National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Water quality standards for imidacloprid

Proposal for an update according to the Water Framework Directive

RIVM Letter report 270006001/2014
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This investigation has been performed by order and for the account of the Ministry of Infrastructure and the Environment, within the framework of the project "Chemical aspects of WFD and RPS"

This is a publication of:

National Institute for Public Health and the Environment
P.O. Box 1 | 3720 BA Bilthoven
The Netherlands
www.rivm.nl/en

Publiekssamenvatting

Herziening waterkwaliteitsnormen voor imidacloprid
Het RIVM stelt voor om de waterkwaliteitsnorm voor het bestrijdingsmiddel imidacloprid te verlagen van 67 naar 8,3 nanogram per liter. Uit nieuwe onderzoeken blijkt dat de schadelijke effecten van imidacloprid op waterorganismen zich al bij lagere concentraties voordoen dan verwacht.

Probleemstof
Imidacloprid is een insecticide dat behoort tot de groep van neonicotinoïden. Het middel wordt op grote schaal gebruikt in de landbouw, maar ook in en om het huis, bijvoorbeeld in mierenlokdoosjes en vlooiendruppels. Neonicotinoïden staan volop in de belangstelling vanwege een mogelijke relatie met bijensterfte. Om die reden heeft de Europese Commissie eind vorig jaar besloten om het gebruik van imidacloprid in de teelt van een groot aantal gewassen te beperken. Imidacloprid is ook een probleemstof in oppervlaktewater en staat in Nederland hoog in de top-10 van normoverschrijdende stoffen.

Huidige norm beschermt onvoldoende
De huidige normen voor oppervlaktewater zijn in 2008 vastgesteld. Sinds die tijd zijn er veel nieuwe studies gepubliceerd naar de effecten van imidacloprid op organismen in water. Recent onderzoek toont aan dat vooral eendagsvliegen (haften) zeer gevoelig zijn voor imidacloprid. Deze studies maken duidelijk dat de huidige norm haften onvoldoende beschermt, en mogelijk ook andere groepen insecten. Het RIVM heeft daarom de beschikbare gegevens geëvalueerd en geconcludeerd dat de norm voor lange-termijn blootstelling in zoetwater moet worden verlaagd met een factor acht. De norm voor kortdurende piekblootstelling van 0,2 microgram per liter blijft hetzelfde.

Lagere concentraties zijn haalbaar
In januari 2014 heeft het College voor de toelating van gewasbeschermingsmiddelen en biociden (Ctgb) extra beperkingen opgelegd aan het gebruik van imidacloprid. Het afvalwater uit kassen moet worden gezuiverd en bij de bespuiting van gewassen in het veld moet worden voorkomen dat het insecticide overwaait naar het nabij gelegen water. Door deze maatregelen komt er minder imidacloprid in het oppervlaktewater terecht, wat de kans vergroot dat aan de nieuwe norm kan worden voldaan.

Het onderzoek is uitgevoerd in opdracht van het ministerie van Infrastructuur en Milieu.

Abstract

Revision of water quality standards for imidacloprid
RIVM proposes to lower the water quality standard for the pesticide imidacloprid from 67 to 8.3 nanogram per liter. Recent research shows that effects of imidacloprid on water organisms become apparent at lower concentrations than expected.

Problematic substance
Imidacloprid is a neonicotinoid insectide with a widespread use in agriculture, but it is also authorised for household uses such as ant or fly control. Neonicotinoids receive a lot of attention because of the presumed relationship with bee health decline. The European Commission decided last year to restrict the use of imidacloprid in a large number of crops. Imidacloprid is also known as a problematic substance from the viewpoint of water quality. It is ranked high in the top-10 of substances that exceed water quality standards for surface water in the Netherlands.

Sensitive aquatic organisms
The current water quality standards were set in 2008. A large number of studies on the effects of imidacloprid on water organisms have been published since then. Recent research shows that mayflies are particularly sensitive. The new data show that the current standard is under protective for mayflies and probably also for other insect groups. Therefore, RIVM evaluated the available data and concludes that an eight-fold lower standard for long-term exposure in freshwater is needed. The standard for short-term peak exposure of 0.2 microgram per liter can be maintained.

Lower concentrations are feasible
In January 2014, the Dutch board for the authorisation of plant protection products and biocides (Ctgb) restricted the use of imidacloprid. Treatment of discharge water from greenhouses is compulsory and further measures should be taken to reduce drift from treated fields to nearby surface waters. These measures will lead to lower emissions of imidacloprid to surface water and increase the chance that the new water quality standards will be met.

This research was carried out by order of the Dutch Ministry of Infrastructure and the Environment.

Contents

Summary

In this report a proposal is made for environmental quality standards (EQSs) for imidacloprid in surface water. Imidacloprid is a neonicotinoid insecticide that is included in Dutch national legislation under the Water Framework Directive (WFD). The current EQSs were derived by RIVM in 2008 and based on these values imidacloprid belongs to the top-10 of plant protection products (PPP) that pose a problem concerning water quality in the Netherlands.

During the past years, a large number of new aquatic ecotoxicity studies have been published. Most probably the attention for imidacloprid is related with the ongoing debate on the presumed relationship between neonicotinoid use and bee health decline worldwide. The new data include long-term studies on aquatic insects, which at the time of standard derivation in 2008 were not available. Recent information shows that mayflies are particularly sensitive, indicating that the current water quality standard for long-term exposure might not be protective for the aquatic ecosystem. The Dutch Ministry of Infrastructure and the Environment ordered RIVM to update the data evaluation and propose new standards for imidacloprid.

The WFD distinguishes two types of water quality standards: a long-term standard, expressed as an annual average concentration (AA-EQS) and normally based on chronic toxicity data, which should protect the ecosystem against adverse effects resulting from long-term exposure; and a standard for short-term concentration peaks, referred to as a maximum acceptable concentration EQS (MAC-EQS). The available literature concerning ecotoxicity to water organisms was (re-)evaluated, including several micro- and mesocosm studies.

From the data it appears that large differences in sensitivity exist among aquatic species, even within one taxonomic group. Overall midges and mayflies appear to be the most sensitive organism groups. Because a relatively large number of acute and chronic data is available, statistical extrapolation techniques were applied for the derivation of standards. Semi-field data were considered as well. Based on the new information the current MAC-EQS of 0.2 µg/L can be maintained. The newly proposed AA-EQS is 8.3 ng/L.

Because the proposed AA-EQS is a factor of eight lower than the current standard, this would potentially lead to a higher frequency and/or number of locations at which the standards are exceeded in the Netherlands. On the other hand, recent restrictions on field and greenhouses applications of imidacloprid should result in decreased emissions to surface water. Future monitoring data will ultimately reveal the overall impact of the newly proposed standard on the assessment of Dutch surface water quality.

1 Introduction

1.1 Background of this report

In this report a proposal is made for environmental quality standards (EQSs) for imidacloprid in surface water. Imidacloprid is a neonicotinoid insecticide that is included in Dutch national legislation in the context of the Water Framework Directive (WFD). The compound is listed as a specific pollutant in the Dutch decree on WFD-monitoring (*Regeling monitoring Kaderrichtlijn water*).
Under the WFD, two types of EQSs are derived to cover both long- and short-term effects resulting from exposure:

- an annual average concentration (AA-EQS) to protect against the occurrence of prolonged exposure, and
- a maximum acceptable concentration (MAC-EQS) to protect against possible effects from short term concentration peaks.

In Dutch, these two WFD-standards are indicated as '*JG-MKN*' and '*MAC-MKN*', respectively[1]. The current AA-EQS for imidacloprid is 0.067 µg/L, the MAC-EQS is 0.2 µg/L [1]. These values were derived by RIVM in 2008 [2]. Based on these EQSs, imidacloprid belongs to the top-10 of plant protection products (PPP) that pose a problem concerning water quality in the Netherlands [3,4].
During the past years, a large number of new aquatic ecotoxicity studies have been published, which apparently has to do with the ongoing debate on the presumed relationship between neonicotinoid use and bee health decline worldwide. The new data include studies on aquatic insects, for which at the time of standard derivation in 2008 only few data were available from short-term studies only. Recent information [5] indicates that for mayflies long-term exposure may result in effects at concentrations that are lower than the present AA-EQS of 0.067 µg/L. This indicates that the current water quality standard is not protective for long-term exposure to imidacloprid. Moreover, the most sensitive taxa were only poorly represented in the study which was used as a basis for the MAC-EQS, indicating that re-evaluation of this standard is needed as well. In view of the above, the Dutch Ministry of Infrastructure and the Environment assigned RIVM to update the data evaluation for imidacloprid and propose new values for the AA- and MAC-EQS.

1.2 Standards considered

As indicated above, this report primarily focuses on the WFD-water quality standards. Next to the AA-EQS and MAC-EQS, the WFD also considers a standard for surface water used for drinking water abstraction. Below, a short explanation on the respective standards is provided and the terminology is summarised in Table 2. Note that all standards refer to dissolved concentrations in water.

- Annual Average EQS (AA-EQS) – a long-term standard, expressed as an annual average concentration (AA-EQS) and normally based on chronic toxicity data which should protect the ecosystem against adverse effects resulting from long-term exposure.

  The AA-EQS should not result in risks due to secondary poisoning and/or risks for human health aspects. These aspects are therefore also

[1] JG = Jaargemiddelde = annual average; MKN = milieukwaliteitsnorm = environmental quality standard.

addressed in the AA-EQS, when triggered by the characteristics of the compound (i.e. human toxicology and/or potential to bioaccumulate). Separate AA-EQSs are derived for the freshwater and saltwater environment.

- Maximum Acceptable Concentration EQS (MAC-EQS) for aquatic ecosystems – the concentration protecting aquatic ecosystems from effects due to short-term exposure or concentration peaks. The MAC-EQS is derived for freshwater and saltwater ecosystems, and is based on direct ecotoxicity only.

- Quality standard for surface water that is used for drinking water abstraction ($QS_{dw, hh}$). This is the concentration in surface water that meets the requirements for use of surface water for drinking water production. The $QS_{dw, hh}$ specifically refers to locations that are used for drinking water abstraction.

The quality standards in the context of the WFD refer to the absence of any impact on community structure of aquatic ecosystems. Hence, not the potential to recover after transient exposure, but long-term undisturbed function is the protection objective under the WFD. Recovery in a test situation, after a limited exposure time, is therefore not included in the derivation of the AA- and MAC-EQS.

Table 1. Overview of the different types of WFD-quality standards for freshwater (fw), saltwater (sw) and surface water used for drinking water (dw) considered in this report.

Type of QS	Protection aim	Terminology for temporary standard[1]	Notes	Final selected quality standard
long-term	Water organisms	$QS_{fw, eco}$ $QS_{sw, eco}$	Refers to direct ecotoxicity	lowest water-based QS is selected as AA-EQS_{fw} and AA-EQS_{sw}
	Predators (secondary poisoning)	$QS_{biota, secpois, fw}$ $QS_{biota, secpois, sw}$	QS for fresh- or saltwater expressed as concentration in biota, converted to corresponding concentration in water	
		$QS_{fw, secpois}$ $QS_{sw, secpois}$		
	Human health (consumption of fishery products)	$QS_{biota, hh food}$	QS for water expressed as concentration in biota, converted to corresponding concentration in water; valid for fresh- and saltwater	
		$QS_{water, hh food}$		
short-term	Water organisms	MAC-$QS_{fw, eco}$ MAC-$QS_{sw, eco}$	Refers to direct ecotoxicity; check with $QS_{fw, eco}$ and $QS_{sw, eco}$	MAC-EQS_{fw} MAC-EQS_{sw}
dw	Human health (drinking water)		Relates to surface water used for abstraction of drinking water	$QS_{dw, hh}$

1: Note that the subscript "fw" refers to the freshwater, "sw" to saltwater; subscript "water" is used for all waters, including marine.

For the purpose of national water quality policy, e.g. discharge permits or specific policy measures, two additional risk limits are derived:

- Negligible Concentration (NC) – the concentration in fresh- and saltwater at which effects to ecosystems are expected to be negligible and functional properties of ecosystems are safeguarded fully. It defines a safety margin which should exclude combination toxicity. The NC is derived by dividing the AA-EQS by a factor of 100, in line with [6,7].

- Serious Risk Concentration for ecosystems (SRC_{eco}) – the concentration in water at which possibly serious ecotoxicological effects are to be expected. The SRC_{eco} is valid for the freshwater and saltwater compartment.

1.3 Methodology

1.3.1 Guidance documents

The methodology is in accordance with the European guidance document for derivation of environmental quality standards under the WFD [8]. This document is further referred to as the WFD-guidance. Additional guidance for derivation of risk limits that are specific for the Netherlands, such as the NC and SRC, can be found in [9]. This guidance document was prepared for derivation of environmental risk limits in the context of the project "International and national environmental quality standards for substances in the Netherlands (INS)", and is further referred to as the INS-guidance. Similar to the WFD-guidance, the INS-guidance is based on the Technical Guidance Document (TGD), issued by the European Commission and developed in support of the risk assessment of new notified chemical substances, existing substances and biocides [10] and on the Manual for the derivation of Environmental Quality Standards in accordance with the Water Framework Directive [11]. The WFD-guidance also takes into account the most recent guidance developed under REACH [12]. It should be noted that the WFD-guidance deviates from the INS-guidance for some aspects. This specifically applies to the treatment of data for freshwater and marine species (see section 4.1) and the derivation of the MAC (see section 4.2), and also holds for the QS for surface waters intended for the abstraction of drinking water ($QS_{dw, hh}$, see section 4.6). Where applicable, the WFD-guidance is followed and the INS-guidance is used for situations which are not covered by the former. In addition to these, additional guidance was used that was developed for the pre-registration and post-registration environmental risk assessment procedures of PPPs in the Netherlands [13,14].

1.3.2 Data sources

For the derivation of the quality standards for imidacloprid, the 2008-report [2] was taken as a starting point. The data covered in this report include the Draft Assessment Report prepared within the context of the former European pesticides directive 91/414/EEC and open literature until 2007. Additional new literature published from 2007-2013 was collected using SCOPUS (http://www.scopus.com/), using "imidacloprid and aquatic" as search string. The Competent Authority Report (CAR) prepared for the evaluation of imidacloprid under the former European biocides directive 98/8/EC was also consulted [15]. The draft EQS-derivation for imidacloprid of the Swiss Oekotoxzentrum, published in May, 2013 [16], was used as a check for any missed references and other relevant information. The registration holders in the Netherlands for PPP based on imidacloprid (Bayer Crop Science and Makhteshim Agan) were informed on the planned update and asked to send in data. Bayer

made use of this opportunity by submitting the draft report of an outdoor enclosure study with a mayfly species (see 3.2.2 and Appendix 2).

1.3.3 Data evaluation

The data from the 2008-report were checked and the additional ecotoxicity studies were screened for relevant endpoints (i.e. those endpoints that have consequences at the population level of the test species) and 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 and in the Annex to the WFD-guidance. In short, the following reliability indices were assigned, based on [17]:

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.).'

Citations
In case of (self-)citations, the original (or first cited) value is considered for further assessment, and an asterisk is added to the Ri of the endpoint that is cited.

Mesocosm experiments were evaluated and effect classes assigned according to [18].

1.3.4 Special notes on data treatment

According to the WFD-guidance, a single endpoint per species is presented based on the lowest relevant endpoint observed. If multiple reliable values are available for the same species and the same endpoint originating from similar tests, the geometric mean is taken. Unbound values are not used for EQS-derivation, but are included in the tables to show that a particular taxon has been tested. In addition, if on the basis of such values it appears that the derived value is not protective, the assessment factor may be adapted.

If endpoints are available from tests with different durations, preference is given to the endpoints from tests that followed the minimum test duration as specified in the guideline, e.g. at least 72 hours for algae, 48 hours for daphnids, 96 hours for fish [13,14]. If lower endpoints are available from test that are shorter than the prescribed duration, e.g. 48 hours for algae or 24 hours for daphnids, the higher values obtained with the minimum prescribed test duration are preferred. In principle, the test duration for daphnids is considered applicable to other invertebrates as well.

For EQS-derivation, studies with the active substance are considered most relevant. Effects of formulations, if present, will be relevant for the edge-of-field surface waters, but less so for larger bodies in which the WFD-monitoring points are located. According to the WFD-guidance, a single endpoint per species should be used by calculating the geometric mean of multiple comparable toxicity values for the same species and the same endpoint. When for a given species results are available from similar tests with the active substance and with formulations (for comparable endpoints), it should be determined whether or not the results can be pooled. Recently, it was proposed to follow the procedure that is used to judge the span of species sensitivities for MAC-derivation, and use the geometric mean of the available values for active substance and products if the standard deviation of the log-transformed individual toxicity values is <0.5 [14]. However, further analysis of this proposal reveals that with small datasets, endpoints differing by more than a factor of 10 can also meet this criterion. Therefore a more arbitrary cut-off value is used here: if the endpoints for product and active substance differ by more than a factor of 3, the value of the active substance is used. However, if for a species the most critical endpoint originates from a test with a formulated product, and no comparable endpoint from a test with the active substance is available, this endpoint of the formulation is used for risk limit derivation.

For imidacloprid, special attention was paid to the maintenance of test concentrations in view of its susceptibility to photodegradation (see Table 4). Dissipation rate in the two static mesocosm studies (see 3.2.2 and Appendix 2) ranged from 28 hours to 13 days, which is most likely due to differences in photolysis caused by e.g. location, time of the year, weather conditions and system related factors such as plant cover and turbidity. From the available data, it is not fully clear whether or not photolysis is a crucial factor under laboratory test conditions. In some studies, no dissipation was observed although exposure was performed under light [19,20]. In other studies, however, dissipation of imidacloprid was observed and some authors report lower toxicity for studies performed under light as compared to studies under darkness [21]. Apparently, the influence of light differs among tests, depending on the light conditions, test water, test vessels, etc. In view of this, studies which were performed under light without analytical verification of test concentrations are assigned Ri 3.

1.4 Status of the results

The results presented in this report have been discussed by the members of the Scientific Advisory Group for standard setting for water and air in the Netherlands (*WK-normstelling water en lucht*). It should be noted that the proposed standards in this report are scientifically derived values, based on (eco)toxicological, fate and physico-chemical data. They serve as advisory values for the Dutch Ministry of Infrastructure and the Environment, that is responsible for setting EQSs. The values presented in this report should thus be considered as advisory values that do not have an official status.

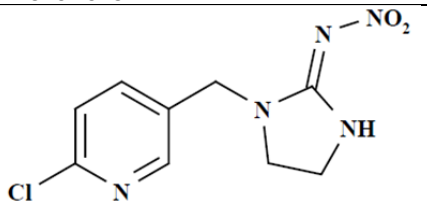
2 Information on the substance

2.1 Intended uses

Imidacloprid is a systemic insecticide belonging to the class of neonicotinoids. The compound is approved for use in the European Union under Regulation (EC) No 1107/2009 (repealing Directive 91/414/EEC). Intended uses in the Netherlands include a variety of crops, among which various greenhouse crops. Applications can be made by means of treated seed, drip irrigation or spray applications. It is also authorised for non-professional use, e.g. to control ants or flies. In May, 2013, the European Commission has adopted a proposal (Regulation (EU) No 485/2013) to restrict the use of imidacloprid and two other neonicotinoid pesticides in response to a scientific report of the European Food Safety Authority (EFSA). EFSA identified potential high acute risks for bees resulting from exposure to dust in several crops such as maize, cereals and sunflower, from exposure to residues in pollen and nectar in crops like oilseed rape and sunflower, and from uptake of guttation fluid in maize [22-24]. Applications in greenhouses and full-crop applications that take place after flowering were not included in the European restrictions. However, based on some of the studies on aquatic arthropods that are also included in this report, the Dutch board for the authorisation of plant protection products and biocides (Ctgb) recently lowered the regulatory acceptable concentration (RAC) to 27 ng/L and restricted the use of several imidacloprid-based products [25,26]. Treatment of discharge water from greenhouses and further drift reduction measures for field applications are made compulsory.

2.2 Substance identification

Table 2 Substance identification

Name	imidacloprid
Chemical name	1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine
CAS number	[138261-41-3] [105827-78-9] former number
Molecular formula	$C_{14}H_{16}ClN_3O$
Molar mass	255.7 g/mol
EC number	428-040-8
Structural formula	
SMILES code	C1CN(C(=N1)N[N+](=O)[O-])CC2=CN=C(C=C2)Cl
Use class	Insecticide
Mode of action	Imidacloprid is a systemic insecticide which binds to the nicotinic acetylcholine receptors of nerve cells [19,27]

2.3 Physico-chemical properties

Table 3 Physico-chemical properties

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	255.7		[19]
Water solubility	[mg/L]	610	20 ºC	[19]
pK_a	[-]	-		
log K_{OW}	[-]	0.57		[19]
		0.41	KowWin	[28]
		-1.56	ClogP	[29]
log K_{OC}	[-]	2.36	K_{oc} 212 L/kg[1]	[19]
Vapour pressure	[Pa]	4×10^{-10} 9×10^{-10}	20 ºC 25 ºC[2]	[19]
Melting point	[°C]	144 ºC		[19]
Boiling point	[°C]			[19]
Henry's law constant	[$Pa.m^3$/mol]	1.7×10^{-10}		[19]

1: mean of 12 soils
2: extrapolated; 50-70 ºC

2.4 Fate and behaviour

Selected environmental properties of imidacloprid are given in Table 4.

Table 4 Selected environmental properties of imidacloprid

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	appr. 1 year	No degradation at pH 5, slight degradation at pH 9.	[19]
Photolysis half-life	DT50	57 min.	pH 7, 23-24.5 ºC, artificial light, sterile water	[19]
		4.2 h.	environmental, calculated	[30]
		4.7-18 min.	25 ºC, 254 nm	[31]
		1.2 h.	24 ± 1 ºC, ≥ 290 nm, deionised water	[32]
		43 min.	HPLC grade water	[32]
		126 min.	formulated product in tap water	[32]
		144 min.	formulated product + TiO_2 in tap water	[32]
Degradability			not readily biodegradable	[19]
Water/sediment systems	DT50 [d]	129 32 142	Stillwell, Kansas, silty clay NL, loamy silt NL, loamy sand	[19]
Relevant metabolites	photometabolites: NTN33893-desnitro-olefine NTN33893-desnitro NTN33893-urea			[19]

From the data in Table 4, it appears that imidacloprid is susceptible to photolysis with DT50 of minutes to hours. It is not possible, however, to clearly identify the potential for photolysis under the conditions of aquatic laboratory tests. As indicated in section 1.3.4, studies which were performed under light without analytical verification of test concentrations are therefore assigned Ri 3.

2.5 Bioconcentration and biomagnification

There are no experimental data available for bioconcentration in fish. In view of the log K_{ow} of 0.57, there is no need to derive an a QS based on secondary poisoning. Using the log K_{ow}, the BCF for fish was calculated to be 0.61 L/kg according to [8,9].

3 Human toxicology and ecotoxicological effect data

3.1 Human toxicological threshold limits and carcinogenicity

The Acceptable Daily Intake (ADI) of imidacloprid is 0.06 mg/kg bodyweight per day. The harmonised classification of imidacloprid with respect to human toxicology under CLP Regulation 1272/2008/EC is H302 (harmful if swallowed). This is equivalent to R22 under Directive 67/548/EEC. According to the triggers as given in WFD-Guidance, there is no need to derive a QS for human exposure via fish.

3.2 Ecotoxicological effect data

3.2.1 Laboratory toxicity data

Detailed aquatic toxicity data for imidacloprid are tabulated in Annex 1. Based on the considerations in section 1.3.4, the valid acute and chronic ecotoxicity data for freshwater organisms are summarised in Table 5. Data for marine organisms are presented in Table 6. Marine species are organisms that are representative for marine and brackish water environments and that are tested in water with salinity >0.5 ‰.
It should be noted that the LC10-values of 14.5 µg/L for *Pteronarcys dorsata* and 34 µg/L for *Tipula* sp. originate from a 14-days test. This is shorter than the minimum test duration for chronic tests with arthropods, and the test is semi-chronic. However, because larvae are tested it is considered justified to include the data in the chronic dataset. The NOEC of ≥ 5.0 µg/L for *Sericostoma vittatum* was also performed with larvae, but lasted only 6 days. Since the result is a ≥-value, it is included merely to show that the species has been tested, the result is not used in the calculation of the $QS_{fw, eco}$.

Table 5 Selected ecotoxicity data of imidacloprid for freshwater organisms.

Acute			**Chronic**		
Taxon / species	**L(E)C50 [µg/L]**	**Reference**	**Taxon / species**	**NOEC / L(E)10 [µg/L]**	**Reference**
Bacteria			**Algae**		
Vibrio fischerii	58876 [a]	[20]	*Desmodesmus subspicatus*	106000 [k]	[20]
V. qinghaiensis sp.	79255	[33]	*Pseudokirchneriella subcapitata*	<100000 [c]	[19]
Algae			**Crustaceans**		
Desmodesmus subspicatus	389000 [b]	[20]	*Asellus aquaticus*	1.35 [d]	[5]
Pseudokirchneriella subcapitata	>100000 [c]	[19]	*Daphnia magna*	1768 [l]	[34]
Crustaceans			*Gammarus pulex*	2.95 [d]	[5]
Asellus aquaticus	119 [d]	[5]	*Hyallella azteca*	0.47 [h, m]	[35]
Ceriodaphnia dubia	2.07	[36]	**Insects**		
Chydorus sphaericus	832	[21]	*Caenis horaria*	0.024 [d]	[5]
Cypretta seuratti	1	[21]	*Chaoborus obscuripes*	1.99 [d, m]	[5]
Cypridopsis vidua	10 [d]	[21]	*Chironomus riparius*	< 0.4 [c,n]	[37]
Daphnia magna	52455 [e]	[19,20]	*Chironomus tentans*	0.42 [m]	[35]
Gammarus pulex	110 [d]	[38]	*Cloeon dipterum*	0.033 [d]	[5]
Gammarus roesseli	1.94 [f]	[39]	*Plea minutissima*	2.03 [d]	[5]
Hyallella azteca	55	[35]	*Pteronarcys dorsata*	14.5 [o,p]	[40,41]
Ilyocypris dentifera	3 [d]	[21]	*Sericostoma vittatum*	≥ 5.0 [m, p]	[37]
Insects			*Sialis lutaria*	1.28 [d]	[5]
Caenis horaria	1.77 [d]	[5]	*Tipula sp.*	34 [m, p]	[41]
Chaoborus obscuripes	284 [d]	[5]	**Fish**		
Chironomus dilutus	2.65	[42]	*Danio rerio*	300000	[20]
Chironomus tentans	6.9 [g]	[35]	*Oncorhynchus mykiss*	1200 [q]	[27]
Cloeon dipterum	1.02 [d]	[5]			
Epeorus longimanus	0.65 [h]	[43]			
Limnephilidae	1.79 [d]	[5]			
Notonecta spp.	18.2 [d]	[5]			
Plea minutissima	35.9 [d]	[5]			
Sialis lutaria	50.6 [d]	[5]			
Simulium vittatum	8.1 [i]	[44]			
Fish					
Danio rerio	227099 [j]	[20]			
Leuciscus idus melanotus	237000	[19]			
Oncorhynchus mykiss	211000	[19]			
Annelids					
Lumbriculus variegatus	6.2	[43]			

Notes
a: geometric mean of 61900 and 56000 for tests with active and formulation; marine species tested in freshwater
b: test with active, endpoint for formulation >3 times lower
c: unbound values are not used as such for EQS-derivation, value included to show that species has been tested
d: lowest relevant endpoint, immobility
e: geometric mean of 30000, 85000, and 56600, 48 h tests with formulation and active, endpoint immobility
f: most sensitive life-stage: spring collected early adults
g: geometric mean of 10.5 and 5.75, lowest relevant endpoint from tests with active
h: endpoint from most relevant test duration
i: geometric mean of 6.75, 8.25 and 9.54
j: geometric mean of 241000 and 214000, tests with active and formulation
k: test with active, endpoint for formulation >10 times lower
l: lowest relevant endpoint, number of neonates; geometric mean of 1250 and 2500
m: lowest relevant endpoint, mortality
n: lowest relevant endpoint, development rate
o: geometric mean of 15.8 and 13.3, 14-d LC10
p: test duration semi-chronic
q: lowest relevant endpoint, growth

Table 6 Selected ecotoxicity data of imidacloprid for marine organisms.

Acute			**Chronic**		
Taxon/species	**L(E)C50 [µg/L]**	**Ref**	**Taxon/species**	**NOEC/L(E)10 [µg/L]**	**Ref**
Crustaceans			**Molluscs**		
Americamysis bahia	35.9 [a]	[19,27]	*Crassostrea virginica*	>23300 [c, d]	[19,27]
Molluscs					
Crassostrea virginica	>145000 [b,c]				
Fish					
Cyprinodon variegatus	161000	[19,27]			

Notes
a: geometric mean of 37.7, 34.1 and 36 from tests with active and formulation
b: highest concentration without 50% effect
c: unbound values are not used as such for EQS-derivation, value included to show that species has been tested
d: lowest concentration without effects

3.2.2 Results from other studies, micro- and mesocosms

Several bioassay experiments and mesocosm studies are available, which are summarised in Appendix 2. Some studies (e.g. [40,41,45]) merely involve indoor single or multiple species tests under more realistic conditions, rather than studies examining the effects on aquatic communities. If valid, results of such tests have been added to the laboratory dataset.
For the derivation of water quality standards, both Canada and Switzerland point at the fact that most of the studies have been performed with formulated products, and that it is not known to what extent the formulation has contributed to the effect [16,46]. No definitive conclusion on this aspect can be drawn from the laboratory data, since there are only few organisms for which valid endpoints are available from both technical imidacloprid and formulated products. Usually, if a difference exists, formulated products tend to be more toxic than the active alone and using the endpoint for the formulation is considered to be worst case. The mesocosm and enclosure studies that are considered valid for EQS-derivation are briefly summarised below.

3.2.2.1 Outdoor pond

An experimental pond study with two spray applications of imidacloprid as Confidor SL 200 at 0.6 to 23.5 µg a.s./L with an interval of 21 days [19,47,48]. Chironomids and Baetidae were most sensitive, the NOEC was established as 0.6 µg a.s./L based on initial concentrations. Following [13], the time weighted average (TWA) concentration over 48 hours is used for derivation of the MAC-$QS_{fw, eco}$. Starting from 0.6 µg/L and using the DT50 of 8.2 days (average observed DT50 in the mesocosms), the 48-hours TWA NOEC is calculated as 0.51 µg/L. It should be judged whether the exposure in the mesocosm has been long enough to consider the study relevant for derivation of chronic water quality standards. For this, Brock et al. (2011) advise that test concentrations between peaks should not decline to <10% of initial [13]. EFSA gives a more strict criterion for the use of a single pulse study for chronic risk assessment, and requires a maximum decline to at most 20% of initial (i.e. higher level remaining) within the time window relating to the duration of the test that triggered the risk assessment [49]. With 12-20% of the initial concentration being present in the water phase just before the second application, it is concluded that exposure has been sufficiently chronic to use the study for derivation of the $QS_{fw, eco}$. For this, the NOEC is expressed as a TWA concentration, based on duration of the most critical chronic laboratory study (28 days), following recommendations of EFSA [49]. Using the average DT50 of 8.2 days, this leads to a 28-days TWA NOEC of 0.23 µg/L. It is noted that some potentially sensitive taxa were not or not well represented (Ostracoda and Amphipoda), and numbers of Ephemeroptera were too low for statistical analysis. The study is considered for EQS-derivation, taking account of these drawbacks.

3.2.2.2 Outdoor pond enclosure

An outdoor pond enclosure study with three applications of technical imidacloprid at 0.6 to 40 µg/L at a 7-days interval [50]. Clear effects on abundance and emergence of several macroinvertebrate taxa were observed at the two highest concentrations of 17.3 and 40 µg/L nominal. Ephemeroptera were most sensitive and showed effects on emergence at 3.2 µg/L nominal. No significant effects were present at 1.4 µg/L. Due to the fast decline (DT50 28 hours), the study can only be used for derivation of the MAC-$QS_{fw, eco}$. For this, the NOEC is expressed on the basis of the 48-hours TWA concentration [13], leading to a value of 0.82 µg/L.

3.2.2.3 Outdoor stream A

An outdoor stream mesocosm study with three 24-hour pulses of Admire 240 g/L at 2 and 20 µg a.s./L at an interval of 7 days [51]. Observations were made after the last pulse. The high dose caused effects on Ephemeroptera, Plecoptera and Trichoptera, Oligochaetes were sensitive as well. Coleoptera were less affected (ca. 29 % reduction). No significant effects were observed for chironomids. Average measured concentration of imidacloprid over the 24-hours exposure time at the low dose was 1.63 µg/L. This 24-hours NOEC is considered for derivation of the MAC-$QS_{fw, eco}$, taking account of the fact that exposure duration was shorter than in the laboratory studies used for MAC-derivation. On the other hand, repeated applications may be considered worst case for derivation of the MAC. It is not known, however, if a higher NOEC would have been derived when observations after a single pulse would have been made, because in other studies effects on Ephemeroptera already became apparent after a single pulse.

3.2.2.4 Outdoor stream B

An outdoor stream mesocosm study with a single 12-hours pulse of Admire 240 g/L at 0.1 to 10 µg a.s./L or continuous treatment with 0.1 to 1 µg a.s./L for 20 days [52]. For the pulse treatment, the 12-hours NOEC for emergence and abundance of the mayfly species *Epeorus* spp. (Heptageniidae) was 3.9 µg a.s./L based on actual measured concentrations of imidacloprid. For *Baetis* spp. (Baetidae), the NOEC was ≥ 9.1 µg a.s./L (actual measured). For the continuous treatment, the 20-days NOEC emergence of *Epeorus* spp. was 0.1 µg a.s./L, the NOEC for *Baetis* spp. was 0.3 µg a.s./L, based on measured concentrations. In both treatments, significant effects on adult thorax and/or head length were observed at the lowest concentration of 0.1 µg a.s./L (NOEC < 0.1 µg a.s./L). Although the ecological implications of reduced head- or thoraxlength are not clear, the authors points at a potential impact on e.g. mating success. The lowest 12-hours NOEC of 3.9 µg/L is considered for derivation of the MAC-$QS_{fw, eco}$, the lowest 20-days NOEC of 0.1 µg/L for derivation of the $QS_{fw, eco}$. In both cases it should be taken into account that exposure duration was shorter than in the laboratory studies used for the respective EQS-derivations. Furthermore, species and community interactions were not studied.

3.2.2.5 Indoor stream

An indoor stream mesocosm study with two series of three 12-hour pulses of imidacloprid (99.9% pure) at 12 µg/L, applied at a weekly interval [53,54]. Significant effects were observed on several insect taxa, with Ephemeroptera (affected after single pulse), Trichoptera (id.), Chironomidae and Gammaridae being most sensitive. The 12-hours NOEC of < 12 µg/L is considered for derivation of the MAC-$QS_{fw, eco}$, taking account of the fact that exposure duration was shorter than in the laboratory studies used for MAC-derivation.

3.2.2.6 Outdoor enclosure with *Cloeon dipterum*

An outdoor enclosure study with *Cloeon dipterum* with two applications of Imidacloprid SL 200 at 0.024 to 3.8 µg a.s./L [55]. Enclosures were stocked with *C. dipterum* larvae in September 2013 and abundance was followed until 37 days after application. The timing of the experiment did not allow for assessment of reproduction and emergence. With 36-40% of the initial concentration being present in the water phase just before the second application, it is concluded that exposure has been sufficiently chronic. A decrease in abundance was observed in one of the replicates of the 3.8 µg a.s./L treatment and consequently the NOEC was set to 1.52 µg a.s./L nominal. Taking the duration of the critical laboratory test as a starting point, a 28-days TWA

concentration is considered as most appropriate to express the NOEC. Using the DT50 of 10.8 days, this leads to a NOEC of 0.82 µg/L and this value is considered for derivation of the $QS_{fw, eco}$. The TWA concentration over 48 hours (1.43 µg/L) is considered for derivation of the MAC-$QS_{fw, eco}$.
It is noted that the 28-days NOEC of 0.82 µg/L is much higher than the EC10 for immobility of 0.033 µg/L that was observed for the same species in the 28-days laboratory test [5]. Similarly, the 48-hours TWA NOEC of 1.43 µg/L is higher than the laboratory based 96-hours EC10 for immobility of 0.1 µg/L [5]. The Minimum Detectable Difference (MDD) in the enclosure study was 49% or higher. With this MDD it is not possible to detect subtle effects at the EC10 level, since only differences of about 50% or higher can be detected as significant. In view of this, it is probably more appropriate to compare the results of the outdoor study with the 50% effect values from the laboratory test. The 96-hours EC50 is 1.02 µg/L and the 28-days EC50 is 0.126 µg/L, which is more in line with the results of the outdoor test. Another possible explanation for the high NOEC in the outdoor study could be that the larvae for the laboratory test were collected in summer (pers. comm. Paul van den Brink, Alterra), while application in the present study took place in late autumn. If animals are preparing for overwintering, this may induce changes in metabolic state. A comparison between spring and autumn collected animals was made in an acute study with *Gammarus roeseli* [39], but no conclusions can be drawn from that experiment because test water and feeding were varied as well (see Appendix 1, Table A1.1). The NOECs of 1.43 and 0.82 µg/L are considered for derivation of the MAC-$QS_{fw, eco}$ and $QS_{fw, eco}$, taking into account that only one species was evaluated and that the timing of the experiment may have influenced the sensitivity of the mayflies.

4 Derivation of water quality standards

4.1 Pooling of freshwater and marine data

According to the WFD-guidance, data for freshwater and marine species may be pooled since there are too few data to perform a meaningful statistical comparison and there are no further indications (spread of the data, read-across, expert judgement) of a difference in sensitivity between freshwater and marine organisms of the relevant taxonomic groups.

4.2 Derivation of the MAC-EQS

Acute toxicity data are available for 30 species, representing seven taxa: bacteria, algae, crustaceans, insects, molluscs (unbound value), fish and annelids. The acute base set (algae, *Daphnia*, fish) is available. Bound values are presented in Figure 1, where acute L(E)C50-values for different taxonomic groups are plotted on a log-scale. From the data in Tables 5 and 6 and Figure 1 it can be seen that there is a large variation in sensitivity among the species tested, both between taxa as well as within taxa. Even closely related species within a taxon show large differences, despite similar life-forms and feeding strategies (see e.g. *Daphnia magna* and *Ceriodaphnia dubia* or *Gammarus pulex* and *G. roeseli*).
Overall, crustaceans and insects represent the sensitive species groups. The single value for *Lumbriculus variegatus* indicates that annelids may also represent a potentially sensitive species group. Within the group of aquatic insects, Ephemeroptera (represented by the mayflies *Caenis horaria*, *Cloeon dipterum* and *Epeorus longimanus*) and Diptera (represented by the midges *Chironomus dilutus* and *C. tentans*, and the blackfly *Simulium vittatum*) are most sensitive. The midge *Chaoborus obscuripes* seems to be an exception with a rather high acute EC50 in comparison to the other midges, but the chronic endpoint for this species is low (see Table 5).

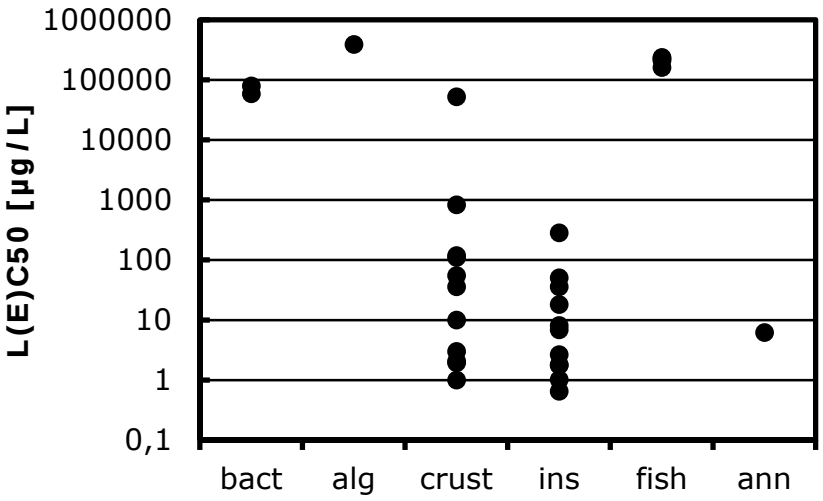


Figure 1 Representation of acute toxicity of imidacloprid to water organisms. Acute L(E)C50-values for bacteria, algae, crustaceans, insects, fish and annelids are plotted on the Y-axis. Note that Y-axis is presented on a log-scale.

4.2.1 *Assessment factor approach*

The MAC-$QS_{fw, eco}$ is derived in the first instance by putting an assessment factor of 10 to the lowest LC50 of 0.65 µg/L for *Epeorus longimanus*, resulting in a AF-based MAC-$QS_{fw, eco}$ of 0.065 µg/L.

4.2.2 *SSD approach*

The dataset does not fully meet the criteria for construction of a Species Sensitivity Distribution (SSD) as listed in the WFD-guidance. According to the guidance, the output from an SSD-based quality standard is considered reliable if the database contains preferably more than 15, but at least 10 datapoints, from different species covering at least eight taxonomic groups. Below, the criteria are copied, together with the representative species from the present dataset:

- Fish: *Danio rerio* (family Cyprinidae)
- A second family in the phylum Chordata: *Oncorhynchus mykiss* (family Salmonidae)
- A crustacean: *Asellus aquaticus*
- An insect: *Caenis horaria* (order Ephemeroptera, family Caenidae)
- A family in a phylum other than Arthropoda or Chordata: *Lumbriculus variegatus* (phylum Annelida, family Lumbriculidae)
- A family in any order of insect or any phylum not already represented: *Chaoborus obscuripes* (order Diptera), *Crassostrea virginica* (phylum Mollusca)
- Algae: *Desmodesmus subspicatus*
- Higher plants: no data

From this list it can be seen that data are missing for macrophytes only. However, in view of the fact that imidacloprid is an insecticide with a very specific mode of action, and algae are clearly not sensitive, derivation of the MAC-$QS_{fw, eco}$ by means of SSD is considered justified.

First, the HC5 value is estimated using ETX 2.0 [56] with all L(E)C50 data. The result is presented in Figure 2, details can be found in Appendix 3. As can be seen from this figure, there is a distinction between bacteria, algae and fish at the upper right side of the distribution, and crustaceans and insects at the left side. The sensitivity of insects and crustaceans seems to overlap, with the exception of *Daphnia magna*, which is clearly insensitive. The annelid *L. variegatus* is located in between insects and crustaceans. Overall, the fit of the distribution is bad which is confirmed by a rejected goodness-of-fit at all levels, except for the Kolmogorov-Smirnov test at 0.01. Based on this figure, it is considered justified to explore the option of a specific SSD for the sensitive taxa as indicated in the WFD-guidance. The first step is to construct an SSD with the species group that in line with the mode of action would be most sensitive [13]. Since there are 11 insect data, the requirements for constructing a specific SSD are met. The result is presented in Figure 3. The goodness-of-fit is accepted at all levels. The median estimate of the HC5 is 0.30 µg/L, with upper and lower limit of 0.04 and 1.0 µg/L, respectively (see Appendix 3).

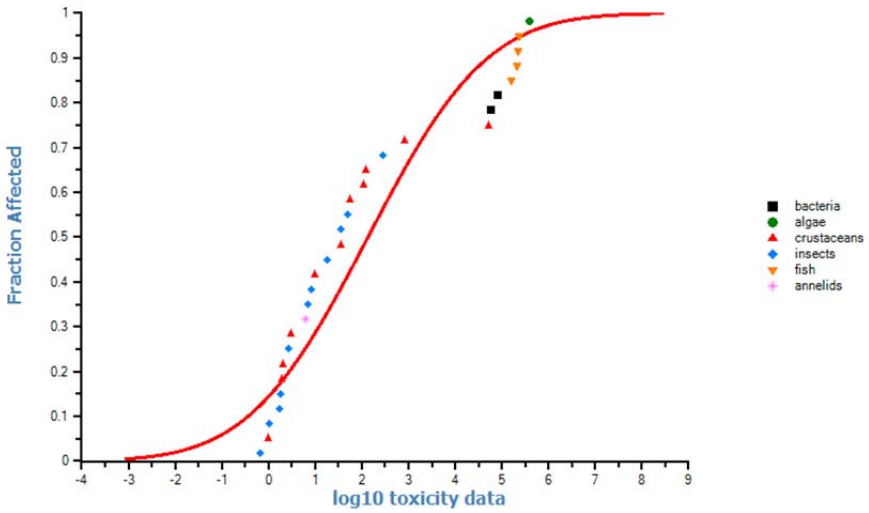


Figure 2 Species Sensitivity Distribution for imidacloprid based on acute toxicity data for all available aquatic species. The X-axis represents log-transformed L(E)C50-values in µg/L, the Y-axis represents the fraction of species affected.

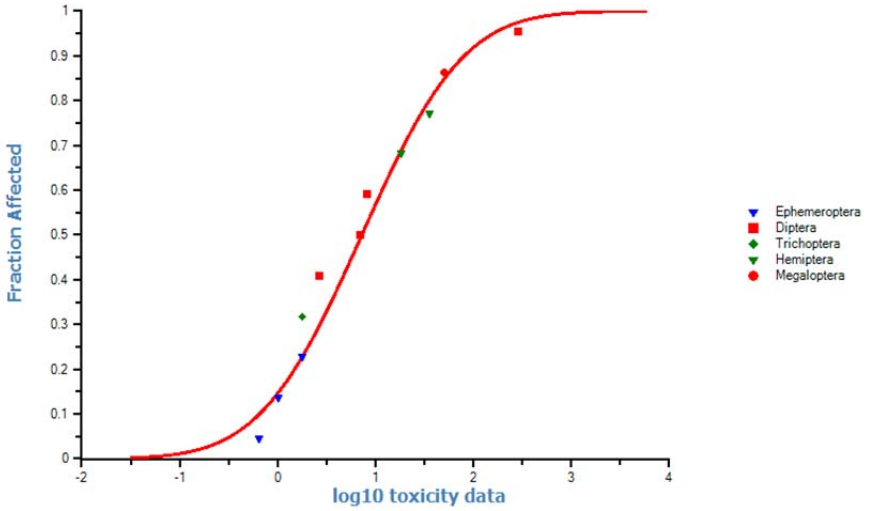


Figure 3 Species Sensitivity Distribution for imidacloprid based on acute toxicity data for aquatic insects. The X-axis represents log-transformed L(E)C50-values in µg/L, the Y-axis represents the fraction of species affected.

Since the data for crustaceans overlap with the insect data, the option of extending the dataset with the most related species group at the next higher taxonomic level (i.e. arthropods) is also explored [14]. This however, results in rejection of the goodness-of-fit (Anderson-Darling, 0.1). The result is shown in Figure 4.

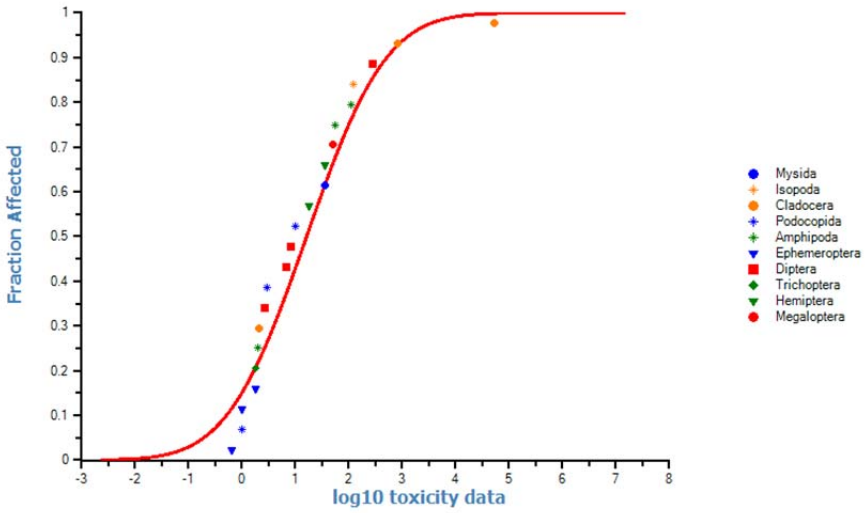


Figure 4 Species Sensitivity Distribution for imidacloprid based on acute toxicity data for aquatic arthropods (insects and crustaceans combined). The X-axis represents log-transformed L(E)C50-values in µg/L, the Y-axis represents the fraction of species affected.

When omitting the high endpoint for *D. magna* from the dataset, the goodness-of-fit is again accepted for all tests at all levels. Figure 5 shows the resulting SSD. The median estimate of the HC5 is 0.36 µg/L, which is slightly higher than the HC5 based on insects only, but with narrower confidence intervals (upper and lower limit are 0.09 and 0.97 µg/L, respectively; see Appendix 3 for details).

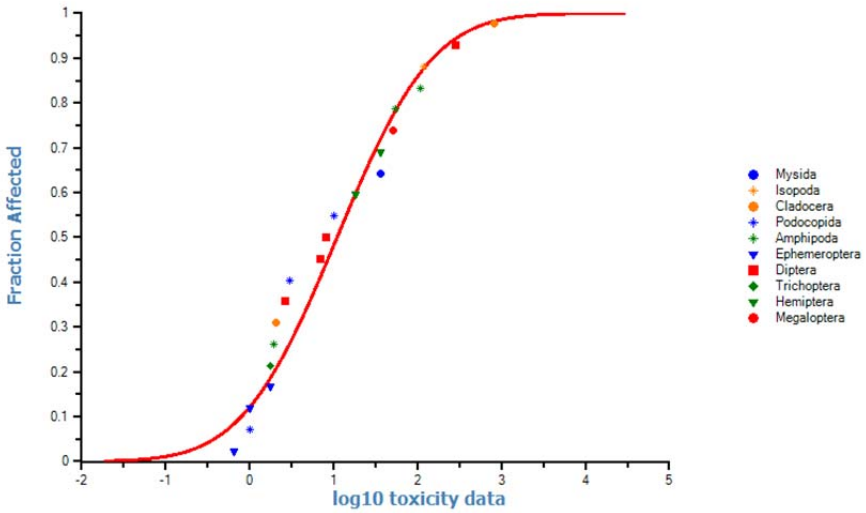


Figure 5 Species Sensitivity Distribution for imidacloprid based on acute toxicity L(E)C50 data for aquatic arthropods (insects and crustaceans combined), endpoint for Daphnia magna omitted. The X-axis represents log-transformed L(E)C50-values in µg/L, the Y-axis represents the fraction of species affected.

It is recognised that omitting the endpoint for *D. magna* from the acute SSD is an arbitrary choice, since no criteria have been defined for classifying a datapoint as an outlier. Some guidance may be found in the EFSA guidance

document on aquatic risk assessment of plant protection products in the context of European authorisation under Regulation 1107/2009/EC [49]. According to this document, a regulatory acceptable concentration may be derived on the basis of the geometric mean of available endpoints. However, in the case of differences in sensitivity of 1 or 2 orders of magnitude (factor 10–100), this option should be used with care because the result may be biased by introducing insensitive species. It is stated that if for aquatic invertebrates the most sensitive species is more than a factor of 100 below the geometric mean of all tested species, a weight of evidence approach should be applied. For imidacloprid, the difference in acute L(E)C50 values among arthropods spans six orders of magnitude, and the EC50 for *D. magna* is more than 3000 times higher than the geometric mean, while the difference for the next lower EC50 (832 µg/L for *Chydorus sphaericus*) is limited to a factor of about 50. Together with the improved fit of the distribution, this is considered an argument to omit the EC50 of *D. magna* from the dataset.

Based on the above presented SSDs, the HC5 of 0.36 µg/L is used. This is almost a factor of 2 lower than the lowest available endpoint (0.65 µg/L for *E. longimanus*). The WFD-guidance recommends to apply a default assessment factor of 10 to the HC5 when L(E)50 data are used in a generic SSD. No guidance is given on the assessment factors in case a specific SSD is constructed for the potentially most sensitive species groups. For this situation, a default assessment factor of 6 was proposed by Brock et al. [13]. It can be seen from Figure 5 that the two lowest datapoints are on the right hand side of the curve, and that the HC5 is protective. This confirms that a lower assessment factor is justified, and the value of 6 is used. This results in an SSD-based MAC-$QS_{fw, eco}$ of 0.06 µg/L. This value is in line with the HC5 of 0.05 µg/L which is obtained using the valid 96-hours EC10 values for eight arthropod species reported by Roessink et al. [5] (see Appendix 1, Table A1.1).

4.2.3 Mesocosm data

A NOEC of 0.51 µg/L is available from a pond study with two applications at a time interval of 21 days. A pond enclosure study with three applications at a 7-days interval resulted in a NOEC of 0.82 µg/L. Both values are expressed on the basis of 48-hours TWA concentrations. NOECs from stream mesocosms with single or repeated 12-24 hours pulse applications are 1.63, 3.9 and < 12 µg/L, respectively. The 48-hours TWA NOEC from the outdoor enclosure study with *C. dipterum* is 1.43 µg/L. It is not known, however, to what extent the timing of the experiment has influenced the sensitivity of the mayflies.

For derivation of the MAC-QS on the basis of a single valid mesocosm NOEC, the WFD-guidance proposes to put an assessment factor of 5 on the NOEC. According to [13], and assessment factor of 2-3 may be put on the Effect class 1 NOEC in case one mesocosm is available with a single application design. In case of multiple applications, a factor of 1-2 is proposed. A lower factor may be applied when more studies are available. To decide on the height of the assessment factor, the following considerations are made:

- According to the DAR [19], the variability in insect species sensitivity was not fully addressed in the pond study, and the most sensitive taxon of the laboratory dataset, Ephemeroptera, was not adequately represented. Ephemeroptera were, however, included in the pond enclosure study (see 3.2.2.2) and in the additional mesocosm stream studies, although the

exposure duration in these latter studies was shorter than the minimum standard test duration for arthropods of 48 hours.
- Both the pond and the pond enclosure study involve multiple applications, but it is not clear if this argument can be used to lower the assessment factor. In the pond study, the application interval was large and effects were already present after the 1st application. This was also the case in the indoor stream study which delivered the NOEC of <12 µg/L (see 3.2.2.5). The NOEC of 1.63 µg/L (stream A, 3.2.2.3) refers to multiple applications, but it cannot be judged if a single pulse would have resulted in a higher NOEC.
- The NOEC for effects on thorax and/or head length of *Baetis* sp. and *Epeorus* sp. was <0.1 µg/L. Although the ecological consequences are not clear, there is reason for concern.

Based on the above, an AF of 3 is maintained on the lowest NOEC, and the mesocosm MAC-$QS_{fw, eco}$ is set to 0.17 µg/L. This is still higher than the NOEC for thorax/head length, and also higher than the 96-hours laboratory EC10 for *C. dipterum* of 0.1 µg/L ([5]; see Appendix 1, Table A1.1). However, the other 96-hours EC10 values are a factor of 2 or more higher, and the lowest 96-hours LC10 of 2.55 µg/L for *C. horaria* is a factor of 15 higher than the mesocosm-based MAC-$QS_{fw, eco}$.

4.2.4 Selection of the MAC-EQS

The MAC-$QS_{fw, eco}$ derived by the assessment factor approach is 0.065 µg/L, the SSD approach results in 0.06 µg/L and the mesocosm approach in 0.17 µg/L. The difference between lowest and highest value is a factor of 2.8. According to the WFD-guidance, preference is given to an SSD- or mesocosm-based MAC since these entail a more robust approach towards ecosystem effects. The SSD-based MAC is obtained with an assessment factor of 6 on the HC5, which results in a value that is slightly lower than obtained with the AF-approach. As argued above, the HC5 might be a worst case estimate and probably even a lower assessment factor may be justified. This is confirmed by the information from the mesocosm studies, but no further guidance exists on the choice of the assessment factor. Based on the available information, the mesocosm-based value is selected and the MAC-EQS_{fw} is set to 0.17 µg/L. This value is very similar to the current MAC-EQS_{fw} of 0.2 µg/L, and it is advised to retain the current standard.

The MAC-$QS_{sw, eco}$ is derived on the basis of the freshwater dataset. Since there are no acute data from specific marine taxa, an additional assessment factor of 10 is applied to the MAC-$QS_{fw, eco}$. This results in a MAC-EQS_{sw} of 0.02 µg/L (20 ng/L).

4.3 Derivation of the AA-EQS

Chronic toxicity data are available for 14 species, representing five taxa: algae, crustaceans, insects, fish and molluscs (unbound value). Bound values are presented in Figure 6.

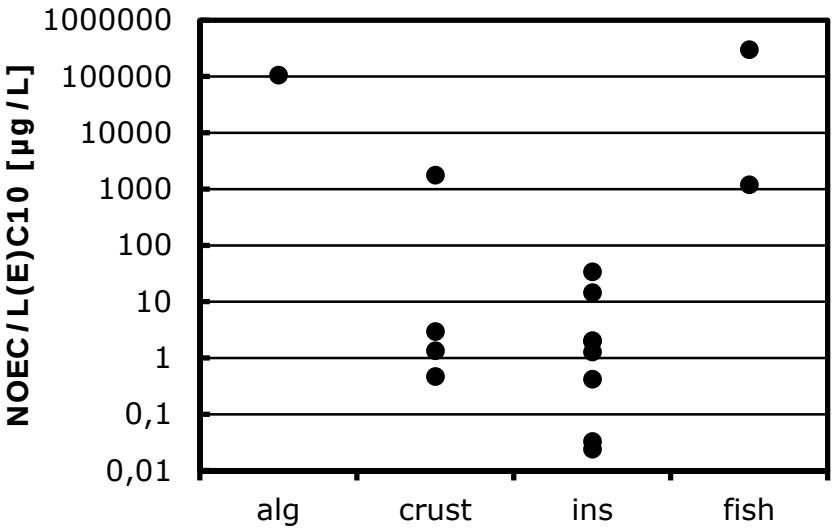


Figure 6 Representation of chronic toxicity of imidacloprid to water organisms. Chronic NOEC or L(E)C10-values for algae, crustaceans, insects and fish are plotted on the Y-axis. Note that Y-axis is presented on a log-scale.

From the data in Table 5 and 6 and Figure 8 it can be seen that there is a similar high variation in sensitivity as is present in the acute dataset. Again, crustaceans and insects represent the sensitive species groups, but the ranking of individual species as regards their relative sensitivity differs between the acute and chronic dataset. In Table 7, the species for which both acute and chronic endpoints are available are ranked from most sensitive (top) to least sensitive (bottom).

Table 7 Ranking of aquatic arthropods with respect to their sensitivity to imidacloprid. Ranking based on the acute and chronic toxicity data from laboratory tests given in Table 5. Most sensitive species in top row.

Acute	**Chronic**
Cloeon dipterum	*Caenis horaria*
Caenis horaria	*Cloeon dipterum*
Chironomus tentans	*Chironomus tentans*
Plea minutissima	*Hyallella azteca*
Sialis lutaria	*Sialis lutaria*
Hyallella azteca	*Asellus aquaticus*
Gammarus pulex	*Chaoborus obscuripes*
Asellus aquaticus	*Plea minutissima*
Chaoborus obscuripes	*Gammarus pulex*
Daphnia magna	*Daphnia magna*

Based on acute and chronic data, *D. magna* is least sensitive while *C. dipterum*, *C. horaria* and *C. tentans* are most sensitive. In between , species switch positions when comparing the acute and chronic data. This emphasises the fact that the question whether or not the potentially most sensitive species is represented in the dataset should not be based on data for individual species,

but should be evaluated considering the combined acute and chronic data of representative taxonomically related species. More guidance is needed on what level of biological organisation should be used to compare acute and chronic sensitivity [14].

4.3.1 *Assessment factor approach*

The $QS_{fw, eco}$ is derived in the first instance by putting an assessment factor of 10 to the lowest EC10 of 0.024 µg/L for the mayfly *C. horaria*, resulting in a $QS_{fw, eco}$ of 0.0024 µg/L = 2.4 ng/L.

4.3.2 *SSD approach*

There are not enough data to construct a generic SSD that meets the criteria of the WFD-guidance. Based on the same considerations as presented above for the derivation of the MAC-EQS, constructing a specific SSD might be considered for derivation of the $QS_{fw, eco}$. Combining the insects and crustaceans into one dataset for arthropods, endpoints for 12 species are available when the NOEC for *D. magna* is included. The goodness-of-fit is accepted for all tests at all levels. Figure 7 shows the resulting SSD. The median estimate of the HC5 is 0.012 µg/L (12 ng/L), with upper and lower limit of 0.0005 and 0.08 µg/L, respectively (for details see Appendix 3).

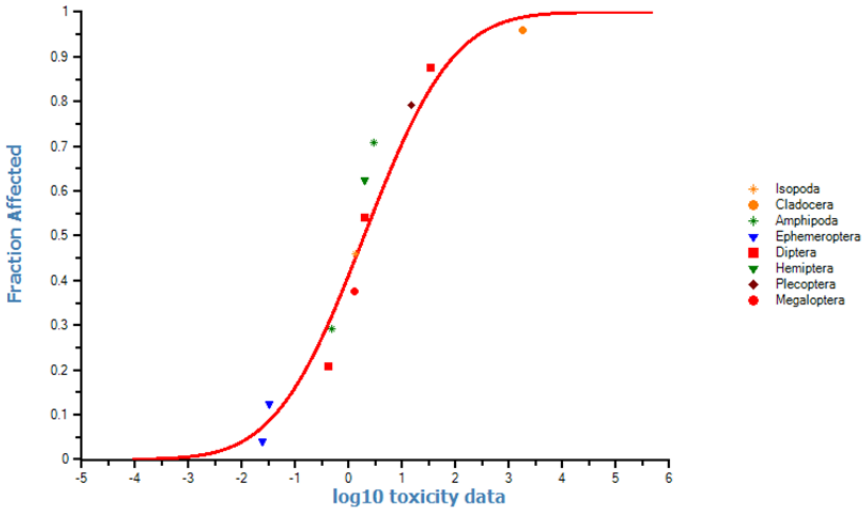


Figure 7 Species Sensitivity Distribution for imidacloprid based on chronic toxicity data for aquatic arthropods (insects and crustaceans combined). The X-axis represents log-transformed NOEC/L(E)C10-values in µg/L, the Y-axis represents the fraction of species affected.

However, following a similar reasoning as for the acute SSD, it is considered justified to leave the NOEC for *D. magna* out of the dataset, since it is more than 900 times larger than the geometric mean of all NOEC/EC10-values. Figure 8 shows the resulting SSD. The goodness-of-fit is still accepted for all tests at all levels. The HC5 is 0.025 µg/L (25 ng/L), which is similar to the lowest NOEC (0.024 µg/L for *C. horaria*). Lower and upper limits are of 0.002 and 0.1 µg/L, respectively, confidence limits are smaller than when *D. magna* is included (see Appendix 3).

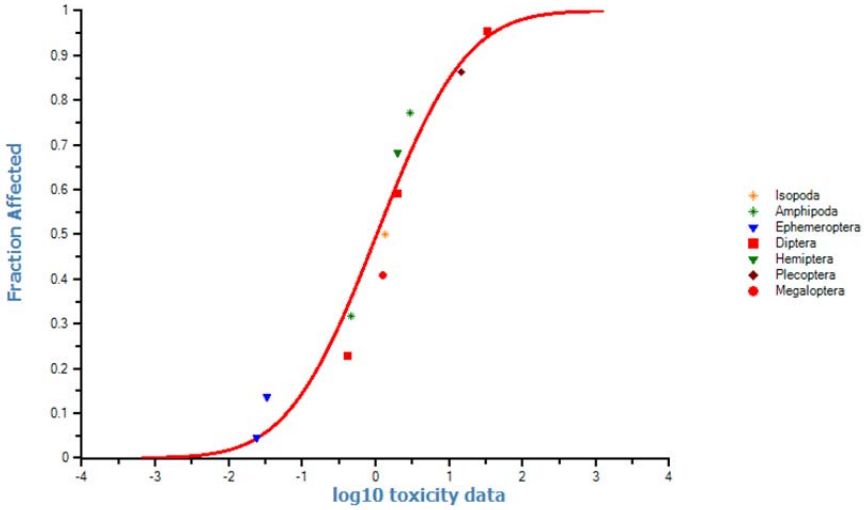


Figure 8 Species Sensitivity Distribution for imidacloprid based on chronic toxicity data for aquatic arthropods (insects and crustaceans combined), Daphnia magna omitted. The X-axis represents log-transformed NOEC/L(E)C10-values in µg/L, the Y-axis represents the fraction of species affected.

The curve without *D. magna* seems to fit less well through the datapoint for *C. dipterum*, and the HC5 is not fully worst case for *C. horaria*. On the other hand, the spread around the HC5 is smaller and this approach is consistent with that followed for the MAC-EQS.

The WFD-guidance recommends to apply a default assessment factor of 5-1 to the HC5 when chronic NOEC/L(E)10 data are used in a generic SSD. No guidance is given on the assessment factors in case a specific SSD is constructed for the potentially most sensitive species groups. A default assessment factor of 3 is proposed by [13]. To decide on the height of the assessment factor, the following considerations are made:

- The dataset is limited and does not meet the requirements of a generic SSD; the number of datapoints for sensitive taxa is only just above the minimum of 10, but the data cover the species groups that have consistently been shown to be sensitive.
- For all species for which acute and chronic data are available, the acute-to-chronic ratio (ACR) is higher than 10, ranging from 16 for *C. tentans* to 143 for *C. obscuripes* (median 39; geometric mean 47). High ACRs are found within the group of crustaceans (e.g. *A. aquaticus*, *H. azteca*) as well as among insects (*C. obscuripes*, *C. horaria*). This is an indication that a number of relatively low endpoints might be added to the chronic dataset if other acutely sensitive species would have been tested chronically. This would potentially lead to a lower HC5, as can be demonstrated using the median ACR for species for which no chronic endpoint is available.
- However, the results of the mesocosm and related studies, although not considered adequate as a direct basis for QS-derivation (see below, 4.3.3), substantiate the assumption that an assessment factor of 3 might be sufficiently protective for the sensitive aquatic taxa.

Therefore, it is proposed to maintain the assessment factor of 3 to the HC5 of 0.025 µg/L, resulting in a $QS_{fw, eco}$ of 0.0083 µg/L (8.3 ng/L). This is a factor of 2.9 lower than the lowest EC10-value.

4.3.3 Mesocosm data

A 28-days TWA NOEC of 0.23 µg/L is available from a pond study with two applications at a time interval of 21 days [19,47,48]. According to the DAR [19], the variability in insect species sensitivity was not fully addressed in this study, and the most sensitive taxon of the laboratory dataset, Ephemeroptera, was not adequately represented. To overcome this deficiency, an outdoor enclosure study with *Cloeon dipterum* was performed using a similar treatment regime as applied in the pond study [55]. The 28-days TWA NOEC for abundance of *C. dipterum* from this new study is 0.82 µg/L. However, this value cannot be used to replace the outcome of the mesocosm study because only *C. dipterum* was evaluated. Moreover, due to the timing of the study, only abundance of nymphal stages was taken into account and reproduction and emergence were not included. In addition, it is not known if the sensitivity of the larvae is similar when tested in autumn as compared to spring or summer.
For the Ephemeroptera *Epeorus* spp. and *Baetis* spp., a lower NOEC of 0.1 µg/L was derived from a stream mesocosm with constant exposure [52]. However, the duration of exposure in this test was 20 days, which is shorter than in the critical laboratory studies (28 days). Given the high ACR, it can be expected that longer exposure leads to increased effects. More importantly, species or community interactions were not included since only two mayfly genera were studied. Furthermore, the NOEC for effects on thorax and/or head length of *Baetis* sp. and *Epeorus* sp. was <0.1 µg/L. In view of this, it is not considered justified to use the mesocosm studies directly for derivation of the $QS_{fw, eco}$. The results, however, are considered for the choice on the assessment factor on the HC5 (see 4.3.2).

4.3.4 Selection of the AA-EQS

For imidacloprid, direct ecotoxicity is the only route considered for derivation of the AA-EQS. The $QS_{fw, eco}$ derived by the assessment factor approach is 0.0024 µg/L (2.4 ng/L), the SSD-approach results in 0.0083 µg/L (8.3 ng/L). The difference is a factor of 3.5. According to the WFD-guidance, preference is given to an SSD-based $QS_{fw, eco}$ since this is a more robust approach towards ecosystem effects. The AA-EQS_{fw} is set to 0.0083 µg/L (8.3 ng/L).

The $QS_{sw, eco}$ is derived on the basis of the freshwater dataset. Since there are no acute data from specific marine taxa, an additional assessment factor of 10 is applied to the $QS_{fw, eco}$. This results in an AA-EQS_{sw} of 0.83 ng/L.

It is noted that the difference between the AA-EQS and MAC-EQS is a factor of 24, which is due to the high ACR. When monitoring data are compared with the standards according to the procedures under the WFD, exceedance of the MAC-EQS will automatically lead to exceedance of the AA-EQS. This means that the MAC-EQS for imidacloprid is of little relevance from the viewpoint of compliance check. However, it may be used for other purposes as well, such as actual risk assessment of incidental peaks.

4.4 NC_{fw} and NC_{sw}

The NC is calculated by dividing the AA-EQS by a factor of 100. The NC_{fw} is 0.083 ng/L, the NC_{sw} is 0.0083 ng/L.

4.5 $SRC_{fw, eco}$ and $SRC_{sw, eco}$

Since more than three long-term NOECs of all required trophic levels are available, the $SRC_{fw, eco}$ is derived from the geometric mean of all available NOECs with an assessment factor of 1. The resulting $SRC_{fw, eco}$ is 14 µg/L. This value is also valid as $SRC_{sw, eco}$.

4.6 $QS_{dw, hh}$ – surface water for abstraction of drinking water

Imidacloprid is an organic pesticide. The drinking water standard according to Directive 98/83/EC is 0.1 µg/L, which is used as $QS_{dw, hh}$. According to the WFD-guidance, a substance specific removal rate should be considered to derive the $QS_{dw, hh}$. At present, such information is not available and water treatment is not taken into account. The $QS_{dw, hh}$ is 0.1 µg/L.

4.7 Implications of the proposed values for water quality assessment

Monitoring data for imidacloprid in the Netherlands are presented in the Dutch Pesticide Atlas [3]. Concentrations at individual sampling locations frequently exceed the water quality standards. In 2012, the MAC-EQS of 0.2 µg/L was exceeded at 45 out of 451 locations (10%), the current AA-EQS of 0.067 µg/L at 54 out of 451 monitoring locations (12%). Exceedance is detected whole year round, but less in winter [3]. Lowering the AA-EQS according to the current proposal would potentially lead to a higher frequency and/or number of locations at which the standards are exceeded. On the other hand, the restrictions on the use of imidacloprid in greenhouse and field applications that were recently issued by Ctgb (see 2.1) may lead to reduced emissions to surface water. It should be noted, however, that the regulatory acceptable concentration (RAC) on which the current authorisations are based is about a factor of 3 higher than the proposed AA-EQS. This is mainly due to the fact that the methodology for authorisation and EQS-setting differ with respect to the use of assessment factors. Moreover, simultaneous or consecutive use on different crops is not accounted for in the authorisation procedure. Meeting the RAC for authorisation is thus still no guarantee for compliance with the proposed WFD-standards, but the restrictions set by Ctgb may lead to improved water quality. The overall impact of the newly proposed standard on the assessment of Dutch surface water quality thus remains unclear until new monitoring data are available.

5 Conclusions

A proposal for water quality standards for imidacloprid is presented based on up-to-date ecotoxicological information from laboratory studies and semi-field experiments. Large differences in sensitivity exist among species within a taxonomic group. Overall midges and mayflies appear to be the most sensitive organisms. A relatively large number of acute and chronic data is available, allowing for statistical extrapolation for derivation of standards. For derivation of the MAC-EQS, semi-field data are considered as well. However, due to uncertainty with respect to species composition and exposure duration, these studies are not considered valid for derivation of the AA-EQS. A summary of the proposed standards is presented below. Based on the new information the current MAC-EQS of 0.2 µg/L can be maintained. The newly proposed AA-EQS is 8.3 ng/L. Because this is a factor of eight lower than the current standard, this would potentially lead to a higher frequency and/or number of locations at which the standards are exceeded in the Netherlands. On the other hand, recent restrictions on field applications of imidacloprid and the use in greenhouses should result in decreased emissions to surface water. Future monitoring data will ultimately reveal the overall impact of the newly proposed standard on the assessment of Dutch surface water quality.

Table 8 Summary of proposed water quality standards for imidacloprid. Values in bold are required standards according to the WFD.

	Value [µg/L]	**Value [ng/L]**
Freshwater		
AA-EQS	**0.0083**	**8.3**
MAC-EQS	**0.2**	**200**
NC	0.000083	0.083
SRC	14	14000
Surface water for drinking water production		
$QS_{dw, hh}$	**0.1**	**100**
Saltwater		
AA-EQS	**0.00083**	**0.83**
MAC-EQS	**0.02**	**20**
NC	0.0000083	0.0083
SRC	14	14000

Acknowledgements

Thanks are due to Connie Posthuma-Doodeman, Peter van Vlaardingen, and Frank de Jong (RIVM) for reviewing the ecotoxicity data tables and evaluating micro- and mesocosm data. Lonneke van Leeuwen and Charles Bodar (RIVM) are acknowledged for checking the final report and for editorial support. The members of the Scientific Advisory Group for standard setting for water and air in the Netherlands (*WK-normstelling water en lucht*) are gratefully acknowledged for reviewing and discussing the report.

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List of terms and abbreviations

AA-EQS	Annual Average Environmental Quality Standard
ACR	Acute to Chronic Ratio
ADI	Acceptable Daily Intake
BCF	Bioconcentration factor
CAR	Competent Authority Report
CLP	Classification Labelling and Packaging of substances
Ctgb	College voor de toelating van gewasbeschermingsmiddelen en biociden
DAR	Draft Assessment Report
DT50	dissipation or degradation half-life time
EC_x	Concentration at which x% effect is observed
EFSA	European Food Safety Authority
EQS	Environmental Quality Standard
ERL	Environmental risk limit
HC5	Hazardous Concentration for 5% of the species
INS	International and National Environmental Quality Standards for Substances in the Netherlands
JG-MKN	Jaargemiddelde milieukwaliteitsnorm
Koc	Organic carbon-water partitioning coefficient
Kow	Octanol-water partitioning coefficient
LCx	Concentration at which x% mortality is observed
MAC-EQS	Maximum Acceptable Concentration for ecosystems
MAC-MKN	Maximum Aanvaardbare Concentratie milieukwaliteitsnorm
MAC-$QS_{fw, eco}$	Maximum Acceptable Concentration for ecosystems in freshwater
MAC-$QS_{sw, eco}$	Maximum Acceptable Concentration for ecosystems in the saltwater compartment
Marine species	Species that are representative for marine and brackish water environments and that are tested in water with salinity > 0.5 ‰.
MKN	milieukwaliteitsnorm
NC	Negligible Concentration
NC_{fw}	Negligible Concentration in freshwater
NC_{sw}	Negligible Concentration in saltwater
NOEAEC	No Observed Ecosystem Adverse Effect Level
NOEC	No Observed Effect Concentration
pKa	Dissociation constant
PPP	Plant Protection Products
$QS_{biota, hh food}$	Quality standard for based on human health expressed as concentration in biota
$QS_{biota, secpois, fw}$	Quality standard for freshwater based on secondary poisoning expressed as concentration in biota
$QS_{biota, secpois, sw}$	Quality standard for saltwater based on secondary poisoning expressed as concentration in biota
$QS_{dw, hh}$	Quality standard for water used for abstraction of drinking water
$QS_{fw, eco}$	Quality standard for freshwater based on ecotoxicological data
$QS_{fw, secpois}$	Quality standard for freshwater based on secondary poisoning
$QS_{sw, eco}$	Quality standard for saltwater based on ecotoxicological data
$QS_{sw, secpois}$	Quality standard for saltwater based on secondary poisoning

$QS_{water, hh\ food}$	Quality standard for freshwater and saltwater based on consumption of fish and shellfish by humans
RIVM	Rijksinstituut voor Volksgezondheid en Milieu National Institute for Public Health and the Environment
SRC_{eco}	Serious Risk Concentration for ecosystems
$SRC_{fw, eco}$	Serious risk concentration for freshwater ecosystems
$SRC_{sw, eco}$	Serious risk concentration for saltwater ecosystems
SSD	Species Sensitivity Distribution
TGD	Technical Guidance Document
TWA	Time Weighted Average
WFD	Water Framework Directive (2000/60/EC)

Appendix 1. Detailed ecotoxicity data

Legend to column headings	
A	test water analysed Y(es)/N(o)
Test type	S = static; R = renewal; F = flow through; c = closed
Purity	refers to purity of active substance or content of active substance in formulation; ag = analytical grade; tg = technical grade
Test water	am = artificial medium; dtw = dechlorinated tap water; dw = deionised/dechlorinated/distilled water; nw = natural water; rw = reconstituted water; rtw = reconstituted tap water; tw = tap water
T	temperature
Ri	Reliability index according to [17]. Valid studies (Ri 2 or higher) are considered for EQS-derivation, depending on relevance and considering notes on data treatment (section 1.3.4)

Table A1.1 Acute ecotoxicity of imidacloprid for freshwater organisms

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Bacteria																
Vibrio fischeri	strain NRRL-B-11,177	Y	S	imidacloprid	ag				15	30 min	EC50	bioluminescence	61900	2	1	[20]
Vibrio fischeri	strain NRRL-B-11,177	Y	S	Confidor	200 g/L				15	30 min	EC50	bioluminescence	56000	2	1	[20]
Vibrio qinghaiensis sp.	Q67	N	S	imidacloprid	99.5%				22	15 min	EC50	bioluminescence	79255	2	2	[33]
Cyanobacteria																
Anabaena flos-aquae		Y	S	NTN 33893 2F	21.6					96 h	EC50		32800	4	4	[27]
Algae																
Desmodesmus subspicatus		Y	S	imidacloprid	ag				21	72 h	EC50	growth rate	389000	2	5	[20]
Desmodesmus subspicatus		Y	S	Confidor	200 g/L				21	72 h	EC50	growth rate	116000	2	6	[20]
Pseudokirchneriella subcapitata		N	S	Confidor					24	72 h	EC50	growth	> 1E6	3	7	[57]
Pseudokirchneriella subcapitata		N	S	imidacloprid	98.6					72 h	EC50	biomass	> 100000	2	8	[19]
Pseudokirchneriella subcapitata		N	S	imidacloprid	98.6					72 h	EC50	growth rate	> 100000	2	8	[19]
Scenedesmus subspicatus	10000 cells/mL	N	S	imidacloprid	tg			8.2-9.1	23	72 h	EC50	biomass	> 10000	3	9	[19]
Scenedesmus subspicatus	10000 cells/mL	N	S	imidacloprid	tg			8.2-9.1	23	72 h	EC50	growth rate	> 10000	3	9	[19]
Scenedesmus subspicatus	10000 cells/mL	N	S	imidacloprid	92.8			8.1-9.2	23	96 h	EC50	growth rate	> 10000	3	10	[58]
Crustacea																
Asellus aquaticus	field collected	N		Confidor	200 g/L	am			10	1 h	NOEC	respiration	100	3	11	[59]
Asellus aquaticus	field collected	N		Confidor	200 g/L					24 h	EC50	immobility	800	3	12	[59]
Asellus aquaticus	field collected	N		Confidor	200 g/L					48 h	LC50	mortality	8500	3	12	[59]
Asellus aquaticus	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	119	2	13	[5]
Asellus aquaticus	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	24.7	2	13	[5]
Asellus aquaticus	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	316	2	13	[5]
Asellus aquaticus	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	61.6	2	13	[5]
Ceriodaphnia dubia	< 24 h	Y	S	Admire Pro	42.8%	dw	80-100		25	48 h	LC50	mortality	2.07	2	14	[36]
Ceriodaphnia dubia	< 24 h old	N	R	Admire	200 g/L	dtw		7.8-7.9	21	48 h	EC50	immobility	571.62	3	15	[60]
Ceriodaphnia reticulata	< 24 h old	N	R	Admire	200 g/L	dtw		7.8-7.9	21	48 h	EC50	immobility	5552.9	3	15	[60]
Chydorus sphaericus	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	132700	3	16	[21]
Chydorus sphaericus	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	2209	3	16	[21]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Chydorus sphaericus	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	832	2	17	[21]
Cypretta seuratti	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	301	3	16	[21]
Cypretta seuratti	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	16	3	16	[21]
Cypretta seuratti	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	1	2	17	[21]
Cypridopsis vidua	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	715	3	16	[21]
Cypridopsis vidua	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	273	2	18	[21]
Cypridopsis vidua	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	3	3	16	[21]
Cypridopsis vidua	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	10	2	17	[21]
Daphnia magna	< 24 h	N	S	imidacloprid	tg	nw			20	48 h	LC50	mortality	17360	3	19	[61]
Daphnia magna	< 24 h	N	S	imidacloprid	tg	nw			27	48 h	LC50	mortality	10440	3	20	[61]
Daphnia magna	< 24 h	Y	S	imidacloprid	95.4		160-180	8.3-8.4	20	48 h	EC50	immobility	85000	2	21	[19,62]
Daphnia magna	< 24 h	Y	S	imidacloprid	95.4					48 h	EC50	immobility	> 32000	3	22	[62]
Daphnia magna	24 h	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	64870	3	16	[21]
Daphnia magna	24 h	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	6029	3	16	[21]
Daphnia magna	< 24 h	N	S	Confidor					20	48 h	EC50	immobility	64600	4	23	[57]
Daphnia magna	< 24 h	N	S	imidacloprid						48 h	EC50	immobility	97000	3	24	[63]
Daphnia magna	4-5 d	N	S	imidacloprid						24 h	EC50	feeding activity	3700	3	25	[63]
Daphnia magna	< 24 h	Y	S	imidacloprid	ag				21	48 h	EC50	immobility	56600	2	26	[20]
Daphnia magna	< 24 h	Y	S	Confidor	200 g/L				21	48 h	EC50	immobility	30000	2	27	[20]
Daphnia magna	< 24 h old	N	R	Admire	200 g/L	dtw		7.8-7.9	21	48 h	EC50	immobility	43265	3	28	[60]
Daphnia magna	< 24 h, 0.94 mm	Y	R	imidacloprid	99.0%	am		7.4-8.2	20	7 d	NOEC	body length	1200	2	29	[64]
Daphnia magna	< 24 h, 0.94 mm	Y	R	imidacloprid	99.0%	am		7.4-8.2	20	7 d	NOEC	time until maturation	4000	2	30	[64]
Daphnia magna	< 24 h, 0.94 mm	Y	R	imidacloprid	99.0%	am		7.4-8.2	20	7 d	NOEC	# offspring	1300	2	30	[64]
Daphnia magna	< 24 h, 0.94 mm	Y	R	imidacloprid	99.0%	am		7.4-8.2	20	7 d	EC50	body length	21727	2	31	[64]
Daphnia magna	< 24 h, 0.94 mm	Y	S	imidacloprid	99.0%	am		7.4-8.2	20	24 h	EC50	feeding	1830	2	32	[64]
Daphnia magna	< 24 h, 0.94 mm	Y	S	imidacloprid	99.0%	am		7.4-8.2	20	24 h	LC50	mortality	> 100000	2	33	[64]
Daphnia pulex	< 24 h old	N	R	Admire	200 g/L	dtw		7.8-7.9	21	48 h	EC50	immobility	36872	3	28	[60]
Gammarus fossatum	field collected	N		Confidor	200 g/L	am			10	1 h	NOEC	respiration	≥ 10	3	11	[59]
Gammarus fossatum	field collected	N		Confidor	200 g/L					24 h	EC50	immobility	70	3	12	[59]
Gammarus fossatum	field collected	N		Confidor	200 g/L					48 h	LC50	mortality	800	3	12	[59]
Gammarus pulex	adults, field collected	Y	S	14C-imidacloprid	> 95%	am	250		13	48 h	EC50	immobility	110	2	34	[38]
Gammarus pulex	adults, field collected	Y	S	14C-imidacloprid	> 95%	am	250		13	96 h	EC50	immobility	131	2	34	[38]
Gammarus pulex	field collected	N	S	imidacloprid	ag	am	180	7.4	15	48 h	LC50	mortality	270	3	35	[65]
Gammarus pulex	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	18.3	3	36	[5]
Gammarus pulex	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	3.63	3	36	[5]
Gammarus pulex	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	263	3	36	[5]
Gammarus pulex	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	99.5	3	36	[5]
Gammarus roeseli	field collected in autumn; juveniles; 6 mm	Y	S	imidacloprid		am		7.7	17	96 h	EC50	immobility	129.5	2	37	[39]
Gammarus roeseli	field collected in autumn; juveniles; 6 mm	Y	S	imidacloprid		am		7.7	17	96 h	EC10	immobility	98.4	2	38	[39]
Gammarus roeseli	field collected in autumn; juveniles; 6 mm	Y	S	imidacloprid		am		7.7	17	96 h	EC50	immobility	86.14	2	39	[39]
Gammarus roeseli	field collected in autumn; juveniles; 6 mm	Y	S	imidacloprid		am		7.7	17	96 h	EC10	immobility	6	2	40	[39]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Gammarus roeseli	field collected in autumn; juveniles; 6 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC50	immobility	14.2	2	41	[39]
Gammarus roeseli	field collected in autumn; juveniles; 6 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC10	immobility	1.4	2	42	[39]
Gammarus roeseli	field collected in spring; early adults; 9 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC50	immobility	1.94	2	43	[39]
Gammarus roeseli	field collected in spring; adults; 11 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC50	immobility	28.9	2	44	[39]
Gammarus roeseli	field collected in spring; adults; 11 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC10	immobility	2.6	2	45	[39]
Gammarus roeseli	field collected in spring; adults; 11 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC50	immobility	14.8	2	46	[39]
Gammarus roeseli	field collected in spring; adults; 11 mm	Y	S	imidacloprid		aw		7.8	12	96 h	EC10	immobility	1	3	47	[39]
Gammarus roeseli	field collected	N	S	not spec.		rw			17.7	26 h	NOEC	drift	≥ 12	3	48	[53]
Hyalella azteca	2-3 mm juveniles	Y	S	imidacloprid						96 h	LC50	mortality	526	2	49	[19,27]
Hyalella azteca	2-3 mm juveniles	Y	S	imidacloprid						96 h	EC50	immobility	55	2	50	[19,27]
Hyalella azteca	2-3 mm juveniles	Y	S	imidacloprid						96 h	NOEC	immobility	0.35	2	50	[19,27]
Hyalella azteca	juveniles, 2-9 d	Y	R	imidacloprid	99.2%	ftw	133	8.2	24	96 h	LC50	mortality	65.4	3	51	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	96 h	LC50	mortality	17.4	3	52	[35]
Hyalella azteca	juveniles, 2-9 d	Y	S	Admire	240 g/L	ftw	133	8.2	24	96 h	NOEC	mortality	≥ 11.93	2	53	[35]
Hyalella azteca	juveniles, 2-9 d	Y	S	Admire	240 g/L	ftw	133	8.2	24	96 h	NOEC	growth	1.15	2	54	[35]
Hyalella azteca	juveniles, 2-9 d	Y	S	Admire	240 g/L	ftw	133	8.2	24	96 h	EC50	growth	9.83	3	55	[35]
Hyalella azteca	juveniles, 2-9 d	Y	S	Admire	240 g/L	ftw	133	8.2	24	96 h	LC50	mortality	9.74	3	56	[35]
Hyalella azteca	juveniles, 2-9 d	Y	S	Admire	240 g/L	ftw	133	8.2	24	96 h	NOEC	mortality	3.53	2	57	[35]
Hyalella azteca	juveniles, 2-9 d	Y	S	Admire	240 g/L	ftw	133	8.2	24	96 h	NOEC	growth	≥ 11.93	2	58	[35]
Ilyocypris dentifera	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	517	3	16	[21]
Ilyocypris dentifera	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	LC50	mortality	214	2	18	[21]
Ilyocypris dentifera	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	3	3	16	[21]
Ilyocypris dentifera	collected from rice fields	N	S	imidacloprid	tg	tw		7.5-7.8	22	48 h	EC50	immobility	3	2	17	[21]
Moina macrocopa	< 24 h old	N	R	Admire	200 g/L	dtw		7.8-7.9	21	48 h	EC50	immobility	45271	3	28	[60]
Insecta																
Aedes aegypti	4th instar	N	S	imidacloprid	97.4	dw			25	72 h	LC50	mortality	84	3	59	[66]
Aedes aegypti	larvae, 3 d	N		imidacloprid		tw				72 h	LC50	mortality	819.5	3	60	[67]
Aedes aegypti (L.)	1st instar, 24 h old	N	S	imidacloprid	tg	am			20	48 h	LC50	mortality	45	3	19	[61]
Aedes aegypti (L.)	1st instar, 24 h old	N	S	imidacloprid	tg	am			27	48 h	LC50	mortality	44	3	19	[61]
Aedes albopictus	4th instar, strain MAmAal	N	S	imidacloprid	97.7	tw			25	24 h	LC50	mortality	600	3	59	[68]
Aedes albopictus	4th instar, strain HAmAal	N	S	imidacloprid	97.7	tw			25	24 h	LC50	mortality	300	3	59	[68]
Aedes albopictus	4th instar, strain VBFmAal	N	S	imidacloprid	97.7	tw			25	24 h	LC50	mortality	800	3	59	[68]
Aedes albopictus	4th instar, strain SFmAal	N	S	imidacloprid	97.7	tw			25	24 h	LC50	mortality	600	3	59	[68]
Aedes albopictus	4th instar, strain Ikaken	N	S	imidacloprid	97.7	tw			25	24 h	LC50	mortality	500	3	59	[68]
Baetis rhodani	larvae, field collected	N	S	imidacloprid	ag	am	180	7.4	15	48 h	LC50	mortality	8.49	3	35	[65]
Baetis rhodani	large larvae, field collected, 0.51 mg, 5.77 mm	N	S	imidacloprid	ag	am		7.8-8.1	12	96 h	LC50	mortality	41.23	3	61	[69]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Baetis rhodani	large larvae, field collected, 0.51 mg, 5.77 mm	N	S	imidacloprid	ag	am		7.8-8.1	12	96 h	EC50	immobility	5.21	3	61	[69]
Baetis rhodani	small larvae, field collected, 0.10 mg, 3.25 mm	N	S	imidacloprid	ag	am		7.8-8.1	12	96 h	LC50	mortality	3.85	3	61	[69]
Baetis rhodani	small larvae, field collected, 0.10 mg, 3.25 mm	N	S	imidacloprid	ag	am		7.8-8.1	12	96 h	EC50	immobility	1.72	3	61	[69]
Caenis horaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	6.68	2	13	[5]
Caenis horaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	2.55	2	13	[5]
Caenis horaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	1.77	2	13	[5]
Caenis horaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	0.325	2	13	[5]
Centroptilum triangulifer	larvae, <24 h old	N	S	imidacloprid	ag	am		7.4-7.5	19-22	72 h	LC50	mortality	8.88	3	62	[69]
Centroptilum triangulifer	larvae, <24 h old	N	S	imidacloprid	ag	am		7.4-7.5	19-22	72 h	EC50	immobility	4.98	3	62	[69]
Chaoborus obscuripes	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	284	2	13	[5]
Chaoborus obscuripes	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	223	2	13	[5]
Chaoborus obscuripes	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	294	2	13	[5]
Chaoborus obscuripes	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	178	2	13	[5]
Cheumatopsyche brevilineata	1st instar larvae, strain M, < 24 h	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	6.6	3	63	[70]
Cheumatopsyche brevilineata	2nd instar larvae, strain M	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	11	3	63	[70]
Cheumatopsyche brevilineata	3rd instar larvae, strain M	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	21	3	63	[70]
Cheumatopsyche brevilineata	4th instar larvae, strain M	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	21	3	64	[70]
Cheumatopsyche brevilineata	5th instar larvae, strain M	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	38	3	64	[70]
Cheumatopsyche brevilineata	1st instar larvae, strain K, < 24 h	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	7	3	64	[70]
Cheumatopsyche brevilineata	2nd instar larvae, strain k	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	10	3	64	[70]
Cheumatopsyche brevilineata	3rd instar larvae, strain k	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	20	3	64	[70]
Cheumatopsyche brevilineata	4th instar larvae, strain k	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	20	3	64	[70]
Cheumatopsyche brevilineata	5th instar larvae, strain k	N	S	imidacloprid	ag	dtw			20	24 h	EC50	immobility	37.9	3	65	[70]
Chironomus dilutus	larvae, 10 d old	Y		Admire 240F		dgw			23	96 h	LC50	mortality	2.65	2	66	[42]
Chironomus riparius	larvae, 6 d, 2nd instar	N	S	Confidor	200 g/L	am	250		20	96 h	EC50	immobility	12.94	3	67	[37]
Chironomus riparius	larvae, 6 d, 2nd instar	N	S	Confidor	200 g/L	am	250		20	24 h	NOEC	respiration	< 0.4	3	68	[37]
Chironomus riparius	larvae, 4 d, 2nd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	growth	0.74	3	69	[71]
Chironomus riparius	larvae, 4 d, 2nd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	locomotion, ventilation	0.74	3	70	[71]
Chironomus riparius	larvae, 4 d, 2nd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	growth	≥ 2.15	3	71	[71]
Chironomus riparius	larvae, 4 d, 2nd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	locomotion, ventilation	≥ 2.15	3	71	[71]
Chironomus riparius	larvae, 7 d	N	S	Confidor	200 g/L	rw				48 h	LC50	mortality	19.9	3	72	[71]
Chironomus riparius	1st instar larvae	Y	S	imidacloprid	99.9					24 h	LC50	mortality	55.2	3	73	[19]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Chironomus riparius	larvae, 10 d old, late 3rd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	locomotion	0.55	3	74	[72]
Chironomus riparius	larvae, 10 d old, late 3rd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	ventilation	0.3	3	74	[72]
Chironomus riparius	larvae, 10 d old, late 3rd instar	Y	R	Confidor	200 g/L	rw				96 h	NOEC	ACh activity	0.55	3	74	[72]
Chironomus riparius	late instar	N	S	not spec.		rw			17.7	26 h	NOEC	drift	< 12	3	75	[53]
Chironomus tentans	2nd instar	Y	R	imidacloprid	95%					96 h	LC50	mortality	10.5	2	76	[27]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	96 h	LC50	mortality	5.4	3	77	[35]
Chironomus tentans	larvae, 7 d	Y	R	imidacloprid	99.2%	ftw	140	8.2	24	96 h	LC50	mortality	5.75	2	78	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	96 h	NOEC	mortality	≥ 3.47	2	79	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	96 h	NOEC	mortality	≥ 3.47	2	79	[35]
Cloeon dipterum	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	1.02	2	13	[5]
Cloeon dipterum	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	0.100	2	13	[5]
Cloeon dipterum	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	26.3	2	13	[5]
Cloeon dipterum	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	6.16	2	13	[5]
Cloeon dipterum	large larvae, 0.65 mg	N	S	imidacloprid	ag	am		7.9-8.0	9	96 h	LC50	mortality	104.63	3	80	[69]
Cloeon dipterum	large larvae, 0.65 mg	N	S	imidacloprid	ag	am		7.9-8.0	9	96 h	EC50	immobility	43.03	3	80	[69]
Cloeon dipterum	small larvae, 0.13 mg	N	S	imidacloprid	ag	am		7.9-8.0	9	96 h	LC50	mortality	100	3	80	[69]
Cloeon dipterum	small larvae, 0.13 mg	N	S	imidacloprid	ag	am		7.9-8.0	9	96 h	EC50	immobility	43.33	3	80	[69]
Cloeon dipterum	late instar; field collected	N	S	not spec.		rw			17.7	26 h	NOEC	drift	≥ 12	3	48	[53]
Culex quinquefasciatus	4th instar, VBFmCq	N	S	imidacloprid	0.977	tw			25	24 h	LC50	mortality	300	3	59	[73]
Culex quinquefasciatus	4th instar, HAmCq	N	S	imidacloprid	0.977	tw			25	24 h	LC50	mortality	200	3	59	[73]
Culex quinquefasciatus	4th instar, MAmCq	N	S	imidacloprid	0.977	tw			25	24 h	LC50	mortality	400	3	59	[73]
Culex quinquefasciatus	4th instar, S-Lab	N	S	imidacloprid	0.977	tw			25	24 h	LC50	mortality	40	3	59	[73]
Culex quinquefasciatus	4th instar larvae	N	S	imidacloprid		tw			27	24 h	LC50	mortality	5	3	81	[74]
Epeorus assimilis	large larvae, 9.74 mg	N	S	imidacloprid	ag	am		7.6-7.9	13	96 h	LC50	mortality	52.33	3	82	[69]
Epeorus assimilis	large larvae, 9.74 mg	N	S	imidacloprid	ag	am		7.6-7.9	13	96 h	EC50	immobility	1.07	3	82	[69]
Epeorus assimilis	small larvae, 7.15 mg	N	S	imidacloprid	ag	am		7.2-7.8	4	96 h	LC50	mortality	20.89	3	83	[69]
Epeorus assimilis	small larvae, 7.15 mg	N	S	imidacloprid	ag	am		7.2-7.8	4	96 h	EC50	immobility	5.06	3	83	[69]
Epeorus longimanus	larvae, early instar, 3 mm, collected from field	Y	S	Admire	240 g/L	dgw		8.1	20	24 h	LC50	mortality	2.1	2	84	[43]
Epeorus longimanus	larvae, late instar, 7.5 mm, collected from field	Y	S	Admire	240 g/L	dgw		8.1	20	24 h	LC50	mortality	2.1	2	85	[43]
Epeorus longimanus	larvae, late instar, 7.5 mm, collected from field	Y	S	Admire	240 g/L	dgw		8.1	20	96 h	LC50	mortality	0.65	2	86	[43]
Epeorus longimanus	larvae, late instar, 7.5 mm, collected from field	Y	S	Admire	240 g/L	dgw		8.1	20	24 h	NOEC	feeding rate	1	2	87	[43]
Epeorus longimanus	larvae, late instar, 7.5 mm, collected from field	Y	S	Admire	240 g/L	dgw		8.1	20	24 h	NOEC	feeding rate	< 0.1-0.5	3	88	[43]
Habrophlebia lauta	large larvae, field collected, 0.65 mg	N	S	imidacloprid	ag	am		7.8-8.6	13	96 h	LC50	mortality	179.92	3	89	[69]
Habrophlebia lauta	large larvae, field collected, 0.65 mg	N	S	imidacloprid	ag	am		7.8-8.6	13	96 h	EC50	immobility	34.65	3	89	[69]
Habrophlebia lauta	small larvae, field collected, 0.17 mg	N	S	imidacloprid	ag	am		7.8-8.6	13	96 h	LC50	mortality	57.62	3	89	[69]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Habrophlebia lauta	small larvae, field collected, 0.17 mg	N	S	imidacloprid	ag	am		7.8-8.6	13	96 h	EC50	immobility	31.18	3	89	[69]
Hydropsyche pellucidula	larvae, 3.44 mg	N	S	imidacloprid	ag	am		7.7-8.0	12	96 h	LC50	mortality	44.93	3	90	[69]
Hydropsyche pellucidula	larvae, 3.44 mg	N	S	imidacloprid	ag	am		7.7-8.0	12	96 h	EC50	immobility	23.07	3	90	[69]
Leuctra sp.	larvae, 0.64 mg	N	S	imidacloprid	ag	am		7.5-8.0	8	96 h	LC50	mortality	247.09	3	91	[69]
Leuctra sp.	larvae, 0.64 mg	N	S	imidacloprid	ag	am		7.5-8.0	8	96 h	EC50	immobility	8.57	3	91	[69]
Limnephilidae	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	1.79	2	13	[5]
Limnephilidae	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	0.532	2	13	[5]
Limnephilidae	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	25.7	2	13	[5]
Limnephilidae	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	9.86	2	13	[5]
Micronecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	10.8	3	92	[5]
Micronecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	9.41	3	92	[5]
Micronecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	28.2	3	92	[5]
Micronecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	8.857	3	92	[5]
Notonecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	18.2	2	13	[5]
Notonecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	3.00	2	13	[5]
Notonecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	> 10000	2	13	[5]
Notonecta spp.	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	> 10000	2	13	[5]
Plea minutissima	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	35.9	2	13	[5]
Plea minutissima	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	30.4	2	13	[5]
Plea minutissima	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	37.5	2	13	[5]
Plea minutissima	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	32.3	2	13	[5]
Pteronarcys comstocki	nymphs, 20 mm	Y	S	Admire	240 g/L	gw			14.5	3 x 24 h	NOEC	feeding rate	1.63	2	93	[51]
Pteronarcys comstocki	nymphs, 20 mm	Y	S	Admire	240 g/L	gw			20	24 h	NOEC	O2 consumption	2	2	94	[51]
Sericostoma vittatum	larvae, field collected	N	S	Confidor	200 g/L	am	250		20	96 h	EC50	immobility	47.22	3	95	[37]
Sericostoma vittatum	larvae, field collected	N	S	Confidor	200 g/L	am	250		20	24 h	NOEC	respiration	1.9	3	96	[37]
Sericostoma vittatum	larvae, field collected	Y	R	Confidor	200 g/L	am	250		20	72 h	NOEC	burrowing behaviour	2.5	2	97	[37]
Sialis lutaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC50	immobility	50.6	2	13	[5]
Sialis lutaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	EC10	immobility	15.7	2	13	[5]
Sialis lutaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC50	mortality	>10000	2	13	[5]
Sialis lutaria	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	96 h	LC10	mortality	>10000	2	13	[5]
Simulium latigonium	larvae, collected from mesocosm	N	S	imidacloprid	ag	am	180	7.4	15	48 h	LC50	mortality	3.73	3	35	[65]
Simulium vittatum	5th instar	Y	S	imidacloprid	98%	rw		7.3-7.7	20	48 h	LC50	mortality	6.75	2	98	[44]
Simulium vittatum	5th instar	Y	S	imidacloprid	98%	rw		7.3-7.7	20	48 h	LC50	mortality	8.25	2	99	[44]
Simulium vittatum	5th instar	Y	S	imidacloprid	98%	rw		7.3-7.7	20	48 h	LC50	mortality	9.54	2	99	[44]
Siphonoperla sp.	larvae, 0.55 mg	N	S	imidacloprid	ag	am		7.5-8.0	8	96 h	LC50	mortality	883.89	3	91	[69]
Siphonoperla sp.	larvae, 0.55 mg	N	S	imidacloprid	ag	am		7.5-8.0	8	96 h	EC50	immobility	8.63	3	91	[69]
Amphibia																
Rana limnocharis	1 month old	N	R	imidacloprid	> 95%	dw			20	96 h	LC50	mortality	82000	3	100	[27,75]
Rana N. Hallowell	1.5 months old	N	R	imidacloprid	> 95%	dw			20	96 h	LC50	mortality	129000	3	100	[27,75]
Pisces																
Danio rerio		Y	S	imidacloprid	ag	nw	140	8.4	21	96 h	LC50	mortality	241000	2	101	[20]
Danio rerio		Y	S	Confidor	200 g/L	nw	140	8.4	21	96 h	LC50	mortality	214000	2	101	[20]
Leuciscus idus melanotus		Y	S	imidacloprid	95.3		230	8.1	21	96 h	LC50	mortality	237000	2	102	[19]
Lepomis macrochirus	27 mm, 0.46 g	Y	S	imidacloprid	95		46	7.4	22	96 h	LC50	mortality	> 105000	3	103	[19,27]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Oncorhynchus mykiss	5.3 cm, 1.3 g	N	S	imidacloprid	95.3		230	8.0-8.1	15.4	96 h	LC50	mortality	211000	2	104	[19]
Oncorhynchus mykiss	4.4 cm, 1.07 g	Y	S	imidacloprid	95		40-48	7.0-7.9	12	96 h	LC50	mortality	> 83000	3	105	[19]
Annelida																
Lumbriculus variegatus	2.5 cm, 1.2 mg	Y	S	Admire	240 g/L	dgw		8.1	20	96 h	EC50	immobility	6.2	2	106	[43]
Lumbriculus variegatus	2.5 cm, 1.2 mg	Y	S	Admire	240 g/L	dgw		8.1	20	24 h	NOEC	egestion rate	≥ 10	3	107	[43]
Lumbriculus variegatus	2.5 cm, 1.2 mg	Y	S	Admire	240 g/L	dgw		8.1	20	24 h	NOEC	egestion rate	0.1-1	3	108	[43]
Tubifex tubifex	adult, 4 cm long, Ø 1-2 cm	N	S	imidacloprid		am	62	7	20	24 h	EC50	locomotory behaviour	90	3	109	[76]
Tubifex tubifex	adult, 4 cm long, Ø 1-2 cm	N	S	imidacloprid		am	62	7	20	24 h	LC50	mortality	320	3	109	[76]

Notes

1 Marine species, but tested in distilled water. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively.
2 Solvent 1% DMSO, solvent control included; no analysis of test concentrations, but short exposure time
4 Based on mean measured concentrations. Study previously assigned Ri2, but information on test conditions and test parameter are not available.
5 Test probably performed according to ISO guideline. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively. Cells counted only at start and 72 h, initial cell density not reported.
6 Test probably performed according to ISO guideline. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively. Toxicity of formulation is more than 3 times higher than that of active substance, preference is given to test with active. Sovent of formulation included in control tests. Cells counted only at start and 72 h, initial cell density not reported.
7 Concentrations not measured, test under continuous light. No details on test water. Endpoint given as growth inhibition, not clear if growth rate or biomass is meant, test was performed according to OECD 1984 which gives both options.
8 Test according to OECD 201. Limit test. Previously assigned Ri3 because endpoint was based on nominal. However, additional information shows that measured concentrations were 100-102% of nominal, endpoint based on nominal concentrations.
8 Test according to OECD 201. Limit test. Previously assigned Ri3 because endpoint was based on nominal. However, additional information shows that measured concentrations were 100-102% of nominal, endpoint based on nominal concentrations.
9 Test according to OECD 201. Concentrations not measured, test performed under light.
10 Test according to OECD 201. Concentrations not measured, test performed under light. Refers to same test as above.
11 Concentrations not measured, not clear if performed under darkness. No details on test water and conditions. Endpoint refers to both ratio of electron transport system activity and respiration.
12 Concentrations not measured, not clear if performed under darkness. No details on test water and conditions.
13 Concentration in dosing solution 97.5%, recovery in concurrent chronic tests was 91.9% on average
14 Mean measured concentration 88% of nominal (range 76-105%), endpoint based on measured concentrations. Concurrent study indicated little degradation over 8 d. Test conditions taken from Deardorff and Stark, 2009.
15 Daily renewal of test solutions, but concentrations not measured and performed under 16:8 h L:D as recommended in OECD 202
16 Concentrations not measured, test performed under 16:8 h L:D.
17 Concentrations not measured, but performed under darkness. Most sensitive endpoint for this species.
18 Concentrations not measured, but performed under darkness.
19 Concentrations not measured, test performed under light. Solvent control included.
20 Concentrations not measured, test performed under light. Temperature too high.
21 Test according to OECD 202. Endpoint based on mean measured concentrations.
22 Test according to OECD 202. Precipitation at two highest concentrations (56 and 100 mg/L), these were not included in EC50 estimation.
23 Concentrations not measured, but test performed in the dark. No details on test water. No details on test compound. Test performed with Daphtoxkit.
24 Test according to OECD 202, no further details on test water and conditions. Concentrations not measured, not clear if performed under darkness.
25 No details on test water and conditions. Concentrations not measured, not clear if performed under darkness. Feeding activity determined from algal growth.

26 Test according to ISO. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively.
27 Test according to ISO. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively. Formulation is more toxic than active substance, preference is given to test with active.
28 Daily renewal of test solutions, but concentrations not measured; performed under 16:8 h L:D as recommended in OECD 202
29 Measured concentrations <10 mg/L within 6.3% of nominal, maximum deviation at >10 mg/L was 26.4%; endpoints reported as nominal; NOEC taken from table S3 in supporting info; endpoint reliable, but in view of exposure duration not relevant for MAC- and/or AA-EQS
30 Reduced feeding; measured concentrations <10 mg/L within 6.3% of nominal, maximum deviation at >10 mg/L was 26.4%; endpoints reported as nominal; NOEC taken from table 3; endpoint reliable, but in view of exposure duration not relevant for MAC- and/or AA-EQS
31 Measured concentrations <10 mg/L within 6.3% of nominal, maximum deviation at >10 mg/L was 26.4%; endpoints reported as nominal; EC50 estimated using data from table S3 in supporting info, using non-linear fit of log-logistic concentrations respons model in Graphpad Prism, bottom fixed to 0; endpoint reliable, but in view of exposure duration not relevant for MAC- and/or AA-EQS
32 Measured concentrations <10 mg/L within 6.3% of nominal, maximum deviation at >10 mg/L was 26.4%; endpoints reported as nominal; test reliable, but consequence of endpoint for population effects not clear
33 Measured concentrations <10 mg/L within 6.3% of nominal, maximum deviation at >10 mg/L was 26.4%; endpoints reported as nominal
34 Acclimation 5 d. Animals fed during test. 12h:12h light;dark. Endpoint based on mean measured concentrations. Hardness calculated from information in Naylor et al., 1989.
35 Concentrations not measured, test performed under 10:14 h L:D
36 Concentration in dosing solution 97.5%, recovery in concurrent chronic tests was 91.9% on average; control mortality 33%, result considered as indicative by authors
37 Exp 1 in paper. Feeding with conditioned alder leaf discs; measured concentrations differed <1% from nominal, result expressed as nominal; EC50 obtained from author upon request, fits with reported difference of factor 9.2 with exp 3 and checked with digitised graph
38 Exp 1 in paper. Feeding with conditioned alder leaf discs; measured concentrations differed <1% from nominal, result expressed as nominal; EC10 obtained from author upon request
39 Exp 2 in paper. No feeding; measured concentrations differed <1% from nominal, result expressed as nominal; EC50 obtained from author upon request, fits with reading from digitised graph
40 Exp 2 in paper. No feeding; measured concentrations differed <1% from nominal, result expressed as nominal; EC10 obtained from author upon request
41 Exp 3 in paper. Feeding with conditioned alder leaf discs; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal
42 Exp 3 in paper. Feeding with conditioned alder leaf discs; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal; EC10 obtained from author; EC10 >2 times lower than lowest test concentration, reason for Ri 3
43 Exp 4 in paper. Feeding with conditioned alder leaf discs; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal
44 Exp 5 in paper. Feeding with conditioned alder leaf discs; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal; EC50 obtained from author upon request, fits with reading from digitised graph
45 Exp 5 in paper. Feeding with conditioned alder leaf discs; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal; EC10 obtained from author upon request; EC10 marginally lower than lowest test concentration/2, value considered acceptable
46 Exp 6 in paper. No feeding; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal; EC50 obtained from author upon request, fits with reading from digitised graph
47 Exp 6 in paper. No feeding; test medium: filtered stream water from control stream mesocosms; measured concentrations differed <1% from nominal, result expressed as nominal; EC10 obtained from author upon request; EC10 factor of 6 lower than lowest test concentration, reason for Ri 3
48 Exposure in carrousel drift meter; stream velocity 0.2 m/s at top, <<0.1 m/s at bottom; 16:8 L:D, concentrations not measured; no passive drift observed
49 DAR only reports endpoints, but summary available in Anatra-Cordone and Durkin, 2005. Endpoint based on measured concentrations. Original study also cited in Stoughton et al., 2008
50 DAR only reports endpoints, but summary available in Anatra-Cordone and Durkin, 2005.
51 Mean measured concentration 64-99% of nominal, results based on mean measured concentrations. Rinsed cheesecloth present. Animals fed during test. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. NOEC is close to LC50 (54.24 µg/L), and LOEC is far above LC50 (243.68 µg/L), this indicates large variation between replicates. No figure available to check concentration response pattern, LC50 not considered reliable.
52 Mean measured concentration 66-96% of nominal, results based on mean measured concentrations. Rinsed cheesecloth present. Animals fed during test. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. NOEC and LOEC much higher than LC50 (48.75 and 263.12 µg/L). This indicates large variation between replicates. No figure available to check concentration response pattern, LC50 not considered reliable.

53 Pulse exposure followed by observation in clean water for 10 d. Mean measured concentration 115-119% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Nitex screen present. Animals fed during test. NOEC reported as 11.93 µg/L, but since LOEC is reported as >11.93 µg/L, NOEC should read ≥ 11.93 µg/L.
54 Pulse exposure followed by observation in clean water for 10 d. Mean measured concentration 115-119% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Nitex screen present. Animals fed during test.
55 Pulse exposure followed by observation in clean water for 10 d. Mean measured concentration 115-119% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Nitex screen present. Animals fed during test. Number of test concentrations (3) too low for reliable estimate of EC50.
56 Pulse exposure followed by observation in clean water for 28 d. Mean measured concentration 115-119% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Nitex screen present. Animals fed during test. Number of test concentrations (3) too low for reliable estimate of LC50.
57 Pulse exposure followed by observation in clean water for 28 d. Mean measured concentration 115-119% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Nitex screen present. Animals fed during test.
58 Pulse exposure followed by observation in clean water for 28 d. Mean measured concentration 115-119% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Nitex screen present. Animals fed during test. NOEC reported as 11.93 µg/L, but since LOEC is reported as >11.93 µg/L, NOEC should read ≥ 11.93 µg/L.
59 Concentrations not measured, test performed under light.
60 Concentrations not measured. No information on test water and conditions.
61 Concentrations not measured, performed under light (1818 lux)
62 Concentrations not measured, performed under ambient light
13 Concentration in dosing solution 97.5%, recovery in concurrent chronic tests was 91.9% on average
63 Concentrations not measured. Acetone used as solvent, max. 0.1% (v/v). Animals not fed. Test performed under continuous fluorescent light. EC50 read from graph.
64 Concentrations not measured. Acetone used as solvent, max. 0.1% (v/v). Glass beads added to test vessel. Animals not fed. Test performed under continuous fluorescent light. EC50 read from graph.
65 Concentrations not measured. Acetone used as solvent, max. 0.1% (v/v). Glass beads added to test vessel. Animals not fed. Test performed under continuous fluorescent light
66 Test performed in dechlorinated groundwater with 0.5 cm washed silicasand; 16:8 h L:D; analysis of low and high exposure concentration, values in between calculated from regression
67 Endpoint based on nominal concentrations, taking into account measured concentration in stock. Hardness calculated from information in Naylor et al., 1989. Assumed that reported "laboratory conditions" (20 ºC, 16:8 h L:D) also refer to conditions of the test.
68 Endpoint based on nominal concentrations. LOEC given as 0.4 µg/L in table (NOEC < 0.4 µg/L), as 1.2 µg/L in text (NOEC 0.4 µg/L). Figure indocates that NOEC is most likely < 0.4 µg/L. Hardness calculated from information in Naylor et al., 1989. Assumed that reported "laboratory conditions" (20 ºC, 16:8 h L:D) also refer to conditions of the test.
69 Measured concentrations are reported as 0.39, 0.74 and 2.15 µg/L (78, 49 and 48% of nominal) at the end of the constant exposure test. Not clear which time period is meant, probably the end of the 10-days exposure period in which half of the test solutions was renewed every 48 h. Exposure over the actual test period not known. Acid-washed inorganic fine sediment present. 43% reduction in growth as compared to control at next higher concentration.
70 Measured concentrations are reported as 0.39, 0.74 and 2.15 µg/L (78, 49 and 48% of nominal) at the end of the constant exposure test. Not clear which time period is meant, probably the end of the 10-days exposure period in which half of the test solutions was renewed every 48 h. Exposure over the actual test period not known. Acid-washed inorganic fine sediment present. ca. 15% reduction in activity as compared to control at next higher concentration.
71 Pulse exposure for 96 h, followed by observation in clean water for 6 d. Measured concentrations are reported as 0.39, 0.74 and 2.15 µg/L (78, 49 and 48% of nominal) at the end of the constant exposure test. Not clear which time period is meant, probably the end of the 10-days exposure period in which half of the test solutions was renewed every 48 h. Exposure over the actual test period not known. Acid-washed inorganic fine sediment present.
72 Range finding experiment for chronic study. Endpoint most likely based on nominal concentrations.
73 Test system equivalent to OECD 202. Measured initial concentrations 95.6-102 % of nominal, concentrations at end not measured. Probably performed under light.
74 Pulse exposure for 96 h, followed by observation in clean water for 48 h; half of the test solutions was renewed after 48 h; measured concentrations are reported as 0.30, 0.55 and 1.20 µg/L (40, 63 and 60% of nominal) at the end of the exposure period; endpoint reported on the basis of measured concentration; no data on initial concentrations and not clear if measured concentrations refer to 48 or 96 h; exposure over the actual test period not known; acid-washed inorganic fine sediment present.
75 Exposure in carrousel drift meter; stream velocity 0.2 m/s at top, <<0.1 m/s at bottom; 16:8 L:D, concentrations not measured; organisms active after 12 h, almost immobile after 26 h
76 DAR reports only 10-d endpoints from this study, 96-h values cited by Anatra-Cordone and Durkin, 2005. Endpoint based on measured concentrations.

77 Mean measured concentration 78-103% of nominal, results based on mean measured concentrations. Silica sand present. Animals fed during test. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. NOEC is close to LC50 (5.11 µg/L), and LOEC is far above LC50 (23.59 µg/L), this indicates large variation between replicates. No figure available to check concentration response pattern, LC50 not considered reliable.
78 Mean measured concentration 78-103% of nominal, results based on mean measured concentrations. Silica sand present. Animals fed during test. Number of test concentrations (4) low, but considered acceptable for LC50 calculation. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling.
79 Pulse exposure for 96 h, followed by observation in clean water for 10 d. Mean measured concentration 113-123% of nominal, results based on mean measured concentrations. Not fully clear if performed under renewal or static conditions, renewal assumed from description of sampling. Silica sand present. Animals fed during test. Survival measured as emergence. No significant difference at highest concentration according to figure. NOEC reported as 3.47 µg/L, but since LOEC is reported as >3.47 µg/L, NOEC should read ≥ 3.47 µg/L.
80 Concentrations not measured, performed under light (1167 lux)
81 Test performed according to WHO protocol. Plastic cups. Acetone control included. Concentrations not measured, not clear if performed in the dark. Experiment to investigate efficacy of different imidacloprid analogues, only pure imidacloprid is reported here.
82 Concentrations not measured, performed under light (3090 lux)
83 Concentrations not measured, performed under light (2300 lux)
84 Test performed in dechlorinated groundwater. Average of three tests. Result based on nominal, actual concentrations 90-120% of nominal.
85 Test performed in dechlorinated groundwater. Result based on nominal, actual concentrations 90-120% of nominal.
86 Test performed in dechlorinated groundwater. Result based on nominal, actual concentrations 90-120% of nominal.
87 Test performed in dechlorinated groundwater. Result based on nominal, actual concentrations 90-120% of nominal. NOEC refers to effect on feeding rate during 24-h exposure period.
88 Test performed in dechlorinated groundwater. Result based on nominal, actual concentrations 90-120% of nominal. NOEC refers to effect on feeding rate over 4 d recovery period after exposure for 24 h. No consistent pattern, NOECs were 0.5, <0.1, <0.1 and 0.1 µg/L on the consecutive recovery days.
89 Concentrations not measured, performed under light (1153 lux)
90 Concentrations not measured, performed under light 3200 lux), 3 individuals appeared to be H. saxonica
91 Concentrations not measured, performed under light (1748 lux)
92 Concentration in dosing solution 97.5%, recovery in concurrent chronic tests was 91.9% on average; control mortality 20%, result considered as indicative by authors
93 In-situ bioassay at outflow of outdoor stream-mesocosms that received three 24-h pulses of 2 or 20 µg/L imidacloprid at 7-d time interval. Average peak concentrations during the pulses were 1.63 and 17.60 µg/L (81 and 88% of nominal). Significant inhibition by 71% at 17.6 µg/L, 27% inhibition at 1.63 µg/L. test reliable, but consequence of endpoint for population effects not clear
94 Oxygen consumption measured during last 4 h of 24 h exposure period. Concentrations not measured, but test performed under darkness and same stocks used as for mesocosm experiment in which concentrations were >80% of nominal. Most likely performed in groundwater; test reliable, but consequence of endpoint for population effects not clear
95 Endpoint based on nominal concentrations, taking into account measured concentration in stock. Hardness calculated from information in Naylor et al., 1989. Assumed that reported "laboratory conditions" (20 ºC, 14:10 h L:D) also refer to conditions of the test. Animals acclimated for 14 d.
96 Endpoint based on nominal concentrations. Not clear if performed under darkness. Hardness calculated from information in Naylor et al., 1989. Assumed that reported "laboratory conditions" (20 ºC, 14:10 h L:D) also refer to conditions of the test. Animals acclimated for 14 d.
97 Partial renewal (100 out of 150 mL) every 48 h. Endpoint reported as LOEC 7.8 µg/L nominal, NOEC is thus 3.9 µg/L nominal. Based on measured concentration in old solutions (66-63% of nominal), actual NOEC recalculated as 2.5 µg/L. Inorganic fine sediment present. Hardness calculated from information in Naylor et al., 1989. Test performed under 14:10 h L:D. Animals acclimated for 14 d. Endpoint measured as number of animals visible on sediment or in water. test reliable, but consequence of endpoint for population effects not clear
98 Endpoint based on average of measured concentrations at start and end; test performed under 16:8 h L:D; acetone control at level of highest amount added
99 Endpoint based on average of measured concentrations at start and end. Test performed under 16:8 h L:D.
100 Concentrations not measured, not clear whether performed under darkness.
101 Test in stream water. Initial concentrations 94-100% of nominal, concentrations remained stable during experiment. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively.
102 Test according to OECD guidelines. Previously assigned Ri3 because endpoint was based on nominal. However, additional information shows that measured concentrations were >85% of nominal, except for highest concentration (1000 mg/L, 54 % recovery). Acceptable recovery at next two lower concentrations where already 100% mortality was observed, endpoint based on nominal.
103 Test according to FIFRA guidelines. DMF 0.1 mL/L, solvent control included. Endpoint based on mean measured concentrations (86-94% of nominal). Previously assigned Ri2, but surface film and precipitate were (partly transiently) noted in the 42, 64 and 105 mg/L test solutions.
104 Test according to OECD 203. Previously assigned Ri3 because endpoint was based on nominal. However, additional information shows that measured concentrations were >80% of nominal. Endpoint based on nominal.

105 Test according to FIFRA guidelines. DMF 0.1 mL/L, solvent control included. Endpoint based on mean measured concentrations (75-101% of nominal). Previously assigned Ri2, but surface film and precipitate were (partly transiently) noted in the 42, 64 and 83 mg/L test solutions.

106 Test performed in dechlorinated groundwater. Result based on nominal, actual concentrations <LOD at 0.1 µg/L, 38 and 69% of nominal at 0.5 and 1.0 µg/L, and 94-100% at 5.0-240 µg/L. Acceptable recovery at level of EC50.

107 Test performed with sediment slurry (16% OM) contaminated with imidaloprid solutions in dechlorinated groundwater. Result based on nominal, actual concentrations of solutions <LOD at 0.1 µg/L, 38 and 69% of nominal at 0.5 and 1.0 µg/L, and 94-100% at 5.0-240 µg/L. Actual concentration in overlying water during test not known. NOEC refers to effect on egestion rate during 24-h exposure period.

108 Test performed with sediment slurry (16% OM) contaminated with imidaloprid solutions in dechlorinated groundwater. Result based on nominal, actual concentrations of solutions <LOD at 0.1 µg/L, 38 and 69% of nominal at 0.5 and 1.0 µg/L, and 94-100% at 5.0-240 µg/L. Actual concentration in overlying water during test not known. NOEC refers to effect on egestion rate over 4 d recovery period after exposure for 24 h. NOECs tend to increase over time, and were 0.1, 0.5, 1 and 1 µg/L on the consecutive recovery days.

109 Hardness calculated from given Ca and Mg concentrations. Concentrations not measured, test performed under 12:12 h L:D. No aeration. Locomotion recorded automatically every 10 min for 4 min. Regression coefficient of concentration-response relationship is low (0.49)

Table A1.2 Chronic ecotoxicity of imidacloprid for freshwater organisms

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Cyanobacteria																
Anabaena flos-aquae		Y	S	NTN 33893 2F	21.6					96 h	NOEC		24900	4	1	[27]
Algae																
Desmodesmus subspicatus		Y	S	imidacloprid	ag				21	72 h	EC10	growth rate	106000	2	2	[20]
Desmodesmus subspicatus		Y	S	Confidor	200 g/L				21	72 h	EC10	growth rate	5600	2	3	[20]
Pseudokirchneriella subcapitata		N	S	imidacloprid	98.6					72 h	NOEC	growth rate	< 100000	2	4	[19]
Pseudokirchneriella subcapitata		N	S	imidacloprid	98.6					72 h	NOEC	biomass	< 100000	2	4	[19]
Scenedesmus subspicatus		N	S	imidacloprid	tg			8.2-9.1	23	72 h	NOEC	growth rate	10000	3	5	[19,62]
Scenedesmus subspicatus		N	S	imidacloprid	tg			8.2-9.1	23	72 h	NOEC	biomass	10000	3	5	[19,62]
Scenedesmus subspicatus		N	S	imidacloprid	92.8			8.1-9.2	23	96 h	NOEC	growth rate	> 10000	3	6	[58]
Diatomea																
Navicula pelliculosa		Y	S	NTN 33893 2F	21.6					96 h	NOEC		6690	4	7	[27]
Crustacea																
Asellus aquaticus	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	1.35	3	8	[5]
Asellus aquaticus	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	1.71	3	9	[5]
Ceriodaphnia dubia	< 24 h	Y	S	Admire Pro	42.8%	dw	80-100		25	8 d	EC10	population growth rate	0.3	3	10	[36]
Ceriodaphnia dubia	< 24 h	Y	S	Admire Pro	42.8%	dw	80-100		25	8 d	EC15	survival founders	0.3	3	11	[36]
Ceriodaphnia dubia	< 24 h	Y	S	Admire Pro	42.8%	dw	80-100		25	8 d	EC14	offspring/female	0.3	3	12	[36]
Ceriodaphnia dubia	< 24 h	Y	S	Admire Pro	42.8%	dw	80-100		25	8 d	EC27	nr. of indiviuals	0.3	3	13	[36]
Daphnia magna	< 24 h	Y	S	imidacloprid	95.4		140-164	7.7-8.3	20	21 d	NOEC	adult length	1800	2	14	[19,62]
Daphnia magna	< 24 h	Y	R	imidacloprid	≥ 99%	am			21	21 d	NOEC	neonates per adult	1250	2	15	[34]
Daphnia magna	< 24 h	Y	R	Confidor	200 g/L	am			21	21 d	NOEC	neonates per adult	2500	2	15	[34]
Daphnia magna	< 24 h	Y	R	imidacloprid	≥ 99%	am			21	21 d	NOEC	brood size, time to 1st brood	2500	2	15	[34]
Daphnia magna	< 24 h	Y	R	Confidor	200 g/L	am			21	21 d	NOEC	brood size, time to 1st brood	2500	2	15	[34]
Daphnia magna	< 24 h	Y	R	imidacloprid	≥ 99%	am			21	21 d	NOEC	broods per adult	5000	2	15	[34]
Daphnia magna	< 24 h	Y	R	Confidor	200 g/L	am			21	21 d	NOEC	broods per adult	5000	2	15	[34]
Daphnia magna	< 24 h	Y	R	imidacloprid	≥ 99%	am			21	21 d	NOEC	mortality	20000	2	15	[34]
Daphnia magna	< 24 h	Y	R	Confidor	200 g/L	am			21	21 d	NOEC	mortality	5000	2	15	[34]
Daphnia magna	< 24 h	Y	R	imidacloprid					20	21 d	NOEC	reproduction	2000	2	16	[77]
Daphnia magna	< 24 h	Y	R	imidacloprid					20	21 d	EC50	reproduction	5500	2	17	[77]
Daphnia magna	< 24 h	Y	R	imidacloprid					20	21 d	NOEC	growth	4000	2	17	[77]
Daphnia magna	< 24 h	Y	R	imidacloprid					20	21 d	NOEC	mortality	10000	2	17	[77]
Gammarus pulex	different ages	N	S	imidacloprid	tg					28 d	NOEC	swimming behaviour	64	3	18	[19]
Gammarus pulex	different ages	N	S	imidacloprid	tg					28 d	NOEC	mortality	128	3	18	[19]
Gammarus pulex	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	2.95	2	19	[5]
Gammarus pulex	field collected	N	S	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	5.77	2	19	[5]
Gammarus pulex	field collected	Y	R	imidacloprid/^{14}C-imidacloprid	99.9%	am		7	13	14-21 d	NOEC	feeding rate	< 15	3	20	[78]
Gammarus pulex	field collected	Y	R	imidacloprid/ ^{14}C-imidacloprid	99.9%	am		7	13	14-21 d	NOEC	mortality	< 15	3	20	[78]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	10 d	LC50	mortality	7.05	2	21	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	10 d	NOEC	mortality	3.53	2	22	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	10 d	LC10	mortality	1.67	2	23	[35]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	10 d	EC50	growth	10.31	2	24	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	10 d	EC10	growth	10.7	2	25	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	10 d	NOEC	growth	≥ 11.95	3	26	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	28 d	LC50	mortality	6.98	2	27	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	28 d	LC10	mortality	0.47	2	28	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	28 d	NOEC	mortality	3.44	2	29	[35]
Hyalella azteca	juveniles, 2-9 d	Y	R	Admire	240 g/L	ftw	133	8.2	24	28 d	NOEC	growth	≥ 11.46	2	30	[35]
Insecta																
Caenis horaria	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	0.024	2	31	[5]
Caenis horaria	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	0.235	2	32	[5]
Chaoborus obscuripes	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	1.99	2	33	[5]
Chaoborus obscuripes	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	4.57	2	33	[5]
Chironomus riparius	larvae, <2-3 d old, 1st instar	N	S	Confidor SL 200	194 g/L					28 d	EC10	emergence	2.56	3	34	[19]
Chironomus riparius	larvae, <2-3 d old, 1st instar	N	S	imidacloprid	98.4					28 d	EC10	emergence	2.09	3	35	[19]
Chironomus riparius	larvae, <2-3 d old, 1st instar	N	S	imidacloprid	98.4					28 d	EC10	emergence	0.87	2	36	[15]
Chironomus riparius	larvae, <2-3 d old, 1st instar	N	S	Imidacloprid OD 200	196 g/L					28 d	NOEC	emergence	3.2	3	37	[79]
Chironomus riparius	larvae, 4 d, 2nd instar	Y	R	Confidor	200 g/L	rw				10 d	NOEC	growth	0.74	3	38	[71]
Chironomus riparius	larvae, 4 d, 2nd instar	Y	R	Confidor	200 g/L	rw				10 d	NOEC	locomotion, ventilation	0.74	3	39	[71]
Chironomus riparius	larvae, 3 d, 1st instar	Y	R	Confidor	200 g/L	am			20	10 d	NOEC	growth	0.4	2	40	[37]
Chironomus riparius	larvae, 3 d, 1st instar	Y	R	Confidor	200 g/L	am			20	10 d	NOEC	emergence ratio	0.4	2	40	[37]
Chironomus riparius	larvae, 3 d	Y	R	Confidor	200 g/L	am			20	10 d	NOEC	development rate	< 0.4	2	40	[37]
Chironomus riparius	larvae, 3 d	Y	R	Confidor	200 g/L	am			20	6 d	NOEC	burrowing activity	0.768	2	41	[37]
Chironomus tentans	2nd instar	Y	R	imidacloprid	95					10 d	LC50	mortality	3.17	2	42	[27]
Chironomus tentans	2nd instar	Y	R	imidacloprid	95					10 d	NOEC	growth	0.67	2	43	[27]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	10 d	NOEC	mortality	≥ 3.57	2	44	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	10 d	LC10	mortality	1.33	2	45	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	10 d	EC50	growth	3.14	2	46	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	10 d	EC10	growth	1.64	2	47	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	10 d	NOEC	growth	1.17	2	48	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	28 d	LC50	mortality	0.91	2	49	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	28 d	NOEC	mortality	1.14	3	50	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	28 d	LC10	mortality	0.42	2	51	[35]
Chironomus tentans	larvae, 7 d	Y	R	Admire	240 g/L	ftw	140	8.2	24	28 d	NOEC	growth	1.14	2	52	[35]
Cloeon dipterum	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	0.033	2	53	[5]
Cloeon dipterum	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	0.041	2	53	[5]
Copera annulata	larvae, head width 1.92 mm			Avermectin/ Imidacloprid	1.8% EC	tw	30			15 d	NOEC	mortality	≥ 0.00018	3	54	[80]
Plea minutissima	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	2.03	2	55	[5]
Plea minutissima	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	4.35	2	55	[5]
Pteronarcys dorsata	field collected	Y	S	Confidor 200 SL	200 g/L	nw			20 ± 3	14 d	LC10	mortality	15.8	2	56	[41]
Pteronarcys dorsata	field collected	Y	S	Confidor 200 SL	200 g/L	nw			20 ± 3	14 d	LC50	mortality	41	2	56	[41]
Pteronarcys dorsata	field collected	Y	S	EcoPrid	50 g/L	nw			20 ± 3	14 d	LC10	mortality	13.3	2	57	[40]

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Sericostoma vittatum	larvae, field collected	Y	R	Confidor	200 g/L	am			20	6 d	NOEC	mortality	≥ 5.0	2	58	[37]
Sericostoma vittatum	larvae, field collected	Y	R	Confidor	200 g/L	am			20	6 d	NOEC	feeding rate	1.23	2	59	[37]
Sialis lutaria	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	EC10	immobility	1.28	2	60	[5]
Sialis lutaria	field collected	Y	R	SL product	200 g/L	rw		7.4-8.3	17.7-19.7	28 d	LC10	mortality	25.1	2	60	[5]
Tipula sp.	field collected	Y	S	Confidor 200 SL	200 g/L	nw			20 ± 3	14 d	LC10	mortality	34	2	61	[41]
Tipula sp.	field collected	Y	S	Confidor 200 SL	200 g/L	nw			20 ± 3	14 d	LC50	mortality	> 63	2	62	[41]
Tipula sp.	field collected	Y	S	EcoPrid	50 g/L	nw			20 ± 3	14 d	LC10	mortality	50	3	63	[40]
Amphibia																
Rana pipiens	egg masses, 70-100 eggs										NOEC	hatching success	88000-110000	4	64	[27]
Pseudacris triseriata	egg masses, 70-100 eggs										NOEC	deformities	17500-20000	4	64	[27]
Ambystoma jeffersonianum	egg masses, 70-100 eggs										NOEC	hatching success	88000-110000	4	64	[27]
Bufo americanus	egg masses, 70-100 eggs										NOEC	hatching success	88000-110000	4	64	[27]
Pisces																
Danio rerio	fertilised eggs	N	Rc	imidacloprid		am	367		26	96 h	NOEC	development	≥ 50000	3	65	[81]
Danio rerio	fertilised eggs	N	Rc	imidacloprid		am	367		28	96 h	NOEC	development	≥ 30000	3	66	[81]
Danio rerio	fertilised eggs	N	Rc	imidacloprid		am	367		30	72 h	NOEC	development	≥ 25000	3	66	[81]
Danio rerio	fertilised eggs	N	Rc	imidacloprid		am	367		33.5	72 h	NOEC	development	≥ 25000	3	66	[81]
Danio rerio	fertilised eggs	Y	S	imidacloprid	ag	am			26	48 h	NOEC	development	≥ 320000	2	67	[20]
Danio rerio	fertilised eggs	Y	S	Confidor	200 g/L	am			26	48 h	LC10	mortality	300000	2	68	[20]
Oncorhynchus mykiss	length 7.2 cm, bw 3.9 g	Y	R	imidacloprid			40-60	7.2-8.0	15	21 d	NOEC	length, weight	28500	3	69	[62]
Oncorhynchus mykiss	fertilised eggs	Y	F	imidacloprid	98.2				9-12	91 d	NOEC	development	9020	2	70	[19]
Oncorhynchus mykiss	fertilized eggs, < 4 h	Y	F	imidacloprid	tg					98 d	NOEC	growth	1200	2	71	[27]
Mollusca																
Marisa cornuarietis	fertilised eggs	N	S	imidacloprid		rtw			26	9 d	NOEC	heart rate	10000	3	72	[82]
Marisa cornuarietis	fertilised eggs	N	S	imidacloprid		rtw			26	9 d	NOEC	mortality	≥ 50000	3	73	[82]
Marisa cornuarietis	fertilised eggs	N	S	imidacloprid		rtw			26	9 d	NOEC	hatching	≥ 50000	3	73	[82]
Marisa cornuarietis	fertilised eggs	N	S	imidacloprid		rtw			26	9 d	NOEC	weight	≥ 50000	3	73	[82]

Notes

1 Based on mean measured concentrations. Study previously assigned Ri2, but information on test conditions and test parameter not available.
2 Test probably performed according to ISO guideline. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively. Cells counted only at start and 72 h, initial cell density not reported.
3 Test probably performed according to ISO guideline. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively. Toxicity of formulation is more than 3 times higher than that of active substance, preference is given to test with active. Solvent of formulation included in control tests. Cells counted only at start and 72 h, initial cell density not reported..
4 Test according to OECD 201. Limit test. Concentrations measured, recovery 100-102% of nominal, endpoint based on nominal concentrations.
5 Test according to OECD 201. Concentrations not measured, test performed under light.
6 Test according to OECD 201. Concentrations not measured, test performed under light. Refers to same test as above.
7 Based on mean measured concentrations. Study previously assigned Ri2, but information on test conditions and test parameter not available.
8 Concentration in dosing solution 95.5%, time weighted average concentration 95.3% of nominal, results expressed as nominal; control immobility too high (20%)
9 Concentration in dosing solution 95.5%, time weighted average concentration 95.3% of nominal, results expressed as nominal; control mortality too high (20%)

10 One concentration tested (0.3 µg/L), with 10% decrease as compared to control. Not possible to check concentration-effect relationship. Mean measured concentration identical to nominal. Concurrent study indicated little degradation over 8 d (measured concentrations between 83-106% of nominal).
11 One concentration tested (0.3 µg/L), with 15% decrease in survival as compared to control. No concentration-effect relationship established. Mean measured concentration identical to nominal. Concurrent study indicated little degradation over 8 d (measured concentrations between 83-106% of nominal).
12 One concentration tested (0.3 µg/L), with 14% decrease as compared to control. No concentration-effect relationship established. Mean measured concentration identical to nominal. Concurrent study indicated little degradation over 8 d (measured concentrations between 83-106% of nominal).
13 One concentration tested (0.3 µg/L), with 27% decrease as compared to control. No concentration-effect relationship established. Mean measured concentration identical to nominal. Concurrent study indicated little degradation over 8 d (measured concentrations between 83-106% of nominal).
14 Test according to OECD 202. DMF 01. mL/L, solvent control included. Endpoint based on mean measured concentrations.
15 Test conditions according to ISO 17025 (acute toxicity for D. magna). Renewal every 2 d. Stability between renewals confirmed, <20% deviation from nominal. Endpoint expressed as nominal concentration. Results presented as LOEC, next lower concentration taken as NOEC.
16 Test according to OECD 211. Measured concentrations in highest and lowest test concentration and stock within 5% of nominal. Endpoint expressed as nominal concentration. NOEC read from bar-graph in which significant differences from control are presented. Water quality parameters within accepted range.
17 Test according to OECD 211. Measured concentrations in highest and lowest test concentration and stock within 5% of nominal. Endpoint expressed as nominal concentration. Water quality parameters within accepted range.
18 Test according to OECD 219 (draft). Water/sediment system. Concentrations not measured, endpoints based on nominal initial concentrations.
19 Concentration in dosing solution 95.5%, time weighted average concentration 97% of nominal, results expressed as nominal
20 Feeding; renewal every 5 d; 12:12 h L:D, wavelength 380-730 nm; measured concentration constant at level of nominal, but analysis for total radioactivity only; not clear if increased wavelength has prevented degradation
21 Mean measured concentration 118-130% of nominal, results based on mean measured concentrations; results for first 10 d of 28-d test; number of test concentrations (4) low, but considered acceptable for LC50 calculation.
22 Mean measured concentration 118-130% of nominal, results based on mean measured concentrations; results for first 10 d of 28-d test.
23 Endpoint recalculated using TechDig analysis of graph; LC50 estimated using TechDig is 7.1 µg/L, which is similar to author's value; mean measured concentration 118-130% of nominal, results based on mean measured concentrations; 122% recovery assumed for 0.3 µg/L nominal (not analysed); results for first 10 d of 28-d test; NOEC is higher than LC25, and LOEC higher than LC50, but concentration-response relationship present; number of test concentrations (4) low, but considered acceptable for LC10 calculation.
24 Mean measured concentration 118-130% of nominal, results based on mean measured concentrations; results for first 10 d of 28-d test; NOEC and LOEC are higher than EC50, but clear concentration-response relationship present; number of test concentrations (4) low, but considered acceptable for EC50 calculation.
25 Endpoint recalculated using TechDig analysis of graph; EC50 estimated using TechDig is 12.4 µg/L, which is slightly higher than author's value; mean measured concentration 118-130% of nominal, results based on mean measured concentrations; 122% recovery assumed for 0.3 µg/L nominal (not analysed); results for first 10 d of 28-d test; NOEC and LOEC are higher than EC50, but clear concentration-response relationship present; number of test concentrations (4) low, but considered acceptable for EC50 calculation.
26 Mean measured concentration 118-130% of nominal, results based on mean measured concentrations. Results for first 10 d of 28-d test. NOEC reported as 11.95 µg/L, but since LOEC is reported as >11.95 µg/L, NOEC should read ≥ 11.95 µg/L. NOEC and LOEC are higher than EC50, probably reduced power because of variation between replicates and/or applied statistical test. Clear concentration-response relationship, preference is given to EC10.
27 Mean measured concentration 115-146% of nominal, results based on mean measured concentrations.
28 Endpoint recalculated using TechDig analysis of graph; mean measured concentration 115-146% of nominal, results based on mean measured concentrations; EC10 marginally lower than lowest test concentration/2, result considered acceptable.
29 Mean measured concentration 115-146% of nominal, results based on mean measured concentrations. LOEC is higher than LC50. Clear concentration-response relationship, preference is given to LC10.
30 Mean measured concentration 115-146% of nominal, results based on mean measured concentrations; no clear concentration-response relationship; NOEC reported as 11.46 µg/L, but since LOEC is reported as >11.46 µg/L, NOEC should read ≥ 11.46 µg/L.
31 Concentration in dosing solution 95.5%, time weighted average concentration 84.9% of nominal, results expressed as nominal; control immobility relatively high (17%), but lower than validity criterion of OECD 211 (chronic Daphnia)
32 Concentration in dosing solution 95.5%, time weighted average concentration 84.9% of nominal, results expressed as nominal
33 Concentration in dosing solution 95.5%, time weighted average concentration 91.7% of nominal, results expressed as nominal
34 Test according to OECD 219 (draft); water/sediment system; endpoints based on nominal initial concentrations; endpoint previously reported as 0.0132 mg/L, but this value refers to the formulation; recalculated to active content, the NOEC is 2.56 µg/L; DAR gives EC15 of 2.7 µg/L as surrogate for NOEC.
35 Test according to OECD 219 (draft); water/sediment system; endpoints based on nominal initial concentrations
36 Test according to OECD 219 (draft); water/sediment system; endpoint 2.09 µg/L based on nominal initial concentrations in water/phase (see above) recalculated using geometric mean concentration in water phase on days 0, 7 and 28.
37 Test according to OECD 219 (draft); water/sediment system; endpoint based on nominal initial concentrations, actual concentrations in water declined from 100% at the start to 25-26% at the end.

38 Measured concentrations are reported as 0.39, 0.74 and 2.15 µg/L (78, 49 and 48% of nominal) at the end of the constant exposure test. Not clear which time period is meant, probably the end of the 10-days exposure period in which half of the test solutions was renewed every 48 h. Exposure over the actual test period not known. Acid-washed inorganic fine sediment present. 34% reduction in growth as compared to control at next higher concentration. Doubtful whether 10-d growth is to be considered as a true chronic endpoint when starting with 2nd instar larvae.
39 Measured concentrations are reported as 0.39, 0.74 and 2.15 µg/L (78, 49 and 48% of nominal) at the end of the constant exposure test. Not clear which time period is meant, probably the end of the 10-days exposure period in which half of the test solutions was renewed every 48 h. Exposure over the actual test period not known. Acid-washed inorganic fine sediment present. ca. 30% reduction in locomotion as compared to control at next higher concentration, and almost no ventilation.
40 Test according to OECD 219. Partial renewal (100 out of 150 mL) every 48 h. Inorganic fine sediment present. Endpoint based on nominal concentrations, measured concentration in old solutions 96% of nominal at level of NOEC. Test performed under 14:10 h L:D.
41 Test according to OECD 219. Partial renewal (100 out of 150 mL) every 48 h. Inorganic fine sediment present. Endpoint recalculated from nominal concentration in paper (LOEC 3.7 µg/L → NOEC 1.2 µg/L), using reported recovery in old solutions of 64% of nominal. Test performed under 14:10 h L:D.
42 DAR only reports endpoints, but summary available in Anatra-Cordone and Durkin, 2005. Original study also cited in Stoughton et al., 2008. Endpoint based on measured concentrations.
43 DAR only reports endpoints, but summary available in Anatra-Cordone and Durkin, 2005. Original study also cited in Stoughton et al., 2008. Endpoint based on measured concentrations. Doubtful whether 10-d growth is to be considered as a true chronic endpoint when starting with 2nd instar larvae.
44 Mean measured concentration 117-160% of nominal, results based on mean measured concentrations. Results for first 10 d of 28-d test. Survival includes emergence. NOEC reported as 3.57 µg/L, but since LOEC is reported as >3.57 µg/L, NOEC should read ≥ 3.57 µg/L.
45 Endpoint recalculated using TechDig analysis of graph. Mean measured concentration 117-160% of nominal, results based on mean measured concentrations. Results for first 10 d of 28-d test. Number of test concentrations (4) low, but considered acceptable for EC10 calculation.
46 Mean measured concentration 117-160% of nominal, results based on mean measured concentrations. Results for first 10 d of 28-d test. LOEC is higher than EC50, but clear concentration-response relationship present. Number of test concentrations (4) low, but considered acceptable for EC50 calculation. Doubtful whether 10-d growth is to be considered as a true chronic endpoint when starting with 7-d old larvae.
47 Endpoint recalculated using TechDig analysis of graph; mean measured concentration 117-160% of nominal, results based on mean measured concentrations; results for first 10 d of 28-d test; number of test concentrations (4) low, but considered acceptable for EC10 calculation; doubtful whether 10-d growth is to be considered as a true chronic endpoint when starting with 7-d old larvae.
48 Mean measured concentration 117-160% of nominal, results based on mean measured concentrations; results for first 10 d of 28-d test; clear concentration-response relationship, preference is given to EC10.
49 Mean measured concentration 114-150% of nominal, results based on mean measured concentrations; survival measured as emergence; NOEC and LOEC are higher than LC50, but clear concentration-response relationship present; number of test concentrations (4) low, but considered acceptable for LC50 calculation.
50 Mean measured concentration 114-150% of nominal, results based on mean measured concentrations. Survival measured as emergence. 55% reduction at 1.14 µg/L, but not significant. LOEC and NOEC are higher than LC50, probably reduced power because of variation between replicates and/or applied statistical test. Clear concentration-response relationship, preference is given to LC10.
51 Endpoint recalculated using TechDig analysis of graph; mean measured concentration 114-150% of nominal, results based on mean measured concentrations; survival measured as emergence; number of test concentrations (4) low, but considered acceptable for LC10 calculation; LC10 marginally lower than lowest test concentration/2, result considered acceptable.
52 Mean measured concentration 114-150% of nominal, results based on mean measured concentrations. No significant difference at 1.14 µg/L, but full mortality at next higher concentration.
53 Concentration in dosing solution 95.5%, time weighted average concentration 86.4% of nominal, results expressed as nominal
54 Renewal after 10 d. Concentrations not measured. Mixture of avermectin and imidacloprid, content of individual compounds not given. Test concentrations presented as insecticide, not clear whether corrected for active content.
55 Concentration in dosing solution 95.5%, time weighted average concentration 92.4% of nominal, results expressed as nominal
56 Results from microcosm experiment with stonefly and cranefly, organic material present, initial concentrations 96-108% of nominal, decline by 53-55% after 14 d, result recalculated based on geometric mean measured concentrations using mortality data from paper.
56 Results from microcosm experiment with stonefly and cranefly, organic material present, initial concentrations 96-108% of nominal, decline by 53-55% after 14 d, result recalculated based on geometric mean measured concentrations using mortality data from paper.
57 Results from microcosm experiment with stonefly and cranefly, organic material present, result recalculated based on twa measured concentrations using mortality data from paper.
58 Partial renewal (100 out of 150 mL) every 48 h. Inorganic fine sediment present. Mortality at all concentrations reported to be <10%, 20% at intermediate concentration 1.9 µg/L nominal, so NOEC is considered to be ≥ 7.8 µg/L nominal. Using reported recovery in old solutions of 66-63% of nominal, this is equal to >5.0 µg/L. Test performed under 14:10 h L:D.
59 Partial renewal (100 out of 150 mL) every 48 h. Inorganic fine sediment present. Endpoint recalculated from nominal concentration in paper (LOEC 3.9 µg/L → NOEC 1.9 µg/L), using reported recovery in old solutions of 66-63% of nominal. Test performed under 14:10 h L:D. Animals acclimated for 14 d. Feeding activity measured as weight loss of alder leaf discs. Feeding rate is not a parameter that is considered for risk limit derivation.
60 Concentration in dosing solution 95.5%, time weighted average concentration 95.3% of nominal, results expressed as nominal
60 Concentration in dosing solution 95.5%, time weighted average concentration 95.3% of nominal, results expressed as nominal
61 Results from microcosm experiment with stonefly and cranefly, organic material present, initial concentrations 96-108% of nominal, decline by 53-55% after 14 d, result recalculated based on geometric mean measured concentrations using mortality data from paper

62 Results from microcosm experiment with stonefly and cranefly, organic material present, initial concentrations 96-108% of nominal, decline by 53-55% after 14 d, result recalculated based on geometric mean measured concentrations, <50% mortality at highest concentration
63 Results from microcosm experiment with stonefly and cranefly, organic material present, result recalculated based on twa measured concentrations using mortality data from paper, ambiguous fit
64 Not clear if based on measured concentrations, test duration and conditions not reported. Original study not available.
65 In view of life stage, test is considered as chronic. Purity of test compound not reported. Stock solutions kept in dark. Renewal every 48 h. Test performed under 12:12 h L:D, but concentrations not measured. No effects at highest concentration tested. Hardness recalculated from reported concentrations of Ca and Mg.
66 In view of life stage, test is considered as chronic. Purity of test compound not reported. Test performed under 12:12 h L:D, but concentrations not measured. Stock solutions kept in dark. Renewal every 48 h. No effects at highest concentration tested. Hardness recalculated from reported concentrations of Ca and Mg.
67 In view of life stage, test is considered as chronic. No effect on series of parameters tested. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively.
68 In view of life stage, test is considered as chronic. Endpoint is most sensitive parameter (heart beat) from series of developmental parameters tested. Test with solvents alone shows contribution of solvent to effect. Stablity of test concentrations in distilled water checked for 21 d at 21ºC, room light. At 70 mg/L and lower stable for 21 d, at 105 and 140 mg/L stable for 17 d, thereafter decline to 84 and 76% of nominal, respectively.
69 Test according to OECD 204. Endpoint based on mean measured concentrations (95-105% of nominal), but precipitation and turbidity was noted at all test concentrations.
70 Test according to OECD 210. Previously assigned Ri3 because endpoint was based on nominal. However, additional information shows that endpoint is based on mean measured concentrations.
71 Endpoint based on mean measured concentrations. Most sensitive endpoint growth after 36 days.
72 Endpoint expressed as nominal concentration. Concentrations not measured, test performed under 12:12 L:D. Test water is tap water with added seasalt, up to conductivity of 820 µS/cm. Significant effect on heart rate.
73 Endpoint expressed as nominal concentration. Concentrations not measured, test performed under 12:12 L:D. Test water is tap water with added seasalt, up to conductivity of 820 µS/cm.

Table A1.3 Acute toxicity of imidacloprid for marine species

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Bacteria																
Vibrio fischeri		N	S	Confidor			20	2		30 min	EC50	bioluminescence	226000	3	1	[57]
Vibrio fischeri		Y	S	imidacloprid		am				15 min	EC50	bioluminescence	101000	3	2	[83]
Crustacea																
Artemia sp.	4th instar nauplii	N	S	imidacloprid	tg	am	38	8	27	48 h	LC50	mortality	361230	3	3	[84,85]
Artemia sp.	4th instar nauplii	N	S	imidacloprid	tg	am	9.5	8	27	48 h	LC50	mortality	> 300000	3	4	[84]
Americamysis bahia	< 24 h old	Y	F	240 S Formulation	22.7%	nw	20	8.2-8.5	19.7-25.0	96 h	LC50	mortality	36	2	5	[27]
Americamysis bahia	< 24 h old	Y	F	imidacloprid	96.2%					96 h	LC50	mortality	37.7	2	6	[19,27]
Americamysis bahia	< 24 h old	Y	F	imidacloprid	96.2%					96 h	LC50	mortality	34.1	2	7	[19,27]
Artemia parthenogenetica	2nd-3rd instar nauplii	N	S	imidacloprid		asw			28	24 h	LC50	mortality	1170	3	10	[86]
Palaemonetes pugio	larvae, 1-2 d, F1 from field collected animals	N	R	imidacloprid	99.5%		20		25	96 h	LC50	mortality	309	3	8	[87]
Palaemonetes pugio	adult, field collected, acclimated 2 wk	N	R	imidacloprid	99.5%		20		25	96 h	LC50	mortality	564	3	8	[87]
Callinectes sapidus	larvae, megalopa stage	N	S	imidacloprid	99.5%	nw	35		25	24 h	LC50	mortality	10	3	9	[88]
Callinectes sapidus	larvae, megalopa stage	N	S	TrimaxPro	40.8%	nw	35		25	24 h	LC50	mortality	313	3	9	[88]
Callinectes sapidus	juveniles	N	S	imidacloprid	99.5%	nw	35		25	24 h	LC50	mortality	1112	3	9	[88]
Callinectes sapidus	juveniles	N	S	TrimaxPro	40.8%	nw	35		25	24 h	LC50	mortality	817	3	9	[88]
Mollusca																
Crassostrea virginica		Y	F	imidacloprid	96.2					96 h	EC50	shell growth	> 23300	2	11	[19,27]
Crassostrea virginica		Y	F	imidacloprid	95.8					96 h	EC50	shell growth	> 145000	2	12	[19,27]
Insecta																
Aedes taeniorhynchus	1st instar	N	S	imidacloprid	tg	am	38	8	27	48 h	LC50	mortality	13	3	13	[84,85]
Aedes taeniorhynchus	1st instar	N	S	imidacloprid	tg	am	12.7	8	27	72 h	LC50	mortality	21	3	4	[84]
Pisces																
Cyprinodon variegatus	29 mm, 0.77 g	Y	S	imidacloprid	96.2					96 h	LC50	mortality	161000	2	14	[19,27]

Notes
1 Concentrations not measured; no details on test water; no details on test compound; Microtox test.
2 Measured concentrations not reported
3 Actual concentrations not measured, test performed under light. Hyperosmotic conditions. Solvent control included.
4 Actual concentrations not measured, test performed under light. Isosmotic conditions. Solvent control included.
5 DO below protocol requirements. Based on measured concentrations.
6 DAR only reports endpoints, but summary available in Anatra-Cordone and Durkin, 2005. Endpoint based on mean measured concentrations.
7 DAR only reports endpoints, but summary available in Anatra-Cordone and Durkin, 2005.
8 Concentrations measured in stock solutions only (103% of nominal), test performed under 16:8 h L:D. Acetone used as solvent in max. 0.1%. Test water parameters measured, but not reported.
9 Concentrations not measured; author confirmed that ambient overhead fluorescent light was present, app. 10:14 h L:D
10 Test compound added as solution in methanol, dried under vacuum before addition of nauplii suspension; incubation under light; concentrations not measured; no details on test substance
11 Test reported in table in the DAR. Not considered valid in the DAR because control performance was less than required. According to information in Anatra-Cordone and Durkin, 2005, results are based on measured concentrations.
12 DAR only reports EC50 >145 mg/L. Limit test, inhibition 22%. According to information in Anatra-Cordone and Durkin, 2005, results are based on measured concentrations.

13 Actual concentrations not measured, test performed under light. Hyperosmotic conditions. Solvent control included. Endpoint refers to most relevant test duration and lowest endpoint.
14 DAR only reports endpoints. According to information in Anatra-Cordone and Durkin, 2005, results are based on measured concentrations.

Table A1.4 Chronic toxicity of imidacloprid for marine species

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	Hardness $CaCO_3$ [mg/L]	pH	T [°C]	Exp. time	Crit.	Test endpoint	Value [µg/L]	Ri	Note	Ref.
Crustacea																
Americamysis bahia	<24 h old	Y	F	imidacloprid	96.2%					28 d	NOEC	reproduction	0.56	3	1	[19]
Americamysis bahia	<24 h old	Y	F	imidacloprid	96.2%					28 d	NOEC	growth	0.163	3	2	[19]
Callinectes sapidus	juveniles	N	S	imidacloprid	99.5%	nw					NOEC	time to metamorphosis	≥ 3.8	3	3	[88]
Mollusca																
Crassostrea virginica		Y	F	imidacloprid	96.2					96 h	NOEC	shell growth	≥ 23300	2	4	[19,27]
Crassostrea virginica		Y	F	imidacloprid	95.8					96 h	NOEC	shell growth	< 145000	3	5	[19,27]

Notes
1 No further details on test conditions provided in DAR, information available from Anatra-Cordone and Durkin, 2005. Endpoint based on measured concentrations. Study rejected in DAR because reproduction rate of controls was too low, and information on individual females is missing.
2 No further details on test conditions provided in DAR, information available from Anatra-Cordone and Durkin, 2005. Study rejected in DAR because reproduction rate of controls was too low, and information on individual females is missing. NOEC for growth was 3.8 µg/L in first test, reason for difference is not clear.
3 Concentrations not measured; static test performed under ambient light
4 Short-term test, but in view of endpoint considered as chronic. DAR only reports EC50 >23.3 mg/L. Information available from Anatra-Cordone and Durkin, 2005. Based on measured concentrations.
5 Short-term test, but in view of endpoint considered as chronic. DAR only reports EC50 >145 mg/L. Information available from Anatra-Cordone and Durkin, 2005. Based on measured concentrations. Decrease by 22% observed. Limit test, not possible to check concentration response relationship.

Appendix 2. Evaluation of micro- and mesocosmstudies

Study 1	
Reference	[47,48]
Species; Population; Community	Phytoplankton, periphyton, invertebrates, zooplankton
Test Method	Mesocosm
System properties	Outdoor ponds, 2.0-2.2 m diameter, 1.0 m deep, 3100-3800 L
Formulation	Imidacloprid SL 200
Exposure regime	0, 0.6, 1.5, 3.8, 9.4 and 23.5 µg/L; 2 applications (May 2 and May 23)
Analysed	Y
Temperature [°C]	Not reported in summary
pH range	Not reported in summary
Hardness [mg $CaCO_3$/L]	Not reported in summary
Exposure time	182 d
Criterion	NOEC
Test endpoint	Population response of benthic invertebrates and zooplankton
Value [µg/L]	0.6 (nominal)
GLP	Y
Guideline	OECD, SETAC
Notes	Original reports not available, based on summary and evaluation in DAR
Ri	2

Description

Test system

Thirteen mesocosms of 2.0-2.2 m diameter, 10 cm natural sediment and 1.0 m water, total 3100-3800 L, sediment not specified. Organisms were added with the sediment and phytoplankton and zooplankton were obtained from natural ponds. Ponds were left to establish during 6 months. Application took place on May 2 and 23, 2001, Treatments, 0, 0.6, 1.5, 3.8, 9.4 and 23.5 a.s. µg/L in duplicate, untreated in triplicate. The substance was sprayed on the pond surface.

Analytical sampling

Concentration was measured in the application solutions, and in initial concentrations in pond water samplings, and regularly during the experiment in water and sediment.

Effect sampling

Effect parameters zooplankton, phytoplankton, chlorophyll-a, emerging insects and macrozoobenthos (by artificial substrate and sediment) were regularly monitored.

Statistical analysis

Univariate and multivariate analyses, PRC.

Results

Chemical analysis

Before the 2nd application, 12-20% of the nominal concentrations was present in the waterphase. The DT_{50} ranged from 5.8 to 13.0 days at all test concentrations after both applications, average DT_{50} 8.2 d. Initial measured concentrations are not reported, but it was concluded that nominal concentrations could be used to express initial exposure. Imidacloprid was found in the sediment, with the highest concentrations one week after second application. Thereafter, the concentration decreased to below LOQ of 7 µg/kg in the highest concentrations after 56-70 d. In the lower treatments, a similar pattern was seen, however the concentrations were close to the LOQ. DT_{50} for imidacloprid in the whole system (determined in the two highest dosages only) is 14.8 d.

Biological observations
Insects (caught by the emergence traps) were the most significantly affected organisms, from 1.5 µg/L upwards. Effects were found on community parameters such as taxa richness, diversity, similarity and principal response. Chironomidae and Baetidae were the most sensitive taxa. No effects were found at 0.6 µg/L, which can be seen as the NOEC. Indirect effects were found on algae, but only the NOEAEC (defined as recovery within 8 weeks after last application) of 23.5 µg/L is reported. For zooplankton, a NOEC of 9.4 µg/L is reported for copepods and cladocerans, for macrozoobenthos the NOEC for the most sensitive species (*Chaoborus* spp.) is 9.4 µg/L.

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? Yes, natural populations of algae, zooplankton and macroinvertebrates were present. Macrophytes and fish were not present.
- Is the description of the experimental set-up adequate and unambiguous? Unclear, not all details are reported in the available summary.
- Is the exposure regime adequately described? Yes.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, but potentially sensitive taxa such (Ostracoda, Amphipoda, Ephemeroptera) were not or not well represented.
- Is it possible to evaluate the observed effects statistically? No, no details concerning measurement endpoint are given for concentrations and effect data. The data are analysed according to up-to-date methods, however.

The study is considered less reliable (Ri 2) mainly because potentially sensitive taxa such as Ostracoda and Amphipoda are not or not well represented, and numbers of Ephemeroptera were too low for statistical analysis. In the DAR, the 0.6 µg/L-treatment is considered as the NOEC (equivalent to 0.51 µg/L expressed as 48-h TWA concentration). No agreement was reached on the level of the NOEAEC [19,89], mainly because doubts were raised on the representativeness of the recovery potential of chironomids for univoltine species. This however, is not relevant since recovery is not taken into account for EQS-derivation.

Conclusion
The NOEC of 0.6 µg/L nominal will be considered for EQS-derivation.

Study 2	
Reference	[90]
Species; Population; Community	Larvae of two frog species (*Acris crepitans* and *Rana clamitans*), periphyton, phytoplankton, zooplankton
Test Method	Mesocosm
System properties	Outdoor ponds, 1.85 m in diameter, ca. 900 L of water and 1 kg of litter
Formulation	Merit
Exposure regime	0 and 9000 µg/L
Analysed	N
Temperature [°C]	Not reported
pH range	Not reported
Hardness [mg $CaCO_3$/L]	Not reported
Exposure time	55 d
Criterion	NOEC
Test endpoint	mortality of amphibians
Value [µg/L]	9000
GLP	No
Guideline	No
Notes	Two experiments were performed, (1) leaves systemically treated with imidacloprid and (2) exposure via water. Experiment 2 is summarized here.
Ri	3 (no measurements of test concentration)

Description

Test system

Aquatic communities in ponds, 1.85 m in diameter, ca. 900 L of water and 1 kg of litter, plankton introduced. Ponds were established ca. 1 month before application. Start experiment: 3 July 2008. Treatments: 0 and 9000 µg a.s./L, four replicates. Other treatments were exposure to predators (fish, crayfish) and a combination of imidacloprid and predators. These treatments are left out of consideration here.

Analytical sampling

Concentration was not measured.

Effect sampling

Survival larvae of frog species *Acris crepitans* and *Ranaclamitans*, periphyton, phytoplankton, zooplankton.

Statistical analysis

Univariate analysis.

Results

Chemical analysis

No chemicals analysis reported.

Biological observations

Tadpoles of *A. crepitans* were significantly affected (mortality) at 9000 µg/L. No effects for *R. clamitans*. Increased oxygen levels by the end of the study (55 days).

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? Yes, but the study only focussed on survival of amphibian larvae.
- Is the description of the experimental set-up adequate and unambiguous? Yes.
- Is the exposure regime adequately described? No. Intended concentration is reported only.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? No, representatives of arthropods are 3 to 4 orders of magnitude more sensitive.
- Is it possible to evaluate the observed effects statistically? Yes (univariate only). However, one test concentration studied only. The effect class system is not designed for this type of studies.

The study is considered to be unreliable (Ri 3), due to the fact that the intended test concentration is not analytically verified. Furthermore, relatively insensitive species were tested.

Conclusion
This study will not be used for EQS-derivation.

Study 3	
Reference	[45]
Species; Population; Community	caged *Gammarus roeseli*
Test Method	Mesocosm
System properties	Indoor stream mesocosm, 73 m, 16.1 m^3, depth 0.2 m, stream velocity 10 cm/s
Formulation	not specified
Exposure regime	Pulse (3 x 12 h) – 7 d interval (application on day 1, 8, 15 and 50, 57, 64); 0 and 12 µg/L
Analysed	Y
Temperature [°C]	16.4
pH range	7.9
Hardness [mg $CaCO_3$/L]	176 (calculated from reported Ca^{2+} and Mg^{2+})
Exposure time	70
Criterion	
Test endpoint	abundance, size distribution, reproductive status, litter degradation
Value [µg/L]	
GLP	No
Guideline	No
Notes	Single species test, no effect class evaluation possible
Ri	2

Description
Test system
Experimental stream indoor mesocosms (length 73 m, volume 16.1 m^3, depth 0.2 m; stream velocity 10 cm/s). Treatment with two series of three 12 µg/L pulses each, weekly interval, first series on day 1, 8 and 15, second series on

day 50, 57 and 64. Application overnight to prevent photolysis. Four pairs of treatment and control, treated on four consecutive days.
Field collected *Gammarus roeseli* were exposed in cages with alder or straw as food source, 32 cages per stream with 10 adults each and four additional cages with food but without animals per stream.

Analytical sampling
Homogeneity of application recorded using fluorescent tracer, exchange of water between stream and cages checked. Water samples every 4 days, analysis of imidacloprid, nutrients and ion compounds; pH, temperature, oxygen and conductivity were monitored permanently.

Effect sampling
Duplicate cages sampled weekly 1 h prior to imidacloprid application, between the two pulse series on day 21 and 28, and after the last pulse on day 70. Gammarids were counted, size distribution was recorded. Females carrying eggs or early instars were counted. Litter material was sieved out and separated into size classes, and analysed for lignin, cellulose and phenols, carbon and nitrogen.

Results
Chemical analysis
Longitudinal homogeneity reached within 10 flow cycles (135 min.) after application. Exchange of stream water with the cages reached within 15 min. Mean measured concentration was 11.9 µg/L after reaching homogeneity, and dropped to 0.08 µg/L when total water renewal was achieved. No significant differences between controls and treatments with respect to water characteristics.

Biological observations
No effects on total abundance, population development, litter decomposition, and size classes. Trend towards lower number of brood carrying females in imidacloprid treatment in presence with alder. At the end, number was 19.8 in control and 13 in treatment (34% difference). Difference was significant on day 49 and 70 when control and treatment were tested in pairs, but not when controls and treatments were tested against each other. Authors conclude that imidacloprid has a delayed effect on brood carrying females.

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? No, study is single species test in mesocosm.
- Is the description of the experimental set-up adequate and unambiguous? Yes.
- Is the exposure regime adequately described? Yes.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, *G. roeseli* belongs to the relatively sensitive species on the basis of acute laboratory data
- Is it possible to evaluate the observed effects statistically? Yes/No. One test concentration studied only, difference in outcome of statistical analysis (testing in pairs/testing all treatments) indicates influence of experimental set-up. The effect class system is not designed for this type of studies.

In view of these criteria, the study is considered to be less reliable (Ri 2), mainly due to the unclear statistical evaluation and the fact that exposure was shorter than the time window considered for derivation of the MAC-$QS_{fw, eco}$. derivation. It is not fully clear what the observed reduction of 34% in brood carrying females means in terms of population development and how the food source interacts with the observed effect. The study can be used as an indication that repeated short-term pulses of 12 µg/L may induce long-term or delayed effects, but it is not possible to establish a statistically underpinned NOEC.

Conclusion
This study is not used for EQS-derivation.

Study 4	
Reference	[40]
Species; Population; Community	Leaf-shredding insects (stonefly: *Pteronarcis dorsata* and crane fly: *Tipula* sp.), microbial decomposers.
Test Method	Microcosm
System properties	Aquaria: 13 X 30 x 21 cm, 6 L, indoor
Formulation	Ecoprid
Exposure regime	0, 1.2, 12, 120, 1200, 12000 µg/L (0, 1.0, 12.0, 135,1550, 15400 µg/L measured 1 h after treatment).
Analysed	Y
Temperature [°C]	18.9-20.4
pH range	6.1-7.1
Hardness [mg $CaCO_3$/L]	Not reported
Exposure time	14 d
Criterion	LC10
Test endpoint	Population response of leaf-shredding insects and microbial decomposers
Value [µg/L]	13.3 (*P. dorsata*)
GLP	No
Guideline	No
Notes	Multi-species test (2 insect species), short study (14 d), no effect class evaluation possible
Ri	2

Description
Test system
Indoor microcosms (glass aquaria, LxWxH 30x13x21 cm), 6 L natural stream water (Sault Ste. Marie, Ontario, Canada), 300 mL stream detritus (1-5 mm sieved; organisms killed by freezing), 10 twigs from speckled alder (*Alnus incana*) trees. Stonefly nymphs (*Pteronarcys dorsata* Say) and cranefly larvae (*Tipula* sp. L.) sampled from local stream. Microcosms were operated for 1 week prior to treatment, organisms (n=9) introduced 2 days before treatment. Treatments 0, 1.0, 12.0, 135, 1550 and 15400 µg a.s./L, four replicates plus two additional replicates for fate assessment. The substance was added to the water surface, while the water was gently stirred.

Analytical sampling
Concentration was in initial concentrations in water samples, and regularly during the experiment in water and leaf material introduced.

Effect sampling

Effect parameters: Stonefly and cranefly were counted after 14 days, microbial decomposition was monitored after 7 and 14 days.

Statistical analysis
Univariate analysis.

Results
Chemical analysis
Initial measured concentrations were 1.0, 12.0, 135, 1550 and 15400 µg a.s./L. Half-lives not reported. Concentrations, were ca. 50% (mean) after 14 days. Average actual concentrations calculated as ≈0.2, 6.1, 73, 902 and 9664 µg a.s./L based on reported measured concentrations in fate replicates. Imidacloprid was found in the introduced leaf material taken in samples of 2 days and later.

Biological observations
Both insect species were significantly affected (mortality) from 135 µg/L and higher. No effects (mortality; including mordibundancy) were found at 12 µg/L, which can be seen as the NOEC. There were no significant differences from controls in oxygen uptake at any test concentration. Microbial decomposition activity was significantly increased at the highest test concentration.

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? No, this study may be considered as a multi-species test (two insect species tested).
- Is the description of the experimental set-up adequate and unambiguous? Yes, but number of test organisms is low.
- Is the exposure regime adequately described? Yes.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, in case of the insects.
- Is it possible to evaluate the observed effects statistically? Yes (univariate only). However, no realistic invertebrate community was tested. Duration of test was 14 days, recovery and community interaction cannot be evaluated. The effect class system cannot be applied.

The study is considered to be less reliable (Ri 2) for evaluation of effects on realistic freshwater communitie. Using the reported measured concentrations and data on mortality, the 14-days LC10 was estimated as 13.3 µg a.s./L for *P. dorsata* and 50 µg/L for *Tipula* sp. The latter value is not considered reliable due to an ambiguous fit.

Conclusion
The LC10 of 13.3 µg/L for *P. dorsata* is included in the chronic dataset.

Study 5	
Reference	[41]
Species; Population; Community	Leaf-shredding insects (stonefly: *Pteronarcis dorsata* and crane fly: *Tipula* sp.), microbial decomposers.
Test Method	Microcosm
System properties	Aquaria: 13 X 30 x 21 cm, 6 L, indoor
Formulation	Confidor 200SL
Exposure regime	Single application of 0, 12, 24, 48, 96 µg/L
Analysed	Y
Temperature [°C]	20 ± 3
pH range	Not reported
Hardness [mg $CaCO_3$/L]	Not reported
Exposure time	14 d
Criterion	LC10, LC50, NOEC
Test endpoint	Mortality, feeding
Value [µg/L]	LC10 15.8, LC50 41 (*P. dorsata*), LC10 34, LC50 > 63 (*Tipulia sp.*) NOEC feeding < 8.8
GLP	No
Guideline	No
Notes	Multi-species test (2 insect species), short study (14 d), no effect class evaluation possible
Ri	2

Description

Test system

Indoor microcosms (glass aquaria, LxWxH 30x13x21 cm), 6 L natural stream water, 300 mL stream detritus (1-5 mm sieved; organisms killed by freezing), 10 twigs from speckled alder (*Alnus incana*) trees. Stonefly nymphs (*Pteronarcys dorsata* Say) and cranefly larvae (*Tipula* sp. L.) sampled from local stream. Microcosms were set up 1 week prior to treatment, organisms (n=9) introduced 2 days before treatment. Treatments, 0, 12, 24, 48 and 96 µg a.s./L, in triplicate. The substance was added to the water surface, mixing by gently stirring.

Analytical sampling

Initial concentrations in water samples were measured, and by the end of the study (14 d).

Effect sampling

Effect parameters: Stonefly and cranefly were counted after 14 days, microbial decomposition was monitored.

Statistical analysis

Univariate analysis.

Results

Chemical analysis

Average initial within 96%–108% of nominal (CV < 10%), final concentrations 53%–55%. Geometric mean concentrations were 8.8, 16, 32 and 63 µg/L.

Effects

Mortality of *P. dorsata* was 3.7% in the control, 3.7 and 7.3% at 12 and 24 µg/L, and 40.7 and 70.4% at 48 and 96 µg/L, latter significant. 14-days LC10 was reported as 20.8 µg/L, 14-days LC50 70.1 µg/L. Mortality of the cranefly, *Tipula* sp., was 11.1% in the control, 7.4, 7.4, 18.5 and 33.3% at the respective test concentrations, differences were not significant. 14-days LC10 was reported as 16.2 µg/L, 14-days LC50 139 µg/L. Live tipulids were sluggish, authors conclude that if those had been quantified and counted as dead, the effects on *Tipula* were similar to those on *P. dorsata*.
Mass loss of leaf material in the imidacloprid treatments was significantly lower than in the control, no visible signs of shredding at 48 and 96 µg/L. Signs of insect feeding at lower concentrations, but at lower rates than the control. No indications of inhibition of microbial decomposition. Authors conclude that concentrations of 12 µg/L are likely to cause significant feeding inhibition in leaf-shredding insects which has the potential to interfere with ecosystem processes.

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? No, this study may be considered a multi-species test (two insect species tested).
- Is the description of the experimental set-up adequate and unambiguous? Yes, but number of replicates and organisms is low.
- Is the exposure regime adequately described? Yes, but no analytical measurements in between
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, in case of the insects.
- Is it possible to evaluate the observed effects statistically? Yes (univariate only). However, no realistic invertebrate community was tested. Duration of test was 14 days, recovery and community interaction cannot be evaluated. The effect class system cannot be applied.

The study is considered to be less reliable (Ri 2) for evaluation of effects on realistic freshwater communities. Endpoints for *P. dorsata* were recalculated using geometric mean concentrations, LC10 15.8, LC50 41 µg/L. LC10 for *Tipula* sp. is estimated as 34 µg/L, LC50 is > 63 µg/L.

Conclusion
LC10 15.8 µg/L and LC50 41 µg/L for *P. dorsata* and LC10 34 µg/L and LC50 > 63 µg/L for *Tipula* sp. are included in the chronic dataset.

Study 6	
Reference	[51]
Species; Population; Community	Benthic macroinvertebrate assemblage, periphyton
Test Method	Mesocosm
System properties	Outdoor stream mesocosms; planar area: 0.065 m^2, 10 L volume, flow-through with water velocity of 11-12 cm/s, coarse and fine substratum
Formulation	Admire (240 g a.s./L)
Exposure regime	Pulse (3 x 24-h) – 7d interval: 0, 1.63, 17.60 µg/L. Average measured peak concentrations
Analysed	Y
Temperature [°C]	14.5 – 14.9
pH range	Not reported
Hardness [mg $CaCO_3$/L]	Not reported
Exposure time	20 d
Criterion	NOEC (Class 1-2)
Test endpoint	Benthic invertebrates: abundance, emergence; microbial decomposition leaf material
Value [µg/L]	1.63 (average measured peak concentration)
GLP	No
Guideline	No
Notes	Short study (20 d), one sampling date, no effect class evaluation possible
Ri	2

Description

Test system

Artificial streams, flow-through, 10 L volume. Inoculated with a benthic invertebrate stream community. The sediment consisted of substratum obtained from gravel beds adjacent to the invertebrate sampling site (Nashwaak River, Canada). Test specimens were introduced 1 day before application. Treatment with three 24-hour pulses at a 7 days interval, concentrations 0, 2 and 20 µg a.s./L. Number of replicates probably 16 (not fully clear from paper). Test performed in August 2005.

Analytical sampling

Samples for imidacloprid analyses were taken at the onset, during and at the end of the pulse.

Effect sampling

Abundance and emergence of benthic invertebrates, one sampling at the end of the experiment (20 days). Microbial decomposition leaf material.

Statistical analysis

Univariate analysis and biotic indices for community response

Results

Chemical analysis

Average measured concentrations over the 24-hours pulse were 1.63 and 17.60 µg/L.

Biological observations
High densities of insects were observed in the control by day 20, dominant taxa were Heptageniidae (Ephemeroptera), Lepidostomatidae, Hydropsychidae and Helicopsychidae (Trichoptera), chironomids, dipteran pupae and elmidae beetles. No differences between both treatments and controls on microbial decomposition rates. Imidacloprid had an adverse effect on benthic communities, ca. 5% reduction at the low pulse (not significant) and 42% at the high pulse (significant). In the high pulse treatment a significant reduction (69%) was observed in combined Ephemeroptera, Plecoptera and Tricoptera taxa (EPT-taxa). Coleoptera were less affected (ca. 29 % reduction). No significant effects were observed for chironomids. Oligochaetes showed a high sensitivity (75% reduction, significant).

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? Yes.
- Is the description of the experimental set-up adequate and unambiguous? Yes.
- Is the exposure regime adequately described? Yes.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, sensitive insect taxa included.
- Is it possible to evaluate the observed effects statistically? Yes. However, effect observations were made only shortly (7 days) after the last of the three 24-hour pulses and recovery and community interactions cannot be evaluated. The effect class system cannot be applied by its full merits, since it involved one sampling date only.

The study is considered less reliable (Ri 2) for the evaluation of effects of short-term exposure peaks on realistic freshwater communities, because longer-term effects were not evaluated. However, Effect class 1 and 2 could be derived for the endpoints reported:

	Treatment level [µg/L]	
	1.63	**17.60**
EPT*	1-2↓	4↓
Diptera (chironomids)	1	1
Coleoptera	1	1-2↓
Oligochaeta	1	4↓
Microbial decomposition	1	1
Most sensitive endpoint	1-2	4

*Ephemeroptera, Plecoptera, Trichoptera

Conclusion
The NOEC is 1.63 µg a.s./L, this value is considered for EQS-derivation.

Study 7	
Reference	[52]
Species; Population; Community	Benthic steam community; effects on two mayfly species reported
Test Method	Microcosm
System properties	Artificial streams; planar area: 0.065 m^2, 10 L volume, flow-through with water velocity of 11-12 cm/s, coarse and fine substratum; outdoor
Formulation	Admire
Exposure regime	Pulse (12-h): 0, 0.1, 0.3, 3.9, 9.1 µg/L Continuous (20 d): 0, 0.1, 0.3, 0.8 µg/L (actual measured)
Analysed	Y
Temperature [°C]	Not reported
pH range	Not reported
Hardness [mg $CaCO_3$/L]	Not reported
Exposure time	20 d
Criterion	NOEC
Test endpoint	Abundance, emergence, adult body size
Value [µg/L]	Pulse (12-h): 3.9 (abundance); 3.9 (emergence); < 0.1 (size); Continuous(20 d): 0.3 (abundance); 0.1 (emergence); < 0.1 (size)
GLP	No
Guideline	No
Notes	Effects on 2 mayfly species reported, being part of a benthic invertebrate stream community. Short study (20 d), no effect class evaluation possible
Ri	2

Description

Test system

Artificial streams, flow-through, 10 L volume. Inoculated with a benthic invertebrate stream community. Sediment consisted of substratum obtained from gravel beds adjacent to the invertebrate sampling site (Nashwaak River, Canada). Test location: Agri-foods Canada facility, New Brunswick, Canada. Test organisms: mayfly species *Epeorus* spp. (Heptageniidae) and *Baetis* spp. (Baetidae), introduced 1 day before application. Intended treatments; pulse (12h): 0, 0.1, 0.5, 1, 5 and 10 µg a.s./L and continuous: 0, 0.1, 0.5, 1 µg a.s./L, n= 8 in both regimes.

Analytical sampling

Samples for imidacloprid analyses were taken at the onset, during and at the end of the pulse and every 5 days for the continuous exposures.

Effect sampling

Abundance, emergence, adult body size.

Statistical analysis

Univariate analysis

Results

Chemical analysis

Actual measured concentrations 0, 0.1, 0.3, 3.9, 9.1 µg a.s./L for pulse treatment and 0, 0.1, 0.3, 0.8 µg a.s./L for continuous exposure.

Biological observations
No differences between both treatment types and controls in algal biomass (chlorofyll-a, ash free biomass). NOECs for abundance, emergence and thorax or head length are presented in the table.

Exposure type		Endpoint	NOEC [µg/L]
Continuous	*Epeorus* spp.	abundance	0.3
		emergence	0.1
		adult male thorax length	0.1
		adult female thorax/head length	≥ 0.8
	Baetis spp.	abundance	0.3
		emergence	≥ 0.8
		adult male head length	< 0.1
		adult female thorax/head length	≥ 0.8
Pulse	*Epeorus* spp.	abundance	3.9
		emergence	3.9
		adult male thorax length	< 0.1
		adult female thorax/head length	≥ 9.1
	Baetis spp.	abundance	≥ 9.1
		emergence	≥ 9.1
		adult male head length	< 0.1
		adult female thorax/head length	≥ 9.1

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? Yes, but the study focussed on effects on two mayfly genera. Effects on other species are not reported.
- Is the description of the experimental set-up adequate and unambiguous? Yes.
- Is the exposure regime adequately described? Yes.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, mayflies belong to the most sensitive taxa from the laboratory dataset.
- Is it possible to evaluate the observed effects statistically? Yes (univariate only). Duration of test was 20 days, recovery and community interactions cannot be/were not evaluated. The effect class system cannot be applied by its full merits.

In view of these criteria, the study is considered less reliable (Ri 2), mainly because species of only two genera were reported, and longer-term effects cannot be evaluated. However, NOECs (Class 1 effects) could be derived for species reported.

Conclusion
The 12-hours NOECs of 3.9 µg/L and the 20-days NOEC of 0.1 µg/L are considered for EQS-derivation. Effect on head and thorax length is taken into account.

Study 8	
Reference	[53,54]
Species; Population; Community	Macrophytes, plankton, macroinvertebrates
Test Method	Mesocosm
System properties	Indoor streams, 75 m long, 1 m wide, 0.2 m water, flow-through with water velocity of 10 cm/s, sand / fine sediment substratum, pool sections
Formulation	Imidacloprid, 99.9% pure
Exposure regime	Pulse (3 x 12 h) – 7 d interval; two series, 2nd series about 50 d after 1st pulse; 0 and 12 µg/L
Analysed	Y
Temperature [°C]	15.7 - 16.3 (1st series), 17.5 - 19.3 (2nd series)
pH range	7.5-8.2
Hardness [mg $CaCO_3$/L]	Not reported
Exposure time	11 w
Criterion	NOEC
Test endpoint	community, drift
Value [µg/L]	< 12
GLP	No
Guideline	No
Notes	Only one concentration tested
Ri	2

Description

Test system

Experimental stream indoor mesocosms (length 753 m, 1 m wide, depth 0.2 m; stream velocity 10 cm/s), sand substratum and equipped with 4 pool sections (3 m long, 1.2 m wide), stocked with macrophyte *Sparganium erectum*. Treatment with two series of three 12 µg/L pulses each, weekly interval, simulating spring and autumn treatment, 2nd series started about 50 days after 1st pulse. Application overnight to prevent photolysis. Four pairs of treatment and control, treated on four consecutive days. Streams were stocked with straw litterbags that had been kept for 2 weeks in a reference stream in spring and were then transported to the mesocosm site and emptied in the streams. Re-stocking with summer communities about two weeks before the 2nd pulse series.

Analytical sampling

Homogeneity of application recorded using fluorescent tracer. Water samples were taken 11.5 h after starting the pulses.

Effect sampling

Quantitative emergence and benthos sampling on 10 occasions, 5 weekly samples during each pulse series. Emergence with 1 m^2 traps, benthos sampling at walls, sand and straw, total abundance estimated using sand to straw area. Live counts of large gammarids were made repreatedly in designated sand areas, *Neureclipsis* sp. (Trichoptera, caddisfly) were quantified by counting filtration nets prior to the 2nd application series.

Drift before, during, and after the pulses was measured using two drift nets that were placed in the middle of the stream bottom above the sediment surface in front of the 2nd and the 4th pool section (distance between nets = 20 m) with

opening in flow direction. Additional drift nets were placed in each stream behind pool sections 1 and 3 on three. In the week prior to dosing, cathes were made during day and night as a references, after dosing, each drift net was checked at the end of each pulse (1st night), at the end of the following day (1st day), and on the second morning (2nd night). Specimens of *G. roeseli* ≤ 3.8 mm total length were counted separately, the 3 large size classes were pooled to one class > 3.8 mm).

Statistical analysis
Univariate and multivariate analysis (PRC), effects of imidacloprid on macroinvertebrate drift were calculated as quotient of all driftnet catches in the treatments and all driftnet catches in the corresponding control stream. Significant differences ($p < 0.05$) between treatment and control catches of driftnets, which were synchronously exposed in the same stream mesocosms, and between replicates were tested pulse by pulse with the Wilcoxon signed-rank test.

Results
Chemical analysis
Longitudinal homogeneity confirmed, measured concentrations during pulse 11.1 to 12.1 µg a.s./L.

Biological observations
Abundance, emergence [54]
Colonisation in spring resulted in mean abundance of 2432 individual per litter bag, dipterans were dominant followed by crustaceans. Latter group was dominant in the summer stock. Coefficient of variation between bags in spring and summer was ≈ 30 and 40% for crustaceans and ephemerids, ≈30 and 55% for trichopterans and 14 and 30% for dipterans. Higher variation was found for rare taxa. All functional groups were present, percentage of predators was ca. 10%. Initial abundance in the streams was ca. 1000 ind/m^2. Overall, 48 taxa were identified, with dipterans being most species rich. Gammarids increased after introduction, insects decreased.

Number of taxa declined over time in control and treatments, mainly due to emergence of dipterans. PRC on abundance of taxa was not significant and showed weak effects of treatment. Species weights indicated that Tanypodinae (Chironomidae) and *Baetis* (Ephemeroptera) were among the potentially affected taxa. Numbers of Tanypodinae were significantly lower in the treated streams on 2 successive occasions during the 2nd pulse series, non-significant decreases were observed for Diptera, Trichoptera and Ephemeroptera during the 2nd pulse series.

Non-emerging arthropods such as gammarids increased during the study. Based on population count data alone, no effects were observed. Live counts revealed significantly lower numbers of larger gammaridson sediment immediately after the 5th pulse. Numbers increased to control values but were significantly lower after the 6th pulse and remained significantly lower on three consecutive samplings for about 10 days. Authors conclude that gammarids have sought shelter in the straw after the pulses and returned to the sand after exposure.

Neureclipsis sp. showed a steady decrease in the control during the 2nd pulse series. In the treatment, numbers remained fairly constant but declined to almost 0 after the 4th pulse and were significantly different from the control on

four consecutive samplings during ca. 10 days. Unlike for gammarids, no recovery was observed.

PRC for emergent insects was significant on three sampling occasions after the 4th pulse. A similar but not significant pattern was observed after the 1st pulse series. Significantly lower emergence was observed for

- Tanypodinae: 1 sampling after pulse 3, 2 samplings after pulse 5, no emergence on last sampling (day 70)
- Tanytarsini: 1 sampling after pulse 4
- Orthocladiinae: 1 sampling after pulse 4
- Ephemeroptera: no emergence during 1st pulse series, significant reduction from 4th pulse on, no emergence on last sampling day.

Drift [53]
Pre-exposure catches revealed significantly higher night-time drift in *Baetis* sp., chironomids (except for some species), higher night drift became more apparent during 2nd series in summer. Only few catches for *Caenis* sp. (Ephemeroptera). Significantly higher drift during and after imidacloprid pulses was observed for *Baetis* sp., *Corynoneura* sp. and Orthocladiinae (Chironomidae) and *G. roeseli* (< 3.8 mm). No significant effect on *G. roeseli* (> 3.8 mm) and Tanypodinae.

Evaluation of the scientific reliability of the field study
Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? Yes.
- Is the description of the experimental set-up adequate and unambiguous? Yes.
- Is the exposure regime adequately described? Yes.
- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes.
- Is it possible to evaluate the observed effects statistically? Yes. Last observations were 70 days (emergence; taxa abundance) or 95 days (gammarids, Neureclipsis) after 1st pulse, but because of restocking 2nd series should be considered separately and duration is 3 - 6 weeks. The effect class system cannot be applied by its full merits.

The study is considered to be less reliable (Ri 2), mainly because only one concentration was tested and duration was too short to consider recovery. Re-stocking can be considered as a kind of re-colonisation, which under natural conditions would only be possible from uncontaminated upstream water. Pulses were shorter than the time window considered for derivation of the MAC-$QS_{fw, eco}$, but repetition represents a worst case. The effects are summarised below according to the Effect class methodology.

	Effect class
abundance	
all taxa	1
Gammarus sp.	1
Diptera	1-2↓
Tanypodinae	3A
Trichoptera	4[#]
Ephemeroptera	3A[#]
PRC	1
life counts	
gammarids	3A

Neureclipsis sp.	3A
emergence	
Tanypodinae	4
Tanytarsini	2
Orthocladiinae	2
Ephemeroptera	4
PRC	4

not indicated as significant, but figure suggests otherwise

Conclusion
The study shows that repeated 12-hour pulses of 12 µg a.s./L lead to effects on abundance and emergence of several taxa, with Ephemeroptera (affected after single pulse), Trichoptera (id.), Chironomidae and Gammaridae being most sensitive. Increased drift was observed for *Baetis*, chironomids and *G. roeseli*. Since only one, relatively high, concentration was tested, the relevance for EQS-derivation is limited, but the study will be considered for EQS-derivation.

Study 9	
Reference	[50]
Species; Population; Community	Macroinvertebrates
Test Method	Outdoor microcosm
System properties	Cosms: 45.5 cm x 30 cm x 21 cm
Formulation	Not specified
Exposure regime	Y
Analysed	3 weekly applications
Temperature [°C]	
pH range	
Hardness [mg $CaCO_3$/L]	
Exposure time	10 weeks
Criterion	NOEC
Test endpoint	Abundance, emergence
Value [µg/L]	1.4 µg/L nominal
GLP	No
Guideline	No
Notes	
Ri	2

Description
Test system.
56 outdoor microcosms (20 L, lxwxh = 45.5 cm x 30 cm x 21 cm) in a reservoir pond in Berlin, Germany. Microcosms were filled with 750 mL fine homogenized sediment (silt and clay loam with 3% o.m.), from an uncontaminated lake, and with 15 L water from the reservoir pond. The microcosm were left floating, covered with a 2 cm mesh net for colonization for three weeks (late May to June). During this period every week an application with imidacloprid took place. After this colonization period, microcosm were covered with a fine nylon mesh and sampling lasted for seven weeks after third application.

In the control microcosms an average number of 680 individuals/microcosm was collected during the entire experiment. The macroinvertebrate assemblage was dominated by Chironomidae (Diptera) (65 %) from the subfamilies Chironominae, Tanypodinae, and Orthocladiinae. The second most abundant and frequent family was Gastropoda (18 %), represented by the pulmonate snail

Radix sp., which probably entered the microcosms at the planktonic stage with the water. Other relatively abundant insect families were Ephemeroptera (*Caenis* sp. and *Cloeon* sp.), whereas Ceratopogonidae. Chaoboridae, Culicidae, other Diptera, and Nematoda were present in only a small number of microcosms.

Systems were exposed to 0.6, 1.4, 3.2, 7.5, 17.3, and 40 µg/L imidacloprid. 7 replicates for treatments, 14 replicates for untreated control. Exact dates (and year) not specified in the paper. Test item not specified else than imidacloprid.

Analytical sampling.
Concentrations were measured 6 h, 1 week and 6 weeks after each treatment and at the end of the experiment. Furthermore sacrificial tanks were set up for the 17.3 µg/L treatment. Here water was additionally sampled 1, 2, 3 and 7 days after each pulse. Whole sediment was taken from the sacrificial microcosm for chemical analyses.

Effect sampling.
Abiotic parameters (O_2, pH, temperature, turbidity, conductivity) were measured weekly. UV radiation was also recorded. Emerging insects were collected weekly after the third pulse. At the end of the experiment the content of each microcosm was filtered through a 500 µm sieve to collect remaining insect larvae. Total abundance, number of species and number of adults of nommon taxa were monitored as endpoints for the experiment.

Statistical analysis
For comparison of abundance, Kruskal-Wallis and Mann-Whitney U tests were performed. Jonckheere-Terpstra trens test was used to detect trend of gradually decrease of endpoints with increasing imidacloprid concentrations. Power analysis was performed to determine the power of the study design.

Results
Chemical analysis.
The DT50 for dissipation in water was determined as 20-36 h in the 17.3 µg/L treated cosms. At the end of the experiment concentrations were < 6% of nominal. TWA values were calculated for all treatments. Although not specified in the manuscript, it is assumed from the context that the TWA is calculated for 1 week, the results are then consistent with the reported DT50. Table below shows the nominal concentrations and the corresponding mean TWA concentrations (mean for three pulse dosages).

Imidacloprid concentrations, nominal and TWA concentrations.

Nominal concentration (µg/L)	Mean TWA (µg/L)	Water concentration at end of experiment (µg/L)	Sediment concentration at end of experiment (µg/kg)
0.6	0.2	0.0	0.0
1.4	0.4	0.06	0.0
3.2	1.0	0.13	0.0
7.5	2.3	0.37	0.02
17.3	5.2	0.99	0.04
40	12	1.72	0.13

The authors discuss that due to the rapid degradation in the water column (partly due to high radiation, and unhindered transmission in water),

concentrations in sediment are low as well, and the study might represent a best-case scenario.

Abiotic parameters
pH 8-9, water temperature 16-22°C, conductivity decreased from 835 µS/cm at the start to 615 µS/cm at the end. Air temperature 10-24°C, radiation 6-11 µW/cm^2. Conductivity decreased in cosms with the highest growth. Differences were present till the end of the experiment.

Biological observations.
Macroinvertebrates
Total # of species and abundance of Chironimidae were significantly decreased in the two highest treatment levels. Effects were caused mainly by three species belonging to the subfamily Orhocladiinae. For Tanypodinae, effects were seen from 7.5 µg/L, significant in the highest treatment.
Number of *Radix* sp. increased significantly at the highest concentration.
Ephemeroptera decreased significantly in the two highest concentrations. Since not all control cosms were colonised, it was not possible to run a powerful statistical test.
Effects on emergence appeared to be related to the mortality in the cosms rather than to effects on emergence itself. Ephemeroptera were sensitive, at concentrations >1.4 µg/L nominal no emerging *Caenis* sp. adults were found.

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? Partly, macro-invertebrates that can colonize the cosm or were introduced with the sediment were studied and reported. Other organisms were not reported.
2. Is the description of the experimental set-up adequate and unambiguous? Yes.
3. Is the exposure regime adequately described? No, Test item not described in detail, application method not specified.
4. Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, imidacloprid is an insecticide, and insects are included in the study.
5. Is it possible to evaluate the observed effects statistically? Data are not presented, it is indicated that the power was estimated, data are not presented however. Re-evaluating is not possible with the available data.

In view of these criteria, the study is considered less reliable (Ri 2). Clear effects occur at the two highest concentrations of 17.3 and 40 µg/L nominal. However, for some groups (Ephemeroptera) emergence effects were found in the 3.2 µg/L treatment. At 1.4 µg/L no significant effects were found. Considering the DT50 of 28 hours, the 48-hours TWA for this treatment is 0.82 µg/L.

Conclusion
The study shows that repeated applications of 1.4 µg a.s./L do not lead to effects on abundance and emergence of macroinvertebrates. Due to the fast dissipation of the compound, the study cannot be used for derivation of the $QS_{fw, eco}$, but the 48-hours TWA NOEC of 0.82 µg/L is considered for the MAC-$QS_{fw, eco}$

Study 10	
Reference	[55]
Species; Population; Community	Cloeon dipterum, macrophytes; large predators actively removed
Test Method	Outdoor enclosure
System properties	Enclosures in outdoor experimental ditch, fine sandy clay sediment
Formulation	Imidacloprid SL 200
Exposure regime	two applications, 21 d interval; concentrations 0, 0.097, 0.243, 0.608, 1.520, 3.800 µg a.s./L.
Analysed	Y
Temperature [°C]	5,5 – 14,8
pH range	7.62-10.16
Hardness [mg $CaCO_3$/L]	Not specified
Exposure time	Application on day 0 and 21, test duration until 37 d
Criterion	NOEC
Test endpoint	Abundance
Value [µg/L]	1.52 (nominal)
GLP	Y
Guideline	
Notes	Single species test
Ri	2

Description

Test system

Enclosures of a polycarbonate, translucent cylinder (diameter: 1.05 m; height: 0.9 m; water volume: ca. 0.45 m^3), placed in experimental ditches. Total of 21 enclosures (four controls, 15 treated at five different concentrations (n=3), two shaded fate enclosures). Fine sandy clay sediment. Water from a water supply basin at the test facility. Macrophytes were present (developing *Elodea* vegetation). Light aeration during experiment.
Aquatic larvae of the mayfly *Cloeon dipterum* were inserted on three occasions (September 16th, 19th and 23rd, 2013). Larvae were collected from previously unused and therefore uncontaminated experimental ditches at the test facility and equally divided over the test systems. In total approximately 900 individuals per enclosure were introduced. Larger predators such as backswimmers (Notonecta) and dragonfly larvae (Anisoptera) and were actively removed.
Test substance was applied twice on October 7th and October 28st, 2013.
Treatment levels: 0 µg/L (control), 0.097, 0.243, 0.608, 1.520, 3.800 µg a.s./L.
Application by pouring dosing solutions and gently stirring.

Analytical sampling

In all enclosures, water samples were taken (day 0: 2 h before application; day 21: 1 h before application), and 4 hours after the application. Additional samples in the (1.520 and 3.800 µg a.s./L, both shaded and unshaded) test systems at 2, 4, 7, 11, 14, 23, 25, 28, 32, and 37 days post first application and sediment samples at day -5, 14, 28 and 37 post first application. Macrophytes were sampled for fate analysis on day 37 in the control systems and fate enclosures (1.520 and 3.800 µg a.s./L, shaded and unshaded).

Effect sampling

Nymphal stages of the mayfly *Cloeon dipterum* were captured by using net samples combined with an artificial substrate (pebble basket). Sampling took place -5, 2, 9, 16, 23, 30 and 37 after the first application. *Cloeon dipterum* nymphs were counted alive and returned to their respective test system. No emergence due to low temperatures.

Temperature, pH, dissolved oxygen (DO) and electrical conductivity (EC) were measured in the morning on days 2, 9, 16, 23, 30 and 37 after first application.

Statistical analysis
Univariate analyses of abundance of *Cloeon dipterum* and community metabolism endpoints.

Results
Chemical analysis
Concentration in dosing solutions were 93-101% of nominal. Measured concentrations 4 h after 1st application were < LOD for control and 0.097 µg a.s./L, 260% of nominal at 0.024 µg a.s./L, and 82-109% of nominal at the higher concentrations. Concentrations at 0.024 µg a.s./L are considered not reliable according to the authors due to the low level and incomplete mixing. At 1.52 and 3.8 µg a.s./L, 36 and 40%% of initial was present just before the 2nd application. The DT50 for dissipation from the water phase was estimated by the evaluator by non-linear regression of 1st order exponential decay using GraphPad Prism 6.03 with measured concentrations at 1.52 and 3.8 µg a.s./L. DT50 in the respective treatment levels was 10.8 and 13.0 days after the first application, and 14 and 14.5 days after the second.

Statistical power
Authors calculated the Minimum Detectable Difference (MDD), which is the percentage change relative to the control that is needed to detect a change as significant. MDD was 33% before application, and ranged from 49% to 63% after application.

Biological observations
Abundance in the respective treatments is presented in the figures below (copied from report). No statistically significant effects were observed at concentrations up to and including 1.52 µg a.s./L nominal. At 3.8 µg a.s./L, a clear decline was observed in one replicate on three last sampling dates (days 23, 30 and 37). Authors conclude that 1.52 µg a.s./L is the NOEC.

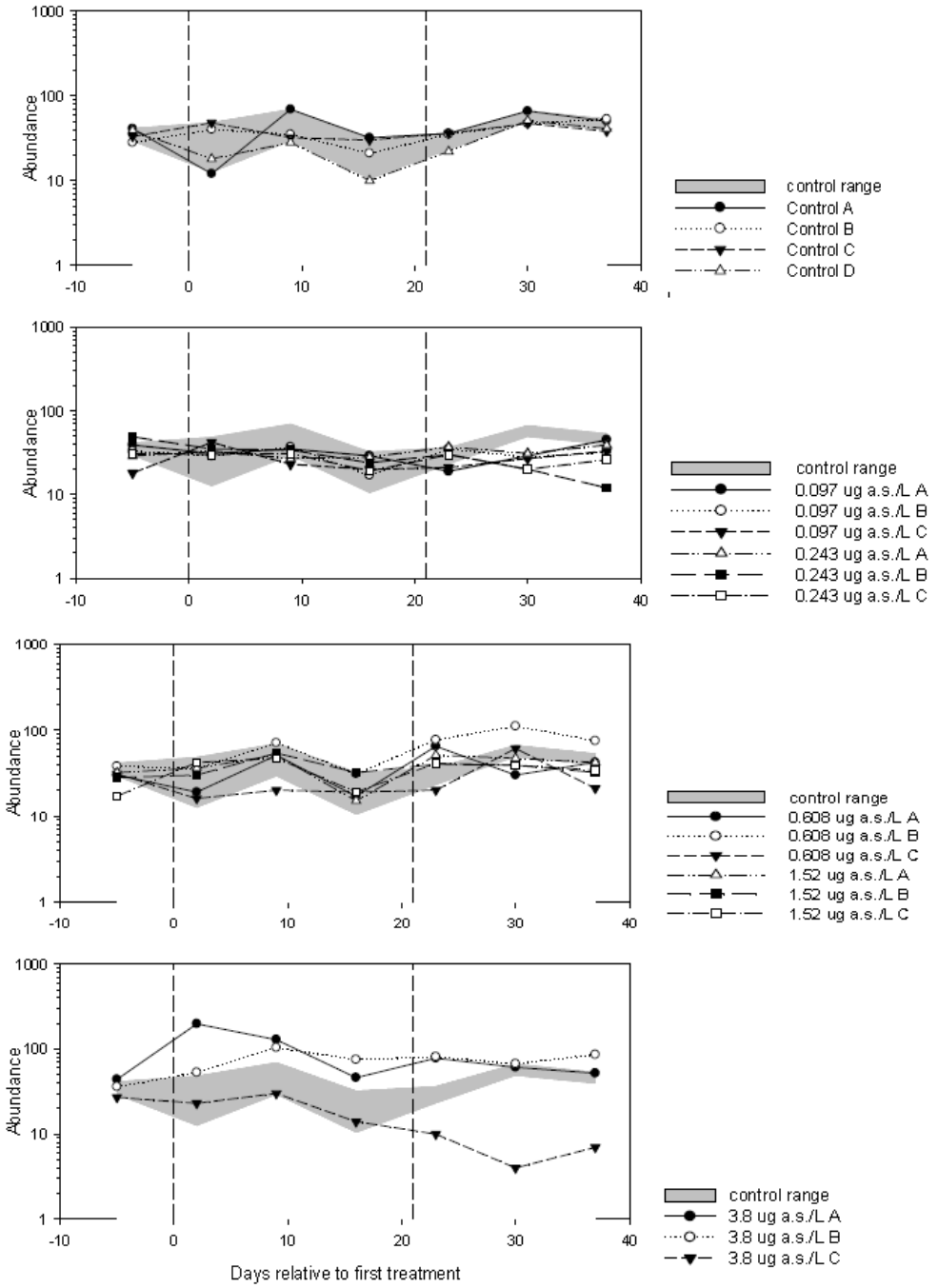

Figure 1. Abundance of *Cloeon dipterum* over time

Evaluation of the scientific reliability of the field study

Criteria for a suitable (semi)field study

- Does the test system represent a realistic freshwater community? Partly, species composition not described, large predators removed
- Is the description of the experimental set-up adequate and unambiguous? Partly, efficiency of sampling method not specified.
- Is the exposure regime adequately described? Yes.

- Are the investigated endpoints sensitive and in accordance with the working mechanism of the compound? Yes, test was aimed at a specific sensitive organism.
- Is it possible to evaluate the observed effects statistically? Yes.

It is recognised that the MDD achieved in this study is considered acceptable by EFSA [49]. However, it is noted that EFSA considers an MDD of 70-90% acceptable, whereas for field studies with other organism groups (earthworms, non-target arthropods) a lower percentage of 50% is used [91,92]. Since the MDD is only recently introduced as a reporting requirement for mesocosm studies, experience has to be gained as to how the MDD should be used as a criterion for assigning the reliability index.
Specimens are nymphal stages, sampled with a net and from pebble baskets. In a number of cases (e.g. cosm A in lowest part of Figure 1), considerable increases in abundance are found. Since nymphal stages do not reproduce, this increase can only be caused be introduction of new larvae (by adults, laying eggs), or it is an artefact of the sampling method. Given the time of the season, it is not very likely that new larvae are introduced. Upon request, the authors confirmed that the differences are caused by variability of the sampling method. They state that the current variation observed in the *Cloeon* abundances is rather normal for macrofauna endpoints in model ecosystem studies, indicating the variation caused by the sampling method reflects the normal technical limitations of such a study. The authors consider the response observed in the replicate systems of 3.8 µg a.s./L as an exception to the normal variation. Although not statistically significantly different from controls, they consider the decline in replicate C as a potential effect of imidacloprid and consequently did not designate this treatment level as a possible NOEC value (pers. comm. I. Roessink, Alterra). Given the time course of abundance (see figure above), it seems reasonable to assume that the oberved decline at 3.8 µg a.s./L was not caused by the 2nd application, but already started as a result of the 1st.

The variation which is caused by the sampling method might have influenced the results, which is a reason to consider the study less reliable. On the other hand, this variation is likely to be present in the control too, and is then accounted for in the MDD. The statement of the authors that the variation is similar to what is normally seen in mesocosm studies is accepted, but it should be noted that full mesocosm studies consider endpoints for multiple species. Moreover, emergence is usually included as an additional parameter to further underpin the sampling methods used here. Therefore, while accepting that the NOEC in this study is the 1.52 µg a.s./L treatment, the representativeness of this NOEC for other systems and other application periods remains to be seen.

Conclusion
The NOEC of 1.52 µg a.s./L nominal is considered for EQS-derivation.

Studies not further evaluated
Mesocosm study in rice paddies [93,94]. Mesocosms were dosed by transplanting nursery boxes with rice seedlings that were treated with imidacloprid in a granular formulation. Treatment was performed in 2010 and repeated in 2011, paddies were drained and left dry in between. Due to the way of dosing and emission, ecosystem characteristics, and agricultural practice, the study might be relevant for risk assessment of imidacloprid in rice cultivation.

However, the relevance for standard derivation of surface water in general is limited. Therefore, the studies are not further discussed here.

Mesocosm studies in rice paddies [95,96]. Mesocosms were dosed by transplanting nursery boxes with rice seedlings that were treated with imidacloprid in a granular formulation. Moreover, fish were introducted in the systems. Similar to the study above, the study design is not considered relevant for standard derivation for surface waters in general.

Study in which eggs of *Sympetrum infuscatum* were placed on the surface of a micro-paddy lysimeter (small lysimeters with soil and rice seedlings) that was treated with imidacloprid in a granular formulation [97]. The study might be relevant for risk assessment of imidacloprid in rice cultivation, but the dosing and exposure is not considered relevant for derivation of standards for surface water. The study is not further discussed here.

Study in which the fate of imidacloprid was assessed after application to a rice plot in Portugal [98]. Measured concentrations in paddy water were compared with modelled concentrations. Water from the plots was sampled and used for laboratory bioassays with *Daphnia magna*, *Heterocypris incongruens*, *Pseudokirchneriella subcapitata* and *Lemna minor* (only results presented, no further details given). Results were used for a risk assessment on the basis of SSDs with literature data.

Appendix 3. ETX output

Table A2.1 Acute SSD, all species

Input toxicity data

Data no	Toxicity data	Label	Species
1	58876	bacteria	Vibrio fischerii
2	79255	bacteria	Vibrio qinghaiensis sp.
3	389000	algae	Desmodesmus subspicatus
4	35.9	crustaceans	Americamysis bahia
5	119	crustaceans	Asellus aquaticus
6	2.07	crustaceans	Ceriodaphnia dubia
7	832	crustaceans	Chydorus sphaericus
8	1	crustaceans	Cypretta seuratti
9	10	crustaceans	Cypridopsis vidua
10	52455	crustaceans	Daphnia magna
11	110	crustaceans	Gammarus pulex
12	55	crustaceans	Hyallella azteca
13	3	crustaceans	Ilyocypris dentifera
14	1.94	crustaceans	Gammarus roeseli
15	1.77	insects	Caenis horaria
16	284	insects	Chaoborus obscuripes
17	2.65	insects	Chironomus dilutus
18	6.9	insects	Chironomus tentans
19	1.02	insects	Cloeon dipterum
20	0.65	insects	Epeorus longimanus
21	1.79	insects	Limnephilidae
22	18.2	insects	Notonecta spp.
23	35.9	insects	Plea minutissima
24	50.6	insects	Sialis lutaria
25	8.1	insects	Simulium vittatum
26	227099	fish	Danio rerio
27	237000	fish	Leuciscus idus melanotus
28	211000	fish	Oncorhynchus mykiss
29	161000	fish	Cyprinodon variegatus
30	6.2	annelids	Lumbriculus variegatus

Parameters of the normal distribution

Name	Value	Description
mean	2.130404	mean of the log toxicity values
s.d.	2.003784	sample standard deviation
n	30	sample size

HC5 results

Name	Value	log10(Value)	Description
LL HC5	0.004812	-2.317669836	lower estimate of the HC5
HC5	0.06312	-1.199831935	median estimate of the HC5
UL HC5	0.422729	-0.37393808	upper estimate of the HC5
sprHC5	87.84798	1.943731756	spread of the HC5 estimate

FA At HC5 results

Name	Value	Description
FA lower	1.703	5% confidence limit of the FA at standardised median logHC5
FA median	5	50% confidence limit of the FA at standardised median logHC5
FA upper	11.785	95% confidence limit of the FA at standardised median logHC5

HC50 results

Name	Value	log10(Value)	Description
LL HC50	32.26987	1.508797227	lower estimate of the HC50
HC50	135.022	2.130404433	median estimate of the HC50
UL HC50	564.9521	2.752011639	upper estimate of the HC50
sprHC50	17.50711	1.243214412	spread of the HC50 estimate

FA At HC50 results

Name	Value	Description
FA lower	38.19713	5% confidence limit of the FA at standardised median logHC50
FA median	50	50% confidence limit of the FA at standardised median logHC50
FA upper	61.80287	95% confidence limit of the FA at standardised median logHC50

Table A2.2 Acute SSD, insects

Input toxicity data

Data no	Toxicity data	Label	Species
1	1.77	Ephemeroptera	Caenis horaria
2	284	Diptera	Chaoborus obscuripes
3	2.65	Diptera	Chironomus dilutus
4	6.9	Diptera	Chironomus tentans
5	1.02	Ephemeroptera	Cloeon dipterum
6	0.65	Ephemeroptera	Epeorus longimanus
7	1.79	Trichoptera	Limnephilidae
8	18.2	Hemiptera	Notonecta spp.
9	35.9	Hemiptera	Plea minutissima
10	50.6	Megaloptera	Sialis lutaria
11	8.1	Diptera	Simulium vittatum

Parameters of the normal distribution

Name	Value	Description
mean	0.860504955	mean of the log toxicity values
s.d.	0.81562814	sample standard deviation
n	11	sample size

HC5 results

Name	Value	log10(Value)	Description
LL HC5	0.03668739	-2.317669836	lower estimate of the HC5
HC5	0.300199311	-1.199831935	median estimate of the HC5
UL HC5	1.026167711	-0.37393808	upper estimate of the HC5
sprHC5	27.97058365	1.943731756	spread of the HC5 estimate

FA At HC5 results

Name	Value	Description
FA lower	0.695	5% confidence limit of the FA at standardised median logHC5
FA median	5	50% confidence limit of the FA at standardised median logHC5
FA upper	18.964	95% confidence limit of the FA at standardised median logHC5

HC50 results

Name	Value	log10(Value)	Description
LL HC50	2.598857425	1.508797227	lower estimate of the HC50
HC50	7.252787526	2.130404433	median estimate of the HC50
UL HC50	20.24078982	2.752011639	upper estimate of the HC50
sprHC50	7.788341763	1.243214412	spread of the HC50 estimate

FA At HC50 results

Name	Value	Description
FA lower	30.99676526	5% confidence limit of the FA at standardised median logHC50
FA median	49.99999998	50% confidence limit of the FA at standardised median logHC50
FA upper	69.00323477	95% confidence limit of the FA at standardised median logHC50

Table A2.3 Acute SSD, arthropods

Input toxicity data

Data no	Toxicity data	Label	Species
1	35.9	Mysida	Americamysis bahia
2	119	Isopoda	Asellus aquaticus
3	2.07	Cladocera	Ceriodaphnia dubia
4	832	Cladocera	Chydorus sphaericus
5	1	Podocopida	Cypretta seuratti
6	10	Podocopida	Cypridopsis vidua
7	52455	Cladocera	Daphnia magna
8	110	Amphipoda	Gammarus pulex
9	55	Amphipoda	Hyallella azteca
10	3	Podocopida	Ilyocypris dentifera
11	1.94	Amphipoda	Gammarus roeseli
12	1.77	Ephemeroptera	Caenis horaria
13	284	Diptera	Chaoborus obscuripes
14	2.65	Diptera	Chironomus dilutus
15	6.9	Diptera	Chironomus tentans
16	1.02	Ephemeroptera	Cloeon dipterum
17	0.65	Ephemeroptera	Epeorus longimanus
18	1.79	Trichoptera	Limnephilidae
19	18.2	Hemiptera	Notonecta spp.
20	35.9	Hemiptera	Plea minutissima
21	50.6	Megaloptera	Sialis lutaria
22	8.1	Diptera	Simulium vittatum

Parameters of the normal distribution

Name	Value	Description
mean	1.209034	mean of the log toxicity values
s.d.	1.170572	sample standard deviation
n	22	sample size

HC5 results

Name	Value	log10(Value)	Description
LL HC5	0.028801	-2.317669836	lower estimate of the HC5
HC5	0.180219	-1.199831935	median estimate of the HC5
UL HC5	0.648917	-0.37393808	upper estimate of the HC5
sprHC5	22.53081	1.943731756	spread of the HC5 estimate

FA At HC5 results

Name	Value	Description
FA lower	1.364	5% confidence limit of the FA at standardised median logHC5
FA median	5	50% confidence limit of the FA at standardised median logHC5
FA upper	13.539	95% confidence limit of the FA at standardised median logHC5

HC50 results

Name	Value	log10(Value)	Description
LL HC50	6.019965	1.508797227	lower estimate of the HC50
HC50	16.18208	2.130404433	median estimate of the HC50
UL HC50	43.49854	2.752011639	upper estimate of the HC50
sprHC50	7.225712	1.243214412	spread of the HC50 estimate

FA At HC50 results

Name	Value	Description
FA lower	36.29128	5% confidence limit of the FA at standardised median logHC50
FA median	50	50% confidence limit of the FA at standardised median logHC50
FA upper	63.70872	95% confidence limit of the FA at standardised median logHC50

Table A2.4 Acute SSD, arthropods minus Daphnia

Input toxicity data

Data no	Toxicity data	Label	Species
1	35.9	Mysida	Americamysis bahia
2	119	Isopoda	Asellus aquaticus
3	2.07	Cladocera	Ceriodaphnia dubia
4	832	Cladocera	Chydorus sphaericus
5	1	Podocopida	Cypretta seuratti
6	10	Podocopida	Cypridopsis vidua
7	110	Amphipoda	Gammarus pulex
8	55	Amphipoda	Hyallella azteca
9	3	Podocopida	Ilyocypris dentifera
10	1.94	Amphipoda	Gammarus roeseli
11	1.77	Ephemeroptera	Caenis horaria
12	284	Diptera	Chaoborus obscuripes
13	2.65	Diptera	Chironomus dilutus
14	6.9	Diptera	Chironomus tentans
15	1.02	Ephemeroptera	Cloeon dipterum
16	0.65	Ephemeroptera	Epeorus longimanus
17	1.79	Trichoptera	Limnephilidae
18	18.2	Hemiptera	Notonecta spp.
19	35.9	Hemiptera	Plea minutissima
20	50.6	Megaloptera	Sialis lutaria
21	8.1	Diptera	Simulium vittatum

Parameters of the normal distribution

Name	Value	Description
mean	1.041856	mean of the log toxicity values
s.d.	0.890582	sample standard deviation
n	21	sample size

HC5 results

Name	Value	log10(Value)	Description
LL HC5	0.085096	-2.317669836	lower estimate of the HC5
HC5	0.358708	-1.199831935	median estimate of the HC5
UL HC5	0.970928	-0.37393808	upper estimate of the HC5
sprHC5	11.40976	1.943731756	spread of the HC5 estimate

FA At HC5 results

Name	Value	Description
FA lower	1.321	5% confidence limit of the FA at standardised median logHC5
FA median	5	50% confidence limit of the FA at standardised median logHC5
FA upper	13.759	95% confidence limit of the FA at standardised median logHC5

HC50 results

Name	Value	log10(Value)	Description
LL HC50	5.089468	1.508797227	lower estimate of the HC50
HC50	11.01173	2.130404433	median estimate of the HC50
UL HC50	23.82533	2.752011639	upper estimate of the HC50
sprHC50	4.6813	1.243214412	spread of the HC50 estimate

FA At HC50 results

Name	Value	Description
FA lower	35.98214	5% confidence limit of the FA at standardised median logHC50
FA median	50	50% confidence limit of the FA at standardised median logHC50
FA upper	64.01786	95% confidence limit of the FA at standardised median logHC50

Table A2.5 Chronic SSD, arthropods

Input toxicity data

Data no	Toxicity data	Label	Species
1	1.35	Isopoda	Asellus aquaticus
2	1768	Cladocera	Daphnia magna
3	2.95	Amphipoda	Gammarus pulex
4	0.47	Amphipoda	Hyallella azteca
5	0.024	Ephemeroptera	Caenis horaria
6	1.99	Diptera	Chaoborus obscuripes
7	0.42	Diptera	Chironomus tentans
8	0.033	Ephemeroptera	Cloeon dipterum
9	2.03	Hemiptera	Plea minutissima
10	14.5	Plecoptera	Pteronarcys dorsata
11	1.28	Megaloptera	Sialis lutaria
12	34	Diptera	Tipula sp.

Parameters of the normal distribution

Name	Value	Description
mean	0.287343	mean of the log toxicity values
s.d.	1.305604	sample standard deviation
n	12	sample size

HC5 results

Name	Value	log10(Value)	Description
LL HC5	0.000519	-2.317669836	lower estimate of the HC5
HC5	0.012012	-1.199831935	median estimate of the HC5
UL HC5	0.079466	-0.37393808	upper estimate of the HC5
sprHC5	153.2559	1.943731756	spread of the HC5 estimate

FA At HC5 results

Name	Value	Description
FA lower	0.774	5% confidence limit of the FA at standardised median logHC5
FA median	5	50% confidence limit of the FA at standardised median logHC5
FA upper	18.064	95% confidence limit of the FA at standardised median logHC5

HC50 results

Name	Value	log10(Value)	Description
LL HC50	0.407833	1.508797227	lower estimate of the HC50
HC50	1.937952	2.130404433	median estimate of the HC50
UL HC50	9.208812	2.752011639	upper estimate of the HC50
sprHC50	22.57985	1.243214412	spread of the HC50 estimate

FA At HC50 results

Name	Value	Description
FA lower	31.74547	5% confidence limit of the FA at standardised median logHC50
FA median	50	50% confidence limit of the FA at standardised median logHC50
FA upper	68.25453	95% confidence limit of the FA at standardised median logHC50

Table A2.6 Chronic SSD, arthropods minus Daphnia

Input toxicity data

Data no	Toxicity data	Label	Species
1	1.35	Isopoda	Asellus aquaticus
2	2.95	Amphipoda	Gammarus pulex
3	0.47	Amphipoda	Hyallella azteca
4	0.024	Ephemeroptera	Caenis horaria
5	1.99	Diptera	Chaoborus obscuripes
6	0.42	Diptera	Chironomus tentans
7	0.033	Ephemeroptera	Cloeon dipterum
8	2.03	Hemiptera	Plea minutissima
9	14.5	Plecoptera	Pteronarcys dorsata
10	1.28	Megaloptera	Sialis lutaria
11	34	Diptera	Tipula sp.

Parameters of the normal distribution

Name	Value	Description
mean	0.018239	mean of the log toxicity values
s.d.	0.958728	sample standard deviation
n	11	sample size

HC5 results

Name	Value	log10(Value)	Description
LL HC5	0.002087	-2.317669836	lower estimate of the HC5
HC5	0.024688	-1.199831935	median estimate of the HC5
UL HC5	0.1047	-0.37393808	upper estimate of the HC5
sprHC5	50.17904	1.943731756	spread of the HC5 estimate

FA At HC5 results

Name	Value	Description
FA lower	0.695	5% confidence limit of the FA at standardised median logHC5
FA median	5	50% confidence limit of the FA at standardised median logHC5
FA upper	18.964	95% confidence limit of the FA at standardised median logHC5

HC50 results

Name	Value	log10(Value)	Description
LL HC50	0.312116	1.508797227	lower estimate of the HC50
HC50	1.042892	2.130404433	median estimate of the HC50
UL HC50	3.484681	2.752011639	upper estimate of the HC50
sprHC50	11.1647	1.243214412	spread of the HC50 estimate

FA At HC50 results

Name	Value	Description
FA lower	30.99677	5% confidence limit of the FA at standardised median logHC50
FA median	50	50% confidence limit of the FA at standardised median logHC50
FA upper	69.00323	95% confidence limit of the FA at standardised median logHC50

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