton-dominated community consisting of algae, cladocerans, copepods, ostracods and rotifers. The microcosms consisted of an all glass cylinder to which a 2 cm thick layer of mixed sediment from an uncontaminated eutrophic ditch were added. The cosms received a single application below the water surface to reach nominal treatment levels of 0, 0.02, 0.08, 0.32, 1.2, 5 and 20 µg as/L after gently stirring. Control microcosms were treated with water only. Each treatment was tested in three replicate cosms. An additional microcosm was set up at 5 µg as/L to investigate dissipation of pyriproxyfen. Two further microcosms were used to provide control samples for chemical analysis.
Samples of water for determination of pyriproxyfen concentration were taken from all dosing solutions. In addition, water samples were taken to determine the actual concentration before pesticide application and on days 1, 3, 7, 14, 28, 42 and 56 days after application.
Chlorophyll-*a* content of phytoplankton and the species composition of the zooplankton were determined 8 and 1 day before application and 3, 7, 14, 21, 28, 35, 42, 49 and 56 days after pesticide application.

Calculations and statistics

Multiple t-test of Williams, multivariate analysis using Principal Repose Curves. NOECs per sampling date were determined by applying the Williams test to the sample scores of the first principal component of each sampling date. Statistical significance of treatment effects at the community level was tested using a Monte-Carlo permutation procedure.

RESULTS

Chemical analysis

In the DAR it is reported that levels of pyriproxyfen in dosing solutions ranged from 96 to 105% of nominal. The level of pyriproxyfen in samples of microcosm water collected within 1 hour after treatment was between 100 and 108% of nominal at test concentrations of 0.32-20 µg as/L. Actual concentration after 1 hour was 138% of nominal in the 0.08 µg as/L treatment and 415% of nominal in the 0.02 µg as/L treatment. At the latter concentration, pyriproxyfen concentrations in duplicate samples from individual microcosms differed by a factor of 2.3, 7.7 and 13.4. According to the author

of the original report (Van Wijngaarden), the high variation was considered to be an artifact of sampling at very low concentrations. For risk assessment under 91/414/EEC, the evaluators of the DAR reasoned that there is no impact on the study validity since conclusions are based on nominal concentrations and measured concentrations in general exceeded nominal concentrations. Moreover, the DAR-evaluators added that NOECs and LOECs were established at a concentration with acceptable analytical confirmation.
In the additional fate microcosm at 5 µg as/L, pyriproxyfen concentrations in the water decreased from 5.1 µg as/L at <1 h post application to 0.012 µg as/L after 7 days. Later on, the actual concentration had dropped below the detection limit of 0.006 µg as/L. The first order DT_{50} value was calculated to be 0.8 days and the DT_{90} value 2.6 days.

Chlorophyll

Concentrations of chlorophyll were very low throughout the test. Therefore, no NOEC-determination could be performed. Inspection of the data suggested that no treatment related response occurred and the NOEC for chlorophyll content was suggested to be ≥ 20 µg as/L.

Cosm water

No concentration related effects were observed for community metabolism indicators, i.e. temperature, oxygen concentration, pH and conductivity. Some isolated statistically significant deviations were found but these were considered no to bear any ecological significance. Thus, the NOEC for community metabolism was considered to be ≥ 20 µg as/L.

Zooplankton

Effects on zooplankton populations were summarized as presented in the table below. This table is copied from the DAR (table B.9.19 in the DAR).

Table 1 NOECs (µg as/L) per sampling date for zooplankton populations and community. Concentrations > NOEC showed significant increases (↑) or reductions (↓). NOECs based on poor data are not shown.

	sampling day										
Parameter	**-8**	**-1**	**3**	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**56**
Cladocera											
Daphnia gr. *galeata*			5 (↓)	1.2 (↓)	5 (↓)	5 (↓)	5 (↓)				
Cladocera total			5 (↓)	5 (↓)		5 (↓)	0.32 (↓)[b]				
Ostracoda							5 (↓)[d]	5 (↓)[d]			
Copepoda	no treatment related effects										
Rotifera											
Anuraeopsis fissa			0.02 (↑)[e]	5 (↑)	5 (↑)	5 (↑)	5 (↑)				
Polyartha remata			5 (↑)	5 (↑)	5 (↑)	5 (↑)	5 (↑)	5 (↑)			
Keratella quadrata	5 (↓)[c]				5 (↑)					5 (↑)	5 (↑)
Rotifera total			5 (↑)	5 (↑)	5 (↑)	5 (↑)					
Community[a]			5	5	5	5					

[a] Determined by William's test applied to the sample scores of the first principal component of each sampling date ($p<0.05$).
[b] No clear concentration–response relationship, isolated observation late in study.
[c] Before treatment. Therefore, not treatment related.
[d] Low and scattered abundance numbers, no concentration-response relationship. NOEC not valid because data not suitable for adequate analysis.
[e] One isolated observation, no concentration-response relationship.

No consistent treatment related effects on ostracods and copepods were recorded. Most sensitive zooplankton species was recorded to be *Daphnia* group *galeata*. This species showed reduction on the first sampling day (day 3) and on day 28 at 20 µg as/L but the population recovered within 35 days. At 5 µg as/L, a significant reduction of density on day 3 was observed, but density had recovered after 1 week post-application. Based on this latter effect, the $NOEC_{population}$ was considered to be the 1.2 µg

as/L treatment. Most rotifer populations were back to normal levels with 42 days. Abundance of *Keratella quadrata* was however reduced until study termination at 20 µg as/L.
PRC analysis identified a $NOEC_{community}$ of 5 µg as/L on basis of statistical significant deviations of the 20 µg as/L treatment between day 0 and 12 (recovery on day 28). The authors of the original report (van Wijngaarden) set the NOEC of the microcosm study at 5 µg as/L, based on a clear long-term effect (increase in *K. quadrata*) with no full recovery within 8 weeks. Also the NOEAEC is set at 5 µg as/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? No, the system is small-sized and does not contain any macroinvertebrates.
2. Is the description of the experimental set-up adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? Yes. The substance disappears rapidly from the system. Therefore, the study can only be used for derivation of a MAC-value.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes.
5. Is it possible to evaluate the observed effects statistically? Yes.

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

Evaluation of the results of the study

For acute effects (3 days post-exposure), the NOEC is the 5 µg as/L treatment. Since actual concentrations ranged from 100 to 108% of nominal one hour after application at test concentrations of 0.32-20 µg as/L, the nominal value of 5 µg as/L as measure of initial concentration is considered to be the NOEC of this study

.

Schaefer and Miura (1990)

Species; Population; Community	zooplankton, macroinvertebrates, fish
Test Method	outdoor macrocosms
System properties	riceplots, 37.2 m^2
Formulation	Pyriproxyfen 10EC
Exposure regime	two applications with 3 weeks interval, at water surface
Analysed	Y
Temperature [°C]	
pH range	
Hardness [mg $CaCO_3$/L]	
Exposure time	24 h
Criterion	$NOEC_{acute}$
Test endpoint	
Value [µg/L]	<11
GLP	
Guideline	
Notes	poor statistical analysis
Ri	2
Reference	Schaefer and Miura (1990)

The study was conducted in experimental rice plots of 37.2 m^2. Average water depths of control, high- and low-rate plots were 21, 18.5 and 16 cm, during the first application and 21, 20 and 20 cm during the second application, respectively. The plots were supplied with water from a reservoir where deep-well water was stored for irrigation use. In one corner of each plot, a sump was excavated and enclosed with wire screen to provide a holding area for bluegill sunfish. The fish were used to measure potential bioaccumulation of pyriproxyfen.

Plots were treated twice with three weeks interval at 0.05 kg as/ha (three replicates) and 0.11 kg as/ha (three replicates). Controls and both treatment levels were replicated three times. Rice plant growth during the first application was in the joining stage; most of the water surface was open to air and plants were 10 to 15 cm above the water surface. During the second application most rice plants were at the booting stage and the entire surface was covered by the rice canopy.

Water, sediment, soil, algae, fish and macrophytes samples were taken on regular basis to determine pyriproxyfen concentrations. Plankton, benthos (drag-netting) and nekton (trapping for 24 hours) were sampled throughout the experiment at least once a week.

Calculations and statistics
Statistical analysis by ANOVA. Control and treatment means were compared with Duncan's multiple range test. To compare the controls and the high and low treatments, the ratio of means before and after treatment were calculated for each organism. From the article is extracted by the present evaluator that this implies that a mean density for the whole post-application period is calculated and statistically analysed.

RESULTS
Chemical analysis
Fortification of water samples at 5 µg/L showed an average recovery of 92.2% ± 1.9%. At the low application rate, actual concentrations ranged between 6.3 and 17 µg/L (mean 11 µg/L) 1 hour post-application. On day 1, actual concentrations ranged between 0.59 and 9.0 µg/L (mean 1.1 µg/L). On day 2 and afterwards, actual concentrations had dropped below the detection limit of 0.05 µg/L. The second application resulted in actual concentrations of 6.2-9.7 µg/L (mean 7.5 µg/L) 1 hour after

application and 0.21 – 0.62 µg/L (mean 0.4 µg/L) one day after application. Thereafter, actual concentrations had dropped below the detection limit.
At the high application level, actual concentrations were between 16 and 58 µg/L (mean 33 µg/L) 1 hour post-application. On day 1, actual concentrations were between 0.56 and 6.4 µg/L (mean 3.5 µg/L) and on day 2 between 0.21 and 0.76 µg/L (mean 0.52 µg/L). On later sampling dates, the actual concentrations had dropped below the detection limit. The second application resulted in actual concentrations of 6.2-9.7 µg/L (mean 7.5 µg/L) 1 hour after application and 0.21 – 0.62 µg/L (mean 0.4 µg/L) one day after application. Thereafter, actual concentrations had dropped below the detection limit.
The lowest detectable limit in mud samples was 1 µg/L. No pyriproxyfen was detected in any of the mud samples. Thus, it was concluded that pyriproxyfen did not accumulate in the soil.
The lowest detectable level in fish tissues was 5 $\mu g/kg_{bw}$, recovery 95-99%, depending on body parts. Highest residues were found on the first days after application, ranging from 0.079 to 0.77 mg/kg_{bw} in the lower treatment and from 0.22 to 3.88 mg/kg_{bw} in the higher treatment. No residues in fish were found in any of the treatments after 3 days. Therefore, it was concluded that no long-term accumulation occurred at these high treatment rates.
The lowest detectable limit in rice plants was 5 µg/kg. Actual concentration was highest 1 h to 1 day after application. Actual concentrations were between 0.37 and 1.013 mg/kg in the lower treatment and between 0.49 and 6.19 mg/kg in the higher treatment.

Invertebrate sampling
Dipper collections
Hydra, planaria, nematodes, rotifers, crustaceans, aquatic earthworms and immature insects (damselflies, dragonflies, corixids, beetes and mosquitoes) were collected by dipping. Most abundant collections made by dipping were cladocerans and copepods. Ostracods were collected but because of their locomotion, numbers were considered not to reflect the actual numbers present in the plots. Immature insects and other invertebrate collections were sporadic. Therefore, only copepod, cladoceran and rotifer collections were examined statistically. Mean densities of these populations were significantly different in the treatments compared to the control. From a figure in the article can be extracted that mean densities of Cladocera were higher in the control compared to both treatments during the whole assessment period. For Rotifera, no dose-response curve can be extracted from the figure. For Eucopepoda, a deline in mean numbers is observed before and until 8 days after the first treatment. Thereafter, mean control densities of Eucopepoda are similar to mean densities in the treatment.
Drag-net collection
Twenty groups of organisms were collected by this method. Nine groups were regularly collected. They were Oligochaeta, Podocopa, Chironomidae, Zygoptera, Anisoptera, Turbellaria, Notonectidae, Gastropoda and Hydrozoa. Groups periodically found in the collections were Nematoda, Hirudinea, Corixidae, Belostomatidae, Gerridae, Veliidae, Ceratopogonidae, Tabanidae, Procoela (tadpole) and Osteichthyes (fish). Periodically appearing groups were not statistically analysed. Means of Notonectidae and Hydrozoa densities in the controls were not significantly different from the treatments. Oligochaeta, Podocopa, Chironomidae, Zygoptera, Anisoptera, Turbellaria, Notonectidae, Gastropoda and Hydrozoa densities in the controls were significantly higher compared to the densities in the treatments.
At this point of the article, the article stops. Only the statistical analyses of densities gathered by traps is presented, but no graphs and test are available. In the table presenting statistics on trap collected invertebrates, mean densities of Hydrophilidae, Dytiscidae, Notonectidae, Anisoptera, Zygoptera and Lycosidae are analysed. Only for Notonectidae and Zygoptera statistical differences between controls and treatments are reported.

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? Unclear, acclimatisation of the rice plots is not reported. Fish were present "periodically". If fish were present in all cosms before the first pesticide application is not reported. Moreover, currently it is unclear how acute effects on tropical systems can be translated to moderate climates.
2. Is the description of the experimental set-up adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? Yes. The substance disappears rapidly from the system. Therefore, the study cannot be used for derivation of a MPC-value.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes.
5. Is it possible to evaluate the observed effects statistically? No. Statistical evaluation as described in the article is unsatisfactory. Mean densities during the whole experimental period after the first application were averaged and subjected to an ANOVA-analyses followed by Duncan's multiple range test. On basis of the data presented in the article no statistics can be carried out. However, although only very basic statistics had been carried out using mean densities of populations during the whole assessment period of 52 days, the NOEC of the present study can be set < low application rate, because even the mean densities over the whole assessment period show statistical deviation of both treatments from the control. At the low application rate, actual concentrations ranged between 6.3 and 17 µg/L (mean 11 µg/L) 1 hour post-application. Thus, the initial NOEC is < 11 µg/L .

This criteria result in an overall assessment of the study reliability. The study is considered to be not reliable (Ri 3), due to uncertainties about the test system and poor statistics. Furthermore, the system is not considered representative for moderate climates.

Appendix 4. Detailed bird and mammal toxicity data

Table A4.1. Bird and mammal toxicity data for pyriproxyfen

Species	Species properties	purity	Application route	Exposure time	Criterion	Test endpoint	Effect concentration [mg/kg diet]	Ri	Notes	Reference
Mallard duck	6d old	95.3	diet	5d	NOAEL	mortality	>4956	2		EC, 2005
Bobwhite quail	13d old	95.3	diet	5d	NOAEL	mortality	>4956	2		EC, 2005
Mallard duck	21w old	95.3	diet	21w	NOAEL	reproduction, survival, mortality	>572	2		EC, 2005
Bobwhite quail	17w old	95.3	diet	22w	NOAEL	reproduction, survival, mortality	>572	2		EC, 2005
rats		97.2	diet	28d	NOAEL	body weight	1000	2		EC, 2005
rats		95.3	diet	13w	NOAEL	body weight	2000	2		EC, 2005
rats		97.2	diet	6 mo	NOAEL	body weight	2000	2		EC, 2005
rats		95.3	diet	2 y	NOAEL	body weight	120	2		EC, 2005
rats		95.3	diet	2 generation	NOAEL	body weight, food consumption	1000	2		EC, 2005
mice		95.3	diet	78 w	NOAEL	mortality	120	2		EC, 2005

rivm

Appendix 5. References used in the appendices

DAR:

European Commission. 2005. Pyriproxyfen, Draft Assessment Report. Rapporteur Member State: The Netherlands.

Other references:

Adames E, Rovira J. 1993. Evaluation of the juvenile growth regulator pyriproxyfen (S-31183) against three species of mosquitoes in Panama. J Am Mosq Control Assoc 9 : 452-453.

Ali A, Chowdhury MA, Hossain ML, Mahmud Ul Ameen, Habiba DB, Aslam AFM. 1999. Laboratory evaluation of selected larvicides and insect growth regulators against field-collected Culex quinquefasciatus larvae from urban Dhaka, Bangladesh. J Am Mosq Control Assoc 15: 43-47.

Brown MD, Carter J, Thomas D, Purdie DM, Kay BH. 2002. Pulse-exposure effects of selected insecticides to juvenile Australian crimson-spotted rainbowfish (Melanotaenia duboulayi). J Econ Entomol 95: 294-298.

Brown MD, Thomas D, Kay BH. 1998. Acute toxicity of selected pesticides to the Pacific blue-eye, Pseudomugil signifer (Pisces). J Am Mosq Control Assoc 14: 463-466.

Brown M, Thomas D, Watson K, Greenwood J, Kay B. 1996. Acute toxicity of selected pesticides to the estuarine shrimp Leander tenuicornis (Decapoda:Palaemonidae). J Am Mosq Control Assoc 12: 721-724.

Darriet F, Corbel V. 2006. Laboratory evaluation of pyriproxyfen and spinosad, alone and in combination, against Aedes aegypti Larvae. J Med Entomol 43: 1190-1194.

Dash AP, Ranjit MR. 1992. Comparative efficacy of aphid extracts and some juvenoids against the development of mosquitoes. J Am Mosq Control Assoc 8: 247-251.

de Resende MC, Gama RA. 2006. Persistence and efficacy of growth regulator pyriproxyfen in laboratory conditions for Aedes aegypti. Revista da Sociedade Brasileira de Medicina Tropical 39: 72-75.

Hatakoshi M, Kawada H, Nishida S, Kisida H, Nakayama I. 1987. Laboratory evaluation of 2-[1-methyl-2-(4-phenoxyphenoxy)-ethoxy]pyridine agains larvae of mosquitoes and housefly. Jpn J Sanit Zool 38: 271-274.

Iwanaga, K Kanda T. 1988. The effects of a juvenile hormone active oxime ether compound on the metamorphosis and reproduction of an anopheline vector, Anopheles balabacensis (Diptera: Culicidae). Appl Entomol Zool 23:186-93.

Kakuchi N, Kitamikado A, Sasamori T, Tanaka Y, Ishiwata Y, Sakurai A, Shimizu K, Kamata Si. 1996. Toxicity of several insecticides against ciliate Colpoda aspera. Anim. Sci. Technol. 67: 844-850.

Kasai S, Weerashinghe IS, Shono T. 1998. P450 monooxygenases are an important mechanism of permethrin resistance in Culex quinquefasciatus Say larvae. Arch Insect Biochem Physiol 37: 47-56.

Kawada H, Dohara K, Shinjo G. 1988. Laboratory and field evaluation of an insect growth regulator, 4-phenoxyphenyl-(RS)-2-(2-pyridyloxy)propyl ether, as a mosquito larvicide. Jpn J Sanit Zool 39: 339-346.

Kawada H, Shono Y, Ito T, Abe Y. 1993. Laboratory evaluation of insect growth regulators against several species of anopheline mosquitoes. Jpn J Sanit Zool 44: 349-353.

Loh P, Yap H. 1989. Laboratory studies on the efficacy and sublethal effects of an insect growth regulator, Pyriproxyfen (S-31183) against Aedes aegypti (Linnaeus). Trop. Biomed. 7-12.

Nayar JK, Al A, Zaim M. 2002. Effectiveness and residual activity comparison of granular formulations of insect growth regulators pyriproxyfen and s-methoprene against florida mosquitoes in laboratory and outdoor conditions. J Am Mosq Control Assoc 18: 196-201.

Paul A, Harrington LC, Scott JG. 2006. Evaluation of novel insecticides for control of dengue vector Aedes aegypti (Diptera : Culicidae). J Med Entomol 43: 55-60.

Schaefer CH, T. Miura. 1990. Chemical Persistence and Effects of S-31183, 2-[1-Methyl-2-(4-Phenoxyphenoxy)Ethoxy]Pyridine, on Aquatic Organisms in Field Tests. J Econ Entomol 83: 1768-1776.

Sihuincha M, Zamora Perea E, Orellana Rios W, Stancil JD, Lopez Sifuentes V, Vidal Ore C, Devine GJ. 2005. Potential use of pyriproxyfen for control of Aedes aegypti (Diptera : Culicidae) in Iquitos, Peru. J Med Entomol 42: 620-630.

Trayler KM, Davis JA. 1996. Sensitivity of Daphnia carinata sensu lato to the insect growth regulator, pyriproxyfen. Ecotoxicol Environ Saf 33: 154-156.

Trayler KM, Pinder AM, Davis JA. 1994. Evaluation of the juvenile hormone mimic pyriproxyfen (S-31183) against nuisance chironomids (Diptera: Chironomidae), with particular emphasis on Polypedilum nubifer (Skuse). J Aust Entomol Soc 33: 127-130.

Tuberty SR, McKenney CL. 2005. Ecdysteroid responses of estuarine crustaceans exposed through complete larval development to juvenile hormone agonist insecticides. Integrative and Comparative Biology 45: 106-117.

Yapabandara AMGM, Curtis CF. 2004. Control of vectors and incidence of malaria in an irrigated settlement scheme in Sri Lanka by using the insect growth regulator pyriproxyfen. J Am Mosq Control Assoc 20: 395-400.

RIVM

National Institute
for Public Health
and the Environment

P.O. Box 1
3720 BA Bilthoven
The Netherlands
www.rivm.com